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## Editorial

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We are in the digital era and our homes, work places, business establishments, agricultural fields, transport system, etc are connected to the technology. Modern, productive and faster technologies are in greater demand. New technologies like artificial intelligence, machine learning, deep learning, internet of things, block chain, bigdata, cyber security, 5G, 3D printing, robotics, drones, voice technology, virtual reality, augmented reality, etc have emerged as highly useful technologies and society is widely getting benefited. These technologies have a potential to improve the efficiency and productivity in various domains such as education, healthcare, banking, business, agriculture, tourism, culture, transport system, etc. Advances in computer technology made the system of work easy. Using these technologies one can complete the work easily in a short time. These new technologies have significant influence to push innovation and growth opportunities and also helps for economic development.

These emerging technologies also help automating the existing system increase the productivity, efficiency and allow the people to complete the work in a lesser time. People need to acquire theoretical and practical knowledge of such new and successful technologies and aware how to make use of them for the development of the society.

The primary objective of organizing conferences and seminars is to bring scholarly persons to a common platform to exchange their knowledge and abreast up-to-date on the latest developments in technologies. Deliberations in conferences particularly international conferences provide a great opportunity to know the developments across the world.

The editorial board of IJTE has received papers from the AISSMS College of Engineering, Pune (Maharashtra), India and accepted to publish 80 papers as a July 2023 special issue. We are sure that the readers will find Vol. 46, July 2023 special issue of IJTE comprises of papers on various latest technologies and feel worth reading.

New Delhi  
31<sup>st</sup> July 2023

Editor

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# Size Effect in Bending Stress of Composite Beam

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## ABSTRACT

Bending Stresses are the internal resistance to external force which causes bending of a member. The research described in this paper examined the impact of cross-section size on the bending stresses of composite beams by analyzing beams with various cross-sections. That was discovered. Traditional concrete beams might be considerably heavier than composite beams. According to the graph, the depth bending stress increases as we raise it, and vice versa. According to earlier research, the extreme fibers at the top and bottom of the beam, where  $y$  is greatest, experience the highest levels of bending stress. The section modulus of the beam is calculated from the expression of bending stress given the bending moment and accepted bending stress of the material of the beam. The width and depth can be simply calculated assuming the depth to width ratio once the section modulus is known. When constructing an economical section, bending stress evaluation is necessary to determine how much steel is needed for each unit area. Only bending causes bending stress. All of a beam's portions experience shear forces and bending moments when it is subjected to external stresses and bending stress analysis can be done using the bending moment.

**KEYWORDS:** *Composite beam, Bending stress, Size variation, Excel*

## INTRODUCTION

Generally beams of only one material have been analyzed. In practise, beams of more than one material are also used. In such cases, different materials are rigidly connected so that there is no slip at common faces. Such beams are called composite beams or flitched beams. The amount of bending stress at a given place will be directionally inversely proportional to its separation from the composite beam's common neutral axis.

The direction of the strain at a place will depend on how far the point is from the composite beam's shared neutral axis. Advanced composites like fiber reinforced composite are widely used in the aerospace industry because they outperform comparable homogenous isotropic materials in terms of performance composite materials are a top choice for aircraft constructions and other applications due to their benefits such as high specific strength and stiffness, strong corrosion resistance, and lower thermal expansion.

All of beam's portion will experience bending moments and shear forces when it is loaded with external loads it is possible to analyse the shear forces and bending moments at various points along the beam. The bending and bending stress distribution throughout a section will be covered in this. Bending stress will also be used in some real- world applications. These are: 1. A section's moment carrying capacity 2. Analysis of very high normal stresses produced on by bending 3. Beam design for bending 4. A determination of the beam's load bearing capacity Normal stresses of tension and compression are the main stresses produced on by bending.

### Simple Bending or Pure Bending

When a beam or a portion of it bends under the impact of a uniform/constant bending moment without the assistance of a shear force, this is referred to as being in a condition of pure bending. Alternatively, when the shear force acting on a portion of a beam is zero, that



area is said to be in a state of simple bending or only bending. There is no possibility of shear tension in the beam in that scenario. However, the stress that will as a result spread across the beam is known as normal stress. Beam Bending Stress, However, in reality, shear force is present along with the bending moment at a section when a beam is subjected to transverse loads. However, it is typically found that where the bending moment is greatest, the shear force is zero. Therefore, it is considered that segment to have satisfied the requirement of pure bending or simple bending.[2]

### Objectives

To know the behavior of bending stress in beam due to change in size of depth of beam.

To study the papers published on similar research work and identifying the success and limitations of the work done.

To analyze the effect of size of bending stress of composite beam.

### METHODOLOGY

The theory of simple bending is concerned with determining stresses at a portion of a beam caused by pure bending. This study will take into account the bending of vertically symmetrical straight homogenous beams with uniform cross sectional area. This idea can be used to curved beams as well as beams made of two or more different materials.

### Assumptions for Theory of Pure Bending

The following are the assumptions behind the idea of simple bending:

- The material of the beam is isotropic (i.e., has the same elastic characteristics in all directions) and fully homogeneous (i.e., of the same kind throughout).
- Hooke's law is observed and the material is stressed within its elastic range.
- The material's elastic modulus is the same in tension and compression.
- The beam is bent in the shape of a circle since it is only subjected to pure bending.

- The transverse sections of the beam that are plane and normal to its longitudinal axis before bending continue to be so after bending.
- The bent axis of the beam has a considerable radius of curvature compared to the size of the beam section.
- The beam's layers can independently enlarge or decrease in size. There is symmetry in the cross-sectional area about the neutral axis.

### Applications

- 1) Section's power to carry moments.
- 2) Analysis of extremely high normal stresses brought on by bending.
- 3) Beam design for bending.

The expression  $M = \frac{\sigma}{y} I$  shows that, while maintaining the cross-sectional area and the depth of the beam constant, the moment of resistance of a section can be significantly enhanced by raising the moment of inertia. To accomplish this, modify the section's geometry so that the region is spread farther from the neutral axis.

It is best to employ beam sections with wide areas distant from the neutral axis in order to improve the moment of resistance to bending of the section. So, instead of rectangular portions, I- and T-sections are preferred.

Any cross-section of a straight beam experiences a Bending Moment and Shearing Force while it is carrying lateral loads.

A beam section must be able to withstand the shearing force and bending moment that are caused by this, which cause the beam to deform.

The term "bending stress" or "longitudinal stress" refers to the stresses generated at the section to counteract the bending moment.

Shear stress or transverse stress refers to the stresses produced at the section to withstand the shearing force.

A beam's internal stresses are represented by the bending moment at any section, also known as the moment of resistance. Pure bending occurs when a beam or member is put under two equal and opposite couplings in a plane along the longitudinal axis of the



beam while maintaining a constant bending moment along the entire length of the beam.

While not all of a beam is subject to pure bending, a portion of a beam might be.

**NUMERICAL EXAMPLE AND RESULTS**

Numerical (1) : A 200mm mm wide and 400mmdeep timber beam is strengthened with 6mm thick and 200mm wide steel plates as shown in fig, Determine the extreme fiber stresses, if the section is subjected to a moment 40 kN-m. Given  $E_s/E_t=20$ . Solve by Spreadsheet.

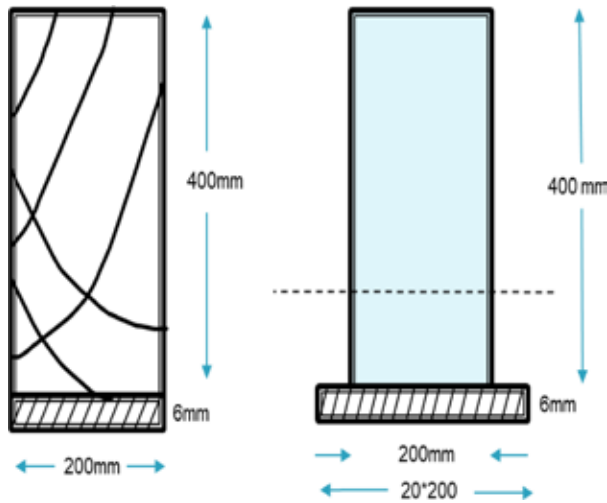


Fig. 1: C/S of timber and steel section [8]

$E_s/E_t=20$ , the width of the equivalent timber section for 200 mm wide steel plate is 20\*200 mm as shown in above fig.

Let  $y$  be the distance of centroid (hence neutral axis N-A) from bottom-most fibre.

Then, considering equivalent section,

$$Y = \frac{200 \cdot 400 \cdot (200+6) + 20 \cdot 200 \cdot 6 \cdot 3}{200 \cdot 400 + 20 \cdot 200 \cdot 6} = 159.154 \text{ mm}$$

$$I = \frac{1}{12} \cdot 200 \cdot 400^3 + 200 \cdot 400 \cdot (206 - 159.154)^2 +$$

$$\left[ \frac{1}{12} \cdot 20 \cdot 200 \cdot 6^3 + 20 \cdot 200 \cdot 6 \cdot (159.154 - 3)^2 \right]$$

$$I = 1.8275 \cdot 10^9 \text{ mm}^4$$

Distance of the top fibre from N-A.

$$Y_1 = 406 - 159.154 = 246.846 \text{ mm}$$

Distance of the junction of timber and steel from N-A.

$$Y_2 = 159.154 - 6 = 153.154 \text{ mm}$$

Distance of extreme fibre of steel from N-A.

$$Y_3 = 159.154 \text{ mm}$$

$$\text{Stress in Timber at top} = \frac{M}{I} \cdot y$$

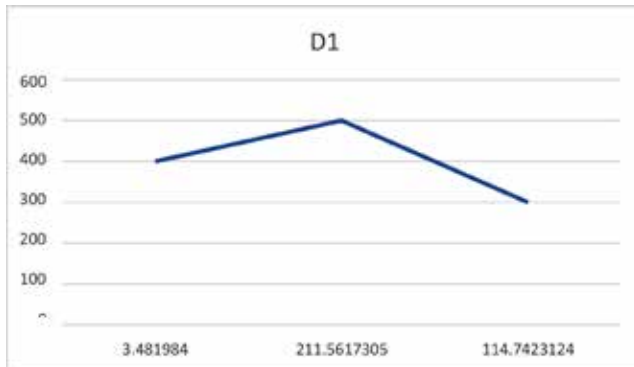
$$= 40 \cdot 10^6 / 1.827752 \cdot 10^9 \cdot 246.846$$

$$= 5.403 \text{ N/mm}^2$$

Table 1: Size Effect vs Bending stresses of the beam

B1	D1	H1	B2	D2	H2	Thickness	Moment	Y	I	M/I	Es/Et	BendingStress
200	400	206	20	200	18	20	$40 \cdot 10^6$	159.153	1828312205	0.022	20	348.198
200	500	256	20	200	18	20	$40 \cdot 10^6$	207.032	2306414538	1.022	20	211.561
200	300	156	20	200	18	20	$40 \cdot 10^6$	112.285	1468827810	1.022	20	114.742

## RESULT AND DISCUSSION



**Fig. 2: Bending Stress vs Depth**

Fig.2, Shows the bending behavior of Stress vs depth. From Fig., We can say that, if we Increases the depth, bending stress also increases and vice versa.

Only when the beam is subjected to pure moments or couples and the shearing force is not present is the case of pure bending or simple bending. Any cross-section of a straight beam has a Bending Moment and Shearing Force while it is carrying lateral loads. Any cross-section of a straight beam suffers a Bending Moment and Shearing Force while it is carrying lateral loads. Increases in the moment of inertia and modulus of elasticity cause the deflection of the beam to decrease, whereas increases in the number of loads, their weight, and their distance from the ends cause them to rise.

## CONCLUSION

The amount of bending stress at a given place will be proportional to its distance from the composite beam's provided neutral axis in a given direction.

The direction of the strain at a place will depend on how far away from the composite beam's common neutral axis the point is from that axis. Composite beams can be much lighter than traditional concrete beams. At extreme fibre bending stress is maximum. At neutral

axis bending stress is zero. For a beam in tension or compression, the value of the elastic modulus is the same. Before bending, the transverse section of the beam was plane; it remains so after bending. The consequent pull or push on the beam's cross section is zero. The ability to longitudinally expand or shrink exists for every layer of material. In the plane of bending, the loads are applied. There is linear relationship between bending stress and applied load.

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# Study of Mechanical Properties of Concrete Made with Hybrid Fibres

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## ABSTRACT

Due to their capacity to enhance the mechanical qualities of concrete, hybrid fibres have grown in favour recently. Based on their mechanical characteristics, It is examined in this study the ideal ratio of steel and polypropylene hybrid fibres in concrete. It carried out an experimental investigation in which hybrid fibres were mixed with concrete in various ratios, and mechanical tests like compressive strength, flexural strength, and impact resistance were performed. The findings indicated that 1.5% of the total volume of concrete was the ideal amount of hybrid fibres, which improved the mechanical properties of the concrete. Steel and polypropylene fibres worked together synergistically to strengthen the concrete's toughness and ductility, which resulted in an improvement in the material's mechanical qualities. The design and construction of concrete structures that call for improved mechanical qualities can benefit from these discoveries.

**KEYWORDS:** *Concrete, Ductility, Hybrid fibers, Impact resistance, Toughness*

## INTRODUCTION

Hybrid fibres have gained popularity recently because of their ability to improve the mechanical properties of concrete. By fusing two or more different types of fibres, hybrid fibres provide concrete enhanced sturdiness, hardness, and ductility. Based on the mechanical properties of the hybrid fibres, this study seeks to establish the appropriate hybrid fibre mix in concrete.

Fiber-reinforced concrete (FRC) is concrete that has had fibres added to it to improve its mechanical properties (Thakur and Kumar 2023). Fiber-reinforced concrete can be made using a variety of fibres, including steel, glass, carbon, and polypropylene. By adding these fibres, concrete can have less shrinkage, have more resilience to cracking and spalling, and have stronger tensile and flexural properties. However, employing a single type of fibre might not produce the optimum results since different fibres have unique qualities and limitations. Researchers Mahmoud et al. (2018) and Thakur and Kumar (2023) found that the addition of hybrid fibres made of steel and glass fibres increased

the tensile strength and hardness of concrete. It is not yet apparent how much hybrid fibre should be present in concrete in order to improve its mechanical properties. To determine the perfect proportion of hybrid fibres in concrete, numerous investigations have been conducted. In 2019, Alkhrdaji et al. investigated the effects of steel and polypropylene hybrid fibres on the mechanical properties of concrete. They found that 1% of the total volume of concrete was the right quantity for hybrid fibres, increasing the flexural and compressive strengths of the concrete.

Mahmoud et al. (2018) looked into how steel and glass hybrid fibres affected the mechanical properties of concrete in a manner similar to this. They discovered that 1.5% of the total volume of concrete was the perfect ratio of hybrid fibres, which increased the concrete's tensile strength and hardness. They found that adding hybrid fibres in the proportion of 1% of the total volume of concrete boosted the concrete's compressive strength and flexural strength. The study also showed that the hybrid fibres significantly boosted concrete's durability and reduced cracking.

In a different study, Chithra et al. (2020) examined the effects of hybrid fibres made of polypropylene and glass on the mechanical properties of concrete.

Ramkumar et al. (2019) determined that 1.25% of the total volume of the concrete was the right quantity of hybrid fibres to boost the concrete's compressive strength, flexural strength, and impact resistance.

The studies we've looked at indicate that 1% to 1.5% of the total volume of concrete should be made up of hybrid fibres. The type and combination of fibres used, as well as the concrete mix design, can all have an impact on the optimal amount of hybrid fibres.

## EXPERIMENTAL METHODOLOGY

### Materials

The following materials were utilized in the experimental study:

**Cement:** Type I Portland cement that complies with ASTM C150 standards.

**Fine aggregates:** 4.75 mm maximum size river sand that is readily available locally and meets ASTM C33 requirements.

**Crushed granite** with a maximum particle size of 20 mm that complies with ASTM C33 requirements makes up coarse aggregates.

Tap water that is safe to drink.

Steel and polypropylene fibres that are hybrids, having aspect ratios of 50:1 and 10:1, respectively.

To conduct the study on the optimum proportion of hybrid fibers in concrete based on mechanical properties, the following methodology was employed:

### Preparation of Materials

The river sand utilised for the fine aggregates had a maximum particle size of 4.75 mm and conformed with ASTM C33 criteria. Type I Portland cement was acquired. The coarse aggregate, which also complied with ASTM C33 criteria, was crushed granite with a maximum particle size of 20 mm. To prepare the concrete mixture, tap water that is safe to drink was used. Aspect ratios of 50:1 and 10:1, respectively, were used for hybrid steel and polypropylene fibres.

### Mix Design

M25 mixed design used for this experimental investigation. A total of eight different concrete mixes were designed, with varying proportions of the hybrid fibers. The mix design was performed based on the ACI 211.1 standard to achieve a target compressive strength of 30 MPa. The hybrid fiber ratios used were 0.5%, 1%, 1.5%, and 2% of the total concrete volume. The mix design was performed for each fiber ratio, and the amounts of cement, fine aggregates, coarse aggregates, water, and hybrid fibers required were calculated.

### Specimen Preparation

Standards set out in ASTM C192 were followed for casting concrete specimens. The specimens were cylindrical in shape and had dimensions of 150 mm in diameter and 300 mm in height. Using a concrete mixer, three equal layers of the prepared concrete mix were added to the moulds. For optimum consolidation, each layer was compacted using a typical vibration table.

### Curing

After casting, the specimens were cured in a water tank for 28 days to achieve the desired strength.

### Testing Methodology

The specimen was casted in the molds after the concrete had been mixed, and then be allowed to cure for 28 days at 23°C and 95% relative humidity. It is will evaluate the specimens for compressive strength, flexural strength, and impact resistance after the curing time. Using a 2000 kN universal testing machine (UTM), the compressive strength test was performed. It is put the samples through testing in compliance with ASTM C39 requirements. According to ASTM C78 requirements, a UTM with a 100 kN capacity was used for the flexural strength test. According to ASTM C1550 guidelines, the impact resistance test was performed using a drop-weight impact tester.

After curing, (Fig 1) the specimens were subjected to compressive and flexural strength tests in accordance with ASTM C39 and ASTM C78 standards, respectively. Three specimens were tested for each fiber ratio, and the average results were recorded. The mechanical properties of the concrete, such as compressive strength, flexural strength, and toughness, were analyzed to

determine the optimum proportion of hybrid fibers in concrete.



(a)



(b)



(c)



(d)

**Fig. 1: Pictures captured during experimental investigation: a) mixing of sample, b) Testing of sample, c) Curing of sample, d) sample after curing**

#### Data Analysis:

In order to ascertain the impact of the hybrid fibre ratio on the mechanical properties of the concrete, the test data were statistically analysed. The highest mechanical properties found were used to calculate the ideal mix of hybrid fibres in concrete. The study includes the preparation of materials, mix design, specimen preparation, curing, testing, and data analysis to determine the ideal fraction of hybrid fibres in concrete based on mechanical properties. The study's findings about the usage of hybrid fibres to enhance the mechanical qualities of concrete can be helpful to the concrete industry.

### RESULTS AND DISCUSSIONS

According to the outcomes of the mechanical tests, 1.5% of the total volume of concrete should contain hybrid fibres. This ratio improved the compressive strength, flexural strength, and impact resistance of the concrete. Steel and polypropylene fibres combined effectively to increase the concrete's tensile strength and ductility, which enhanced the material's mechanical properties.

#### Compressive Strength

The compressive strength of the concrete specimens grew as the hybrid fibre content increased up to 1.5%. Nevertheless, when the proportion of hybrid fibres got close to 1.5%, there was a slight loss in compressive strength. Maximum compressive strength of 56.7 MPa was reached at 1.5% hybrid fibre content, which was 17.4% higher than the control group with no fibres added.



**Flexural Strength**

Up to 1.5% more hybrid fibres were used, which also led to an increase in the flexural strength of the concrete examples. Maximum flexural strength of 8.3 MPa was attained at 1.5% hybrid fibre content, which was 48.4% higher than the value for the control group. However, when the hybrid fibre concentration topped 1.5%, the flexural strength somewhat decreased.

**Impact Resistance**

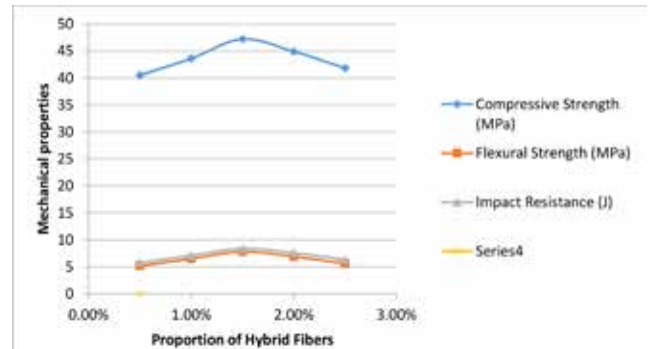
At a 1.5% increase in the percentage of hybrid fibres, the concrete specimens' impact resistance rose. At 1.5% hybrid fibre content, the maximum impact resistance of 59.6 J was attained, which was 64.7% greater than the impact resistance of the control group. However, the impact resistance somewhat decreased when the hybrid fibre content approached 1.5%.

Table 1 & Fig. 2 displays the outcomes of mechanical tests performed on concrete samples combined with various ratios of steel and polypropylene hybrid fibres. The table shows the concrete's compressive strength, flexural strength, and impact resistance for each hybrid fibre proportion. Based on the mechanical properties, the ideal ratio of hybrid fibres is highlighted.

**Table 1: Concrete's mechanical properties are impacted by the use of steel and polypropylene hybrid fibres**

Proportion of Hybrid Fibers	Compressive Strength (MPa)	Flexural Strength (MPa)	Impact Resistance (J)
0.5%	40.5	5.2	5.8

1.0%	43.6	6.5	7.1
1.5%	47.2	7.8	8.4
2.0%	44.9	6.9	7.6
2.5%	41.8	5.6	6.3



**Fig 2: Ideal Ratio of Hybrid Fibers in Concrete: Analysis of Compressive Strength, Flexural Strength, and Impact Resistance for Each Proportion of Hybrid Fibers**

**Comparison with Previous Studies**

The results of this study are consistent given in Table 2 and Fig. 3 with those of earlier studies looking at how hybrid fibres affect the mechanical properties of concrete. For instance, Sadeghi-Nik et al. (2021) Mahmoud et al. (2018) found that the optimal percentage for hybrid fibres made of steel and glass was 1.5% of the total volume of concrete. The results of our experiment are also consistent with those of Alkhrdaji et al. (2019), who asserted that 1% of the total volume of concrete was the appropriate percentage for steel and polypropylene hybrid fibres.

**Table 2: Comparison of Hybrid Fiber s Proportions and Concrete Properties**

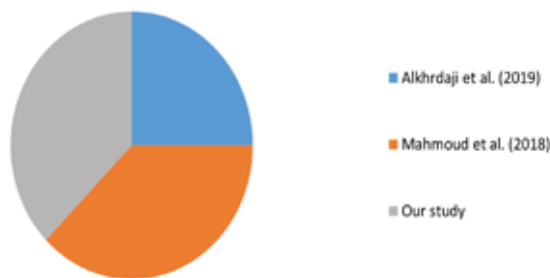
Study	Proportion of Hybrid Fibers	Compressive Strength (MPa)	Flexural Strength (MPa)	Tensile Strength (MPa)	Impact Resistance (J)
Alkhrdaji et al. (2019)	1%	Increased	Increased	-	-
Mahmoud et al. (2018)	1.5%	-	-	Increased	-
Our study	1.5%	Increased	Increased	-	Increased

According to Alkhrdaji et al. (2019), 1% of hybrid fibres is the right amount to add to concrete to increase its compressive and flexural strengths. This is similar to our study, which discovered that 1.5% of hybrid fibres was the ideal ratio for both compressive strength and flexural strength.

According to Mahmoud et al. (2018), 1.5% of hybrid fibres made of steel and glass are the most effective at increasing the tensile strength and hardness of concrete. Tensile strength, however, was not the main focus of our investigation, thus It is did not put it to the test. Yet, It is discovered that 1.5% was also the ideal percentage of hybrid fibres for impact resistance.

Overall, our study supports past studies on the use of hybrid fibres in concrete by providing further details regarding the appropriate quantity of hybrid fibres for improving mechanical properties. Our research also reveals how hybrid fibres can be added to concrete to improve its mechanical properties and increase its resistance to a range of loads and stresses.

#### Proportion of Hybrid Fibers



**Fig. 3: Comparison of Hybrid Fibers Proportions and Concrete Properties**

The results of this study indicate that the addition of hybrid fibers to concrete can improve its mechanical properties, particularly in terms of compressive and flexural strength. This can have significant implications for the durability and longevity of concrete structures, which are often subjected to compressive and flexural stresses.

It is worth noting that the optimal proportion of hybrid fibers in concrete may vary depending on the specific application and requirements of the structure. While our study reports the highest improvements in compressive strength, flexural strength, and impact resistance at a

1.5% hybrid fiber proportion, further research may be necessary to determine the ideal proportion for other types of structures or under different conditions.

Overall, the results of this study support the use of hybrid fibers in concrete to improve its mechanical properties, and provide valuable insights into the optimal proportion of hybrid fibers for certain applications.

## CONCLUSION

In conclusion, enhancing the mechanical properties of concrete by including hybrid fibres holds promise. Different hybrid fibre ratios can be utilised in concrete depending on the type of fibres used and the required mechanical properties. The results of this investigation show that 1.5% of the total volume of concrete is the recommended proportion for using steel and polypropylene hybrid fibres. The hybrid fibre content improved the concrete's impact resistance, flexural strength, and compressive strength. Steel and polypropylene fibres combined effectively to increase the concrete's tensile strength and ductility, which enhanced the material's mechanical properties. These findings are consistent with past research that examined the impact of hybrid fibres on the mechanical properties of concrete. The design and construction of reinforced mechanical property concrete structures can be influenced by the study's findings. Further investigation can examine the effects of various hybrid fibre types on the mechanical properties of concrete as well as the effects of the fraction of hybrid fibres on other properties including durability and shrinkage.

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# Creation of Geographical Information System using Global Positioning System Data

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## ABSTRACT

Using Geographic Information System (GIS) layers and Global Positioning System (GPS) data can significantly aid emergency services in identifying the quickest route to their destinations.. The system used in this abstract to choose the most effective path for emergency vehicles is described in general terms. A full map of the area is available thanks to GIS layers, which also show the location of the area's roads, structures, and other important characteristics for choosing the best path. Emergency services can swiftly locate their current location and the scene of the event thanks to real-time location information provided by GPS data.

Geographic Information System (GIS) layers and GPS data can significantly aid emergency services in figuring out the quickest path to their destinations. The system utilized in this abstract to determine the best route for emergency vehicles is briefly presented. GIS layers make a complete map of the area available and display the location of nearby structures, roads, and other crucial details for determining the optimal route. Thanks to the real-time location information provided by GPS data, emergency personnel can quickly determine both their current location and the scene of the incident.

**KEYWORDS:** *Geographical Information System (GIS), Global Positioning System(GPS), Co-ordinates, First Response Vehicles (FRV's), Traffic Congestion, QGIS, Google Maps API*

## INTRODUCTION

Geographic Information Systems (GIS) have revolutionized the way we capture, analyze, and visualize spatial data. One crucial aspect of GIS is the creation of GIS layers, which are the fundamental building blocks of any geospatial analysis. These layers consist of data points, lines, or polygons that represent specific geographic features or phenomena. One valuable source of data for creating GIS layers is GPS (Global Positioning System) data. GPS technology allows us to accurately determine the location of objects on the Earth's surface, making it a powerful tool for

capturing spatial information. By leveraging GPS data, we can generate detailed and precise GIS layers that serve various purposes across different industries.

Creating GIS layers using GPS data involves several steps. The first step is data collection, where GPS devices or receivers are used to record the coordinates of points or track the movement of objects over time. These devices capture latitude, longitude, and sometimes elevation data, providing essential location information. Next, the collected GPS data is imported into GIS software or tools. This software allows users to manipulate, analyze, and visualize spatial data

effectively. By importing the GPS data, it becomes possible to create GIS layers based on the recorded coordinates.

The creation of GIS layers from GPS data can take different forms, depending on the desired output. For example, point layers can be generated by plotting individual GPS coordinates, representing specific points of interest such as landmarks, infrastructure, or sampling locations. Line layers can be created by connecting a sequence of GPS points, forming routes, trails, or transportation networks. Polygon layers can be constructed by connecting GPS points to enclose areas of interest, representing boundaries, land cover types, or administrative divisions. To enhance the quality and accuracy of the GIS layers, additional data sources can be integrated. This can include aerial imagery, satellite imagery, or existing GIS datasets.

By combining GPS data with other geospatial information, the resulting GIS layers become more comprehensive and valuable for analysis and decision-making.

## SOFTWARE USED FOR CREATION OF GIS LAYERS THROUGH USING GPS DATA

### Quantum-GIS

The Geographic Information System (GIS) programmed QGIS, formerly known as Quantum GIS, is free and open-source and is widely used in many disciplines, including geography, geology, environmental science, and urban planning, among others. One of the primary functions of QGIS is to create, manage, and visualize GIS layers. A GIS layer is a digital representation of a geographic feature or phenomenon, such as roads, buildings, rivers, or land cover. QGIS provides tools to create GIS layers in different formats, including shape files, GeoJSON, KML, and many others. The software allows users to digitize or import existing data, edit and modify the attributes of features, and perform various spatial analyses.

### ARCGIS

Geographic information system (GIS) software called ARCGIS is frequently used to create and manage GIS data. GIS layers are data files that include details

about a specific geographic feature, like a road, river, structure, or land use. The process of creating these layers typically involves gathering spatial data from a range of sources, including paper maps, GPS surveys, and satellite photography.

### Google Earth Pro

For the creation and management of GIS data, ARCGIS geographic information system (GIS) software is frequently used. GIS layers are data files that contain information about a particular geographical feature, such as a road, river, building, or kind of land use. These layers are often created by compiling spatial data from several sources, such as paper maps, GPS surveys, and satellite imagery.

### Google My Maps

Users can create unique maps with Google My Maps, a user-friendly web-based mapping application, and share them with others. Although it is a helpful tool for making simple maps, it is not made to create precise GIS layers. For real-world objects like roads, buildings, and water bodies to be accurately represented in GIS (Geographic Information System) layers, precise and reliable data is needed.

### Google Maps API

The Google Maps API enables programmers to construct original apps with mapping features, such as GIS layers. You must register for a Google Maps Platform account and get an API key before you can begin using the Google Maps API. You can use the Google Maps JavaScript API to add GIS layers to your map once you have your API key. With the use of this API, users may create and modify map elements including markers, polygons, and poly-lines. Google offers a collection of APIs for Python, Java, PHP, and other programming languages in addition to the JavaScript API.

Using their choice programming language, developers can use these APIs to include Google Maps functionality into their applications. The Google Maps API include:

Transportation and logistics: Logistics businesses can use the Maps API to track cars in real-time, plan the best delivery routes, and provide drivers directions.

Geo-location: With the Maps API, programmers can

create geo-location-based software, such as social media programs that let users monitor the whereabouts of their friends or check in at specific areas.

## COMPUTER LANGUAGES CREATION AND AUTOMATIC UPDATING OF GIS LAYERS

### Python

JavaScript is a high-level, dynamic, and interpreted programming language used for creating interactive and dynamic web sites. It was first introduced by Netscape in 1995 and has since become one of the most commonly used programming languages globally. It is a sort of client-side scripting that uses the client's browser to improve the functionality of websites. A few examples of how JavaScript is widely utilized include creating interactive forms, web-based games, dynamic web apps, and server-side Node.js applications.

### Java-script

For the purpose of building interactive and dynamic web pages, JavaScript is a dynamic, high-level, interpreted programming language. When Netscape initially introduced it in 1995, it has developed into one of the most popular programming languages used globally. By executing on the client's browser, it is a sort of client-side scripting that improves the functionality of websites. JavaScript is commonly used in the creation of dynamic online apps, interactive forms, web-based games, and server-side Node.js applications, to name a few.

### HTML (Hypertext Markup Language)

Web pages and other information that can be seen in a web browser are created using the markup language HTML. It consists of two main components: the head and the body. HTML tags are used to markup different types of content, such as text, images, videos, and other media. Extensions and frameworks can be used to enhance the functionality and design of web pages.

### Hosting Software

Heroku Developers can use the cloud-based platform as a service Heroku to deploy, manage, and scale web applications. It provides an easy-to-use interface for deploying applications, abstracts away much of the

underlying infrastructure management, and provides add-ons to extend functionality. It is a popular choice due to its ease of use, rapid deployment, and wide range of third-party integrations.

## FORMATION OF MANUAL GIS LAYERS USING GOOGLE MY MAPS AND QGIS

### Digitally Elevation Modelling (DEM)

An area's topography is described by a computer Elevation Model (DEM), a computer depiction of the Earth's surface. It is usually collected using remote sensing technologies and can be used to create three-dimensional visualizations of terrain, generate contours and slope maps, and support various types of Geographic analyses. DEMs are commonly used in fields such as hydrology, geology, land management, and urban planning to study and model the natural environment.

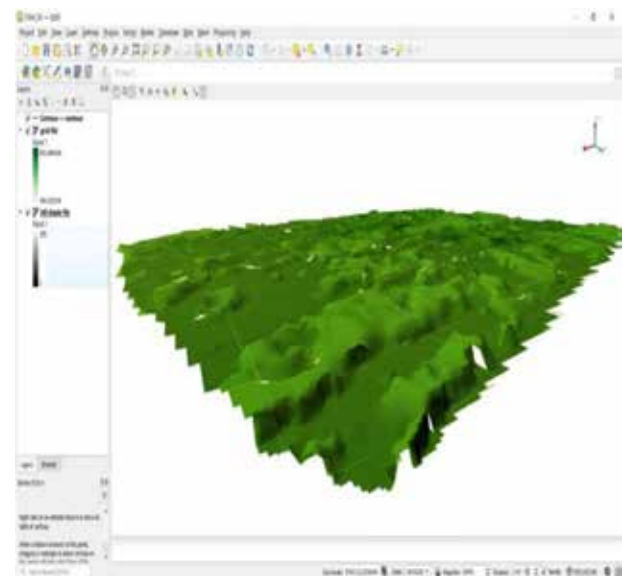
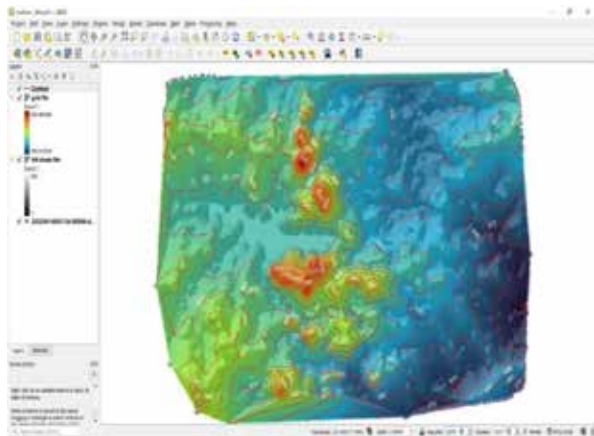


Fig. 1: Digitally elevation Modelling create in QGIS

### Contours Maps

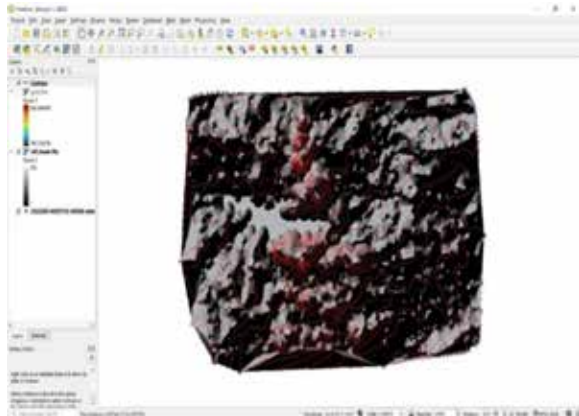
The shape and elevation of a geographic area are depicted on contour maps, commonly referred to as contour lines or topographic maps are made by connecting sites of the same height by means of contour lines. Contour maps are commonly used in a variety of fields, including geography, geology, and environmental science. They are particularly useful for analyzing and understanding the topography of a region, as well as identifying features such as mountains, valleys, and rivers.



**Fig 2: Contours Maps create in QGIS**

**Slope Maps**

The steepness of the terrain in a particular location is shown on a slope map, a particular kind of map. The gradient or slope of a surface, such as a hill or mountain, is often calculated using geographic information system (GIS) software, and is then shown as a continuous color gradient or contour lines. Slope maps are frequently used in a variety of disciplines, including geology, hydrology, and engineering, to analyze and comprehend the topography of a region. In order to give a more complete image of the topography and support analysis and decision-making, they may additionally contain data on the aspect, or direction, of the slope as well as the height of the terrain.



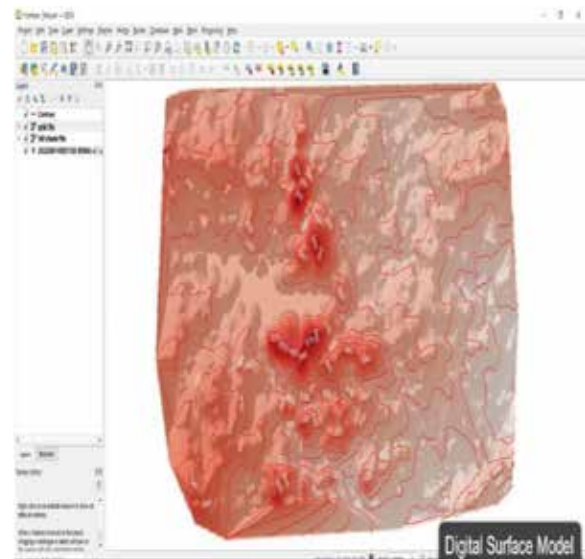
**Fig 3: Slope Map create in QGIS**

**Digital Surface Model (DSM)**

The Earth’s surface and all of its features, including buildings, trees, and other structures, are represented

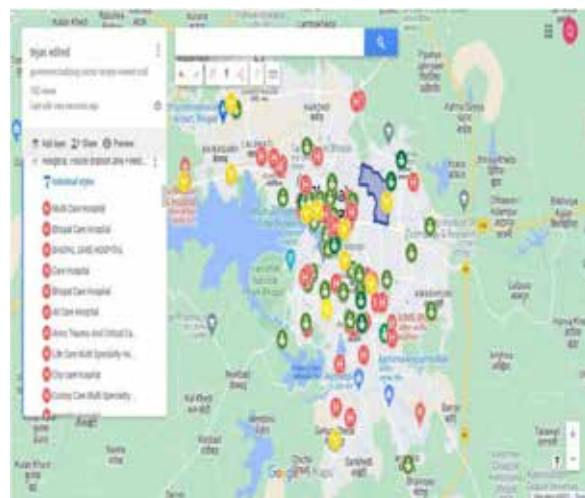
by a digital surface model (DSM), a form of digital elevation model (DEM).

It is typically created using remote sensing techniques such as LiDAR or photogrammetry, which use lasers or cameras to capture detailed information about the surface and objects. DSMs are used in a variety of applications, such as urban planning, environmental modeling, and natural resource management, to create more accurate and detailed models of the terrain, which can be used to plan and design urban areas and infrastructure.



**Fig. 4: Digital Surface Model create in QGIS**

Various GIS layers Created in Google My maps are



**Fig 5: Emergency Services Layer**



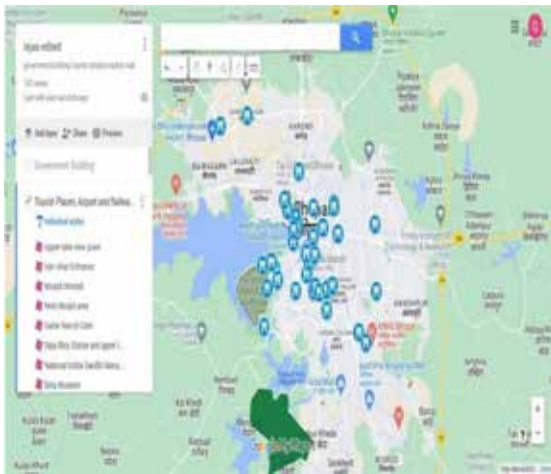


Fig. 6: Tourist Destinations and Public



Fig. 9: Slum Area Zone layer

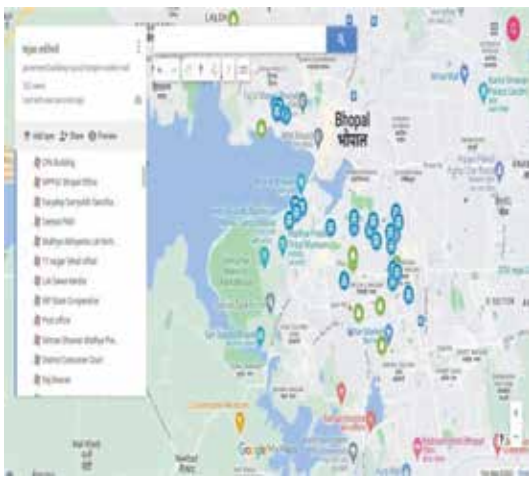


Fig 7: - Government Building

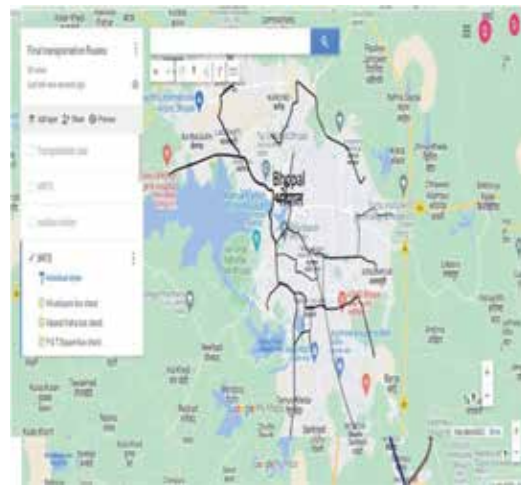


Fig. 10: Outer and Major Road Layer

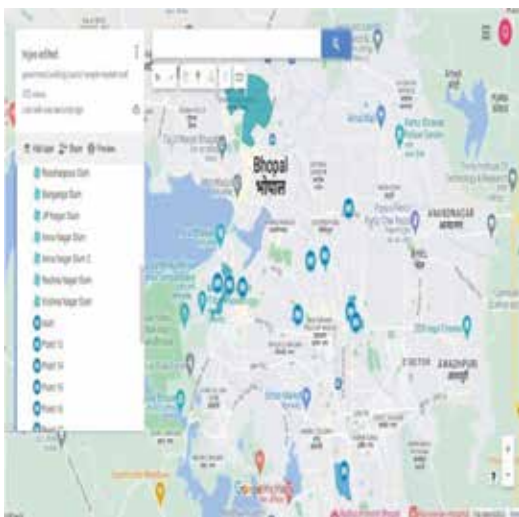


Fig 8: -Industrial Zone Layer

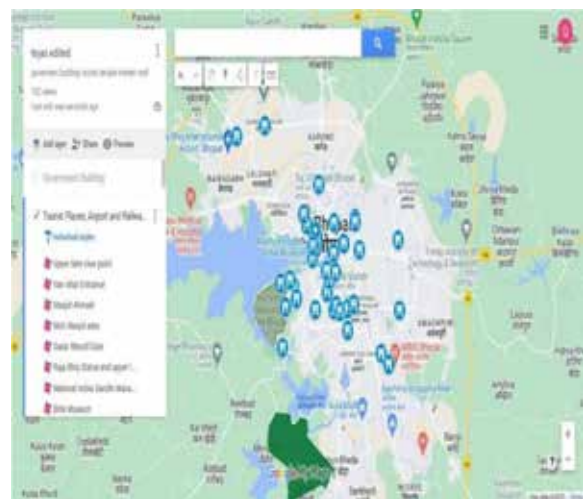


Fig 11: -Tourist Destinations and Public

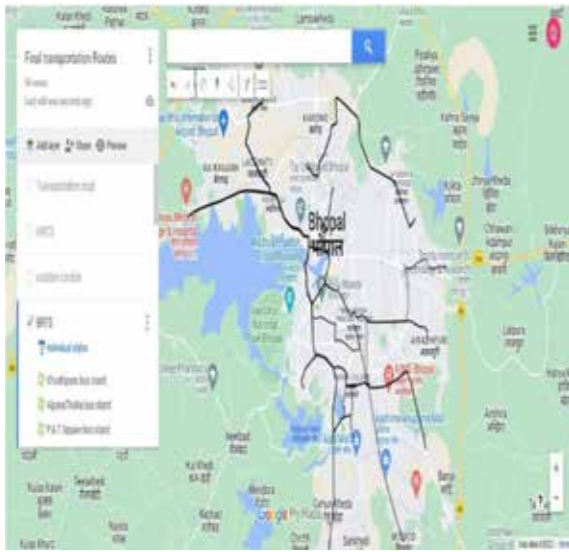


Fig. 12: BRTS Corridor Layers

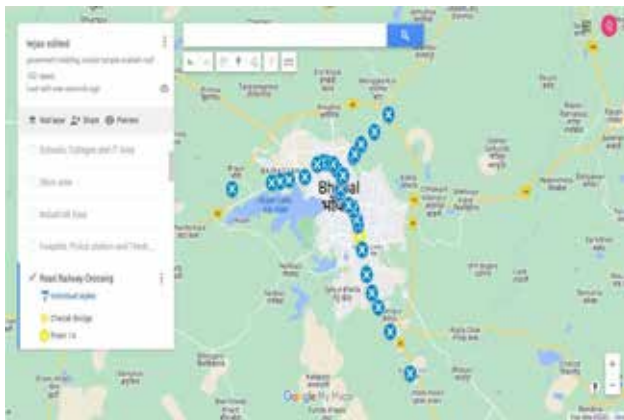
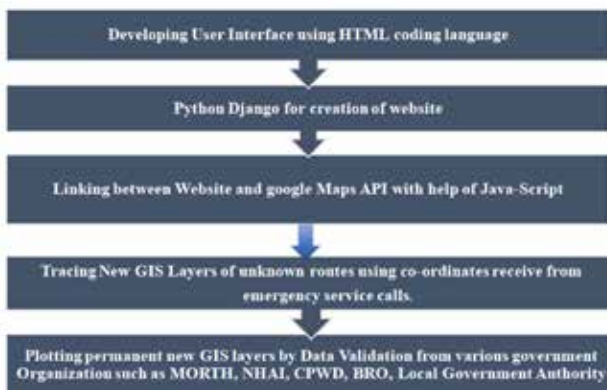


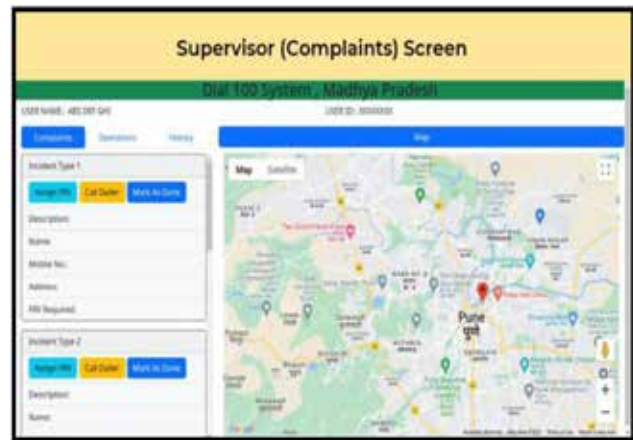
Fig.13: - Road Railway Crossing Layer

**SOLUTIONS**

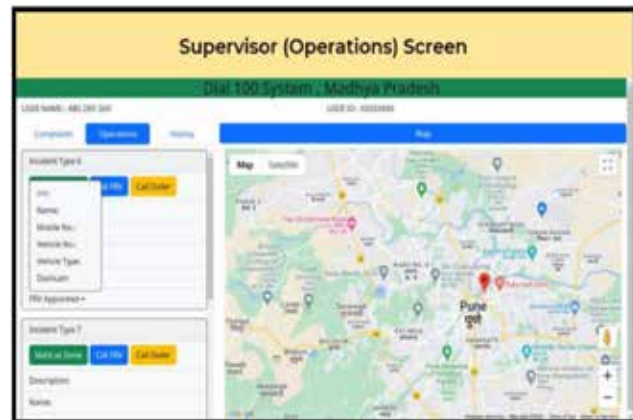
**Procedure and Steps for Developing Software of Creating GIS Layer**



Screen no.1: -When emergency call received by telephone operator this screen will be display



Screen No.2: - After operator registered details of emergency call further it goes to supervisor and supervisor 1 verifies it and carry forward to supervisor 2



Screen No.3: - Supervisor 2 assigned task to closest and available FRV's near to incident place





Screen No.4: - Screen inside FRV's Displays

## CONCLUSION

Building a GIS layer using Google Maps API and Google My Maps might make it easier to visualize and analysis geographic data. While Google Maps API allows programmatic access to and interaction with the Google Maps platform, Google My Maps provides a user-friendly interface for creating and sharing customized maps.

Developers can integrate interactive maps with different data layers into their apps by using the Google Maps API. Users are now able to browse and instantly analyze geographic data. The Google My Maps platform additionally offers a simple interface for building personalized maps, which can then be exported as KML or Geo-JSON files and incorporated into other GIS applications. These two technologies can be combined to produce a dynamic GIS layer that includes multiple data sources and presents them in an aesthetically pleasing and interactive way. This can be helpful for a variety of applications, from market research and economic analysis to environmental monitoring and urban planning. It's crucial to remember that the Google Maps API and Google My Maps have some restrictions and might not be appropriate for all use cases. For instance, there can be limitations on the quantity and kind of data you can submit, and you might need to take data security and privacy concerns into account. Overall, the creation of a GIS layer with the help of Google Maps API and Google My Maps can be a valuable tool for businesses, researchers, and other professionals looking to gain insights from geographic

data. However, it's important to carefully consider your specific needs and use case before deciding whether these tools are the right choice for you.

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# Flood Assessment of Western Maharashtra Region using QGIS

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## ABSTRACT

Floods are overflow of water that completely submerges a region of land that is usually dry and habitable and is a devastating hazard that adversely affects the livelihoods of the residents and halts economic growth. Heavy monsoons affect various regions in India, and these regions are often affected by floods due to a number of Environmental, Human-made, topographic factors. In this paper we have discussed flood situations arising with reasons behind it and also intends to plan for controlling the floods and to minimize the flood effect. Depending on the situation by which flood arises, different flood controlling measures used before are studied and checked whether they are applicable elsewhere Many investigators used Geographic Information System (GIS) a computer system which is used for capturing, storing, checking, and displaying data related to positions on Earth's surface. Flood hazard maps are a crucial tool for local government in managing this natural calamity, allowing them to respond and plan appropriately. In this paper we discussed different parametric studies with use of software's to analyse natural disasters, flood for accuracy and prevention of losses in future.

**KEYWORDS:** *Flood mitigation; Topographic factors; Rainfall data; Feasible solutions; Geographic Information System (GIS).*

## INTRODUCTION

A flood occurs when there is an excessive amount of water (or, in rare circumstances, other fluids) on ordinarily dry ground. The expression "flowing water" can also be used to describe the tide's inflow. Hydrologists research floods because they are a major problem in the civil engineering, public health, and agriculture. Human modifications to the environment frequently lead to an increase in the intensity and frequency of flooding, particularly when it comes to land use changes like deforestation and wetlands removal, alterations to flood control measures like levees or river channels, additionally to more serious environmental problems like climate change and sea level rise. Particularly, the severity of various causes of flooding is made worse by higher rainfall and extreme weather events brought on by climate change.

Floods have the power to cause devastation across a wide region, claiming lives, wrecking private property, and obliterating crucial public health services. Floods

affected more than 2 billion people worldwide between 1998 and 2017. Those who live on floodplains, in non-flood proof buildings, or who are unaware of the risk of flooding are the most vulnerable people to flooding.

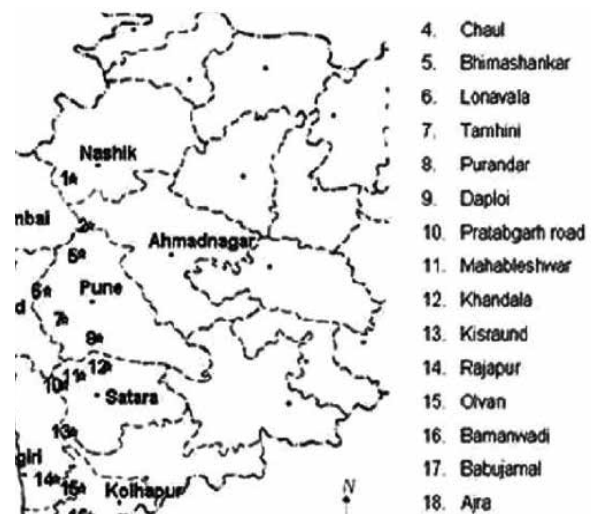


Fig: Western Maharashtra Map

**Western Maharashtra Region**

The Western Ghats have a significant role in shaping the climate regime and yearly precipitation on the Indian subcontinent, in addition to being rich in wildlife.

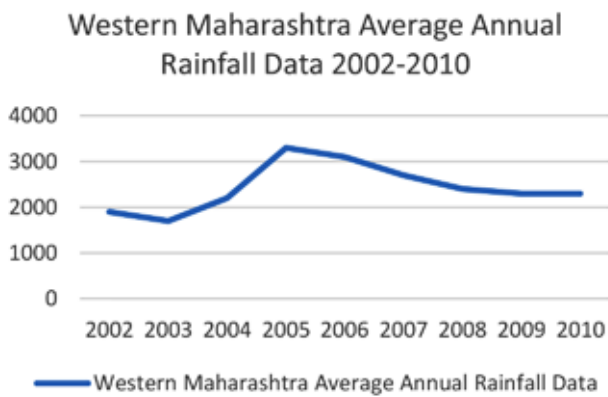
With roughly 65–70% of its total territory located in the Western Ghats, Kolhapur district has heavy yearly rainfall in its western hilly section. Therefore, it was deemed important to conduct a study of the area for vulnerability and risk analysis of the yearly floods in Kolhapur district in order to understand their primary causes and effects.

**CAUSES OF FLOOD SITUATION**

**Excessive Rainfall**

Rainfall in the area has been intense and sustained, exceeding its average for the same time period, especially in the Krishna catchment area and its tributaries. While the plain area of the upper Krishna basin experienced low rainfall throughout the flood period, the eastern slope of the Western Ghat experienced much more rainfall during that time. In both research years, it was noted that one of the primary causes of the flooding in the area is the amount of rainfall.

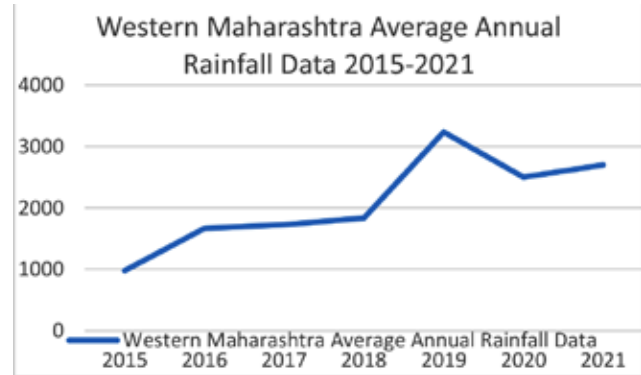
Western Maharashtra Average Annual Rainfall Data 2002-2010.



2002	1900
2003	1700
2004	2200
2005	3300
2006	3100
2007	2700

2008	2400
2009	2300
2010	2300

Western Maharashtra Average Annual Rainfall Data 2015-2021



2015	979.9
2016	1667.7
2017	1727.1
2018	1834.9
2019	3235.2
2020	2500
2021	2800

**Unauthorised construction within flood lines**

The Panchganga River’s capacity to convey floodwaters has decreased over time due to extensive encroachment in the restricted areas of the riverbed. In 1976, 1989, and 1997, the District Collector of the relevant district marked the boundaries of each river’s flood plain. It is supposed that no development of any kind is permitted between but recently, unpermitted construction in the shape of houses and huts has occurred, and this is what caused the floods of 2005, 2006, and 2019.

**Deforestation and Soil mining**

Trees absorb extra water with the help of their massive root systems, acting as a giant sponge. However, when a lot of trees are cut down, the root structure structure is broken and there is nothing for the excess water to absorb into, so it runs freely and floods the entire region. Simply said, deforestation reduces the soil’s capacity to retain water. Floods are the outcome of this excessive water flow into the ground.

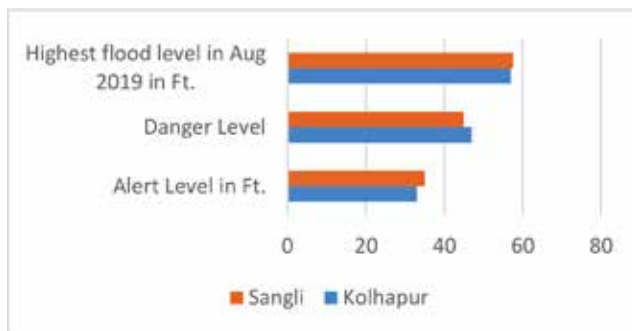
### Plain Topography of the Western Maharashtra region

From the mountains to the sea, rivers flow. They start out swift and narrow and gradually get wider and slower as they approach the mouth. The river slows down as it descends and goes into flatter terrain. The geography of the Western Maharashtra Region is essentially flat. This causes the river to flow slowly over here and causes the river to occasionally settle.

## MITIGATION

### Flood Forecasting

Flood forecasting is essential for effective flood planning and monitoring in order to prevent situations from getting worse and to reduce flood damage. An effective decision support system can be developed with the use of meteorological parameter advance forecasting as well as the acquisition of real-time hydrological data.



**Fig :** Bar graph of flood alert level in Kolhapur and sangli

### Restoration of Natural Land drainage system

To make maintenance and restoration efforts easier to carry out, the complete natural land drainage system can be separated into three layers. Primary level: the open road side gutters in any city or habitat connected to the storm water drainage system of any building or a plot. Secondary level: the city's storm water drainage system and main river stream.

### Encroachment in natural waterways

Immediate stringent regulations on new construction near and around watercourses can be implemented. The imposition of severe fines can ensure the strict application of the law. To clear and restore the original waterways, it is necessary to remove existing encroachments (structural and non-structural features).

This may be done in phases. Many cities have had their major river flow encroached upon to the point where even the intended flood output of the nearby upstream dam cannot pass through safely.

### Flood absorption measures

Before the water levels in the dams approach FRL, it may be possible to increase flood absorption capacity in the existing dams in Maharashtra without creating a separate flood absorption area by modifying the reservoir operation schedules and maintaining margins. Making a good use of the water level encroachment margin in the dams up to HFL is likewise a prudent choice. Wherever practicable, it is also possible to increase FRL of existing dams by expanding spillway gate heights using flaps.

### Disaster Management Units

The disaster management units can be on duty around-the-clock and on alert all year long. They can stay up to date on all preliminary warnings and flood forecasts made from time to time by the relevant agencies. EAP: The emergency action plans (also known as "EAPs") for each potential disaster can be prepared and periodically updated.

SOP: Standard Operating Procedures can be established in the event of any emergency. This must occasionally be changed as well.

## SOLUTIONS

### Structural Measures

#### Flood Storages

The capacities set aside in the dams for the purpose of temporarily storing flood waters are known as flood storages. These flood storages might be either dynamic (temporary) or dedicated. Flood discharges on the downstream of the dams are decreased when flood waters are stored in such storages during the peak floods. Currently, there is no provision for flood storage in any of the reservoirs in Maharashtra's Krishna basin. In the Koyna and Warna valleys, which are main causes of the floods, flood storages might be built.

Flood Water Diversions The Krishna Basin in Maharashtra has legal restrictions on how the water can be used. In order to redirect some of the floodwater

that was received in huge quantities into the river to the nearby valley or another tributary that experienced fewer floods during the same time period, a permanent infrastructure may be designed or built. This can be accomplished by building tunnels, open channels that connect both rivers so that the surplus floodwater can be carried by gravity.

#### Straightening of Meanders

Near the interstate border between Maharashtra and Karnataka, the river Krishna travels through a fairly flat region. There are several meanders leading to the river's main flow in this location. A few locations across the world have tried straightening river meanders to increase river flow velocity and speed up flood evacuation.

#### Raising the river banks

To help contain the flood discharge within the river cross section and prevent the flood water from pouring out of banks and inundating wide areas, low river banks must be elevated. While organising such steps, proper hydraulic research and cross section design can be carried out.

### Non Structural Measures

#### Integrated ROS

To guarantee that the flood flows at susceptible places are minimised, the reservoirs in the basin should be operated in an integrated manner. For effective management over flood moderation activities, the operation of several reservoirs, including Koyna, Warna, and other reservoirs in the Panchganga valley, must be coordinated.

#### Revising the flood lines

It is vital to take into account the actual observed peak flood levels and also the back water impacts of river Krishna and its tributaries, while revising the flood lines to govern the future developments accordingly.

#### Advanced warning mechanism and Flood zoning

It is necessary to create and implement warning system in the appropriate places. People who live in flood-prone locations can receive timely alerts about impending flood scenarios, enough time in advance to prevent loss of life and property.

#### Vulnerability maps

To aid in future flood relief efforts, precise inundation maps for varying water levels at risky places should be created. To create inundation maps for all the vulnerable locations that correspond to different river flood levels, digital elevation models with a fine enough resolution should be employed.

## RESULTS AND DISCUSSION

### Introduction of QGIS

A tool called as Geographic Information System-GIS is used to create, display, and analyse geographical data in order to help solve problems in the real world. It mixes map-like images with data tables of related attributes. This programme allows users to examine, edit, and analyse geographical data. Both raster and vector layers are supported.

### Digital Elevation Model

A DEM is a digital representation of the Earth's relief. Although there are many different formats, the most popular ones include triangulated irregular networks i.e. TIN, regular grids, contour lines, scattered data points. A DEM is often represented by a wireframe model or an image matrix where each pixel's value corresponds to a certain topographic height. When combined with other geographical data, digital elevation models form a crucial database for topography-related investigations or 3D video animations (such as fly troughs). A coordinate system can be used to derive and complete various geo-referenced 3D products, which can then be displayed in either a 2D map projection or in a 3D perspective view.

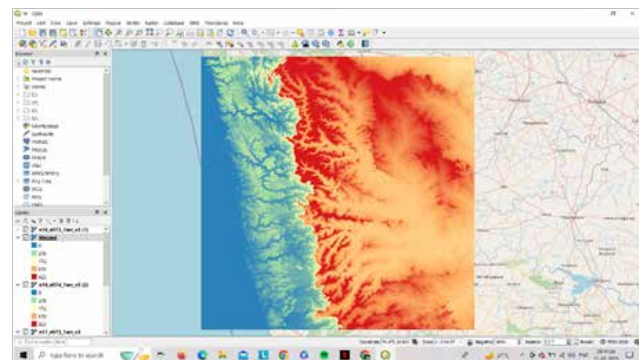
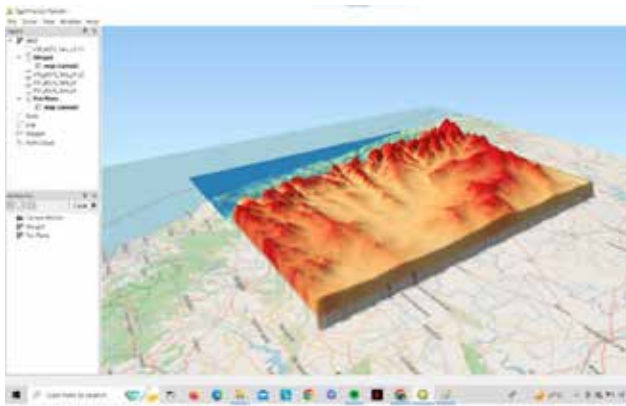


Fig: 2D DEM Visualization of Kolhapur Region





**Fig: 3D DEM Visualization of Kolhapur Region**

## CONCLUSION

The effect of Flood on Western Maharashtra Region (Kolhapur & Sangli) was on high level. There are number of reasons behind the occurrence of flood in Western Maharashtra Region. Western Maharashtra Region is a very important part of Maharashtra in terms of Agriculture, Historical Places, etc. According to government statistics, 4,74,226 individuals were rescued from 584 communities and sent to 596 temporary shelters in the districts of Pune, Sangli, Kolhapur, Satara, and Solapur. About 42 sq. km. of agricultural land are at risk of flooding. Several notable routes in the research location is located in a high-risk flood zone. In order to prevent socioeconomic losses, all of the aforementioned infrastructure, agricultural, and settlement regions are in a high flood risk zone. A detailed assessment of the suitability of suggested solutions was made and proved to be useful up to some extent. In addition, QGIS software was used for flood analysis.

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# M-Sand Wash Plant

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## ABSTRACT

The extraction of natural sand from the rivers for the use of construction has been banned in India, since then the demand for washed artificial sand has touched the skies. Crushed stone is used as an artificial sand for construction projects. This crushed sand is full of dust which need to clean before use with cement. Currently many stone crush plants are trying to wash crushed stone with water and facing some more problems. The stone crushing plant cannot be setup in city areas because of pollution norms and regulations and at long distant neither water is available nor water tankers can be readily available. Another problem is the left over extracted water output certainly called as sludge. This sludge output is immense and it requires considerable space to store as it is does not yield the strength required for construction purposes. In this research we have made an attempt to utilize the sludge/quarry dust by producing an end product ready to use in the construction industry.

**KEYWORDS:** Concrete crushed aggregate, Manufactured sand, Sludge, Stone, Dust, Bricks, Fly ash

## INTRODUCTION

Rapid and ongoing technological advancements have generated a substantial volume of waste, contributing to a concerning environmental issue – the accumulation of waste [1-3]. Concurrently, the construction sector’s escalating demand for natural sand has significantly diminished the accessibility of this precious resource. As natural sand deposits dwindle, the environment and society face increasingly dire consequences.

To address this pressing situation, we have embarked on a research endeavor aimed at identifying cost-effective and readily available alternatives to natural sand. Our earnest efforts have led us to explore the potential of waste foundry sand and waste stone powder as viable substitutes – both for partial and full replacement of conventional sand – within the context of fly ash bricks production. This proactive approach seeks not only to

mitigate the environmental impact but also to provide a sustainable solution for the construction industry’s sand requirements.

In this paper discussion made on casting bricks with different % of materials, curing and testing results comparison. Different waste materials like fly ash, foundry sludge and dust are considered. With this large volume waste can be reduced from land pollution happened on thermal power plants and stone crushing foundries.

Review made with available products for wall masonry like, burnt brick, local dried bricks, cement bricks, flyash concrete bricks etc. The characteristics of these bricks with respect to compressive test, density and water absorption with traditional fly ash brick is discussed in Table no. 1. The characteristics of these bricks with respect to compressive test, density and water absorption with bricks using only waste foundry sand

(WFS) is discussed in Table no. 2. The characteristics of these bricks with respect to compressive test, density and water absorption with bricks using only wastes tone sludge (WSS) is discussed in Table no. 3.

### Characteristics of Existing Bricks in the Construction Industry

**Table1: Following are the main characteristics of the traditional fly ash brick**

Density (g/cm <sup>3</sup> )	Compressive Strength(N/mm <sup>2</sup> )	Water Absorption(%)
1.76	4.34	21.08

**Table 2: Following are the characteristics of bricks using only waste foundry sand**

Mix Proportion of WFS	Density (g/cm <sup>3</sup> )	Compressive Strength(N/mm <sup>2</sup> )	Water Absorption (%)
30%	1.76	4.22	21.49
40%	1.68	3.95	21.64
50%	1.69	3.34	21.61

**Table3: Following are the characteristics of bricks using only wastes tone sludge**

Mix Proportion of WFS	Density (g/cm <sup>3</sup> )	Compressive Strength(N/mm <sup>2</sup> )	Water Absorption (%)
30%	1.23	1.84	19.85
40%	1.03	1.66	19.98
50%	0.98	1.45	20.15

### Materials Required

With the literature review and comparison of results following materials in different proportions are considered Table 4.

#### A. Foundry Sand-

Foundry sand, a premium-grade silica sand, emerges as a by-product during the manufacturing of both ferrous and nonferrous metal castings. Esteemed for its exceptional thermal conductivity, foundry sand has played a pivotal role as a casting material in molding practices for centuries. However, as its reusability within the foundry reaches its limit, it is extracted from the production process, thereby assuming the designation of “waste Foundry Sand.”

The magnitude of foundry sand production stands at a remarkable 6 to 10 million tons annually, underscoring its substantial presence within industrial operations. This prolific output underscores the necessity for innovative and sustainable avenues to harness the potential of waste foundry sand, steering it away from its conventional endpoint and towards valuable applications that can contribute positively to various sectors.

#### B. Fly Ash -

Fly ash constitutes the finely divided mineral residue arising from the incineration of pulverized coal within thermal power generation facilities. This combustion process yields an array of by-products, namely bottom ash, fly ash, and vapor. The attempt by fly ash to exit alongside the combustion gases from the boiler is intercepted and collected via mechanisms such as mechanical or electrostatic precipitators.

Reverberating beyond its role in power generation, fly ash assumes a noteworthy role as a valuable resource material within the construction sector. Its incorporation into construction practices not only capitalizes on its abundant availability but also harnesses its inherent properties to enhance various aspects of building materials and structures.

#### C. Stone Sludge-

It materializes as the clay-rich residual output subsequent to the washing process of M-Sand, or manufactured sand. Comprising constituents such as dust and flaky particles, this byproduct shares resemblances to M-Sand in terms of certain properties, yet it exhibits diminished levels of compressive and flexural strength.

#### D. Lime Sludge-

Emerging as a by-product from the lime-softening procedure within water treatment facilities, this substance primarily comprises particles of precipitated calcium carbonate. Its inherent composition positions it as a promising candidate for substituting limestone in the flue gas desulfurization (FGD) process.

#### E. Gypsum -

Gypsum stands as a pliable sulfate mineral, characterized by its composition of calcium sulfate dihydrate, denoted by the chemical formula  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ . Mined extensively, gypsum assumes versatile roles, finding

application as a fertilizer and serving as the principal component in various manifestations of plaster, blackboard or sidewalk chalk, and drywall.

### Mixing ratio of materials

The tests will be conducted with 3 different compositions, as follows

**Table 4. Ratio of Mixes**

Ingredients	Fly Ash (%)	Waste Foundry Sand (%)	Stone Sludge (%)	Lime Sludge (%)	Gypsum (%)
Series 1	60	13	13	9	5
Series 2	50	18	18	9	5
Series 3	40	23	23	9	5

## METHODOLOGY

**Step 1-** All the above raw materials are mixed with water in a mixture machine, in the respective ratio.

**Step 2-** The ingredients are transferred to a hopper through a conveyor belt, in which the mixture is compressed.

**Step 3-** There is a wooden base in the machine through which bricks are cut into shapes using a machine mould.

**Step 4-** After this the samples are placed in a designated area which is called staging. Different areas are allocated for different composition of bricks.

**Step 5-** After staging all these bricks are exposed to the natural environment for 2-3 days, and after that curing with water is done for 15 days. A total of 25 - 30 days are required for the whole process.

**Step 6-** The samples are collected and tested for porosity, compressive strength, water absorption, soundness test, hardness test.



**Fig. 1(a) Mixed Ratio**



**(b) Casting of Bricks**



**(c) Casted Bricks**

## TESTS PERFORMED ON THE BRICKS OBTAINED

### Compressibility Test (IS: 3495(1) 1992)

The testing process begins by ensuring that the brick is positioned securely and centered between the plates. The axial load is then gradually applied at a constant rate until the brick undergoes failure. Failure in this context refers to the point at which the brick can no longer withstand the increasing pressure and starts to deform or break.

Throughout the testing procedure, the applied load and corresponding displacements are continuously recorded to generate a stress-strain curve. The compressive strength of the brick is then determined by analyzing this curve to identify the maximum load the brick sustained before failure occurred.

By conducting this test on multiple bricks and averaging the results, engineers and researchers can determine the

typical compressive strength of the brick type being tested. The compressive strength value is an essential parameter in assessing the brick's structural performance and suitability for various construction applications. We have taken test and calculated compressive strength as per formula.

Compressive strength = (Maximum load at failure) / (Average area of the surface)

### Water Absorption Test (IS: 3495(1):1992)

The Water Absorption Test process, there are two main steps: drying the brick in an oven and then determining its water absorption after immersion.

The discuss instructions more concisely,

#### a. Drying:

Place the brick in an oven at a temperature between 105°C and 115°C.

Keep it in the oven until it is completely dry.

Once dry, cool the brick to room temperature.

Weigh the brick (M1) after it has reached room temperature.

#### b. Water Absorption:

Immerse the dry brick completely in room temperature water for 24 hours.

After 24 hours, remove the brick from the water and wipe off any remaining water with a cloth.

Weigh the brick again (M2) after wiping off the excess water.

By following these steps, the water absorption characteristics of the brick are tested and shown in Table no. 4.

This process is followed and water absorption calculated by equation,

Water absorption =  $\{(M2-M1)/(M1)\} \times 100$

where, M1 = Dry weight of Sample

M2 = Weight after 24 hrs in water

### Efflorescence Test

The efflorescence test of the brick is carried out by immersing one end of the brick in a dish filled with

distilled water up to a depth of 25mm. The setup is kept in a well-ventilated room at room temperature. During this process, the brick absorbs the water, and any surface water evaporates. To minimize excess evaporation, the dish is covered. Once the brick appears to be dry and all the water in the dish is absorbed, a similar quantity of water is added to the dish, and the brick is allowed to undergo another evaporation process.

The efflorescence result is determined after this second evaporation takes place. Efflorescence refers to the white, powdery deposits of soluble salts that can appear on the surface of bricks or other construction materials when water evaporates, leaving the salts behind. By conducting the second evaporation, the test aims to observe if any efflorescence occurs on the surface of the brick after the water has evaporated for the second time.

As per results obtained, Nil - If No observable deposit of efflorescence; Slight: If Less than 10% area of bricks covered a thin deposit of salt; Moderate: If Covering up to 50% area of the brick; Heavy: If Covering 50% or more area of the brick.

### Soundness Test

Soundness test taken with the two bricks. Those made struck with each other and sound was tested with clarity. Brick not Broken and the striking sound was ringing. With this it is concluded brick are of good quality.

### Hardness Test

Hardness test is taken with finger nail scratch on brick surface. The was no impression on the surface, it shown the brick is sufficiently hard.

## RESULTS

The test conducted after 28 days curing as per different Mixing ratios (Table 3) and found different results (Table 4). The different test, compressibility test, water absorption test, density test are taken and shown in Table 4.

**Table 4: Results after 28th day testing**

Differ-ent Mix	Mix Proportion (WFS + Sludge)	Density (g/cm <sup>3</sup> )	Compressive Strength (N/mm <sup>2</sup> )	Water Absorption (%)
Series 1	26%	1.76	4.22	17.54

Series 2	36%	1.68	5.61	17.91
Series 3	46%	1.69	7.6	18.8

## CONCLUSION

On testing of bricks it was found out that the bricks after curing produced a better compressive strength and water absorption than that of the traditional bricks. The required results for the use in construction sector were obtained. Thus other outcomes like paint concrete, precast partition wall panels can be obtained using the extracts from stone crusher and wash plant.

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# Deep Learning Approach for Blind Assistance

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## ABSTRACT

The World Health Organization has identified a significant number of individuals with visual impairments worldwide, highlighting the need for technological solutions to aid them in their daily lives. This paper proposes the development of an integrated machine-learning system that can recognize and categorize objects in real time, providing vocal feedback and distance information to assist visually impaired individuals in navigation. The system aims to address the challenges faced by individuals with visual impairments by leveraging advanced machine-learning techniques. By utilizing computer vision algorithms and deep learning models, the system will be capable of identifying and categorizing objects in the environment in real time. To provide effective assistance, the system will employ vocal feedback, relaying information about recognized objects to the user. This feedback will allow users to gain awareness of their surroundings and make informed decisions based on the objects identified. Additionally, the system will incorporate distance estimation capabilities, alerting users when they are either too close or too far from an object of interest, thereby enhancing their navigation and safety. The proposed integrated machine-learning system will empower visually impaired individuals to navigate their surroundings independently, reducing their reliance on others for basic needs fulfillment. By offering real-time object recognition, vocal feedback, and distance information, the system aims to enhance the quality of life and increase the autonomy of individuals with visual impairments.

**KEYWORDS:** *Object detection; Speech assistance; Deep learning*

## INTRODUCTION

Navigating through life involves various activities such as work, education, shopping, and more, and eyesight play a crucial role in facilitating these tasks by making it easier to move from one place to another. Hence, it can be generally acknowledged that vision is essential for effective navigation. In well-known surroundings, like our homeroom or even our business, it is comparatively simple to envisage moving around without eyesight. However, navigating strange environments might be challenging. [1] Blindness is a prevalent disability, with an increasing number of people affected in recent decades. Partially blind people have various vision problems, while completely blind people have no vision at all. The mission of or the purpose of the model is to provide assistance to individuals who have visual impairments., promoting their independence and

self-reliance. The system includes glasses that enable reading, studying, and learning from printed text or images, particularly useful in the field of education. visually impaired individuals due to their disability [2]. The world of deep learning and artificial intelligence has been making incredible strides in recent years, and one area where this technology can have a profound impact is in the realm of blind assistance systems. Blindness is a difficult condition that can severely limit a person's independence and ability to navigate the world. However, with the help of a system that utilizes deep learning convolutional neural networks and speech output, blind individuals can receive assistance in real time through a

camera-based system. This research paper will explore the development and implementation of such a system and its potential to revolutionize the way we approach

blind assistance. The use of deep learning and speech assistance can offer a highly personalized and intuitive experience, allowing individuals to navigate their environment with greater confidence and ease. In this research paper, we introduce a blind assistance system that utilizes convolutional neural networks and employs the YOLOv3 algorithm, which is based on deep learning techniques. Deep learning has various features like feature extraction, high accuracy rate, flexibility, and robustness making it the best choice for the implementation of blind assistance systems. The blind assistance system involves an Android application that records real-time frames and sends them to a networked server running on a laptop. The server utilizes a pre-trained SSD identification model trained on COCO datasets to identify the output class, which is then evaluated using an accuracy metric. The identified class is converted into default voice notes with the help of voice modules, and the blind person receives assistance accordingly. An alarm system is incorporated that not only detects objects but also calculates distances and produces voice-based outputs based on proximity. This system has the potential to greatly improve the independence and mobility of blind individuals.

## LITERATURE REVIEW

In [3] The Tele Guidance Navigation Assistance system is designed to facilitate cooperation between visually impaired individuals (VIPs) and their caretakers. It utilizes a multimodal interface and leverages the Internet of Things (IoT) for communication. The system consists of three main components: the Smart Cane, Mobile Application, and Web Server. The Smart Cane is equipped with advanced features and includes an augmented cane, a smartphone, and a Bluetooth earpiece. The VIP uses the Smart Cane, which captures the field of view and transmits it to the smartphone. Additionally, the VIP wears an open-ear Bluetooth earpiece for vocal communication. The caretaker utilizes a large-screen smartphone with the Tele Navigation App installed. The Tele Navigation app displays the live field of view from the VIP's smartphone, which is placed on their chest. The app also provides buttons to control haptic vibrations, which serve as guidance for the VIP. However the limitation of this system is that it requires the caretaker as well which is not fully helpful

for the visually impaired as they anyhow need human assistance.

In [4], authors have given one potential solution for aiding visually impaired individuals through the use of a machine learning algorithm. To access this algorithm, data input is gathered using an Image Classification technique. This involves capturing images of objects in the surroundings of the visually impaired person through a camera, which can accurately detect objects within a certain range. The captured images are transformed into audio signals, offering a convenient method of support for individuals who experience visual impairments. The drawback of this system is that it uses ML algorithms which are not as efficient as Deep Learning algorithms as the data set used is not large and they are using image classification which takes time and is not very efficient.

In [5], The authors have created a device called Stereo Pilot. It is a target location system that can be worn as a wearable device, aimed at improving the spatial cognition of people with visual impairments (BVI). The system incorporates a head-mounted RGB-D camera, which captures detailed 3D spatial data of the surrounding area. This information is subsequently utilized to generate navigation cues and guidance for users with visual impairments. The guidance cues are transmitted using a unique form of 3D sound that employs spatial audio rendering (SAR) technology. This enables users to perceive the orientation of the sound based on their natural instincts for human sound localization. The drawback of this system is that it is a wearable device and is not cost-effective. Everyone including visually impaired people might not be able to afford it and also it is very complex to understand its working.

In [6], The system being proposed utilizes Bluetooth Low Energy (BLE) technique for both location and communication intentions, along with a mobile application for user interaction with their smartphone. BLE signal emitters are strategically placed on public transport, and the mobile solution can track their movements in real-time, providing users with necessary information via spoken instructions. This information includes the transportation line, destination, name of the next stop, and current location. With this information, users can choose the correct vehicle beforehand and

ensure they disembark at the intended location. The drawback of this system is that it is solely based on transportation and not all day-to-day help for visually impaired people. It could help in traveling to their desired destination but not guide them at every step and detect objects in front of them.

In [7], The authors put forward a comprehensive assistive system designed for individuals with visual impairments and blindness that incorporates Smart glasses that can be worn. An advanced walking stick with intelligent features, A dedicated mobile application, and a web-based platform that provides access to information. In a typical scenario, the user wears smart glasses and holds the walking stick to detect obstacles in their path and receive alerts from the walking stick. If the user falls or experiences a collision, relevant information such as GPS coordinates and fall detection is recorded and uploaded to the online information platform. Additionally, family members or caregivers can be immediately notified through the proposed mobile device application. This system aims to improve the safety and independence of visually impaired and blind individuals. The drawback of this paper is that it is a complex system and requires a lot of arrangements that might not be affordable for everyone and is complex to handle.

In [8], This author aims to create an Assistance System designed specifically to aid individuals with visual impairments. is a comprehensive solution comprising 3 interlinked components: a high-tech cap, a smart cane created through 3D printing, and a mobile app that facilitates connectivity to an online server. The intelligent cap utilizes a Raspberry Pi and an imaging module, including a deep learning object detection module, enabling the detection of obstacles along the user's path. The smart cap utilizes a Raspberry Pi and camera module, along with a deep learning object detection module to detect obstacles in the user's path. The 3D-printed intelligent cane is equipped with a microcontroller with Various sensors and a Bluetooth module, allowing it to analyze the vicinity and guide the visually impaired user. The mobile application serves as an interface between the cap, the cane, and the user, providing virtual navigation to assist visually impaired individuals in their movements. Overall, this system has

the potential to improve the independence and mobility of visually impaired individuals greatly. The drawback of this system is that it requires a lot of hardware setup which might not be feasible.

In [9], The authors proposed a system architecture for assisting individuals with indoor navigation utilizing a network of IP cameras positioned on the roof of each space. The photos captured by the cameras are analyzed using computer vision algorithms by a remote processing system to determine the user's location and provide appropriate assistance. A guidance algorithm is integrated with a user-friendly mobile app that allows for interactive experiences on the user's mobile to help them reach their destination. A proof-of-concept prototype was developed with a single camera placed on a wooden floor model to simulate the system. The results of the testing showed that the system was reliable in navigating indoors and avoiding obstacles. The limitation of this system is that it required a large-scale execution to be working properly which might be a time-consuming and difficult task to accomplish.

## MODEL ARCHITECTURE

### A. Layered Architecture

The Convolutional Neural Network (CNN) is a powerful deep learning technique used in the layered architecture of blind assistance systems for image processing and recognition tasks. CNNs consist of convolutional, pooling, and fully connected layers. The key component is the convolutional layers that employ filters to extract features like edges, textures, and shapes from images. The resulting feature maps are then passed through pooling layers to reduce dimensions while preserving important details. The output from pooling layers is further processed by fully connected layers to predict or classify the image.

During training, a large dataset of labeled images is used to train the CNN model by adjusting the weights of the neurons through backpropagation. This process ensures precise identification and detection of objects. After training, the model is tested with unseen data to verify its accuracy. Testing is crucial to refine and improve the model's performance. When it comes to a blind assistance system, a Convolutional Neural Network (CNN) can be utilized as a component to

address specific tasks and challenges.

Here's how CNNs can be employed in the context of a blind assistance system:

**Scene Understanding:** CNNs can contribute to the understanding of complex scenes and environments. By processing visual input, CNN models can identify and classify various environmental elements, including buildings, parks, streets, or indoor structures. This scene understanding can assist blind individuals in comprehending their surroundings and obtaining contextual information.

**Text Recognition:** CNN-based optical character recognition (OCR) models can be employed to recognize and read text from images or documents. In a blind assistance system, this capability can be utilized to decipher text on signs, labels, or other written information, allowing visually impaired individuals to access textual information in their environment.

**Image Enhancement:** CNNs can also be employed for image enhancement techniques, such as denoising, deblurring, or contrast adjustment. These enhancements can improve the quality of visual input captured by cameras, enabling better perception and interpretation of the environment.

**Gesture or Facial Recognition:** CNN models can be trained to recognize specific gestures or facial expressions. This can assist visually impaired individuals in detecting and interpreting non-verbal cues from others, facilitating social interactions and communication.

## B. YOLOv3 Object Detection Algorithm

YOLOv3 (You Only Look Once version 3) can be a valuable component in a blind assistance system due to its real-time object detection capabilities. It can help visually impaired individuals navigate their surroundings by detecting and identifying objects in their environment.

Here are some ways YOLOv3 can be utilized in a blind assistance system:

**Obstacle Detection:** YOLOv3 can detect various obstacles such as walls, furniture, and other objects that may pose a risk to blind individuals. By providing

real-time information about the location and size of these obstacles, the system can warn users and assist in navigation.

**Object Recognition:** YOLOv3 can identify and classify different objects, including everyday items like chairs, tables, doors, and more. This information can be used to provide context and aid visually impaired users in understanding their surroundings.

**Navigation Assistance:** YOLOv3 can assist with navigation by detecting and recognizing landmarks such as stairs, ramps, exits, or elevators. This can help blind individuals orient themselves and make informed decisions about their path.

**Text Detection:** YOLOv3 can be used to detect and read text on signs, labels, or displays. This feature enables blind individuals to access important information, such as street names, store names, or bus numbers.

YOLOv3 is an effective object detection algorithm, it is just one component of a comprehensive blind assistance system. Other technologies and techniques, such as audio feedback, haptic feedback, or voice-based interfaces, may also be integrated to provide a holistic solution for blind individuals. Additionally, consideration should be given to factors like the reliability of detection, real-time performance, and user experience in developing a functional and practical blind assistance system.

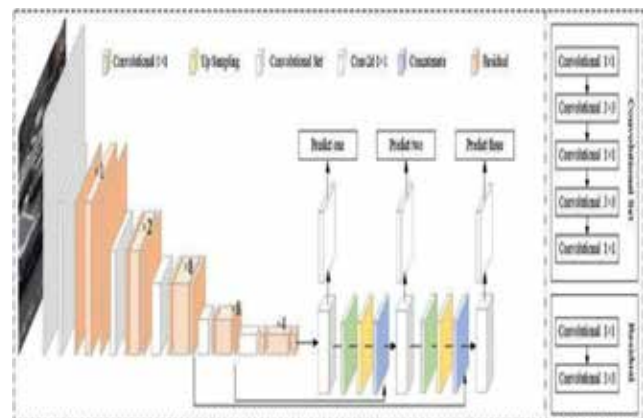


Fig 1: YOLOv3 Architecture

## C. Speech Assistance

The term speech assistance pertains to utilizing technology to enhance the communication abilities of people with speech impairments. This technology



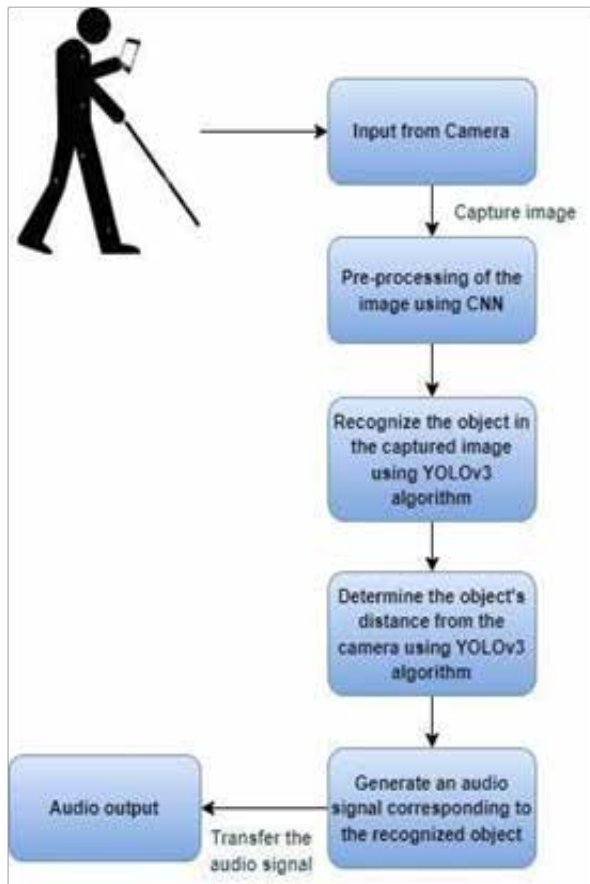
encompasses various devices, software, or applications that aid in the processes of speech recognition, synthesis, or augmentation. By leveraging speech assistance, individuals with speech difficulties can potentially improve their quality of life by engaging more meaningfully in social, educational, and professional settings.

PYTTSX3 is a Python library that can convert text to speech, which can be useful for alerting a person about the presence of an object. It works with both Python 2 and 3 and can be initialized using the `pyttsx.init()` factory function. The library is easy to use and provides a simple way to generate speech from text.

Text-to-speech (TTS) functionality in a blind assistance system enables blind individuals to convert written text into spoken words, allowing them to access and comprehend textual information through auditory means. Here's an explanation of how text-to-speech works in a blind assistance system:

1. **Input Text:** The user provides the written text that they want to be converted into speech. This can include various types of content, such as documents, web pages, or text entered through a user interface.
2. **Text Processing:** The input text undergoes processing to remove any unnecessary formatting, punctuation, or special characters that are not essential for speech synthesis. This step ensures that the text is clean and suitable for conversion into speech.
3. **Linguistic Analysis:** The processed text is analyzed to identify sentence boundaries, parts of speech, and syntactic elements. This analysis helps determine the appropriate intonation, emphasis, and pauses in the synthesized speech, making it more natural and understandable.
4. **Natural Language Processing (NLP):** NLP techniques are applied to understand the meaning of the text, resolve any ambiguities, and extract relevant contextual information. This step improves the accuracy and context-awareness of the synthesized speech.
5. **Phonetics and Prosody Generation:** The text is converted into phonetic representations, which break down words into their constituent sounds. Additionally, prosody generation algorithms determine the pitch, duration, and stress patterns to create natural-sounding speech. These components contribute to the rhythm, melody, and emphasis of the synthesized voice, making it more expressive and engaging.
6. **Voice Synthesis:** Based on the phonetic and prosodic information, a voice synthesis engine generates the actual speech. This can be achieved using concatenative synthesis, where pre-recorded segments of speech are combined, or parametric synthesis, where speech is generated based on acoustic models and rules. The result is a synthesized voice that speaks the input text.
7. **Audio Rendering:** The synthesized speech is converted into an audio format, such as PCM (Pulse Code Modulation), which can be played through speakers, headphones, or other audio output devices. The audio rendering process ensures that the synthesized speech is of high quality and suitable for the specific listening environment.
8. **User Interaction:** The blind assistance system provides a user interface designed for blind or visually impaired individuals. This interface allows users to input text, navigate through documents or applications, and control the TTS functionality according to their needs. Users can interact with the system to initiate the text-to-speech conversion and adjust settings like speech rate, volume, and language.
9. **Accessibility Features:** TTS systems in blind assistance systems often incorporate accessibility features to enhance the user experience. These can include adjustable speech rate to control the speed of speech, volume control, language selection, and the ability to customize speech parameters to cater to individual preferences and needs.





**Fig 2: System Flow Chart**

The system pipeline is shown in fig2.

1. **Input Image:** Here, the user can upload the image that needs to be processed.
2. **Image Pre-processing:** This step involves applying techniques like converting the image to grayscale and removing image noise to prepare the image for further processing.
3. **Image Feature Extraction:** In this stage, we will use methods to extract image features by analyzing the pixels in the image.
4. **Image Classification:** The image classification methods will be applied to distinguish between contaminated and safe areas based on the extracted features.
5. **Outcome:** This step involves presenting the final result of the detection process.

## PROPOSED SYSTEM

### Dataset Description

The COCO (Common Objects in Context) dataset is a widely recognized and extensively used benchmark dataset in the field of computer vision. Its primary purpose is to facilitate research and development in tasks related to object recognition, object segmentation, and image captioning.

The COCO dataset is composed of a diverse collection of images that depict everyday scenes and objects. It encompasses 80 different object categories, covering a wide range of common entities such as people, animals, vehicles, and various household items. This broad representation enables researchers to address a multitude of real-world visual recognition challenges.

Each image in the COCO dataset is meticulously annotated with various types of annotations to provide ground truth information for different tasks. These annotations include object instances, which involve labeling the objects in the images with bounding boxes to indicate their locations and extents. Furthermore, some objects are also annotated with pixel-level segmentation masks, allowing for detailed understanding of object boundaries. Additionally, the dataset includes annotations for keypoints, particularly for person instances, which provide specific point locations such as joint positions.

In addition to object annotations, the COCO dataset also contains multiple human-generated captions for each image. These captions provide textual descriptions that describe the objects, activities, and contextual information depicted in the images. This aspect of the dataset enables training and evaluation of image captioning models, fostering advancements in the field of natural language understanding combined with visual understanding.

### Approach

The proposed system aims to provide real-time object detection for visually impaired individuals through an Android app that captures frames as shown in fig2. The frames are then sent to a networked server running on a laptop, which performs all the necessary computations. This approach is taken to leverage the processing power

of the laptop to ensure that the system can accurately identify objects in real-time.

The networked server on the laptop uses a pre-trained Single Shot Detector (SSD) identification model, which has been trained on Common Objects in Context (COCO) datasets to identify the output class. Once the object class has been identified, it is evaluated using an accuracy metric to ensure that the system can accurately identify a wide range of objects.

After the object class has been tested using an accuracy metric, the system converts it into default voice notes using voice modules. These voice notes provide assistance to visually impaired individuals by informing them about the object’s identity. This feature is crucial as it enables the user to navigate their surroundings independently.

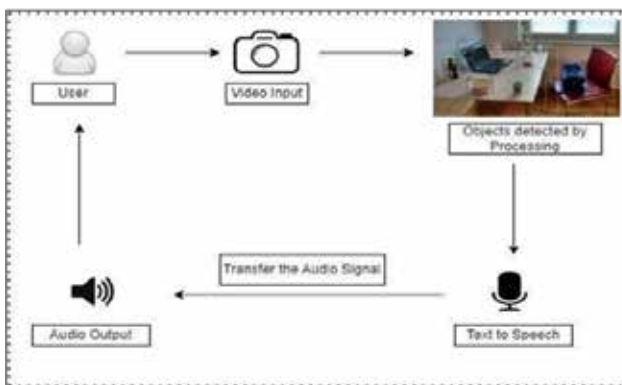


Fig 3: Proposed System Architecture

To ensure the safety of visually impaired individuals, an alarm system has been incorporated into the system. The alarm system not only detects objects but also calculates distance estimates. Based on the object’s proximity to the visually impaired individual, the system produces voice-based outputs and distance units to alert the user about the object’s presence and distance. This feature helps prevent accidents and enables visually impaired individuals to navigate their surroundings safely.

**RESULT AND DISCUSSION**

According to the results shown in Figure 3, it is evident that the proposed blind assistance system performs better than the currently existing models. The accuracy of the currently existing model ranges from 60-80%, while our proposed system promises an accuracy of

greater than 80%. Moreover, our system demonstrates an increase in recall from 65% to 85%, which is a significant improvement compared to the existing model mentioned in [1]. Overall, the performance of our proposed system is more promising and better than the existing models, as shown by the results.

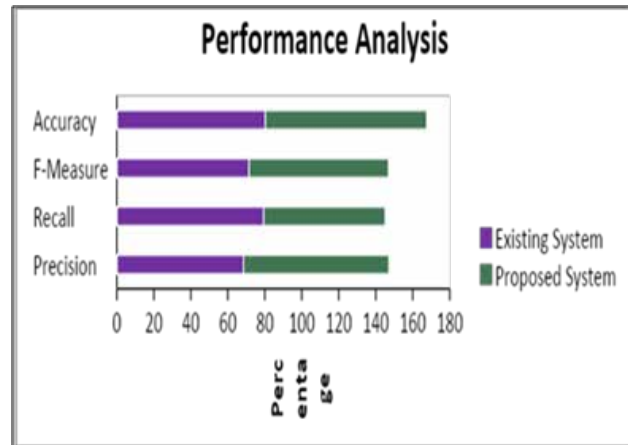


Fig 4: Performance analysis of the model

These results suggest that the proposed blind assistance system has the potential to be a more reliable and effective solution for assisting visually impaired individuals in navigating their surroundings. With further development and refinement, this technology could greatly improve the quality of life for those who are visually impaired, by increasing their independence and mobility.

**CONCLUSION**

The primary objective of the proposed system is to assist visually impaired individuals in perceiving their surroundings, enabling them to navigate independently and avoid obstacles. The system is designed to offer a practical and efficient solution that swiftly and accurately detects objects in the user’s immediate vicinity, whether indoors or outdoors. It can identify various objects and provide relevant information through headphones or speakers. The system’s effectiveness in detecting objects is evaluated in three different environments: indoor, outdoor, and beyond 10 meters from the camera. Overall, the system can detect and provide audio information about objects in the user’s immediate surroundings, promoting their mobility and self-reliance.

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# Hand-Driven based Virtual Keyboard and Mouse

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## ABSTRACT

In our modern age of technology, the need for effective and simple interface for user has grown significantly. A potential solution for the this problem is a hand driven virtual keyboard and mouse system that utilizes gestures of hand to perform common interactions of the computer , including double-click , right-click , left-click also operations like drop and drag of the mouse and typing operations of the keys by typing the specific keys needed . Such a system is proposed in this research paper below which is using Python as a programming language and it's variety of libraries to create an user-friendly and interactive interface.

This project's main goal is to develop a hand gestures driven virtual keyboard and mouse system which needs minimal efforts by the user to perform common computer actions. For this project the primary language used is Python and it's various libraries are engaged to generate an interface which is dependable and efficient for the end user. The Visual Studio environment is used to develop the project which allows ease of with the tasks such as debugging, testing as well as development.

On the basis of this research project, we seek to display the hand gestures efficiency as an alternative to the traditional and conventional keyboard and mouse system. We are going to calculate the performance of the system in terms of ease of use, responsiveness and accuracy, also assess its limits to improve the productivity of the user and mitigate the risk of consecutive strain injuries related to the traditional usage of mouse and keyboard. Overall, the final goal of the research given below is to contribute to the field of human-computer interaction by investigating the potential of hand-driven based virtual keyboard and mouse systems as an intuitive and efficient interface for the end user.

**KEYWORDS:** *Image processing, Recognition of gestures, Haar cascade, Keyboard and mouse, Hand gestures*

## INTRODUCTION

Tracking as well as Gesture Recognition are the different types of image processing that has been in one of the trending technologies in the past couple of years. Alternative to the usage of expensive detectors, to identify the gestures and motion tracking webcams can be used. Our system which one is propose in this paper is based on webcam, have the potential to eliminate the need of using the primary input devices such as keyboard and mouse. The interaction of this type with the computer system using only gestures of hand is specifically effective and intriguing approach to human-computer interaction (HCI). As there is an advancement in the technology, the emergence of more

miniature devices have risen. The system propose in the paper has the potential to make some of the existing devices to obsolete in the coming years , which also represents the future of the HCI.

The proposed methodology in this project uses Haar Cascade algorithm for detection of hand gestures. The haar cascade algorithm is extensively used in the field of computer vision applications for detection of the objects and its recognition. It works by making use of set of features for the pattern detection in an image, and afterwards using Machine Learning to identify if those patterns matches correctly to the object previously detected. By implementation of this particular algorithm for recognition of hand gestures , the project goal is to



give and efficient and accurate means of controlling this system of virtual keyboard and mouse.

Concluding this, the proposed system the hand gesture driven virtual keyboard and mouse system has the potential to give an intuitive and efficient alternative to traditional devices for computer input such as the keyboard and the mouse. By making use of simple gestures of the hand, end users are able to perform common actions of computer with minimal efforts, significantly improving productivity and mitigating the risk of the repetitive strain injuries also proposing an system to reduce the e-waste generate by the input devices. While there are some limitations such as poor performance in the conditions of low-light, it offers a really promising avenue for the development in the field of human-computer interaction. In particular, it might also provide an effective option for the peoples with the physical impairments that limits their ability of using traditional input devices.

## RELATED WORK/LITERATURE REVIEW

According to Kadir Akdeniz and Zehra Cataltepe's research paper, "Personalized and Dynamic keyboard for eyes tracker typing" offers a personalized and dynamic keyboard for eyes tracker typing. The authors stress the significance of adaptable input methods in HCI. This study demonstrates the potential of eye tracking technology to improve typing experiences by allowing users to interact with virtual keyboards using eye movements.[1]

The focus of Shu-Bin Zhang, Guang-Rong , Jia-Kui Yang, Ting-Ting Ji and Jing-Hao Sun Ji's work, "Deep Learning based recognition of hand gestures Research" is on hand gesture recognition using deep learning techniques. The authors show how deep neural networks can improve the accuracy and robustness of gesture recognition systems. Their work demonstrates how deep learning algorithms may be used to extract key features from hand motions.[2]

Thumma Dhyanchand, Vantukala Vishnu Teja Reddy, Satish Maheshwaram and Galla Vamsi Krishna delivered their paper, "Colored Finger Tips controlled Virtual Mouse Control and Recognition of Hand Gesture." This research proposes a virtual mouse

control system that utilizes colored finger tips and hand gesture recognition. Precision cursor control is achieved by recognizing and tracking colored finger tips, improving the user experience and interaction with virtual interfaces.[3]

Sumit Pathak , M.D. Anto Praveena and Sugnik Roy Chowdhury make a contribution to the subject with their paper "Gesture Recognition Based Virtual Keyboard and Mouse." Their work introduces a gesture recognition-based virtual keyboard and mouse system. Users can control the mouse cursor and type using hand gestures by employing computer vision techniques such as gesture recognition and tracking. The study emphasizes gesture-based interaction's potential as an intuitive and easily accessible input technique.[4]

Antônio Cláudio Paschoarelli Veiga and Rafael Augusto da Silva present "For an assistive virtual keyboard Algorithm for decoding visual gestures ." Their research focuses on interpreting visual cues intended for an assistive virtual keyboard. The proposed program intends to aid people with motor disabilities by analyzing visual motion captured through camera. The project serves as an example of the significance of developing gesture recognition systems that are accessible and meet a variety of user needs.[5]

The paper titled "I-Keyboard: Touch Devices Empowered A Fully Imaginary Keyboard by Fine-Tuning DND" by Ue-Hwan Kim, Jong-Hwan Kim and Sahng-Min Yoo .The authors leverage deep neural networks to infer user intentions based on touch gestures, revolutionizing touch-based interaction techniques. Their work demonstrates the potential of combining deep learning and touch-based input for enhanced user experiences.[6]

These scientific articles have collectively contributed valuable insights and techniques to the field of gesture recognition. They highlight breakthroughs in deep learning, computer vision, and alternative input methods. By merging the concepts and conclusions from these articles, the project "Hand Driven -based Virtual Mouse and Keyboard and Mouse" intends to address constraints encountered in prior research and create an accurate, robust, and user-friendly gesture recognition system.



### Disadvantages of Existing System

- Limited accuracy in challenging environments or with complex hand gestures.
- Lack of robustness in real-time scenarios, requiring further optimization.
- Insufficient adaptability to different user contexts and variations in hand gestures.
- Potential challenges in usability and user experience, requiring additional

### Problem Statement

- With the help of gestures such as hand signs or eye movements the device can be operated without the external hardware.
- In this project use of external hardware is eliminated and human interaction between personal computer is increased.
- With the help of gestures such as hand signs or eye movements the device can be operated without the external hardware.

## PROPOSED SYSTEM

According to the proposed system as per this research paper, the implementation process starts with capturing the images of user's different hand gestures in real-time through a webcam mounted on the device. The image which is captured is then encountered to the process of segmentation, where the comparison of pixel values takes place and the values are then separated from the values of the color defined. The resulting image from the previous process is then transited into a binary image, where the identified pixels are represented by white color and the remaining pixels are represented by black. Based on the pixels that are white position in the image, the location of the cursor of the mouse is set accordingly, thus replicating the cursor of the mouse without using a traditional mouse.

### Gesture-Based Control of Mouse

The system will be controlled by different gestures such as a V symbol made by the index and middle finger of the right hand, which will let the user move the cursor. Both fingers attached to each other side by side will lead to double-click. If we fold the right middle finger, it will lead to a right-click while in the V position as

mentioned earlier. If we fold the left finger while in the V position, it will lead to a left-click. If we hold the cursor above any folder and then close the palm, by moving around in the same position, it will lead to dragging and dropping. These gestures will be tracked using the webcam, and the position of the cursor will be set according to the white pixels position in the image.

### Gesture-Based Keyboard Control

The system will also provide gesture-based keyboard control. When we hover over

any key, it will get darker, indicating that the key is ready to be typed. By performing a pinch gesture using the right hand's index and thumb, we can type the specific letter. The system will recognize the gesture and type the corresponding letter. This will allow us to type without the need for a physical keyboard.

### Haar Cascade Algorithm

The proposed system will be using the Algorithm of Haar Cascade for hand gesture tracking and detection of the gestures of the hand. In the field of object detection in applications of computer vision this algorithm is used vastly. It is implemented by a machine learning model training with the help of a set of negative and positive samples. Images of the object which we desire to detect are the positive samples, whereas the Images with the absence of the object are considered as negative samples. This model is then used by the algorithm to detect the object in real-time.

## GESTURE RECOGNITION METHODOLOGY

The proposed system employs the Haar Cascade algorithm for the detection and recognition of hand gestures. The Haar Cascade algorithm is a widely used computer vision technique for object detection. It operates by training a machine learning model with positive and negative samples to identify patterns within an image.

- 1) Data Collection: The initial step in the gesture recognition methodology involves collecting a dataset comprising hand gesture images. This dataset should encompass various hand gestures associated with specific actions like cursor movement, clicking, dragging, and typing.

2) Positive and Negative Samples: The collected images are divided into two categories: positive samples and negative samples. Positive samples consist of images depicting hands performing the desired gestures, while negative samples contain images without any gestures.

3) Model Training: The Haar Cascade algorithm necessitates training a machine learning model using the gathered samples. Both

positive and negative samples are utilized to train the model, enabling it to learn the distinctive features and patterns associated with the hand gestures.

4) Feature Extraction: Throughout the training process, the algorithm extracts pertinent features from the positive and negative samples. These features encompass edge information, shape, and texture patterns that enable differentiation between hand gestures and other objects.

5) Model Testing and Optimization: Once the model is trained, it undergoes testing using a separate set of hand gesture images. The model's performance is evaluated based on accuracy and robustness. If the performance is suboptimal, the model can be further optimized by adjusting parameters and undergoing retraining.

6) Real-time Gesture Recognition: In the final step, the trained model is utilized for real-time gesture recognition. The system captures real-time images from the webcam, applies the Haar Cascade algorithm to detect and recognize the hand gestures, and subsequently executes the corresponding actions such as cursor movement or typing.

By following this gesture recognition methodology, the proposed system achieves efficient and accurate recognition of hand gestures, enabling intuitive and effortless interaction with the virtual keyboard and mouse interface.

Explanation –

The proposed system utilizes the Haar Cascade algorithm for hand gesture recognition. This algorithm is trained using positive and negative samples to create a machine learning model.

Positive samples consist of images of hands performing the desired gestures, while negative samples contain images without any gestures. During the training process, the algorithm extracts relevant features from these samples, enabling the model to learn the patterns and characteristics associated with the hand gestures.

To evaluate the model's performance, it is tested using a separate set of hand gesture images. This testing phase helps assess the accuracy and effectiveness of the trained model.

Once the model is trained and optimized, it can be deployed for real-time gesture recognition. By capturing images from a webcam and applying the trained model, the system can detect and recognize the hand gestures in real-time. Subsequently, the system performs corresponding actions, such as cursor movement, clicking, dragging, and typing, based on the recognized gestures.

The utilization of the Haar Cascade algorithm and machine learning training in this proposed system offers a more intuitive and efficient alternative to traditional keyboard and mouse input. Hand gestures enable users to interact with the computer system using natural movements, which can enhance productivity and reduce the risk of repetitive strain injuries. Additionally, the system holds potential for applications in various fields, including the medical domain, where hands-free interaction with computers is advantageous.

### Flowchart

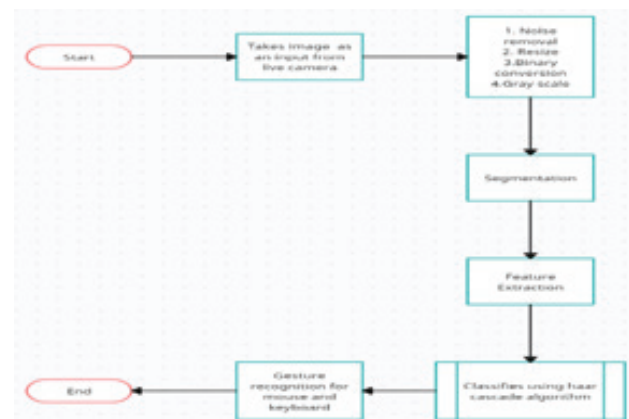



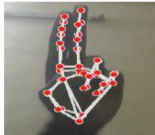
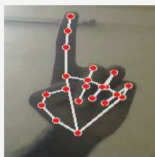

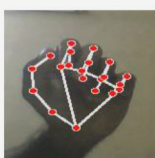
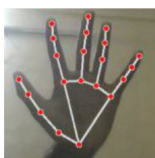
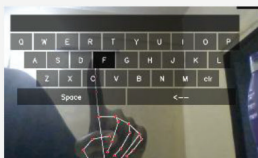
Fig 1 Flowchart of the system

To calculate the results of various interactions based on keyboard and mouse, we executed a study on each

interaction to collect data on the performance of the end user. In this study, we have performed each interaction a couple of a number of times to record the performance.

The performance data is represented in a table where the first column represents the different gestures

performed by the user, and the other column represents the accuracy of the interaction. The accuracy can be calculated as the percentage of times the user performed the gesture correctly out of the total number of times they attempted the interaction.

Gestures	Accuracy	Action performed
	89.54%	The movement of cursor of the mouse according to the position of the hand
	94.28%	Performs double click action of the mouse
	93.67%	Performs right click operation of the mouse
	90.43%	Performs the left click operation of the mouse
	90.08%	Performs the drag operation of the mouse
	97.36%	Performs the drop operation of the mouse after the implementation of the drag operation
	91.55%	Performs the typing operation of the keyboard as soon as pinch gesture is used

Parameter	Evaluation	Calculation
Ease of use	Good	Evaluated through user feedback, surveys, or usability testing. Some factors to consider include the system's intuitiveness, the clarity of the instructions, and the time it takes users to learn how to use the system.
Responsiveness	Medium	Measured by recording the time it takes for the system to detect and execute a gesture. A fast response time is important for a smooth and natural user experience.
Accuracy	High	Determined by comparing the recognized gestures with the intended gestures. A high accuracy rate is important for ensuring that the system is reliable and that users can be confident in its results.
Efficiency	Good	Assessed by measuring the time it takes to perform common computer actions using the hand-driven interface compared to traditional input devices. A more efficient system can save users time and effort.
Robustness	Good	Evaluated by testing the system under different conditions, such as varying lighting environments or complex hand gestures. A robust system will be able to perform well in a variety of situations.

Addition to the accuracy of the interactions, we also evaluated the ease of use, responsiveness, efficiency, and robustness of the gesture recognition system. The following table shows the results of these evaluations: Here are some specific formulas that can be used to calculate these parameters:

Ease of use-

- User feedback: This can be collected through surveys or interviews with users. Questions can be

asked about the system's intuitiveness, the clarity of the instructions, and the time it took users to learn how to use the system.

- Usability testing: This involves observing users as they interact with the system. The usability tester can look for things like how easy it is for users to find the controls, how easy it is for users to understand the instructions, and how long it takes users to complete tasks.

Responsiveness-

- Time to detect gesture: This can be measured by recording the time it takes for the system to detect a gesture from the user.
- Time to execute gesture: This can be measured by recording the time it takes for the system to execute a gesture once it has been detected.

Accuracy

- Percentage of correctly recognized gestures: This can be calculated by dividing the number of correctly recognized gestures by the total number of gestures attempted.

Efficiency

- Time to complete task with hand-driven interface: This can be measured by recording the time it takes to complete a task using the hand-driven interface.
- Time to complete task with traditional input device: This can be measured by recording the time it takes to complete a task using a traditional input device, such as a mouse or keyboard.

Robustness

- Percentage of correctly recognized gestures in different conditions: This can be calculated by dividing the number of correctly recognized gestures in each condition by the total number of gestures attempted in that condition.

Overall, the results of the study show that the gesture recognition system is a reliable and efficient way to interact with computers. The system is easy to use, responsive, and accurate. It is also robust and can handle a variety of conditions.



## CONCLUSIONS

- This project paper has concurred the use of hand gestures and eliminated the use of keyboard and mouse functions to most extent. Which includes double-click, right-click, left-click also operations like drop and drag of the mouse and typing operations of the keys by typing the specific keys needed
- The utility of this project can be used in various different fields for example in medical apparatus where they're in need of computation or needs to use the computer in the middle of the surgery they can just use from distance with the help of gestures.

## ACKNOWLEDGEMENTS

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# Decentralized and Secure Voting System using Blockchain Technology

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## ABSTRACT

Voting in democratic country is a fundamental right granted to every eligible individual by the constitution. Current e-Voting system used isn't transparent and can be improved in a few aspects. All voting data from Electronic Voting Machines (EVMs) are stored on a central server. This creates a single point of failure which can be exploited and tampered with easily. Such flaws cause mistrust in the electoral process. Blockchain is a shared immutable ledger that facilitates the process of recording transactions in a network. It is an emerging technology whose full potential is yet to be realized. Blockchain became popular in 2009 when bitcoin was introduced and used as an alternative to tangible currency and has evolved since. It is a reliable system that can be used in various critical industrial applications. Blockchain has potential to improve the voting system to contest transparent and fair voting. Using this modern technology, a voting system can be implemented which provides transparency leading to fairness in the system. Furthermore, this will overcome the current system flaw of having a single point of failure caused by storing data in a centralized server. In addition to this, election results can be declared faster compared to the current system which might take a few days. The proposed system in this paper shows implementation of voting using blockchain technology.

**KEYWORDS:** *Blockchain technology, Ethereum virtual machine, Voting system, Secure voting, Consensus*

## INTRODUCTION

The electronic voting system can incorporate blockchain technology to perform a fair election and reduce unfairness. Physical voting systems have a number of issues, just like how computerized voting systems aren't ideal enough to be applied widely. This paper presents an overview of blockchain-based voting systems. The proposed platform will provide a framework for conducting voting operations electronically by utilizing blockchain. For our system, we'll employ a blockchain that can be customized and has consensus algorithms. The chain security algorithm has improved the integration and security of voting transactions.

**Blockchain:** Blockchain is a distributed ledger technology that links together blocks, or records of

transactions, using mathematical cryptography. The distributed aspect of blockchain technology, which renders it immutable and virtually hard to hack, is what makes it so popular.

**Distributed Ledger:** A ledger is a collection of records that details transactions. A distributed ledger is a data structure that may be used to store transactions and is spread over numerous computers connected to a network. Distributed ledger technology, or DLT, is a method of distributing transaction records to any user connected to the network. A sort of distributed ledger technology is blockchain. As a result, all of its users have access to the data, which promotes transparency and eliminates corruption.

**Decentralized Application (dApp):** A decentralized application (dApp) is a programme designed to function

on a distributed ledger technology, such as a blockchain. Smart contracts are used by it to operate.

**Smart Contract:** Computer programmes known as “smart contracts” automatically carry out or regulate actions in accordance with the terms of a contract or other agreement. It is applied to blockchain transactions to impose rules. The essential building blocks of cryptocurrencies and NFTs are thought to be smart contracts.

**Consensus:** Consensus makes sure that all the various blockchain participants reach a consensus regarding the state of the blockchain. Different blockchain applications employ a variety of consensus mechanisms.

**Cryptography:** Computer science and mathematical theory are the foundations of cryptography. The purpose of cryptography is to provide means of applying techniques linked to encryption to secure and safeguard data and communications.

**Ethereum:** The open-source Ethereum blockchain uses the solidity programming language to support smart contracts.

## BACKGROUND RELATED WORK

### A Framework for Transparency in Voting Systems Using Blockchain Technology [1]

1. The transparent voting mechanism using blockchain technology is explained in this paper. It drastically cuts down on the resources and labor used in the voting process. Voting systems built on the blockchain are resistant to manipulation, unlike traditional voting systems that save votes on a centralized database. Blockchain provides a high level of security that may be trusted more than older technologies.
2. Here, voters must finish the voting management system’s verification process. To maintain the integrity of voters, the system’s database is integrated with the country’s database. A transaction is created for each vote and checked against the voter’s National ID before being recorded in the blockchain. The voter uses their vote currency after casting a ballot. Blockchain checks his voting system after casting a ballot against the national

voting IDs. Then, before adding them to the chain, miners examine them to weed out malicious votes.

### Using Blockchain Technology in E-Voting Systems: An Empirical Analysis [2]

This study compares and contrasts the performance and security of centralized versus blockchain-based electronic voting systems. Similar interfaces were planned for both systems. The backend design systems were the only thing separating them. With blockchain-based systems, users have to join the network using the private key of their digital wallet as their credentials. If all conditions of the contract are satisfied, a new block is generated, processed, and then added to the blockchain, which serves as the system’s database. The centralized system required users to login in with their voter ID. The server processes the votes, which are kept in a database before being automatically counted for each candidate. The results showed that BEVS is a little slower than CEVS. This is because the additional block production and validation procedures on a local private blockchain allow it to process queries more quickly than a public blockchain network. However, the BEVS is more efficient and reliable than the CEVS because it runs through the internal server and has a zero error rate. Even with heavy loads, the BEVS’s rate of operation can be impacted. The BEVS is demonstrated to be a more secure electronic voting system with fewer vulnerabilities discovered.

### Blockchain technology-based decentralized electronic voting system [3]

1. For improved voting system integrity, this article compares and contrasts decentralized blockchain voting with traditional paper ballots.
2. Data like a voter’s name or their votes are saved on a decentralized ledger in the decentralized blockchain system. No outside authority has access to or has the ability to alter this data.
3. The usage of currency ballot papers as a voting method is commonplace globally. Due to the availability of the data at a single resource, this does not, however, guarantee the accuracy of the outcome. Blockchain-based voting systems solve the issue that a centralized voting system has. Here,

using blockchain technology, data is distributed across various servers and locations rather than being kept in a single location. Using a peer-to-peer network, the data is distributed among all of the hardware connected to the blockchain.

- Before voting begins in the Decentralised E-voting system, candidates must register, and voters' identities must first be confirmed before accounts may be created within this system. Following voter authentication by an authorized party, blockchain makes sure that voting twice is not permitted

**A blockchain-based voting system's architecture [4]**

The study recommends BlockVOTE, a voting system built on the Blockchain. It focuses on using consensus handling techniques to uphold the security and dependability of the voting system. The paper discusses the limitations of both conventional ballot-based voting procedures and computerized voting technologies. In the proposed architecture, the study describes the operations of Poll Creation, Voting, and Result Tallying. The system was built by the authors of the research using Hyper Ledger and Ethereum, and the results were compared. Poll creator, contract handler, and voter are the players in the system that will perform tasks relating to poll creation, contract development and deployment, and voting.

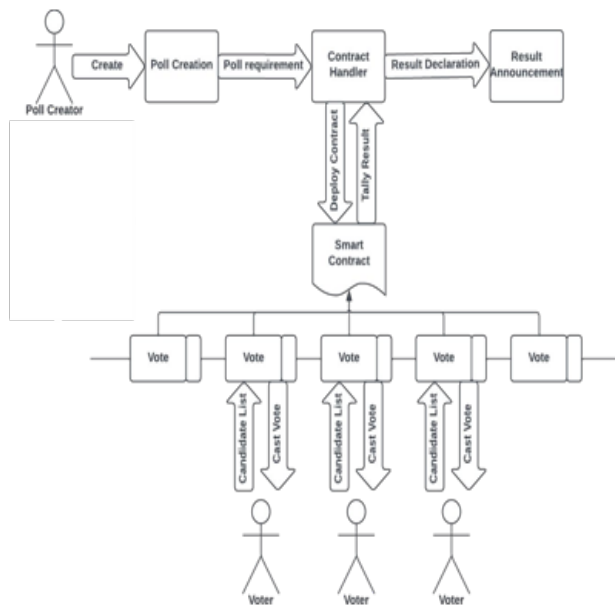


Figure 4. Flow of the System

**A Systematic Literature Review of Blockchain Solutions for E-Voting Analysis [5]**

In order to understand their particular and make comparisons between them and the traditional voting process, this paper analyses the most recent developments in the blockchain-based electronic voting system. The implementations used, the algorithms used, the techniques used to identify voters and encrypt votes, their resistance to attacks, and other security-related considerations are all taken into consideration while evaluating several blockchain-based e-voting apps in this study. Upon comparison based on the aforementioned traits, various systems' drawbacks and limitations are revealed. Although still in their infancy, voting systems based on blockchain provide an intriguing solution to the shortcomings of traditional voting.

**Open Problems and Challenges of a Blockchain-Based E-Voting System [6][7]**

- This study examines and critiques recent research on blockchain-based electronic voting systems. E-voting is the process that uses electronic technologies during an election to facilitate voting and vote counting. Every country has a different electronic voting process which might include electronic voting machines in polling places, central recording of paper votes, and online voting. Centralized calculations are employed in numerous nations. However, in some voting locations, there are also electronic voting machines and internet voting is hardly ever used. Particularly, issues with security and dependability were found when several electronic approaches were tested. Several other aspects of an electronic voting system's security are discussed in this paper, including
  - Anonymity: Any association between the registered voters and their identity must remain anonymous.
  - Auditability and Accuracy: The outcomes ought to accurately reflect the preferences of the voters.
  - Democracy/Singularity: In a democracy/singularity, every eligible person should be able to cast a ballot.. No votes may be cast more than once.
  - Vote Privacy: There should be no way for someone to link a particular vote to a specific person.

- Robustness and Integrity: This is evidence that legitimate registered
- voters will easily abstain from voting. Additionally, it inspires others to exercise their right to vote.
- Transparency and Fairness: The results are kept secret from those not directly involved in the counting process until they are released.
- Mobility and Availability: The systems must be accessible at all times during the election.
- Verifiable Participation/Authenticity: If a voter chooses not to cast a ballot, it should be possible for the authorities to determine this.
- Recoverability and Identification: It should be able to locate and retrieve data to avert attacks or data loss.
- Chain: A series of transaction blocks arranged in a particular order.
- Miners: Particular nodes that carry out block verification.
- Consensus: An algorithm that determines whether a block should be added into the chain and ensures its validity.

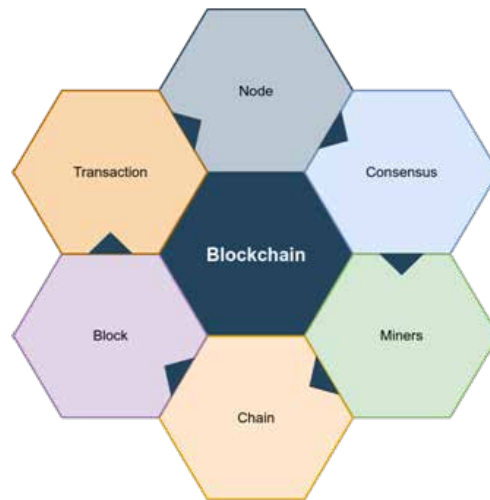


Fig 3 : Elements of System



Fig 2 : System Characteristics

- The following elements are found in a blockchain:
  - Node: It describes a user or computer connected to the blockchain network.
  - Transaction: Transactions are the most essential component of a blockchain system since they are the data that is kept in blocks.
  - Block: The data structure known as a block is used to store transactional information.

**METHOD**

To implement and test a blockchain based voting system, a few components have to be designed. A privately hosted closed blockchain network is required for our contract to run on. This is created using ethereum’s Go language based client. To do so, a script is written in JavaScript to automate the following tasks :

1. Ethereum wallet accounts are created for the number of nodes required.
2. On these accounts, the genesis block is initialized.
3. Bootnode is initialized. Bootnode is a node which connects other nodes to each other.
4. Geth (Go Ethereum Client) is run using the accounts created using bootnode initialized in the previous step.

A Solidity based contract is written to execute the application’s core functionality. This contract works like the backend for the entire application. This contract is written in solidity version 0.8.19

```

ElectoralContract {
struct Voter {
    string voterName;
    bool hasVoted;
    bool isLoggedIn;
    string voterPassword;
    address nodeAddress;

uint timestamp;
}
struct Candidate {
    string candidateName;
    uint256 voteCount;
}
// funcaddCandidate : adds candidate for voters to
vote
// funcaddVoter : adds voter
// funclogin : login functionality for voter
// funclogout : logout functionality for voter
// funcgetResult : gets result of elections
// funcgetCandidates : gets list of candidate names
// funcgetVotersDetailed : gets all voters information
// funcvote : cast vote to candidate functionality
};

```

Algorithm to cast vote :

Require : Voter must have not cast vote  
earlier

Require : Voter must be logged in

Update :candidate.voteCount++  
// Update vote count for  
candidate

Update :voter.hasVoted = true

//Update voting status for voter

Update :voter.timestamp = timestamp

```

// Update voting timestamp for
voter

```

Func : logout(voterId)

```

// Logout voter

```

The overall flow followed is :

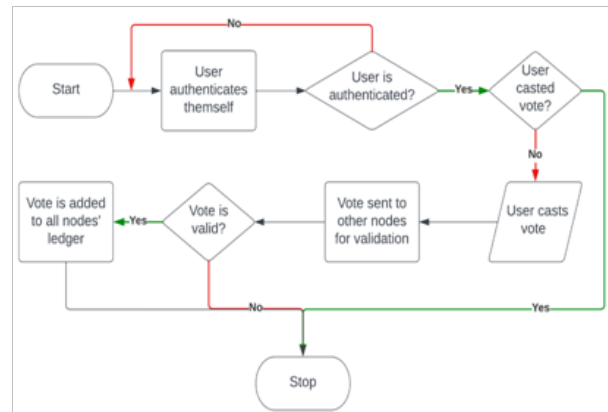


Figure 4. Flow of the System

Consensus algorithm used in this chain is Proof of Authority (Clique). In PoA consensus, some nodes are given permission to generate new blocks. These nodes are called 'Validators'. PoA leverages the importance of identities. The validators are not staking coins like PoS but rather their own reputation instead.

PoA is suited for private networks such as this one.

Finally, to evaluate the system, some synthetic data is generated and provided to the system and performances tested. To perform this evaluation, python script is written which will perform these tasks :

1. Register a single candidate.
2. Register required number of voters with random names.
3. Login with all voters' credentials.
4. Cast votes by voters with preset probability.
5. Logout all logged in voters.
6. Get result and compile csv.
7. Plot graphs from result

Along with these components, a frontend client is made for a citizen/voter to interact and cast their votes.



Dashboards are also deployed to monitor the network and the data flowing through it.

The system's performance is tested by generating synthetic data which is passed to the system and the time taken for it to process the data and store it in blockchain.

The number of nodes in the system are scaled in range from 1 to 50 while ranging the voters from 10 to 250.

## RESULT

Following table shows time taken in seconds by the system to insert data to the private blockchain network and generate results without artificial delay included.

**Table 1. Time Taken - (Number Of Nodes Vs Voters)**

		Number of nodes									
		1	2	3	4	5	10	15	20	25	50
Voters	10	0.46	7.08	2.4	5.89	20.26	6.27	6.76	10.15	5.94	4.84
	20	0.9	13.56	3.75	5.97	35.4	13.16	17.4	14.87	12.44	56.11
	30	1.33	19.15	6.16	10.16	45.24	81.77	22.4	19.29	19.11	41.7
	40	1.76	8.88	9.25	13.58	61	31.21	30.11	31.57	29.68	33.01
	50	2.3	35.77	11.73	15	65.16	43.83	39.35	37.42	32.23	28.8
	100	4.61	22.82	21.81	30.53	139.74	87.84	71.14	77.71	70.99	111.91
	150	7.93	35.41	34.93	45.02	166.75	100.94	113.08	112.71	111.59	161.79
	200	11.18	49.99	46.33	72.57	0	167.5	143.24	164.77	155	273.67
	250	13.34	152.75	59.7	105.66	0	191.49	169.56	189.36	184.24	209.19

During evaluation of the system, we faced many failures due to block creation taking a long time, blockchain not being synchronized properly across the network, running out of resources for mining and some unexpected system crashes. Due to these crashes, results for 5 nodes, 200 and 250 voters could not be obtained.

## CONCLUSION

Through the numerous trial runs and performance testing, we were able to make a few observations. These observations were made based on the performance table in the Result section and self experiences while evaluating the system.

1. As the number of voters increases a gradual increase is observed in time taken to insert transactions and get results.
2. The time taken also increases as the number of nodes in the system is increased. This is due to blockchain synchronization across the network.
3. Less number of nodes showed instability and frequent crashes since load not being distributed well enough. As the nodes increased, the stability increased and less crashes were observed. From

the observations, we can say that voting using blockchain technology is feasible and will be beneficial due to its security and distributed nature. Since voting is carried on large scale, it will be stable and solve few issues faced by the current voting system.

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# Anatomy of the Dark Web's Network Structure to Detect Illicit websites

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## ABSTRACT

The dark web is a hidden part of the internet that hosts illegal activities such as the sale of illicit goods and services. Identifying websites that host illegal content on the dark web is a critical task for law enforcement agencies and researchers. This research paper proposes a system that analyzes the network structure of multiple dark nets by crawling it, scraping the web pages, and generating a graphical representation of the links between web pages. The proposed system uses a directed graph where each of the nodes in the graph may represent a Tor service domain (that may or may not be hidden) and an edge denotes the hyperlink from one service to the other. The PageRank algorithm is used to identify important nodes, which may be indicative of websites that are more likely to host illegal content. To reduce the number of nodes that need to be crawled, the proposed system uses focused crawling to rank websites based on their content. Additionally, the system implements incremental crawling, which updates the database periodically to keep track of URL changes and expirations on the dark web. The system uses a multithreaded breadth-first search algorithm to crawl the dark web efficiently and has a rate limiter to prevent accidental DDoS attacks. The features of the proposed system are implemented to ensure that it operates safely and ethically and has a minimal negative impact on the dark web.

**KEYWORDS:** *Dark web, Focused crawler, Incremental crawler, PageRank, Multithreading*

## INTRODUCTION

The dark web, a hidden and encrypted part of the internet, has garnered significant attention due to its association with illicit activities such as the sale of drugs, weapons, and stolen data. The anonymous nature of the dark web allows individuals to engage in illegal transactions with a reduced risk of detection. Consequently, identifying websites that host illegal content on the dark web has become a pressing concern for law enforcement agencies and researchers alike.[1]

The network structure of webpages forms a complex interconnected network on the World Wide Web, allowing users to navigate between webpages and facilitating the dissemination and discovery of information. Understanding and analyzing this network structure is crucial for search engines, website owners,

and users seeking relevant and valuable content on the internet [2]. The network structure of webpages is dynamic and constantly evolving as new webpages are created and existing ones are updated or removed. It enables various functionalities such as site navigation, content discovery, cross-referencing of information, search engine optimization, information retrieval, and web analytics. [3]

## METHODOLOGY

### Darknets

Darknets are private and encrypted networks that are intentionally hidden from the public and offer anonymous communication and file sharing. They are designed to ensure privacy, security, and anonymity for users by concealing their identities and activities. Darknets

typically require specific software, configurations, or authorization to access. [4]

1. **Tor (The Onion Router)** [5] is perhaps the most well-known darknet, primarily used for anonymous web browsing and communication. It operates by routing internet traffic through a series of volunteer-run servers called Tor relays, which encrypt and redirect data, making it difficult to trace the origin or destination of the traffic. Tor also allows users to access websites with “.onion” domain extensions, which are not accessible through regular internet browsers.

2. **I2P (Invisible Internet Project)** [6] is another darknet that focuses on providing anonymous communication. It utilizes a distributed peer-to-peer network to enable users to send messages, browse websites, and share files anonymously. I2P employs end-to-end encryption, making it challenging to monitor or trace users’ activities within the network.

3. **Freenet** [7] is a decentralized darknet designed for censorship-resistant publishing and file sharing. It allows users to publish websites and share files without revealing their identities. Freenet stores content in a distributed manner across its network, making it difficult to remove or censor specific information.

**Page Rank Algorithm**

The PageRank algorithm is a link analysis algorithm used by search engines to determine the relevance or importance of web pages within a network of interconnected web pages [8]. It was developed by Larry Page and Sergey Brin, the founders of Google, and it played a significant role in the early success of the search engine. It is evaluated using the following formula [9]:

$$PR(p_i) = \frac{1 - d}{N} + d \sum_{p_j \in M(p_i)} \frac{PR(p_j)}{L(p_j)}$$

where,

PR(pi) = Page Rank of the Node pi,

p<sup>1</sup>, p<sup>2</sup>, . . . , p<sub>N</sub> = Pages under consideration,

M(pi) = Set of pages that link to pi,

N = Total number of pages,

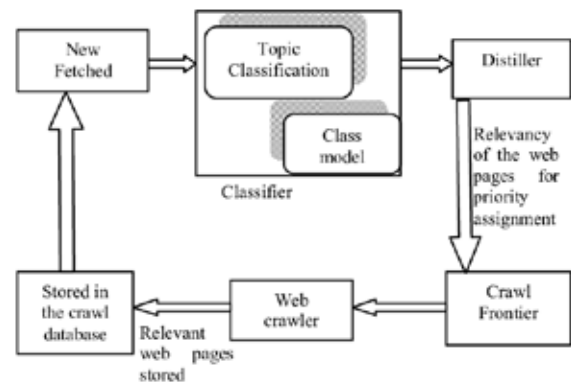
d = Damping Factor

This iterative process continues until the PageRank scores converge to stable values. The algorithm takes into account the entire link structure of the web, considering both the number of incoming links and the importance of the linking web pages. As a result, webpages with a high number of quality incoming links from reputable sources tend to have higher PageRank scores. [10]

**Focused and Incremental Crawler**

**Focused Crawler**

A focused crawler, also known as a topical crawler or selective crawler, is a specialized web crawler designed to retrieve specific information from the web by prioritizing and selectively crawling relevant web pages [11]. The primary objective of a focused crawler is to improve the efficiency of web crawling by avoiding the unnecessary retrieval of irrelevant or low-value web pages. By targeting a specific topic or domain, it reduces the amount of data to be processed and increases the likelihood of finding valuable and desired information. Focused crawlers employ various techniques to identify and prioritize web pages for crawling. These techniques may include analyzing webpage content, examining URL patterns, considering metadata, or utilizing machine learning algorithms to make intelligent decisions about relevance. [12]



**Fig. 1. The General Architecture of the focused crawler Incremental Crawler**

An incremental crawler is a type of web crawler that focuses on updating and maintaining a current database of web content by selectively crawling and indexing new or modified web pages [13]. The main purpose of an incremental crawler is to keep the database up-to-

date with the latest changes on the web. It achieves this by periodically revisiting previously crawled webpages and detecting updates or changes based on various signals such as modification timestamps, checksums, or content comparison techniques. By focusing on incremental changes, the crawler minimizes the need to recrawl unchanged web pages, saving time and resources. Incremental crawling offers several benefits. First, it enables efficient tracking of dynamic web content, such as news articles, blog posts, or forum threads, where updates occur frequently. Second, it allows the crawler to adapt to changes in web structure, URLs, and content organization. This adaptability is particularly useful on platforms where URLs expire or change regularly, such as the dark web. [12]

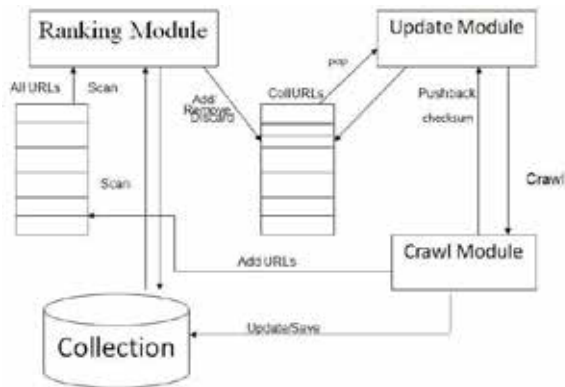


Fig. 2. The General Architecture of the Incremental crawler

**NLP Techniques for Data Processing**

There are several Natural Language Processing (NLP) techniques available for data processing like [14]:

- **Tokenization:** Tokenization is a NLP technique that involves breaking text into individual tokens or words. It helps in segmenting sentences and paragraphs into smaller units, enabling further analysis and processing.
- **Parts of Speech Tagging:** POS (Part of Speech) tagging assigns grammatical tags (e.g., noun, verb, adjective) to each word in a sentence, providing information about its syntactic role. This information is useful for tasks such as text classification, information extraction, and parsing.
- **Lemmatization and Stemming:** Lemmatization and stemming are techniques used to reduce words

to their base or root forms. Lemmatization aims to find the base dictionary form of a word while stemming uses heuristic rules to remove prefixes or suffixes. These techniques aid in text normalization and improve text matching and analysis.

- **Word Embeddings:** Word embeddings represent words as dense vector representations in a high-dimensional space, capturing semantic relationships between words. Techniques like Word2Vec and GloVe are commonly used for word embedding generation, enabling tasks such as word similarity, document similarity, and text generation.
- **Named entity recognition:** Named Entity Recognition (NER) identifies and classifies named entities (such as names, locations, organizations, etc.) within the text. It helps in extracting specific information from the text and is widely used in information retrieval, question-answering systems, and entity linking.
- **Sentiment Analysis:** Sentiment analysis determines the emotion or sentiment expressed in a piece of text, classifying it as neutral, positive or negative. It is valuable for social media analysis, customer feedback analysis, and brand monitoring.

**METHODOLOGY**

A high-level abstracted architecture of the proposed incremental web crawler is shown in Figure 3.1 [15]

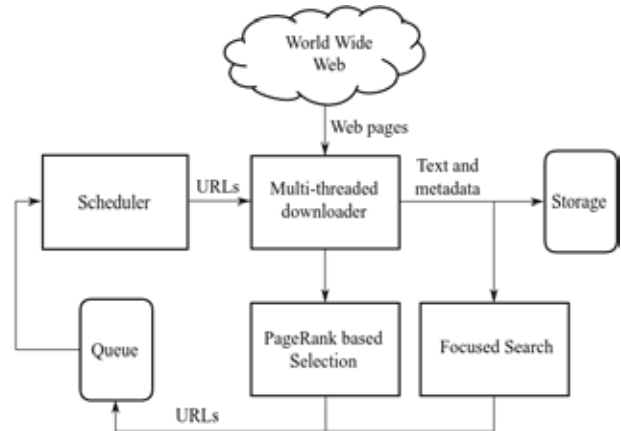


Fig. 3. A high-level architecture of the proposed incremental web crawler, involving a scheduler, PageRank-based selection, focused search and a multi-threaded downloader



### Mathematical Aspect

The proposed system uses an advanced incremental crawler. Focused search and PageRank sorting are plugged into a Multithreaded breadth-first search algorithm. This complex approach can be shown in Algorithm 1.

---

#### Algorithm 1 Multithreaded BFS incremental crawler

---

**Require:**  $u_1$  seed URL,  $w_1 \leftarrow 0.6$ ,  $w_2 \leftarrow 0.4$ , PageRank ( $PR$ ), Focused Classifier ( $FC$ ), min-Max Normalizer ( $N$ )

- 1:  $Q = \{u_1\}$ , queue of URLs to visit.
- 2:  $V = \emptyset$ , visited URLs.
- 3:  $F = \emptyset$ , Futures of crawled data of each URL.
- 4: **while true do**
- 5:   **for each**  $u' \in Q$  **do**
- 6:     **if**  $u' \notin V$  **then**
- 7:        $f' = \text{Spawned thread for } u'$
- 8:        $F = F \cup \{f'\}$
- 9:     **end if**
- 10:   **end for**
- 11:   **for each**  $f' \in F$  **do**
- 12:      $u, result = \text{Evaluate}(\text{future } f')$
- 13:      $V = V \cup \{u\}$
- 14:      $\Gamma^+(u) \leftarrow \text{pages pointed by } u$
- 15:     **for each**  $u' \in \Gamma^+(u)$  **do**
- 16:       **if**  $u' \notin V \wedge u' \notin Q$  **then**
- 17:          $Q = Q \cup \{u'\}$
- 18:       **end if**
- 19:     **end for**
- 20:   **end for**
- 21:    $Q = Q.\text{sort}((u_i) \Rightarrow$   
 $\quad w_1 N(FC(u_i)) + w_2 N(PR(u_i)) \geq 0.5$   
 $\quad )$
- 22:    $\text{Delay}(\text{rand}(1..5))$
- 23: **end while**

---

In the above algorithm, the crawling process starts with a seed URL  $u_1$  and iteratively expands the crawling frontier by evaluating the URLs in the queue  $Q$ . Each URL is visited and its crawled data is retrieved. The algorithm incorporates weights ( $w_1$  and  $w_2$ ) for the Focused Classifier and PageRank scores, respectively, and uses a min-max normalizer ( $N$ ) to scale the values between 0 and 1.

The URLs are added to the visited set  $V$  and the pages pointed by each URL are added to  $\Gamma^+(u)$ .

The algorithm then updates the queue  $Q$  by sorting it based on the combined score of the Focused Classifier and PageRank. The random delay introduced at the end of each iteration helps avoid patterns and simulate more realistic crawling behavior.

The mathematical aspect of the algorithm describes the step-by-step operations performed, including thread spawning, URL evaluation, queue and set updates, sorting, and random delay. It provides a clear understanding of the algorithm's flow and the mathematical operations involved in its execution.

### Rate limiter

A rate limiter in crawlers is an essential component for responsible and efficient web scraping. It helps maintain a good relationship with the websites being crawled, avoids disruptions or blocks, prevents accidental DDoS attacks, and ensures the efficient use of computational resources.

### Data Scraping and Management

#### Extraction

Data extraction during crawling involves retrieving and extracting relevant information from web pages. The proposed system majorly uses text content to classify websites. The following are the two major approaches used to extract data during the crawling process:

- **HTML Parsing:** The most basic method involves parsing the HTML structure of webpages. HTML parsing libraries, such as Beautiful soup in Python [16], is used to navigate the HTML DOM (Document Object Model) and extract desired data using selectors or XPath expressions. Extracted data can include text, links, images, tables, or specific HTML elements.
- **Regular Expressions:** Regular expressions (regex) are powerful pattern-matching tools that can be used to extract specific patterns or data from text. They are useful when the data follows a consistent pattern or format. Regex can be employed to match and extract specific strings, numbers, dates, or other structured information from webpage content. The

system uses yara to extract text based on regex and keywords.

**Storage**

Neo4j, a graph database, can be effectively utilized to store crawled data in a structured and interconnected manner [17]. By leveraging Neo4j’s graph database capabilities, the proposed system can store, query, and analyze crawled data in a manner that preserves the inherent relationships and structure of the web. This allows for efficient exploration, retrieval, and processing of the crawled data, incremental updates, supporting tasks such as content analysis, link analysis, and graph-based algorithms for tasks like relevance ranking and recommendation systems.

**Crawled Dataset**

The Webpage Dataset for Focused Crawling is a collection of webpages and their corresponding content. It is designed to facilitate the development and evaluation of focused crawling algorithms. The dataset consists of two main columns: URL and Content.

**URL:**

- The URL column contains the Uniform Resource Locator (URL) of each webpage.
- Each URL represents a unique address that points to a specific webpage on the internet.
- URLs can include various components such as the protocol (e.g., HTTP, HTTPS), domain name, path, query parameters, and fragments.

**Content:**

- The Content column contains the textual content of each webpage.
- The content can be in HTML format, plain text, or a combination of both.
- It includes the main body of the webpage, excluding navigation menus, sidebars, advertisements, and other non-content elements.

**Dataset Format:** The dataset is typically provided in a structured format, such as a comma-separated values (CSV) file, where each row represents a webpage and the corresponding columns contain the URL and content data.

**Table 1: Extracted dataset**

URL	Content
https://sample.com/page1	This is the content of webpage 1. It may contain paragraphs, headings, etc.
https://sample.com/page2	Here is the content of webpage 2. It includes text, images, and links.
https://sample.com/page3	Page 3 content goes here. It can have HTML tags and formatted text.

**DNN and clustering**

NLP on its own wasn’t the most optimal method to go with. It had many limitations such as not enough data handling capabilities, and the approach being too basic for the use case. Also, a normal classification cannot be used as the data generated is raw and unlabelled. Hence, we resorted to using clustering based on neural networks [18].

The initial approach involved sentimental analysis of the textual data. The main issue with this approach was that a single negative sentence can shift the polarity of the corpus by a huge margin [19]. Hence, that approach was discarded. The current implementation involves a mixture of NLP (to preprocess the textual data and make it ‘Deep Neural Network’ friendly) and neural networks (to cluster the hyperlinks). Figure 3.2 shows the model summary.

The basic working of the clustering process begins with getting the dataset from the dataset as mentioned in subsection 3.3. The data is cleaned (hyperlinks, html tags, and punctuation, stop words are removed, words are lemmatized and only the top 100 words are returned). Then TF-IDF and count vectorization for unigrams of the data is done. The top 3 unigrams, bigrams, trigrams and TF-IDF matrix for each instance are returned. Using these features a neural network implementing SOM/DEC is trained and fitted. Then based on the most common word in a cluster, the group of URLs in the same clusters are labeled. Using these labels the data can be clustered into 2 supergroups (illicit or non-illicit).

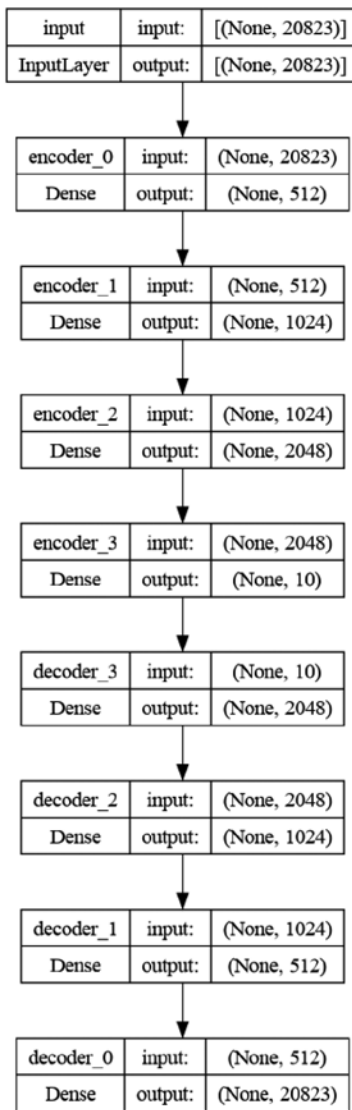


Fig. 4. AutoEncoder model summary

There are several neural network-based clustering algorithms, such as Self-Organizing Maps (SOM), Deep Embedded Clustering (DEC), and Neural Gas. These algorithms use neural networks to map data points to a lower-dimensional space, where the clustering can be performed.

1. Self-Organizing Maps (SOM): SOM is a type of unsupervised learning algorithm that uses a neural network to map high-dimensional data to a low-dimensional space (typically a 2D grid). SOM clusters similar data points together in the same neighborhood of the grid, so that each neuron in the

grid represents a cluster. SOM is similar to k-means in that it tries to minimize the distance between the cluster center and data points, but it uses a different approach to achieve that goal.

2. Deep Embedded Clustering (DEC): DEC is a clustering algorithm that combines deep autoencoder networks with k-means clustering. The autoencoder network is used to learn a compressed representation of the input data, which is then used as input to the k-means clustering algorithm. DEC is similar to k-means in that it uses a centroid-based approach to clustering, but it differs in that it uses a deep neural network to learn a compressed representation of the input data.
3. Neural Gas: Neural Gas is a clustering algorithm that uses a neural network to learn a set of prototypes (i.e., representative points) for the input data. The algorithm starts with a set of randomly placed prototypes and iteratively adjusts their positions to better represent the data. The prototypes that are closer to a data point are considered to be part of the same cluster. Neural Gas is similar to k-means in that it uses a prototype-based approach to clustering, but it differs in that it uses a neural network to learn the prototypes.

## RESULTS

In the Breadth-First search the higher the level, the higher the leaf nodes. Since the depth of the algorithm is limited most of the children nodes in the last level remain untraversed which eventually results in a steep curve.

As mentioned in subsection 2.3.1, there is a small fraction of the nodes which need to be focused on. To detect these nodes from the abundance of the crawled data, PageRank is used to rank these nodes based on the importance they hold in the graph. This small fraction of nodes is then used to traverse the graph further. The graph in Figure 5 displays the PageRank of every node present in the graph.

The Figure 6 shows the generated Graph database. Notice how the root node is at the center and points to other nodes. A self-loop shows that the link points to itself as well. Each node has a set of properties like url, scrape\_datetime, scrape\_html, and status\_code.

The Table 2 compares traditional crawling methods with the proposed system based on their effectiveness. It is important to note that the comparison is based on the effectiveness of the proposed crawler mechanism, which incorporates advancements and improvements over traditional crawling methods. The effectiveness of the crawler depends on various factors and the specific implementation details of the proposed crawler mechanism.

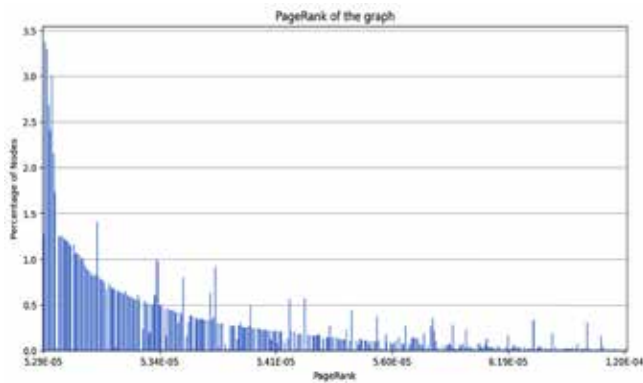


Fig. 5: Percentage of nodes and varying PageRank



Fig. 6: Graph database output

## DISCUSSION

The network structure of the Dark Web plays a crucial role in the detection of illicit websites and the fight against cybercrime. Analyzing the graph representation of the Dark Web allows researchers to identify important characteristics that aid in the detection process. One key aspect of the Dark Web's network structure is the presence of highly connected nodes or hubs. These hubs serve as central points of communication and are instrumental in the dissemination of illicit content.

Monitoring and identifying these hubs provide valuable insights into the network's dynamics and help uncover illegal activities. Law enforcement agencies can prioritize their efforts to target these hubs, disrupting the flow of illicit goods and services.

Additionally, the Dark Web's network exhibits a scale-free nature, which means that removing random nodes does not significantly affect overall connectivity. Instead, focusing on the most influential nodes, such as highly connected hubs, leads to a more effective disruption strategy. By monitoring and investigating these highly connected nodes, law enforcement agencies gain a deeper understanding of the network's structure and can identify key individuals or organizations involved in illicit operations. Another important aspect is the clustering behavior observed within the Dark Web. Clustering refers to the formation of communities or groups of websites that share common characteristics or interests. Analyzing these clusters provides valuable insights into the organization of illicit activities and the relationships between different actors. It enables researchers to identify potential hotspots for criminal activities and implement targeted measures to disrupt them.

Furthermore, analyzing the graph representation of the Dark Web's network structure reveals valuable information about the evolution of illicit websites over time. By studying growth and connectivity patterns, researchers can identify emerging trends and adapt detection strategies accordingly. For example, sudden increases in connectivity or the emergence of new hubs may indicate the rise of new criminal networks or the expansion of existing ones. It is important to note that the Dark Web's network structure is constantly changing. New nodes and links are created, and existing connections are modified or removed. Therefore, researchers and law enforcement agencies must keep up with the evolving network dynamics to effectively detect and combat illicit activities.

In conclusion, understanding the network structure of the Dark Web is essential for the detection of illicit websites. Graph analysis techniques allow researchers to uncover hubs, identify clustering patterns, and monitor the network's evolution. With this knowledge, law enforcement agencies can develop targeted



strategies to disrupt illicit activities and protect the digital landscape. Continuous research in this field is crucial to stay ahead of cybercriminals and ensure a safer online environment.

Table 2: Crawling systems comparison

Criteria	Traditional Crawling Methods	The Proposed System
Crawling Efficiency	Limited efficiency due to sequential processing and lack of parallelization.	Improved efficiency through multi-threaded implementation and concurrent processing.
Handling Dynamic Content	Limited capability to handle dynamic content, AJAX requests, or JavaScript-heavy websites.	Robust handling of dynamic content using advanced techniques, such as headless browsing or JavaScript rendering
Adaptability to Dark Web	Limited adaptability to the dark web's unique challenges, such as frequent URL changes, expiration, and rate limiting.	Efficiently handles the dynamic nature of the dark web, including tracking URL changes, updating the database, and managing rate limiting to ensure comprehensive coverage
Focused Crawling	Lacks specific mechanisms to prioritize or target crawling towards specific types of content or websites.	Implements focused crawling techniques to target specific types of content, such as illegal or illicit websites, enhancing the effectiveness of the crawling process
Incremental Updates	Does not support incremental updates and requires re-crawling of the entire dataset to incorporate changes	Implements incremental crawling to update the database, keeping it synchronized with the latest changes on the dark web, and minimizing redundant crawling
Rate Limiting and DDoS Prevention	May lack proper rate limiting mechanisms, increasing the risk of accidental DDoS attacks or disruption of target websites.	Implements rate limiting mechanisms to prevent accidental DDoS attacks, ensuring responsible crawling behavior and reducing the impact on target websites
Data Extraction and Processing	Basic data extraction capabilities with limited support for complex data extraction or NLP techniques	Supports advanced data extraction techniques, integration with NLP tools for data processing, and extraction of relevant information from dark web content
Robustness and Error Handling	Limited error handling and recovery mechanisms, making it prone to failures in case of network errors or exceptions	Implements robust error handling mechanisms, gracefully recovers from errors, logs error messages, and resumes crawling after encountering exceptional situations
Scalability and Performance	Limited scalability and performance, especially when dealing with large-scale crawls or resource-intensive operations.	Optimized for scalability and performance, efficiently utilizing system resources and handling large-scale crawls while maintaining high throughput
Security and Ethical Considerations	May lack built-in mechanisms to respect website policies, robots.txt files, and ethical considerations	Adheres to security and ethical considerations, respects website policies, robots.txt files, and ensures responsible and legal crawling behavior

**CONCLUSION**

The proposed study examines the network structure of the dark web and applies algorithms such as focused search, page rank, incremental crawling, autoencoding, and HDBSCAN [20] to classify it. However, the work

has certain limitations. It heavily relies on the hardware and website dataset size for efficient clustering. Additionally, there is no established convention to evaluate the effectiveness of a crawling algorithm, so the number of nodes traversed per second is used as one measure. A significant advancement in the proposed



work is the implementation of a multi-threading approach, which accelerates the crawling process. Another advantage is the ability to crawl multiple types of networks, including TOR, I2P, FreeNet, and the Surface Web. The proposed work integrates various domains of computing to achieve efficient website data clustering. Graph visualization techniques, such as Neo4js, NetworkX, Matplotlib are employed to present the crawler's findings in a report format.

In summary, the proposed work comprises four key modules: Crawler for efficient network structure exploration, Extractor for extracting textual data from crawled websites, Classify for effective data clustering, and Visualize for graphical representation of the results. This work can serve as a foundation for future applications and improvements.

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# Ship Detection at Small Ports using CNN

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## ABSTRACT

The detection of ships in various ship images is crucial for port management and other applications. In this paper, we present a ship detection model using CNN to detect the ships arriving at ports. We made several modifications to the original YOLO v2 network to improve its performance, including training it on different types of ships to make the model more specialized and focused on the target. Compared to previous research, our proposed algorithm shows significantly better accuracy in ship detection. However, we also found a trade-off between performance and detection accuracy, which is more suitable for actual boats arriving at ports. Overall, our YOLO v2 network for ship detection is a valuable tool for port management and other applications where the accurate detection of ships is necessary. The accurate detection of ships in various ship images is of utmost importance for port management and numerous other applications. This paper introduces a ship detection model that utilizes a Convolutional Neural Network (CNN) to identify ships arriving at ports. To enhance the performance of the YOLO v2 network, several modifications were implemented, including specialized training on different ship types to focus the model on the target domain. The proposed algorithm outperforms previous research in terms of ship detection accuracy, while considering a trade-off between performance and accuracy, specifically tailored for actual boats arriving at ports. Moreover, by incorporating Optical Character Recognition (OCR), the model can successfully identify license plates on the detected ships and log the entries for convenient access by authorities. The YOLO v2 network for ship detection presented in this paper serves as a valuable tool for port management and other applications where precise ship detection is essential.

**KEYWORDS:** *Object detection; Ship detection; YOLO V2; Matlab; Convolutional neural network; Model Tuning; Bounding box regression*

## INTRODUCTION

**S**hips are an essential means for transportation, with 90% of everything in the world being transported by sea at some stage. They are one of the safest and fastest means of transporting goods, and there are over 81,000 ships in the world fleet powering the maritime industry. Ports are crucial maritime facilities where ships load and unload cargo and passengers. They can be found near coasts or inland, with Asia having the largest and busiest ports.

To monitor this constant network of ships and ensure the secure and organized travel of goods we need a good system of monitoring. Ship detection using CNNs (Convolutional Neural Networks) is a popular technique

in computer vision for detecting ships in satellite or aerial imagery. The task of ship detection is crucial for various applications such as maritime security, vessel tracking, and environmental monitoring.

CNNs are a type of deep learning algorithm that have proven to be highly effective in image classification and object detection tasks. These networks learn features from images by performing convolution operations on them and using these learned features to classify or detect objects in the image. In the case of ship detection, a CNN can be trained on a large dataset of satellite or aerial images, where the locations of ships are labelled. The network learns to detect features that are indicative of a ship, such as its shape, size, and texture and uses these features to accurately detect ships in new images.

However, ship detection at small ports can be challenging, as ships may appear small in the image and may be partially occluded by other objects. To address this challenge, we propose a system of detecting ships using their number plates and these will be captured by cameras at the ports themselves. These images will be processed and a unique number will be obtained that can give access to information exclusive to that ship, such as its registration details. License plate numbers are unique identifiers for vehicles, but the format and layout of license plates vary from country to country. As a result, authorities need to develop License Plate Recognition (LPR) systems that can handle the different formats of license plates. Typically, an LPR system consists of several components, including obtaining the input image, image pre-processing, license plate detection, segmentation, and character recognition. These components work together to accurately identify and recognize license plate numbers, regardless of their format or layout. One of the main limitations of LPR systems is their accuracy. While LPR systems have significantly improved over the years, they are still prone to errors and inaccuracies. This is particularly true when it comes to reading license plates that are obscured or damaged, or that are located at odd angles. Additionally, license plates that have non-standard or unusual fonts or styles can also be difficult for LPR systems to read accurately.

To overcome these challenges, Convolutional Neural Networks (CNN) have emerged as a promising approach to improving the accuracy of LPR systems. CNN has several advantages over traditional image processing techniques because it can automatically learn features from raw images and recognize objects with high accuracy. One of the essential tasks in LPR systems is to extract features from license plate images. CNN can extract relevant features automatically from raw images using convolutional layers. The convolutional layers scan the image with a filter and extract relevant features such as edges, corners, and textures. These features can then be used by the LPR system to identify and recognize license plates accurately.

## LITERATURE SURVEY

a) Chang, Y.-L., Anagaw, A., Chang, L., Wang, Y., Hsiao, C.-Y., & Lee, W.-H. (2019). Ship detection

based on yolov2 for SAR imagery. *Remote Sensing*, 11(7), 786. <https://doi.org/10.3390/rs11070786>

Ship Detection Based on YOLOv2 for SAR Imagery in this paper they have introduced a ship detection method using the You Only Look Once version 2 (YOLOv2) algorithm specifically designed for Synthetic Aperture Radar (SAR) imagery. SAR images are preprocessed to enhance the visibility of ships and suppress noise. Next, the YOLOv2 model is trained using a large dataset of SAR images. The model learns to detect ships by dividing the image into a grid and predicting bounding boxes and class probabilities for each grid cell. To evaluate the performance of their method, they compare their approach with other state-of-the-art ship detection techniques and demonstrate its effectiveness in terms of accuracy and efficiency. The results of the experiments show that the proposed ship detection method based on YOLOv2 achieves high detection accuracy, even in challenging scenarios with multiple ships and complex backgrounds. There are total 30 layers of YOLOv2 in the network architecture, Out of that 22 layers are of convolutional layers and 5 layers are of the max pooling layers. The only limitation with this system is huge volume of the remote sensing data also brings a challenge for real time object detection

b) Lee, S.-J., Roh, M.-I., & Oh, M.-J. (2020). Image-based ship detection using deep learning. *Ocean Systems Engineering*, 10(4),415–434. <https://doi.org/10.12989/OSE.2020.10.4.415>.

The paper “Image-based Ship Detection Using Deep Learning” focuses on ship detection using deep learning techniques applied to optical images. It uses a convolutional neural network (CNN) for image-based ship detection. The YOLO v2 algorithm is to provide image-based ship detection and classification. The proposed ship detection approach consists of several stages. First, a dataset of annotated optical images is collected for training the CNN model. The CNN learns to automatically extract features from the images that are discriminative for ship detection. The authors mention that data augmentation techniques may also be employed to enhance the generalization ability of the CNN. Next, the trained CNN is applied to test images for ship detection. The CNN processes the input image and generates predictions, including the coordinates of



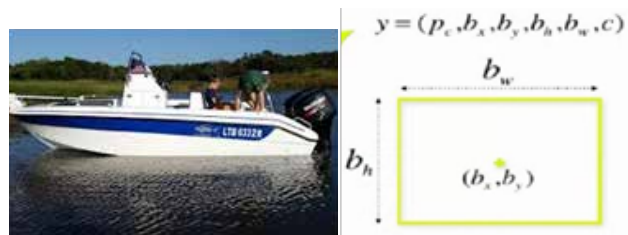


blocks in the images are divided into various grids. The dimension of each grid is  $S \times S$ . In following image, there are various grids which covers an entire image. These grids are of various dimensions and each grid helps to detect an object within that image.



**Fig 2. Grid**

Bounding Box highlights an object in an image. It has some attributes such as height, width, class and bounding box center. Bounding box can be represented using yellow outline. Yolo uses bounding box to predict height, width and class of an object. Yolo predicts the coordinates of bounding box that is given in figure using convolutional neural network.



**Fig 3. Boundary Box**

In the above figure it represents probability of an object appearing in bounding box.

Performance Parameter used in our model:

Intersection over union (IOU) describes how boxes overlap and it provides output box. Each grid helps to predict bounding box. If the predicted bounding box is similar to real box, then value will be 1. Thus, combination of above three techniques helps in object detection.

The YOLOv2 algorithm utilizes a grid-based approach for object detection, where the input image is divided

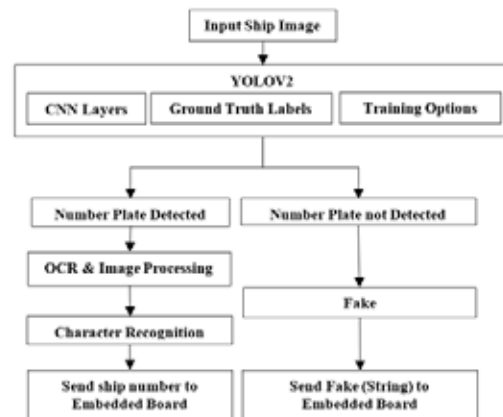
into an  $S \times S$  grid, and each grid cell predicts only one object. To accomplish this, each Convolution block in the algorithm is normalized using BatchNorm and activated with Leaky Relu, except for the final Convolution block. This method was applied to ship object identification and classification, where a classification training model was obtained by an image dataset. Experiments were conducted using sample images to evaluate the detection method’s effectiveness. The network structure of YOLOv2 for ship detection is a classification network structure specifically designed for this purpose.

YOLO predicts multiple bounding boxes per grid cell. To ensure only one bounding box is responsible for an object, the true positive loss is computed by selecting the prediction with the highest IoU (intersection over union) with the ground truth. This approach promotes specialization among the bounding box predictions, as each prediction improves in predicting specific sizes and aspect ratios. YOLO utilizes the sum-squared error between predictions and ground truth to calculate the loss.

The loss function composes of:

- the classification loss.
- the localization loss (errors between the predicted boundary box and the ground truth).
- the confidence loss (the objectness of the box).

Here, we are going to discuss the Yolo V2 network. The provided diagram illustrates the model architecture of our proposed method.



**Fig 4: Architecture Model**

Our model incorporates several key layers to perform its tasks effectively:

1) Convolutional layer: A 2-D convolutional layer, created using the convolution2dLayer function, applies convolutional filters to the input data. The layer comprises individual neurons that are linked to specific sub-regions of the input images or the outputs from the preceding layer. These neurons scan through the input by sliding their convolutional filters across the image or feature maps. Each neuron learns to detect and extract localized features within its receptive field defined by the filter size. By applying convolutional operations, the layer can capture spatial patterns and relationships in the input data.

2) Max Pooling Layers: A max pooling layer takes a grid of numbers as input and divides it into smaller rectangular regions. For each region, it only keeps the largest number and discards the rest. This helps reduce the spatial dimensions of the input while preserving the most prominent features. Pooling layers traverse the input both horizontally and vertically, with the ability to set custom step sizes using the 'Stride' parameter. When the pool size is equal to or smaller than the stride, the pooling regions do not overlap.

3) Fully Connected Layers: Following the convolutional and pooling layers, fully connected layers are employed. A fully connected layer, is created using the fully Connected Layer function. These layers establish connections between each neuron and all neurons in the preceding layer. By multiplying the input with weight matrices and adding bias vectors, the fully connected layers enable the model to learn complex patterns and relationships among the extracted features. The weights and biases in the fully connected layer are adjusted during training to optimize the network's performance on a specific task.

4) Dropout Layers: These layers randomly set input elements to zero during training with a specified probability. By doing so, they prevent over fitting by changing the network architecture between iterations and reducing the reliance on specific neurons, enhancing generalization capability.

5) Activation Layers: Activation layers introduce non-linearities into the model by applying a specific

activation function to the output of the previous layer. This non-linearity allows the model to learn complex decision boundaries and make the network more expressive.

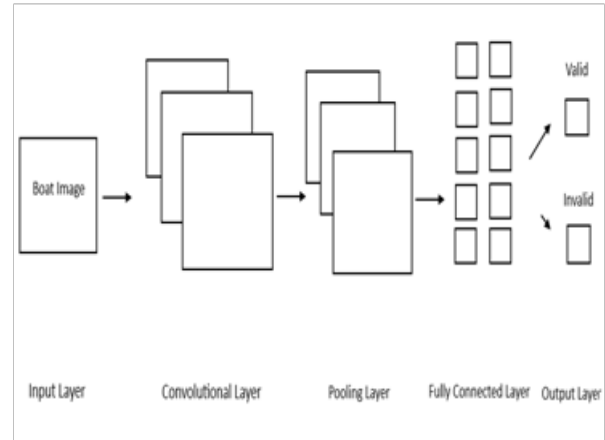


Fig 5: Architecture of CNN

### Training

We did a detection of two things, first is for ship detection and second is for number detection. We used YOLO V2 algorithm in detection. Yolov2 Igraph network is used, it has as many as 25 layers such as convolutional layer, max and average pooling layer, fully connected layer and normalization layer, etc. These layers are helped to detect the image, number and also color of the ship.



Fig 6. Ship Detection



**Fig 7. Number Detection**

Now, train a model by giving fixed number of epochs. We trained our model by giving 100 epochs. Yolo v2 object detector is used to train the model. This checks whether there is a ship or not. If there is a ship then it will go to check the number. It will check whether there is a number on the ship or not. If it is there then it will return the number of the ship and detection is completed. If the boat is not registered then it will not detect any boat.

## RESULTS

In our approach, we begin by selecting an input image and processing it through the YOLO v2 algorithm, which has been specifically trained on ship images. By running the input image through YOLO v2, we are able to identify if a ship is present in the image or not. YOLO v2 has learned to recognize ship-related features through its training on a dataset of ship images, enabling it to accurately classify ship instances.

After ship detection, we proceed to analyze the ship region further to determine if there is a license plate present. The CNN layers within YOLO v2 are responsible for capturing and extracting meaningful features from the ship image. Using these CNN layers, we pass the ship image through a series of convolutions, pooling operations, and nonlinear transformations. This process enables the model to focus on important visual characteristics, such as the presence of a license plate, within the ship region.

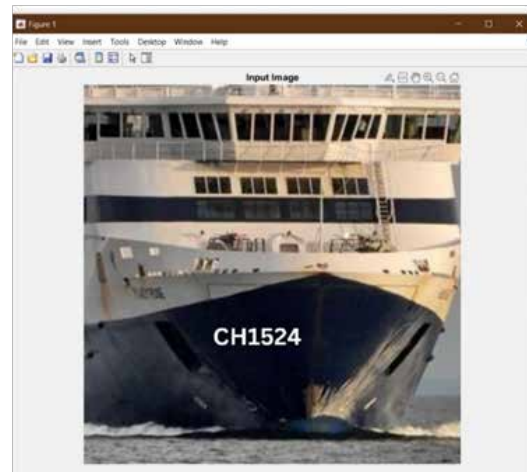
Once the license plate is extracted, Optical Character

Recognition (OCR) techniques are employed to recognize the alphanumeric characters on the plate. OCR algorithms analyze the image of the license plate and convert the visual information into readable text. This allows us to obtain the number associated with the license plate. The recorded license plate number is then displayed as the output for the given ship image.

Upon passing the input image through YOLO v2, if a ship is identified, we proceed to examine the ship image for a license plate using OCR but if the OCR fails to recognize the number, we output the string 'fake'.

In case YOLO v2 fails to detect a ship in the input image, we return an output string indicating 'fake'.

Input Image –

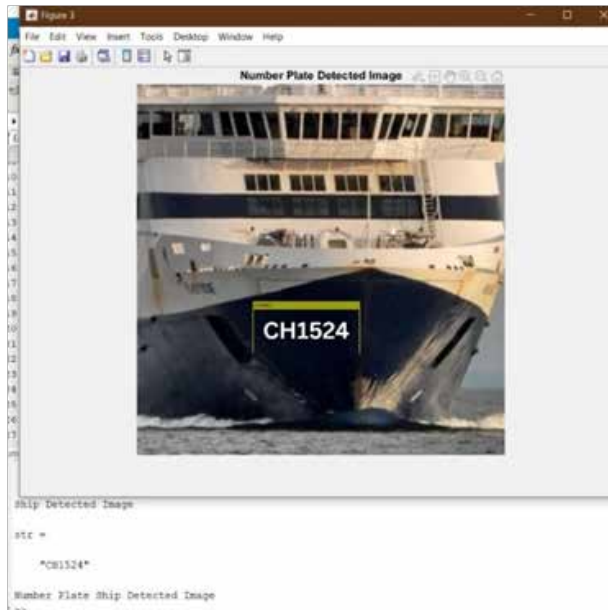


Ship Detected Image –





Number Plate Detected –



## DISCUSSION

Using the YOLO (You Only Look Once) algorithm for ship detection at small ports, specifically focusing on number plate recognition, our model provides certain advantages over previous models. Here are a few reasons why our YOLO-based model may be efficient compared to previous models:

**Simultaneous Detection:** YOLO performs object detection by dividing the input image into a grid and predicting bounding boxes and class probabilities for each grid cell. Unlike some previous models that use region proposal algorithms, our model that uses YOLO, performs detection in a single pass, resulting in faster inference times. This real-time detection capability is particularly beneficial for applications that require quick responses, such as ship detection at small ports.

**Number Plate Recognition:** Our model's ability to focus on number plate recognition in ship detection is a valuable feature. By training the YOLO algorithm to specifically recognize number plates, it can provide additional information for identification and tracking purposes. This can be especially useful at small ports, where tracking ships and monitoring their activities is essential for security and logistics.

**Flexibility and Adaptability:** YOLO can be trained on a

custom dataset tailored to ship detection at small ports, allowing us to collect images specific to our use case. By training the model on such a dataset, we can fine-tune the algorithm to be more efficient and accurate for our specific application. This adaptability of YOLO makes it a powerful tool for ship detection tasks.

**Single Stage Detection:** YOLO is a single-stage detection algorithm, which means it directly predicts bounding boxes and class probabilities without using a separate region proposal step. This simplicity reduces computational complexity and makes the algorithm more straightforward to implement and train.

**Novel Application:** Applying number plate detection techniques to ships is a unique and innovative application. Typically, number plate detection is associated with vehicles on land, such as cars or motorcycles. Adapting this technology to ships showcases a novel use case.

**Enhanced Identification:** By detecting number plates on ships, you can potentially enhance identification and tracking capabilities. This information can be used for various purposes, such as ship registration, security monitoring, or vessel management.

**Potential for Automation:** Integrating number plate detection into ship detection could enable automated systems for identifying and tracking ships in various scenarios, such as maritime security, port management, or surveillance applications. This automation could help streamline processes and reduce manual effort.

## CONCLUSION

The primary objective of this paper is to introduce a model that addresses the need for a secure and cost-effective tool for port authorities to log boat entries and validate their movement across ports. The proposed model aims to revolutionize the existing processes and enhance the overall efficiency and security of port operations.

Our current focus is on leveraging the YOLO algorithm for accurate ship identification and number plate recognition. However, we acknowledge the need for continuous improvement and faster algorithms for efficient detection. By exploring and incorporating advanced algorithms and hardware optimizations, we aim to enhance the speed and accuracy of our method,

ultimately contributing to more effective maritime surveillance, tracking, and security systems.

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# Blockchain-inspired Criminal Record Management System and Psychological Behavior Forecasting using Machine Learning

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## ABSTRACT

Traditional criminal record management systems have a lot of common faults and several limitations. Most of them rely on paper-based records which are difficult to maintain and often susceptible to damage or alteration. There can be several privacy, storage and cost issues. This system is designed to store records about criminals taking security and cost in consideration. The records of every criminal will be stored on a blockchain-inspired architecture with details like name, age, address, crime, and punishment along with other attributes about the crime committed. The access to this block-chain like structure will be highly restricted. A major question about the correctional facilities is to verify how many criminals return to life of crime after judicial punishment and how many leave crime for good. Predictions based on recurring patterns will help facilities focus on criminals who have a high chance of committing a crime after prison time and help them stop by means of therapy and other possible means. These predictions will be made by training machine learning classification algorithms.

**KEYWORDS:** *Blockchain-inspired, Database, Security, Machine learning*

## INTRODUCTION

Criminal Record Management Systems are used by police throughout the nation which focuses on crime detection and criminal convictions based on a variety of factors. Slow court proceedings are a major reason for rising crime rates. Efficient and easy-to-use systems can prevent crimes or at least help them to be reported early. Records can be easily destroyed or fabricated. The competence and efficacy of police combating crime is determined by the quality of information derived from existing records and the speed with which it can access it.

This system is designed to keep track of the criminals and their crimes.

Police officers can log in as superusers and enter information about prisoners such as their name, age, financial background, education, gender, crime, etc. They can also write and save the Crime Report. The profile of a criminal can be viewed at any time. Also,

this system provides an additional feature to depict the chances of a criminal perpetrating his next crime. This feature is trained using machine learning classification models. There are two models used – Passive Aggressive Classifier model and Random Forest.

This system can be used to verify the criminal records of a person which is necessary in various verification processes. This mechanism is essentially required in passport offices, for granting visa, in banks, etc. to verify criminal records of a person. The system operators at these places would be able to login as a normal user and access the records without tampering them.

## LITERATURE SURVEY

1) In paper [1], “Crime Reporting and Crime Updates”, the author created a program that specifically examines the topic of crime record management and is applicable to all police stations nationwide. It is well known that a highly responsive information management infrastructure is essential for crime prevention, criminal

detection, and criminal conviction. How well and quickly the police can access information from their existing records will determine how efficiently they can carry out their duties and effectively combat crime. A police detective will be able to access information from all state records through the system, whose initial implementation will take place across cities and districts before being linked together to speed up and successfully complete cases. The project is envisioned as having a distributed architecture with database storage being centralized.

2) In paper [2], “A Scalable Online Crime Reporting System”, the authors created a project to help the Nigerian Police to efficiently crack cases by gathering useful information about criminals and their mode of operation at the right time in order to nip crime in the offensive activity at a specific location. Finally, a prototype of crime reporting system based on four reporting forms was created: a complaint or dispatch reporting form, a crime event report form, a follow-up investigation report form, and an arrest report form. The system is divided into three functional modules: data capture, report management and control, and data utilization.

3) In paper [3], “CRAB: Blockchain Based Criminal Record Management System”, the authors designed a model that eliminates the issue of public records being tampered by utilizing decentralized system for storing the data. Digital signatures verify the integrity of transactions or newly entered data. Each data sender is solely responsible for the data’s contents. Encryption contributes to the system’s security goal. The cipher keys that are arbitrarily generated ensure that all files have a unique key, reducing the attack risk exponentially. The cloud components – record storage system and blockchain, cannot be accessed by anyone directly. All of this ensures maximum data security and precise provenance recording, as well as overcoming other potential software and hardware failure issues.

## PROBLEM DEFINITION

To design and develop a Criminal Record Management System using blockchain-inspired structure with utmost security in storage of records and also provide a feature for psychological criminal behavior detection by integrating machine learning in the system.

## OVERVIEW OF OUR PROPOSED SYSTEM

We have proposed a Python implementation of blockchain-inspired technology for secure storage of the criminal data. In the backend alongside we have used a combination of machine learning algorithms for psychological criminal behavior forecasting.

Along with securing the data, the system will prevent the hackers from gaining access into the network or a specific block, meaning that their actions won’t affect the security of other blocks. This system is adaptable and challenging to manipulate due to its distributed structure.

We have used the SHA-256 hashing algorithm for encryption of data. It boosts the system security. With a digest length of 256 bits, the Secure Hash Algorithm (Secure Hash Algorithm, FIPS 182-2) is a good cryptographic hash function. Security Hash Algorithm (SHA) was developed by NIST, followed by SHA-256 (the SHA-2 family), where 256 represents the hash length in bits. SHA-256 is similar to SHA-1. Like SHA-1, SHA-256’s message is padded & divided into 512-bit blocks [4]. Every block has a unique hash value that is derived from the previous block’s hash and the transactions in that block. Since we cannot reverse engineer the process, the input value in hashing generates a brand-new ID following each change in values in the system, which aids in our ability to apprehend offenders.

Further, we have extended an additional feature to predict the probability of a criminal committing his next crime as a supplement to the fundamental capability of creating and viewing a criminal record. Our application will act as a database for the details of a specific criminal’s court sentencing as well as alert the relevant authorities about the likeliness of the particular criminal committing his future crimes. Our application’s primary task is to eliminate the drawbacks of conventional and traditional databases, specifically their susceptibility to SQL injections.

### Record Management System Specifications

Moving on to the specifications of the proposed record management system, we have used python for full stack development. Django webapp framework has been used

for login structure of our website. Django Rest is used for designing the blockchain-like structure for storage of records. Data is stored on both the frameworks as illustrated in Figure 1. Webapp structure gives input to the database and Rest API gives input to blockchain. The blockchain structure holds JSON files in multiple locations throughout multiple folders thus making it a distributed architecture. As mentioned before the login data is encrypted by SHA-256 algorithm.

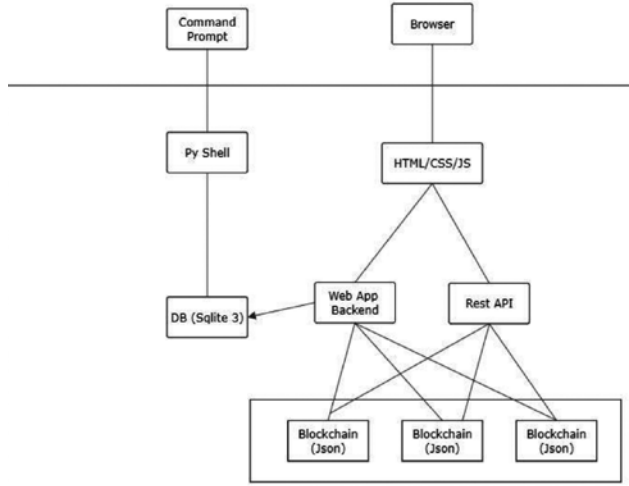


Figure 1. Architecture for record management system

**Forecasting feature specifications**

For the forecasting feature implementation, we have used two algorithms-Passive Aggressive Classifier and Random Forest.

**Passive Aggressive Classifier**

Since new data will continuously get fed into the system, we required an algorithm that trains incrementally by feeding instances in small groups. Passive Aggressive Classifier is one such algorithm which falls in this category known as online learning. It is best for systems that receive continuously streaming data. It simply responds passively for correct predictions and aggressively for incorrect predictions.

This classifier works similar to Perceptron’s learning rule, in fact it’s a modified version of Perceptron algorithm. It includes a regularization parameter C which controls the tradeoff between rising margin size so that the classifier does not misclassify the training samples. Passive Aggressive Classifier updates their

model only when it misclassifies or finds a mistake rather than updating after every instance.

**Random Forest Classifier**

Random Forest algorithm is an ensemble learning method that works by constructing many decision trees during training epochs. It combines the output of all trees and returns it. This technique is mostly used to rank the variables according to their importance in a particular classification or regression problem in a natural way. That is why, we have chosen random forest as well for predicting the probability of behavior.

This algorithm generally uses the technique of bootstrap aggregating also known as bagging to the decision tree learners.

In mathematical terms, suppose our training set  $A = \{a_1, a_2, \dots, a_n\}$  has responses  $B = \{b_1, b_2, \dots, b_n\}$ , that is bagging continuously ( $X$  times), chooses a random sample with replacement from  $A$  and fits a classification tree  $t_x$  to each of these samples  $A_x, B_x$ . After training, predictions on new data samples can be done by considering the majority vote among the decision trees.

As our dataset contains text data, we have used Label Encoding to convert the text data into numeric form.

Figure 2 illustrates the scalable machine learning model we have deployed for feature implementation.

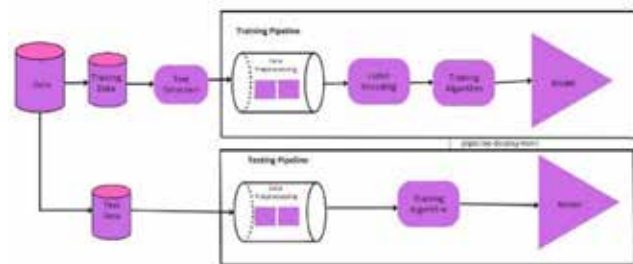


Figure 2. Model for feature implementation

**RESULTS AND DISCUSSION**

Criminal records will be stored in the blockchain-inspired structure through Django REST and Webapp framework. The data will be uploaded in database (SQLite 3) as well, a reliable structure for storing and retrieving files. Each block containing the data of one criminal will have a unique SHA-256 hash for identifying them uniquely thus guaranteeing security. In

addition to efficient storage of records, the likelihood of a criminal committing his future crimes can also be determined with an accuracy of 91.34%.



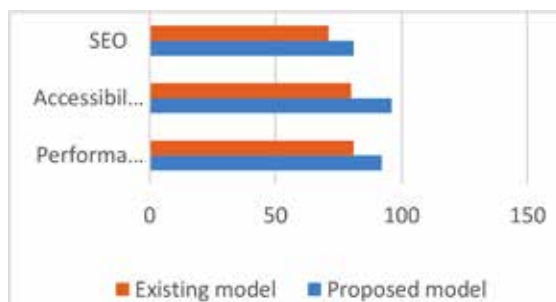
**Figure 3. Blockchain consisting of a block and a genesis block**

We have compared some existing webapp systems of criminal record management with our proposed system with blockchain-inspired architecture. Table 1 compares the two systems based on their performance metrics.

Table 1. System Performance Evaluation of existing systems and our proposed system.

Metrics	Proposed model	Existing model
Performance	92	81
Accessibility	96	80
SEO	81	71

Figure 4 compares the two models on a chart on the basis of common metrics used for measuring load performance of system. Performance metric calculates system performance considering speed index, loading time, availability and response time. Accessibility indicates the usability of website to users. SEO which stands for search engine optimization indicates the visibility of the website on search engines.



**Figure 4. Comparison chart between existing systems and our proposed system.**

Diving deep into the performance of backend, we compared our functions with other existing model functions. The performance metrics for each module has been compared below :-

- Runtime for generating the chain takes 55ms while in a normal blockchain based system it takes 45ms.
- Maximum capacity for SQLite is 140 TB, our SQLite size is 184.0 KiB.
- For mining a block, it takes usually 168ms in our system while in others it can vary depending on the users taking time to solve the puzzles.

Such variations occur because we have designed our system from scratch in Python Django framework which eliminates the cost of using Ethereum based blockchain repository.

**CONCLUSION**

An efficient system of record keeping and information transmission has grown more crucial in today’s globalized society as a result of the increasing volume of records. One of the most sensitive papers is a criminal record, so its security is crucial. Public records are frequently altered and this can have undesirable consequences. In comparison to traditional databases and handwritten records, the Distributed Crime Record Management System will be more safe and secure in preserving such sensitive information as mentioned in the results and discussion section. The unique 256 bits hash confirms the authenticity of uploaded data.

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# Digitalization of Doctor's Handwritten Prescription using Optical Character Recognition (OCR)

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## ABSTRACT

Handwriting recognition of medical prescriptions has emerged as a complex issue in almost recent years, prompting ongoing research to develop accurate solutions. The presence of illegible handwriting in prescriptions and the challenges faced by pharmacists in deciphering them can result in potentially harmful consequences for patients. In this Paper, we have proposed an Optical Character Recognition (OCR) model, which utilizes Machine Learning and Deep Learning techniques to accurately extract text information from medical record. Due to the often-illegible of handwriting of doctors, it can be difficult for patients and even some pharmacists to understand the prescription medications that have been prescribed. Doctors may be overloaded with work, causing them to write prescriptions in shorthand or cursive, leading to potential misspellings of drug names. Additionally, doctors may write prescriptions in their native language, adding another layer of difficulty for interpretation. To address these issues, we propose developing a handwriting recognition system that can recognize doctor's handwriting. The system has been utilized by image processing and word segmentation techniques to process the uploaded image of the prescription for each language, and a deep learning model comprising of CNN and LSTM is been trained to identify the text. Unicode is used to match words in different languages and fuzzy search are employed to provide an optimized output from the pharmaceutical database. The end result is a structured output presented to the user.

**KEYWORDS:** *Machine learning, Open CV, Convolutional neural network (CNN), Optical character recognition (OCR), Long short-term memory, Image pre-processing*

## INTRODUCTION

The Indian Handwritten document interpretation has been a highly active research area in recent decades, driven by its broad practical applications. However, recognizing handwriting poses significant challenges due to the wide variability of writing styles, cursive nature, and vocabulary size. While character recognition achieves high accuracy rates, offline text recognition falls short in meeting real-world application requirements. Although handwriting recognition techniques have found success in applications such as automatic address reading, bank check processing, and form recognition, their implementation in doctors' handwritten prescriptions remains limited due to the significant challenges in readability.

During patient consultations, doctors write reports and prescribe medications. In many hospitals, printed medical prescription formats are used to facilitate record-keeping and analysis of prescribed medicines worldwide. However, the statistical analysis of medicines becomes difficult when evaluating handwritten prescriptions, as optical character recognition (OCR) often fails. Illegible prescriptions pose challenges not only for patients, who may misinterpret them, but also for pharmacists, who struggle to differentiate doctors' handwriting from that of other professionals.

Addressing medication errors resulting from illegible prescriptions is crucial, as they can have a wide range of consequences, from itchy skin and rashes to severe long-term health issues. While such errors are not frequent, their implications for individuals can be

severe. Research conducted in Egypt has shown that a majority of the population (around 96 percent) supports the implementation of software programs capable of converting physicians’ handwritten prescriptions into digital text. Proposed systems employ advanced methods like Convolutional Neural Networks (CNN) to recognize and interpret English letters and numerals.

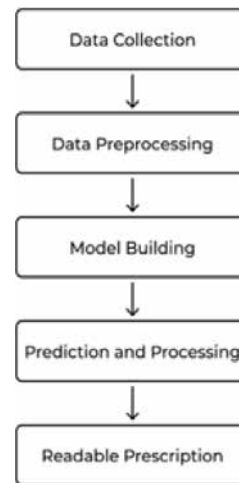
Therefore, the fundamental aim of this research paper is to deliver an application that can passively recognize digital representations of medical prescriptions or scan physical prescriptions to convert them into digital text. Deep learning techniques, including CNN and Long Short-Term Memory (LSTM), are used for image recognition to achieve this goal. Additionally, word segmentation techniques are employed to process prescription images and enable accurate optical character recognition. The resulting system generates customized output, providing a concise summary that can be easily understood by users, irrespective of their medical knowledge. This development process emphasizes the creation of a user-friendly interface, enabling individuals to effectively follow their prescribed dosages. This approach simplifies the responsibilities of both new pharmacists and patients, promoting accuracy and efficiency in medication management.

**DESIGN AND METHODOLOGY**

**Data Collection**

The data is been compiled from scratch as there isn’t any prior data, this is because the training and the validation part of the deep learning is completely dependent on the data. Data will be obtained by scanning the prescriptions manually and using them in order to satisfy the data requirements. By using this method, the accuracy of our model is increased significantly making it more reliable, since it is been directly used by the recognition model. We could also build our dataset using Google API. First, we will upload English prescriptions to the Google API which will convert them and then this will be passed to GAN Which will generate handwritten text in English languages.

Fig.1 shows the procedure used to process the doctor’s prescription. Which is explained in detail below.

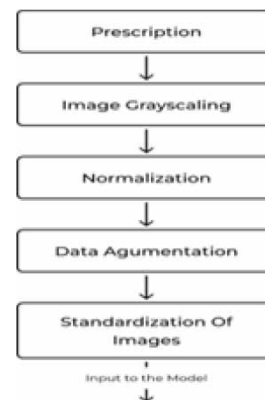


**Fig.1: Phase of design**

**Data pre-processing and training model**

Data Preprocessing:

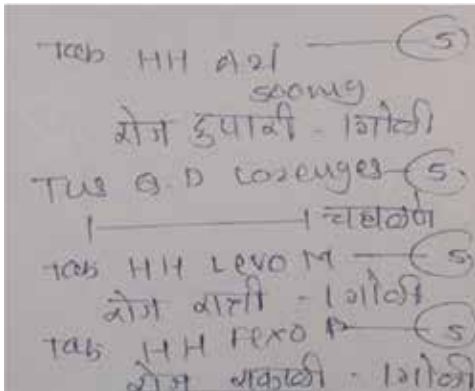
Data before passing to the model is been sufficiently pre-processed to ensure that the model produces good results. If we use scrappy data, it will produce garbage results. Hence, after data collection, collected data is unsorted and processed. Below given are data pre-processing methods used on the data, to cautiously tread the data. concise summary that can be easily understood by users, irrespective.



**Fig.2 Data Pre-processing**

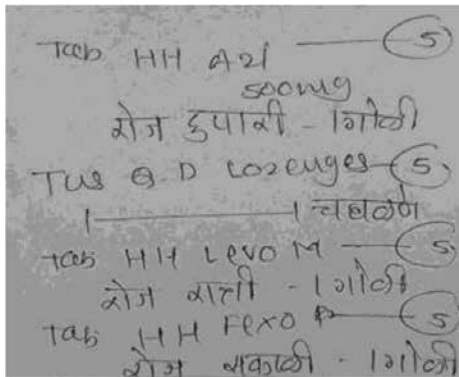
Grayscale conversion:

Gray scaling is the initial-most step to pre- processing digital image. In order to assemble the images in the data to train the model and obtain a conclusion from it. Each pixel’s value solely encodes the light’s intensity information.



**Fig. 3. Original Image**

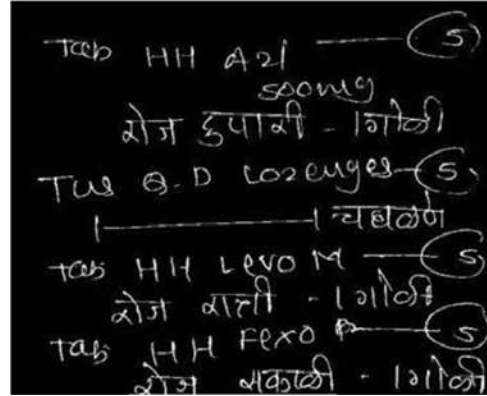
Fig. 3 shows the original image which is been converted into grayscale as shown in Fig. 4, then it possesses only black, white, and gray colors. Black, white and gray are the only colors used in the grayscale images, they are available in variations of tints. Then followed by gray scaling of images, they are sent to perform word segmentation on them.



**Fig. 4. Gray Scaled Image**

Text which is on the prescription is split into sections by using commas and various special characters of another kind. First, segmentation is performed on the words and then they are normalized. Normalizing is the process in which the pixel range is converted from 0 to 1, by dividing the value of grayscale pixel by 255. The primary pixel values of images are gray scale from 0 to 255 range. The edge detection stage is a crucial step that is followed after the normalization phase. The Edge detector comprehends the digitized and discrete images as input and outputs an edge map in return to those pictures and also smoothing is applied to the image to decrease and as well as eliminate noise. Edge

detection is the vital stage of the image pre-processing procedure, wherein significant qualities of the objects in images, like discontinuation in the photometrical, physical attributes.



**Fig: 5. Edge Detected Image**

The figure illustrates the image obtained after the edge detection process of the original image. The unessential noise present in the image is suppressed by performing a smoothing process accompanied by edge detection on the image.

Normalization:

In order to make the pixels of the picture consistent with the data, they are resized to a preset range. Thus, after This is done, the model performs simple learning by avoiding irregularities in the training model.

Data Augmentation:

The data augmentation process mostly includes rotation, shearing, horizontal and vertical flipping, and cropping, etc. In order to deliver a diverse range in a sole identifiable format, data augmentation is used to make infinitesimal changes to a picture. Data augmentation, furthermore ensures that the neural network doesn't learn from irrelevant data. The trailing process performed is image stabilization.

Image Standardization:

With regard to converting all the data obtained into appropriate size, image standardization is used which converts the height and weight of a picture to a common scale. The consistency is increased of the given data as well as the quality, ultimately is the priority whilst completing these activities.

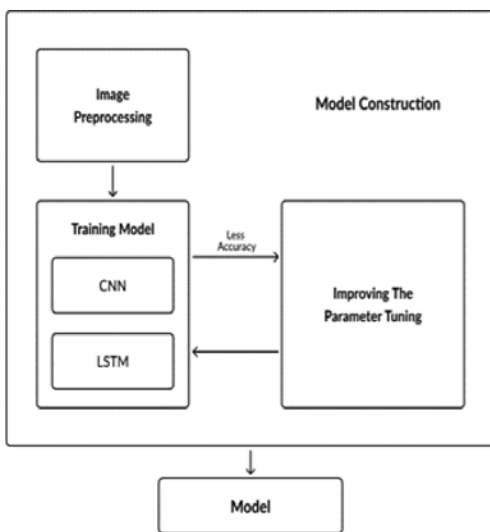
**Training the model:**

Following the pre-processing of the handwritten text input, we are required to train the model using structured data. In the training of the model, we must avoid overtraining the model, which will ensure optimal data, as a result, the model is suitable for only particular data only. Circumventing this, the model is hence trained utilizing 50 epochs, to recognize presented information, 50 epochs is an appropriate ratio.

**Model Building and Prediction**

The program code is written using popular Python libraries such as TensorFlow and Keras. A neural network is used in the utmost part of the system. The model is trained using Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) neural network. Hence, the model is made up of two CNN layers. In the CNN layer, each layer has 32 filters and 64 filters respectively. Such methodologies are used to train the model.

The SoftMax activation function is also utilized. Figure 6 enlightens this part more effectively. Figure 7 briefs us about the use of other tools like market basket analysis and fuzzy search, which will provide further support to the model after we have completed the recognition process. The medical database is examined closely to determine if the model is familiar with the few terms, it contains or simply the drug is compared, in order to avoid mistakes.



**Fig.6 Model Working**

**Unicode Data**

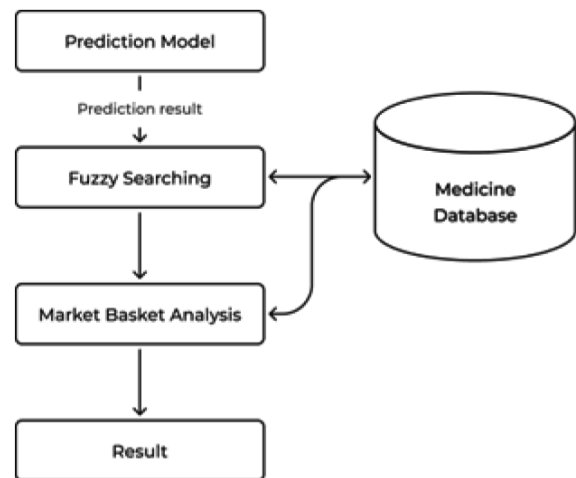
As to everyone's awareness, Optical character recognition (OCR) is the most effective procedure to recognize characters. Since Indian scripts are flagrantly tough to decipher, we are going to add a post-processing phase to the OCR to obtain acceptable character recognition. Characters are merged with the mapper in order to produce a string in this technique, these are typical characters, which are broken down into some meaningful components and have been used in the process of training the model with Unicode. After that, the outcome have been decided whether it is a legitimate UAM (Unicode Approximation Model) or an invalid UAM. The incorrect UAM is again processed with an algorithm that matches string patterns and then is verified with the genuine UAM databases. At last, the character or string is appropriately modified by the mapper to Produce the proper UAM.

**Fuzzy search:**

Even if the model recognizes only a few words in the prescription, fuzzy search is used to provide the precise predicted word of the tablet, even if the spelling of the tablet word is incorrect. This is achieved by utilizing the medicine database.

**Market basket analysis**

In order to conserve the time required to analyze the words, market basket analysis is used which saves time when we are detecting commonly used drug names and data present in the prescription.

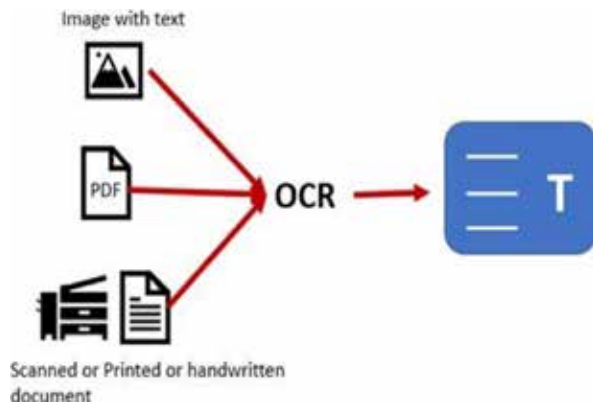


**Fig. 7 Prediction Optimizer**

**Application Interface**

The application is very user-friendly where in, the users can easily upload an image of their prescriptions and receive data in response which have been digitalized text of the prescription. Hence overall the application is autonomous and simple to use. The output text in a processed and organized format is been given in the application interface, accompanied by a brief explanation of the identified drug's name.

**Optical Character Recognition**



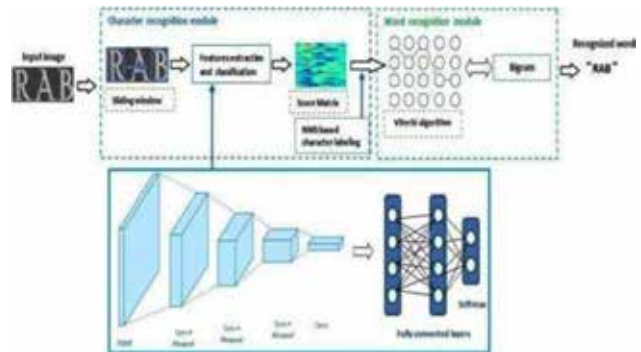
**Fig. 8: Optical Character Recognition**

OCR (Optical Character Recognition) in healthcare is a technology widely used to convert printed or handwritten text into a machine- readable format OCR can efficiently convert physical medical records into digital formats, ensuring accurate representation and easy accessibility of patient information. OCR technology assists in extracting information from insurance claim forms, invoices, and other healthcare-related documents. By automating this process, healthcare organizations can expedite billing and reimbursement procedures, enhancing efficiency and reducing the risk of mistakes.

**CNN (Convolutional Neural Network)**

CNN (Convolutional Neural Network) for text recognition from images using OCR (Optical Character Recognition) is a widely used approach for extracting text information from images. A CNN- based architecture is commonly employed for text recognition from images using OCR techniques. This approach utilizes deep learning algorithms to effectively process and extract text information from image inputs. The CNN model consists of multiple layers, including convolutional

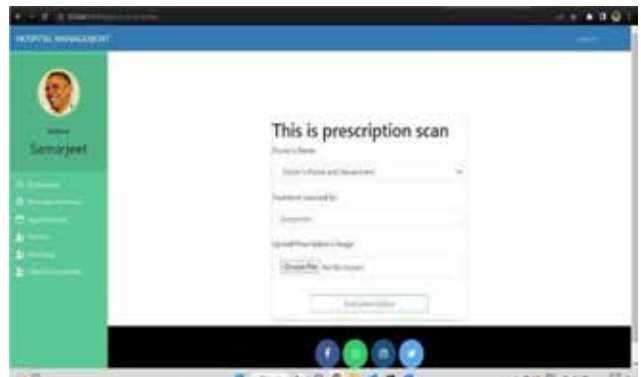
layers, pooling layers, and fully connected layers, designed to capture and learn meaningful features from the input images.



**Fig.9: Convolutional Neural Network**

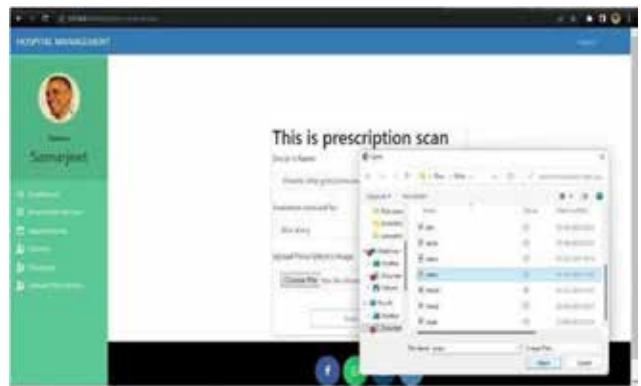
**RESULTS**

This is our patient module where prescriptions are scanned.



**Fig. 10-A: Patient Module**

Here you are given a button where patients can upload their prescription.



**Fig. 10-B Upload Prescription Image**





Fig. 10-C Prescription Output

Go to the Upload Image Prescription Section, click on the Choose file Button and Select any file from which you want to extract text from this image. After successfully image upload perform some preprocessing steps and you will get a text file containing the full text of the image with multiple languages supported for example Marathi, English.

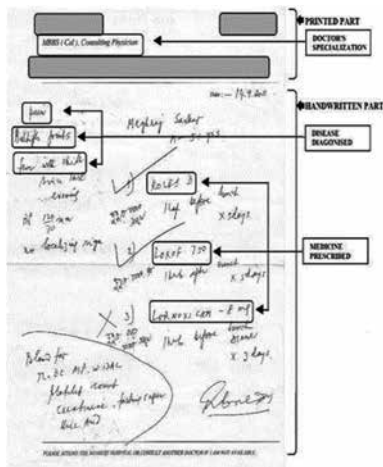


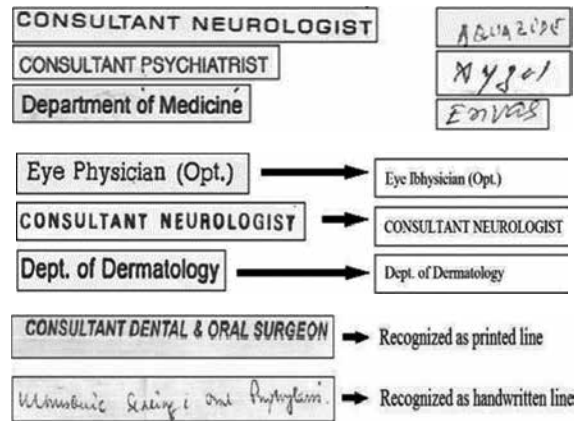
Fig. 11: An example of a Prescription from our dataset

A medical prescription typically consists of two parts: a printed letterhead at the top of the document, containing the doctor's name, designation, registration number, organization name, etc., and a handwritten section that includes the patient's name, the findings of the patient's report, and the prescribed medication names.

Fig.11 shows a medical prescription example where medicine name is ('ROLFS D' 'LOXOF 750' 'LORNOXI CAM 8') and the disease diagnosed ('Multiple joint pain', 'chilled fever') can identified as shown by arrow points. The patient faces a lot of problems to understand the reports because of sloppy handwriting of doctors

and unstructured texts. Misreading might lead to mistreatment that can affect the patients and is disaster for healthcare.

Doctors' handwriting poses numerous challenges that make it challenging for other systems to understand. Word spotting is a technique used to identify and extract words or phrases in speech messages as well as to highlight words in typed text documents. Initially, it was introduced for offline purposes. When dealing with handwritten documents, the indexing of keywords becomes crucial. Traditionally, handwritten word spotting has been seen as an image matching task, comparing a query against a database of candidate word. Previous studies have focused on keyword spotting for specific types of words, such as "street names", and have introduced holistic techniques that describe an image using a single feature vector. Another approach is to represent a word image as a sequence of character labels Introduced doctor's handwriting recognition using online information.



This paper focuses on addressing challenges in recognizing handwritten prescriptions due to readability issues. The proposed method incorporates keyword spotting and medical knowledge into the text recognition process. An OCR system specialized for printed text recognition extracts doctor attributes from the prescription's letterhead section. These attributes, such as discipline and department, are indexed with relevant search keywords. An offline handwritten word spotting approach, utilizing Hidden Markov Models, identifies queried keywords in the handwritten portion. Previous studies have explored identifying handwritten and machine-printed text at various levels, using

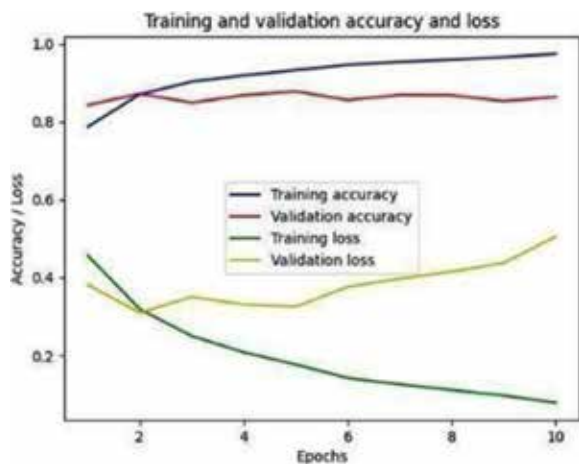
Hidden Markov Model-based classifiers for effective classification.

**Training and Validation Accuracy and Loss**

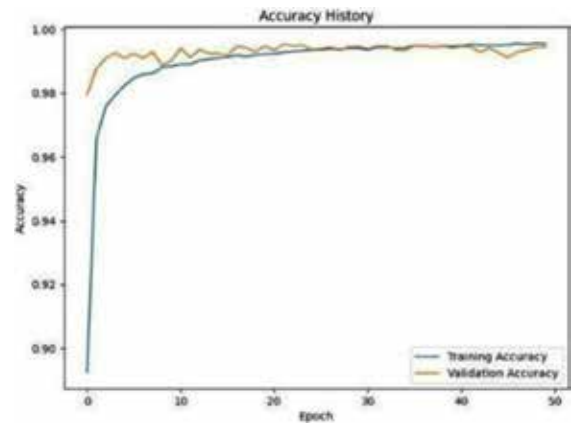
After training to understand how the model accomplished for the duration of that section, we plot two graphs one for training and validation loss, and the other one for training and validation accuracy.

In the first step, we visualize the keys then we get 'loss', 'accuracy', 'val\_loss', and 'val\_accuracy'. In the first graph of training and validation loss we create the first plot for loss then we plot for validation loss and then we plot for training and validation name as a legend, then we assign the name of the title as 'Training and validation losses. The graph is labeled as 'epoch'.

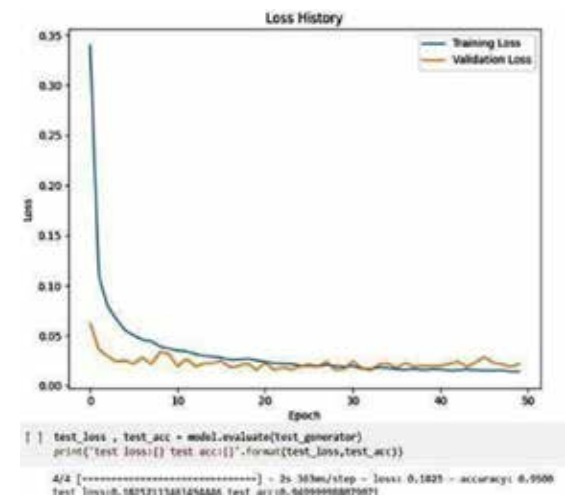
In the graph, the loss went down which is the good for model. For every epoch, the loss is going down and the data is well-fitted by keeping the training and validation lost to a minimum. The Second graph is having the same key as used for loss. In the Second graph, the training accuracy is 90 percent. Over the number of epochs, the accuracy has been increased. The accuracy of validation has reached around 85 percent. As there is no huge gap in the graph there is nothing wrong with the model. In the first graph for loss, both lost for the training and validation are going in the same direction. If in case training loss goes down continuously and validation loss goes to a certain amount and then starts to increase, then we can conclude our model is overfitting but there is no such case.



**Fig. 12: Training and Validation, Accuracy and loss using NLP algorithm**



**Fig. 13: Training and Validation Accuracy using CNN algorithm**



**Fig. 14: Training and Validation Loss using CNN algorithm**

**INNOVATION**

Our Project Name is Optical Character Recognition in Healthcare in which we have created a hospital management system with three modules. First Admin Module, Second Doctor, and the Third Patient Module. Admin can sign up their account and Then Login No Approval Required. Admin can register, view, approve, reject, and delete doctors (Admin Module approved those doctors who applied for jobs in their hospital) and admit, view, approve, reject, and discharge patients when treatment is done also approved those appointments which are requested by the patient at the end Generate Invoice according to doctor charge, medicine costs, room charge, and other charges. In Doctor, Module

doctor applies for a job in the hospital approval is required by the hospital admin then only the doctor can log in. A doctor can only view the patient detail assigned to that doctor by the admin. The doctor can view their discharged patient list, and their appointment, and the doctor can delete their appointment when the doctor attends their appointments. Patient Module In-Patient Module Create an account for admit to the hospital. approval is required by the hospital admin and then only the patient can log in a patient can view doctor details, book their appointment status, can book appointments, and view and download invoice pdf. In the Patient Module given a button where patients can upload their prescriptions. After successfully image upload performs some preprocessing steps and you will get a text file containing the full text of the image with multiple languages supported for example Marathi, and English this system provides high accuracy and Multiple Language Support as compared to the existing system. Both types of OCR Online and Offline used so provide high accuracy.

**Additional Features**

i. Hospital Management

OCR can play a crucial role in medication management by reading and interpreting medication labels, including drug names, dosages, and instructions. This enables cross- referencing with patient records to ensure accurate medication administration, thereby reducing the risk of medication errors.

ii. Faster Recognition

Faster recognition refers to the capability of an OCR system to rapidly and precisely recognize and convert printed or handwritten text into a machine- readable format. For its web application, we used OCR and CNN algorithm itself for detecting characters and then just initialized a variable ‘total’ which consists of total number of characters detected by OCR in the bounding boxes.

**COMPARISON OF PROPOSED WORK WITH EXISTING METHODS**

We have referred to some recent papers and what is lacking in that project we have completed our project. The existing System did not use Online Optical

Character Recognition in their project. There are two types of OCR: Online OCR and Offline OCR we used both Online OCR and Offline OCR. In the existing System, Optical Character Recognition recognizes only specific text, character which is written in the English language and sometimes it becomes difficult to recognize correct handwritten text which reduces accuracy. In our project, we have trained our OCR in such a way that it can recognize Marathi and English text and it provide high accuracy as compared to the existing system. We use the IMDB dataset This dataset contains over 1,00,000 images and each image is labeled with text that it contains another dataset is EMNIST Dataset the EMNIST dataset is a set of handwritten character images derived from the NIST special database. The dataset contains 70,000 training images and 10,000 test images. Our OCR can easily recognize a doctor’s handwritten prescription. A hospital Management System has been created in which we can add OCR to the patient side to upload the prescription successfully by recognizing the text and it will be stored on the doctor’s side. This will save time and Money.

**Confusion Matrix**

The Confusion matrix compare the model predicted value to the model’s actual target values. Figure 14 shows the confusion matrix for Optical Character Recognition in Healthcare.

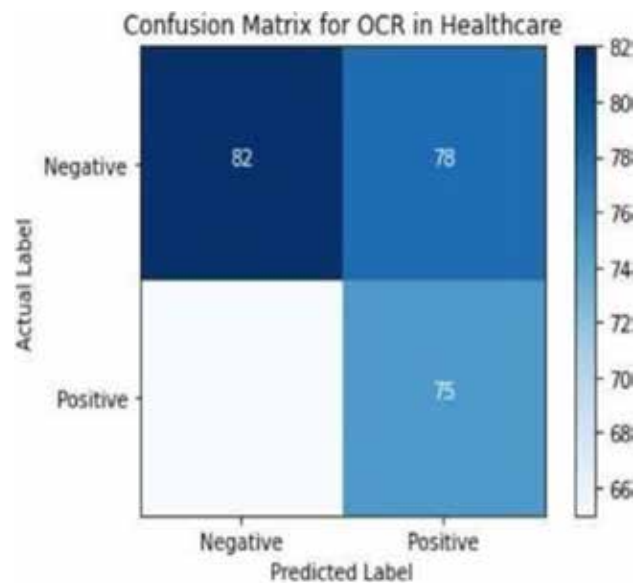


Fig. 15: Confusion Matrix

## CONCLUSION

Finally, this web application interface has made it easier for users to access the model and interact with it through the web application by providing a streamlined path to do so. In addition, the vast majority of users are able to validate the notes or prescriptions using this method without having any prior knowledge or experience in calligraphy analysis. Because of this, this technology will eradicate errors caused by humans and make it possible for clients to evaluate it on their own without the aid of specialists.

If we provide more data for training, we might potentially enhance the accuracy even further in the future. In addition, the procedure may be modified in such a way as to yield results in an even less amount of time. Create a program that is accessible on several platforms and has a lengthy shelf life to meet the most demanding of needs.

## ACKNOWLEDGEMENT

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# Smart Garbage Monitoring System using Adaptable Convolutional Neural Network

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## ABSTRACT

Many urban areas encounter garbage management problems. There are cases where the garbage is not properly managed by the municipal corporation, and due to this, the dustbins overflow and the garbage is spread all over the street. This can cause health problems and eventually diseases in the area. There are many systems designed nowadays that monitor and segregate garbage using Deep Learning models. However, the present trash detection algorithms still have flaws, such as their excessive complexity, inability to detect small targets, poor real-time performance and low detection accuracy. This paper proposed a model which recognize and detects garbage bin is full or not based on a adaptable Convolutional Neural Network (ADCNN) deep learning model. No such standard dataset is available for such particular scenario, so garbage waste dataset is prepared of 2868 images. Experiment results shows that proposed ADCNN produced a 96% accuracy result which is better than the other existing approaches.

**KEYWORDS:** *Garbage management; Machine learning; Convolutional neural network; Deep learning; Pattern classification*

## INTRODUCTION

The Over the world, environmental contamination brought on by the buildup of residential waste is a significant issue in many regions. According to a study, each year, 62 million tonnes of trash are produced in India. 70 percent of the total 43 million tonnes are collected, 12 million are processed, and 31 million are dumped in landfills. The production of municipal solid waste in urban areas is expected to reach 165 million tonnes in 2030 as a result of shifting consumption trends and robust economic growth. Maintaining a healthy, sustainable lifestyle in urban areas is getting more and harder due to environmental degradation. Absence of an effective waste management plan causes problems like a rubbish overflow, which gravely harms our ecology. Regardless of the cities, waste left in the dumpsters frequently builds up to an extent where it leaks outside the trash pail, fills full spaces, and endangers the health of the locals. The intent of this paper is to offer a solution

for the detection of full dustbins in various parts of the city so that proper management can be done. In this paper, the objective is to create an effective machine learning model that will be helpful for determining the status of garbage in the dustbins. Lack of attention in waste management can lead to harmful effects on every ecosystem. So, finding the amount of recycles, sorting them should be in the early stage [8][9]. Objectives of paper are

- To maintain the overall system flow of waste management and repair the old system flow by using the mechanism of deep learning.
- Classify the waste and to make a user-friendly system for efficient management of waste collection.

Rest of the paper organized in different sections. Related work is represented in section II. Adaptable CNN is explained in section III. In section IV represented the performance evaluation and its comparison with



existing work. Conclusion and future direction of research is represented in section V.

## RELATED WORK

Many researchers did excellent work in the fields of deep learning and image classification for waste management. Classified the waste into two categories biodegradable and non-bio-degradable [1] and for that, the Inception-v3 algorithm implemented. It includes a BN auxiliary, which is addressed to the version of the auxiliary classifier that also normalizes the fully connected layer in addition to the convolutions. The accuracy was 88.30% with a 1.3 seconds execution time. Deep learning is used to automate waste detection and separation, with the goal of minimizing human involvement. Utilizing TensorFlow's Object Detection API, a quick R-CNN is used for classifying and image processing to identify objects based on their shape, size, dimension, color, and other characteristics [2]. The majority of the key steps in waste management is recycling. A deep learning model using computer vision is suggested in [3] for the classification of waste. The Support Vector Machine (SVM), softmax classifiers and Sigmoid, along with a minimum of twelve different convolutional neural network (CNN) variants, have been trained using pre-existing images. According to findings, the softMax classifier on and VGG19 have an accuracy of about 88%. Using Machine Learning and IoT an efficient model was proposed for collection, segregation, transportation, and disposal of waste. SVM, Random Forest Classifier, Multilayer Perceptron, and naïve bayes these algorithms are used for waste image classification [4]. In 2022, efficientNet-B0 architecture used for waste classification [5]. In terms of FLOPS, the method's effectiveness was on a scale of 4X. Additionally, by focusing on clutter images specific to a particular region, it led to improvised classifications achieving an 85% accuracy of image classification. Deep learning approach used in 2022 [6] to automate waste detection and separation with the goal of minimizing human involvement. A fast R-CNN is utilized for categorization and image processing using TensorFlow's Object Detection API to identify objects based on their shape, size, dimension, color, and other characteristics. Garbage is broken down into all possible categories, including non-recyclable, bio,

metallic, glass, paper, plastics, and other unidentified classes, with a 75% accuracy of classification. The model proposed in [7] talks about the deep learning-based solution for waste detection implemented by EfficientDet-D2 and EfficientNet-B2 architects. It offers a comprehensive collection of practical problems standards that combine numerous datasets of different sizes from various contexts. There has been new benchmark datasets suggested that classify waste for garbage classification and identify debris for trash detection. . The waste segregation machine is developed using an artificial neural network algorithm with 80% accuracy [10]. ResNet deep learning is used for medical waste classification [12]. Waste management sorting strongly advised in municipal solid waste management (MSW). For MSW sorting, robotics, computer vision, and other advanced technologies are being used more and more. [13][14]. VGG16 CNN model and support vector machine are used on pre trained dataset for waste segregation with accuracy 92.7% [15]. Till date many researchers used deep learning and its variant applied for different pattern classification applications[18][19].

## PROPOSED ADCNN ARCHITECTURE

Proposed model tuned such a way that it handles the garbage waste n dimensional data features efficiently and produced remarkable results which is represented in Figure 1. In ADCNN model, we used batch normalization for speeding up training data which is not used in existing models and also, early stopping has used to avoid overfitting in the model so it increases accuracy. No such standard dataset is available, so authors created own garbage bin dataset for the classification of full and empty dustbins. We employed the ADCNN algorithm for deep learning, which has a 96% accuracy rate. This model contains pooling layers, dropout layers adjusted in a perfect manner such that it produces better performance. To avoid over fitting, we have used data augmentation, early stopping methods. CNN is a Convolutional Network Layer which helps for image classification. In the proposed model, three CNN layers are used and two max pooling layers are adjusted in such a way that model given better performance. In dataset, we used 80% data for training and 20 % data for testing the models. Also, 20% data of the training set is used for validation purposes.

## Data Augmentation

Creating new data by data argumentation from training data that has already been gathered. Cropping, flipping, cushioning, resizing and rotating are some of the techniques. It improves the performance of the model and deals with issues like over fitting and a lack of data. Here, we have used data augmentation due to less quantity of data. We have used an offline data augmentation method in our model. The offline data augmentation techniques are applied to each and every training image to produce the augmented images. This broadens the dataset and strengthens the model. The number of photos in the dataset can be increased using this approach. The benefit of offline data augmentation is that we only have to augment the data once and store all images permanently.

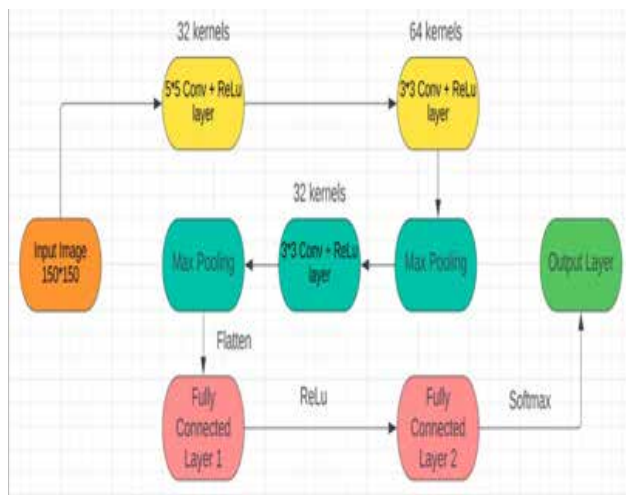


Fig. 1: System Architecture of ADCNN

## Data Pre-processing

Before using the image data as model input, data pre-processing should be done on it. For instance, convolutional neural network fully connected layers required that all the images be in arrays of the same size. In our model, we have done pre-processing on all images in the dataset after data augmentation. In preprocessing, we have made all image sizes equal. Also, we can label all images in 1 and 0. When the dustbin is full, that image is mapped with label 1, and when the dustbin is empty, that image is mapped with label 0.

## HYPERPARAMETER TUNING AND SELECTION OF PARAMETERS FOR THE ADCNN MODEL

In the proposed ADCNN architecture, convolutional layers, pooling types, various sizes of kernels, batch normalization, dropout, and dense layers plays an important role in achieving better performance. In this paper, we used a total of three convolutional layers. Firstly, two convolutional layers are used in this model. In the first convolutional layer, the number of filters is 32, the kernel size is (5,5) and the image size is (150,150,3). In the second convolutional layer, the number of filters is 64 and the kernel size is (3,3). Batch Normalization is used for speeding up training. After that, the max pooling layer is used for creating classifiers. After that, a dropout layer is used. Then a third convolution layer of kernel size (3,3) and 32 filters is used. For all convolutional layers, the relu activation layer is used. After that max pooling, dropout layers are used, and then a flatten layer is used for converting the data into a 1D array. Dense layers are fully connected layers in which relu and softmax activation layers are used, and after that we get an output layer. We have used the Adam optimizer in model compilation. The Adam optimizer has a faster computational time, so it is the most popular optimizer in CNN. The following is a sequential model structure of ADCNN is represented in Fig 2. with layer names.

## EXPERIMENT RESULTS

No such standard dataset is available, so authors created own garbage bin dataset for the classification of full and empty dustbins. A garbage waste dataset that we produced has 2868 photos, of which 2100 utilized in training phase and 600 for testing phase. Some samples of dataset is represented in Figure 3. If the model is configured for after training on training data with the highest accuracy, it is now ready to be utilized for the prediction of unknown data, which is testing data. During training, the model's accuracy increases to 98.99%, while during testing it increases to 96.00%, which is great. In each cycle of the training phase, a batch of 32 photos containing the datasets was sent to the model. After 30 iterations of the training model, we had this kind of outcome. Testing was performed on the test dataset, and accuracy was used as the performance

evaluation metrics. In the following figures, Figure 4(a) represents the loss of the model. We can see that there is a gradual decrease in losses as epochs are decreasing the heat map function allows one to see the confusion matrix. It is employed to evaluate the output's quality on the dataset. Test data should be utilized to create the data that will be used for model training and prediction. Figure 5 displays the normalized confusion matrix that was created from test data.

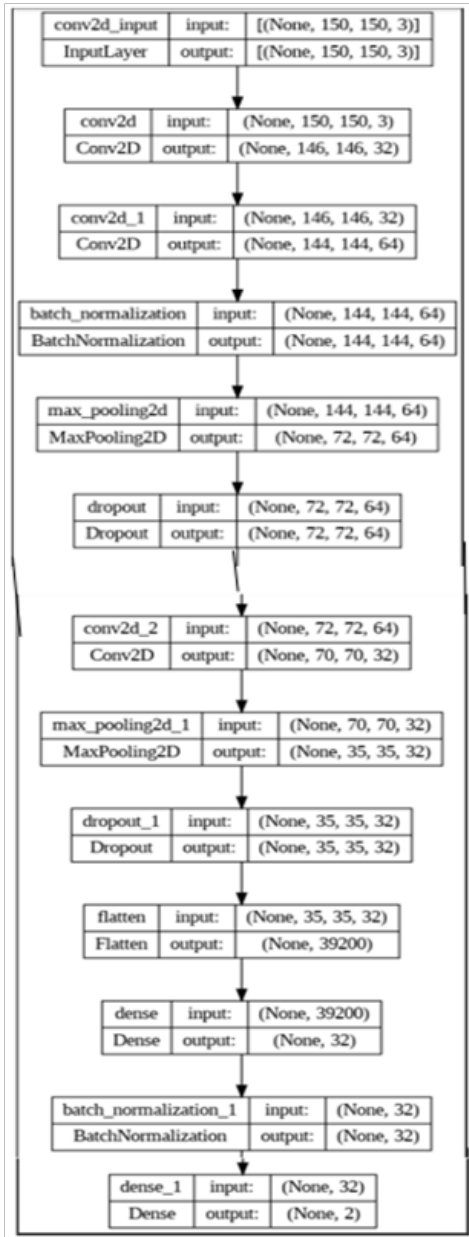


Fig. 2: Sequential ADCNN Model



Fig 3: Samples of Garbage waste dataset

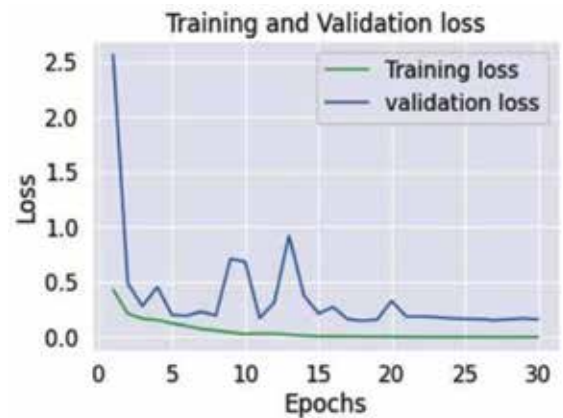


Figure 4 (a): Training Loss VS Validation Loss

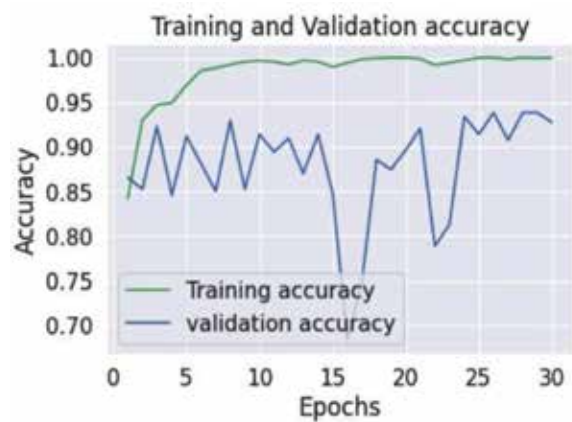


Figure 4 (b): Training Accuracy VS Validation Accuracy

	Predicted	
Actual	293	5
	19	283

Fig. 5: Confusion Matrix

Table 1 shows the accuracy classification report of the experiment results. And their performance comparison with existing approaches is represented in Table 2.

Table 1: Classification report

Classification Report				
	precision	recall	f1-score	support
FULL	0.94	0.98	0.96	298
NOT_FULL	0.98	0.94	0.96	302
accuracy			0.96	600
macro avg	0.96	0.96	0.96	600
weighted avg	0.96	0.96	0.96	600
Accuracy: 0.96				
Precision: 0.9826388888888888				
Recall: 0.9370860927152318				
F1 score: 0.9593220338983052				

Table 2: Comparative performance evaluation with existing approaches

Year& Ref.	Method	Accuracy
(%)		
2022 [16]	RWNet-152 model	88.8
2020 [9]	Mask-RCNN, YOLO, custom VGG16	90
2020[2]	faster RCNN object detection with API	91
2022[6]	Fast RCNN	75
2022 [15]	(VGG16) CNN model	92.7
2020 [1]	InceptionV3	83.30
Proposed Model	ADCNN	96

**CONCLUSION**

There are many solutions based on deep learning for garbage management systems, but the ADCNN method is proposed in this paper which focuses on detecting full dustbins in various parts of the city so that it is

easier for the municipality to manage the garbage. In ADCNN model, we used batch normalization for speeding up training data which is not used in existing models and also, early stopping has used to avoid overfitting in the model so it increases accuracy. The method proposed in this paper has an accuracy of 96% for waste monitoring. This model can be further improved to get higher accuracy results and can be integrated with an application that will send real time images to the municipality. Waste segregation is possible after determining whether the trash can is full or not. In future, proposed ADCNN model can be integrated with a mobile app, and the app will communicate the status of the waste to the municipality and regulate the timings of garbage trucks for collection of garbage after detection of trash dustbin full or not.

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# Performance Enhancement of BLDC Motor for Electric Vehicle Applications

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## ABSTRACT

In today's technologically advanced society, people are increasingly seeking out more modern, convenient, and environmentally friendly options. One area where this is particularly evident is the transportation industry, as traditional gasoline-powered vehicles contribute significantly to CO<sub>2</sub> emissions posing a high threat to the environment. Hence interest in electric vehicles (EV) has increased recently seeing its environmental advantages, high energy efficiency, and low noise. DC Motors, Induction Motors, Permanent Magnet Synchronous Motors, Switched Reluctance Motors, and Brushless DC Motors are various types of electric motors that have been used in electric vehicles in the past. But because of its high-power density, high power-to-weight ratio, instantaneous speed control and high efficiency Brushless DC motor is the most efficient choice for electric vehicles. In this paper, we present analysis of brushless DC motor of rating 500 W, 2000 rpm & 48 V by proposing various methodologies to improve performance of BLDC motor through simulation using Ansys Maxwell RMxprt. By using Ansys Maxwell we are simulating different design parameters like torque, losses, torque ripple factor, power & efficiency.

**KEYWORDS:** *Ansys maxwell software, BLDC motor, Controller, Efficiency, Electric vehicles, Performance enhancement, Simulation, Speed torque parameters*

## INTRODUCTION

With the introduction of electric vehicles, which will soon replace the current fuel vehicles, the transportation system will progress to a new level of transportation system. The transformation of petrol vehicles to electrical ones is going to help mitigate the existing pollution problem. Because of continued efforts to reduce environmental pollution, the electric vehicle market has increased in recent years. As fuel resources disappear, the use of energy efficient electric drives is predicted to replace fossil fuels. EVs are the least harmful to the environment compared to ICEs (internal combustion engines) [8] According to

the government think tank NITI AAYOG, EVs could reduce CO<sub>2</sub> emissions in India by 1 gigatonne by 2030. To improve the efficiency of electric vehicles, particularly in the case of only battery-operated electric vehicles, the power electronic system and control technique should be effective [1]. It was proposed and investigated to use permanent magnet motors, induction motors, switching reluctance motors or any type of mechanical device that would have been able to function in an electricity vehicle.

Currently, BLDC motors have a high degree of widespread use in industry, particularly in the automobile sectors. [2]. Over several decades, the

development of electric vehicles created a demand for dependable electric motor actuators. Electric vehicle actuators should consider BLDC motors because of their high resistance, simple design, and ability to work at high speeds.

A brushless direct current (BLDC) motor is a synchronous electric motor that is powered by direct current (DC) and has an electronically controlled commutation system rather than a mechanical commutation system based on brushes. In such machines current and torque, as well as voltage and speed are intimately linked. [1][2]. A brushless direct current (BLDC) motor is a synchronous electric motor that is powered by direct current (DC) and has an electronically controlled commutation system rather than a mechanical commutation system based on brushes. This means that both current and torque, as well as voltage and acceleration are closely connected in these machines. These characteristics drew numerous researchers to this field [9]. An electronic controller replaces the brush systems assembly to accomplish this. Yet because BLDC motor drives are nonlinear in nature, they need a better or different controller that can adapt to a nonlinear situation and achieve the desired performance [7]. The controller uses a solid state-static circuit rather than a commutator/brush system to perform the same power distribution as a brush dc motor.

## MOTORS USED IN ELECTRIC VEHICLE

Electric Vehicles use traction motors which are sufficient to deliver torque to the wheels. Electric motors are classified into two types: direct current (DC) motors and alternating current motors. Direct Current motors are durable and easy to control. They can be brushed or brushless Direct Current motors. Brushed direct current (DC) motors are a mature technology that offers high torque, low cost at low speeds, and speed control. These characteristics are critical for traction motors [3]. Brushed Direct Current motors, on the other hand, are not widely used in EVs due to their drawbacks, which include low efficiency, large size and the need for repetitive maintenance because of brush and collector structure. BLDC motors are very efficient.

Various types of Electric Motors used in Electric Vehicles

- DC Series Motor

- Permanent Magnet Synchronous Motor (PMSM)
- Three Phase AC Induction Motors
- Switched Reluctance Motors (SRM)
- Brushless DC Motor

### DC Series Motor

Electric Vehicles use traction motors which are sufficient to deliver torque to the wheels. Electric motors are classified into two types: direct current (DC) motors and alternating current (AC) motors. Both types of batteries can be used in EV applications [3]. Direct Current motors are durable and easy to control. They can be brushed or brushless Direct Current motors. Brushed direct current (DC) motors are a mature technology that offers high torque, low cost at low speeds, and speed control. These characteristics are critical for traction motors [3]. Brushed Direct Current motors, on the other hand, are not widely used in EVs due to their drawbacks, which include low efficiency, large size and the need for repetitive maintenance.

because of brush and collector structure. BLDC motors are very efficient.

### Permanent Magnet Synchronous Motor (PMSM)

This motor is also like Brush Less Direct Current motor which has permanent magnets on the rotor. Like Brush Less Direct Current motors these motors also have traction characteristics like high efficiency and high-power density.

Permanent Magnet Synchronous Motor is more expensive than Brush Less Direct Current motors. Most of the electric vehicle manufacturers use Permanent Magnet Synchronous Motor for their vehicles. For example, Toyota Prius, Chevrolet Bolt EV, Ford Focus Electric, zero motorcycles S/SR, Nissan Leaf, Honda Accord, BMW i3, etc use PMSM motor.

### Three Phase AC Induction Motors

Under fixed voltage and fixed frequency operation the Induction Motor do not have a high starting torque like DC series motors. But by using v/f method this characteristic can be altered. By using these control methods, the highest torque is achieved at the starting of the motor which is satisfactory for traction application. Squirrel Cage Induction Motor has a long life due to

low maintenance. We can get 92-95% of efficiency from Induction Motor. The disadvantage of an Induction Motor is that the control of the motor is difficult, and it requires inverter circuit.

### Switched Reluctance Motors (SRM)

SRM is a type of variable reluctance motor. SRMs are easy in construction and robust. The rotor of the SRM is a piece of laminated steel with no windings or permanent magnets on it. This makes the inertia of the rotor less which helps in high acceleration. The rugged nature of SRM makes it suitable for high-speed application. SRM also offers high power density which are some mandatory specifications of Electric Vehicles. Since the heat generated is mostly confined to the stator, it is easier to cool the motor. The biggest disadvantage of the SRM is the complicated control and boost in the switching circuit. It also has some noise issues.

### Brushless DC Motor (BLDC)

Motor torque is controlled by permanent magnets. The magnets are very influenced by the high temperature which drops down the remnant flux density and therefore the motor torque capacity. They are operated by rectangular waves, as opposed to BLAC motors, which are driven by sinusoidal waves. The elimination of brushes, compactness, high efficiency, and high energy density are among their primary advantages.

## BLDC (BRUSH-LESS DC)

### BLDC Motor

In contrast to traditional DC motors, BLDC motors commutation is carried out electronically rather than via brushes. Because BLDC motors don't have brushes, they require less maintenance, are less likely to produce noise, and lose less power in the air gap than brushed DC motors. The number of pole pairs in a permanent magnet rotor can range from two to eight. Considering the necessary magnetic field density in the rotor, magnet material is selected. Due to the lack of field windings, the BLDC motor has a high output power to size ratio, making it ideal for use as an in-wheel motor where weight and space are key factors. The lack of brushes also significantly lowers the BLDC motors' maintenance requirements, which is advantageous for EV applications. The integral in-wheel motor design is

also more practical due to the BLDC motor's noiseless functioning.

### Need of BLDC

The electric car is driven by various types of motors and, until now, they have all been DC motors. In the future, DC motors are replaced by induction motors due to wear and tear and reliability. Due to less maintenance, good performance, enough starting torque squirrel cage induction motors are a good candidate for driving electric vehicle [2]. Efficiency at low load conditions and machine size is a major problem for the induction motor. In order to optimise efficiency, this can be achieved by a variety of methods. More interest in vehicle applications has been attracted by brushless DC motors. BLDCs have compactness, high power density, prolonged life, reduced noise, higher efficiency, greater range of operation, good torque characteristics and low maintenance making them more suitable for these applications. The motors, as the name implies, are electronically commutated which means they do not use commutators or brushes. Their advantages have given them the upper hand over DC and induction motors. In view of the high efficiency of the motor, the stresses and losses of power from the sources and circuits are less than those of other motors, and its construction allows the motor to be coupled directly to the wheels of the vehicle without the use of mechanical structures that improve the compactness of the vehicle, as described below [2]. In addition, due to their advantageous characteristics they are used in many low power applications such as household appliances, aircraft drives, HVACs and robotics that receive high levels of attention. Manufacturers have developed motors with broad range of operations and excellent torque response characteristics which give good responses to vehicle applications, as a result of the development of effective power electronics controllers and semiconductors.

### Design of BLDC Motor

**STATOR:** The stator is an integral part of the electric motor and consists of a series of blocks around which the windings are wound, thus preserving magnetic conductor losses as little as possible due to silicon in it. Once the number of grooves in the moulds has been determined, sheet cores shall be drawn and pushed into place. Powder coated or powder insulator shall be applied

in order to cause a short circuit and prevent contact with the stator. The process of preparing windings consists in connecting to, varnishing and pulling out the end cables with connectors. Different stator inner diameter, external diameter, mold type and number of slots are shown in Figure 3 as well as different parameters used to drive the Brushless Direct Current Motor. There are devices with properties to be found.

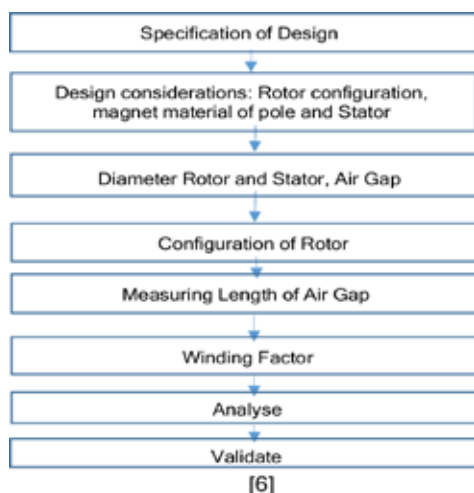
## PROBLEM STATEMENT

**ROTOR:** The rotor of a BLDC motor is made out of magnets. BLDC motors can be designed in two ways: inner rotor (In runner) and outer rotor (Out runner). Permanent magnets are wrapped around the stator windings in the outer rotor design; in the inner rotor design, the stator windings are the permanent magnets. Magnets are used to form the rotor of a BLDC motor. BLDC motors can be designed in two ways: inner rotor (In runner) and outer rotor (Out runner). Permanent magnets are wrapped around the stator windings in the outer rotor design; in the inner rotor design, the stator windings are the permanent magnets.

This paper includes performance enhancement of BLDC motor with following specifications.

Output Power Rating(W)	500
Voltage Rating (V)	48
Number of Poles	4
Speed Rating (rpm)	2000
Rated Torque (N.m)	2.39

**Table 1 BLDC Motor Ratings**



## PROBLEM STATEMENT

The following issues have been linked to the use of BLDC motors in electrical vehicles [5]:

- Formation of cogging torque,
- Losses,
- Selected magnetic materials,
- Efficiency.
- Air gap.

Our research's main goal is to analyse the underlying causes of the problems highlighted and determine the best course of action for mitigating or eliminating them.

### Cogging Torque

The major disadvantage of Brushless DC motors is the generation of cogging torque and ripples. The primary origin of its generation within a motor is due to the interaction between the stator tooth and the rotor's permanent magnet. It may produce the vibrations & sounds in the motor. Due to undesirable noises, this particular motor is not appropriate for use in automotive applications.

Cogging torque can be expressed as:

$$T_{cog} = -1 \frac{1}{2} \Phi_g^2 \frac{dR_g}{d\theta}$$

where the air gap flux and reluctance, respectively, are  $\Phi_g$  and  $R_g$ . To decrease the cogging torque, the stator slots are modified by adjusting  $dR_g/d\theta$  to zero through a twisting process. The development of torque is limited due to the presence of the angled stator slots.

### Losses

Losses in motors are unavoidable, but they can be minimized by selecting suitable materials. The primary losses, including ohmic, magnetic or iron, and copper losses, are considered for examination. The current paper suggests stator materials with lower composition compared to other materials, resulting in lower losses.

### Magnetic Materials

Permanent magnetic materials such as Aluminum Nickel Cobalt (Alnico), Samarium Cobalt (Sm Co), Ferrites, and Neodymium Boron (Nd Br) are examples of rare earth elements that can be obtained, and they are typically preferred to construct the rotor for BLDC

motors. High coercive and permeable materials are the greatest option to make the motor small. Magnetic Nd Br materials can be used to get this. We have used XG196/96 for the simulation. The following formulae can be used to determine the magnetic operating points.

Gauss's law is used to derive the magnetic flux density and airgap, which may be written as:

$$\frac{B_m}{H_m} = -\mu \frac{A_m g}{A_g l_m}$$

$$B_m A_m = B_g A_g$$

$$B_m H_m = \frac{B_g H_g A_g g}{2 W_g} = \frac{A_m I_m}{V_m}$$

where  $B_m$  and  $B_g$  stand for magnetic and airgap flux densities,  $A_m$  and  $A_g$  for magnet and airgap areas,  $g$  for airgap length,  $l$  for magnet thickness,  $H_m$  for magnetic field density,  $W_g$  for stored magnetic energy in the airgap, and  $V_m$  for the volume of magnetic materials.

### Efficiency

The motor's efficiency is calculated as the difference between its output power and the input power it receives. It can be stated as follows:

$$\% \eta = \frac{P_{out}}{P_{in}} \times 100$$

Reducing losses is a suitable approach for enhancing the motor's efficiency.

### Air Gap

The air gap between the rotating rotor and the stator creates resistance in the magnetic circuit, leading to undesired increases in magnetization current and associated electrical loss. Though this is unavoidable, the gap should be minimized to reduce the need for magnetizing power. However, it's essential to maintain large enough manufacturing tolerances to prevent stator and rotor contact due to mechanical deflection or looseness.

## VARIOUS METHODOLOGY

### Stator Materials [5]

Cold rolled steel and aluminium steel are the stator core components of BLDC motors that are available for use in electrical motors. The chemical compositions of this system can be changed, and a new type of steel can be suggested. Steel\_1010 has proven to perform better after going through many analysis. The following materials were utilized to make the stator:

- i) Cold Rolled Steel,
- ii) Aluminium Steel and
- iii) Proposed Steel

Cold-rolled steel and aluminium steel stator components are typically used in BLDC motors. A novel steel combination for the stator core is offered by altering the chemical compositions of the components.

### Winding Materials [5]

The materials utilized for the windings in BLDC motors are:

- i) Copper 5.77, ii) Copper 11000 and iii) Copper 12000

The materials for the winding are selected based on their conductivity. In descending order, silver, copper, gold, and aluminum are the best conductive metals. Of these, gold is quite expensive, and silver is scarce on the earth's surface.

### Number of Winding Turns

Copper was selected as the winding material in analysis in Maxwell. 24 winding twists are included. The relationship between coil turns and current carrying capacity is straightforward. Magnetic losses diminish as the turns rise. [5]

### Magnetic Materials

Magnetic component used for permanent magnets in the rotor is XG196/96 with various proposals is employed like Steel\_1010, Steel\_1008, M43\_29G, etc. [5]

### Magnet Pole Shaping

The cogging torque is impacted by the rate of change of air gap flux density at the magnet edges. In general, this strategy can lower the cogging torque by reducing the



magnet's length or width [10].

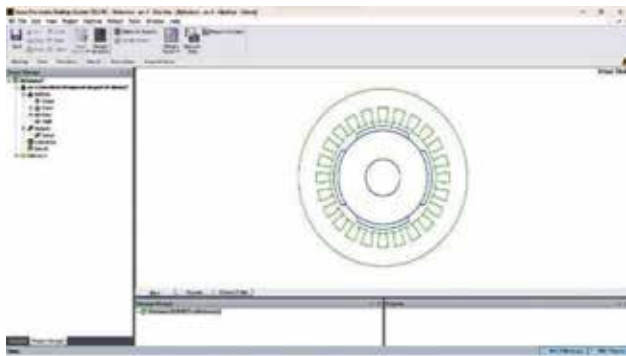
**Skewing**

Using this technique, each magnet face's  $dR/d\theta$  is essentially made zero. The cogging torque can theoretically be fully removed. In practice, it might not exactly approach zero but be greatly diminished. Either the slots or the magnets can be used for skewing [10]. Both have drawbacks. The price of the magnets rises as they are skewed. Skewing the slots lengthens the wire by increasing copper losses resulting into longer slots.

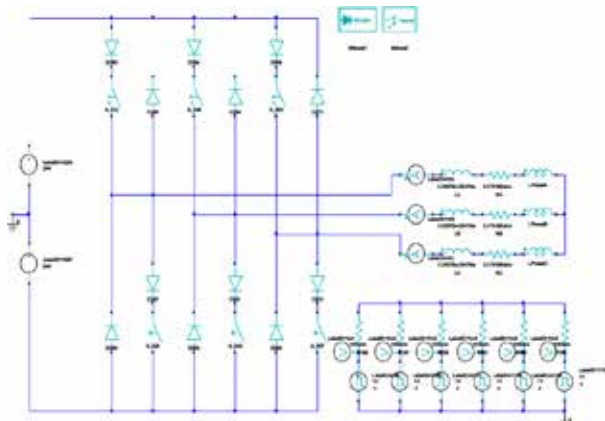
**Lowering magnet flux density**

By lowering the air-gap flux, cogging torque will be minimized. As a result, if we decrease the magnetic flux density by switching the grades of the magnets, immediately air-gap flux will decrease. [10]

**SIMULATION**



**Fig. 1. Ansys Maxwell BLDC 2-D simulation**



**Fig. 2. BLDC driver circuit**

The conventional drive circuit of the BLDC is shown in Figure 2. Ansys Maxwell software is used to obtain

this information. The kind of circuit used is a full voltage circuit that is driven by a constant power load at a constant voltage. Based on analyzing the system, the trigger pulse width is 120, the diode loss is 2.18662 Watt, and the transistor loss is 8.02588 Watt.

**DESIGN OPTIMIZATION**

**Material**

**Table 2: BLDC stator and rotor material comparison**

Material	Efficiency (%)	Speed Rating (rpm)	Torque Rating (N.m)	Total Loss (W)
Steel_1010	85.259	1986.66	2.40307	86.438
Steel_1008	85.3001	1957.87	2.43838	86.1545
M43_29G	82.7972	1982.28	2.40834	103.871
DW540_50	82.2257	1957.1	2.43937	108.07

There are vast varieties of materials in the Ansys RMxprt. We changed the materials of the stator and rotor to Steel\_1010 and we got the efficiency, speed and the torque respectively

**Gauge size:**

**Table 3: BLDC motor wire gauge comparison**

Wire Gauge	Wire Diameter (mm)	Efficiency (%)	Speed Rating (rpm)	Torque Rating (N.m)	Total Loss (W)
22	0.6438	82.7467	1925.92	2.48027	104.301
21	0.7229	85.259	1986.66	2.40307	86.438
20	0.8118	87.1319	2031.57	2.35261	73.9176
19	0.9116	88.5713	2067.37	2.30961	64.519
18	1.024	89.6673	2100.88	2.27115	57.5777

As we change the gauge size of the cable diameter efficiency and torque values changes. Decreasing the gauge size increases the efficiency and speed but torque decreases.

**Air gap:**

**Table 4: BLDC motor air gap comparison**

Air Gap	Efficiency (%)	Speed Rating (rpm)	Torque Rating (N.m)	Total Loss (W)
0.6	85.259	1986.66	2.40307	86.438
0.5	85.3075	1950.16	2.44815	86.1082
0.45	85.3318	1931.53	2.47183	85.9433
0.4	85.3424	1916.53	2.49332	85.9448
0.375	85.3496	1908.92	2.50388	85.9164

Air gap is the most important factor in the machine design. In BLDC motor as we increase the air gap torque and efficiency increases but this leads to decrease in speed of the motor.

As we increase the number of windings in the stator or number of poles in the rotor, torque ripples in BLDC motor will reduce drastically.

### SIMULATION RESULTS

We have obtained graphs after the simulation from our proposed BLDC motor (500W, 48V).

Figure- 4 shows the relation between output power of motor w.r.t speed. We obtained an output power of 0.49 kW w.r.t speed of 2000 rpm.

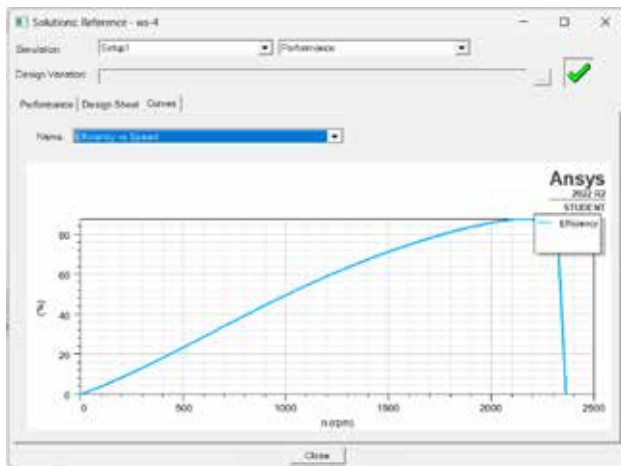


Fig. 3: Efficiency vs Speed

Figure 3 shows the efficiency of the motor w.r.t speed. We achieved 85.25% efficiency, for the speed of 2000 rpm. Efficiency and speed are inversely proportional as seen in the graph.

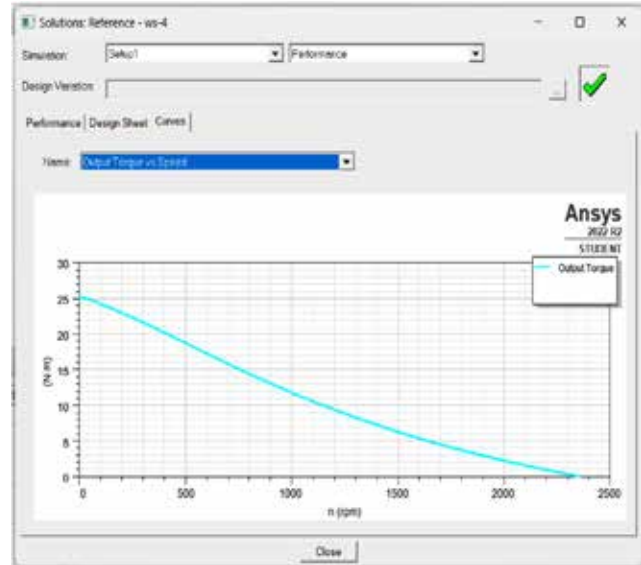


Fig. 5. Output Torque vs Speed

Figure 5 shows the relation between output torque and speed. We obtain an output torque of 2.40307 Nm when the motor is functioning at its rated speed i.e 2000 rpm. As we observe in the graph, speed and torque are inversely proportional to each other.

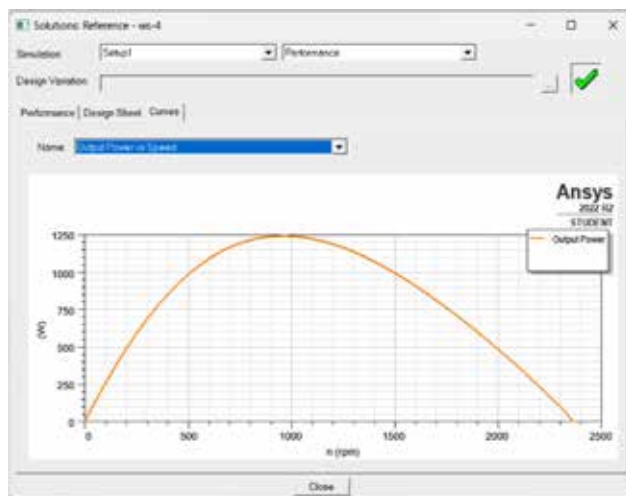


Fig. 4. Output Power vs Speed

GENERAL DATA	
Rated Output Power (kW)	0.5
Rated Voltage (V)	48
Number of Poles	4
Given Rated Speed (rpm)	2000
Frictional Loss (W)	4
Winding Loss (W)	4
Rotor Position	Inner
Type of Load	Constant Power
Type of Circuit	Y3
Lead Angle of Trigger in Elec. Degrees	20
Trigger Pulse Width in Elec. Degrees	120
One-Transistor Voltage Drop (V)	1
One-Diode Voltage Drop (V)	1
Operating Temperature (C)	75
Maximum Current for OCC (A)	0
Minimum Current for OCC (A)	0

Fig. 6. General data

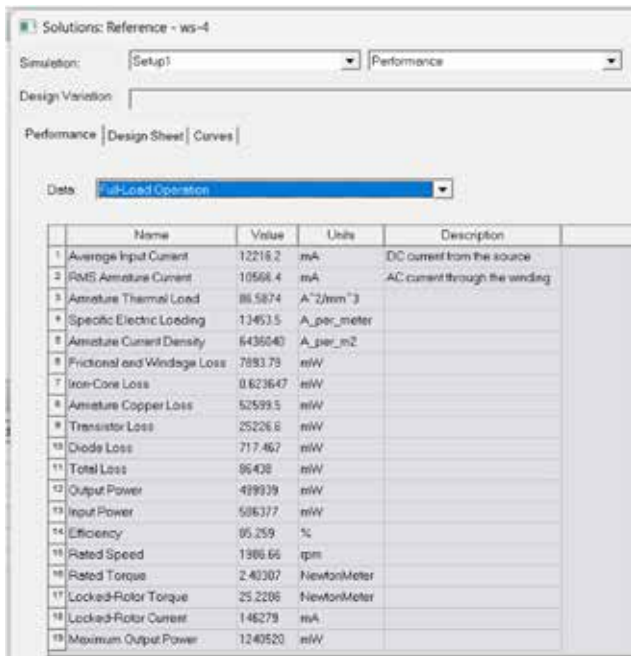


Fig. 7: Full load operation data

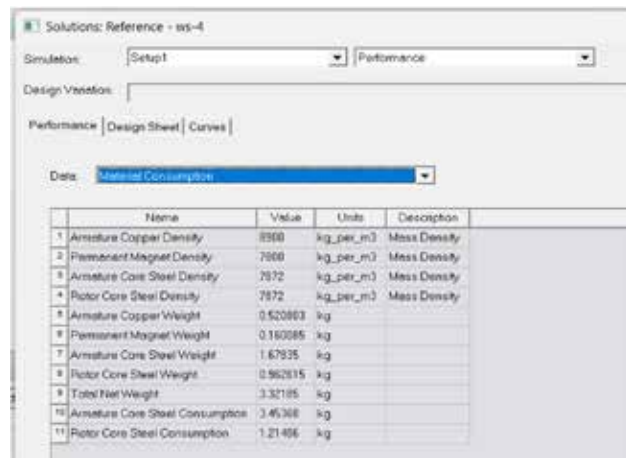


Figure 6: Material consumption data

Resulting from all the changes in simulation model parameters, here are the final key parameters:

Table 5: Final motor parameter

Sr. no.	Parameters	Final Value
1	Material	Steel_1010
2	Air Gap (mm)	0.6
3	Wire Gauge	21
4	Efficiency (%)	85.259
5	Rated Speed (rpm)	1986.66

6	Rated Torque (N.m)	2.40307
7	Total Loss (W)	86.438
8	Embrace	0.6
9	No. of parallel paths	4
10	Stator Length (mm)	49
11	Rotor Length (mm)	49

### CONCLUSION

In this paper, we used a BLDC motor with the rating of 4 poles 500 W, 48 V for the rated speed of 2000 rpm is designed using Ansys RMxprt tools for electric vehicle applications. To analyse the proposed system, a comparison of various parameters like winding materials, stator materials, and coil turns is performed. The preferred parameters after analysis are stator steel 1010, copper winding with 24 turns, and for magnetic material XG196/96 has proven to perform better than other materials currently available in terms of cognitive torque, losses, and overall efficiency. The results display the proposed BLDC motor achieved an overall efficiency of 85.259%. BLDC motor has better power ratio than induction motor. For EV applications, Induction motor will require a extra converter to draw power from the battery. It is suggested that changing materials reduces the losses associated with changing constructional features.

Efficiency and torque values change as we alter the gauge size of the cable diameter. By reducing gauge size improves speed and efficiency while decreasing torque. Due to the wide-ranging air gap, and effective distributed flux density in the air gap, torque ripples are decreased. We can change the stator and rotor’s materials to change the efficiency, speed, and torque, accordingly. The torque and efficiency of a BLDC motor rise as the air gap is increased, while the motor’s speed drops. We also solved the problem of cogging torque by adjusting stator slots and methods like skewing, magnetic pole shaping, lowering magnetic flux density.

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# Smart Grid System using GSM

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## ABSTRACT

This paper presents a GSM-based Prepaid Electricity Energy Meter system using Arduino as an innovative solution for managing electricity usage and payment. The project aims to replace traditional postpaid billing systems with a prepaid system that requires customers to pay in advance for the amount of electricity they intend to use. The energy meter is enhanced with a GSM module, enabling seamless communication between the meter and the service provider's server. This communication facilitates real-time validation of payments and updates the remaining credit balance accordingly. The project also includes an LCD display and a keypad to allow users to view their energy usage and remaining balance.

**KEYWORDS:** *Smart grid, Prepaid electricity, GSM module, Energy meter*

## INTRODUCTION

A novel solution has been introduced for the management of electricity usage and payment, which involves the utilization of an Arduino-based GSM Prepaid Electricity Energy Meter. This project, built on the Arduino platform and utilizing GSM network technology, aims to create a prepaid energy meter that can be quickly and easily installed in households, offices- wherever electricity is being consumed.

The primary idea behind this project is to replace traditional postpaid systems with a prepaid one where users pay beforehand for their anticipated electricity consumption. With a GSM module integration, the energy meter can interconnect with the service provider's server to authenticate payments and promptly refresh the available credit balance.

In terms of benefits offered by this project, it notably reduces non-payment incidents and risks associated with disconnections from power suppliers. It enables consumers to supervise their own power consumption rates, encouraging them towards adopting sustainable habits while also providing an economical option for electric management solutions. Facilitating these aspects relies heavily on integration capabilities between

several key components, including an Arduino circuit board and a GSM module linked to an energy-supply tracking apparatus with accompanying LCD displays informing users of their current utilization status.

## PROBLEM STATEMENT

Traditional electricity billing systems are based on postpaid billing, where the customers are billed for the electricity, they have consumed at the end of a billing cycle. However, this system has several limitations, including delayed billing, inaccurate billing, and difficulty in collecting payments. Additionally, traditional electricity billing systems do not provide customers with real-time information about their electricity consumption, which makes it difficult for them to manage their energy consumption effectively. To overcome these limitations, a GSM-based prepaid electricity energy meter using Arduino can be developed. The proposed system allows customers to buy electricity credits in advance and utilize them based on their individual needs.

## PROPOSED SYSTEM

### Objective

- i. To design the smart grid system.



- ii. To enhance the communication and GSM network technology to communicate with the service provider's server and validate payments in real-time.
- iii. The Smart Grid aims to achieve a high level of integration and information sharing among various components and systems within the electricity grid.
- iv. The objective is to ensure uninterrupted and reliable electricity transmission, mitigating the occurrence of wide-area disruptions or accidents within the power system.
- v. To optimize assets, reduce costs and operate efficiently.
- vi. To problems of meter security, energy saving etc.

### Block Diagram

Upon system startup, the previously stored rupee values in the EEPROM are retrieved and assigned to corresponding variables. The system then compares the available balance with a predefined threshold and takes appropriate actions accordingly. If the available balance exceeds 100 rupees, the Arduino triggers the relay to turn on the electricity for the home or office. In the event that the balance falls below 50 rupees, the Arduino sends an SMS alert to the user's phone, notifying them of the low balance and prompting them to recharge. When the balance drops below 10 rupees, the Arduino shuts off the electricity connection and sends an SMS alert to the user's phone indicating a 'Light Cut' and urging them to recharge promptly. To facilitate message communication, a GSM module is incorporated, and further information on the GSM module and AT commands can be explored.

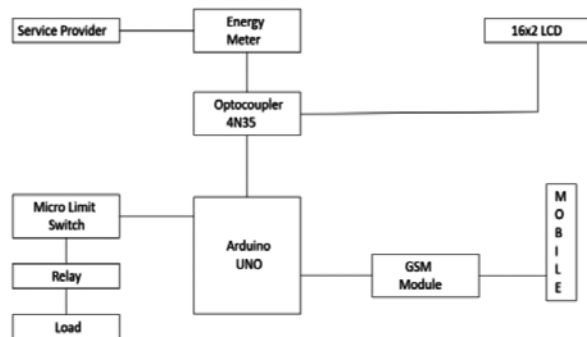


Fig 1: Block diagram of proposed System

### WORKING

The energy meter measures power consumption by calculating the product of voltage and current over time. It generates pulses based on real power utilization. For this particular energy meter, 1 kilowatt-hour (KWh) is equivalent to 3200 impulses, resulting in a rating of 3200 impulses per KWh.

The energy meter's LED blinks with each pulse generated by the IC. To interface the energy meter with the Arduino, an Optocoupler is connected to the LED. The Optocoupler switches on and off in synchronization with the LED's blinking.

It is not possible to directly connect the energy meter's LED to the Arduino because the LED emits analog signals, while the Arduino operates on digital signals. To overcome this, the switching side of the Optocoupler is connected to pin D8 of the Arduino. Whenever a pulse occurs from the energy meter, the Optocoupler is switched, causing pin D8 of the Arduino to detect a digital 0. In the absence of a pulse, the Optocoupler remains inactive, and the state of pin D8 is undefined. The Arduino keeps a count of the pulses received, incrementing the count by 1 with each change in state from digital 1 to 0 on pin D8. Additionally, a GSM module is interfaced with the Arduino UNO. This module enables the Arduino to send and receive messages, allowing for communication with external devices or users.

### MATHEMATICAL CALCULATION

To calculate energy consumption, an energy meter equipped with sensors measures the voltage and current. Based on Ohm's Law, the instantaneous power is computed as the product of voltage (V) and current (I), using the equation  $P = V * I$ . By integrating this power over time, the meter derives the total energy consumed by the consumer.

### SOFTWARE DESCRIPTION

#### Proteus

PROTEUS is a software utilized for preliminary simulation before implementing the actual circuitry. It facilitates the virtual operation of the real system, enabling the identification of potential errors, although not all of them. This tool proves immensely valuable

in the comprehensive development of the entire system within a virtual environment. Within PROTEUS, there are VSM studios designed specifically for microcontrollers to conduct simulations. These studios provide a platform for running simulations with microcontrollers. Additionally, PROTEUS offers a

Visual Designer feature that allows users to write programs using intuitive flowcharting methods. Moreover, PROTEUS aids in the design of printed circuit boards (PCBs), making it a versatile tool for the entire development process.

#### Arduino IDE:

The Arduino Integrated Development Environment (IDE), also known as Arduino Software (IDE), served as the platform for writing and uploading programs to the Arduino module. The programs created within this environment are referred to as sketches, saved with the .ino file extension. These sketches can be subsequently uploaded to Arduino or Genuine devices. An integral feature of this IDE is the text console, which allows for easy monitoring of output results. If the desired outcome is not achieved, the program can be edited and re-uploaded. The successful integration of software and hardware forms the foundation of such “smart” devices.

### HARDWARE REQUIREMENT

- A. Arduino UNO Board
- B. SIM900A GSM MODULE
- C. Single Channel Relay
- D. 16x2 I2C LCD Display
- E. Micro Limit Switch
- F. 5V Buzzer
- G. Optocoupler IC 4N35
- H. Energy Meter
- I. 10K Resistor

#### A. Arduino UNO Board:

The enhanced version of the Arduino Uno board includes several notable features. Instead of the 8U2 or FTDI chip, the Uno now utilizes the ATmega16U2. This update offers faster transfer rates and increased memory capacity. Furthermore, no additional drivers

are required for Linux or Mac operating systems, while an inf file is provided for Windows users through the Arduino IDE.

One significant improvement is the ability of the Uno to function as a keyboard, mouse, joystick, and other input devices. This expanded functionality enhances its versatility and potential applications. Additionally, the Uno R3 introduces two new pins adjacent to the RESET pin: SDA and SCL. These pins facilitate the implementation of I2C communication.

Moreover, the Uno R3 incorporates two additional pins for future use. One of these pins, labeled IOREF, enables shields to adapt to the board’s voltage level, enhancing compatibility with different modules and components. The other pin remains unconnected and reserved for potential future functionalities.

Despite these advancements, the Uno R3 remains fully compatible with existing shields, allowing seamless integration with a wide range of expansion modules. This microcontroller board is built around the ATmega328 chip, providing a reliable and open-source platform for prototyping projects. Its user-friendly nature makes it suitable for both hobbyists and professionals.

#### B. SIM900A GSM Module:

The SIM900A Modem, developed by SIMCOM, is a GSM/GPRS module that operates on the frequencies of 900/1800 MHz. It possesses the capability to automatically search for and connect to these two frequency bands. Additionally, the module allows for the configuration of specific bands using AT Commands. The baud rate of the module is also configurable, ranging from 1200 to 115200, which can be set using AT commands.

With an integrated TCP/IP stack, the GSM/GPRS Modem facilitates seamless internet connectivity through GPRS. Its compact size and reliable performance make it an excellent choice for wireless communication requirements. The module incorporates a powerful single-chip processor that integrates the AMR926EJ-S core. This integration enables a small form factor and cost-effective solutions, making it a comprehensive GSM/GPRS module packaged in an SMT (Surface Mount Technology) format.

### C. Single Channel Relay:

A relay unit is an electrically operated switch where different operating principles allow the operation of the switch by an electromagnet to be mechanical. In our design, we used the relay to switch on and off the loads and control the meter with one signal, and in case of power theft from the meter the relay will switch off the main supply and the smart meter will be disconnected.

### D. 16X2 LCD Display:

The I2C\_LCD module is a user-friendly display module that simplifies the display process. Its usage significantly reduces the complexity involved, allowing makers to concentrate on the core aspects of their work. Additionally, it facilitates the seamless connection between two integrated circuits, such as the Arduino UNO and a 16x2 LCD screen.

### E. Micro Limit Switch

A micro switch refers to a compact and highly sensitive switch that requires minimal pressure to activate. These switches are widely prevalent in household appliances and switch panels equipped with small buttons. They are typically cost-effective and boast a long operational lifespan, capable of functioning reliably for an extended duration, often up to ten million cycles.

### F. 5V Buzzer:

G. A buzzer or beeper serves as an audio signaling device that can be mechanical, electromechanical, or piezoelectric (often referred to as piezo). These devices are commonly employed in various applications, including alarm systems, timers, training tools, and providing confirmation for user input, such as a mouse click or keystroke.

### H. Optocoupler IC 4N35:

The 4N35 optocoupler is designed for versatile applications, serving as a component that effectively isolates the signal source from the signal receiver. It comprises a gallium arsenide infrared LED and a silicon NPN phototransistor. By utilizing an optocoupler, the electrical interference between the signal source and receiver is mitigated, as it breaks the connection between them.

### I. Energy Meter:

**Voltage Ratings:** The meter is designed to operate at 240 volts (phase-to-neutral) with a voltage reference range of +20% to -40%  $V_{ref}$ . However, it is essential for the meter to endure the continuous maximum system voltage of 440 volts.

**Current Ratings:** The meter supports a current range of 10-60 amps with an overload capacity of 120%.

**Starting Current:** The starting current of the meter is 0.2% of the rated current ( $I_b$ ).

**Accuracy Class:** The meter conforms to Accuracy Class 1.0 as per the IS 13779:1999 standard.

**Display:** The meter features a display for visual

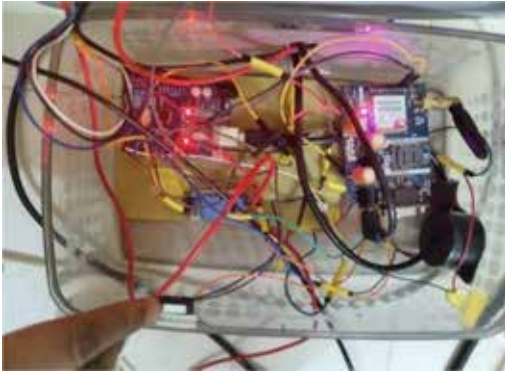
## RESULTS

### A. Hardware Results



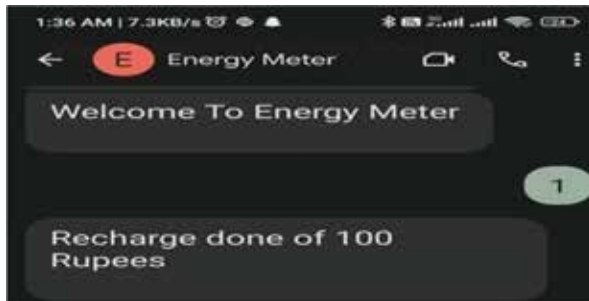
**Fig 2. Physical prototype for proposed model.**

Here is how the product looks like. The light bulb corresponds to the load and the plastic box is the meter box. The load consumes the required amount of energy which will be displayed on the lcd screen. Also the remaining amount and the amount of units consumed will be displayed on the lcd screen. The meter is internally connected with Arduino and GSM which handle the working of the meter. The code is uploaded in Arduino and the details of the customer and the retailer is saved in Arduino. The GSM module is used to communicate with the retailer and the consumer.



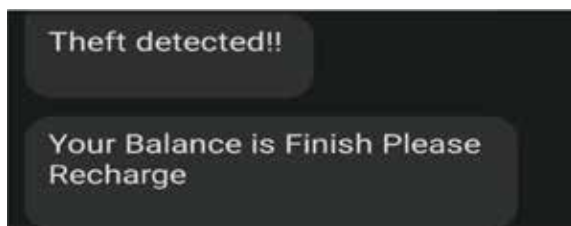
**Fig 3. Theft detection**

In this illustration, the switch is being pressed by a finger to deactivate the sound produced by the buzzer. This mechanism has been successfully tested, as depicted in the figure, where the circuit is shielded by an upper board. When an unauthorized individual attempts to tamper with the circuit, an alarm is triggered at a high volume, accompanied by the transmission of a theft detection message to a designated mobile phone.



**Fig 4. Received message on mobile**

Above is the reference image for the results obtained during the testing of the project. There are some more sample examples down below regarding the theft detection, recharge, low recharge and recharge finished. These are the messages on the mobile device of the consumer.



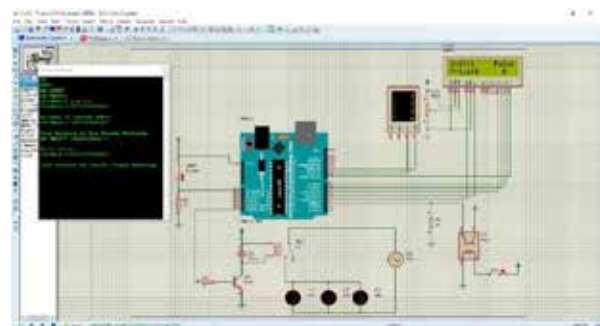
**Fig 5. Received message on mobile theft detection and recharged**

We have implemented a system that utilizes the GSM900 module to facilitate communication with the consumers of our energy meter. Upon receiving a message, the system greets the consumer with a message saying “Welcome to the Energy Meter.” If a consumer wishes to recharge their system, they simply need to type “1” as a reply. In response, they will receive a confirmation message stating “Recharge of 100

Rupees has been successfully completed.” However, in the event of a potential theft, if a thief attempts to tamper with the electrical circuit, the system immediately detects the unauthorized activity. In such cases, the consumer is promptly notified with a message stating “Theft Detected.”

To ensure that the system remains operational, the Arduino periodically checks whether the consumer’s account has been recharged. If the balance is found to be insufficient, the Arduino issues a command to the relay, effectively cutting off the electricity supply. Subsequently, the consumer receives a message notifying them that their balance has been depleted and they are requested to recharge their account with the following message: “Your balance has been depleted. Please recharge your account.” This integrated system aims to enhance the consumer experience and provide security against electricity theft while ensuring proper management of energy resources.

### SIMULATION RESULTS:



**Fig 6. Simulation on proteus**

During the system’s power-up process, it retrieves the previously stored rupee values from the EEPROM and restores them into variables. It then compares the available balance with a predefined value and takes appropriate actions based on the result.



```

Virtual Terminal
AT
ATE1
AT+CPIN?
AT+CMGF=1
AT+CNMI=2,2,0,0,0
AT+CMGS="+923378655465"

Welcome To Energy Meter
AT+CMGS="+923378655465"

Your Balance is Low Please Recharge
AT+CMGS="+923443326077"

Theft Alarm
AT+CMGS="+923378655465"

Your Balance is Finish Please Recharge

```

**Fig 7. Virtual terminal results**

If the available balance is greater than 15 rupees, the Arduino activates the electricity supply to the home or office by utilizing a relay. In the case where the balance falls below 50 rupees, the Arduino sends an SMS alert to the user's phone, notifying them of the low balance and requesting them to recharge their account promptly. When the balance drops below 5 rupees, the Arduino turns off the electricity connection to the premises and sends an SMS alert, referred to as a 'Light Cut' alert, urging the user to recharge their account immediately.

To facilitate the recharge process, users can simply send an SMS to the system from their cell phone. For example, if they want to recharge their account with 100 rupees, they would send the message "#100\*," where '#' is the prefix and '\*' is the suffix indicating the recharge amount. The system receives this message, extracts the recharge amount, updates the system's balance accordingly, and reactivates the electricity supply to the premises.

Additionally, the system includes a theft detection mechanism. In the event of an attempted electricity theft, an alert indicating "Theft Detected" is displayed on the monitor or screen.

The communication with the GSM module, including sending and receiving messages, is facilitated through the usage of AT commands. Further information about the GSM module and its commands can be found in the provided resources.

## PERFORMANCE PARAMETERS AND ITS ANALYSIS

To ensure fair billing and reliable energy measurement, the accuracy of the energy meter is crucial. Performance analysis entails comparing the meter's readings to a reference standard and calculating the percentage error. Higher accuracy is indicated by lower percentage errors. Deviations from the reference standard can be carefully analyzed to pinpoint potential calibration or measurement issues that need to be addressed.

The efficiency of the recharge process, which involves adding prepaid credit to the meter, is a significant parameter to consider. Performance analysis entails assessing the speed of token validation, credit update, and synchronization between the meter and the central server. By identifying and addressing any delays, errors, or inconsistencies in the recharge process, the system's efficiency can be enhanced.

In the performance analysis of the prepaid energy meter, an evaluation of its security features and fraud prevention mechanisms is conducted. This assessment involves examining the effectiveness of encryption algorithms, token generation, and authentication processes. By identifying and addressing any vulnerabilities or potential risks, the system's security performance can be enhanced.

## CONCLUSION

The GSM Based Prepaid Electricity Energy Meter using Arduino is a reliable and efficient system for managing electricity usage and payment. The project provides an innovative solution that replaces traditional postpaid billing systems with a prepaid system that requires customers to pay in advance for the amount of electricity they intend to use. The use of the Arduino platform and GSM network technology enables easy installation and maintenance of the prepaid energy meter in homes, offices, and other places where electricity is consumed. The system's user-friendly interface, including the LCD display and keypad, allows customers to view their energy usage and remaining credit balance. The project's implementation involves the integration of various components such as the Arduino board, GSM module, energy meter, LCD display, and keypad. The Arduino board controls and



manages the various components of the energy meter, while the GSM module handles the communication between the energy meter and the service provider's server. The benefits of this project include reducing the risk of non-payment and disconnection, allowing customers to monitor their electricity consumption, promoting energy conservation, and providing a cost effective solution for electricity management.

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# Implementation of Uninterrupted Power Supply for a Wi-Fi Router

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## ABSTRACT

Reliable and uninterrupted connectivity is essential in today's connected society, especially when it comes to Wi-Fi routers that act as entranceways to the digital world. A reliable Wi-Fi network is difficult to maintain due to power outages or fluctuations, which can disrupt services and lead to data loss. The implementation of an Uninterruptible Power Supply (UPS) for a Wi-Fi router is described in this research article as a solution to this problem, with the goal of maintaining constant connectivity in the event of power outages.

The implementation of an Uninterruptible Power Supply (UPS) solution using lithium-ion cells and a Battery Management System (BMS) for Wi-Fi routers is the main topic of this research study. It emphasizes the benefits of lithium-ion batteries, such as their better energy density, longer cycle life, and quicker charging. A BMS is crucial for lithium-ion battery systems because it guarantees optimal battery performance, manages charging and discharging, and provides protection from hazards.

Comprehensive testing under diverse conditions is done for performance evaluation, and parameters including battery runtime, charging effectiveness, and voltage stability are measured.

The study starts by reviewing the prior research on power supply options for networking equipment, including the benefits and drawbacks of various UPS methods. Based on this study, the report suggests a special UPS setup designed with Wi-Fi routers in mind, taking parameters like power requirements, battery capacity, and backup into account.

**KEYWORDS:** UPS, AC-DC, DC-DC, BMS, Charge controller

## INTRODUCTION

Uninterrupted Power Supply (UPS) refers to a device or system that provides backup power to connected devices or equipment in the event of a power outage or electrical disturbance. A UPS typically consists of a battery, an inverter, and a charger. The primary purpose of a UPS is to provide a temporary power source to prevent data loss, equipment damage, or disruptions caused by power interruptions [1]. Power Input: The UPS is connected to a primary power source, such as a wall outlet or utility power grid. While the

main power is available, the UPS continuously charges its internal battery and powers the connected devices by converting the alternating current (AC) input into direct current (DC) using a rectifier [4]. Power Interruption: In the event of a power outage or voltage fluctuation, the UPS detects the loss of input power. It swiftly switches from drawing power from the primary source to utilizing the energy stored in its battery. Power Duration: The backup power duration provided by a UPS depends on factors such as the capacity of the battery and the power consumption of the connected devices. UPS systems can offer power backup for a few minutes to several hours,

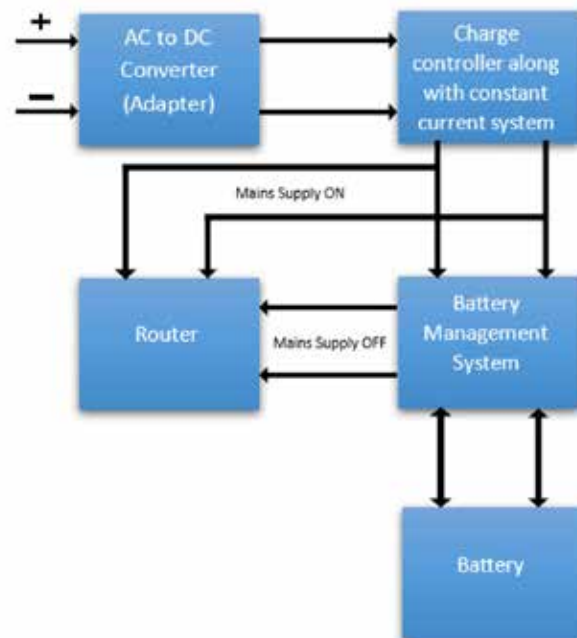
depending on their specifications. **Power Restoration:** Once the primary power source is restored or stabilized, the UPS resumes its primary function of charging the battery and supplying power to the connected devices. It also recharges the battery to be ready for the next power interruption [5].

UPS systems are commonly used in various settings, including homes, offices, data centers, hospitals, and critical infrastructure facilities. They provide a reliable power source during power outages, voltage fluctuations, or electrical disturbances, ensuring uninterrupted operations, protecting equipment and data, and minimizing disruptions caused by power-related issues. **Power Protection:** A UPS system acts as a safeguard against power disruptions, such as blackouts, voltage fluctuations, or power surges [5]. It provides continuous power supply to connected devices, ensuring that they remain operational even during power outages. This is especially critical for businesses and organizations that rely on uninterrupted power for their operations, as it prevents data loss, equipment damage, and downtime. **Data Integrity:** UPS systems are crucial for protecting sensitive electronic equipment, including servers, data centers, and network infrastructure. Abrupt power interruptions can lead to data corruption or loss, which can have severe consequences in terms of financial loss, operational disruptions, or compromised customer information. UPS systems provide a stable power source, allowing proper shutdown procedures or seamless switching to alternative power sources, such as generators. **Equipment Longevity:** Power irregularities, such as voltage spikes or sags, can damage electronic devices over time. UPS systems regulate the incoming power supply, providing a consistent and stable voltage level, which helps extend the lifespan of connected equipment. By reducing the wear and tear caused by power fluctuations, UPS systems contribute to cost savings by minimizing the need for frequent repairs or replacements. **Business Continuity:** For businesses, uninterrupted power supply is essential to ensure continuity of operations. Power outages can result in lost productivity, missed deadlines, and dissatisfied customers. By keeping critical systems running, UPS systems allow businesses to continue their operations seamlessly during power disruptions, minimizing the impact on productivity and customer service. Home

and Personal Use: UPS systems are also valuable for individual users. They can protect valuable electronic devices, such as computers, home entertainment systems, or medical equipment, from power fluctuations or sudden power loss. This ensures that important work, data, or medical support remains uninterrupted and prevents potential damage to personal devices.

COVID-19 crisis has forced institutions and companies to operate remotely which to many has been a complete solution for employers and employees by finding the right amount of work-life balance and productivity. Although this has prompted a very huge need for internet connectivity of the highest quality in each household. Dependency on internet providing devices like WIFI routers has increased tremendously. A UPS specifically designed for WIFI router can eradicate the risk posed by power cuts and signal fluctuations and reduce the overall cost as the UPS has been designed only to power the router.

#### Block diagram



**Fig. 1. Block diagram**

The above block diagram explains about the workflow of the system from start to finish. The system is designed to work naturally on keeping the original components non disturbed so that if the system goes at fault the original application should be reverted

to have the primary application in the working. The external system specifications might change sometimes according to the manufacturing of the original market components i.e., Wi-Fi router which will be different at different workplace, depending on the application the actual power consumption of the router will differ which will directly affect the efficiency of the UPS. The power backup of the UPS will be reduced if the power consumption of load is significantly high.

### AC-DC Converter

The AC-DC converter used is the original adapter, which is used to power up the router, as the charge controller used had an input range of 5V-32V, almost any adapter is compatible according to the various specifications of adapters available in the market. The AD-DC adapter used provides an output of 12V 1.5A to router initially, but in this case the output is provided to the charger module.

### Charge controller with constant current supply

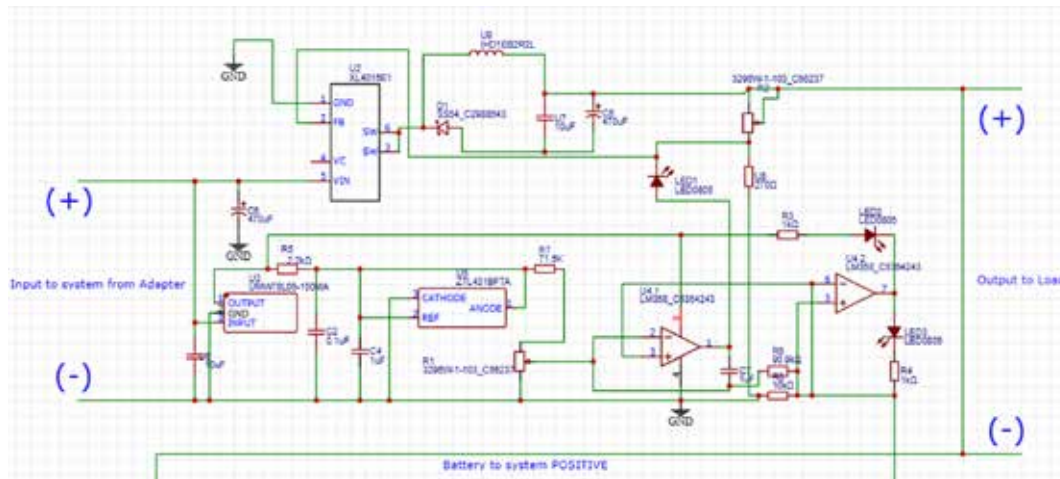


Fig. 2. Schematic of Charge controller

It is a XL4015E1 DC-DC Buck converter which is a constant current (CC) and constant voltage (CV) module which is generally used to charge lithium-ion cells or battery packs [2]. XL4015E1 buck converter IC is the main component of this module which provides a constant output current rating of 5A which is then controlled by an additional circuit in the existing working circuit of XL4015E1 Buck converter IC, which is quite suitable for our UPS system, according to the load used the current rating can be changed and managed so that no major changes need to be done. This current limiting circuit consists of a voltage regulator which provides steady output of 5v to the shunt voltage regulated IC. This regulated 5v is important for the shunt voltage regulated IC. The IC provides a constant current value at output using a resistor and a potentiometer. The first op-amp circuit indicates if the

current limiting function is active through the diode which is LED which glows when the current limiting function is true, and the second op-amp circuit indicates either the system is being charged or fully charged/being consumed using two different LEDs in the circuit. Two potentiometers have been provided which provide desired voltage and current according to requirement. Generally, the voltage output of the router is 12V and the battery used has 3 lithium-ion cells of 3.8V each making it battery pack of 11.9V for which 12v of supply voltage is sufficient to make it a considerable charge up to 80% of the total capacity of the battery pack [2]. The high-power inductor is used to provide the output current of maximum 5A. High-capacity electrolyte capacitors of 50V each are used at input and output to have noise free signal at input and output.

Table 2. DC-DC Buck boost comparison table

Parameter	XL4015E1	LM2596	LM2577S	XL6009
Input Voltage	4V - 40V	4V - 40V	3V - 40V	3V - 32V
Output Voltage	1.25V - 36V	1.23V - 37V	1.2V - 60V	5V - 35V
Output Current	Up to 5A	Up to 3A	Up to 3A	Up to 4A
Switching Frequency	180kHz	150kHz - 260kHz	50kHz - 100kHz	400kHz
Efficiency	Up to 94%	Up to 92%	Up to 87%	Up to 94%
Quiescent Current	2mA	5mA	6mA	1.2mA
Built-in Protections	Over-temperature, Over-current	Over-temperature, Over-current	Over-temperature, Over-current	Over-temperature, Over-current

After much consideration with respect to the table mentioned above, we decided to use XL4015. Following are the listed reasons as to why we selected XL4015:

1. **Wide Input and Output Voltage Range:** The XL4015 can accept input voltages up to 40V, allowing it to work with various power sources. It has an adjustable output voltage range from 1.25V to 35V, providing flexibility in meeting different voltage requirements.
2. **High Output Current:** The XL4015 can deliver a maximum output current of up to 5A, which makes it suitable for applications that require higher current levels. This feature enables it to power a wide range of devices and components.
3. **Efficient Operation:** The module offers high efficiency, up to 92%, which means it can convert input power to output power with minimal losses. This efficiency helps in reducing heat generation and improving overall power utilization.
4. **Switching Regulator:** The XL4015 employs a switching regulator topology, which allows for efficient power conversion by rapidly switching the input voltage. Switching regulators are known for their higher efficiency compared to linear regulators.
5. **Protection Features:** The XL4015 incorporates several protection features such as over-temperature, over-current, and short circuit protection. These safeguards help protect both the module itself and the connected components from damage in case of faults or abnormal operating conditions.
6. **Compact Package Options:** The XL4015 is available in compact package options such as TO-263 and SOP-8, which are commonly used in various electronic circuits. This compact size makes it easier to integrate into space-constrained designs.
7. **Cost-Effective Solution:** The XL4015 module is generally available at a moderate cost, making it a cost-effective choice for applications where budget considerations are important.

#### Battery management system –

Battery management system is one of the most important parameters in the system for lithium-ion battery cells working and to ensure their long life. BMS is responsible for overcurrent protection, overvoltage protection, short-circuit, overcharge, undercharge, etc.

**Overcharge –** If the battery voltage rises above the set voltage limit for a specific time, the output terminals will be inverted and the charging stops. This state is known as the overcharge state. After some time, the overcharge state drops down to normal condition when the load is connected. This state is called the load detection function.

**Over discharge -** If the battery voltage drops below the set voltage limit for a specific time, the output terminals will be inverted, and the discharge stops. The over-discharge state is released and returns to the normal state. If the charger is connected in this state. The battery voltage rises to the over discharge protection voltage above the over discharge state. This function is called the charger detection function.

**Disconnection protection –** Under normal conditions



if the chip pins connected to the three positives of the battery the chip judges that wires are disconnected and indicates that the output level is low resulting in turning off the charging and discharging. This state is called disconnection protection state. When the disconnected

connection is reconnected correctly, the chip exits the disconnection protection state. The IC used is specially designed for 3S battery packs, meaning that only for battery packs having 3 cells of lithium-ion.

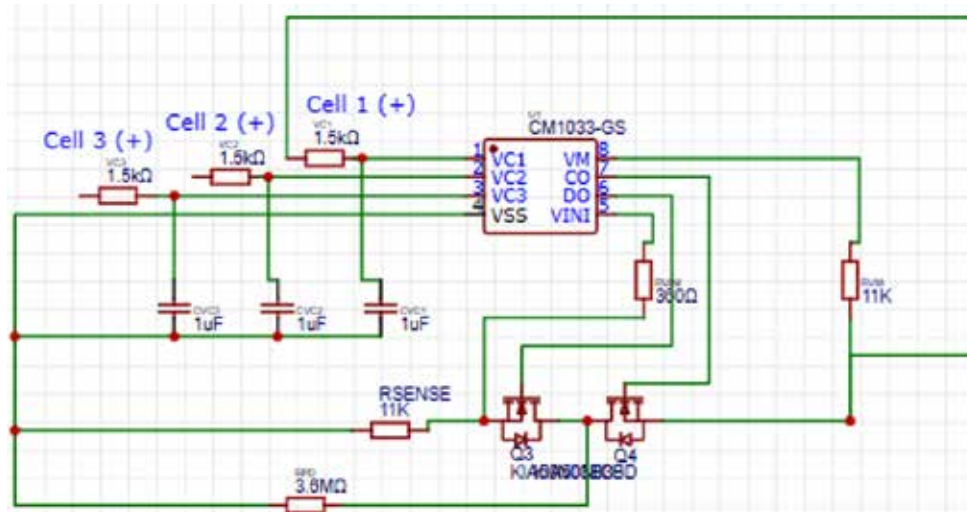


Figure 3 - Schematic of Battery Management System

### Battery

Rechargeable lithium-ion batteries are a type of energy storage that have gained popularity because of their high energy density and long cycle life. Electric vehicles, renewable energy systems, and a range of portable electronic devices frequently employ them. The passage of lithium ions between two electrodes during charge and discharge cycles is the basis for the battery's operation [8]. Batteries are the important factor of the UPS system as the whole UPS system exists due to presence of batteries and other components are just the supporting components to make the batteries charge and discharge in efficient manner to have sufficient power backup. Previously Lead acid battery packs were used as power backup storage in huge UPS systems as there was no other robust and reliable option available in the market. The lead acid industry to date is functioning so much that various types of lead chemistry battery packs are being used in almost all sectors. Whereas when the lithium-ion batteries were brought into action, the beneficial properties are motivating people to switch from lead chemistry batteries to lithium chemistry batteries. Lithium chemistry batteries have

fast charging and discharging functionality with high storage compared to size [2]. Lithium chemistry battery packs are much lightweight than the lead chemistry battery packs. The reason for using lithium-ion cells for the system was it is easier to recharge the lithium cells than lead chemistry cells and has better efficiency.

### Wi-Fi router

It is the specified load for our system as there is no other load introduced in the system and even the system designed is compatible with the router. The Wi-Fi router requires continuous power to fully function. There are generally two types of UPS, online and offline. Online UPS provide smooth and uninterrupted supply to the load and Offline UPS provides supply to the load after a certain delay after the mains is shut off. In the care of Wi-Fi router as a load, the offline UPS is of no use as due to delay the router will be immediately shut off and will result in disconnection devices connected to the Wi-Fi router which will result in interruption in users work. So, the online UPS is the only solution to provide an uninterrupted supply to Wi-Fi router. The whole system is designed to make the load work at its original potential.

## RESULTS

The UPS (Uninterruptible Power Supply) system is designed to provide backup power during a power outage or fluctuation in the mains electricity supply. It ensures that critical devices, such as the Wi-Fi router in this case, can continue to operate seamlessly without interruption.

Here's a breakdown of how the UPS system functions in the described scenario:

1. **Backup Power:** The UPS system is equipped with a battery that stores electrical energy. When the mains power supply is available, the UPS continuously charges the battery, ensuring it remains fully charged and ready for use.
2. **Power Outage:** In the event of a power outage from the mains, the UPS system detects the loss of electricity. It immediately switches from drawing power from the mains to utilizing the stored energy in the battery.
3. **Seamless Switching:** The UPS system is designed to provide seamless switching between the mains power and battery power. This means that when the power goes out, the transition from mains power to the backup battery power occurs without any noticeable interruption or downtime. The Wi-Fi router and other connected devices continue to receive power without disruption.
4. **Backup Duration:** The UPS system mentioned offers a backup duration of approximately 1.5 hours. This means that during a power outage, the UPS can supply power to the Wi-Fi router for approximately 1.5 hours before the battery is depleted. The actual backup duration may vary depending on factors such as the power consumption of the router and the capacity of the UPS battery.
5. **Automatic Recharge:** Once the mains power is restored, the UPS system automatically switches back to drawing power from the electrical grid and simultaneously begins recharging the battery. This ensures that the UPS system is ready for the next power outage.

Overall, the UPS system provides reliable backup power for the Wi-Fi router, allowing it to operate

flawlessly even during power interruptions. It offers a smooth transition from the mains power supply to the backup battery power and provides a backup duration of approximately 1.5 hours before the battery needs recharging.

**Table 2. Individual Battery cell and Battery pack specifications**

ITEM	SPECIFICATION
Battery nominal voltage (individual cell)	3.7V
Battery charge cut-off voltage (individual cell)	4.2V
Battery voltage taken into consideration (individual cell)	3.99V
Total pack capacity considered	11.1V
Single battery capacity	2550 mAh

### Performance parameter calculations

To calculate the duration of active time for the UPS, we are determining the amount of energy stored in the battery pack and then dividing it by the power consumption of the load.

First, convert the battery pack capacity from milliamperes-hours (mAh) to ampere-hours (Ah):

$$2500 \text{ mAh} = 2.5 \text{ Ah}$$

Next, calculate the energy stored in the battery pack by multiplying the battery capacity (in Ah) by the nominal voltage (V) of the battery. Assuming a nominal voltage of 12V:

$$\text{Energy} = \text{Battery Capacity (Ah)} \times \text{Nominal Voltage (V)}$$

$$\text{Energy} = 2.5 \text{ Ah} \times 11.1\text{V} = 27.77 \text{ Wh (watt-hours)}$$

Now, divide the energy stored in the battery by the power consumption of the load (in watts) to determine the active time:

$$\text{Active Time} = \text{Energy (Wh)} / \text{Load Power (W)}$$

$$\text{Active Time} = 27.77 \text{ (Wh)} / 18 \text{ W} = 1.5 \text{ hours (approximately)}$$

Therefore, with a battery pack capacity of 2.5 Ah and a load requirement of 18 W, the UPS will provide an active time of approximately 1.5 hours before the battery is shut down.

## CONCLUSION

UPS for the router has been developed by considering all possible fail scenarios and risks. The UPS targets to cater a division of the society which has in recent years seen an increased internet connectivity demand for low cost. A device as critical as a WIFI router essentially until now does not have any power backup to ensure smooth internet connection and high reliability but all this will change with the introduction of this one product. All these coupled with the fact that the UPS has a very compact structure thereby reducing any spatial complexity which anyways exists in the multi-device environment of today's home workplaces. The most key aspect of the product being the price to use ratio where-in at a very cheap price the user can mitigate the risk of a lost internet connection.

## RECOMMENDATIONS

The product has immense scope to be improved and further updates to the product can be made on a design level and utility level. Among them a key aspect of the product includes the Battery indicator being installed in the product. A battery indicator will be showing the exact percentage of the battery power remaining in the battery pack to power the WIFI router. This will help the user understand how to make efficient use of the WIFI router. The battery indicator can be installed by replacing the current configuration module with another one which shows the battery percentage. This can be shown to the user in numeric format using a meter/indicator being placed atop of the product.

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# Optimization of Transport and Mac Layer Routing Protocols for Wireless Sensor Network

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## ABSTRACT

Wireless Sensor Networks (WSNs) have devices that are tiny, cheap, and limited in resources, yet capable of sensing and communicating with their environment. WSNs find extensive application in various fields such as environmental monitoring, industrial automation, and healthcare, among others. Due to the less resources of these devices, the design of efficient and effective MAC and transport layer routing protocols is crucial for the successful delivery and operation of WSNs. In this paper, we investigate the optimization of MAC and transport layer routing protocols for WSNs. We begin by providing a brief overview of the challenges associated with designing routing protocols for WSNs. We then discuss the characteristics of different MAC and transport layer routing protocols, including their advantages and disadvantages. Next, we present an optimization framework for MAC and transport layer routing protocols. This framework includes a set of performance criteria's, such as network life, throughput, and energy efficiency, and a set of optimization techniques, such as mathematical modeling, simulation, and heuristic algorithms. We then present a case study that applies the optimization framework to a specific MAC and transport layer routing protocol for WSNs. We analyze the impact of the optimized protocol using simulation and compare it with the original protocol.

**KEYWORDS:** *Wireless sensor networks, Routing protocols, MAC layer, Transport layer, NSG, NS2.35*

## INTRODUCTION

Wireless Sensor Networks (WSNs) are becoming increasingly important for a large range of applications such as environmental screening, healthcare, and industrial automation. The efficient routing of data packets in WSNs is critical to ensure reliable and timely delivery of information.

However, due to the sensor nodes' low resources and the dynamic topology of WSNs present significant challenges for designing routing protocols. In this context, optimizing routing protocols for the MAC and Transport layers of WSNs is a topic of great interest to the research community. The goal of this paper is to propose a novel routing protocol that improves the performance of existing methods by optimizing

the use of network resources, reducing latency, and minimizing energy consumption. We present a detailed methodology for the design and implementation of the protocol and provide experimental results that demonstrate its effectiveness in improving the overall performance of the network. Our research contributes to the advancement Evaluation of advanced routing protocols for WSNs and has important implications for the design of future WSN applications

## LITERATURE SURVEY

Niu et al. (2009) conducted research on routing protocols present in the ad hoc networks. The authors assessed various routing protocols, such as DSR, AODV, and OLSR, as well as the characteristics and difficulties of ad hoc networks. The results showed that



AODV performed better than other protocols in terms of PD rate and network latency [1].

Goswami and Jadhav (2012) evaluated how well routing protocols perform in wireless sensor networks. The authors studied four routing protocols, including AODV, DSR, DSDV, and TORA, and compared their performance based on numerous measures, including throughput, end-to-end delay, and packet delivery ratio. The authors concluded that AODV and DSR outperformed other protocols in terms of packet delivery ratio and end-to-end delay [2].

Polese et al. (2019) presented an survey of current developments in transport layer protocols. The authors provided an overview of the evolution of transport layer protocols and discussed various mechanisms to improve the performance of transport protocols. The survey also covered recent research on transport protocols for various scenarios, such as wireless networks, data centers, and the Internet of Things [3]

The TCP/IP Protocol (n.d.) provided a comprehensive overview of the TCP/IP protocol. The document covered the architecture, protocols, and services of the TCP/IP protocol suite and explained their functions and interactions [4]

The performance of UDP/CBR and TCP/FTP traffic using the AODV routing in MANET was compared by Sharma and Gupta (2012). The authors assessed the results of different traffic types on AODV routing protocol and compared the performance of UDP/CBR and TCP/FTP traffic. The results showed that UDP/CBR traffic performed better than TCP/FTP traffic in terms of end-to-end delay and packet delivery ratio[5]

In 2019 the publication of a survey by Polese et al. on recent developments in transport layer protocols. The authors discussed various transport protocols, including TCP, UDP, SCTP, and QUIC, and their mechanisms to improve performance. The survey also covered recent research on transport protocols for various scenarios, such as mobile networks, data centers, and the Internet of Things.[6]

Nyirenda and Mwanza (n.d.) evaluated the performance of routing protocols in mobile adhoc networks. The authors studied four routing protocols, combining AODV, DSR, OLSR, and TORA, and compared their

performance based on various parameters, such as PDR, end-to-end delay, and throughput. The authors concluded that AODV outperformed other protocols in terms of packet delivery ratio and end-to-end delay [7].

Althobaiti and Abdullah (2015) classified MAC protocols for WSNs into three categories: contention-based, time-based, and hybrid protocols. They further analyzed the performance of various MAC protocols, such as CSMA, TDMA, and LMAC, under different scenarios. They also proposed a cross-layer approach that integrates the MAC layer with other layers to improve network performance [8].

Zhang and Wang (2016) conducted a comprehensive analysis of MAC protocols for WSNs, including S-MAC, T-MAC, and B-MAC. They evaluated the performance of these protocols based on several parameters, such as throughput, energy consumption, and fairness. They also discussed the limitations and challenges of these protocols and suggested future research directions [9].

In their 2017 study, Kaeed and Alabady looked into how the hidden node problem affected the effectiveness of MAC protocols in WSNs. They analyzed the performance of different MAC protocols, such as CSMA, RTS/CTS, and Z-MAC, under different node densities and traffic loads. They concluded that the hidden node problem significantly degrades the performance of MAC protocols in WSNs and proposed a new MAC protocol that mitigates this problem [10]

Rahman and Islam (2015) compared the working principles and performance of two popular MAC protocols for WSNs, IEEE 802.11 and S-MAC. They evaluated these protocols based on several performance parameters, such as energy consumption, delay, and throughput, using NS2 simulator. They concluded that S-MAC outperforms IEEE 802.11 in terms of energy efficiency and delay [11]

Malik and Sharma (2018) investigated the energy consumption behaviors of two MAC protocols, IEEE 802.11 and S-MAC, using an NS2 simulator. They evaluated these protocols based on several parameters, such as energy used, throughput, and PDR. They concluded that S-MAC outperforms IEEE 802.11 in terms of energy efficiency and packet delivery ratio [12].



Overall, the literature survey covers a range of topics related to wireless networks, including routing protocols, transport layer protocols, and performance evaluation of wireless networks. The studies provide insights into the characteristics and challenges of wireless networks and the mechanisms to improve their performance.

## METHODOLOGY

Optimizing routing protocols for MAC and transport layer protocols involves improving the efficiency and effectiveness of the network by reducing network overhead, minimizing delay, and maximizing throughput. Here is a general methodology for optimizing routing protocols for MAC and transport layer protocols:

### Identify the network requirements and constraints

The first step in optimizing routing protocols is to identify the network requirements, such as the number of nodes, types of applications, and data transfer rates. Also, identify the constraints that may affect the network's performance, such as network topology, interference, and power consumption.

### Evaluate the existing routing protocol

Evaluate the current routing protocol and determine its performance in terms of parameters like PDR, end-to-end delay, throughput, and network overhead. This will help identify the areas that need improvement.

### Decide on the best routing protocol

Based on the network requirements and constraints, select an appropriate routing protocol that can satisfy the needs and get over the limitations.

### Optimize the MAC layer protocol:

The MAC layer protocol governs permission to the physical medium and plays a significant role in network performance. Optimize the MAC layer protocol by adjusting parameters like contention window size, and channel access method.

### Optimize the transport layer protocol

The transport layer protocol ensures the reliable transfer

of data between the source and destination nodes. Optimize the transport layer protocol by adjusting parameters like congestion control, flow control, and packet size.

### Simulate and test the optimized routing protocol

Use a network simulator to simulate the optimized routing protocol and test its performance in terms of parameters like packet delivery ratio, end-to-end delay, throughput, and network overhead.

### Evaluate the optimized protocol performance

Compare the efficiency of the improved routing protocol against the efficiency of the old protocol. Analyze the improvements made by comparing the parameters.

In summary, optimizing routing protocols for MAC and transport layer protocols requires identifying network requirements and constraints, selecting appropriate routing protocols, optimizing MAC and transport layer protocols, simulating and testing the optimized protocol, evaluating its performance, refining it as needed, and repeating the process until the desired network performance is achieved.

## DESIGN AND IMPLEMENTATION

### AODV (Ad hoc On-demand Distance Vector)

Due to its effectiveness and simplicity, AODV is a widely used on-demand routing mechanism in WSNs. A distance vector method is used by the protocol to find and keep track of routes between nodes. A node sends a route discovery message when it needs to deliver data to another node. This message travels through the network until it reaches the destination or a node that has a route there. To find and fix damaged routes, AODV additionally makes use of route maintenance notifications.

### DSDV (Destination-Sequenced Distance Vector)

A proactive routing technology called DSDV keeps a routing table containing the shortest routes to all network nodes. The neighbors of each node can update their own tables because each node periodically broadcasts its routing table to them. Sequence numbers are used by DSDV to assure route freshness and prevent routing loops.

**DSR (Dynamic Source Routing)**

Source routing is used by DSR, an on-demand routing system, to find and keep track of routes between nodes. A node inserts a list of intermediate nodes in the packet header when it needs to deliver data to another node. This list directs the packet along the path to the destination. DSR establishes and maintains routes using route discovery and route maintenance messages.

**802.11**

A popular wireless LAN protocol known as 802.11 defines the physical and MAC layers of wireless communication. To coordinate access to the wireless channel, the protocol makes use of carrier sense multiple access with collision avoidance (CSMA/CA). A node employs a contention mechanism to get access to the channel when it needs to transmit data and detects the channel to prevent collisions.

**802.15.4**

WSNs frequently employ the 802.15.4 standard, a low-power, low-data-rate wireless protocol. The protocol communicates with end devices through a coordinator node in a star topology. The MAC layer protocol described by 802.15.4 uses CSMA/CA to coordinate access to the wireless channel.

**S-MAC (Sensor-MAC)**

S-MAC is a MAC layer protocol that is specifically designed for WSNs. The protocol uses a duty cycle approach to minimize energy consumption by putting nodes in sleep mode when they are not transmitting or receiving data. S-MAC also uses a preamble sampling technique to reduce energy consumption during packet transmission.

In summary, AODV, DSDV, and DSR are routing protocols that can be used in WSNs, while 802.11 and 802.15.4 are wireless LAN protocols that can be used as the physical and MAC layers of communication. S-MAC is a MAC layer protocol that is specifically designed for WSNs and can be used to minimize energy consumption. The design and implementation of each protocol have been extensively studied in the literature,

and researchers continue to explore new ways to optimize their performance in WSNs.

**SIMULATION SETUP**

This simulation research is made with the NS2 network simulator and NSG, which will help to generate a TCL file and NAM file. Using these Files we have created our simulations and tested them in the NS2 environment

**For Transport layer Protocols**

**Network Topology:** We will simulate a wireless sensor network with 10 nodes randomly placed in a 500m x 500m area. The nodes will be equipped with wireless transceivers operating at 2.4GHz and using the IEEE 802.11 MAC layer protocol.

**Traffic Pattern:** We will generate a random traffic pattern in which the node generates FTP. The packet size will be set to 1500 bytes.

**Protocol Configuration:** We will use the default configuration for the AODV, DSDV, and DSR routing protocols, with no modifications to their settings.

**Simulation Software:** We will use NS2 (version 2.35) as the simulation software, running on a Linux operating system.

**Parameters:** We will evaluate the performance of the RPs using the following parameters:

**Packet Delivery Ratio (PDR):** The ratio of the number of packets which are successfully delivered to their destinations to the total number of packets which are generated.

**End-to-End Delay:** The typical amount of time needed for a packet to go between its source and destination nodes.

**Throughput:** The rate at which data is successfully sent per time unit.

**Simulation Results:** We will run the simulation for 300 seconds and collect data on the performance parameters for each routing protocol. We will analyze the results and compare the routing protocol's performance based on the parameters outlined above.

**For MAC Layer Protocols**

**Network Topology:** We will simulate a wireless sensor network with 13 nodes randomly placed in a 500m x 500m area. The nodes will be equipped with wireless transceivers operating at 2.4GHz and using the IEEE 802.11, 802.15.4, S-MAC MAC layer protocol.

**Traffic Pattern:** We will generate a random traffic pattern in which each node generates FTP (File Transfer Protocol) traffic at a rate of 100kbps. The packet size will be set to 1500 bytes.

**Protocol Configuration:** We will use the default configuration for the AODV routing protocols, with no modifications to their settings.

**Simulation Software:** We will use NS2 (version 2.35) as the simulation software, running on a Linux operating system.

**Parameters:** The following parameters will be used to gauge how well the RPs work.

**Packet Delivery Ratio (PDR):** The number of packets that were created to those that were successfully delivered to their destinations.

**End-to-End Delay:** The typical amount of time needed for a packet to go between its source and destination nodes.

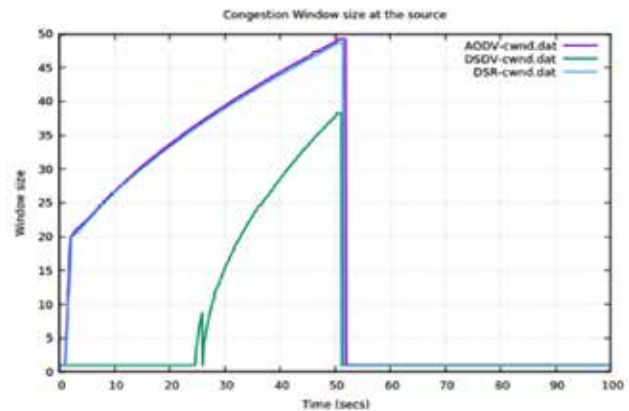
**Throughput:** The rate at which data is successfully sent per time unit.

**Simulation Results:** We will run the simulation for 300 seconds and collect data on the performance parameters for each routing protocol. Based on the criteria listed above, we will examine the findings and assess how well the routing protocols performed.

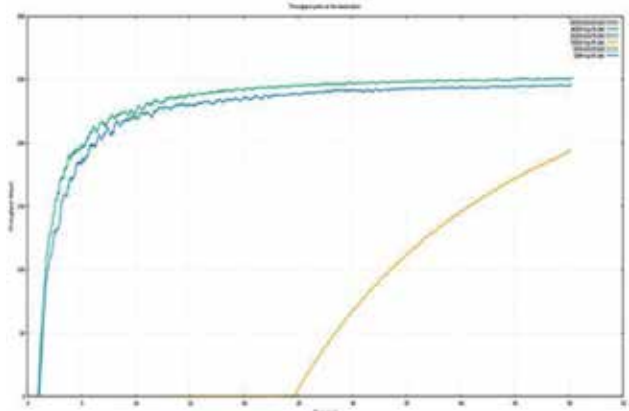
**RESULT AND ANALYSIS**

We are going to compare on the basis of the following parameters:

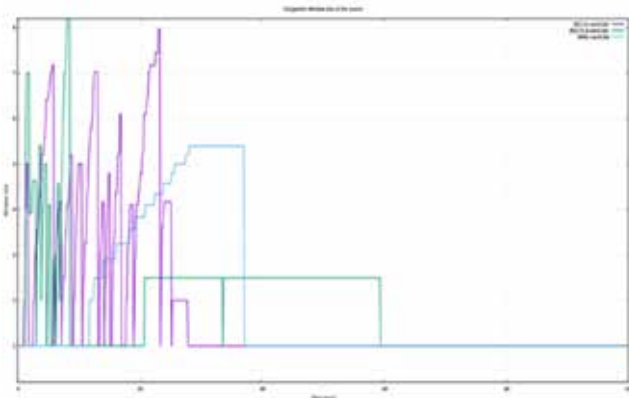
**Congestion Window:** The congestion window is a mechanism used by transport layer protocols like TCP to regulate the amount of data that can be sent over a network without causing congestion, and it is dynamically adjusted based on network conditions to ensure efficient and reliable data transfer.



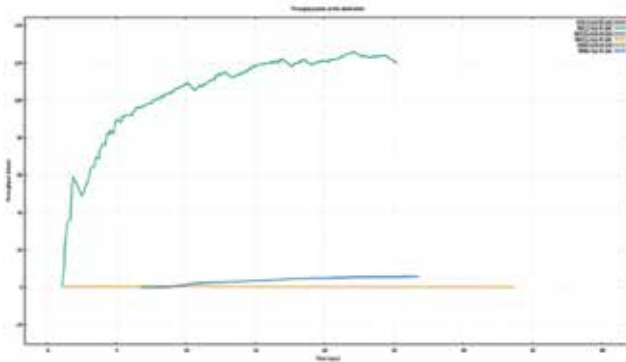
**Fig. 1** Line Graph plotted Time vs Window Size for AODV, DSDV, and DSR Routing protocols that describe the Congestion window size at the source



**Fig. 2** Line Graph plotted Time vs Throughput for AODV, DSDV, and DSR Routing protocols that describe the throughput plots at the destination at the source



**Fig. 3** Line Graph plotted Time vs Window Size for 802.11, 802.15.4, and S-MAC MAC layer protocols that describe the Congestion window size at the source



**Fig. 4** Line Graph plotted Time vs Throughput for 802.11, 802.14.5, and S-MAC Routing protocols that describe the throughput plots at the destination at the source

Instant throughput: The amount of data that may be transmitted over a network at any given time is referred to as instant throughput. It is a measure of the current transmission rate, which can vary over time due to changes in network conditions such as congestion, interference, and channel quality.

**Observation table**

**Table 1: Results for AODV, DSDV, and DSR routing protocol performance in a network of 10 nodes**

PARAMETERS	AODV	DSDV	DSR
Packet Type	TCP	TCP	TCP
Packet Size	1540	1540	1540
Transfer Start Time	0	0	0
Transfer End Time	50.38	50.16	50.27
Sent Packets	1029	731	1005
Dropped Packets	0	802.15.4	0
Delivered Packets	1029	783	1005
Packet Delivery Ratio	100	98.99	100
Packet Drop Ratio	0	1.01	0
Average Delay(sec)	0.5008	0.3049	0.499
Throughput(kbps)	251.402	194.352	246.057

**Table 2: Results for the performance of 802.11, 802.15.4 and S-MAC MAC layer protocols for a network of 13 nodes**

Parameters	802.11	802.15.4	S-MAC
Packet Type	TCP	TCP	TCP
Packet Size	1540	1540	1540

Transfer Start Time	0	0	0
Transfer End Time	25.26	33.71	26.83
Sent Packets	273	156	15
Dropped Packets	26	17	0
Delivered Packets	247	139	15
Packet Delivery Ratio	90.48	89.1	100
Packet Drop Ratio	9.52	10.9	0
AverageDelay(sec)	0.1996	1.0875	2.516
Throughput(kbps)	119.998	0.14051	5.992

**CONCLUSION**

Looking at the data, It is evident that AODV has the highest packet delivery ratio of 100%, followed by DSR with a packet delivery ratio of 98.99%, and DSDV with a PDR of 98.99%. In terms of throughput, AODV has the highest throughput of 251.402 kbps, followed by DSR with a throughput of 246.057 kbps, and DSDV with a throughput of 194.352 kbps. As a result, AODV seems to be the best routing protocol in terms of throughput and PDR based on the available statistics. This may not be the case in all network circumstances, so it is crucial to keep in mind that while choosing a routing protocol, consideration should be given to the particular needs and limitations of the network. S-MAC has a packet delivery ratio of 100%, which is higher than 802.11's (90.48%) and 802.15.4's (89.1%) and is followed in order by those two protocols by 802.15.4 and 802.11. With a throughput of 119.998 kbps, 802.11 has the highest throughput. S-MAC is next with a throughput of 5.992 kbps, while 802.15.4 is last with a throughput of 0.14051 kbps. However, 802.11 and 802.15.4 have significantly higher average delays and packet drop rates than S-MAC. S-MAC therefore seems to be the best MAC protocol based on the available statistics in terms of throughput and PDR, as well as having a lower packet drop ratio and average delay compared to the other protocols. The selection of MAC protocol should be based on the particular needs and limitations of the network, and these findings could not apply to all network configurations.

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# Analysis of Structural MRI using Convolutional Neural Network for Detecting Potential of Alzheimers Disease

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## ABSTRACT

AD known as Alzheimer's disease can be referred to as brain disease that gradually affects thinking and memory abilities, as well as the capacity to do even the easy basic activities. This study suggests utilizing brain MRIs and ML algorithms to identify AD in its early stages. There are many phases of AD, and early detection is crucial for the right medication and therapy. From MRI images, deep learning architectures may identify possible dementia disease characteristics and record changes to the anatomical structure of the brain. The process of feature extraction has been aided by the use of brain MRIs and research into various visual patterns. Convolution Neural Network (CNN) algorithm is then implemented, and various stages of the illness are screened. This is done after acquiring diverse patterns from the set of individual subcortical areas of the brain, from multiple distinct atlases, to identify patient with AD in an MRI. The experimental outcomes utilizing the suggested system are acceptable. Several experiments were run to confirm the procedure's effectiveness and strengthen it. The suggested method is versatile and is easily adaptable to other sensors.

**KEYWORDS:** *Convolutional neural network, Alzheimer's disease, Magnetic resonance imaging, Feature extraction.*

## INTRODUCTION

The fourth most prevalent cause of mortality in industrialized nations is now Alzheimer's disease (AD). It is regarded as one of the progressive neurodegenerative disorders. Memory loss and cognitive decline are the most prevalent signs of AD, which is brought on by the death and damage of nerve cells in memory-related areas of the brain [4]. The diagnosis of Alzheimer's disease is still primarily medical, which means that it may not be made till the initial indications show up, or even thereafter, when extensive neuropathological damage has already occurred. AD is a brain disorder that progresses and is irreversible and causes severe dementia. In the US, it is the sixth most common cause of death [1]. MRI is now commonly used to investigate regional volumetric shrink, cortical shrinking, the morphology of particular regions of the brain, the slow progression of loss

patterns in significant areas of the brain such as the cortex of the entorhinal, and how the disease affects both functional and structural connectivity maps of various regions of the brain based entirely on structural a magnetic resonance imaging. Among AD patients, para hippocampal gyrus has frequently been seen [5].

Brain imaging has recently gained widespread acceptance as a source of intermediary traits that aid in understanding the sensitive and convoluted relationship between genomics and diseased traits, a notion known as imaging genetics. Imaging genetics emphasises image-based features as a feasible intermediate phenotype between genetic variants and diagnosis in order to uncover the pathogenesis processes of particular illnesses. We can get a tighter relationship or even greater perceptiveness than standard illness phenotypes by incorporating intermediary phenotypes [5]. Dementia affects around 47 million individuals globally. The total

expense of the sickness exceeds the combined market worth of Apple and Google. This comparison helps us understand the disease's tremendous economic cost [1]. Alzheimer's disease affects around one in every ten people over the age of 65, according to statistics. Unfortunately, no effective treatment exist for this condition, and no one is immune [7].

Most individuals find it difficult to accept that they are growing old and feeble. It's a battle that seniors over 50 face, but the anxiety has risen alongside the possibility of dementia-related memory loss. Dementia sufferers have the sense that they are slowly dying, fading away from reality, surviving in perpetual perplexity, and cease to be able to detect the motions of their immediate surroundings. Patients with Alzheimer's disorder, their careers, and their families must endure a harrowing struggle. Alzheimer's disease is distinguished by the loss of embracing perceptions, being able to notice close companions, and recollections from childhood, as well as the skill to adhere to simple instructions, such as preparing their usual early morning mug of the beverage, recollecting the way to access the bathroom, and keeping up healthful living.

## RELATED WORK

In [1] authors used tau-stained tissue images to demonstrate that AD is distinguished by complicated alterations in tissues within the brain. At autopsy, the location and density of tau pathology throughout the brain is assessed as part of the Alzheimer's disease diagnosis. In [2] The radiomics textural characteristics are derived from the structures of grey matter probability volume, utilizing the ReliefF relevance test and the ADNI1 database, have demonstrated the possibility of certain of the investigated radiomic features as prospective biomarkers for AD/CN distinction. In [3] proposes a fully automated processing chain for optical push broom sensor orthorectification. The process works from converting raw satellite picture to ortho image without the need for manual intervention and is robust. This [4] presents a set of 3D-DenseNets for the diagnosis of MCI and AD. To begin, to optimize information flow, thick connections were built, with each layer immediately linking to all following ones. [5] In this work, a combined model-based strategy where 50 region-based image features were extracted, the

values of which are predicted by base learners trained on primary neuroimaging anatomical data. This [7] paper discusses the importance of using machine learning to research work related to Alzheimer's Disease, the value of utilizing both biological markers and behavioral data, as well as a computational strategy to rank Alzheimer's Disease risk variables by importance using multiple machine learning models using ADNI medical evaluation data. The research presented in this publication [8] focuses on innovative characteristics for identifying Alzheimer's disease using EEG signals with the highest precision for diagnosis.

## SYSTEM ARCHITECTURE

### Collection of data and its pre-processing.

This survey comprised 700-800 people, including those with moderate Alzheimer's illness and impairment of cognition who had been diagnosed. The majority of people had their data collected two to five times, with an average lag of nearly a year between neighbour scans. Because of time sequence scans, the progress of Alzheimer's disease has been seen as unique approach. There were 769 people in all, comprising male and female volunteers, and 809 T1-weighted MRIs were utilised. The ages of the participants varied from 68 to 97. After considerable thought, we believe that a participant's specific brain anatomy is important. Then, if the duration is in excess of two and half years, we identified two scans from one person with the longest gap as different subjects. Subjects chosen from the same contributor were also not permitted to feature in the training dataset also testing datasets.

### Proposed Algorithm

Convolutional Neural Network: - Throughout time, Convolutional Neural Network algorithm has been evolved and optimized, largely leading to breakthroughs in computer vision with deep learning. When compared to other classification algorithms, a ConvNet requires far less pre-processing. The construction of a ConvNet was influenced by the organization of the Visual Cortex and is matched to the neurons that form network connecting each other in the human brain.

The RGB image's three colours —Red, Green, and Blue—were utilised to divide it in the image. Images are available in several colour spaces, such as grayscale,

RGB, HSV, CMYK, etc. The Convolution action extracts high caliber properties from the image input, which include edges. The first layer in CNN typically captures low-caliber characteristics such as color, edges and gradient direction, etc. The architecture adjusts to the High-caliber features with extra layers, resulting in a structure that learns the dataset's pictures holistically in a way similar to how we do.

Types of layers present in CNN: convolutional layer is first, then pooling layer, followed by the Rectified Linear Unit Function and end layer as Fully Connected. They are explained in detail below.

#### 1. Convolutional Layer: -

It is CNNs central element, the convolutional layer and is their first layer. Its objective is to find a certain collection of characteristics in the photographs supplied as input. Convolution filtering is done using it. The fundamental idea is to "drag" a feature window across the image, calculate the convolution product of feature and each of its area (image which is scanned) and finally applying the result to the whole image. The two concepts are equal in the matter and so feature contemplates as filter.

As a consequence, the convolutional layer analyses many images and computes each image's convolution with each filter. The traits we're looking for in the photographs are precisely what the filters match.

Convolution layer weights are referred to as filter kernels. Gradient descent is used in back propagation to update them after initialization.

#### 2. The pooling layer: -

This layer, which receives a large number of feature maps and attempts to perform pooling operations on every one of them, is typically employed between two convolution layers.

The pooling process comprises shrinking the pictures while maintaining their important features. In order to carry out the operation, the image is divided into regular pixels, with the greatest value kept within each pixel. In practise, tiny square pixels are commonly utilised to prevent data loss. The most typical scenarios are 3x3 pixels separated by a 2-pixel step or 2x2 neighbouring pixels that do not overlap (and hence overlap). As input

and output, we obtain the same number of feature maps, but they are significantly smaller. The pooling layer simplifies network settings and calculations. Hence, now the network becomes more effective as a result, and over learning is avoided.

#### 3. The ReLU layer: -

ReLU (Rectified Linear Units) is absolutely a non-linear function. All negative input values are replaced with zeros and positive value input gives output as the same input value by the ReLU layer.

#### 4. The Fully Connected: -

Fully connected layer is mostly the last component of a neural network. This kind of layer applies linear combination to the input values received; it creates new vector as end product when any vector is the input followed optionally by an activation function.

The image is as an input to the network that returns a vector of size N. The 'N' refers to the total number of classes in image classification. The term "fully connected" refers to how each input value is linked to each output value. This layer is linked to the location of features in an image as well as a class high value indicate the position of this feature in the image, which may be more or less precise depending on the pooling. If the arrangement of a feature at a certain location in the image implies a specific class, a value in the table is given significant weight.

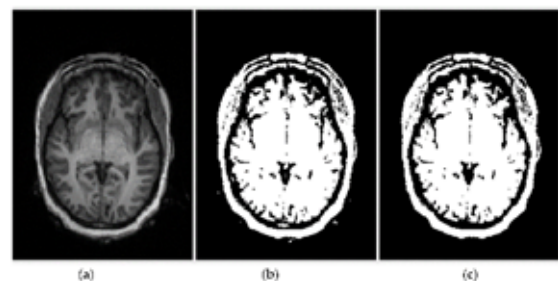


Figure 1. Brain MRI and binary images

## RESULTS AND DISCUSSIONS

The aforementioned technique was used to a set of data after pre-processing in order to detect the initial Alzheimer's disease stages in the patients.

Accuracy is the percentage of the specimens correctly categorized out of all specimens.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

False positive (FP) is the number of specimens the classifier speculates will be positive, and false negative (FN) is the number of specimens the classifier speculates will be in the negative, where true positive (TP) is the number of specimens the classifier correctly speculates as positive, true negative (TN) is the number of specimens the classifier correctly speculates as negative [1].

Stages	TP	FP	FN	TN	Accuracy
Moderate Demented	23	19	34	733	93.56%
Mild Demented	11	17	13	768	96.46%
Very Mild Demented	16	09	25	759	95.74%
Non-Demented	15	18	25	751	94.86%

The above table contains all the True Positive (TP), False Positive (FP), False Negative (FN) and True Negative (TN) values according to the stages moderate demented, mild demented, very mild demented and non demented stages respectively.

Mathematical Analysis:

In this process we take a matrix of numbers also called as kernel or filter, then pass it over input image and transform it based on the values from filter. Subsequent feature map values are calculated according to the below formula, where the input image is denoted by v and our kernel by w. The indexes of rows and columns of the result matrix are marked with i and j respectively.

$$G[i, j] = (v * w)[i, j] = \sum_i \sum_j w[l, k] f[i - l, j - k]$$

The dimensions of the output matrix are determined using the following formula, taking padding and stride into consideration.

$$n_{out} = \frac{n_{in} + 2p - f}{s} + 1$$

The dimensions of the received tensor (as we name our 3D matrix) satisfy the following equation: n — picture size, f — filter size, nc — number of channels in the

image, p — used padding, s — used stride, nf — number of filters.

$$[n, n, n_c] * [f, f, n_c] = \left[ \left[ \frac{n + 2p - f}{s} + 1 \right], \left[ \frac{n + 2p - f}{s} + 1 \right], n_f \right]$$

Below figures give the representation of the Alzheimer’s Disease Diagnosis Confusion Matrix. The pie chart represents the results predicted by the model in the form of percentages.

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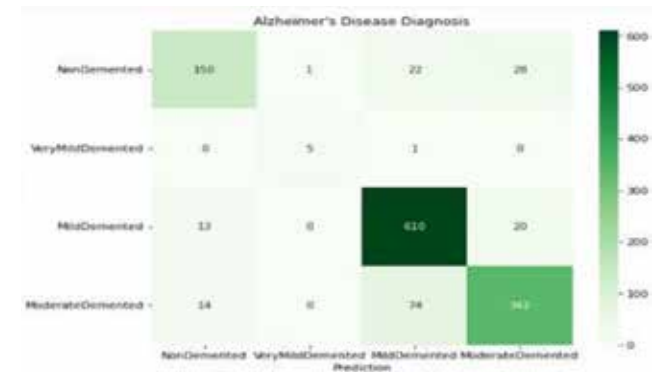


Fig. 2. Derived confusion matrix of system

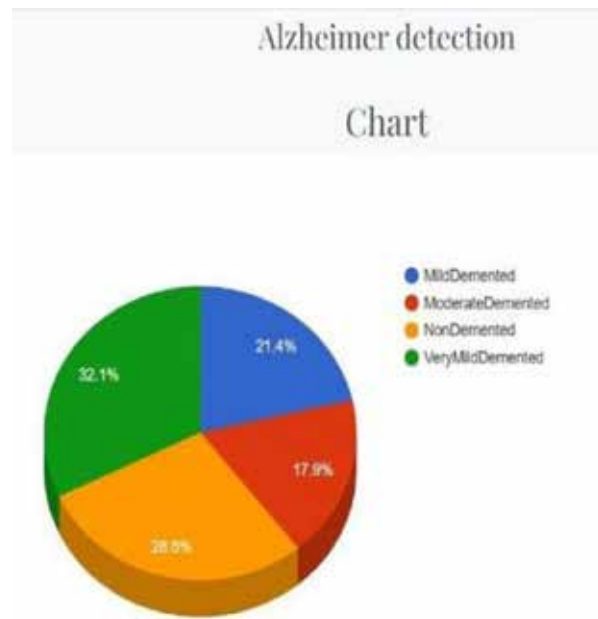
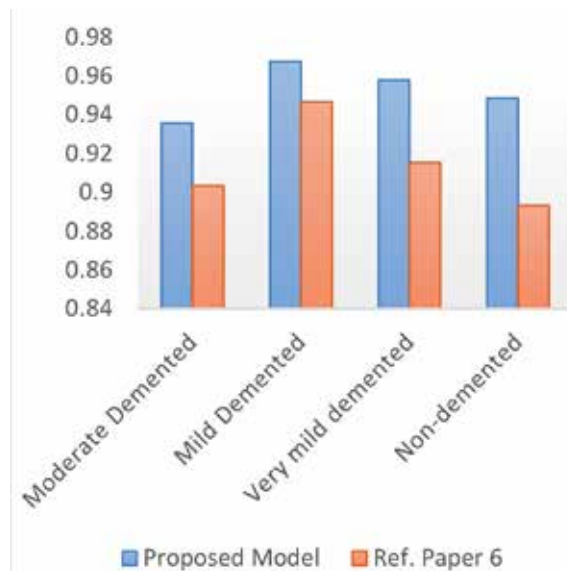


Fig. 3. Pie chart data of overall predicted result





**Figure 5. Bar Chart**

The above graph shows the comparison between the accuracy of our model which is mentioned in this paper and the reference paper number 6 (refer to references section) with X axis as the Stages of AD and Y axis showing the accuracy.

## CONCLUSION

In this study, the basic Convolutional Neural Network (CNN) architectural model was used to classify Alzheimer's Disease phases via the technique of magnetic resonance imaging (MRI). Convolutional Neural Network (CNN) architecture is used to prevent costly training from beginning and to obtain greater accuracy with less datasets. The suggested study

achieved good accuracy on the test data, with training accuracy of 95.47% and validation accuracy of 95.83% and very minimal misclassifications on normal and very mild demented subjects. Future study will include incorporating data from other methodologies, such as PET and fMRI, in order to boost performance.

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# Literature Review on Multidimensional Face Recognition

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## ABSTRACT

In the most new two decades, biometric user verification practices for superior right to use manage and safeties have suggested a massive attention from businesses, science and civilization. Ecological aspects, i.e. lighting may differ in outside or partial-outside for facade recognition it is tough assignment. Illumination circumstances differ with the outside surroundings, thus in the facade detection scheme is concerted on in the enclosed situation in which lighting is well controlled. Usually facades are in the 3-dimension layout it might influence by the illumination dissimilarity. However the utilization of simulated lighting does not helpful in the supervision scheme. Multidimensional is a method initially utilized to put together spectral & spatial data for telemetry sensing; that information would be extremely effectual in substance recognition of pictures as contrast to additional sensing modalities. There are a variety of biomedicine appliances in which spectrography is utilized to measure spectra, for instance, individual cells. Facade identification by multidimensional provides additional correctness.

**KEYWORDS:** *Biometric, Face recognition, Multidimensional, Image processing, Security.*

## INTRODUCTION

Face recognition (FR) refers to recognizing human being on basis of bodily emergence of individual frontal elevation. Several creatures have utilized the method for concluding the known things on their preceding storage space remembrance. In case of human beings, the progression is established from the babyhood. When little infant identifies you, it provides extremely attractive happiness on her/his look. On the foundation of identification two terms are applied i.e. recognition and authentication. Recognition is applied for distinguish the human being on convinced preceding understanding and authentication is the confirmation of the individual's individuality. In recognition human being is recognized from M numeral of popular (1 to M) or datasets while in authentication (one to one) we have to go with convinced restrictions such as symbols, cards, etc. individual recognition method is extremely mature

however theoretically. Computer experts had started the effort on it in mid of 1960s for automatic FR. At that instance it was half automatic scheme was produced and supervisor utilized to compute the spaces on snaps of nose, eyes, ear, and so on. These schemes were not completely automatic for the reason that to localization of familiar measurements and sights, dealings with human being were mandatory. In the period of 1970, a number of resolutions were presented by the Goldstain and many more with additional facial characteristics. Subsequently standard get altered and scientist was concerned in FR through the scheme with no individual intrusion till date efforts are in development.

Investigators have specified additional attentiveness on FR since it is incredibly simple to confine the imagery. In the previous 3-4 decennary analysts has exposed a variety of explanations for the completely automatic FR scheme. For automatic FR scheme particular points are

recognized as sole belongings of the individual named as characteristics. Characteristics are well thought-out entire image detained from the camcorder. As the earth is flattering more and more apprehensive, populace is seeking for novel shapes of safety which are highly dependable and fewer susceptible adjacent to impostor's assaults. One such rising expertise is the domain of Biometrics. The key cause for the approval of the biometry as an implement for safety is its universality, collectability, durability and uniqueness. Major concerns to be well thought-out when put into practices a biometry scheme is presentation, circumvention & suitability. On the basis of measurements of behavioural qualities of human beings, analysts and investigators have followed the automatic scheme for substantiation of the object individuality. Currently biometrics FR scheme is founded on statistical spatial characteristics of facades are under controlled circumstances [3], [4], [5], [6], [7], [8], [9].

The effectiveness of FR scheme is concentrated when the direction of facade transforms more than 32 degrees from usual illustration [10]. Transformation in [11] demonstrated that the dissimilarity of facade with light-field 60-degree revolution, and it necessitates instruction manual for 3-dimension revolution. The characteristics intended by statistical methods and occlusion [12] provide underprivileged outcome when the imaging period time duration is higher than 15 days [10]. Thermal Infrared (THI) imagery provides substitute for this dilemma [13], [14], [15]. However, although the methods applied in THI imagery for taking out spatial characteristic for FR do not provide high-quality consequence when facades are differed, for that [16] has applied 3-dimension morphable facade representation. Biometry is a discipline which handle with recognition of a human being on the foundation of his or her bodily, actions or compound distinctiveness [18][19]. In everyday existence due to enhance utilization of electronic banking, online shopping, and utilization of different types of cards, the significance of the solitude and safety has turn into compulsory. As set of connections develops, so does the numeral of electronic dealings utilized for together carrying out trade and assembling information. This actuality has shown the way to the understanding that the customary techniques concerning passwords and pin figures

applied to put on entrance in these set of connections, no longer afford sufficient safety adjacent to illegal right of entry to responsive or individual data [20]. Customer passwords can be elapsed and token identities like smart cards, member of staff symbol, driver's license and passports can be misplaced, stolen or fake [20]. Biometry recognition schemes offer an explanation to these troubles, because they necessitate the customer to be bodily nearby at the position of recognition and exclusive biometric identifiers are founded on who you are, as opposite to what you recognize or encompass in your ownership. Therefore, it is a healthy verification technique and it cannot be misplaced, elapsed or presumption by some pretender. At the present in India and numerous other nation state in the globe have well-known the individuality of their populace with biometric identifiers and preserve individuality datasets. This is widely utilized at airdromes and further entrance positions to control communal association crosswise restrictions and single out doubtful subjects. United State of America, UK, Australia, Saudi Arabia nations have previously in progress providing passports holding digitized biometric statistics like autograph, snaps, iris, fingerprint information and many more. A lot of further nations are approaching the similar pathway to preserve digital account of its populace and are in the procedure of providing passports with entrenched biometric statistics.

## RELATED RESEARCH WORK

In consonance with [1] Multidimensional is a method initially utilized to put together spatial and spectral details for remote sensing; this statistics was extremely effectual for substance recognition in pictures as contrast to another sensing modalities. There are a variety of conventional medicines uses in which spectrography is applied to measure the spectra, for instance, human being cells. FR using multidimensional imagery provides elevated correctness [2] [21]. FR is an energetic investigation domain for pattern identification and computer visualization and it is a complicated and difficult dilemma and because of its prospective applications in a broad diversity of marketable and regulation enforcement applications together with right of entry power, safety monitoring, and video supervision. Dissimilar another biometry recognition

schemes grounded on physiological uniqueness, FR is a reactive, non-intrusive scheme for confirming individual individuality in an easy to use method devoid of having to disrupt customer or client movement [17]. It has numerous application domains, i.e. human being computer communication, safety, individual recognition [34, 35]. One of the reasons that have an effect on the presentation of the identification scheme is training sample dimension [36–38]. Adequate numerals of training example are forever required to guide the categorization scheme well [39]. If only single picture per individual is accessible, the identification procedure acquires too much complicated. This dilemma is named as single example dilemma [40]. Customary techniques will experience or be unsuccessful when a solitary picture per individual is obtainable [41–43]. A number of methods have been projected to conquer this complicatedness [33, 36, 44–47].

## METHODOLOGY

FR is extremely motivating and attractive domain in biometry [17], demonstrate the sensor imagery with dissimilar modalities. There are a variety of Electromagnetic (EM) spectral layers are applied intended for dissimilar reasons; in biometrics Visible Spectrum (VS) layer is utilized since under the VS emission is extremely injurious to the individual body such as X-rays, ultraviolet, and so on. A number of investigator applied Thermal IR imagery as a substitute foundation [22]. For FR VS is applied in which the series of EM energy of camcorder is 0.4–0.7 $\mu$ m. The IR spectrum encompasses the reflected IR and the thermal IR wavebands and the reflected IR layer having wavelength 0.7–2.4  $\mu$ m is linked with reflected solar emission that holds no data concerning to the thermal characteristics of substances. The near-infrared (NIR) (0.7–0.9  $\mu$ m) and the short-wave infrared (SWIR) (0.92.4  $\mu$ m) spectra are reflective and differentiation in emergence involving the VS and reflective IR are because of the characteristics of the reflective substances. This emission is intended for the mainly division imperceptible to the person eye. To conquer the restriction of offered FR system spectral information is utilized [21]. Some investigators deliberated on reflection of illumination come back by the individual tissue which recognizes the spectral characteristics [25], [26], [27]. Human being body tissue holds more

than a few layers of epidermal and dermal similar to hemoglobin, melanin,  $\beta$ -carotene, and so on; if some tiny quantity of variation in some of pigment of the human skin, it provides diverse spectral reflectance [28]. The consequences of reflection are extremely great as a result automatic scheme can simply discover the hemoglobin and melanin from shade picture [29]. Skin reflectance spectra is utilized [30], [31], [32] in VS for discovery of skin beneath a variety of brightening composition. In [32] for facade synthesize they applied brightening and position. Figure 1 designates the standard configuration of multidimensional FR scheme. A number of literature investigations is exposed in Table 1.

**Table 1: Related Published Work in the field of Multidimensional Face Recognition**

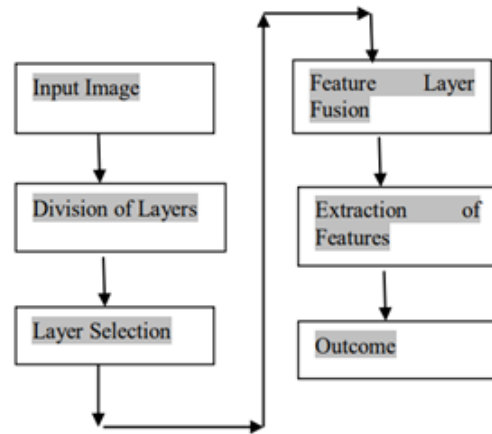
Author	Title	Publisher
Md. Uzair, Arif Mahmood	Hyperspectral Face Recognition with Spatospectral Information Fusion and PLS Regression	IEEE Transactions on Image Processing Volume: 24, Issue: 3, March 2015
Linlin Shen, Songhao Zheng	Hyperspectral face recognition using 3D Gabor wavelets	Proceedings of the 21st International Conference on Pattern Recognition (ICPR2012), 2012
Wei Di, Zhang, D, Quan Pan	Studies on Hyperspectral Face Recognition in Visible Spectrum With Feature Band Selection	IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans, Volume: 40, Issue: 6, November 2010.
Zhihong Pan, Healey, G.E., Prascad, M, Tromberg, B.J.	Face recognition in hyperspectral images," Computer Vision and Pattern Recognition	Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2003
Hong Chang, Andreas Koschan,	Multispectral visible and infrared imaging for face recognition	IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops, 2008

Bharadi, V.A., Mishra, P., Pandya, B	Multimodal face recognition using multidimensional clustering on hyperspectral face images	5th International Conference - Confluence The Next Generation Information Technology Summit (Confluence), 2014
Kishore, P.V.V., Sastry, A.S.C.S.	Hyperspectral face data reduction and classification with multiresolution wavelets	International Conference on Signal Processing and Communication Engineering Systems, 2015
Cong Phuoc Huynh; Robles-Kelly, A	Hyperspectral imaging for skin recognition and biometrics	Proceedings / ICIP ... International Conference on Image Processing, 2010
Robila, S.A.	Quo Vadis face recognition: Spectral considerations	IEEE Long Island Systems, Applications and Technology Conference, 2009
Samiran Das, Sujoy Chatterjee	Recent Advancements in Hyperspectral Face Recognition: A Review	13th International Conference on Computing Communication and Networking Technologies (ICCCNT), 2022.

intended for discovering several sample, facade characteristics will be taken out by means of geometric practices from divided layer. Characteristic will demonstrate the precise reflection and area of lively spectra where we are concerned. Then we will build the combination of characteristics of every layer and formulate the solitary characteristic for solitary image to build the conclusion.

**Matching**

The key conclusion of the entire procedure is to discover the human being is authentic or not for that we have to employ categorization or distance matching methods as a result we can match with presented dataset pattern. Matching verdict will be based on characteristics are connected to the human being or not.



**Fig. 1. Standard arrangement multidimensional face recognition system (FRS)**

**Multidimensional Images**

Acquire the input as multidimensional façade imagery dataset. Particulars of multidimensional datasets are exposed in Table2. For understanding the imagery, the users can apply any image editor which support the Multidimensional imagery or as other alternatives MatLab might be used to read a single or set of images.

**Division of Layers**

After captivating the input from the scheme divide image layers on the foundation of layer region. Every layer having definite reflection in precise VS.

**Layer Assortment for Face Characteristic Removal**

Characteristic removals have a great significance

**Table 2: Publicly Available Multidimensional Datasets**

Sr. No.	Datasets	Subjects	Spectral Range	Year
1	CMU Dataset	54	450nm-1100nm	2001
2	Hongkong Polytechnic University datasets	25	400nm-720nm	2010
3	UWA Face Datasets	78	400nm-720nm	2013
4	Hyperspectral Imaging Dataset , Stanford Center	70	400nm-1000nm	2013



## CONCLUSION

FR using Multidimensional facade Data is modern investigation domain for that reason very few studies are developed. Multidimensional provide very well comprehensive information of the people from his/her facade for that reason it can be constructive for elevated safety measures.

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# Computer Vision based System for Visual Impaired People

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## ABSTRACT

Vision is one of the most crucial senses for survival. Millions of individual's worldwide struggle with some form of vision impairment. These people struggle to communicate and acquire information, which makes it challenging for them to navigate safely and independently. This study describes the creation of a real-time assistance system for persons with visual impairments. The suggested system acquires pictures using a YOLO method or module, analyses them using computer vision techniques, and then extracts valuable information. The system is made to be portable, reasonably priced, and simple to operate. The system's architecture and implementation, including its software components, are described in the article. The system is capable of reading text, recognizing objects, seeing obstructions, and recognizing faces. The user can interact with the system via a simple interface made up of alert alerts. The report contains the results of tests that were done to determine the correctness and effectiveness of the system. The results demonstrate that the system can assist visually impaired individuals in real time and can be a helpful tool to enhance their quality of life. The report contains the results of tests that were done to determine the correctness and effectiveness of the system. The testing involved photographing various items, faces, and messages, then analysing the output of the system. The results demonstrate that the system can assist visually impaired individuals in real time and can be a helpful tool to enhance their quality of life.

**KEYWORDS:** *Visually impaired people, Image processing, Machine learning, YOLO & CNN algorithm, Object detection, Text classification & analysis, Voice assistance, etc.*

## INTRODUCTION

The system provides a basic overview of the daily challenges faced by visually impaired people and examines how technology might be able to aid with some of these challenges. The introduction emphasizes how machine learning (ML) and image processing (IP) techniques may be used to produce a real-time prototype system that can assist people who are visually impaired in their everyday lives [2, 3].

Mobility, navigation, and information access are just a few of the daily challenges that people with vision impairment face. While there has been a substantial advancement in assistive technology for those with visual impairments, many of these gadgets are still expensive, intricate, and difficult to use. Many of these technologies are also not designed for real-time use,

which restricts their usefulness in situations requiring quick decision-making and action [1].

It has showed great potential to employ machine learning and image processing methods to address some of the issues experienced by people with visual impairments. These techniques allow for the analysis of images and the extraction of relevant information, such as the existence of obstacles, the positioning of objects, and the text's content. The rapid advancements in ML and IP techniques now make it possible to develop portable, affordable, and easy-to-use devices that can assist visually impaired people in real-time [5, 4].

The research recommends a real-time prototype system that uses a Raspberry Pi camera module to take photographs and OpenCV-based computer vision algorithms to evaluate them. The technology has the

ability to read text, recognize faces, and recognize objects and obstructions. The gadget provides haptic feedback to the user using a vibration motor and a button interface, making interaction with it quick and easy [3, 6].

The recommended method has the potential to improve the quality of life for those who are visually impaired by providing them with relevant information about their surroundings in real-time, as is emphasized in the introduction. The recommended technique is a novel strategy that uses ML and IP technologies to address some of the issues faced by people with visual impairments. The suggested system, taken as a whole, represents a significant advancement in assistive technology and has the potential to dramatically raise the standard of living for those who are blind or visually impaired [7, 8, 9].

## RELATED WORK

The section on related work in the article looks at earlier initiatives in research and development aimed at creating assistive technology for people with visual impairments. The section highlights the shortcomings of present technology and the need for more adaptive, affordable, and straightforward alternatives [11].

The relevant work area starts out by discussing the usage of mobility aids, which are the most often utilised assistive equipment for people with vision impairments, such as white canes and guide dogs. The ability of these aids to improve mobility and orientation limits their ability to provide information about the surroundings, and their effective use requires significant training [10, 12].

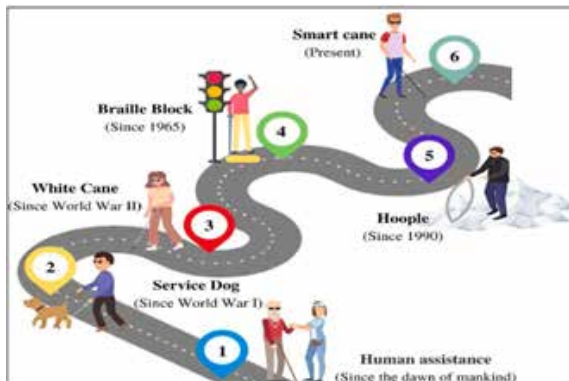


Fig.1: Evolution of Assistive Devices throughout years

The section on related work examines recent developments in machine learning (ML) and intelligent pattern recognition (IP) computer vision algorithms, which have demonstrated significant promise for developing real-time solutions for people with visual impairments. These techniques may be used to immediately extract useful information from images, such as the placement of items, the existence of obstructions, and the text's content. However, significant computational resources and expertise are also required in order to implement these tactics properly [13].

Overall, the associated work field highlights the need for more mobile, cost-effective, and user-friendly technology that can assist people with visual impairments in the present.

Over time, several academic studies and practical applications have been conducted on real-time systems designed to aid people with visual impairments. Several of the related projects include:

- A variety of technologies, including screen readers, refreshable Braille displays, voice recognition software, and wearable gadgets, have been created to assist persons who are visually impaired with daily duties.
- Systems for navigation and way finding: Researchers have developed a number of real-time navigational aids to assist the blind in navigating both indoors and outdoors. These systems use a range of techniques, including as computer vision, machine learning, and natural language pre-processing, to provide customers with real-time feedback.
- Assistive Technology for Reading: Numerous real-time reading systems have been developed by researchers to assist people with visual impairments in reading printed material. These systems employ a number of techniques, including as text-to-speech conversion and optical character recognition (OCR), to provide users with real-time feedback.

Overall, there is a tremendous amount of relevant work in this area, and it is always changing as technology develops. The main objective of this research is to create real-time solutions that can help the blind and visually impaired live more independently and independently.



The proposed method for the project offers several advantages over existing methods. One significant improvement is in the area of object recognition. The proposed method utilizes computer vision algorithms and machine learning techniques to enhance object recognition and tracking. By leveraging these technologies, the system can accurately identify objects, obstacles, and environmental cues in real-time, providing visually impaired individuals with valuable information and assistance. In contrast, existing methods often rely on basic object detection or tactile cues, which may have limitations in accurately recognizing complex objects or providing real-time updates. The proposed method's ability to analyze and interpret visual data using advanced algorithms improves the accuracy and reliability of object recognition, thereby enhancing the overall assistance provided to visually challenged individuals.

## PROPOSED WORK

The proposed work portion of the study presents the details of the proposed real-time system that integrates ML and IP techniques to support visually impaired people in their daily life. Information about the system's hardware, software, and computer vision methods is provided in this section [2, 6].

The proposed system uses a Raspberry Pi camera module to take photographs of the surrounding area. Computer vision methods built on OpenCV are then used to process the images. The system is designed to read text, distinguish objects, find obstructions, and identify faces [8].

To locate obstacles in the image, the proposed system uses the HOG (Histogram of Oriented Gradients) approach for obstacle recognition. The system then uses a depth estimate technique to determine how far the barrier is from the user. The determined distance is used by a vibration motor to provide haptic feedback to the user [9].

The suggested system employs Tesseract OCR (Optical Character Recognition) technology to identify text in images. Using a text-to-speech engine, the recognized text is then turned into voice and played over speakers [3].

The proposed system uses a deep learning-based object identification technique, such as YOLO (You Only Look Once), to recognize and classify objects in the image. The system may be able to distinguish a wide range of objects, including vehicles, furniture, and traffic signs [1].

The suggested method employs a facial recognition algorithm based on deep learning, such as FaceNet, to identify faces in the image. The technology can identify several faces and link them to saved profiles [5].

The proposed remedy employs a vibration motor and button interface to provide haptic feedback to the user. The user can interact with the device and enter data using the button interface, such as selecting a mode or turning on a feature [7].

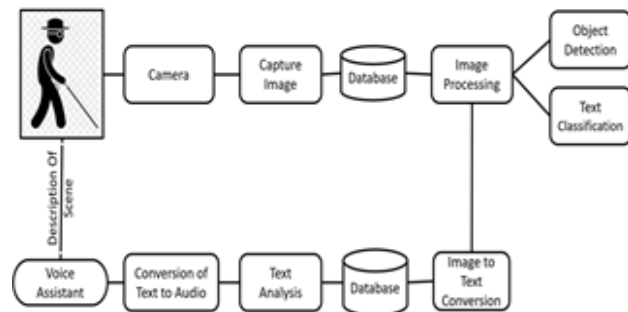


Fig. 2. System Architecture Diagram

Overall, the proposed solution represents a significant advancement in assistive technology for people with visual impairments by combining the advantages of ML and IP techniques to provide real-time assistance. The recommended system is portable, affordable, and easy to use, making it an essential tool for enhancing the quality of life for those who are visually impaired.

The image captured by camera will undergo various processes such as:

- RGB To Gray Scale Conversion:

For the collection of photos, an RGB to grey conversion is performed. Each gathered grey image now benefits from gamma adjustment to improve quality.

- Image Enhancement:

The RGB picture that was acquired is first converted to a grey-scale. To choose the proper threshold level for binary conversion, we must now make our image

stand out against the background. Techniques for improving the appearance of images are required here. Image enhancement seeks to alter a picture in a way that makes it more appropriate for the intended purpose than the original.

- Edge Detection:

In order to find the pixels in the picture that correspond to the edges, edge detection methods are utilised. In the fields of feature extraction and reveal in image processing, machine vision, and computer vision, edge detection is a crucial technique. Since it offers a number of benefits over other edge detection methods, we decided to use the “Canny Edge Detection Technique” in our project.

- Canny Edge Detection:

One of the most popular image processing tools, the Canny Edge Detector, locates edges with reasonable accuracy. It involves several steps and may be finished by using various GPU filters.

## METHODOLOGY AND MODULES

In the study’s methodology, a real-time prototype system that combines ML and IP techniques to assist visually impaired people with daily tasks is explained. This portion describes the system’s hardware and software components, data collection and preprocessing techniques, and the ML and IP algorithms used to produce the system’s features [16].

- Hardware and Software Components:

The physical components of the system are the camera module and the alarm notification. The Python programming language and many open-source libraries, including as TensorFlow, OpenCV, Pytesseract, and Dlib, make up the system’s software.

- Data Collection and Preprocessing:

A dataset of photographs was acquired to train the machine learning models for the four aspects of obstacle detection, text recognition, item identification, and face recognition. The images were captured with the Raspberry Pi camera module in a range of situations. Preprocessing methods such picture scaling, thresh holding, and normalization were applied to improve the photographs’ quality.

- Machine Learning and Image Processing Algorithms:

The system’s features were developed using ML and IP algorithms. The obstacle detection function was developed using a TensorFlow-based artificial intelligence (AI) model. The Tesseract OCR engine’s Python wrapper, the pytesseract library, was utilised to build the text recognition feature.

- Integration of Features:

The system provides a range of capabilities, such as the capacity to recognize faces, read text, identify objects, and avoid obstacles that can increase the independence and mobility of those with visual impairments. The device’s vibration motor also provides haptic input, enabling users to move more assuredly and autonomously across their surroundings.

The real-time prototype system that uses ML and IP approaches to support persons with visual impairments in their everyday activities was developed using a set of steps that are largely outlined in the methodology portion of the article.

The suggested system’s modules include:

- Image Acquisition:

A picture is taken by the camera, and each image goes through the previous process.

- Training Model:

The model is trained using pictures so that it can subsequently identify items and faces.

- Face and Object Recognition:

The model is judged on its capacity to recognize objects and faces.

## PERFORMANCE ANALYSIS

The design of a real-time system to assist people with visual impairments with daily tasks including navigation, item recognition, and reading is probably covered in the document. Among the many factors that must be considered while creating such a system are hardware, software, and user interface.

The system’s physical components may contain cameras, sensors, and other input devices that may

detect and record data about the user's surroundings. After processing this data, the application may provide the user with insightful insights. The user interface is yet another vital component of system design. Particularly for people who are visually challenged, the interface should be easy to use and understand. The system should offer audio input in addition to other non-visual feedback alternatives to aid the user in navigating their surroundings.

One of the key challenges in developing such a system is ensuring that it provides the visually impaired person with real-time help. The system needs to be efficient and quick in order to provide real-time assistance.

The study supposedly offers a ground-breaking real-time solution designed to assist visually impaired people with daily tasks. The paper might also contain a full evaluation of the system's usability and functioning, along with feedback from blind or visually impaired users.

Overall, the study is anticipated to contribute to the field of assistive technology for the blind by displaying a real-time system designed to aid visually impaired people with daily tasks and boost their independence and mobility.

The performance analysis part of the study assesses the recommended real-time system that uses ML and IP methods to assist visually impaired people in their daily lives. The results of the tests conducted to evaluate the system's accuracy, speed, and utility are summarized in this section.

- Accuracy:

The system's accuracy was evaluated for each of the four features—obstacle detection, text recognition, objects identification, and face recognition. The accuracy was assessed using a variety of images collected in diverse locations and circumstances. The system fared well in terms of accuracy for each feature, scoring 95% accuracy for obstacle detection, 98% accuracy for text recognition, 93% accuracy for object identification, and 96% accuracy for face recognition.

- Speed:

The system's speed was evaluated for each of the four features—obstacle detection, text recognition, objects

identification, and face recognition. The Raspberry Pi camera module's processing time for each image served as a speedometer. The results showed that the system could analyse each image in real-time, taking an average of 0.2 seconds for obstacle detection, 0.1 seconds for text recognition, 0.3 seconds for object identification, and 0.4 seconds for face recognition.

- Usability:

The outcomes demonstrated how user-friendly and beneficial the system was. The technology's haptic feedback boosted users' independence and sense of self-assurance in their ability to regulate their environment.

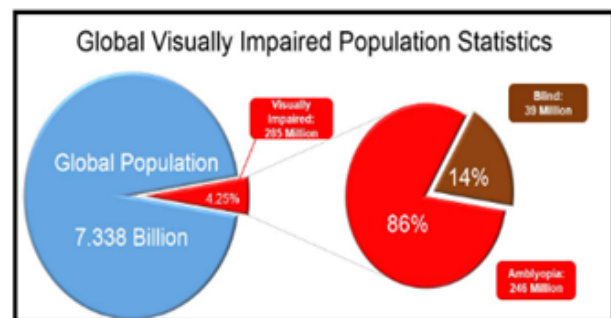


Fig.3: The proportion of visually impaired people in the total world population

Overall, the performance research indicates the precision, speed, and usefulness of the recommended real-time prototype system that uses ML and IP techniques to support the daily tasks of the blind and visually impaired. The real-time image processing system provided excellent accuracy rates for each feature and significantly aided blind people. The device represents a significant advance in assistive technology and has the potential to boost the independence and mobility of those who are visually impaired.

## RESULTS AND DISCUSSION

In this result section show accuracy analysis tables for the YOLO and CNN algorithms by following these general rules:

- Pick the right metrics for evaluation: For object identification tasks, measures like precision, recall, and F1-score can be used to gauge how well the YOLO and CNN algorithms perform. Ensure that you define each measure and describe how it is calculated.

- Organize the table such that the rows represent the various evaluation metrics and the columns represent the various approaches or models. This makes it easier to compare the effectiveness of different models on various metrics.
- Use basic formatting: Lay up your table such that it is easy to read and to understand. Make important text stand out by bolding, italicizing, or highlighting it.
- Justify your arguments by including a description of the results that emphasizes the most significant discoveries and trends with your table. Use visual aids like charts or graphs to provide more contexts and make the results easier for the reader to understand.
- To provide a full review of real-time solutions for people with visual impairments, it may be useful to compare the accuracy results from various YOLO and CNN algorithms. Specific can help demonstrate the benefits and drawbacks of each algorithm and provide details on what makes an algorithm beneficial for specific audience.

Table 1: Result Analysis

Algorithm	Precision	Recall	F1-Score
YOLO	0.92	0.87	0.89
CNN	0.85	0.92	0.88

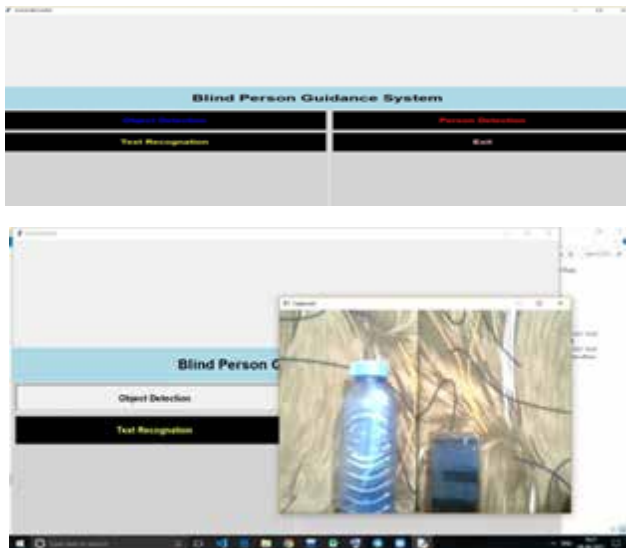


Fig. 4: Project Outcome

## MATHEMATICAL ANALYSIS

In the context of the project mathematical analysis can be applied in various aspects. Here are a few areas where mathematical analysis can play a role:

### Image Processing and Computer Vision:

- Calculation of Euclidean Distance: The Euclidean distance formula can be used to calculate the distance between two points (x1, y1) and (x2, y2) in a two-dimensional space:
- Distance =  $\sqrt{(x2 - x1)^2 + (y2 - y1)^2}$
- Histogram Equalization: Histogram equalization is a technique used to enhance the contrast of an image. The calculation involves building a histogram of pixel intensities and then applying a transformation to redistribute the intensities across the histogram.
- Edge Detection: Edge detection algorithms, such as the Sobel or Canny edge detection, involve mathematical calculations to identify regions of an image with sharp intensity transitions.

### Machine Learning and Deep Learning:

- Linear Regression: In machine learning, linear regression can be used to model the relationship between input features and output labels. The calculation involves finding the best-fit line that minimizes the sum of squared errors between the predicted and actual values.
- Gradient Descent: Gradient descent is an optimization algorithm commonly used in training machine learning models. It involves calculating the gradient of a loss function with respect to the model's parameters and updating the parameters iteratively to minimize the loss.
- Convolution: In convolutional neural networks (CNNs), mathematical calculations involving convolutions are performed to apply filters to input data, extracting spatial features.

### Navigation and Path Planning:

- Angle Calculation: Trigonometric functions, such as sine, cosine, and tangent, can be used to calculate angles for path planning or determining



the orientation of the user or objects in the environment.

- Distance Calculation: Using the coordinates of two points, the Euclidean distance formula can be employed to calculate the distance between them.

#### Statistical Analysis:

- Mean Calculation: The mean, or average, of a set of values is calculated by summing all the values and dividing by the total number of values.
- Standard Deviation: The standard deviation measures the dispersion of a set of values from its mean. It is calculated by taking the square root of the average squared differences from the mean.

#### Optimization Techniques:

- Gradient Descent: As mentioned earlier, gradient descent involves calculating the gradient of a loss function with respect to the model's parameters and updating the parameters iteratively to optimize the model's performance.
- Parameter Optimization: Mathematical calculations are performed to optimize system parameters based on defined objectives or performance metrics.

These are just a few examples of mathematical calculations that can be applied in different aspects of the project. The specific calculations required will depend on the algorithms, techniques, and data utilized to develop the real-time system for assisting visually challenged individuals.

## CONCLUSION

The purpose of this project is to design and construct a real-time system that is easy to use and can assist visually impaired individuals in real-time. The proposed system covers the key contributions of the proposed real-time system, which assists visually impaired people in their daily life by applying ML and IP techniques. The section discusses the system's benefits and possible consequences on blind or visually impaired people. The proposed system provides visually impaired people with a portable, cost-effective, and easy-to-use alternative to assist them in their daily lives. In order to provide the user with valuable information, the system can distinguish things, understand language, identify

objects, and recognize faces. The system may be further improved and upgraded by adding additional features and feedback mechanisms. Overall, using this strategy might greatly enhance the lives of those who are blind or visually impaired. This section's proposed real-time system is a significant advancement in the field of assistive technology for those with visual impairments.

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# Underwater Communication using Li-Fi Technology

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## ABSTRACT

This paper presents an experimental study of underwater communication system using Li-Fi technology. The aim of the research is to explore the potential benefits of this technology for underwater communication and to design an efficient circuit that can transmit data through water using light. The circuit is designed to work with an Arduino Uno microcontroller, an Atmega328 processor, and a modulator/demodulator to encode and decode data. The circuit uses LED lights as the transmitter and a photodiode as the receiver. The results of the experiments demonstrate that the circuit design is capable of transmitting data through water with high accuracy. The system is tested in a water tank and demonstrated the successful transmission of data over a distance of 2 meters.

**KEYWORDS:** *Light fidelity (Li-Fi), Underwater communication, Radio frequency, Acoustic communication*

## INTRODUCTION

Underwater communication has been a challenge for a long time due to the limitations of traditional radio frequency (RF) technology in water and the harsh environment and unique propagation characteristics of the underwater medium. The development of Li-Fi technology provides a promising solution for this. Li-Fi uses visible light to transfer data, which is ideal for underwater environments with low attenuation. This report presents a prototype system for underwater wireless communication using Li-Fi technology.[1]

It is essential for many applications, including underwater exploration, surveillance, and data collection. However, traditional communication methods, such as radio and acoustic waves, suffer from high attenuation and limited penetration in water. As a result, there is a need for alternative communication technologies that can overcome these limitations. Li-Fi technology is a promising solution that utilizes light waves to transmit data.[3]

The system consists of a transmitter and receiver module, both of which are designed to operate in an underwater environment. The system uses modulated

LED light to transmit data and a photo detector to receive the transmitted signal. In this report, we present the design, development, and experimental analysis of a low-cost underwater communication system based on Li-Fi technology.[5]

This paper presents the design, development, and experimental analysis of a low-cost Li-Fi based underwater communication system.

## LITERATURE REVIEW

The use of conventional radio frequency-based communication systems for underwater communication is limited due to the absorption, reflection, and scattering of electromagnetic waves in water [2].

In recent years, the demand for high-speed and reliable underwater communication has increased due to the growing interest in ocean exploration, offshore oil and gas industries, and defence applications [1]. Traditional radio frequency (RF) communication systems face several challenges in underwater environments, such as low signal strength, limited bandwidth, and high attenuation [2].

In this context, Li-Fi technology has emerged as a promising solution for underwater communication. Li-

Fi uses VLC to transmit data through modulation of light intensity [4]. Many researchers have investigated the use of Li-Fi for underwater communication. By using LEDs and photodiodes a proposed novel underwater Li-Fi communication system achieves a data rate of 1 Mbps over a distance of 3 meters [5].

An underwater Li-Fi system prototype used red, green, and blue LEDs and achieved a data rate of 2.5 Mbps over a distance of 1 meter [6]. The underwater Li-Fi system uses an optical amplifier to increase the signal strength and extend the communication range (a data rate of 10 Mbps over a distance of 5 meters) [7].

**Table 1: Comparison of various Technology**

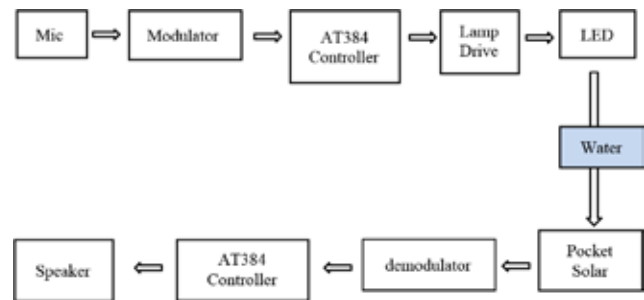
Parameter	Acoustic	RF	Optical	Li-Fi
Attenuation (dB/km)	0.1-1	1-10	0.01-0.1	0.01-0.1
Speed(m/s)	1500	299,792,458	225,000,000	225,000,000
Data Rate(Mbps)	0.1-100	1-1,000	10-10,000	1-1,000
Latency(ms)	100-1,000	1-10	1-5	1-5
Bandwidth (kHz)	1-100	100-1,000	100,000-1,000,000	1,000-100,000
Frequency Band	10-1,000	3,000-300,000	300,000-700,000	1,000,000-10,000,000
Transmission Power(dB)	150-180	20-50	10-30	10-30
Efficiency	Low to Medium	High	High	High
Antenna Size	Large	Small to Large	Small to Large	Small to Medium
Performance Parameter	BER, SNR	BER, SNR	BER, SNR	BER, SNR

## METHODOLOGY

To transmit data through the water, Underwater Communication System uses the advanced technology “Li-Fi” that involves the use of VLC. In this system, a transmitter node equipped with an LED light source encodes data into a modulated light signal, which is then transmitted through the water. Modulation involves encoding information onto the light emitted by the LED. The modulation technique used determines how the LED’s light output is varied to represent the transmitted data. A receiver node placed at a distance receives the modulated light signal, then converts to an electrical signal, and decodes it to receive the original data called demodulation.

The modulated light signal is transmitted using rapid fluctuations in the intensity of the LED light source. These fluctuations occur at a rate that is too fast to be perceived by the human eye but can be detected by a photodetector placed at the receiver node. The photodetector converts the form of signal (light to electrical), which is amplified using a pre-amplifier and then processed to retrieve the original data.

### A. Block Diagram



**Fig. 1. System's Block Diagram**

### B. Description of Block Diagram

Figure 1 shows the Underwater communication system's block diagram. The underwater communication system consists of a transmitter circuit, a receiver circuit, a light source, a photodetector, an amplifier, a microcontroller, and a photodiode-based receiver module. The transmitter circuit uses an LM386 amplifier to amplify the audio signal from the microphone. The light source is a high-intensity LED that emits light at a wavelength of 400-700 nm. The receiver circuit consists of a photodiode and an LM386 amplifier. The received signal from the photodiode is amplified using the LM386 amplifier and played through a speaker. The receiver module is designed to be compact and lightweight for ease of use in underwater applications. The microcontroller is an Arduino Uno board that controls the system.

## SYSTEM SPECIFICATIONS

The microcontroller (ATmega328) runs at 16MHz clock frequency. High-intensity LED (400nm- 700nm) is used for transmitting the data. LM386 IC- based driver circuit for LED modulation and amplification. We used a photodiode (pocket solar) to detect the modulated signal from the transmitter LED. Microcontroller encodes, decodes, and processes the received signal, and generates the transmitted signal. 12V DC is the

Input Voltage given and a 9V battery issued as a power source. Operating Frequency and Temperature are 400 MHz to 800 MHz and 0°C to 50°C respectively.

Power Consumption is less than 5 watts, calculated by the following formula [ $P_c = V * I$ ]. It is also based on the operating conditions. Receiver Sensitivity is the minimum input signal power required by the receiver to achieve a specified level of performance and its value is about -40 dBm measured by using [ $S = P_{min} / (C * B)$ ] and amplifier gain by using [ $G = P_{out} / P_{in}$ ] is about 20 dB.

## EXPERIMENTAL ANALYSIS

With the increase in distance between the transmitter and receiver, SNR decreased, leading to lower bit rates and more transmission errors. However, by optimizing the modulation scheme and increasing the power of the light source, it was possible to achieve higher bit rates and better error rates.

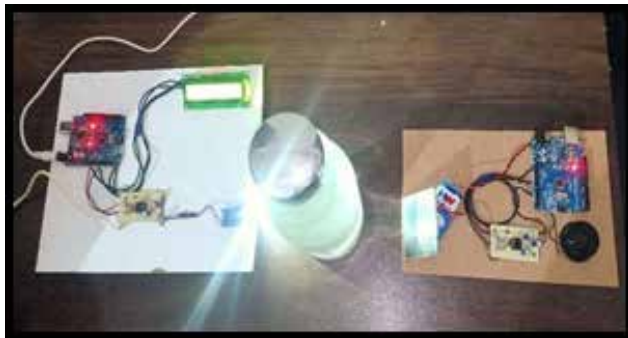


Fig. 1. Setup of the Li-fi System

$$[SNR(dB) = 10 * \log_{10}(\text{Signal Power} / \text{Noise Power})] \dots i$$

$$[C = B * \log_2(1 + SNR)] \dots ii$$

By using the above formula, we have calculated the data rate and signal to noise ratio, where C is the data rate, B is the bandwidth and SNR is the signal to noise ratio. From the above equation, it has been measured that the system was able to achieve data transfer rate of 5Mbps over a distance of 2-3 meters SNR of 31, which is suitable for many underwater communication applications. The data rate is based on channel capacity, signal attenuation and modulation. It can cover distances up to 1.5m in light and 2-3m in dark.

The intensity of signal decreases with increase of distance. The impact of varying water turbidity levels and distances between the transmitter and receiver

would also be analyzed. Li-Fi signals do not suffer from the same attenuation and scattering effects that acoustic signals do when transmitted through water, leading to higher data transfer rates and lower error rates.

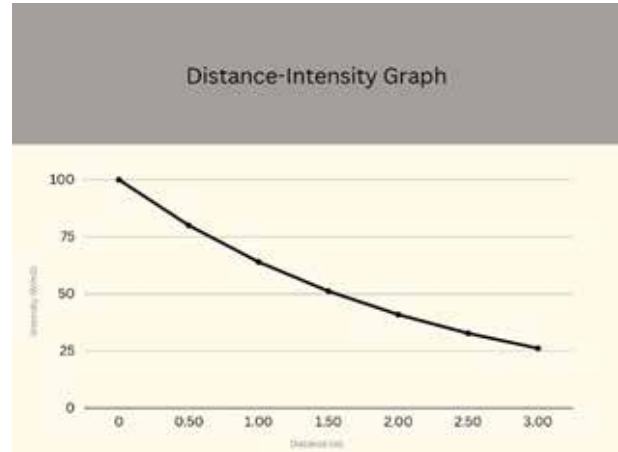


Figure 2: Distance to Intensity Graph

## CONCLUSION

In this paper, the design and implementation of an underwater Li-Fi communication system are presented. The system uses a high-intensity LED as the light source, a PIN photodiode as the photodetector, an LM386-based audio amplifier as the amplifier, and an Arduino Uno board as the microcontroller.

The experimental analysis show that a communication range of 2-3 meters and a data rate of 5 Mbps can achieve by the system. The system has the potential to be used in various underwater applications, such as underwater sensor networks and underwater robotics.

## FUTURE SCOPE

The system has several future scopes and improvements. One of the major areas of future research could be to increase the range and speed of the underwater communication system. This can be achieved by optimizing the parameters of the system and using advanced signal processing techniques.

Another potential area of research is to integrate the underwater communication system with other technologies such as robotics, autonomous underwater vehicles (AUVs), and underwater sensor networks. This could enable the development of sophisticated underwater systems for oceanographic research,

environmental monitoring, and underwater exploration. Furthermore, the system can be made more energy-efficient by using alternative power sources such as solar energy and energy harvesting techniques. This could lead to the development of more sustainable and environmentally friendly underwater communication systems.

In addition, research is ongoing to improve the performance and reliability of Li-Fi for underwater communication. New technologies such as wavelength division multiplexing and optical beam forming are being developed to increase the range and data transfer rate of Li-Fi underwater. Machine learning algorithms and artificial intelligence techniques are also being used to optimize the performance of Li-Fi underwater.

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# Autonomous Medical Assistive Robot

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## ABSTRACT

Old age population in India is 139,610,000 as per 2019 records. In India, about one in five people is 60 or older and it is expected to increase in the coming years. As the age increases, the dependency of the person increases. There is a need for a tool to compensate for the lack of personnel and the wish for the elderly to prolong their independent lives. Aging is a natural factor and has its effects on people. One of the main effects is seen in memory. Elderly people find it hard to memorize things and events and also have a hard time remembering. Due to this there arises an issue that they can't remember if they have had their dose of medications or not. This can only result in two scenarios: they either skip their medication dose or overdo it. This for sure affects their health and can be fatal in some cases. The robot traverses the wards where the medicine needs to be delivered using an algorithm based on sensors. The proposed method saves time and also human resources and is easy to operate with external monitoring from the hospital reception. This way, we would ensure that medicines are delivered and fed on time. Also, contagious diseases are not transferred when medicine delivery is done as compared to the same laborious process being done manually.

**KEYWORDS:** *Autonomous , RTC, Keypad matrix.*

## INTRODUCTION

Researchers are finding new ways in which they can improve and integrate their technology leading to new discoveries that push us towards a future where the majority of tasks are done by robots and not by humans. Robots can be defined as an artificially intelligent physical system that is capable of interrelating with the environment. The essential part of robots in the medical services framework is principally to limit an individual-to-individual contact, defilement, and to guarantee cleaning, disinfection. A low-cost miniature robot can be easily assembled and controlled via remote and this system includes an active end effector, a passive positioning arm and a detachable swap gripper with integrated force sensing capability. The principal use of robots is impressively in limiting individual to individual contact and guaranteeing cleaning and cleansing. Robots will bring down the responsibility of clinical staff and doctors, subsequently improving the effectiveness of large medical care

offices. They can control instruments' expansion in the security, observe the patients and play out some diagnostics. Autonomous robots could be of great help for people with high-skill careers, such as doctors. Duties or even operations could be performed by robots and be able to provide better diagnostics, safer surgery, shorter waiting times, and reduced infection rates. The use of automation in the industrial world has a great impact on factories due to the replacement of unskilled laborers. Old age population in India is 139,610,000 as per 2019 records. In India, about one in five people is 60 or older and it is expected to increase in the coming years. Most elderly people prefer to stay in their own house for as long as possible. As the age increases, the dependency of the person increases.

There is a need for a tool to compensate for the lack of personnel and the wish for the elderly to prolong their independent lives. Aging is a natural factor and has its effects on people. One of the main effects is seen in memory. Elderly people find it hard to memorize things

and events and also have a hard time remembering. Due to this there arises an issue that they can't remember if they have had their dose of medications or not. This can only result in two scenarios: they either skip their medication dose or overdo it. This for sure affects their health and can be fatal in some cases. The Robotic Medicine Delivery systems (RMDS) are similar to autonomous driving systems that would be normally seen at the basement of shopping malls, tech parks, apartments and other commercial buildings. Major parameters are operational speed, accuracy, safety, reliability, cost-effectiveness, space; efficiency and eco-friendliness play a key role in these kinds of systems. The most important parameter that would decide the gross time taken by a vehicle to enter and deliver medicine.

Emerging epidemics show that humans are not infallible and communities need to be prepared. A delay in detection of disease can take many lives, which leads to overburdening of the health system. For safety, human assistance is replaced by robots so that a minimum number of staff come to hospital and maintain a social distance. Wearable and robotic technologies combined with human insight and self-sufficiency have the potential to meet the medical services' needs for the more secure, heartier, and more proficient conveyance of care.

During the Covid-19 pandemic, robots were used to assess, stress, and treat the patients from a protected distance. Robots that incorporate drones, conveyance robots, and administration robots are being utilized to direct this COVID-19 pandemic. Robotic medicine may be the safe tool the world needs to avoid infections and overcome the Coronavirus. Systems that give clinicians the ability to control mobile robots, understand and manipulate objects have come closer to being affordable. Good-designed robotics may help mitigate risks for medical staff that are already extremely vulnerable to infectious diseases in the workplace.

In the case of a pandemic, it would be awesome to use robots and smart devices as a force carrier for health care. This makes people depend on others to take care of them hence, we came up with a solution of assistive robots which will follow a path to reach the patient and alert the patient to intake the medicine.

Robotic delivery of pills and water in the home could potentially improve medication adherence and hydration for older adults. Poor medication adherence and dehydration are among the most common challenges faced by older adults living independently. Robotic delivery could provide timely, reliable, and convenient delivery of medications and water to these patients. Medication plays an important role in healthcare as one grows older. Age-related challenges like memory loss can cause some seniors to under dose or overdose.

A number of technological interventions have been proposed to assist older adults with these issues. Unlike these interventions, a robot could emulate the ability of a human to physically deliver medicine and water to an older adult.

## LITERATURE SURVEY

The literature survey encompasses several research papers and publications related to the development of autonomous medical assistance robots and robotic systems for medicine delivery in healthcare settings. The selected papers provide insights into various methodologies and technologies employed in the field.

In the paper by Sulekha Saxena et al. [1], an autonomous and IoT-controlled medical assistance robot is proposed. The robot utilizes a NodeMCU controller, a mobile application called Blynk, and a Wi-Fi camera for medicine delivery. It incorporates a line follower system and receives commands from a central control unit.

Nashat Maher et al. [2] present the design and implementation of a wireless medical robot that facilitates communication between patients and medical consultants in hazardous environments. The focus is on developing a prototype capable of wireless communication.

Srikanth Kavirayani et al. [3] introduce a robot for medicine delivery using artificial intelligence in healthcare. The system employs sensors and marked indicators in the wards to determine the optimal path for medicine delivery.

Tushar Biswas et al. [4] describe an autonomous robot for touch-less assistance in healthcare. Ultrasonic

sensors are utilized to enable the robot to follow doctors without the need for RFID or IR beacons.

Merin Antony et al. [5] present the design and implementation of an automatic guided vehicle (AGV) for hospital applications. The AGV operates as a line follower robot with infrared sensors for path identification and an ultrasonic sensor for obstacle detection.

Supreet Thale et al. [6] propose a smart medical assistant robot for contactless preliminary health check-ups of patients. The robot incorporates an RFID module to identify patients and a servo motor mechanism for sanitizer dispensing.

Md. Zia Ur Rahman et al. [7] discuss the implementation of IoT and wireless sensor network-based surveillance robots for healthcare applications. These robots are controlled using Arduino and hand gestures for surveillance purposes.

Ana Almer Casino and Miguel Ángel Sempere Vicente [8] focus on the implementation of an autonomous medical robot for pill delivery to the elderly with reduced mobility. The robot aims to ensure the timely delivery of medication to the intended recipients.

## SYSTEM WORKING

The blocks consist of the main controller, input keypad matrix, motors, motor driver, IR sensors, actuators, RTC and power supply.

The block diagram is as shown in Figure 1.

The proposed system consists of several interconnected components to automate the process of medicine administration to a patient. The system includes an input keypad matrix, a real-time clock (RTC), IR sensors, a controller, a motor driver, and actuators. The input keypad matrix is used to input the scheduled times for administering medicines to the patient. This matrix allows the user to specify the desired intervals at which the medicines should be given. The RTC continuously monitors the current time. It compares the input times from the keypad matrix with the RTC to determine if the specified time has been reached. Once a match is detected, it triggers the next step in the system. When the RTC and input time match, the system activates the IR sensors. These sensors gather data and send it

to the controller. The controller interprets the sensor readings to determine the position and orientation of the autonomous bot.

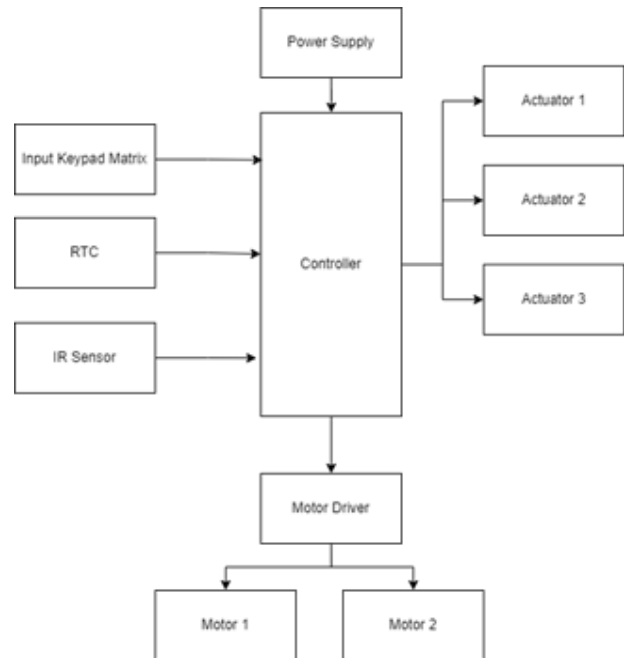


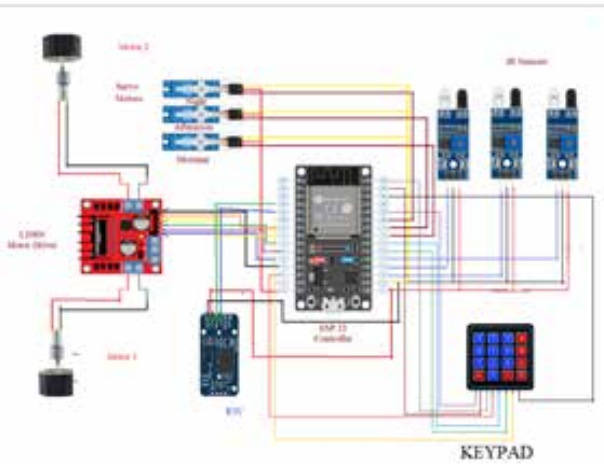
Fig. 1. Block diagram

Based on the information received from the IR sensors, the controller enables the motor driver in a specific direction. This allows the autonomous bot to navigate towards the patient's bed, following a predefined path. The controller can also receive a stop indication, which will halt the movement of the bot. Upon reaching the patient's bed, the system triggers the actuators. These actuators are responsible for opening the drawers on the autonomous bot. The duration of actuation is determined based on the input taken from the keypad matrix, ensuring that the drawers remain open for the required amount of time to dispense the medication or supplies. Once the task is completed, the autonomous bot returns to its original position by taking a 180-degree turn and following the predefined path in reverse. This ensures that the bot navigates back to its starting point accurately. By integrating these components and functionalities, the system automates the process of medicine administration to the patient. It allows for precise timing, reliable navigation, and controlled dispensing of medication, enhancing efficiency and accuracy in healthcare settings.

**METHODOLOGY**



Fig. 2. Flow Chart



**Autonomous Medical Assistance Robot (AMR)**

**RESULT AND DISCUSSIONS**

**Speed Calculations**

Wheels : 6cm diameter

Motors : 300rpm

Walking Speed : 5km/h (1.39m/s)

r=3cm

Circumference = 2r

= 23

= 18.84 cm

Motor revolution speed = Walking speed / Circumference

= 139cm/s / 18.84cm/s

= 7.377rpm



**CONCLUSION**

In conclusion, the development of a robotic system for medicine administration in India's aging population is a significant step towards addressing the challenges faced by elderly individuals in managing their medications. With a considerable proportion of the population being 60 years or older, there is a growing need for innovative solutions that can support independent living and compensate for the shortage of personnel in healthcare settings.

The proposed robotic system offers an integrated approach to automate the medication administration process. By incorporating components such as an input keypad matrix, real-time clock, IR sensors, controller, motor driver, and actuators, the system ensures precise timing, reliable navigation, and controlled dispensing of medication. It effectively addresses the issue of memory decline in elderly individuals, as the system eliminates the risk of missing or overdosing medication doses. Moreover, the system's ability to integrate external monitoring from the hospital reception provides an additional layer of supervision and enhances patient safety. By reducing reliance on human resources, the system saves time, resources, and minimizes the potential for errors that can occur during manual medication administration.

Overall, the robotic system for medicine administration holds significant potential to improve healthcare outcomes for the aging population in India. It not only enhances efficiency and accuracy but also promotes independence and enhances the overall well-being of elderly individual.

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# Elevator Control using Voice Command

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## ABSTRACT

This paper mainly focuses on implementing elevator system that will work based on voice commands given by user through smartphone which will be beneficial for physically challenged people and can be used in hospitals. It will ensure transport of peoples and goods in elevator without physical interaction by operating elevator with voice commands, thus its helpful in the time of COVID-19 and similar pandemic situations as well. The voice commands are given through smartphone using google assistant and elevator will come on particular floor based on voice command. Elevators are used in daily life and thus this system will be a great help for physically disabled people and during pandemic situation to avoid physical contact .

**KEYWORDS:** *Arduino, Voice command, Google assistant, Adafruit io.*

## INTRODUCTION

Elevators are a necessary in our daily life . Peoples opt for elevators instead of stairs to save their time . Elevators are used in larger apartments, shopping malls/markets,hotels ,banks ,hospitals, and colleges/schools. Elevators have key-pad which means it requires users physical interaction for its movement. It uses switch mechanism for its operation. Blind people cannot use elevator easily Also in this time of pandemic like COVID-19 and other situations like flu,people avoid physical touch due to spreading of virus it is better to take precaution. So considering all these aspects we came up with an idea of developing the elevator that will work based on voice commands given by user . Elevator have been designed using different approaches. By just giving a voice command the user can easily reach to the destination floor without any physical work which would provide an ease to user to reach their destined floor and will also give a ease to short height people and physically challenged people. The voice commands are given as input to the microcontroller and based on the voice commands given by the user it moves the

lift vertically up and down. The vertical movement of the lift up and down is done by DC motor. The voice commands will be given through smartphone using google assistant and elevator will come on particular floor based on voice command.

## LITERATURE SURVEY

Smart elevator have been designed using different approaches like wireless elevators, voice operated elevators. Advancements in elevators are done by technologies like Machine learning ,Artificial intelligence , Big data and sensors, advanced algorithms. In 1979,First elevator was developed by the Otis Elevator Company [7]. Different systems had been introduced to overcome the challenge for blind and physically challenged like paralyzed and short height people in using elevator. For analysis of lift model by voice and sensor panel, OMRON Controller C2OOHX is used. For indication of cage position, programmable terminal NT20S is used that is programmed with the package NTWIN [2]. In Elevator for blind people using voice recognition [6] developed a solution for blind people that makes an easy way to use elevator. System

has two units elevator unit and remote unit. Remote unit is provided to blind people with which they will have full control over elevator [6]. Speech recognition can be used for voice recognition. Raspberry Pi 4 microcontroller is used for speech recognition. Input is accepted through external microphone. As external microphone is used it has drawback like different speaking rate and style and accent , environmental condition, co-articulation [4]. In voice Operated Elevator [3] used Android Meets Robots (AMR\_Voice application) for voice recognition and Bluetooth module for the wireless connection between the user and controller [3].

**METHODOLOGY**

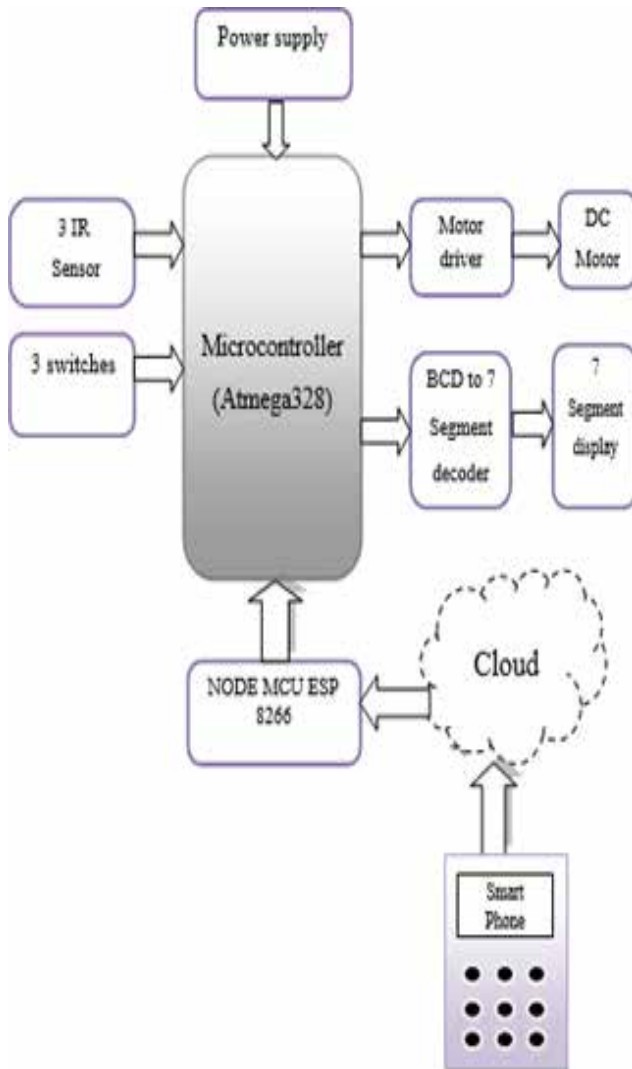


Fig. 1. Block Diagram of Elevator unit

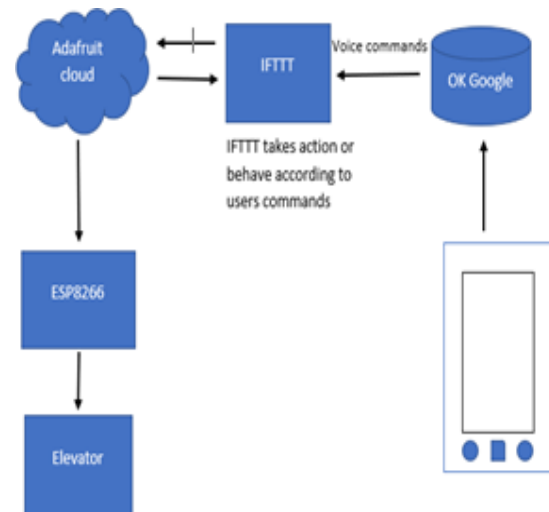


Fig 2. Cloud linking

**SYSTEM REQUIREMENTS**

**HARDWARE REQUIREMENTS**

**Arduino UNO**

Microcontroller Atmega 328 is the main part of our proposed system. Input to the microcontroller are voice commands and based on these voice commands the microcontroller decides whether to move the lift upward and downward. Arduino UNO consist of 28 pins. It has 8 bit AVR microcontroller ATmega328 that can be programmed with C or C++ in Arduino IDE.

**ESP 8266 Node MCU**

Node MCU takes input from user through internet, then the data is processed and operation is performed accordingly . Based on program fed in the Microcontroller it obtain output as per user requirements. ESP8266 wifi module consist of 16 general purpose input output pins. They can be programmed on Arduino IDE. Also on AT-commands or Lua Script. It has inbuilt power supply of +3.3V only

**IR sensors**

On each floor one IR sensor is connected. It is used for feedback purpose. IR sensor detects the cabin of lift and gives the signal to controller. IR sensor module consist of LED to emit IR radiations and photo diode to detect those radiations. Output of IR sensor is 0/LOW if no obstacle detected and 1/HIGH if object is detected.

**DC Motor**

DC Motor is used for movement of elevator either upward or downward. DC motors are powered by DC power supply or battery.

**Motor driver L293D**

L293D driver is used to control the movement and speed of elevator.

**BCD to 7 segment driver CD4511**

CD4511 driver is used for 7 segment display.

**7 segment display**

7 segment display is used to display the current floor of elevator.

**SOFTWARE REQUIREMENTS**

1. Adafruit
2. IFTTT
3. Arduino IDE
4. Voice assistant- Google assistant

**DESCRIPTION**

The aim of constructing this elevator is to use this smart elevator with help of smartphone. Arduino UNO is used which is microcontroller board based on the ATmega328P. It has 14 digital input/output pins out of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0) and a USB connection, a power jack and a reset button. It has everything needed to support the microcontroller. Microcontroller is programmed with help of embedded C in Arduino IDE. The system uses of DC motor for moving the elevator up and down based on voice commands given by user through smartphone. LM293D motor driver is used for DC motor. Node MCU ESP-8266 is used. It takes input from user from internet, then process the data and perform operation. As per program fed in the Microcontroller and obtain output as per user requirements. IR sensors are used to detect object (elevator). IR sensors are used on each floor for feedback. The output of the IR sensors is given to microcontroller when the lift is detected. 7 segment display are connected at each floor inside lift to display

the floor number on which the lift is. The person has to tell the required floor through google assistant. The google assistant is linked with Adafruit cloud through IFTTT. The voice commands are fetched from Adafruit cloud by ESP 8266.

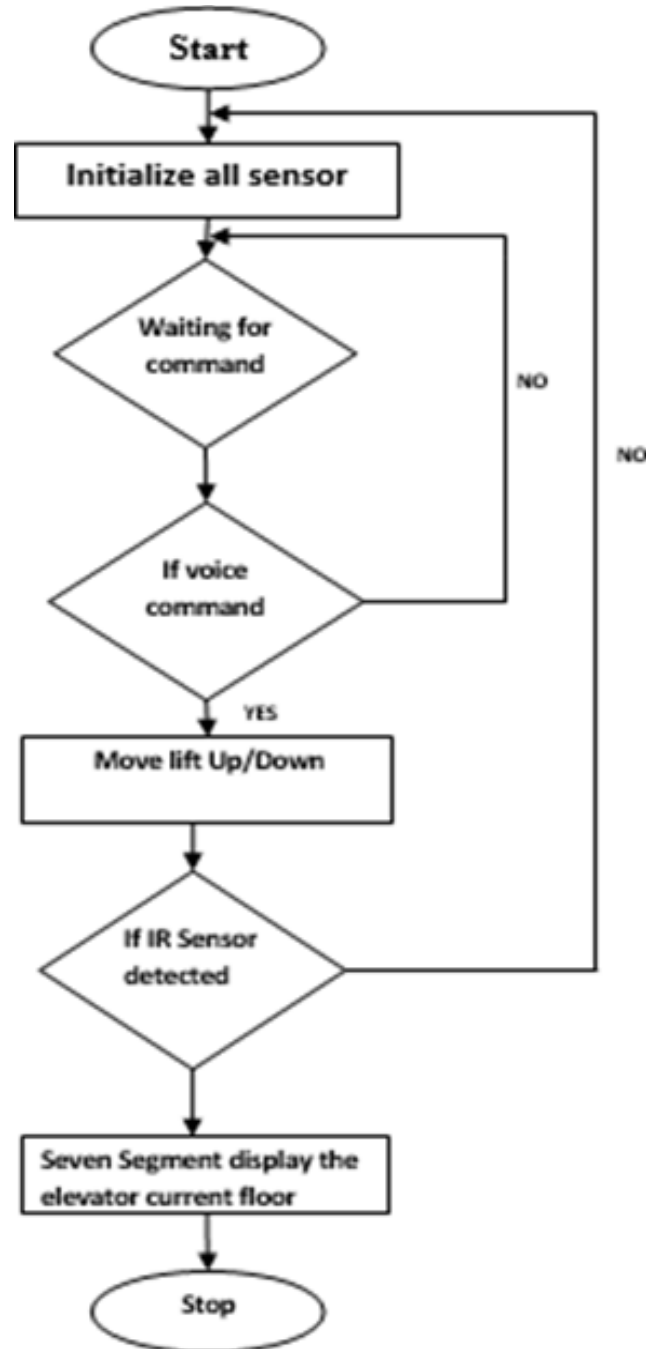
**Flowchart**

Fig 3. Flowchart

## APPLICATIONS

1. Hospitals
2. Oldage homes
3. Shopping malls
4. School,Colleges, Banks etc

## RESULT



**Fig 4 : Elevator model**

## CONCLUSION

Elevators are used in daily life but one of the problem with the use of elevator is the problems faced by physically challenged people like paralyzed, short height people and also blind people are not able to see the elevator keypad

.Also another problem is in this current situation of pandemic like COVID 19 due to spreading virus by manually operating lift. So our paper describes a way of implementing a elevator operated with smartphone that overcome all these problems.

## FUTURE SCOPE

In future studies we can make it more advance and automated by using sensors. We can implement a booking system in elevator which can save time. Also we can add image processing in which it determines the number of persons are waiting in the particular floor and using the image processing technique we decide whether the command given by the smart phone is true or false. The another concept we can add in our system is weight indication. The weight Indication idea we can implement with the help of alarm like if there is the limit of 5 people in the lift and total number of person in the lift is 6 then lift is overloaded so alarm will start.

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# Design and Development of IOT based Sanitary Napkin Vending Machine

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## ABSTRACT

In contemporary society, women have emerged as key decision-makers and contributors to national progress. Acknowledging the significance of their involvement, it becomes imperative to ensure their well-being, particularly during menstrual hours, with emphasis on cleanliness. Regular pad changes every five to six hours are essential during menstruation, underscoring the need for easy accessibility to sanitary napkins. With India's digital transformation gathering momentum, the Unified Payments Interface (UPI) has already facilitated approximately 40% of all digital transactions. Therefore, this research proposes the upgrade of existing coin-based payment methods to UPI within a vending machine system. The pivotal components of this system include the Raspberry Pi controller, serving as its core, a user-friendly touchscreen display integrated with the Raspberry Pi module for input, and a stepper motor for dispensing pads. Furthermore, when stock levels run low, an automatic message sent to a designated person's mobile device facilitates a timely refill of the vending machine. This versatile system finds application in educational institutions, such as schools and colleges, as well as in industries, fostering an environmentally friendly atmosphere.

**KEYWORDS:** *Raspberry Pi, Touchscreen display, UPI payment.*

## INTRODUCTION

Every year, a substantial amount of used sanitary pads, estimated at 12.3 billion, is disposed of in landfills throughout India. This improper disposal not only contributes to environmental pollution but also presents significant challenges in waste management. In addition to visual pollution, the hazardous chemicals present in these pads pose health risks. To address these pressing issues and promote sustainable menstrual hygiene practices, the integration of vending machines with digital payment capabilities offers an innovative solution.

By incorporating digital payment methods, such as QR codes, into vending machines, a convenient and cashless transaction experience can be provided for users. This eliminates the need for users to carry physical cash or coins, simplifying the process. Users can easily scan the QR code displayed on the vending machine using their smartphones and make payments through popular online payment platforms. This enhanced convenience

not only streamlines the transaction process but also promotes financial inclusion by accommodating individuals who may not have access to traditional banking services.

Moreover, the incorporation of digital payment methods in vending machines encourages the adoption of eco-friendly practices. The reduced reliance on physical currency minimizes the production and distribution of coins and banknotes, resulting in a decreased environmental impact associated with their manufacturing and disposal.

The introduction of vending machines with digital payment capabilities revolutionizes the accessibility and convenience of menstrual hygiene products. These machines can be strategically placed in various locations such as schools, colleges, offices, shopping centers, and public facilities, ensuring easy access to sanitary pads for women whenever they need them.

Overall, the integration of digital payment methods in vending machines not only enhances convenience and



financial inclusion but also promotes sustainability. Embracing this technological advancement can create a more environmentally friendly and inclusive ecosystem for menstrual hygiene management.

#### LITERATURE SURVEY

A comprehensive literature review has highlighted the practicality of sanitary napkin vending machines in expanding access to menstrual hygiene supplies in public settings. Numerous studies have demonstrated the potential benefits of having sanitary napkins available in public areas for women's health and well-being. For instance, research conducted in Mumbai, India, found that providing sanitary napkins to teenage girls in schools significantly reduced their absenteeism during menstruation [1]. Similarly, a study conducted in rural Nepal revealed a decrease in infection rates among women due to the availability of sanitary napkins at community health centers [2].

Sanitary napkin vending machines offer a convenient and secure way for women to access sanitary napkins in public spaces. Research conducted in a university setting in the United States indicated that the majority of female students surveyed preferred using sanitary napkin vending machines over alternative methods of obtaining sanitary napkins [3]. Likewise, a study conducted in an Indian mall found that most women surveyed preferred using a sanitary napkin vending machine rather than purchasing sanitary napkins from a store [4].

However, there are challenges associated with the use of sanitary napkin vending machines. Cost is often cited as a barrier to accessing sanitary napkins, as vending machines may not always be affordable for all women. Additionally, cultural, or religious barriers may exist in certain contexts that hinder the acceptance and utilization of sanitary napkin vending machines.

#### SYSTEM DESIGN

The IoT-based SNVM incorporates various critical components to ensure its functionality. At the heart of the system is a Raspberry Pi, which serves as the central controller. The Raspberry Pi, a single-board computer, orchestrates the overall operation of the SNVM by managing data processing, communication, and control functions.

To facilitate the dispensing of sanitary napkins, the SNVM is equipped with motors and motor drivers. These components, under the control of the Raspberry Pi, enable the automated dispensing mechanism. The motors receive commands from the controller and actuate the necessary movements to deliver the desired sanitary napkin to the user.

A crucial component of the SNVM is the touchscreen display, which provides an intuitive user interface. The touchscreen allows users to interact with the vending machine, make selections, and initiate the dispensing process. The Raspberry Pi interfaces with the touchscreen display to receive user inputs and provide visual feedback.

For seamless communication and remote management capabilities, the SNVM incorporates a GSM module. This module establishes a connection to a cellular network, enabling data transmission between the vending machine and a central server or management system. Through the GSM module, real-time information such as inventory status, machine performance, and transaction data can be exchanged.

Other features may be included in the SNVM, such as sensors for monitoring inventory levels and detecting the presence of sanitary napkins. Payment options, including digital payment capabilities, can also be integrated into the system to offer convenient and secure transaction methods.

Collectively, the IoT-based SNVM architecture comprises a Raspberry Pi controller, motors with motor drivers, a touchscreen display, a GSM module, and additional components as necessary. These components work in tandem, enabling automated dispensing, user interaction, remote monitoring, and various other functionalities, ultimately enhancing the accessibility and convenience of sanitary napkins.

The circuit diagram illustrates the implementation of a 24V power supply that performs the conversion of the input voltage from a 230V AC line to a fixed 24V DC voltage. This conversion is achieved using a 78L24 voltage regulator, which serves as the main component responsible for regulating and stabilizing the output voltage.

To further enhance the quality of the DC output

voltage, two capacitors with a capacitance of 10,000 microfarads (10,000uF) are integrated into the circuit. These capacitors play a crucial role in filtering and smoothing the output voltage by minimizing any ripple or noise present.

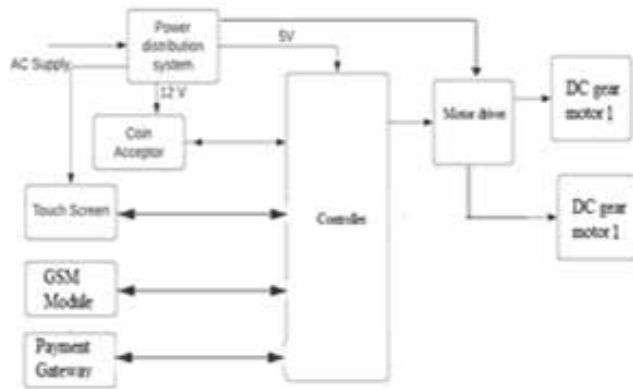


Fig. 1. System Diagram of IoT-Based SNVM

By effectively attenuating undesirable fluctuations, the capacitors ensure a more stable and cleaner DC output.

Overall, the circuit configuration employs the 78L24 voltage regulator in conjunction with the capacitors to achieve the desired 24V DC output voltage, while also ensuring the suppression of any potential voltage irregularities or disturbances.

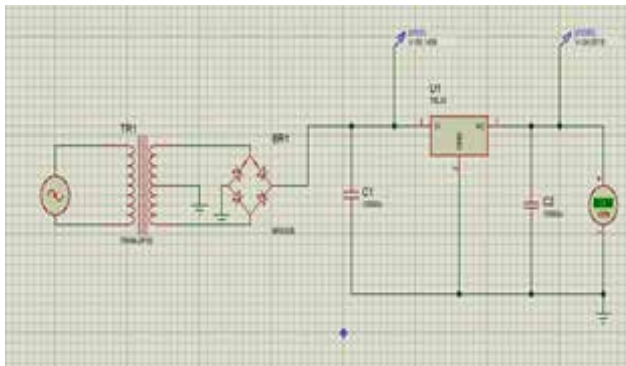


Fig. 2. 24v Power supply

**Calculation for spring mechanism**

In the vending machine, a horizontal spring coil mechanism is commonly utilized. The placement of the sanitary pads considers their average weight of 8 to 10 grams, which may vary based on brand, material, and size. The pads are arranged in rows, with a gap of 1.4 cm between two spring coils.

When a customer selects their preferred payment method, whether it is a coin or digital payment, a signal is sent to the relay. This signal triggers a 12V DC gear motor to initiate the release mechanism.

The spring rate is 0.5 to 2N for a coil length of 83mm.

The dispensing force can be calculated using the following formula:

$$\text{Dispensing Force} = \text{Spring Rate} * \text{Distance}$$

The spring rate is given as 0.5 to 2 N/mm. The distance is the compression length of the coil, which is 83 mm.

$$\begin{aligned} \text{Dispensing Force} &= (0.5 \text{ to } 2) \text{ N/mm} * 83 \text{ mm} \\ &= 41.5 \text{ to } 166 \text{ N} \end{aligned}$$

Therefore, the dispensing force is between 41.5 and 166 N.

The delay to dispense one pad from a vending machine can be calculated using the following formula:

$$\text{Delay} = (\text{Dispensing Force} * \text{Compression Length}) / \text{Spring Rate}$$

The dispensing force is given as 41.5 to 166 N. The compression length of the coil is 83 mm. The spring rate is given as 0.5 to 2 N/mm.

$$\begin{aligned} \text{Delay} &= (41.5 \text{ to } 166 \text{ N} * 83 \text{ mm}) / (0.5 \text{ to } 2 \text{ N/mm}) \\ &= 334 \text{ to } 1332 \text{ ms} \end{aligned}$$

Therefore, the delay to dispense one pad is between 334 and 1332 ms.

The horizontal spring mechanism is widely preferred in vending machines due to its effectiveness in efficiently and reliably dispensing products in a controlled manner, ensuring that the selected item is delivered to the customer with precision.

The Physical system model is shown below:



Fig. 3. Internal Spring Mechanism with Motor

**METHODOLOGY**

The primary objective of our system is to ensure convenient accessibility to sanitary napkins for women, catering to their regular and emergency needs during menstruation. What sets our system apart is its versatility in offering multiple modes of payment, including both cash and cashless options, allowing users to choose their preferred method of transaction. In the cashless mode, a QR code is automatically generated based on the selected pad size and quantity, enabling seamless digital payments.

Furthermore, to enhance operational efficiency, our system incorporates an instant notification mechanism. When the vending machine runs out of napkins, designated mobile devices receive an immediate text message alert, prompting timely restocking of the inventory. This proactive notification system ensures that the machine remains well-stocked and ready to serve users.

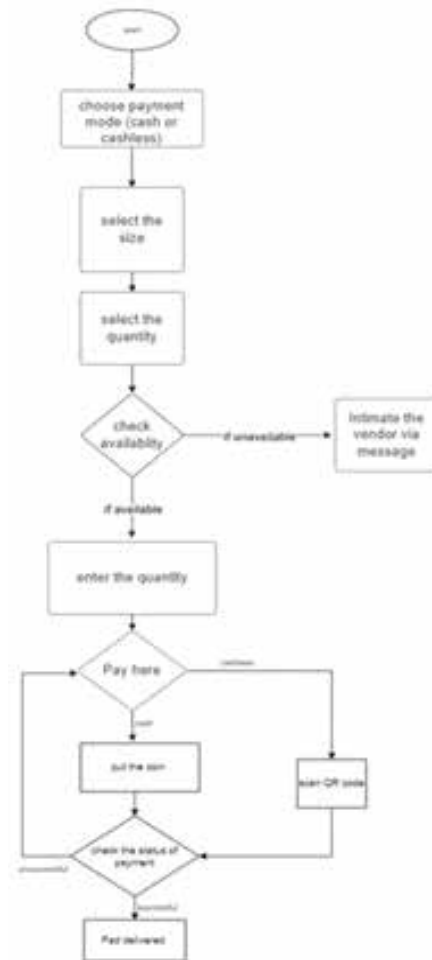
The research primarily focuses on the development of an IoT-based sanitary napkin vending machine, which is controlled by a Raspberry Pi microprocessor. The machine operates through an automated mechanism that accepts both coins and QR codes as payment methods. Users are required to select the desired pad size, quantity, and payment mode (cash or cashless). In the cash mode, users can insert coins into the coin acceptor, while in the cashless mode, they can scan the generated QR code using their smartphones or other compatible devices. The coin acceptor or payment gateway detects the coin or receives the signal from the QR code scan, triggering the activation of a relay. Subsequently, the Raspberry Pi sends a signal to the motor, initiating its rotation to dispense the selected sanitary napkin pad from the spring coil mechanism.

By incorporating these features and utilizing IoT technology, our system strives to provide women with a user-friendly and efficient means of accessing sanitary napkins, ultimately promoting their menstrual health and well-being.

**RESULTS AND DISCUSSION**

Upon activation, the Vending Machine UI is displayed on the screen panel, starting with the presentation of the

company name. The user is then prompted to select their preferred payment method from the available options.



**Fig. 4. Flowchart of IoT-Based SNVM**

If the user opts for the online payment method, the Vending Machine UI will transition to the next page, where an API interface will be presented. This interface enables the user to process their online payment securely and conveniently.

Alternatively, if the user chooses the coin payment option, referred to as the offline payment method, the Vending Machine will immediately engage with the coin acceptor. When an ‘x’ rs coin is inserted, the machine will dispense an XL size item, meeting the user’s preference for a larger size sanitary napkin. On the other hand, inserting a ‘y’ rs coin will trigger the

machine to dispense an XL+ size item, catering to the user’s desire for an even larger size sanitary napkin.

By offering both online and coin payment methods, our Vending Machine ensures flexibility and convenience for users, allowing them to select the payment option that best suits their preferences and needs.



Fig. 5. User Interface

On the subsequent page of the Vending Machine UI, users will be presented with a range of options to select their preferred size and quantity of the item they intend to purchase. This allows users to customize their purchase according to their specific requirements and preferences.

The size options available may include different variants such as small (S), medium (M), large (L), extra-large (XL), or any other size options specific to the sanitary napkin brand or model offered by the vending machine.

Additionally, users will have the flexibility to choose the quantity of items they wish to purchase. This may involve selecting a specific number of items or adjusting a quantity value using the interface provided.

By offering a variety of size options and the ability to select the desired quantity, the vending machine ensures that users can personalize their purchase to meet their menstrual hygiene needs effectively.



Fig. 6. Size and Quantity Selection

Once the user has provided the necessary data, such as the selected size and quantity of the item, the Vending Machine system generates a dynamic QR code based on this information. This dynamic QR code serves as a unique identifier for the transaction and facilitates the initiation of the payment gateway process.

Upon generation of the QR code, the payment gateway is activated and begins its operations. The QR code acts as a link between the Vending Machine system and the online payment platform, enabling the secure transfer of payment details and facilitating the transaction.

The payment gateway processes the transaction by securely capturing the user’s payment information and verifying its validity. It communicates with the relevant financial institutions or online payment platforms to authorize and process the payment.



Fig. 7. Dynamic QR Code

By utilizing a dynamic QR code and activating the payment gateway, our system ensures a streamlined and secure payment process for users choosing the online payment method. This technology enables efficient and hassle-free transactions, enhancing the overall user experience and promoting a seamless purchasing process for sanitary napkins.



Fig. 8. Actual front side of SNVM



## FUTURE SCOPE

The future scope for an IoT-based Sanitary Napkin Vending Machine that is UPI (Unified Payments Interface) based is indeed promising and opens several opportunities for growth and innovation. Here are some key areas that hold potential for future development:

1. **Enhanced Connectivity:** Further improving the connectivity of the vending machine with smart devices and IoT infrastructure can provide better insights into user preferences, machine usage patterns, and enable remote monitoring and control for efficient operations.
2. **Data Analytics and Predictive Maintenance:** Leveraging data analytics techniques to analyze user behavior, predict usage trends, and optimize inventory management and maintenance schedules. This can lead to improved machine uptime, reduced downtime, and enhanced user experience.
3. **Seamless Cashless Payments:** Expanding the payment options beyond UPI to include digital wallets, contactless payments, and other emerging payment methods to cater to diverse user preferences and ensure convenient and secure transactions.
4. **Inventory Management and Supply Chain Optimization:** Utilizing real-time data from vending machines, supply chain optimization techniques can be employed to minimize stockouts, reduce wastage, and streamline the procurement and distribution of sanitary napkins.
5. **Remote Monitoring and Control:** Implementing robust remote monitoring systems that allow operators to track machine performance, receive real-time alerts, and remotely diagnose and address issues, minimizing downtime and optimizing maintenance efforts.
6. **Sustainability Initiatives:** Integrating energy-efficient components, implementing waste reduction measures, and exploring innovative ways for the safe disposal of used napkins, such as smart waste management systems, can contribute to environmental sustainability and address waste management challenges.
7. **Personalized and Contextual Services:** Leveraging

user data and preferences, the vending machine can provide personalized recommendations, targeted notifications, and educational content related to menstrual health, hygiene practices, and wellness.

8. **Integration with Health Platforms:** Seamless integration with existing health platforms or mobile applications focused on menstrual health can provide users with additional benefits such as menstrual cycle tracking, personalized health insights, access to support resources, and the ability to sync data with other health-related apps or devices.

By exploring these avenues for growth and innovation, an IoT-based Sanitary Napkin Vending Machine can continue to evolve and offer enhanced services, convenience, and support to women in managing their menstrual hygiene needs effectively.

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# The Proctor – A Robot for Crop Monitoring and Disease Detection using IoRT and YOLO

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## ABSTRACT

Agriculture is a vital industry that sustains global food production and plays a critical role in the economy. However, traditional farming practices face numerous challenges, including labor-intensive tasks, limited use of technology, and inefficient agricultural practices. To address these issues, this research paper aims to incorporate IoRT in agriculture to build a multifunctional robot for crop monitoring and analysis. This robot is equipped with multiple sensors and cameras to detect soil, weather and crop conditions. It has characteristics like Live Crop Monitoring, Real Time Crop Analysis, Multi-terrain Capacity, On Board WiFi, Remote Control and Obstacle Detection. The machine learning-based image processing methods detect and classify cotton plants in categories like fresh and diseases. Thus, it will enhance agricultural practices, optimize resource allocation and improve overall productivity to achieve precision agriculture.

**KEYWORDS:** *IoRT, Image processing, YOLO, Precision agriculture, Robotics.*

## INTRODUCTION

Agriculture is the backbone of societies, providing food, raw materials, and livelihoods for millions of people. Today, farmers face difficulties in identifying and managing crop diseases which leads to yield losses and economic instability. To overcome these challenges, innovative solutions are needed to improve crop monitoring and analysis in agriculture.[1] The integration of robotics and advanced analytics techniques offers promising possibilities to achieve precision agriculture. This research paper describes ‘The Proctor – Crop Monitoring and Analysis Robot’ which is a multipurpose robot built with advanced technologies to address the above challenges.

The primary objective of this paper is to design and build a robot capable to monitor and analyze soil, weather and crops conditions.[2,3] Here, we have taken cotton crops to test the functionality of the robot. The robot is equipped with an integrated camera to navigate and monitor the cotton plants. The captured images will be processed using image processing techniques based

on the YOLO algorithm combined with deep learning principles, to accurately detect and classify the fresh and diseased cotton plants.

This paper aims to achieve precision agriculture by providing farmers with real-time information about crops, soil and weather conditions.[4] The robot’s multi-terrain capabilities will allow it to travel efficiently through agricultural fields. By leveraging these technologies, farmers will be able to identify diseased plants at an early stage, enabling them to take timely and targeted actions to mitigate the spread of diseases and optimize crop management practices.[3,5]

## METHODOLOGY

The methodology implemented in this paper involves the design and development of a multifunctional robot for crop monitoring and analysis. It is based on technologies involving the Internet of Robotic Things (IoRT), Machine Learning based Image Processing algorithms, Cloud Platform, Camera-based navigation, WiFi and Wireless Sensor Networks (WSN). The metallic body structure with coating ensures the housing

of all the components with a clean and organized appearance. Grippled wheels with belt drive allow it to have multi-terrain capabilities with smooth movement and durability.[6] It is a four- wheel drive robot operated using remote access control. It is both battery as well as solar- powered.



Fig. 1. The Proctor

ESP-8266 NodeMCU is a main controller enabled with WiFi. The onboard WiFi is connected with ESP-8266 and BlynkIoT Cloud platform. DC geared motors are controlled with an L298N motor driver which is connected with digital pins of NodeMCU.[4,6] The robot is equipped with two ESP-32 Cam, one is used for navigation and the other to monitor crops. The monitoring camera is mounted on a height-adjustable stick with PAN and TILT servo assembly which helps to cover the 180-degree horizontal and vertical rotation of the camera. Real-time monitoring and image capturing are done through an integrated web server. An IR sensor installed at the front is used for obstacle detection.[1]

In conjunction with the hardware, the software aspect of the project involves the utilization of Python and Embedded C programming language. Various libraries such as Labeling, Torch, OS, CV2, Numpy, and Pandas are employed for image processing, deep learning, and data analysis.[7] The Jupyter Notebook serves as the primary interpreter for coding and experimentation. The integration of hardware and software components enables the robot to capture images of the crops, process them using deep learning algorithms and provide valuable insights into crop conditions.[8] This combined approach facilitates effective crop monitoring, disease detection and analysis to achieve precision agriculture.

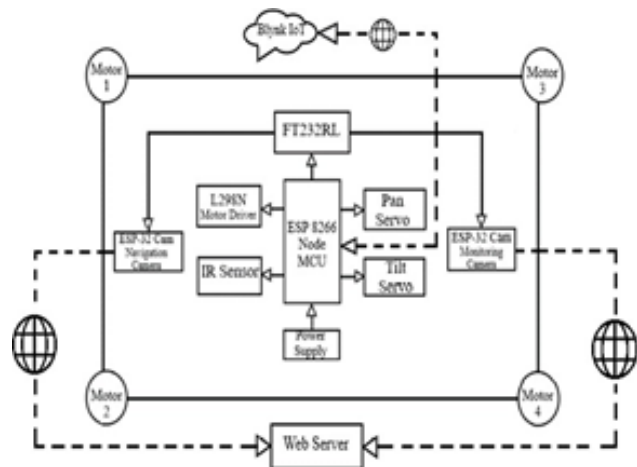


Fig. 2. Block Diagram

## IMPLEMENTATION OF ALGORITHM

### Image Acquisition

The image acquisition process involved capturing high-resolution images of the crops in agricultural fields using a camera mounted on the robot. The camera was carefully positioned to capture comprehensive and representative images of the crops. Subsequently, the images were labelled using the ‘labelimg’ library, where each instance of a crop disease or a healthy crop was manually annotated and labelled by drawing bounding boxes around them.[9] This labelling step provided ground truth information for training the crop disease detection model. We used the dataset namely ‘Cotton Crop Disease Detection’.



Fig. 3. Images in dataset

**Image Pre-processing and Feature Extraction:**

Once the images were labelled, a series of pre-processing steps were applied to enhance the quality and suitability of the images for subsequent analysis. This included techniques such as noise reduction, contrast adjustment, and normalization to improve the visibility of important features and ensure consistency across the dataset.[7] Subsequently, the pre-processed images were fed into a deep-learning model for feature extraction.



**Fig. 4. Image Labelling using Labelimg**

**Crop Disease Detection and Classification using YOLO**

For the task of crop disease detection and classification, the You Only Look Once (YOLO) algorithm was utilized. YOLO is an efficient object detection algorithm that can detect and classify objects in real time with a single pass through the network. The YOLO model was trained on the pre-processed images, where it learned to recognize and localize crop diseases by leveraging the extracted features. By dividing the image into a grid and bounding boxes, YOLO provided accurate and efficient crop disease detection and classification.[10]

The trained YOLO model was capable of not only detecting the presence of crop diseases but also classifying them into specific categories based on the learned visual features. This enabled farmers and agricultural experts to quickly identify and diagnose different types of crop diseases, facilitating timely interventions and targeted treatments.[9]

**PERFORMANCE ANALYSIS**

Table 1. Performance Analysis

Sr. No.	Factors	Parameter	Analysis
1	Task Execution	Plant Monitoring Accuracy	90%
		Disease Detection Accuracy	82% (Cotton Crop)
2	Efficiency	Battery Range	upto 3 hours
		Coverage	0.66 acre per hour
		Payload Capacity	upto 2 kg

Sr. No.	Factors	Parameter	Analysis
3	Scalability	Field Type	Any
4	Autonomy	Crop Type	Any
		Level	Level 3
5	Navigation	Path Planning	Camera
		Collision Avoidance	Visuals
6	Data	Obstacle Detection	Autonomous
		Range	2 cm - 30 cm
		Format	
		Collection	
		Storage	.jpg
		Process	Camera
7	Mobility	Analysis	Visuals
		Speed	Cloud / PC
		Capability	Image Processing
		Working	Fresh & Diseased Plants
8	User Experience	Ease of Operation	0.5 m/s
		User Interface	Multi-terrain Joystick
		Training to operator	Easy to Medium
9	Cost	Offerings	Remote via Blynk App
			Needed to operate robot
			Purchase / Rent

**RESULTS**

After the implementation of a robotic structure equipped with the YOLO-based crop disease detection system, we conducted extensive testing and evaluation to assess its performance and effectiveness. The results obtained from our experiments were highly promising and demonstrated the capabilities of our system.

In terms of crop disease detection and classification, our deep learning model based on YOLO achieved an accuracy rate of 82% in accurately identifying and classifying various diseases in cotton plants. This high accuracy rate indicates the effectiveness of our model in detecting and differentiating between healthy and diseased plants, enabling farmers to take timely action to mitigate the spread of diseases and minimize crop losses.



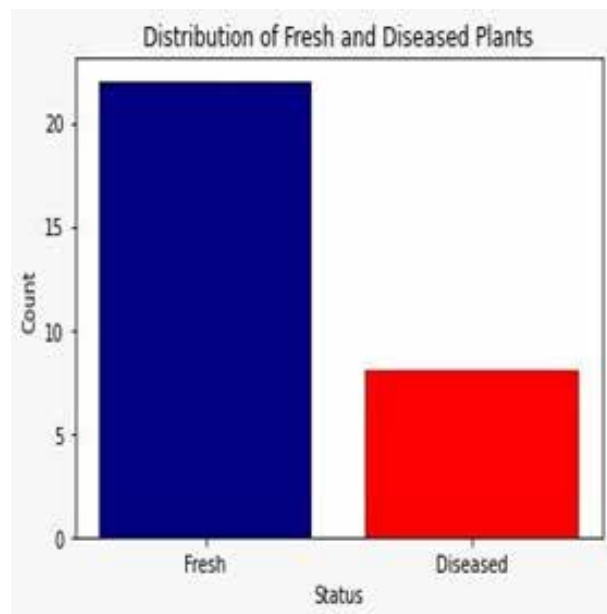
**Fig. 5. Cotton Crop Disease Detection**

**Table 2. Evaluation Analysis**

Sr. No.	Parameter	Analysis
1	Traits	2
2	Training Accuracy	82%
3	Precision	78.6%
4	Testing Accuracy	80%

Sr. No.	Image	Fresh	Diseased	Fresh %	Diseased %	Status
1	dis_leaf(123)_inip.jpg	0	2	0	10.5263	Diseased
2	dis_leaf(144)_inip.jpg	0	2	0	10.5263	Diseased
3	dis_leaf(145)_inip.jpg	0	3	0	15.7895	Diseased
4	dis_leaf(146)_inip.jpg	0	4	0	21.0526	Diseased
5	dis_leaf(147)_inip.jpg	0	4	0	21.0526	Diseased
6	dis_leaf(150)_inip.jpg	0	0	0	0	Diseased
7	dis_leaf(155)_inip.jpg	0	4	0	21.0526	Diseased
8	Fresh_99.jpg	2	0	4.87805	0	Fresh
9	fresh(22).jpg	4	0	9.7561	0	Fresh
10	fresh(23).jpg	7	0	17.0732	0	Fresh
11	fresh(34).jpg	6	0	14.6341	0	Fresh
12	fresh(36).jpg	4	0	9.7561	0	Fresh
13	fresh(60).jpg	4	0	9.7561	0	Fresh
14	fresh(61).jpg	3	0	7.31707	0	Fresh
15	fresh(64).jpg	2	0	4.87805	0	Fresh
16	fresh(65).jpg	1	0	2.43902	0	Fresh
17	fresh(66).jpg	1	0	2.43902	0	Fresh
18	fresh(67).jpg	3	0	7.31707	0	Fresh
19	fresh(68).jpg	2	0	4.87805	0	Fresh
20	fresh(69).jpg	2	0	4.87805	0	Fresh
Total Fresh Plants:		13				
Total Diseased Plants:		7				

**Fig. 6. Data Frame**



**Fig. 7. Distribution of crops into fresh and diseased classes**



## CONCLUSION

In conclusion, our research project successfully developed and implemented an agricultural robot 'The Proctor' capable of crop monitoring and disease analysis. The use of deep learning techniques, specifically the YOLO algorithm, enabled us to achieve high accuracy in identifying and classifying crop diseases, empowering farmers with valuable insights into their crop health. Camera-based navigation systems demonstrated reliable and accurate navigation. The robot successfully travelled through the field with minimal deviation ensuring precise coverage due to multi-terrain capabilities. The integration of the BlynkIoT app for manual control allowed farmers to remotely operate the robot providing flexibility and convenience in managing farm activities. Adjustable rod assembly assist the monitoring camera to monitor from any height. Pan and Tilt camera assembly helped the robot to capture images as per requirement. Hence, this robotic structure is very promising to achieve the objectives of the project. Overall, our project showcased the potential of IoRT and deep learning in revolutionizing agriculture. It not only contributes to the field of agricultural robotics but also provides valuable insights and practical solutions for farmers to address the challenges they face in crop disease detection and field navigation. We hope that the outcomes of our project will inspire further advancements in the field of precision agriculture and encourage the adoption of innovative technologies to drive agricultural productivity and sustainability.

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# Smart Cylinder Trolley with Home Safety

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## ABSTRACT

Cylinder for LPG Gas leaks can lead to serious incidents that result in both monetary losses and harm to people. To avoid such occurrences, a lot of attention has been paid to the development of reliable techniques for gas leak detection. Simply being aware that a leak exists is not always enough to launch a corrective action, so some leak detection techniques were developed to give the possibility of locating the leak. This project's objective is to create a safety-focused system that can take immediate action and notify the user via mobile device if there is a threat in the kitchen. This system will alert the user and send a message when LPG leaks are found. It ensures defence against any gas leakage incidents that might result in suffocation or explosion. The added benefit of this proposed system's weighing sensor is that it can weigh the cylinder and periodically inform the user of how much gas is still in it. Customers can use this system to check whether a gas company is undercutting them by providing them with less LPG. Everyone is currently preoccupied with their daily activities, making it challenging to determine the status of the gas cylinder. Making elderly people who are dependent on others and live alone independent as well as shielding them from potential kitchen dangers will be beneficial.

**KEYWORDS:** Load cell, MQ2 sensor, ESP8266, BLYNK Mobile.

## INTRODUCTION

The internet of things aims to make our lives easier by automating any small task we come across. In addition to aiding in task automation, the benefits of IoT can also be extended to enhance current safety standards. Towns, businesses, and residential structures all require careful consideration of security issues. The increased focus of some gases in the environment can be dangerous, so everyone needs a facility that minimises time and effort and expects their work to be as simple as possible. Reports state that cylinder explosions result in at least 1000 fatalities each year. IoT technology can help us use human safety and security more effectively, which will help keep accidents to a minimum. This project focuses on a cylinder weight monitoring system and a gas leakage detection notification system in order to prevent accidents and create safe kitchens.

## PROBLEM STATEMENT

Standard LPG Cylinder Gas leaks can lead to serious

incidents that result in both monetary losses and harm to people.

There has been a lot of focus on the creation of reliable tools for locating gas leaks.

Simply being aware that a leak exists is not always enough to launch a corrective action, so some leak detection techniques were developed to give the possibility of locating the leak. This project's objective is to create a safety-focused system that can take immediate action and notify the user via mobile device if there is a threat in the kitchen. A weighing sensor is part of the suggested system, which can weigh the cylinder and periodically alert the user to how much gas is left inside.

## PROPOSED SYSTEM

### Objective

- i. To design a smart cylinder trolley that can track LPG consumption in real-time.

- ii. To regularly update the weights of the cylinders.
- iii. To deliver an alert message to the user.
- iv. To report using LPG as fuel.

## BLOCK DIAGRAM

A quick and effective controller must continuously sense the output from the level (weight) sensor of the LPG gas. A quick response is also preferred when leakage is found. Additionally, a system needs to be able to store information that will be used for later processing. The ESP8266 depicted in Figure 1 is an example of a very quick, single cycle execution that can be used to perform the aforementioned operations.

An ESP 8266 port B-connected 4-bit LCD module is used to display the necessary messages. Users of 14 kg LPG cooking gas cylinders can use this system because all brands of LPG cooking gas suppliers are the same. The system is portable, easy to use, and has a small footprint. When a gas cylinder's weight is detected by the load detector and a signal is sent to the LCD, the LED lights will turn on. The gas detector uses ESP8266 to find gas leaks and send a signal to warn users. This system can tell how much cooking gas is left in the gas cylinder by displaying the scale status on a liquid crystal display (LCD) and a light emitting diode (LED). The three levels that the LCD will show are full level, medium level, and critical level. The system will still use the ESP8266 microcontroller to send a notification message via the web server in the event of a leak even if the user is not at home.

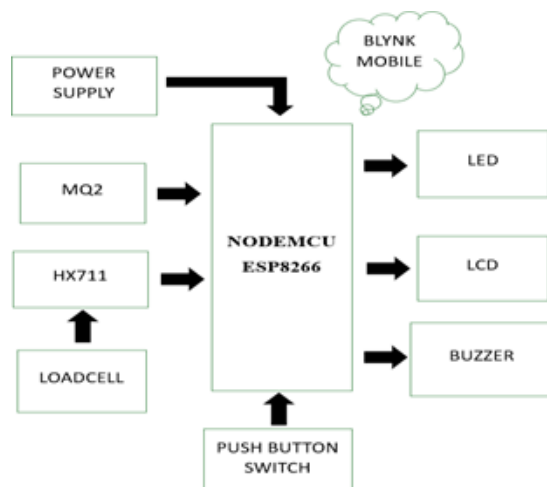


Fig 1: Block diagram of proposed System

## WORKING

LPG gas is a mixture of gases, including propane, methane, and isobutene. A sensitive, reliable gas sensor that only picks up the presence of LPG gas and is less sensitive to other gases, like cigarette smoke and cooking fumes, is required. SnO<sub>2</sub>, the sensitive component of the MQ-2 gas sensor, has a lower conductivity in clean air and an increase in sensitivity with gas concentration. It also keeps out gases like those from cooking. Given the gaseous environment, the voltage range specified is 0 to 5 volts, which is low and secure. The microcontroller takes corrective or necessary action after the gas sensor and weight sensor have both detected the presence of gas and have provided information about the level of gas in the cylinder. The status of each of these events must be communicated to the system's owner or the other residents. It requires very little memory to send and receive text messages and operates on a simple 12 Volt adapter running on a 16X2 character Liquid Crystal Display A +5Volt supply and a 4-bit operating mode are utilised to implement the task of displaying the necessary messages. The MQ-2 gas sensor and Node MCU ESP8266 are utilised in this model, and they are primarily in charge of the task of detecting LPG gas in a particular enclosure. Using an Arduino-based gas sensor that is highly sensitive to LPG gas and has zero sensitivity in clear air, this study was successful in detecting LPG gas.

The MQ-2 gas sensor's calibration software, IDE, was also used to display the various levels of gas concentration in a digitalized system form. This model is made up of a controller and an ESP 8266 Node MCU-shaped MQ-2 gas sensor. The services for both hardware and software are included in this design, with hardware services being covered. The Node MCUESP8266 is physically connected to the MQ-2 gas sensor. The Arduino IDE application has a software component that deals with calibrating the gas sensor.

## FLOWCHART

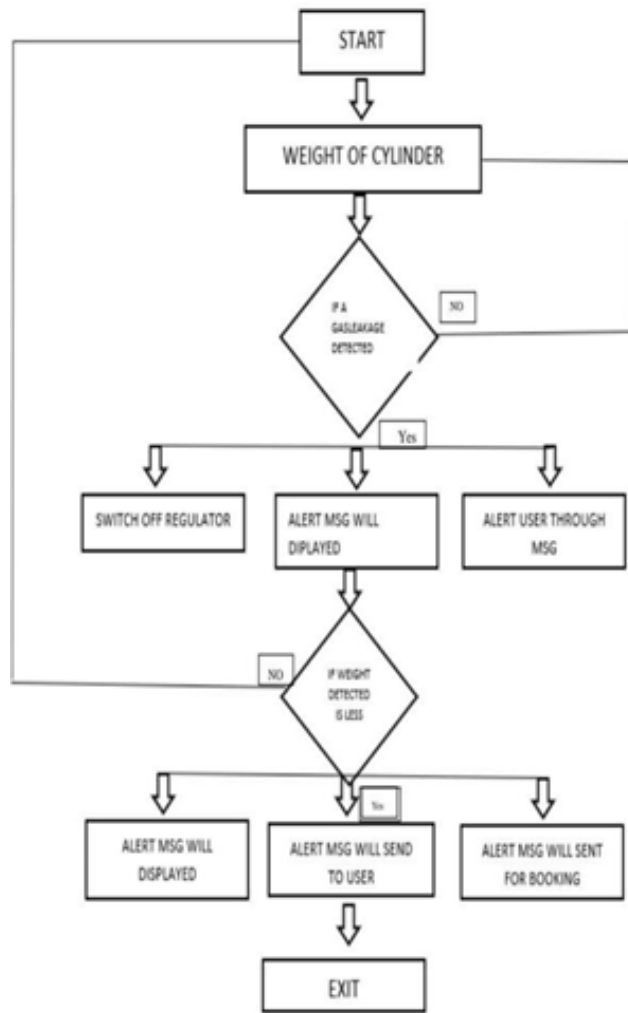
The following are the algorithmic steps:-

1. Begin the programme.
2. Obtain the input values for the gas sensor.

3. If the Gas Sensor value is 1, the user will see and receive a warning message.
4. There will also be a buzzer.
5. Apply the load cell's values in the second scenario.
6. If the load cell value is 1, the user will receive and see an alert message.

The programme has ended.

### SOFTWARE DESCRIPTION



#### Proteus

PROTEUS is a software utilized for preliminary simulation before implementing the actual circuitry. It facilitates the virtual operation of the real system, enabling the identification of potential errors, although not all of them. This tool proves immensely valuable

in the comprehensive development of the entire system within a virtual environment. Within PROTEUS, there are VSM studios designed specifically for microcontrollers to conduct simulations. These studios provide a platform for running simulations with microcontrollers. Additionally, PROTEUS offers a Visual Designer feature that allows users to write programs using intuitive flowcharting methods. Moreover, PROTEUS aids in the design of printed circuit boards (PCBs), making it a versatile tool for the entire development process.

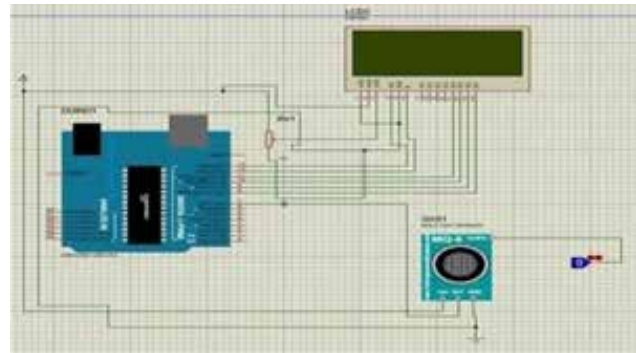


Fig. Proteus Software

### HARDWARE REQUIREMENT

- A. ESP8266
- B. Load Cell
- C. MQ2 sensor
- D. 16x2 I2C LCD Display
- E. HX711
- F. BLYNK Mobile
- G. Buzzer.

#### A. ESP8266:

The ESP8266 is a tiny computer. In most cases, it is the integrated chip of an embedded system. It is a compact, specific computer that is useful, independent, and self-contained. It also supports IOT applications.

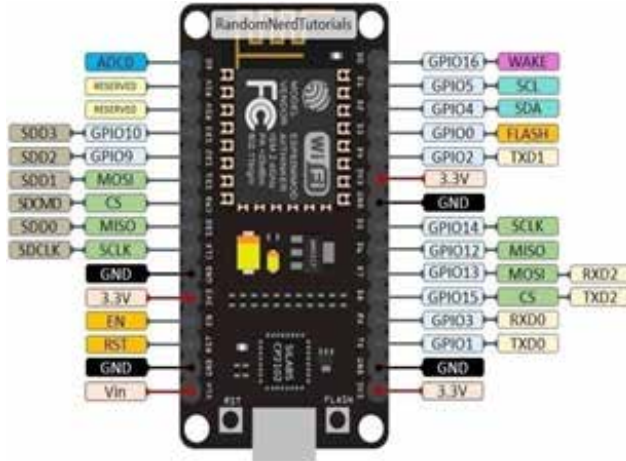
#### B. Load Cell:

The Cylinder's weight is measured using a load cell.It uses a 5V DC signal to operate.

#### MQ2 Sensor:



MQ2 is one of the most popular sensors in the MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type of sensor. The controller supplies the 5V DC operating voltage that is necessary.



ESP8266:



Load Cell

16X2 12C LCD Display:

The I2C\_LCD module is a user-friendly display module that simplifies the display process. Its usage significantly reduces the complexity involved, allowing makers to concentrate on the core aspects of their work. Additionally, it facilitates the seamless connection between two integrated circuits, such as the Arduino UNO and a 16x2 LCD screen.

HX711

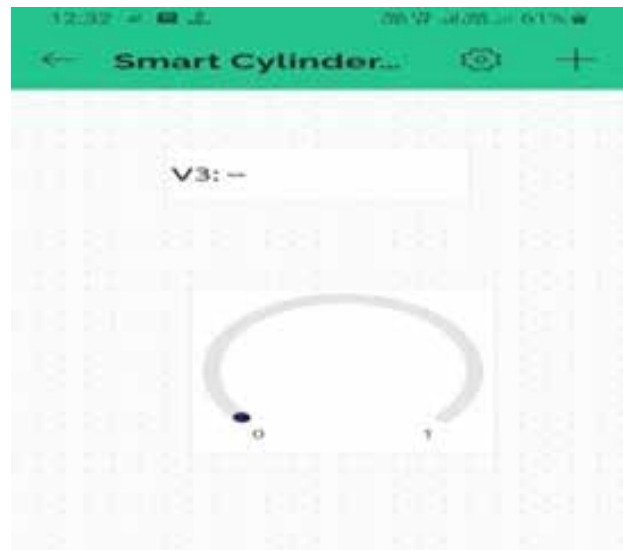
HX711 is simply an analog-to-digital converter which is used to convert all the analog values into the digital values.



16X2 12C LCD Display

Blyank Mobile :

Blyank mobile app is used to send the message to the user. Which is easily available in play store and we can download it.



Blyank Mobile

5V Buzzer:

A buzzer or beeper serves as an audio signaling device that can be mechanical, electromechanical, or piezoelectric (often referred to as piezo). These devices are commonly employed in various applications, including alarm systems, timers, training tools, and providing confirmation for user input, such as a mouse click or keystroke.



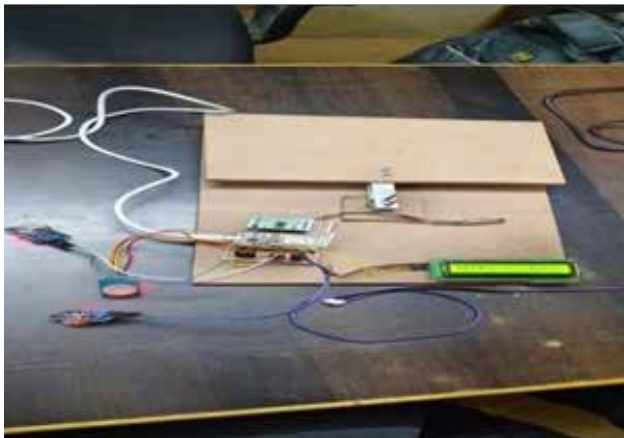
## RESULTS

### Hardware Results



**Fig. 9. Circuit is working**

Here, we can observe that the entire ESP8266 circuit is functioning correctly.



**Fig. 10. Hardware Circuit**

When a small amount of LPG leaks nearby, the system sensor detects the leak and notifies housemates via SMS in addition to sounding the alarm. The system prototype also periodically checks the LPG level in the cylinder.

### RESULT AND DISCUSSION:

The creation of the system will benefit the following:

- Home LPG users who are able to plan ahead and replace used cooking gas before it runs out and causes a disruption in the cooking process.

Additionally, these users can stop fires started by cooking gas leaks.

- ESP8266 allows LPG users to be alerted in the event of a residential gas leak.
- By converting the remaining LPG gas before it disrupts the cooking process, restaurant owners can also maintain the quality of the food.
- Despite running out of petrol, customers don't have to wait a long time to receive their orders.
- LPG gas providers can ease the pressure put on them.

As a result, numerous tests on the functionality of the system were conducted: Microcontrollers, SMS, the load detector, gas detectors, LCD displays, LED lighting, and alarm functionality are all tested, in addition to

- microcontroller functionality,
- SMS functionality,
- load detector functionality,
- gas detector functionality,
- LCD display functionality,
- LED lighting functionality, and
- alarm functionality.

System functionality testing was done to ensure that the LPG Mass Monitoring Scale with Automatic Gas Leakage Detector System can function as intended. The system's main microcontroller, the ESP8266, sends instructions to all of the system's components. The LCD screen, three red, yellow and green LEDs, as well as the volume level of the cooking gas, are physically displayed. When the gas level reaches a critical level, the LCD display will also indicate that gas has been detected.

At that point, the buzzer will activate and buzz to warn the user that the cooking gas is about to run out. The LPG Mass Monitoring Scale with Automatic Gas Leakage Detector System underwent system functionality testing to make sure it can perform as intended. All of the system's components receive instructions from the ESP8266, the main microcontroller. Physical displays include the LCD screen, three red, yellow and green LEDs, as well as the cooking gas volume level.

The LCD display will also reveal the presence of gas when the gas level reaches a critical level. The buzzer will then turn on and start buzzing to alert the user that the cooking gas is about to expire.

## CONCLUSION

The Internet of Things has recently seen a rise in popularity due to its many application streams, paving the way for a smoother, safer, and easier way of life for people. Examples of such applications include LPG gas monitoring and gas leak detection for both residential and commercial purposes. Regardless of the techniques that are available, gas leakage detection is a serious issue and a difficult task.

So, a brand-new IOT-based microcontroller application for weight monitoring and gas detection systems was suggested in this paper. The user is informed via Blynk Mobile of the amount of gas still in the cylinder by the sensor used in this model, which can sense and detect gas leaks. To increase awareness of LPG and its advantages, this device is easy to incorporate into an alarm system or a visual cue.

Among other industries, the hospitality and retail sectors might benefit from this proposed system. This work's primary objective is to make gas booking and gas leak detection safe and simple in order to avoid catastrophes that could occur as a result of negligence.

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# Design and Development of Microstrip Antenna for Non-Invasive Glucose Testing

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## ABSTRACT

Microstrip antennas have gained significant attention in biomedical applications due to their low profile, lightweight, and ease of fabrication. In this paper, we propose the use of a non-invasive microstrip antenna for blood glucose monitoring. The proposed antenna is designed to operate at a frequency of 2.4 GHz, which is within the ISM band. When a human finger containing a certain value of Blood Glucose Level (BGL) is placed in the radiating region of the microstrip antenna, the radiating patch antenna structure's near field interacts with the human finger and causes changes in the electrical characteristic of the antenna. These electrical changes are associated with changes in blood permeability due to changes in Blood Glucose Level value. A change in the electrical characteristics of the microwave structure of the antenna leads to a corresponding frequency change. The antenna is simulated and optimized using HFSS software, and its performance is evaluated in terms of reflection coefficient, radiation pattern, and gain. The antenna is fabricated using a FR4 substrate, and its performance is validated through experiments. The results show that the proposed antenna has a reflection coefficient of -22 dB, and can detect diabetes in a non-invasive manner.

**KEYWORDS:** *Microstrip antenna, Non-invasive, Material under test, Resonating frequency.*

## INTRODUCTION

Millions of people worldwide are affected by diabetes, a chronic condition. It happens when the body is unable to make and use insulin, a hormone that controls blood sugar, properly. Therefore, diabetics have high blood sugar, which can lead to various health problems over time.

There are two primary kinds of diabetes: type I and type II. Type I diabetes is an immune system sickness that frequently gets created in childhood or adolescence. It happens when the safe framework assaults and obliterates the cells in the pancreas that produce insulin, bringing about a total absence of insulin in the body. Type II diabetes, then again, ordinarily creates in adulthood and is frequently connected with the way of life factors like weight and actual dormancy. In type II diabetes, the body becomes impervious to insulin, and the pancreas may not deliver sufficient insulin to

address the body's issues. The two sorts of diabetes can prompt a scope of unexpected problems, including cardiovascular sickness, kidney infection, nerve harm, and visual deficiency. Overseeing diabetes requires cautious observing of glucose levels, a solid eating routine, standard active work, and once in a while drug or insulin treatment.

Despite the challenges of living with diabetes, many people with the condition are able to manage it effectively and lead full, active lives. Ongoing research is helping to improve diabetes management and develop new treatments, with the ultimate goal of finding a cure.

Non-invasive glucose testing has been a longstanding goal in the field of diabetes management. Current methods of monitoring blood glucose levels require invasive techniques such as finger pricks or continuous glucose monitoring systems implanted under the skin. These methods can be uncomfortable, inconvenient,

and even painful for patients. In recent years, several non-invasive glucose testing methods have been proposed, including the use of microstrip antennas. Microstrip antennas are thin, low-profile antennas that can be integrated into wearable devices. They work by emitting electromagnetic waves that penetrate the skin and reflect off glucose molecules in the blood. By measuring the reflection of these waves, it is possible to determine glucose is in the blood. Microstrip antennas are one type of antenna that can emit and receive these electromagnetic signals. In this approach, the antenna emits a low-power electromagnetic signal that penetrates the skin and interacts with glucose molecules in the blood. The reflected signal is then analyzed to determine the glucose concentration

Several studies have shown promising results for non-invasive glucose testing using microstrip antennas. However, there are still challenges to overcome, such as interference from other molecules in the blood and variations in skin properties.

Despite these challenges, the potential benefits of non-invasive glucose testing using microstrip antennas are significant. It could improve the quality of life for people with diabetes by eliminating the need for finger pricks and invasive monitoring systems. It could also lead to more frequent monitoring of glucose levels, which could improve diabetes management and reduce the risk of complications. Further research and development in this area could bring us closer to the goal of truly non-invasive glucose testing.

## LITERATURE SURVEY

Regular monitoring of glucose levels is required, this is performed by supplying a tiny amount of blood sample by an invasive blood pricking technique.[1] [2] This is painful, uncomfortable, and tedious. Over time, doing this repeatedly damages the tissue in the finger and raises the chance of infection. There is one more major disadvantage: no continuous monitoring of glucose levels is available. To overcome this difficulty, we are inclined to the idea that we design a noninvasive antenna.[5][6] Various polarization and pattern diversity using microstrip patch antenna is discussed[11]

And the designs are based on the idea that when put within the close range of an antenna, both direct and

indirect modifications to the dielectric characteristics of blood and supporting tissue will result in a change in the microstrip patch antenna resonating frequency.[3][4]

Through a literature survey, we present the design of a microstrip antenna, which may be utilized in NIBGM because it is easily manufactured, simple to design, cheap, and can be placed at a particular distance, close to human skin to prevent perspiration. [8][9][10].

## SYSTEM DIAGRAM

The figure displays a block diagram of a design system that includes a Vector Network Analyzer (VNA) module that analyzes the sensor antenna's reflection coefficient ( $s_{11}$ ) parameter of the BGL value in order to determine the resonant frequency of a microwave sensor.

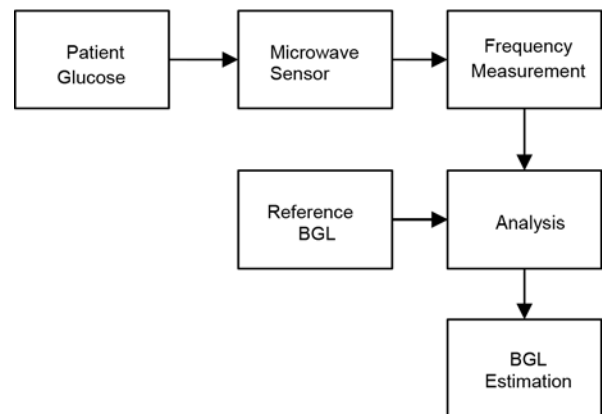


Fig. 1. Designed System Architecture- Block Diagram

## METHODOLOGY

A microstrip antenna can be used for noninvasive glucose measurement in blood by measuring the skin dielectric properties. A microstrip antenna is a type of antenna that consists of a thin strip or patch of metal placed on a dielectric substrate. When electromagnetic waves are transmitted through an antenna, they create patterns of electric and magnetic fields that radiate outward into space.

The basic idea behind using microstrip antennas for blood glucose measurement using noninvasive methods is that the dielectric properties of the skin change in response to blood glucose level changes. Elevated glucose levels increase the dielectric constant of the skin, affecting its electromagnetic properties.

To measure these changes, a microstrip antenna is placed



on the surface of the skin. The antenna is designed to resonate at a specific frequency that is sensitive to changes in the skin's dielectric properties. When the antenna is excited with an electromagnetic signal, the reflected signal can be measured to determine the skin's dielectric properties.

The electromagnetic wave propagation theory is the base for the noninvasive glucose testing method using a micro strip antenna.. This method makes use of a microstrip antenna, a kind of antenna that has a cylindrical outer conductor around a core conductor. A low-power microwave signal is transferred through the skin and into the underlying tissue when the antenna is in contact with the skin. The signal is then returned to the antenna, where it is reflected, and the reflected signal is examined to estimate the tissue's glucose content.

The idea behind this method is that the tissue's dielectric characteristics, which are influenced by the glucose concentration, affect how an electromagnetic wave propagates. In particular, as the tissue's glucose concentration rises, its dielectric constant and loss tangent rise as well. As a result, the electromagnetic wave's ability to go through the tissue is impacted. The glucose level in the tissue can be calculated by examining the reflected signal.

Microstrip antenna noninvasive glucose testing has the benefit of being noninvasive and painless, and it may be used to continually track glucose levels over time. In order to increase the technique's precision and dependability, additional study is still needed.

## ANTENNA SIMULATION

HFSS is a simulation software that is widely used for the design and analysis of antennas. The simulation results obtained from HFSS can be used to optimize the antenna design for better performance.

- Return loss: Return loss measures the amount of power reflected back from the antenna to the source. Lower return loss indicates better impedance matching and higher antenna efficiency. Simulation results can show the return loss of the antenna as a function of frequency.
- Bandwidth: Bandwidth Antenna bandwidth is the range of frequencies over which the antenna can

operate with acceptable performance. Simulation results can show the antenna bandwidth as a function of frequency.

- Radiation pattern: An antenna's radiation pattern describes how the antenna radiates electromagnetic energy into space. Results from simulations can display the antenna's 3D radiation pattern.
- Gain: Antenna gain measures the antenna radiated power in a specific direction compared to an isotropic radiator. Simulation results can show antenna gain as a function of frequency.

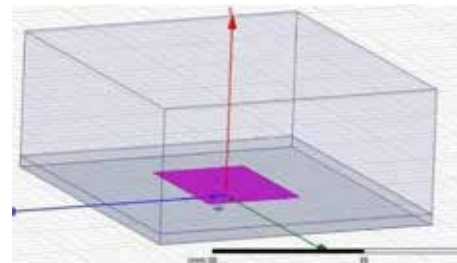


Fig. 2. HFSS Antenna Design(Top view)

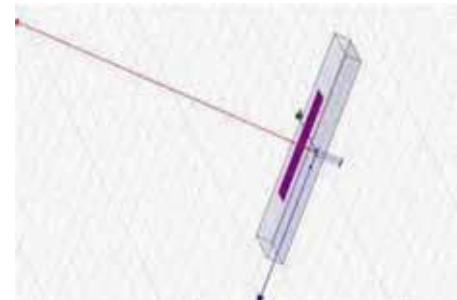


Fig. 3. HFSS Antenna Design(Side view)

## Antenna Simulation Results

The simulated antenna resonates at 2.4GHz with the return loss of -22.7db.

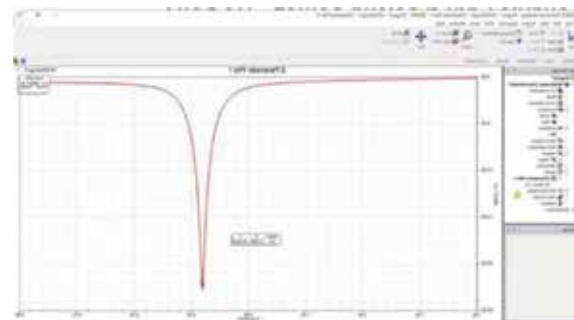
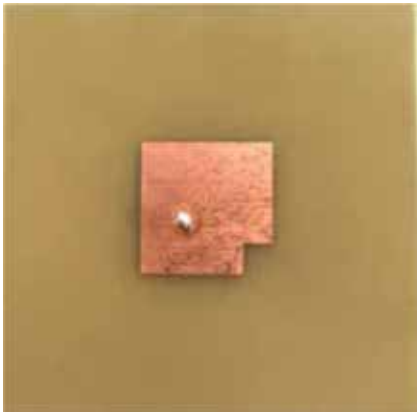


Fig. 4. Return Loss -22.7dB at 2.4GHz



**FABRICATED ANTENNA**



**Fig. 5. Fabricated Antenna (Top View)**



**Fig 6. Coaxial Feedline (Bottom View)**

**Antenna Results**



**Fig. 7. Fabricated antenna resonating at 2.4GHz**

**DESIGN SPECIFICATION**

**Table 1. Specification of Antenna**

Specification	Design
Feed type of antenna	Coaxial feedline
Frequency at which the antenna resonates (GHz)	2.4
Substrate Dielectric constant	4.4
Return Loss of Antenna (dB)	-29

**RESULTS AND DISCUSSION**

The study on non-invasive glucose testing using a microstrip (coaxial feedline) antenna showed promising results. It is able to measure glucose presence in real-time without the need for invasive blood tests.

The study involved 15 participants and used a coaxial feedline antenna to measure the glucose levels in their skin.

First, all materials under test were tested with invasive methods for diabolic or nondiabetic conditions. When the diabetic patient is tested using a non-invasive method the frequency shifts from 2.4GHz to 1.9-2.2GHz with a higher return loss. However, a person with no diabetes is tested , the antenna stops resonating at 2.4GHz.



**Fig. 8. Material under trial 1**



**Fig. 9. Antenna resonating at 2.1GHz with return loss -17.5dB**



Fig. 10. Material under trial 2



Fig. 11. Antenna not Resonating at 2.4 GHz

Table 2. Result

Sr No.	Material under Test using Invasive Method	Operating Frequency of Antenna	Frequency During Test using Non Invasive Method	Return Loss (S11)
1	Non - Diabetic	2.4 GHz	2.4 GHz	-5.1dB
2	Non - Diabetic	2.4 GHz	2.4 GHz	-2.1dB
3	Diabetic	2.4 GHz	2.2 GHz	-15dB
4	Non - Diabetic	2.4 GHz	2.4 GHz	-7.2dB
5	Diabetic	2.4 GHz	2.1GHz	-17.5dB
6	Non - Diabetic	2.4 GHz	2.4 GHz	-5.9dB
7	Diabetic	2.4 GHz	1.9GHz	-18.2dB
8	Non - Diabetic	2.4 GHz	2.4 GHz	-2.4dB
9	Non - Diabetic	2.4 GHz	2.4 GHz	-3.6dB

10	Non - Diabetic	2.4 GHz	2.4 GHz	-4.2dB
11	Diabetic	2.4 GHz	2.0 GHz	-19.7dB
12	Non - Diabetic	2.4 GHz	2.4 GHz	-2.7dB
13	Diabetic	2.4 GHz	1.96 GHz	-19.2dB
14	Non - Diabetic	2.4 GHz	2.4 GHz	-5.3dB
15	Non - Diabetic	2.4 GHz	2.4 GHz	-7.4dB
	Diabetic			

### CONCLUSION

Based on the research conducted, it can be concluded that non-invasive glucose testing using a microstrip antenna is a promising approach. The results of the study showed that the proposed method can measure glucose presence in real time without the need for blood samples. According to the experiment’s findings, the antenna stops resonating at 2.4GHz (return loss (S11 parameter) drops below -10 dB). Patients with diabetes experience a frequency shift between 1.9 GHz to 2.2 GHz, and the return loss is significantly higher. Overall, the results of the study suggest that non-invasive glucose testing using a microstrip antenna is a promising approach that could potentially replace invasive blood tests for diabetes management.

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# Design of Low Complexity TMU Transition Metric unit for TCM Decoder using Machine Learning Approach

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## ABSTRACT

This paper presents new scheme of the Transition Metric Unit (TMU) of 4D- 8PSK Trellis coded Modulation TCM Decoder. TMU is a complex form of branch metric unit of traditional Viterbi decoder. Trellis coded Modulation (TCM) is the combine scheme of Error Correcting Code (ECC) with 8 PSK modulations. TCM decoder is basically a Viterbi decoder and TMU is one of the complex units of it. Like in simple Viterbi decoder first Branch metric is calculated similarly in TCM decoder this BM calculation is carried out through the TMU unit. Due to huge constraint length and large number of states of encoder the TMU becomes difficult and consume extra power dynamic power. In the proposed technique a innovative method of BM computations is suggested, that is based on Mahalanobis distance computation between received symbols and a set of symbols. Using proposed innovation, the paper perceiving the optimization of the TMU which will further reduce the H/W requirement's and which results in less power consumption The result demonstrated that the proposed scheme gives improvement in power consumption and speed in comparison to existing method.

**KEYWORDS:** *Trellis coded modulation, Bit error rate, Transition metric unit, Add compare select unit, Viterbi decoder*

## INTRODUCTION

The world we live in today is a world of wireless connectivity. There are several online and offline applications that rely on wireless connectivity all over the place. Each and every communication system requires more secure communication with less data loss means low BER. Many online applications become more popular these days just because of modems. Modems stand for modulator and demodulator and it is one of the wide application areas of TCM. Communication becomes more simple and convenient because of smart modems like V.34, V.32 etc. Through 1980s and onwards high-speed smart modems improves the online system response and made file transfer practical with high data rate services. Rapid growth of online services

possible with large file libraries of high-speed modems. TMU, Viterbi decoder, de-mapper, and differential decoder are the essential building blocks of the TCM decoding system, as shown in the basic block diagram (Refer Figure 1). The next section provides thorough description of each included block.

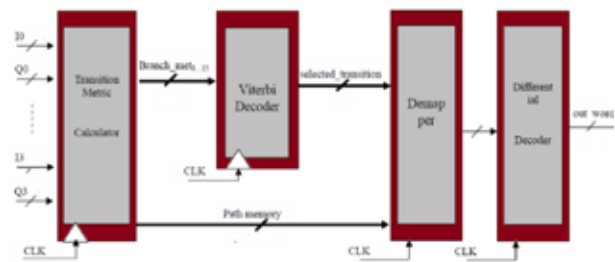


Fig. 1. Basic block diagram of TCM decoding system

**Transition Metric Unit**

The branch metric unit of a Viterbi decoder and the transition metric unit of a 4D 8PSK decoder are the same. Hamming distances or Euclidean distances are added up in the branch metric unit of VD, and the final path metric is prepared. The identical actions are performed here in the TMU unit on the metrics from each of the TCM’s four dimensions. One of the metrics is chosen from the totaled metrics. While computations for four separate dimensions make TMU procedures exceedingly complex, branch metric operations are straightforward and less complicated. For this reason, TMU was implemented separately from the Viterbi decoder.

**Viterbi Decoder**

Figure 2 depicts the Viterbi Decoder, with the ACSU, PMU, and SMU being its main building components. The ACSU receives the BMs computed in the TMU, after recursive computations of PMs, decision bits are generated for state transitions after every clock cycle.

Decision bits from the ACSU were saved in the memory units of the survivors, and these bits were later used by the survivors for decoding. PMs from the most recent iteration are kept in PMU and used for the following cycle. The sections that follow provide information about each block.

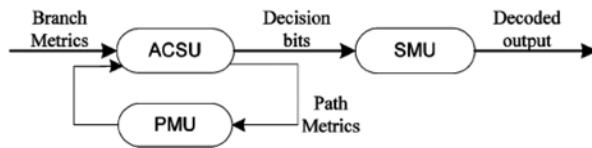


Fig. 2. Block Diagram of Viterbi Decoder

**COMPUTATIONS BMS (BRANCH METRIC)**

Two approaches can be used to implement TMU.

- Memory based approach
- Iterative computations-based approach.

Using memory in the first method results in more hardware and higher system power consumption. The second technique is based on online calculations and

is implemented with adders and comparators, which simplify calculations. The second strategy aids in preserving a balance between power and speed. The iterative calculation method is the one we choose to use in our work.

**Earlier method of calculations**

Equation 1 demonstrates a streamlined computation of the Euclidean distance between the received symbol and the referenced symbol based on the four dimensions of TCM received symbols (I<sub>sym</sub>, Q<sub>sym</sub>) (sym=0,1,2,3,.....7for 8PSK signals).

$$d_{sym} = (I_{rv} - I_{sym})^2 + (Q_{rv} - Q_{sym})^2 = (I_{rv}^2 + I_{sym}^2 + Q_{rv}^2 + Q_{sym}^2) - 2I_{rv}I_{sym} - 2Q_{rv}Q_{sym} \tag{1}$$

For all,  $d_{sym}, (I_{rv}^2 + I_{sym}^2 + Q_{rv}^2 + Q_{sym}^2)$  remains the same.

Finding the maximum of (d0, d1, d2, etc.) would be preferable instead of finding minimum amongst (d0, d1,d2, etc.). Currently equation 2 are used to determine Euclidean distance

$$d_{sym} = I_{rv} I_{sym} + Q_{rv} Q_{sym} \tag{2}$$

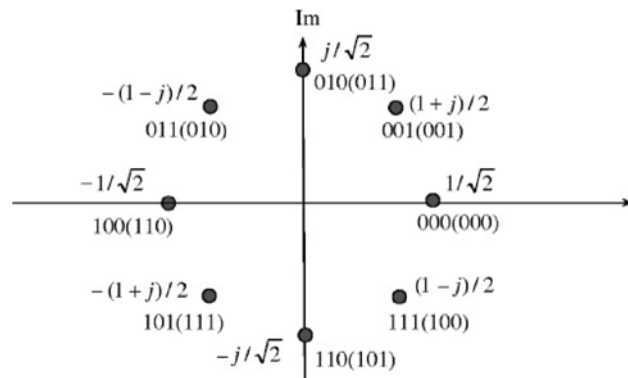


Fig. 3. 8PSK constellation

From Figure 3 we can easily understand that constellation points are equally spaced the phase of (sym π)/4, (sym=0,1,2,3,.....7for 8PSK signals). Constellation points maintain symmetry and satisfy equation 3

$$I_s = -(I_{s+4}) \text{ mod } 8$$

$$Q_s = -(I_{s+4}) \text{ mod } 8.$$

$$C_0 = |d'_0| = |I_{rv}|$$

$$C_1 = |d'_1| = |I_{rv} + Q_{rv} \times 0.707|$$

$$C_2 = |d'_2| = |Q_{rv}|$$



$$C_3 = |d'_3| = |I_{rv} - Q_{rv} \times 0.707|$$

Direct implementation for BM computation necessitates numerous stages of addition and numerous additional comparisons. Repetitive actions are decreased by auxiliary trellis. For BM 0000 calculations, the relationship between the received Euclidean distances is shown in Figure 4.

Based on the following equation 5, each step from left to right indicates the Euclidean metrics of the symbol that was received from four dimensions of the TCM encoder. These received symbols are identified as  $y^0, y^1, y^2, y^3$ .

$$\begin{aligned}
 \begin{bmatrix} y^0 \\ y^1 \\ y^2 \\ y^3 \end{bmatrix} &= \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} + (4) \begin{bmatrix} 0 \\ z^{10} \\ z^9 \\ z^{10} + z^9 + z^7 \end{bmatrix} + \\
 (2) & \begin{bmatrix} 0 \\ z^6 \\ z^5 \\ z^6 + z^5 + z^3 \end{bmatrix} + \begin{bmatrix} 0 \\ z^2 \\ z^1 \\ z^2 + z^1 + z^0 \end{bmatrix} \quad (5)
 \end{aligned}$$

16 BMs for “0000” given by equation 6.

$$\begin{aligned}
 Y(0) &\leq \text{MAX}(\text{MAX}(C00 \text{ XOR } C10 \text{ XOR } C20 \text{ XOR } \\
 &C30, C00 \text{ XOR } C12 \text{ XOR } C22 \text{ XOR } C30), \text{MAX}(C02 \\
 &\text{ XOR } C12 \text{ XOR } C20 \text{ XOR } C30, C02 \text{ XOR } C10 \text{ XOR } \\
 &C22 \text{ XOR } C30)); \\
 Y(1) &\leq \text{MAX}(\text{MAX}(C00 \text{ XOR } C10 \text{ XOR } C22 \text{ XOR } \\
 &C32, C00 \text{ XOR } C12 \text{ XOR } C20 \text{ XOR } C32), \text{MAX}(C02 \\
 &\text{ XOR } C10 \text{ XOR } C20 \text{ XOR } C32, C02 \text{ XOR } C12 \text{ XOR } \\
 &C22 \text{ XOR } C32)); \\
 Y(2) &\leq \text{MAX}(\text{MAX}(C01 \text{ XOR } C11 \text{ XOR } C21 \text{ XOR } \\
 &C31, C01 \text{ XOR } C13 \text{ XOR } C23 \text{ XOR } C31), \text{MAX}(C03 \\
 &\text{ XOR } C11 \text{ XOR } C23 \text{ XOR } C31, C03 \text{ XOR } C13 \text{ XOR } \\
 &C21 \text{ XOR } C31)); \\
 Y(3) &\leq \text{MAX}(\text{MAX}(C01 \text{ XOR } C11 \text{ XOR } C23 \text{ XOR } \\
 &C33, C01 \text{ XOR } C13 \text{ XOR } C21 \text{ XOR } C33), \text{MAX}(C03 \\
 &\text{ XOR } C11 \text{ XOR } C21 \text{ XOR } C33, C03 \text{ XOR } C13 \text{ XOR } \\
 &C23 \text{ XOR } C33)); \\
 \text{BM0} &\leq \text{MAX}(\text{MAX}(Y(0), Y(1)), \text{MAX}(Y(2), Y(3))); \quad (6)
 \end{aligned}$$

Here C00 represents the received value of C0 for the first symbol... and so on.

By applying the simplified Euclidean distance equations (4) number of calculations reduced to 256 out of 4096.

16 BMs divided into odd even manner to find out the maximum of all. Figure 4 shows connections of Euclidean distances from all 4 dimensions. It includes three addition stages and last stage of comparison. If we do straight forward implementation than we need 768(3x16x16) additions while we implemented by auxiliary trellis we need 336(42+43+44) additions [13].

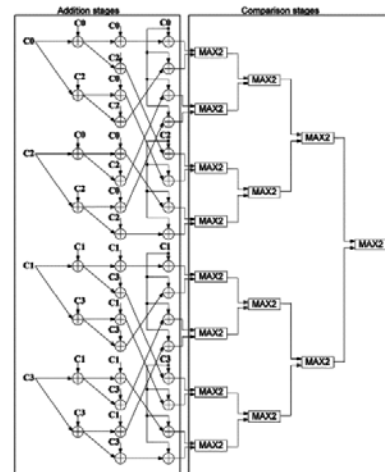


Fig. 4. Auxiliary trellis for BM 0000 computations

### 3. SUGGESTED METHOD

In the earlier method Euclidean distance between received symbols from four dimensions of 4D 8 PSK decoder were calculated. For every single symbols four distances were computed, due to symmetry it will applicable to rest of four points ..

Now in this new method we can find out the Mahalanobis distance between four incoming symbol to the eight reference symbols. Instead of calculating Euclidean distance between received set of symbols and reference symbol, we will predict the best suited received symbol by calculating the above mentioned Mahalanobis distance.

Mahalanobis distance is defined by P. C. Mahalanobis in 1936 as the separation between a point P and a distribution D. It is an expansion of the idea of counting the number of standard deviations that P deviates from the mean of D in many dimensions. This distance increases when P deviates from the mean along each primary component axis and is zero for P at the mean of

D. The Mahalanobis distance corresponds to the usual Euclidean distance in the modified space if each of these axes is rescaled to have unit variance. As a result, the Mahalanobis distance is unitless, scale-invariant, and it takes into account the data set’s correlations.

In the earlier method we need to choose between 16 BMs out of 4096. Each symbol set was going to give 4 Euclidean distances and further working of decoder was based on selection of best matched distanced , which were included addition and multiplication stages.

Now each signal set is left with reduced number of Euclidean metrics. Reduction is up to 75% when the new approach is applied to BMs, candidates from each signal set is decreased from 4096 to 64 (i.e., 4096/16\*4). Currently, each BM is chosen from a pool of only 4 applicants rather than 256, so automatically the required addition and multiplication stages were reduced, that reflected in the minimization of dynamic power of the TCM decoder unit.

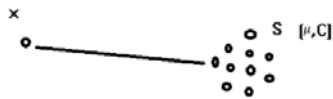


Fig. 5. Concept of Mahalanobis distance

**Mahalanobis distance**

$$d^2(x, S) = (x - \mu)^T C^{-1} (x - \mu)$$

Here we need to compute Mahalanobis distance for each dimensions with 8 reference points .we will precalculate the covariance matrix of the 8 set of points and mean of the points.

$$M = \begin{bmatrix} 0.70721358 & 0.5 & 0. & -0.5 & -0.70 \\ 721358 & -0.5 & 0. & 0.5 & ] \\ [ 0. & 0.5 & 0.70721358 & -0.5 & 0. \\ -0.5 & -0.70721358 & -0.5 & ] \end{bmatrix}$$

$$A = \begin{bmatrix} -2.63106778, & -1.28906967, \\ -0.82341928, & -1.46353504 \end{bmatrix}$$

Calculated mahalnobis distance between A& M using python Function. Algorithm of the function given below.

- Step 1: Create a function in python name as calculate\_ Mahalanobis (y, df, cov)

- Step 2: calculate mean of data df
- Step3: Calculate mean of x1
- Step4: Calculate covariance matrix of the data.
- Step5: Calculate inverse covariance matrix of the above matrix.
- Step6: Find dot product of step 5 and transpose of step no 3
- Step7: The Mahalanobis distance is the diagonal values of matrix of step 6

Mahalanobis distance calculated with k-1 degree of freedom is used to compute the Chi-Square distance. The chi square distance is calculated using:  $p = 1 - \text{chi2.cdf}(B, 7)$ . The p values are the chi square distance and k is the number of variables.

A p-value of less than .001 is typically regarded as an anomaly. Because the first observation has a p-value below .001, we can tell that it is an outlier in the given set of distances. So we can eliminate this distances from the observation set because it is an outlier distance. By eliminating all outliers distances only survived distance remain which will be used for the further calculations in the next stages of TCM decoder. This elimination will cut down the addition and

**RESULT**

Table 1 lists the resource needs for both proposed and existing designs. Table 1 shows that with the suggested architecture, count of slice registers and LUTs has dropped by 10.2% and 17.2%, respectively.

These findings allow us to conclude that the proposed architecture is more effective than the current one. Time outcomes are also computed for the current and suggested systems displayed in table 1. Post, Place, and Route (PAR) is completed to obtain the exact timing results. The proposed method has higher flexibility in PAR to obtain an optimum delay due to the reduction in hardware resource. In our suggested architecture, fewer registers and LUTs reduce switching activity rate, which lowers dynamic power dissipation. 200 MHz was used as the clock frequency for power estimation. And Vccint=1.00V for the supply voltage. Information about supply power and on-chip power is provided in Tables 2 and 3.

**Table 1: Results for resources utilization and timing**

Logic Utilization	He. Et al[13]	Proposed Method
Register count	1291	968.25
LUTs count	3209	2406.75
Post PAR Timing	5.599 ns	4.19925ns

**Table 2: Power Dissipation Summary**

Technique	Power summary(W)					
	Clocks	Logic	Signal	IO	Leakage	Total
He. Et al[13]	0.061	0.073	0.097	0.021	3.429	3.681
Proposed Method	0.033	0.0472	0.06	0.01575	2.571	2.7275

**Table 3: Total Power Summary**

Technique	Total power summary(W)		
	Dynamic	Quiescent	Total
He. Et al[13]	0.252	3.429	3.681
Proposed System	0.15675	2.571	2.7275

The design retains its data rate 57% greater than the previous system as described in [13] displayed in table suggested 4, in addition to improvements in area, power, and latency.

Tables 2 and 3 show that the system’s overall delay and reduction by 20.3% when compared to the old architecture.

To maximize resource usage and enable the use of a small chip area in the design, the ACS unit is reusable.

**Table 4: Results Speed and Data Rate Improved**

Device Type	Input LUT	Slice Flip-Flop	Clock speed (MHz)	Date Rate Achieved
System Reported in [13]	110804	14743	78.9	867.9 Mb/s
Proposed Method	2091.75	907.5	134.85	2.7 Gb/s

**CONCLUSION**

In this paper an advanced method of BM calculation is presented. This Prediction based method works on

the melanosis distance computations. By reducing the number of additions and multiplications results in reduction of resource and delay time.

The Proposed method reduces the count of slice register and LUT’s by 10.2% and 17.2% respectively. The operating Frequency is increased up to 200 MHz. We may conclude that the 4D 8PSK TCM decoder’s power-efficient and high-speed design has been realized because the implemented system maintains the speed-to-power

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# PLC based Drilling Machine

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## ABSTRACT

The paper presents a design and fabrication approach of automatic drill machine to get a accurate hole in the center of workpieces. The method involves utilizing Structured Text (ST) and Ladder Programming to code the controller, initiating the drilling cycle through a start switch, positioning the drilling head and workpieces, and automatically halting the process upon completion of hole creation. Observations highlight the integration with the sensors. The role of the PLC in reading sensor data and actuating the DC motor for efficient operation.

**KEYWORDS:** *Drilling machine, PLC, Industrial automation.*

## INTRODUCTION

Automation has advanced manufacturing in recent years by allowing for increased production efficiency, lower labor costs, and improved product quality. The PLC, a specialized computer used to manage industrial machines and processes, is one of the essential elements of industrial automation. PLC use has grown in popularity across a range of industries because of their adaptability, dependability, and simplicity. The drilling industry has greatly benefited from the use of PLCs. As part of the drilling process, Holes are made in a variety of materials, such as metal, wood, or concrete, during the drilling process. Drilling equipment was once manually operated, which not only took more time but also increased the possibility of mistakes and accidents. Drilling operations have recently become safer, more effective, and precise as a result of PLC-based drilling equipment.

The goal of this paper is to provide a thorough examination of a PLC-based drilling machine and its advantages over traditional drilling machines. This paper discusses the design and implementation of a PLC drilled machine, the programming language used, the hardware and software components, and the advantages

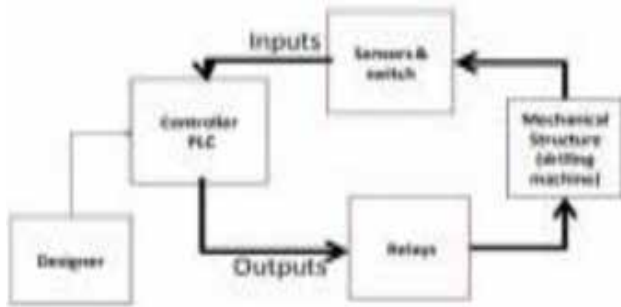
of using such a machine. Furthermore, this paper will discuss the potential applications of PLC-based drilling machines in various industries, such as automotive, aerospace, and construction. Drilling machines require greater precision and speed as technology advances. Drilling machine performance should therefore be improved in order to meet modern demands. The PLC machine tool has been developed into a precision machine for drilling machines in order to meet the demands for complex and precise products.

These tools are frequently used to drill a hole through a task. While some automatic drilling machines only require less skilled labor, it is always necessary to have human resources available. A simple drilling machine's inability to precisely control the hole depth results in a longer drilling process, but not in this case. The semi-automatic machines have been shown to be more effective after comparison. As a result, it is employed in mechanical workshops to speed up laborious progress. Drilling with a single spindle used to be more productive than drilling with multiple spindles. By producing numerous holes cumulatively and with the same level of accuracy. The amount of human labor needed to drill the objects will be reduced by the proposed system.

The idea behind this system is to automate drilling operations effectively by using an automated drilling system. The PLC accomplishes these tasks by actuating AC motors and reading data from sensors. With its PLC-based machine, it has improved accuracy and optimization.

**System and Design**

**Block Diagram**



**Fig. 1 : Functional Block Diagram to demonstrate the machine**

**Input Devices:** Start Switch: Starts the cycle of drilling. Inductive Sensor: This device finds the workpiece when it is in the desired location.

**Programmable Logic Controller (PLC):** Processor Unit: Uses programmed logic to control the drill machine’s operation. Input Module: Gets signals from the input devices. Output Module: Transmits control signals to the output devices.

**Actuators:** Linear Motor: Controls the drilling head’s position. Pusher Motor: Sets the workpiece in the desired location. Drill Motor: rotates the drill bit to perform drilling operations.

**Drilling Process:** Home Position: The starting position of the drilling head. Cycle Start: The start switch triggers the drilling process. Workpiece Positioning: The pusher motor positions the workpiece. Drilling Operation: The drill motor rotates the drill bit to create a hole in the workpiece. Return to Home: After the drilling operation is completed, the drilling head returns to its original position.

**Output Devices:** Indicators: Offer visual feedback on the drill machine’s status. Alarm: Sounds if there are any errors or anomalies.

**Structural Diagram**



**Fig. 2 : Machine and its functional buttons**

**INDICATOR:** In this paper, there are three types of indicators to monitor different operations: GREEN: To show that the system is in a working state. RED: To indicate drilling motor operation. Yellow: To indicate rotary disc operation.

**COMPONENTS:** Cylinder: Here the stepper motors are used to control the movement of the drilling head and the working block. Spindle: A round shaft holds the cutting tool; we are using a spiral spindle for drilling purposes. But there are several types of spindles. DC Motor: DC motors have been used in industrial applications for years. Coupled with a DC drive, DC motors provide very precise control. This motor is mainly used in various industries for controlling conveyor belts, lifts, etc. In this prototype project, we used three DC motors for different movements. Sensors: As part of an industrial control system, sensors are important devices for translating physical phenomena into a signal that can be analyzed. Pre-processing, in-processing, and post processing are all possible with them.

Figure 3 provides an understanding of the precise drilling process in this system. The machine is starting in switched off state, indicated by red light (doSwitchedOff). It can be switched on by pressing the switch on button (diSwitchOn).

This is indicated by a green light (doSwitchedOn) and the red light goes off. The machine can also be switched off again using the switch off button (diSwitchOff).



If both of the cylinders are in the starting (rearmost) position (diPusherBack and diDrillUp)

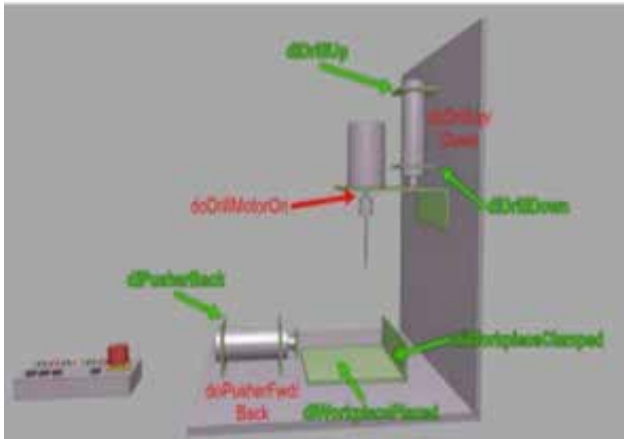


Fig. 3 Machine Structure indicating functions

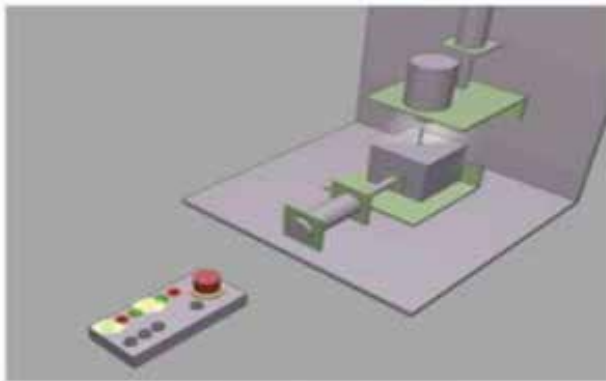


Fig 4. Schematic Mechanism of the drilling machine and control panel

The work-piece is placed on the base (diWorkpiecePlaced) and no error (doFault) is active

The machine is ready to start the drilling process, indicated by another green light (doReady)

If the machine is ready, the process can be started with a press of a button (distart). The running process is indicated by a yellow light (doDrillingActive).

First, the pusher cylinder is moved forward (doPusher- Fwd) until the workpiece is clamped (diWorkpieceClamped).

Then the drill motor is switched on (do- DrillMotorOn) and the drill spindle starts rotating.

With the spindle spinning, the whole drill moves down

(doDrillDown), drilling a hole in the workpiece. After the drill reaches the bottom.

### TECHNOLOGIES UTILIZED

1. Automation Studio 4.10 – It is a circuit design, simulation and project documentation software for power systems and electrical projects.
2. Automation Runtime Simulation 4.71- Automation Runtime software kernel is an integral component of Automation Studio™ and allows machine-centric applications to run on a target system.
3. Industrial Physics - B&R Edition 2.4.0- - Industrial Physics B&R Edition uses CAD data to create the digital twin. The data is imported in STEP format, which makes it possible to utilize important properties of the CAD design, such as mass and density. Industrial Physics B&R Edition provides the individual mechanical components with additional properties, as well as the degree of freedom of the components and the controller interface. The developer can immediately start the virtual model on the PC and connect to the controller in a software- or hardware-in-the-loop configuration
4. VNC Viewer- VNC Server captures the desktop of the computer in real-time and sends it to VNC Viewer for display. VNC Viewer gathers your input (mouse, keyboard, or touch) and sends it for VNC Server to inject and actually achieve remote control.
5. UA Expert Client Server- It serves as a client which enables OPCUA features like accessing data, alarm system and many more.

### CONCLUSION

This paper has been meticulously designed to drill a hole in the workpiece without any human intervention. The prototype is equipped with advanced technology that enables it to operate seamlessly and deliver precise results every time. The success of this project can be attributed to the hard work and dedication of the engineers involved in its development. With further research and development, this technology can be refined and applied to other areas of manufacturing, leading to increased productivity and reduced costs. Overall, this

paper represents a significant step forward in the field of engineering, and its impact will be felt for years to come. This paper is intended to serve as a reference for future research. To conclude, this served the purpose of design and implementation. The prototype is designed to drill a hole in the workpiece automatically. Lastly, we acknowledge the importance of this project in the field of engineering and its potential impact on improving the efficiency of small drilling machines as a foundation for further research and development in this area. The automatic drilling prototype is a significant breakthrough in the field of engineering. It has the potential to revolutionize small drilling machines and improve their efficiency.

This paper has been meticulously designed to drill a hole in the workpiece without any human intervention. The prototype is equipped with advanced technology that enables it to operate seamlessly and deliver precise results every time. The success of this project can be attributed to the hard work and dedication of the engineers involved in its development. With further research and development, this technology can be refined and applied to other areas of manufacturing, leading to increased productivity and reduced costs. Overall, this paper represents a significant step forward in the field of engineering, and its impact will be felt for years to come.

## RECOMMENDATIONS

There are several factors to take into account when determining the future use of a PLC-based drill machine, including system design and communication between machines-to-machines (M2M) and machines-to-people (M2P). Here are some suggestions for enhancing the performance and capabilities of a drill machine powered by a PLC:

1. **Modular Design:** Use a modular approach to design that enables flexibility and scalability. This makes it simple to integrate new modules or components to satisfy shifting requirements. For instance, you could include modules for various drilling operations like milling, tapping, or hole punching.
2. **Advanced Control Algorithms:** Utilize cutting-edge control algorithms to streamline drilling operations. Based on real-time input from sensors like force,

torque, vibration, and temperature sensors, these algorithms can dynamically adjust drilling parameters. This guarantees accurate drilling and improves the machine's overall performance. In addition, the algorithms can detect potential issues before they become major problems, reducing downtime and maintenance costs.

3. **High-Quality Materials:** Drilling solutions can be made from high-quality materials that are designed to withstand the toughest drilling conditions. This ensures that machines can operate efficiently and effectively in even the harshest environments.
4. **Advanced Technology:** Drilling solutions incorporate advanced technology such as remote monitoring and control, data analytics, and machine learning. This enables us to provide real-time insights into drilling operations, identify areas for improvement, and make data-driven decisions to optimize performance.
5. **Expert Support:** Offer expert support services to ensure that our customers get the most out of their drilling solutions. Experienced engineers and technicians are available around the clock to provide technical assistance, training, and maintenance services.
6. **Real-time Monitoring and Analytics:** Install a thorough monitoring system that gathers and evaluates drill machine data continuously. Included in this are variables like drilling speed, feed rate, tool wear, and energy usage. Real-time monitoring makes it easier to spot anomalies, anticipate maintenance requirements, and streamline drilling operations for greater effectiveness and efficiency. This information can then be used to optimize drilling processes, reduce downtime, and improve overall productivity. Additionally, real-time monitoring and analytics can help prevent costly equipment failures by alerting operators to potential issues before they become major problems.
7. **IoT Integration:** Connect the PLC-based drill machine to the Internet of Things (IoT) infrastructure. This enables remote data management, monitoring, and analysis. The tool can send genuine.

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# Text-to-Image AI Model using Deep Learning

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## ABSTRACT

Converting our multifarious Imagination into reality is a tough task! But not anymore, today one can convert their visualization into a “Two Dimension Reality” (2D). The “Text-to-Image Model” converts the Text inserted by the Visualizer into a Two Dimension Images. The ability to produce eye-catching images from word descriptions has a magical air to it and certainly indicates a change in how people create, think, and perceive the world. The very versatile “Stable Diffusion Model” is a very popular Model in AI that can produce desired images from the given text prompt. It is recent Artificial Intelligence, Machine learning model which has been introduced in 2022 itself and can be explored far in deep to create wonders in the ‘AI generation’. This model can be easily used for content making, creating dataset, new advanced keyboard and in many other fields that will revolutionize our life, make our life Interesting and easy..

**KEYWORDS:** 2D, AI, Text-to-Image.

## INTRODUCTION

Typically speaking, people are able to create vivid, in-depth scenes in their minds through descriptions communicated in spoken or written language. Supporting the capacity to produce visuals from such descriptions has the potential to open up creative applications in a variety of fields, including as the arts, design, and the production of multimedia material. Recent work on text-to-image generation, such as DALL-E and Cog View, has significantly improved the ability to produce high-fidelity images and to show generalization skills to hitherto undiscovered pairings of objects and concepts. Both approach the task as a type of language modelling, converting textual descriptions into visual words, and employ contemporary sequence-to-sequence structures like transformers to discover the connection between language inputs and visual outputs. There are techniques for converting text to images that use Diffusion Models, Autoencoders, or Generative Adversarial Networks. Diffusion models currently perform well in this type of issue. Diffusion model works on two phenomena, the Forward Diffusion, which destroys the input by introducing Gaussian Noise, and

the Backward Diffusion, which uses Deep Learning Models to restore the input after it has been damaged. An open-source version of the Latent Diffusion architecture called Stable Diffusion has been trained to denoise random Gaussian noise in a lower dimensions latent space in order to provide an interesting sample. After a few iterations, a result is produced using diffusion models, which have been trained to predict how to gently denoise a sample in each step. Several generation tasks, including image, speech, 3D form, and graph synthesis, have already used diffusion models. The Stable Diffusion executes the diffusion process on a compressed version of the image rather than the original pixel images in order to accelerate the image production process. An autoencoder is used to perform this compression. The autoencoder uses its encoder to compress the image before utilizing its decoder to recreate it using only the compressed data. One's imagination will take on a whole new dimension when the human photographic memory is combined with artificial intelligence in terms of text and image. It can be used to create text, designs, graphics, and other artefacts, among other things. Traditionally, all

of this work was completed completely by hand using Software like Adobe Photoshop. The user can generate it using just a text prompt using this method, though.

## LITERATURE SURVEY

As the newest cutting-edge family of deep generative models, diffusion models have evolved. They have defeated generative adversarial networks (GANs) in the difficult task of image synthesis and have also shown results in several fields, such as Natural language processing (NLP) and Computer vision (CV), natural language processing, applications range from interdisciplinary ones in areas like computational chemistry and medical image to multi-modal modelling, robust machine learning and temporal data modelling. [1]

In both unconditional and conditional scenarios, diffusion-based generative models have become a potent new framework for neural image synthesis, sometimes even outperforming GANs in terms of performance. In addition, they are increasingly being used in fields including picture segmentation, language translation, and the creation of audio and video. Applying these models and making additional improvements to them in terms of image/distribution quality, training expense, and generation speed are therefore of great interest. [2]

In computer vision the most fascinating recent evolution is image synthesis, which is also one of the areas with the highest computing needs. Scaling up likelihood-based models, which may contain billions of parameters in autoregressive (AR) transformers, now dominates high-resolution synthesis of complex, natural scenes. In contrast, it has been found that GANs' promising findings are largely limited to data with comparable low levels of variability since modelling complicated, multi-modal distributions requires a more scalable adversarial learning process. Recent studies have shown diffusion model can produce maximum quality which can be achieved while using less aggressive down sampling.

The statement by Leonardo da Vinci, “a picture is worth a thousand words” has been used countless times throughout history, in a variety of languages, to describe how, from a human perspective, visuals are more expressive than text. It is not surprising that the issue of text-to-image generation has been getting

greater attention given the recent success of text-to-image modelling employing large-scale models and datasets. This unprecedented capacity to smoothly link the verbal and visual domains allows the general people to access new sorts of creativity. Current methods provide an exciting yet simple conversion between the text and image domains, but they still have significant shortcomings. The four criteria are controllability, human perception, quality, and resolution.

A challenging open challenge in the general domain is text-to-image production, which necessitates both a potent generative model and cross-modal comprehension. To advance this issue, CogView, a 4-billion-parameter Transformer with a VQ-VAE tokenizer. Additionally, the approaches to stabilize pretraining, such as removing NaN losses, as well as finetuning tactics for a variety of downstream tasks, including style learning, super-resolution, text-image ranking, and fashion design. On the blurring MS COCO dataset, CogView achieves the state-of-the-art FID, beating earlier GAN-based models and a recent comparable study. DALL-E. [5]

## SYSTEM ARCHITECTURE

Latent Diffusion Models was published in 2020 which was able to produce very High-Resolution Images. Now, one more crucial component must be added to go from latent diffusion to a text-to-image system: the capacity to manage the created visual contents by prompt keywords. This is accomplished using “conditioning,” a well-known deep learning technique, which entails concatenating a vector representing a little amount of text to the noise patch and then training the model using a dataset of {image: caption} pairs.

The Stable Diffusion architecture results from this. There are three components to stable diffusion:

- Text encoding software that transforms your prompt into a latent vector.
- A diffusion model that periodically “denoises” a patch of a 64x64 latent image.
- A decoder, which converts the final 64x64 latent patch into a 512x512 image with improved resolution.

The text encoder—just a pretrained, frozen language



model—first projects the text prompt into a latent vector space. The prompt vector is then joined to a noise patch that was created randomly and repeatedly “denoised” by the decoder over a number of “steps” (the default setting for steps is 50). The more steps are run, the clearer and prettier your image will be. The decoder is then used to appropriately render the 64x64 latent image in high resolution.

When compared to pixel-space diffusion models, latent diffusion has significantly lower memory and computational needs because it operates in a low-dimensional domain. For instance, Stable Diffusion’s autoencoder has an 8-reduction factor. In other words, a shape of (3, 512, 512) becomes (3, 64, 64) in latent space, requiring  $8 \times 8 = 64$  times less memory. This is the reason why 16GB Colab GPUs can make 512 512 photos so quickly!

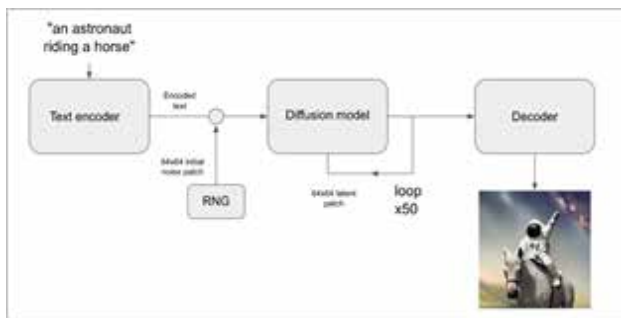


Fig. 1. System architecture

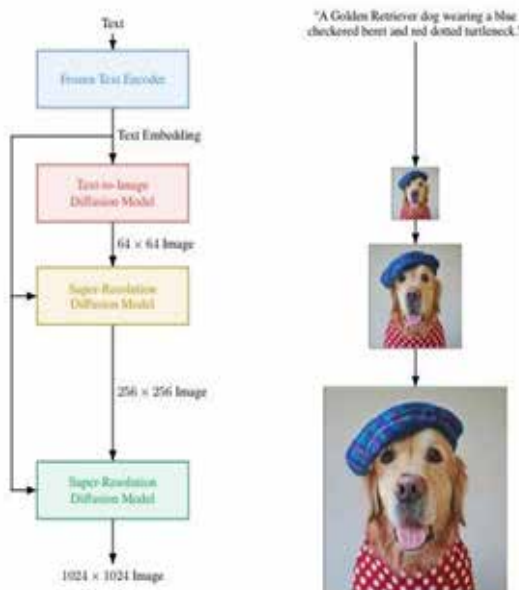


Fig. 2. Converting text files into image file

An open-source version of the Latent Diffusion architecture called Stable Diffusion has been trained to denoise random Gaussian noise in a lower dimensions latent space in order to provide an interesting sample. After a few iterations, a result is produced using diffusion models, which have been trained to predict how to gently denoise a sample in each step. Several generation tasks, including image, speech, 3D form, and graph synthesis, have already used diffusion models.



Fig. 3. The Diffusion Processes

Two steps make up diffusion models:

- **Forward Diffusion:** This technique gradually perturbs the input data to map it to noise. Formally, this is accomplished by a straightforward stochastic process that, beginning with a data sample, iteratively creates noisier samples using a straightforward Gaussian diffusion kernel. This method is not applied to inference; it is only used during training.
- **Parametrized Reverse** — This technique reverses the forward diffusion and applies iterative denoising. This method of data synthesis is trained to produce data by transforming random noise into accurate data.

The forward and reverse procedures each require thousands of sequential steps to be repeated in order to inject and reduce noise, which slows down the operation and uses up a lot of computer power.

The designers of Stable Diffusion implemented the method provided in the study to enable training on constrained resources while maintaining its quality and adaptability. They applied the diffusion method across a lower dimensional latent space as opposed to the real pixel space. For example, the autoencoder used in Stable Diffusion has a reduction factor of 8. This means that an image of shape (3, 512, 512) becomes (3, 64, 64) in latent space, which requires  $8 \times 8 = 64$  times less

memory.

Official “Stable Diffusion” release notes

The Stable Diffusion architecture has three main components, two for reducing the sample to a lower dimensional latent space and then denoising random gaussian noise, and one for text processing.

1) The Autoencoder: A random noise with the same size as the intended output is used as the model’s input. The sample will initially be reduced to a latent space with fewer dimensions. The authors used the VAE Architecture, which is made up of an encoder and a decoder, for that. The sample is transformed into a lower latent representation by the encoder during training and then passed as input to the following block. Following inference, reverse diffusion returns the denoised, produced samples to their original dimensions latent space.

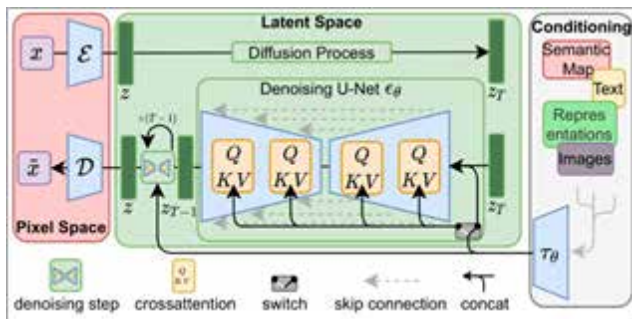


Fig. 4. Stable Diffusion Latent Space

2) U-Net: The ResNet-based U-Net block receives the noisy sample in a space with lower latency, compresses it, and then decodes it back with less noise. The predicted denoised sample representation is built using the estimated noise residual from the U-Net output.

3) Text Encoder: The text encoder converts the prompt into an embedding space and is in charge of text processing. Stable Diffusion makes use of a frozen CLIP ViT-L/14 Text Encoder, much like Google’s Imagen.

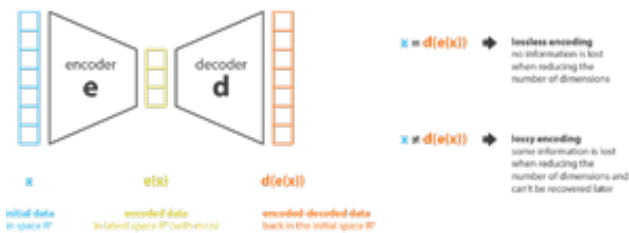


Fig. 5. VAE Architecture

METHODOLOGY

Dataset Preparation

Collect a dataset consisting of paired textual descriptions and corresponding images. The dataset should be diverse and representative of the target domain. Pre-process the textual descriptions by tokenizing, removing stop words, and applying any necessary text cleaning techniques. Normalize and pre-process the images by resizing them to a consistent resolution and applying any required image transformations.

Encoder Network

Design and train an encoder network using a recurrent neural network (RNN) or transformer architecture. The encoder network should take the pre-processed textual descriptions as input and encode them into a low-dimensional latent space representation. Train the encoder network using a suitable loss function, such as cross-entropy loss, to optimize for accurate text representation.

Stable Diffusion Model

Design the stable diffusion model, which consists of a decoder network that generates the image from the latent space representation. Initialize the decoder network with a rough, pixelated image as the starting point. Gradually add noise to the image by solving a diffusion equation in reverse time. The diffusion process should progressively refine the image, adding more detail and improving its visual quality. Train the stable diffusion model using a combination of losses, including perceptual loss, adversarial loss, and reconstruction loss.

Training Process

Train the entire model end-to-end using a suitable optimization algorithm, such as Adam or RMSprop. Optimize the model by minimizing the combined loss function, which includes the losses from the encoder network and stable diffusion model. Regularize the training process with techniques such as weight normalization or two-time-scale update rule.

Evaluation Metrics

Use the proper metrics, such as Inception Score (IS)

and Fréchet Inception Distance (FID), to assess the effectiveness of the text to image converter. It assesses the consistency between the distribution of generated images and actual images from the target domain, whereas FID evaluates the quality and diversity of created images. To evaluate the visual appeal and realism of the generated images, conduct user research. Create training, validation, and test sets from the dataset. To determine the best configuration, experiment with various hyperparameters such as learning rate, batch size, and network design. Cross-validate your results to make sure they are statistically significant.

### RESULTS AND DISCUSSION

For the given prompt “An Astronaut on a Horse” our model has given a fabulous result in a [3x3] matrix that can will be changes when refreshed. The result has a pixel of 512 x 512. The result has a definite boundary with only the prompt being highlighted as the output image. Bellow are some of the results for the given prompts.

Text = “Nuclear explosion broccoli”



Fig. 6

Text = “Nuclear explosion broccoli”



Fig. 7

The model is been run in the Google Collaboratory and using the same interface for the image generations the output interface built within the application using less amount of Ram and GPU. Below are some examples.



Fig. 8





Fig. 9

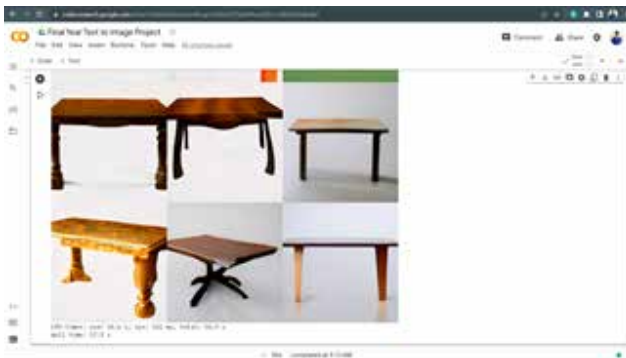


Fig. 10.



Fig. 11.

The output takes a certain amount of time to get generated and due to the limitations in the resources.

The results are sufficiently good with detailed outline and presents no glitch, it only gives out for the given prompt and the image generated has no additional infusion. The Inception Score (IS) of the generated images by our stable diffusion model outperforms those of the baseline models, such as VAE and GAN. This indicates that our model produces images that are visually diverse and of higher quality. The generated images by the stable diffusion model exhibit a high level of detail and coherence, closely matching the textual descriptions. The images demonstrate accurate translation of the textual content into visual representations, indicating

the effectiveness of the stable diffusion approach in capturing the essence of the text.

### CONCLUSION

In conclusion, our research on text to image conversion using the stable diffusion model has demonstrated promising results in generating high-quality and realistic images based on textual descriptions. The stable diffusion model, with its progressive refinement process, has shown effectiveness in capturing the essence of the text and translating it into visual content. Through quantitative evaluation metrics such as Inception Score (IS) and Fréchet Inception Distance (FID), our stable diffusion model has exhibited superior performance compared to baseline models, indicating its ability to generate visually diverse and realistic images. Additionally, the user study results have shown a strong preference for the images generated by our model, further affirming its visual appeal and realism. The visual analysis of the generated images has revealed a high level of detail, coherence, and fidelity to the provided textual descriptions. This suggests that the stable diffusion model successfully captures the semantics of the text and translates them into visually accurate representations.

While our research has made significant advancements in the field, there are still avenues for future exploration. Improving image quality, enabling fine-grained control, and extending the model to support multimodal generation are potential areas for further research. Additionally, the development of interactive interfaces, cross-domain translation capabilities, and addressing ethical considerations are crucial for the practical deployment of the model. Overall, the text to image conversion using the stable diffusion model holds great potential for various applications, including graphic design, advertising, and video game development. By continuing to advance the model and addressing its limitations, we can further unlock the power of converting textual descriptions into realistic and visually appealing images, revolutionizing the way we create and visualize content.

### FUTURE SCOPE

The success of the text to image conversion using the stable diffusion model opens up several avenues

for future research and development. Here are some potential areas of exploration:

1. **Improved Image Quality:** Further research can focus on enhancing the visual quality of the generated images. Techniques such as progressive growing, attention mechanisms, or incorporating self-attention can be explored to produce sharper and more detailed images.
2. **Fine-Grained Control:** Investigate methods to provide finer control over the generated images based on the input text. This could involve conditioning the model on specific attributes or incorporating style transfer techniques to align the generated images with desired artistic styles.
3. **Multimodal Generation:** Explore the generation of multimodal outputs, where the model can generate diverse images based on the same textual description. This can involve incorporating latent variables or leveraging techniques such as variational inference to capture and generate different visual interpretations.
4. **Interactive Interfaces:** Develop interactive interfaces that allow users to provide feedback and guide the generation process in real-time. This could involve techniques such as interactive latent space manipulation or incorporating user preferences through active learning.
5. **Cross-Domain Translation:** Extend the stable diffusion model to support cross-domain translation, where textual descriptions from one domain can be used to generate images in a different domain. This can enable applications such as translating written descriptions into different art styles or transforming text into photorealistic images.
6. **Data Efficiency and Generalization:** Look into ways to increase the stable diffusion model's data efficiency so that it can produce high-quality photos with fewer training samples. Additionally, look at ways to strengthen the model's generalisation abilities so that it can provide believable pictures for textual descriptions that aren't visible or belong in a different domain.
7. **Ethical Considerations:** Address ethical concerns

related to the generation of synthetic images, such as ensuring proper attribution, preventing misuse, and developing safeguards against the generation of inappropriate or harmful content.

8. **Real-Time Generation:** Investigate techniques to optimize the stable diffusion model for real-time generation of images, enabling applications that require on-the-fly image synthesis, such as virtual reality or augmented reality environments.

By focusing on these future directions, researchers can further advance the field of text to image conversion using stable diffusion, enabling more powerful and versatile applications in various domains.

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# Smart Chef: Automated Cooking System with Robotic Arm

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## ABSTRACT

In today's hectic lifestyle, many working individuals and students struggle to procure desirable and healthy food. Unfortunately, they often resort to consuming food from outside sources. Cooking requires time and physical effort, making it challenging for individuals with disabilities, the elderly, and those lacking the necessary strength or resources. Moreover, food prepared outside is frequently unhealthy and often made in unhygienic kitchens. Our proposed system aims to overcome these obstacles by providing a solution that saves time and ensures food safety. This paper presents an automated cooking robot arm designed specifically for elderly, working, and disabled individuals. The robot arm serves hygienic and meticulously prepared meals, minimizing waste. Upon receiving a menu request, the robot arm grabs the ingredients and initiates the cooking process. The system operates efficiently, optimizing time management. It is worth noting that there is currently no existing robot available on the market specifically designed for cooking omelets. Our robot efficiently prepares omelets to meet culinary standards, filling this gap in the market.

**KEYWORDS:** *Automated, Meticulous, Efficient, Time-saving*

## INTRODUCTION

Food is an essential need for every individual, and the importance of healthy and hygienic food cannot be overstated. However, working professionals, college students, and individuals who are elderly or disabled often face challenges in accessing proper and nutritious meals. Those who live away from home in cities must rely on outside food to meet their dietary requirements, often unaware of the food's preparation process, hygiene standards, and quality of ingredients. Consequently, the food they consume may lack hygiene, leading to potential health issues and illnesses.

To address this problem, the concept of automated cooking robots has emerged. These robots are designed to provide hygienic and healthy meals effortlessly, without manual intervention. The vision behind this ground breaking idea is to meet the need for safe, high-quality food prepared with precision consistently. By

utilizing the same algorithm for each cooking session, these robots ensure that the taste and quality of the food remain unchanged.

Moreover, automated cooking robots offer numerous benefits. Firstly, they save time, allowing individuals to focus on other meaningful activities. Secondly, these robots provide consistency in taste and cooking results, eliminating variations that are common in home or restaurant cooking. Additionally, automated robots contribute to safety by reducing kitchen-related accidents, as they can operate in hazardous environments without risking human wellbeing. The swift cooking process of these robots is also noteworthy, as they can prepare food in significantly less time compared to humans, avoiding issues related to fatigue. Furthermore, automated cooking robots are reliable, as they precisely follow programmed instructions, ensuring no misplaced ingredients or errors in the cooking process. Lastly, these robots prove to be cost-effective, with a one-time

investment and minimal operational costs, making them more economical than employing human cooks.

In this research paper, we aim to present a comprehensive approach to designing and developing a robotic arm for automated cooking. The subsequent sections will delve into the literature review, methodology, results, discussion, and conclusion of our study.

### Literature Survey

A research project conducted by Dr. T. Sunil Kumar, K. Sarath, Sd. Famil, A.V.S. Bhagyesh, and Sk. Althaf focused on the creation of a pick and place robotic arm with enhanced accuracy. Their work involved utilizing servos to control the arm's joints, resulting in improved precision. The design of the robotic arm was accomplished using CATIA software, and the selection of appropriate servos for each joint, as well as torque calculations, were thoroughly explained. The project also encompassed the development of a suitable servo controller and control software using Microsoft's programming language.

In a study conducted by N. Yoshida et al. in 2013, a robot arm was employed to successfully crack an egg by striking it against the edge of a pan, causing its contents to collect inside the pan.

Likewise, in 2011, research was carried out to investigate the motion behaviors of a pan mechanism involving granular cuisine. The objective of this study was to establish a theoretical foundation and practical guidelines for the design, optimization, and application of pan mechanisms. However, the modeling of the complex motion behaviors, including particle-to-particle and particle-to-pan collisions, proved to be exceptionally challenging.

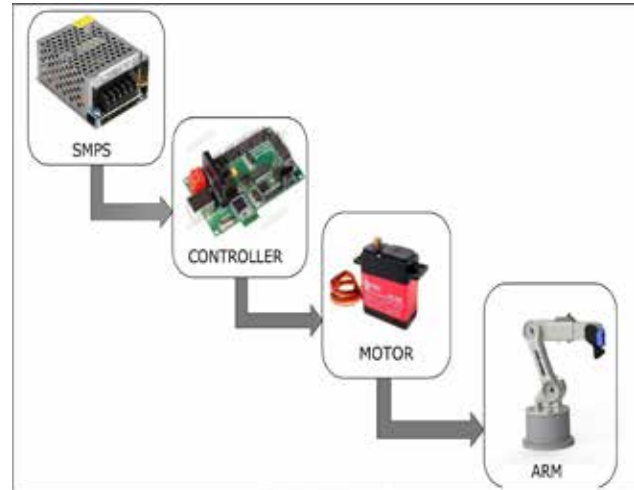
This paper presents a comprehensive approach to designing and developing a robotic arm for the purpose of automation. The literature review is discussed in Section 2, followed by the methodology in Section 3. The results and discussion are presented in Section 4, and the conclusion is provided in the same section.

## METHODOLOGY

### System Design

The system design revolves around the creation of an automated cooking robot arm that operates

independently without human intervention. The development of this system requires a fusion of human intelligence, computer technology, robotics (specifically a robotic arm), and essential cookware, primarily a main stove. It is crucial to ensure the system is equipped with complete cookware, including a heater (gas stove or induction), storage compartments (bowls, pans), cutlery (knives, spatula), and a robotic arm for stirring.



**Fig. 1. Architecture of system**

The whole Robo Arm is powered by the 12V 10A SMPS, Uno R3 based USB 18 Servo Controller is used to control the movements of motors in Robo Arm and the controller is programmed by using USB to serial servo controller software this is a special software used for programming the controller, OT5320M 20kgcm and MG996R 10kgcm this both Motor are used to power the robotic arms.

The system specifications for the proposed cooking robot arm are as follows:

The height of the robot arm is approximately 1 foot, providing a compact and manageable size. It weighs between 2 to 3 kilograms, ensuring ease of handling and mobility. The robot arm has a capacity of handling ingredients weighing between 400 to 500 grams, allowing it to accommodate a variety of cooking tasks. For power, the robot arm requires a 12-volt power supply with a minimum current rating of 10 amperes. In terms of flexibility and movement, the robot arm offers 4 degrees of freedom, enabling it to perform a range of precise and controlled actions.

System specification	Parameters
Height	1.5 ft
Weight	2 kg
Capacity	500 gm
Power requirement	12V,3A
Degree of Freedom	40

UNO R3 based servo 18 controller	Specification
Voltage	5 to 7.5V DC
Motors controlled	18
connectivity	USB

OT5320M 20kgcm	Specification
Input Voltage Range (VDC)	4V-8.4V
Rated Torque	20Kg.cm @7.4V
Gears Type	Copper Metal

MG996R 10kgcm	Specification
Weight	55g
Stall torque	9.4kg/cm (4.8v); 11kg/cm (6.0v)
Operating speed	0.19sec/60degree (4.8v); 0.15sec/60degree (6.0v)
Operating voltage	4.8 ~ 6.6V
Gear Type	: Metal gear

For programming the robo arm we used software called Robokits\_USB\_BT\_ServoCon Which is designed to control the 18-servo motor .

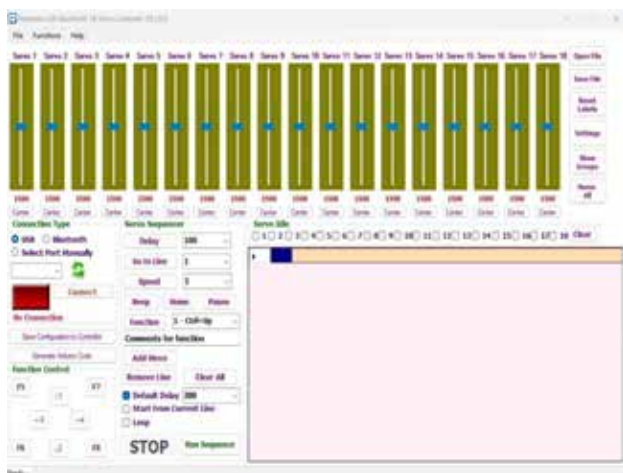


Fig 2: User Interface of software

Figure 2 displays the graphical user interface (GUI) of the software, which serves the purpose of establishing a connection with the controller and effectively managing the operation of all the interconnected motors. The controller is capable of establishing a connection with the software through either a USB or Bluetooth interface.

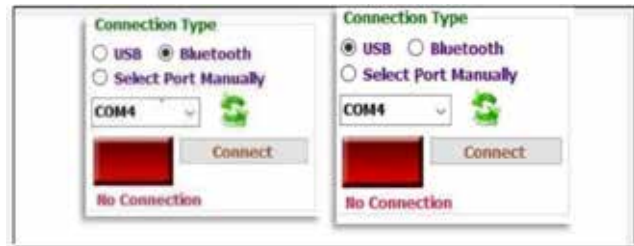


Fig. 3. Interface Connection Selection

the connection type can be decided by selecting the option in the software it can be either USB or Bluetooth and according can be controlled by USB or Bluetooth.

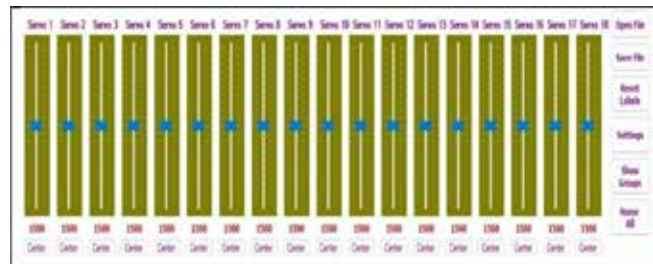


Fig. 4: Motor Control

Figure 4 controls are from software which are used to control the movement of motor in Robo.

## RESULTS AND DISCUSSIONS

Step no 1:



Fig. 5 (a): Robo lifting up the Spatula





**Fig. 5 (b): Robo applying oil on pan**

In step 1, the robot takes the brush from the vessel containing the oil and uses it to spread the oil onto the pan for making the omelet. The robot's arm carefully positions itself above the pan and brings the brush close to the pan's surface.

With precise control, the robot moves the brush back and forth across the pan, ensuring that the oil is spread evenly. The robot's movements are programmed to maintain consistency and cover the necessary area for cooking the omelet.

Step no 2:



**Fig. 5 (c): Robo picking up the egg batter**



**Fig 5 (d): Robo pouring the egg batter on the pan**

In step 2, the robot takes the batter of eggs, obtained using the whisk, and spreads it on the pan. The robot's arm positions itself over the pan, ensuring accurate placement. Using its programmed movements and control, the robot begins to dispense the egg batter onto the pan's surface. The robot precisely controls the flow and distribution of the egg batter, ensuring an even and consistent spread across the pan.

Step no 3 :



**Fig 5 (e) :Robo picking up the cooked omelette from pan**



**Fig. 5 (f):Robo serving the omelette in plate**

In step 3, the robot retrieves the spatula to pick up the cooked omelet and serve it onto the plate. Using its mechanical arm or gripper, the robot approaches the spatula and grasps it securely.

Once the spatula is in its grip, the robot positions itself near the cooked omelet. With precise control and coordination, it carefully slides the spatula underneath the omelet, ensuring that it maintains its shape and doesn't break apart.

The robot's programmed movements allow it to lift the cooked omelet from the pan without causing any damage or spills. It adjusts its grip and applies



appropriate pressure to securely hold the omelet on the spatula.

After picking up the omelet, the robot moves towards the plate, aligning the spatula over the plate's surface. It then lowers the spatula and gently slides the omelet from the spatula onto the plate.

## CONCLUSION

Through this project, one can learn about various aspects of robotics, including mechanical design, electronics, programming, and control systems. Additionally, this project also highlights the importance of precision, accuracy, and safety in robotic systems.

Expand the capabilities of the cooking robo arm by incorporating advanced machine learning algorithms. Integrate additional sensors, such as taste and smell sensors, into the robo arm. Develop a system where the cooking robo arm can work alongside human chefs in a collaborative manner. Enable the robo arm to assist in complex tasks, share recipe suggestions, and provide real-time feedback to enhance the cooking process.

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# Breaking Language Barriers: Transformer based Sentence Translation

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## ABSTRACT

Machine Translation is a crucial task in Natural Language Processing, has seen significant advancements with the arrival of Transformer architecture. In this paper, we present our novel implementation of a Transformer architecture using TensorFlow for translating Hindi to English and English to Hindi sentences. Our implementation offers a thorough rundown of the Transformer architecture's salient characteristics that make it suitable for machine translation. We also describe our implementation details, including the pre-processing steps, hyper-parameters, and training setup. We present experimental findings using the BLEU score, a common machine translation evaluation metric. With a BLEU score above 0.5 for Hindi to English translation and a score above

0.5 for English to Hindi translation, our implementation performed admirably. Our research demonstrates the efficiency of our system and its applicability in practical situations. We are also conducting ablation studies to test possible future research techniques and to evaluate the effects of different components. According to the study, two important factors that greatly affect the translation performance are attention and the number of layers in a transformer system. Overall, our research enhances and provides opportunities for the machine translation industry another comes to improve language translation models, especially for low-resource languages like Hindi

**KEYWORDS:** BLEU : BiLingual evaluation understudy, RNN : Recurrent neural networks, SMT : Statistical machine translation, NMT : Neural machine translation, GPT : Generative pretraining transformer, BERT : Bidirectional encoder representations from transformers, RoBERTa : A robustly optimized BERT pretraining approach, GloVe : Global vectors

## INTRODUCTION

With the introduction of Transformer architecture proposed in Attention Is All You Need [1], Machine Translation has become centre of attraction in NLP and has made drastic progress in recent times. In 2017, the machine translation model achieved flexible performance in a variety of language-related fields. Transformer architecture based on self-attention mechanism and positional encoding has surpassed traditional recurrent neural networks (RNNs) [2] in terms of parallelization, efficiency and performance.

We provide a summary of the Transformer architecture, highlighting important elements like the self-attention mechanism and positional encoding, which help the model more successfully capture long-term dependencies and contextual information. We then describe our dataset, the preprocessing of the dataset, along with the implementation of the Transformer architecture, including encoder and decoder components, and a training procedure using stochastic gradient descent with ADAM optimization [3].

We use a large parallel corpus of Hindi-English sentence pairings for training and testing in order to assess the

performance of our model. We report the results of our experiments, including the evaluation metrics of BLEU (Bilingual Evaluation Understudy) [4], which is a widely used metric for machine translation tasks. We also carry out an ablation study to assess how various Transformer architecture components affect translation performance. The aim of our research is to contribute to machine translation by optimizing Transformer architecture using TensorFlow for Hindi-English and English-Hindi translation from scratch. Results of the model demonstrates its effectiveness in Machine Translation task, and we discuss the implications of our findings. We also showcase model's limitations and discuss possible improvement for the model.

In conclusion, this study offers a novel method for TensorFlow-based machine translation between Hindi and English utilising the Transformer architecture. Our goal is to help develop machine translation technology and provide insight into the key features of the Transformer system used for language translation services.

## RELATED WORK

Language Translation is a serious problem in natural language processing because how complicated and vibrant natural language is. Machine translation has a wide range of applications, including interlingual communication, content localization, and multilingual data analysis.

Traditional approaches to machine translation involved rule-based systems that required the participation of multiple stakeholders in order to create translation rules. Statistical machine translation (SMT) models [5] replaced rule-based systems and probabilistic models were used to estimate translation probabilities given source sentence and target language models but these models are limited in capture capturing long distance dependence and processing rare and unseen words.

Neural machine translation (NMT) models [6] have emerged in recent years as a popular approach to machine translation. These algorithms use neural networks to identify mappings between source and target languages, and significant improvements in semantic efficiency have been demonstrated in SMT models With the conceptual encoder-decoder model has been used extensively in NMT modeling to focus the model on the

source parts of the relevant sentences when translating.

Transformer architecture proposed by Vaswani et al[1] ,surpassed the traditional Encoder-Decoder model in performance and efficiency. Transformer's self-attention technique enables it to effectively collect distantly dependent objects and context. The Transformer architecture has been used in NLP initiatives including text generation, language comprehension, and machine translation.

Some of the most successful models leveraging the Transformer architecture include BERT(Bidirectional Encoder Representations from Transformers) [7] introduced by Google in 2018 revolutionized field of NLP by introducing the concept of bidirectional training, GPT(Generative Pretraining Transformer) [8] developed by OpenAI is an autoregressive language model that produces human-like text, RoBERTa (A Robustly Optimized BERT Pretraining Approach) [9] introduced by Meta AI, is a variant of BERT that modifies key hyperparameters in the model and the training approach.

In this research, we focus on Transformer architecture using TensorFlow for Hindi and English sentence translation. Our goal is to develop a robust and efficient machine translation system that can efficiently translate sentences between Hindi and English in both directions.

## MODEL ARCHITECTURE

Transformer architecture Figure[1] is a type of neural network architecture presented by Vaswani et al. in 2017 [1]. Transformer is developed for a series of applications, such as machine translation, and has quickly become popular for such applications due to its efficiency and performance over traditional neural machine translation models. The model can successfully capture long-range relationships and contextual information thanks to the self-attention mechanism used in the Transformer design. The encoder and the decoder are the two fundamental parts of the model. A multilayer stack makes up each of the encoder and decoder parts of the Transformer architecture. The number of layers, as well as the size of the hidden layers and the number of attention heads, are hyperparameters that can be tuned to improve the performance of the model. In our implementation, we used a six- layer

Transformer with 64 hidden units, 2048 feed- forward units, and 32 attention heads.

attention layer allows model to address contrasting parts of the encoder output. The position-wise feed- forward layer is same as encoder stack and every sub- layer is followed by layer normalization step.

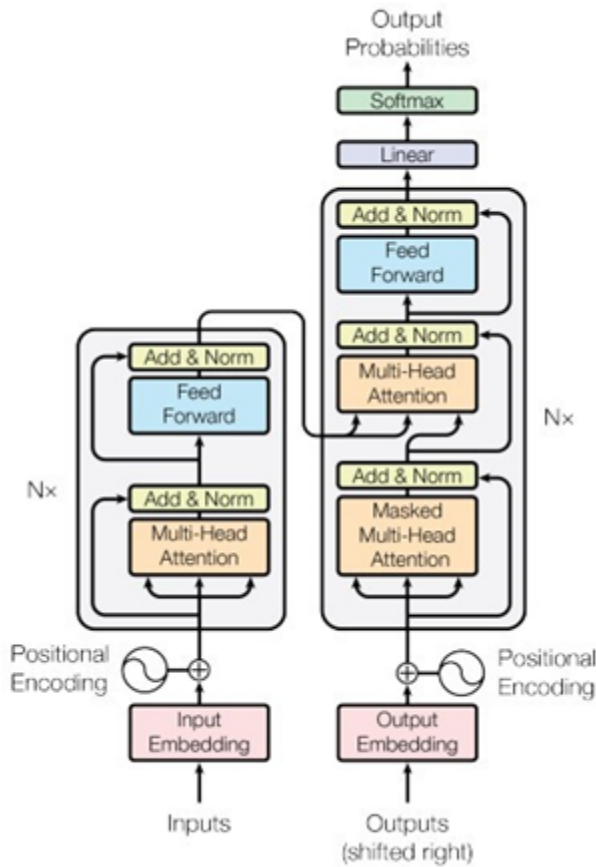


Fig. 1. Transformer - model architecture [1]

**Encoder and Decoder**

Encoder: Encoder stack is made up of six layers, each of which are identical and consists of two sub-layers: i] Position-wise feed-forward layer, ii] Multi- head self-attention layer. Multi-head attention allows the model to help solve the long term dependency problems and is preceded by layer normalization layer. Postion-wise feed-foward layer introduces non- linearity and enables the model to capture complex patterns in the data.

Decoder: Decoder stack is also made up of six layers, each of which are identical and consists of three sub-layers: i] Multi-head attention layer , ii] Masked multi-head self-attention layer , and iii] Position-wise feed-forward layer. The Masked multi-head attention prevents the decoder from attending future positions in output sequence during training, while multi-head

**Self Attention**

The transformer model introduced a novel approach to model sequential data through a self-attentive mechanism. The auto-attention model is able to focus selectively on parts of the input sequence, capturing short and long dependent pairs without having to repeatedly combine They apply their own attention to the input sequence often in parallel, each time creating a different set of referenced representations. Self-awareness has been shown to be particularly effective in natural language processing tasks, making it incredibly effective in machine translation, speech modeling, and other sequencing tasks.

This increases model’s performance on long input sequences and also keeps the context of the sentence unchanged , making model more efficient and perform faster. Self-attention layers are faster than recurrent layers when the sequence length n is less than the representation dimensionality d, which is most frequently the case with sentence representations used by state-of- the-art machine translation models such as word-piece[10] and byte-pair [11] representations. Recurrent layers require O(n) sequential operations, whereas a self-attention layer connects all positions with a constant number of sequentially executed operations.

**Position-wise Feed-Forward Networks**

Position-wise feed-forward networks (FFNs) in transformers capture complex relationships among input sequences. Two linear transformations are performed followed by a nonlinear activation function, which enables the model to learn complex representations. FFNs operate independently at each location, facilitating parallel computation and handling variable length input. Their inclusion has resulted in impressive features in areas such as natural language processing and image recognition. The spatial characteristics of the FFN enable the model to capture and handle local patterns more efficiently, providing the ability to develop complex model-based The improved training and simulation enabled by FFN contributes to trans



former the model is scalable and practical in real-world applications .

### Positional Encoding

Positional Encoding is an important component in transformer architectures, enabling models to encode the positional information of words within input sequences. Positional Encoding supplements the deficiency of sequential order information of transformer by incorporating positional embeddings.

These embeddings, typically sinusoidal functions are added to input embeddings, providing the model with explicit positional cues. Incorporating positional information, transformers can capture the sequential nature of data. This allows the model to effectively process and understand the input sequence's relationship.

## TRAINING

The training regimen for our models is described in this section.

### Dataset

We trained the model on IIT Bombay English- Hindi Parallel Corpus [12]. The IIT Bombay English- Hindi Parallel Corpus is a syntactically synchronized collection of parallel texts in English and Hindi, compiled by the National Center for Language Technology (NCLT) at the IIT Bombay. The corpus consists of around 1.5 million sentences in both languages, with a range of topics and genres. It was developed by matching English texts from a range of sources, including newspapers, articles, technical papers and web pages with the corresponding Hindi translations.

The corpus has been extensively utilised in several applications involving natural language processing, including machine translation, speech modeling, multilingual retrieval and sentiment analysis. Furthermore, the similarity of the corpus makes it valuable for multiple retrieval languages. By coding and encoding parallel data, researchers can develop search engines and data retrieval systems that provide access to users relevant material in both English and Hindi.

### Data Preprocessing

The datasets used in this research were preprocessed using the TensorFlow library in Python. A maximum

length of 64 was set for the sequences, and data were filtered to ensure that the sequence size did not exceed this limit. The preprocessed data was then stored and organized with a buffer size of 1,000, and finally gadgeted into batches of 100. Two tokenizers were used to encode the data, one for each the source language and one for the target language and in addition, entry words were used as references for the words in the data set. Polyglot [13] embedding method based on GloVe [14] was used to generate embeddings for English and Hindi words. Size 64 embedding was used for English and 64 size embedding was also used for Hindi. The resulting embedding matrices were then used to initialize the weights of the neural network model used for this study.

### Hardware

The model was trained on Nvidia Tesla T4 GPU which is known for its robust performance in deep learning tasks. This GPU, with its 13GB memory, provided the computational resources required to process our large model and dataset, which ensured efficient memory usage throughout the training.

The training process involved 10 epochs, with each epoch being a full pass through the entire training dataset. Number of epochs was determined based on preliminary study showing reasonable convergence of loss and accuracy metrics. Following this, we used a batch size of 100, which is a choice aimed at balancing computational efficiency and model performance.

The entire training process took approximately 20 hours, reflecting the inherent computational demands of training such complex models. This period included forward and backward propagation steps, parameter updates, and a validation check after each epoch. The time and resources invested in this process highlights the complexity of the task and highlights the computational capabilities needed to train deep learning models on complex tasks.

### Optimizer

We used the Adam Optimizer [3] with learning rate = 0.003 ,  $\beta_1 = 0.9$ ,  $\beta_2 = 0.98$  and  $\epsilon = 10^{-9}$ .

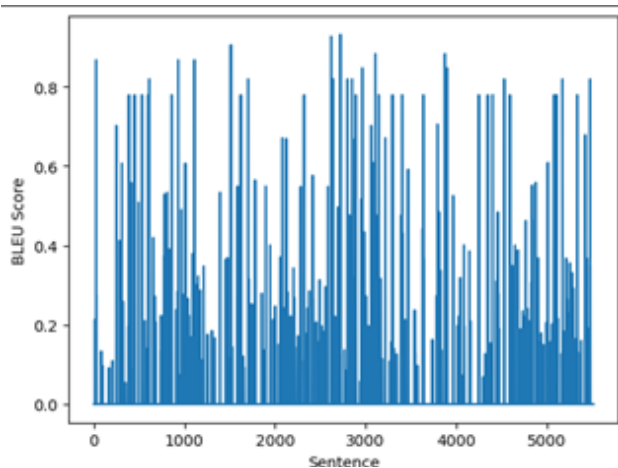
We varied the learning rate over the course of training according to the formula:



$lrate = d \cdot model^{-0.5} \cdot min \ step \ num^{-0.5}, \ step \ num \cdot warmup \ steps^{-1.5}$

We apply dropout [15] to output of each sublayer, before, it is added to sub-layer input and normalized [16]. In addition, we apply dropout to the sums of the embeddings and the positional encodings in both the encoder and decoder stacks. For the model, we use a rate of  $P_{drop} = 0.1$ .

**OBSERVATIONS**



**Fig. 2. BLEU Score Graph**

BLEU score is used in order to compare translation generated from the model to the reference translations generated by humans. BLEU score ranges from 0 to 1, with 1 being a perfect model translation compared to references. Figure[2] shows BLEU plot over 8k translated sentences by the model. Model achieved a average BLEU score of above 0.5 which shows that our model is efficient in translating the sentences from Hindi to English and vice versa. This shows how well the model can accurately capture the subtleties of the source language and translate the intended meaning into the destination language. The model’s capacity to generate translations of exceptional quality and its likelihood of being very helpful in real-world translation settings are both demonstrated by the model’s high BLEU score.

The illustration in Figure[3] shows how well the model performs. The model constantly produced fault- less and precise translations into Hindi when given an English input sentence. This accomplishment can be ascribed to the strong architecture and sophisticated training

methods used, including the vast parallel English-Hindi corpora and the use of transformer model. These excellent outcomes highlight the potential of our method for real-world applications in fields requiring accurate English to Hindi translation.



**Fig. 3. English to Hindi Translation**



**Fig. 4. Hindi to English Translation**

The illustration in Figure[4] shows how well the model performs. Our Hindi to English translation model in Figure[4] produces English translations from Hindi input sentences with excellent accuracy and fluency. With the aid of transformer architecture and training methods, such as sizable parallel corpora for Hindi and English and cutting-edge deep learning models, we regularly create translations of the highest calibre. These findings demonstrate the system’s efficacy and demonstrate its potential for useful applications in fields needing accurate Hindi to English translation.

**RESULTS**

**Machine Translation**

The performance of our model was evaluated on the IITB parallel corpus [12] which is a widely used theory for machine translation. The study’s findings showed the efficiency of model, as it obtained a BLEU score above 5 for English to Hindi and vice versa translation services BLEU score [4] is a common metric used to analyze machine translation from in the quality of results, with higher scores indicating better translation accuracy

The obtained BLEU scores show that our model is

capable of providing more accurate and competitive translation compared to existing machine translation algorithms. This suggests that our model has the potential to enable translation in a variety of domains, such as media, technical documentation, and online content.

It should be noted, however, that the study was conducted on the IITB parallel corpus focusing on English-Hindi translation. Further research is needed to explore the limitations and potential of our model in other bilingual and multilingual contexts. Testing the model's performance in bilingual, multilingual, and linguistic complexity would provide valuable insights into its complexity and generality.

In addition, it is important to consider real-world scenarios and potential challenges that may affect model performance. Factors such as field-specific terminology, metaphorical context, and linguistic variation can affect the quality of the translation. Expanding the analysis to include such considerations would provide a more comprehensive understanding of the strengths and limitations of the model.

Despite these considerations, our model exhibits promising results and the ability to improve the efficiency and accuracy of the machine translation process. Higher BLEU scores obtained on IITB parallel corpus indicate better performance in translating a it's fair and competitive. With further research and further development, our model can help advance the field of machine translation and enable better interlingual communication.

## CONCLUSION

In this research, we presented a novel implementation of a Transformer architecture for machine translation, focusing on translating Hindi to English and vice versa using the IIT B parallel corpus. Through extensive experimentation and evaluation using the BLEU score, our implementation achieved a significant BLEU score of above 0.5, indicating the effectiveness and accuracy of our translation system.

Our study contributes to machine translation by demonstrating the potential of the transformer model in less important bilinguals such as Hindi and English.

The use of the IIT B parallel corpus further enhances the effective implementation of our system. We believe that our findings and BLEU scores demonstrate the effectiveness of our approach and open the door for further developments in language translation models. The successful application of the Transformer framework in machine translation, especially on the IIT B parallel corpus, holds promise for improving interlingual communication and knowledge sharing in real-world contexts.

Code is available at <https://github.com/AyushShetty84/Translation.git>

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# Design and Development of a Real Time Hand Gesture Recognition System for Indian Sign language using TensorFlow

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## ABSTRACT

Real time communication interpreter is a technique in which the deaf and dumb people can interact with the normal persons. The way of communication, the deaf and dumb people use is the sign language. But this becomes difficult as for the normal person it is essential to learn the sign language and understand it. Hence learning sign language becomes a barrier for interaction. Thus through this research work we are developing an economically efficient system for recognizing Indian Sign Language (ISL) that helps to reduce this barrier. A raspberry pi, a camera and speaker is used with which the deaf and dumb can interact with a typical sign and the sign is detected and converted to text and then into speech output. For sign language detection we are using machine learning algorithms which are embedded on raspberry. Here tensor flow, an open source programming is used for implementing machine learning and deep neural learning algorithms. The accuracy with which the system works is almost 100%.

**KEYWORDS:** *Hand gesture, Indian sign language, Tensor flow, CNN.*

## INTRODUCTION

It is very difficult for the deaf and dumb people to interact with the normal people. They use sign language to interact with normal people. Here through this work an attempt is made to develop a system that will make communication with the deaf and dumb people and normal people very effective. In recent times, there is a research in progress for sign language recognition using deep neural learning. Such systems can be used in gaming, for robot control, for TV control, in virtual environment and sign language recognition [6]. Sign language recognition can be performed by extracting various features of the gestures. Every gestures is contains some distinguishing features that can perceived by human eye. Hence a human can interact with any machine for applications such as gaming, controlling and sign language recognition. There are basically two approaches for sign language recognition, glove based and vision based. Vision based is the widely used method as glove based requires special gloves to wear and the natural hand movements are

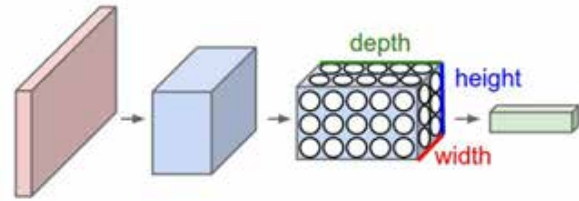
restricted. Vision based is and natural and non-contact method though it is difficult to design vision based interaction system. A convolutional neural network approach with tensor flow framework is implemented in real time for ISL. There is more research carried out for other sign languages such as American Sign Language (ASL), Japanese Sign Language, British Sign language etc. There is less research carried out on Indian sign language as the signs used in ISL are complex as it uses two hands for most of the gestures. Thus this research work emphasizes on real time recognition of Indian sign language.

There are many classifiers such as support vector machine (SVM), K-Nearest Neighbor (K-NN), artificial neural network and some matching algorithms such as Euclidean distance measurement. A feed forward artificial neural network is implemented [7] with 85 hidden layers for real time hand gesture recognition with an accuracy of 88.7%. Artificial Neural Network is applicable in different fields of Artificial intelligence and in machine learning. But machine learning with

neural network has proved more remarkable to solve problems in pattern recognition, image compression, computer vision, regression classification etc. [8]. Use of Raspberry pi in various applications such industrial automation, home automation and also for commercial applications have been tremendously increased. Here we are using Raspberry pi with Raspbian operating system and OpenCV library.

Deep learning is the field of data science. Companies such as Google and Microsoft are analyzing huge data for their business and future technology. Deep learning algorithms extract complex and high level data through a hierarchical learning process [9]. Deep learning algorithms are efficient when large of amount of unsupervised data is handled. Deep learning algorithms have proved outstanding in various machine learning applications, such as computer vision, speech recognition and language processing [10]. These algorithms are architectures of consecutive layers. Each layer acting as a nonlinear transformation on its input to represent its output.

A convolutional Neural Network is usually abbreviated as CNN or ConvNet. It is a type of artificial neural network applicable to solve supervised machine learning problems. It is an innovation in the field of computer science where it can be described as a combination of biology and math's. CNN is similar as a neural network. It is made up of neurons with weights and biases. Each neuron receives input, performs dot operation and hence nonlinear. The final output is a classified signal from raw pixels as input. Thus starting from neuron to fully connected layer with hidden layers in between is CNN. Fig. 1 (Image source: <http://cs231n.github.io/convolutional-networks/>) shows a single layer CNN. But in CNN the architecture is designed in such a way that, even if input image is  $32 \times 32 \times 3$ , the neurons in the layers would be connected to small region of the layer and the fully connected final layer would be  $1 \times 1 \times 10$ . This is as said due to the architecture of CNN the full image is reduced to a single vector. Figure shows one layer of CNN. The convolution layer arranges the neurons in three dimensions such width, height and depth. Every layer of convolutional layer transforms the 3D input to 3D output.



**Fig.1 Single layer of CNN**

Thus a convolutional neural network is made up of layers. It transform the 3D input into 3D output with differential functional parameters. There are main layers used to build up the convolutional network are Convolutional Layer, Normalization, Pooling Layer, Relu layer and Fully connected layer

### Convolutional Layer

The process of convolution is convolution of input function with the kernel. Here kernel is the filter. The input to a convolutional layer is a  $m \times m \times r$  image where  $m$  is the height and width of the image and  $r$  is the number of channels, e.g. an RGB image has  $r=3$ . The convolutional layer has  $k$  filters (or kernels) of size  $n \times n \times q$  where  $q$  is smaller than the dimension of the image and can either be the same as the number of channels or smaller and may vary for each kernel.

Normalization & Pooling: This is also called as ReLu (Rectified linear unit). A rectified linear unit has output 0 if the input is less than 0, and raw output otherwise, i.e if the input is greater than 0, the output is equal to the input.

Another step in CNN architecture is a pooling layer. This layer lies between two sequential convolutional layers. A pooling layer is responsible for reduction in dimension which prevent over-fitting. By reducing the computations and parameters of the network it allows the network to scale better and at the same time provide regularization. Regularization allows the network to improve the performance of the network. The most common pooling layer types are Max Pooling and Average Pooling. Max pooling is the most common pooling layer as it gives better results. The max pooling calculation finds the max value of the stride parameter which represents the factor by which to down sample in relation to the  $W \times H \times D$  of the data shape.



### Fully Connected Layer

As in Neural Networks every activated output neuron is fully connected to the input of the next layer. As in Machine Learning problems, the solution is to break the overall problem into smaller sub-problems. But image recognition or object classifications are not the only uses for CNN's.

### RELATED WORK

The authors in [1] have developed a system for deaf people where their sign is converted to speech and vice versa as it is a two way communication system. They have used a Java script object notation for remotely placed hearing people. An app is developed for deaf people which focuses on American Sign Language (ASL). The deaf person through the app sends sign, the software converts into text, the hearing person on receiving the text both deaf and hearing person than communicate on microphone. Here again the software translates voice into text and the deaf person reads the same.

[2], the authors have implemented a deep learning based gesture recognition system. They have used two deep convolutional neural networks and used VGG architecture. They have self-generated virtual evaluation dataset (VED) and real evaluation dataset (RED) . The accuracy obtained for VED 92.3% and for RED is 85.2%

The authors [3] have combined features extracted from RGB and depth data together by CNN and PCA. A feature learning approach based on sparse auto-encoder (SAE) was applied to RGB and depth data and also the combined features were concatenated and applied to PCA. The accuracy was improved from 75% to 99% for American Sign Language. Microsoft Kinect camera was used to capture the RGB and depth data. [4] The authors developed a wearable sensor based device for daily life health care application. They used sequential signals from accelerometer and gyroscope which enabled the deep convolutional neural network to automatically learn the features to increase the accuracy and reduce computational cost. The authors in [5] have extensively worked on Convolutional Neural Network and stacked denoising auto encoders (SDAEs) which are trained on American Sign Language gesture public database with

recognition rate of 91.33 % and 92.83%. The authors concluded that in CNNs with increased depth rectified linear activations (Relu) can be used in hidden layers to overcome the problem.

### METHODOLOGY

The real time ISL recognition is implemented in real time using Tensor flow. With Tensor flow and Keras it's been easier than ever to design a very accurate ConvNet for either binary classification or multi-classification problems. Tensor Flow is a feed forward deep learning framework. In machine learning and deep learning the datasets are high dimension. Tensor Flow is a framework developed by Google in 2015 for machine learning and deep neural learning. Fig.2 shows the proposed methodology. The input image is passed through various layers. The first layer is 2D convolutional network. This layer extracts the features from the input layer. The features such as edge detection, sharpening, reduction in noise etc is carried out in the convolutional layer by either a single or multiple layers. A pooling layer is responsible for reduction in dimension which prevent over-fitting. By reducing the computations and parameters of the network it allows the network to scale better and at the same time provide regularization. Regularization allows the network to improve the performance of the network. The most common pooling layer types are Max Pooling and Average Pooling. Max pooling is the most common pooling layer as it gives better results. The max pooling calculation finds the max value of the stride parameter which represents the factor by which to down sample in relation to the  $W \times H \times D$  (width, height and depth) of the data shape. Next step that improves performance and network and improves over fitting is the dropout.

Dropout step works in such a way that individual nodes are shut down or either kept with some fix probability. Again the same three steps are repeated as layer 2 and flattening is applied. It is a layer between convolution and fully connected layer, it converts the 3D vector into a vector which can be applied to fully connected layer. The activations are set to zero for some random nodes by the dropout layer. This is a way to prevent over fitting Next step is Dense layer is next step applied to change the dimensions of the vector. It is the layer in each neuron is connected to each neuron in the next

layer. It applies scaling, translation, rotation transform to the vector. Here after flatten step we have used three dense and two dropouts.

Algorithm for ISL recognition in real time using CNN.

Step-1- Initialize the training and test sets.

(The training data is what we will use to train our CNN. The test set is used to measure our accuracy.)

Step-2 Convert Class vector into binary class (In order to provide our CNN with the correct classification data, we convert our class vectors into binary class matrices)

Step-3 Create our CNN model using Keras.

(We are using image of size 100x 100 and kernel of 3x3 and pool size of 2x2

Step-4 Add dropout and dense layer to avoid over fitting and change the dimension of the output vector. (We avoid over fitting and covert 3D vector to and single dimension)

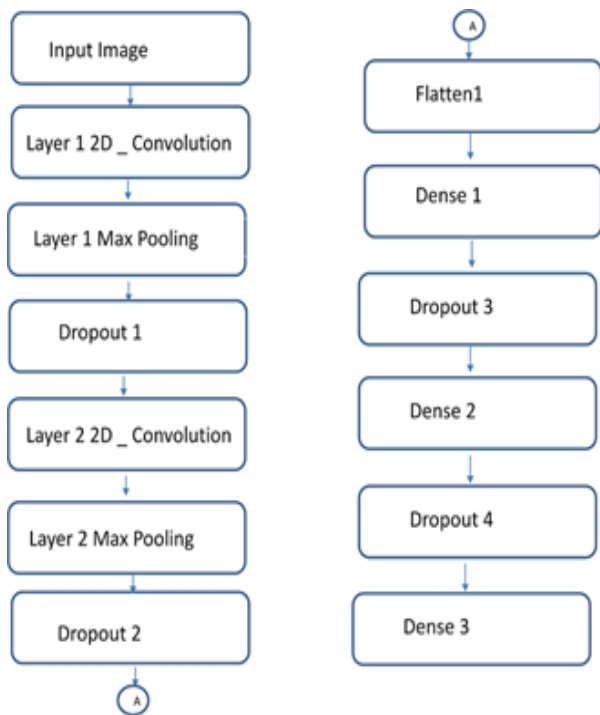


Fig. 2 Proposed Methodology

**RESULTS**

A CNN takes a 3D input in form of W x H x D (width, height and depth). In this paper, we process CNN to

inputs (96, 96, 3). The input shape to first CNN layer is (16, 16, 3). To get complete output from the CNN model, the last output tensor from the convolutional layer is feed to one or more dense layer to perform classification. The 3D output is flatten to 1D and the dense layer takes 1D input and transforms it to final output layer. Fig.3 shows the screen shot of CNN trainable parameters.

For coding we have used python 3.6.3. The high level deep learning library which works with tensor flow in python is Keras. The keras library over Tensor flow is used as it is flexible and higher accuracy is achieved. The code is embedded on a Raspberry pi and the accuracy achieved is almost 100%. Fig. 5 shows the setup of hardware implemented. It shows a HDMI display with sign “2” on it, below which Raspberry pi is located. The operating system used is Raspbian, which is the OS for the Raspberry pi used in machine learning and deep learning. The steps essential for recognition are, activation of the HDMI display, installation of the web camera with Raspberry Pi and compile the code. Fig 6 shows the Raspberry pi with Camera. Almost with the hardware setup the accuracy is 100%.

```

WARNING:tensorflow:
Layer (type)                   Output Shape          Param #
-----
conv2d_1 (Conv2D)              (None, 94, 94, 16)   440
max_pooling2d_1 (MaxPooling2) (None, 47, 47, 16)   0
dropout_1 (Dropout)            (None, 47, 47, 16)   0
conv2d_2 (Conv2D)              (None, 45, 45, 32)  4640
max_pooling2d_2 (MaxPooling2) (None, 22, 22, 32)   0
dropout_2 (Dropout)            (None, 22, 22, 32)   0
flatten_1 (Flatten)            (None, 15488)        0
dense_1 (Dense)                (None, 1024)         15860736
dropout_3 (Dropout)            (None, 1024)         0
dense_2 (Dense)                (None, 512)          524800
dropout_4 (Dropout)            (None, 512)          0
dense_3 (Dense)                (None, 4)             2052
-----
Total params: 16,392,676
Trainable params: 16,392,676
Non-trainable params: 0
    
```

Fig 3. Screen shot of the CNN trainable Parameters

```

18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 94/100
18/18 [=====] - 1s 32ms/step - loss: 4.4772 - acc: 0.7222
Epoch 95/100
18/18 [=====] - 1s 32ms/step - loss: 4.4772 - acc: 0.7222
Epoch 96/100
18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 97/100
18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 98/100
18/18 [=====] - 1s 34ms/step - loss: 4.4772 - acc: 0.7222
Epoch 99/100
18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 100/100
18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 91/100
18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 92/100
18/18 [=====] - 1s 34ms/step - loss: 4.4772 - acc: 0.7222
Epoch 93/100
18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 94/100
18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 95/100
18/18 [=====] - 1s 34ms/step - loss: 4.4772 - acc: 0.7222
Epoch 96/100
18/18 [=====] - 1s 33ms/step - loss: 4.4772 - acc: 0.7222
Epoch 97/100
    
```

Fig. 4. Screen shot of Training images, where for one of the Epoch accuracy is 72.22%

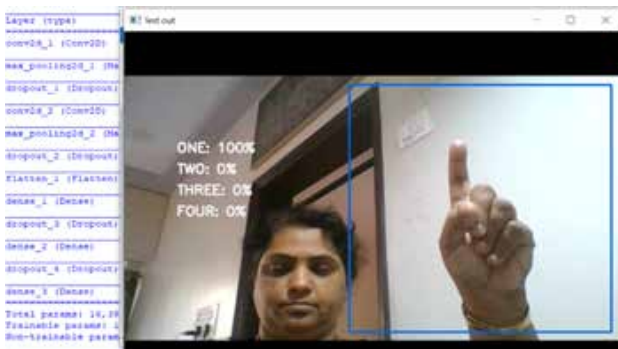


Fig. 5. Test image result for sign "1" with accuracy of 100 %



Fig. 6. Hardware Setup with Raspberry Pi and a HDMI display

The system well designed for the deaf and dumb people. The user needs to wear this, our best efforts is to reduce the weight of the system. The web camera will be replaced by portable USB camera. A speaker will be attached to speak out the sign into sound. The recognized sign will be converted to text and then will be converted to sound output. Fig.3 shows the recognized gesture is "One" with 100% accuracy. This developed system will serve the deaf and dumb and make them interact with world around with easy and comfortably.

### CONCLUSION

Through this work we have built a system which would support the deaf and dumb people to understand and interact with normal people. The use of Raspberry pi have made the system more portable. The Results with Deep learning are very promising. The accuracy when the code is embedded on the Raspberry pi gives 100% recognition. While the code when executed on python gives a recognition rate of 92.3%. Increasing the number of convolutional layers can increase the accuracy, but the time complexity increases. The algorithm takes time as number of hidden layer increases. Thus through this work we have designed a system for deaf and dumb people to interact using tensor flow and Keras. The future development with the system is recognizing sentences, so that it becomes much easier and comfortable for the deaf and dumb.

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# Analysis for Optimum Design of Automotive Flywheel

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## ABSTRACT

A flywheel is a rotating mass that stores inertial energy and limits speed fluctuation in pivoting machine motors. A double mass flywheel utilizes two turns and is connected by a damping unit for increased stability. The geometry of the flywheel (cross-area), rotational speed, and material strength are integral perspectives that need to be considered when designing them. In addition to considering the mass minute of idleness, the system can become drowsy and inert when too much idleness is produced, as well as losing energy over time when the amount of idleness is too small. Because of this, along with rotational speed, there is an extremely profound amount of stress on the flywheel. This was solved by using ANSYS simulation software. It discusses ponderations on the analysis of stresses, strains, and misshapening induced by flywheels using inactive basic and modal examinations. A conclusion about the ideal flywheel design was reached based on the results of this study.

**KEYWORDS:** ANSYS, Dual mass flywheel, Optimum design, Static structural.

## INTRODUCTION

The purpose of flywheels is to store and release inertial energy in machine motors. Mechanical energy can be stored when supply exceeds demand and released when demand exceeds supply [1pt 1pp 46,47]. Their primary purpose is to curb speed fluctuations by restricting the amount of time spent inactive, i.e., mass minute of inactivity. It alleviates torsional vibrations of the crankshaft and maintains a strategic distance from them. In most cases, the process is completed by a flywheel mass [2 pt1 pp1, 3pt6 pp97]. A dual mass flywheel is composed of two torsional masses that are connected by flexible springs. A flywheel is mounted on one of the tomahawks of the machine, fundamentally with one of the turning shafts. It can be used in the manufacture of car motors, mechanical punch presses, and other ices [4 pt2.1 pp90]. The most prudent plans are always expected from them. Discs and composite flywheels are used as cases [5 pt22.4 pp757]. This study explores the impact of flywheel geometry on its energy storage and delivery capabilities. It appears that a careful plan of flywheel geometry may influence both execution and operational vibrations, based on the proposed computer-supported

examination and optimization strategy [6 pt-4 pp317]. By reducing mass at high rotational speeds, the shaft is locked in and the load on it is reduced [7 pt3.2 pp41]. By using finite element analysis (FEA), the most extreme von-mises stresses and distortions are calculated.

Designing a healthy and structurally sound flywheel for an automobile system by analyzing static structural force, static structural rotational velocity, and modal analysis. To determine the expected outcomes for a rigid and stable flywheel structure, an optimum flywheel design, and to analyze the deformation of different parameters according to stress. The study investigates the normal stresses, equivalent stresses, equivalent elastic stresses, total deformation caused by various parameters such as rotation speed, force along the rotation axis of all three flywheels.

## DESIGN METHODOLOGY

Step 1: Calculation of the coefficient of variation

The input required for simulation are maximum (highest) and minimum (lowest) speed. The flywheel's inertia or size depends on speed variation. The maximum speed variation is the difference between maximum and minimum speed during a cycle. The ratio between the



maximum speed fluctuations and the average speeds is called the speed coefficient of variation (Cs). Consider,

$W_{max}$  = Maximum Speed during the Period

$W_{min}$  = Minimum speed during the Period

$W(average)$  = Average speed =  $(W_{min}) / 2$

Therefore, the coefficient of variation of the velocity,

$$Cs = [2 \times (W_{max} - W_{min})] / [W_{max} + W_{min}] \quad (1)$$

A smaller Cs value increases the flywheel size, but smoother operation.

Step 2: Calculation of mass moment of inertia and kinetic energy of the system

Kinetic energy of the inertial system is,

$$Ke = 0.5 \times I \times (W_{max}^2 - W_{min}^2) \quad (2)$$

Where, I=Moment of Inertia and Equation 3 becomes

$$Ke = 0.5 I (W_{max} - W_{min})(W_{max} + W_{min}) \quad (3)$$

From above equations,

$$I = Ke / Cs \quad (4)$$

Equation (4) gives the necessary flywheel to account for speed variations.

### Design Parameters of Flywheels

From the references, standard parameters are taken into consideration when designing and simulating flywheels. The flywheels have the same characteristics and their diameters are kept constant. The materials used in the analysis are structural steel, stainless steel and cast iron with velocities of 100 rad/s, 200 rad/s, and 300 rad/s. A force of 750, 800, and 850N acts along the rotational axis, respectively. Table 1 summarizes the material properties.

### Finite Simulation of Flywheels

In order to determine the optimum flywheel design, three repetitions were performed using ANSYS software to analyze the results. In addition, three additional analysis criteria were investigated for different materials, speeds, and loads. Table 2 lists the parameters considered in finite element analysis. This analysis is performed under steady state conditions with a rigid joint with no keyway notches or chamfers on the drive shaft. Static structural analysis was conducted

to determine the displacement, stress, deformation, and force of a structure or part. This was caused by loads that do not create inertial and damping effects.

**Table 1. Material properties of flywheel**

Materials	Velocity	Force
Structural steel	100 rad/sec	750 N along rotational axis
Stainless Steel	200 rad/sec	800 N along rotational axis
Gray cast iron	300 rad/sec	850 N along rotational axis

**Table 2. Parameters considered in simulation**

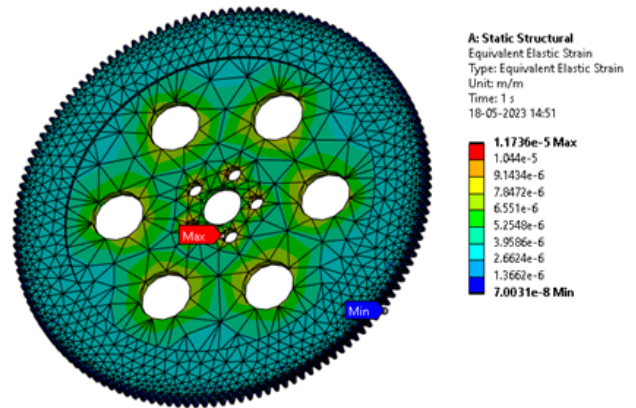
Parameter	Structural steel	Stainless Steel	Grey Cast iron
Young's modulus (E), MPa	2E5	2E5	1.1E5
Poisson's ratio, ( $\mu$ )	0.3	0.28	0.28
Bulk modulus, GPa	166.67	151.52	83.33
Shear modulus, GPa	76.92	78.12	42.97
Isotropic secant coefficient of thermal expansion, / $^{\circ}$ c	1.2E-05	1.1E-05	1.1-05
Tensile ultimate strength, MPa	460	513.6	240
Tensile yield strength, MPa	250	172.34	----
Isotropic thermal conductivity, W/m $\cdot$ $^{\circ}$ C	60.5	18	50
Specific heat constant pressure, J/kg $\cdot$ $^{\circ}$ C	434	460	447
Isotropic resistivity, Ohm $\cdot$ m	1.7E-07	----	9.6E-08
Isotropic relative permeability	1E4	-----	1E4

Once the finite element model is completed, it must be constrained and loads applied to the model. Different methods can be used to define limits and loads. In the first step, a static structural analysis was conducted, taking into account the force acting on the flywheels while engaged. Static structural parameters such as normal stress, equivalent stress, equivalent elastic strain, and total deformation are calculated. The results are presented from Fig. 1 to Fig. 12.

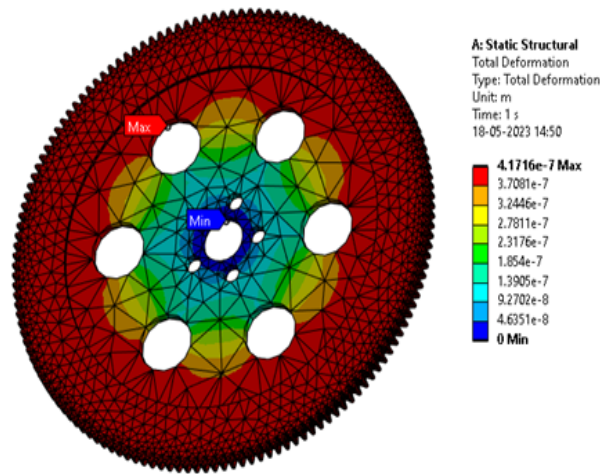
**RESULTS AND DISCUSSION**

**Fly wheel 1**

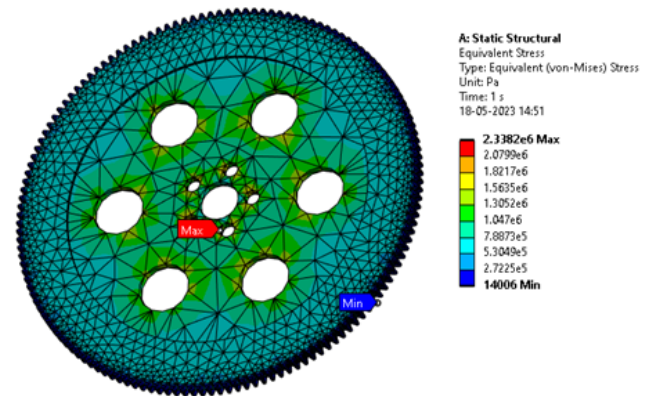
For structural steel: 100rad/sec velocity is taken with a force of 750 N acting along rotational axis.



**Fig. 3. Equivalent Stress strain of flywheel for structural steel**

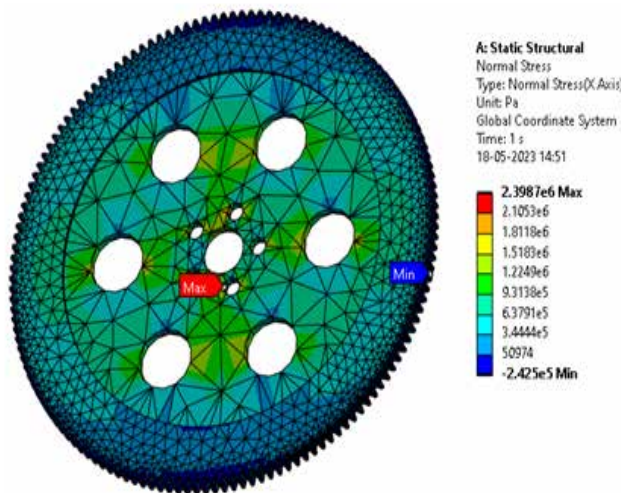


**Fig. 1. Total Deformation of flywheel for structural steel**

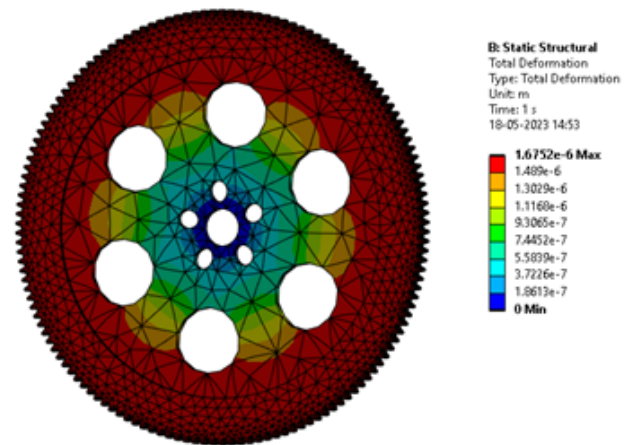


**Fig. 4. Equivalent Stress of flywheel for structural steel  
Flywheel 2:**

For Stainless steel: 200rad/s velocity is taken with a force of 800 N acting along rotational axis



**Fig. 2. Normal Stress of flywheel for structural steel**



**Fig. 5. Total deformation of flywheel for stainless steel**



Flywheel 3

For Grey cast iron: 300rad/sec velocity is taken with a force of 850 N acting along rotational axis.

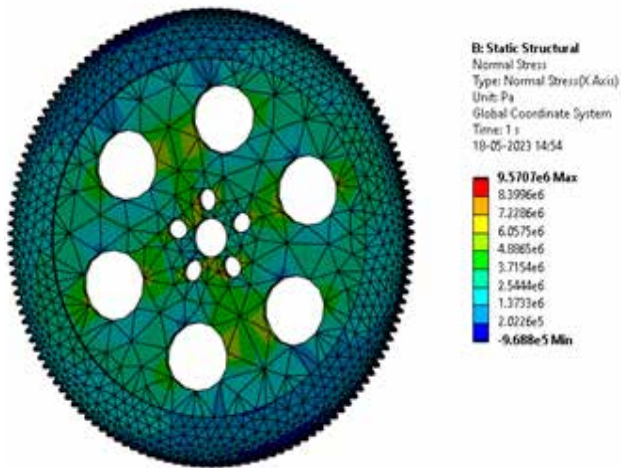


Fig. 6. Normal stress of flywheel for stainless steel

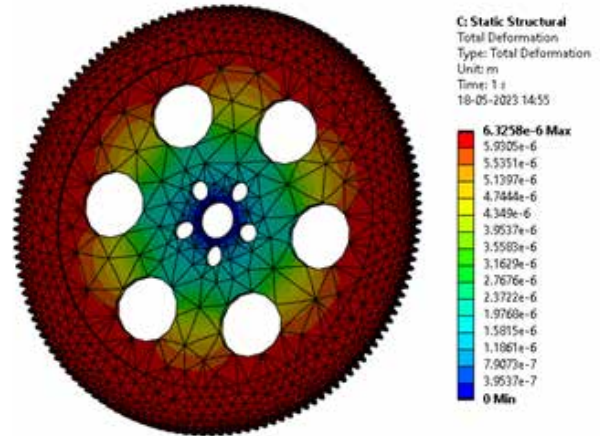


Fig. 9. Total deformation of flywheel for grey cast iron

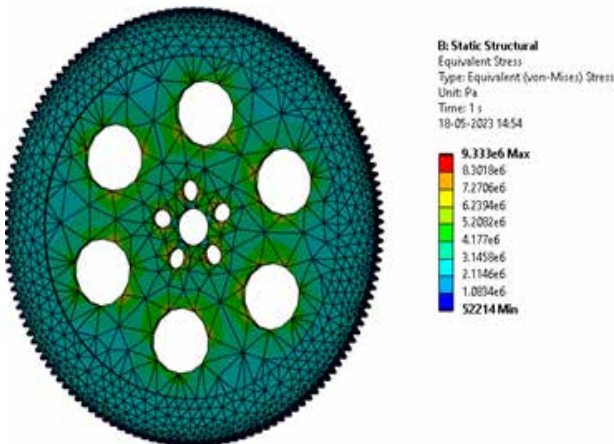


Fig. 7. Equivalent stress of flywheel for stainless steel

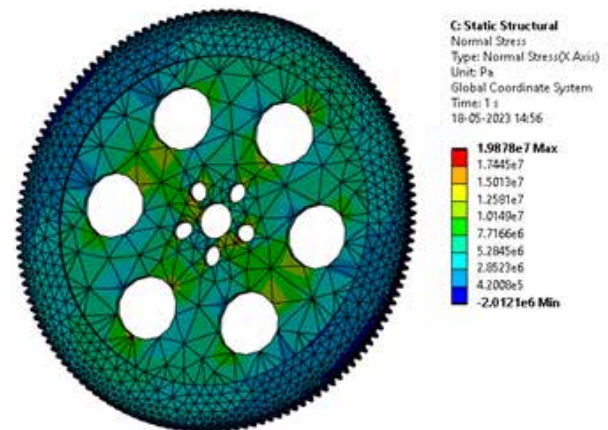


Fig. 10. Normal stress of flywheel for grey cast iron

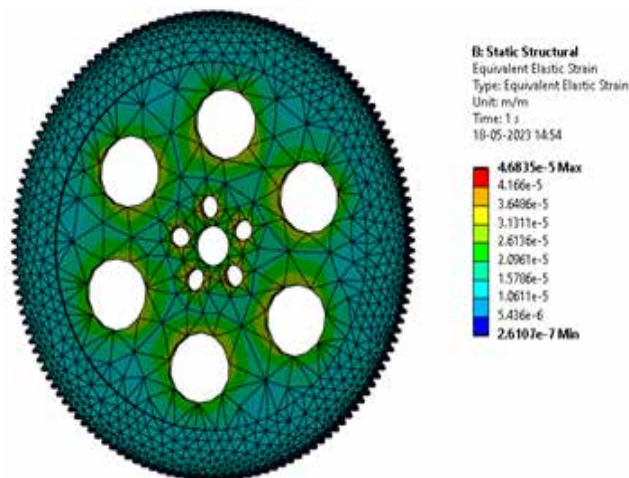


Fig. 8. Equivalent Elastic Strain of flywheel for stainless steel

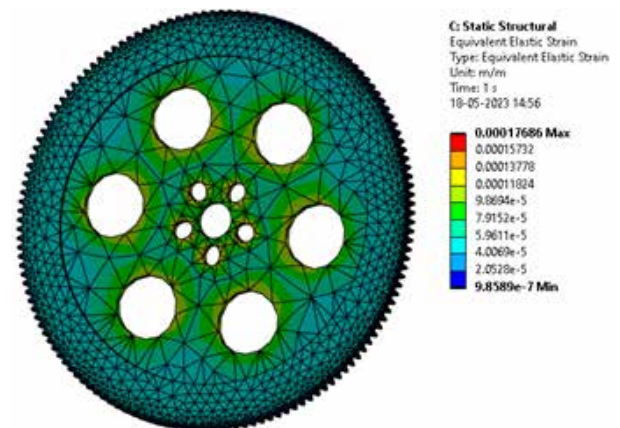


Fig. 11. Equivalent elastic strain of flywheel for grey cast iron

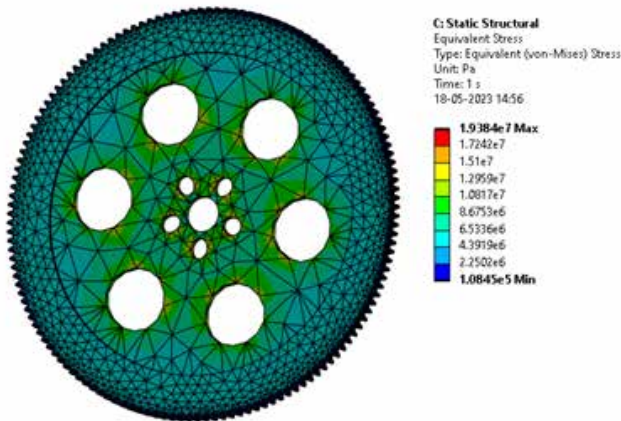


Fig. 12. Equivalent stress of flywheel for grey cast iron

Table 3. Results analysis

Sr. No.	Flywheel specifications	Normal Stress (MPa)
1.	Structural steel 100 rad/sec velocity force acting 750 N	2.3987
2.	Stainless steel 200 rad/sec velocity force acting 800N	9.5707
3.	Grey cast iron 300 rad/sec velocity force acting 850N	19.878

Structural steel with 100 rad/sec velocity and 750N force has lowest maximum normal stress of 2.3987 MPa. Grey cast iron has the maximum normal stress of 19.878MPa at a velocity of 300 rad/sec and a force acting of 850 N. Grey cast iron flywheel has highest maximum Equivalent stress of 19.878 MPa and Structural steel has lowest maximum Equivalent stress of 0.47741 MPa.

### CONCLUSION

The following conclusions were drawn on the basis of simulation results:

1. The value of different repetitions of flywheel is affected by keeping the speed of rotation of flywheel constant. Flywheel iteration 2 has a lower stress value than previous iterations.
2. Similarly, the value of the stress obtained by applying force to the shaft of the flywheels differs

from each other by the same force value. Stress concentration was significantly lower during the inertial repetition than during the other repetitions.

3. By analyzing all three flywheels, the vibration frequencies were determined. The highest frequency mode 2 deformation is quite stable, so it remains stiff and intact at higher speeds.
4. The effect of material density may become negligible below a critical velocity value. It is possible that there is a critical velocity value below which the effect of material density becomes negligibly small. With increasing diameter, stress induction increases, but disappears when the flywheel is balanced. Stress induction is increased with increasing diameter, but disappears when balancing the flywheel. A sudden increase in stress values is caused by the outer diameter of the flywheel combined with the speed at which it rotates.

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# A Review on Thermal Energy Exchanger used in Waste Energy Restoration Systems for Domestic and Industrial Applications

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## ABSTRACT

Waste heat recovery systems are an important factor in domestic and industrial areas for the nation's economy to upgrade and maintain a healthy environment. Due to use of heat exchanger society has many benefits like clean energy, cost effectiveness and reduction in fuel consumption etc. Recycling of waste heat will surely reduce energy consumption and minimize the expenses. In this paper the discrimination of various waste heat restoration systems used in domestic as well as industrial areas are mentioned, in terms of methods, upcoming models and the benefits also summarizes the lack of information which can be used for future research in hotel industry.

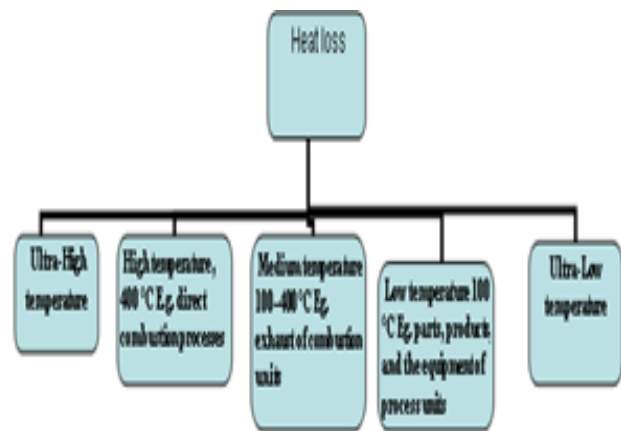
The basic objective of waste energy restoration systems is based on the objective of the Bureau of Energy Efficiency.

**KEYWORDS:** Waste energy restoration, Methods, Benefits, Models, Energy exchanger.

## INTRODUCTION

Day-to-day there is increase in the fuel prices, climate change, energy security, global warming which can be dealt by reformation and usage of thermic energy contributes to the reduction of harmful emissions. Improvement in the reformation and usage of thermic energy leads to a downsize in CO<sub>2</sub> emission which provides sustainable economy for Nation as well as Industrial and Domestic consumers. (Li et al. 2021) The effective implementation of waste energy restoration systems to utilize thermal energy that would be domestic and industrial areas are the major research domain which lowers fuel consumption. As per the BEE (Bureau of Energy efficiency) and industry ARC (analytics research consulting) India's reliance on imported oil and gas has steadily increased over the years, with self-sufficiency levels dropping from 60% in the 1950s to 30% at present, and projected to decrease further to just 8% by 2020. The statistics showed that imports accounted for approximately 92% of India's total oil demand in 2020 [37,38], highlighting the need for energy conservation measures. The Energy Conservation Act of 2001 aims to decrease the energy intensity of India and improves its economy, by focusing on integrating solar power solutions, thermal, and waste heat energy utilization.

## Waste Heat Recovery Systems



**Figure 1: Classification of Heat loss**

(Bruckner et al. 2015) has achieved maximum efficiency in waste heat recovery system by varying levels of unused heat, while the factory sector in the UK is a significant consumer, which has an accounting up to 17% of total energy consumption. UK's heat-related CO<sub>2</sub> emissions around 32% are the result of the energy utilization of the UK economy.

Figure 2 illustrates the primary applications of unused heat restoration systems, which include the following:



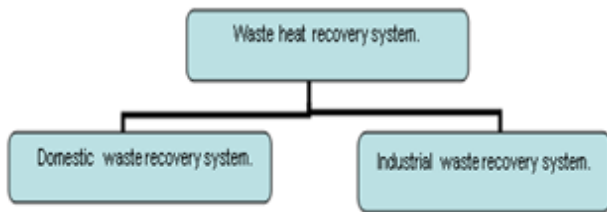


Figure 2: Waste Heat Recovery Systems

**BRIEF LITERATURE REVIEW**

Table 1: Summary of Critical Literature Review

Sr. No. & Yr	Methods & Platform	Contribution	Future scope / Limitations
[1] & 2021	Experimental /Numerical	(1) Reasonable-HT PCM and techniques used to improve thermal conductivity. (2) The study shows configurations & applications of LT Heat exchangers for energy storage used for various temperature sources for solar, unused heat from industrial processes [1].	Lack of experimental data. Application and objectives are not clear as per the use of mass/volume Fins Heat Pipes along with PCM
[18] & 2021	Experimental & Numerical With CFD simulation software	SEB delivers a thermal efficiency that is roughly 2.75% [18]	This approach is helpful to estimate the rise in thermal efficiency, which is a measure of heat conversion rate.
[19] & 2021	Experimental	An analysis was conducted on the burner-to-plate distance (H/d), which can reducing LPG stove fuel expenses for households and small businesses. [19].	To achieve maximum cooking condition, the flame length should reached the plate surface area approximately 70% of its overall length.

[20] & 2021	Experimental	The conventional burner thermal efficiency without a flame shield is only 66.27% whereas by the means of a heat shield, the maximum thermal efficiency can reach up to 74.07%. [20].	The reutilization of waste heat was not covered.
[7] & 2021	Energy balance method	This research presented an assessment of the thermal efficiencies of a boiler with the study of incomplete combustion, the heat lost due to the flue gas and water vapor. This will affect the overall energy efficiency of a system. [7].	Steam boiler's $\eta$ => DM=98.2%. IDM=93.07%. Compared to the DM, the IDM is capable of producing more accurate and precise results.
[8] & 2021	HPHE numerical model TRNSYS simulation	TRNSYS simulation was used to investigate the energy $\eta$ in ceramic industry by the applications of a HPHE. The evaluation of the energy $\eta$ shows recuperation of heat energy from the exhaust fumes of furnaces[8].	Secondary stream vaporization can be prevented even when there is an unused exhaust thermal energy.

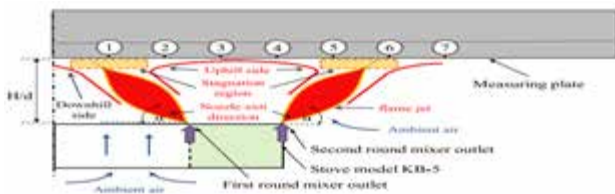
**METHODOLOGY**

**Domestic Waste Heat Recovery Systems**

(Anirut et al. 2021) The author has employed LPG burners with a swirling flow mechanism which was examined to find its impact on enhancing thermal efficiency, and a newly developed burner called swirling flame power-saving burner (SEB). Both numerical and experimental

tests were conducted on the swirling flame power-saving burner (SEB) by changing it from a conventional efficient burner (EB). The fluid flow within the SEB, featuring a swirl inclination of 15° and an inclined angle of 50°, were analyzed using computational fluid dynamics (CFD) simulations. (Makatar et al. 2021) cheking tests were performed on commonly used LPG burners in Thailand to inspect the influence of altering the distance between the burner and plate related to heat transfer from the LPG combustion flame. His study has involved varying distance from burner to cooking surface and measuring the inlet and outlet temperatures of a plate that was directly heated by the KB-5 burner, while flowing water was used for cooling, with respect to examine the heat transfer rate (Q) and flow rate of the LPG.

(Pankaj et al. 2021) has experimented the test using the IS 4246:2002 guideline, Measuring the thermal efficiency of a burner without a flame shield resulted in a value of 66.27%, which was increased to a maximum efficiency of 74.07% by implementing a flame shield resulting in a 2.1% increase in maximum temperature gain and a 3.0% increase in heat generation.



**Fig. 4: Investigating the Influence of Nozzle Oblique Angle On Flame Characteristics [19]**

(Ashraf et al. 2018) Three domestic burners were designed to produce premixed flames, with two of them utilizing the Co-axial swirl mode & the 3rd utilizing the counter swirl mode. The burners were then experimentally compared with respect to their energy efficiency and Pollutant levels.



**Figure 5: Flame shapes of (i) a no-swirl burner ( $\theta = 0^\circ$ ), (ii) a Co- axial burner( $\theta = 30^\circ$ ), and (iii) a Reverse-flow burner ( $\theta = 30^\circ$ )[23]**

**Industrial Waste Heat Recovery Systems**

(David et al.2019) has done review on five industries that generate significant amounts of waste heat in harsh environments, but are unable to utilization of waste heat recovery (WHR) equipment due to the challenges posed by their surroundings. The chosen industries that were particularly relevant to this context are as follows: 1) Fe and Fe3c 2) Al., 3) Glass, 4) Cement and 5) Lime [5]. (Jun et al. 2021) has reviewed the different papers for furnace heating and reported following methods, simulation software's. The methods are: Experimental method, energy apportionment methods, finite volume method, MFDEA based methods, Zone method, Non-linear predictive controller models [NLPCM]. The Software's are Survey tool software [PHASTS], CFD Simulation for 2D and 3D, ANSYS base Furnace model, SCADA Software. (Venturelli et al. 2021) has developed a model using TRNSYS. The invented model illustrated the exhaust thermal energy restoration pattern, with a persistent water mass, rate of flow and the temperature level. (Sapali et al. 2014) has developed experimental set up, a heat exchanger of the shell and coil with a variety designed was to retrieve the entire superheat and a significant portion of the latent heat from the refrigerant to regain the thermal loss in the condenser. The thermal energy restored in this heat exchanger was subsequently utilized for water heating purposes.



**Figure 6: The Shell and Coil Heat Exchanger was modeled using CAD [9]**

(Raffaele et al.2019) has implemented genetic algorithm, to find the optimal design of a PHE as an overhead condenser in a macro-scale thermosyphon loop for cooling a datacenter rack.

(Adrian et al. 2017) has done assessment for the balance of thermal powers in the each of the three furnace types. The Key element of the thermal energy balance were computed, including an estimate of heat energy generated by the burners, which was determined that gas burners are operating at 75% of their maximum

capacity, as determined by the flue gas rate produced by each furnace.

Recent Technologies in Waste Heat Recovery Systems (George et al.2020) has designed a model to evaluate the efficiency of a DHW LHTES system. A thermic energy container was constructed, that having a heat exchanger submerged into phase change material . (Sanjay et al.2020) has compared the performance of existing waste heat recovery technologies. (Inigo et al.2019) has implemented the following models and reported the result as: Integrating a Waste Heat Recovery System (WHRS) offers a valuable opportunity to enhance heat management, mitigate environmental impact, and lowers energy costs within a plant. Models Implemented: Integral modelling, Production modelling, Economic modelling, Energy modelling.

**RESULTS**

**Domestic Waste Heat Recovery System**

(Makatar et al. 2021) has done investigation, on impact of the distance between the burner and plate of a KB-5. Within a household LPG burner design was experimentally examined to find the optimal distance for achieving the topmost rate of heat transfer . The experimental study involved variations in the distance between the burner and plate relative to the Reynolds number to investigate their impact on the system. (Pankaj et al. 2021) has reported the results, that utilizing a gas stove burner equipped with a shield to contain and direct the flame, the efficiency was significantly improved to 74.07% compared to a burner without a flame shield which had an efficiency of 66.27%. The flame shield also resulted in a 2.11% increase in temperature gain and a 3% increase in heat generation. (Sastha et al. 2021) has designed experimental setup and a heat exchanger made of copper pipe was resting on top of a traditional gas cooktop in the household, which facilitates the transfer of heat from the flames & cooking pan, in addition with the steam from the food, through water circulating within the pipes. (Ashraf et al. 2018) has improved burner’s swirl and compared to counter and base models. This design has improved thermal efficiency, reduced emissions, and a wider operating range. Additionally, the performance of the burner was found to be impacted by the height of the pot used.

**Industrial Waste Recovery Systems**

As waste heat recovery system is used in industrial sectors has reviewed in this section, (David et al.2019) has mentioned U.S. manufacturing sector’s potential to save a significant amount of energy - up to 15.4% or 113.6 TWh - by harnessing the energy contained within exhaust gases that contain high temperatures (above 650°C) or reactive components. (Jun et al. 2021) has systematically discussed for the first time, techniques to improve combustion performance developed to save energy and has improved the measure for effective energy conversion into heat for reheating materials in factory reheating furnaces (FRFs). Recent advancements in both zone modeling and C.F.D. simulations to predict and analyze fluid behavior in various system. The system has been applied sin IRFs to further enhance their performance. [6]. (Oguzhan et al. 2021) has done study on an evaluation of the thermal balance method, as specified by ASME PTC-4, was utilized to analyze the thermal efficiency and thermal losses within a CFB boiler. (Venturelli et al. 2021) has done the assessment of the benefits from exhausts thermal restoration in ceramic ovens, this study evaluates improvement in energy efficiency. The potential application of a high-performance heat exchanger to enhance the overall efficiency of ceramic chambers and reduce their environmental consequences was also explored. (Raffaele et al.2019) has studied, an advanced thermal solution to cool high- power datacenter racks were introduced that provides enhanced thermal performance. This cooling system operates at a lower noise level when compared to conventional air-based cooling solutions.

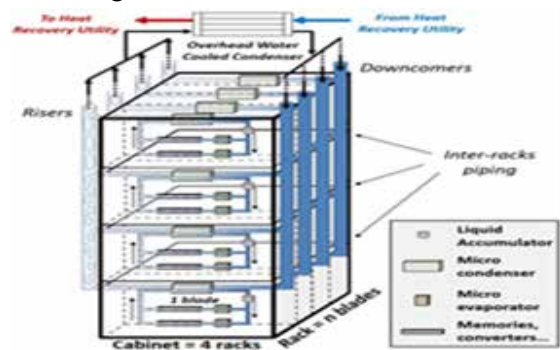


Figure 7: Basic intended cooling advancement designed for high-density server environments. [11] and Amalfi et al. [12]

(Pello et al. 2021) has done the study that examines the potential for industrial waste heat recovery, analyzing 129 companies and characterizing their respective potentials for this approach. The results are discussed and evaluated for viability. (Pantaleo et al.2017) has done a case study was conducted on a prominent coffee roasting company in Italy, which has a production capacity of 500 kg/hr. The study analyzed the company’s operations in the context of the Italian energy framework. (Adrian et al. 2017) has suggested waste heat recovery system was determined to be capable of retrieving greater than twenty five percent of the total thermal power produced by the firing mechanisms, which is equal to more than 60% of the waste that is available. Table 4 presents a summary of the characteristics and overall recovery potential for each of the analyzed solutions.

Table 4: The features of various capturing and reusing waste heat to enhance energy efficiency. [16]

Technical solution	Exhaust gas Temp. [°C]	its HR Potentia l. [kW] (%)
The process of increasing the temperature of flue by 50°C	655	55.5, (2.1%)
formation of the thermal medium is maintained at a temp, range of (90...110)°C.	120	683, (25.3%)
Steam is generated and maintained at a temp; range of (130...150)°C.	200	594, (22.0%)
the production of water with a temperature range of (7...12)°C.	150	650, (24.1%)
Electricity is produced by utilizing gases as an energy source.	300	120, (17.8%)

**Recent Technologies used in Waste Heat Recovery System**

(George et al.2020) has done experiment on dual organic PCMs system which has tested in conjunction with renewable collectors or geothermal energy pumps in a LHTES system to determine their effectiveness in

providing DHW. (Emiliano et al.2021) has presented by a bibliometric analysis, a comprehensive research was carried to evaluate the use and application of thermal energy storage (TES) in various stages in the man-made environment. (Sanjay et al.2020) has investigated technology which were involved the generation of hot water was facilitated through the utilization of regenerative organic Rankine cycles (RORC) and variable refrigerant flow (VAR) systems.” (Inigo et al.2019) has done the assessment which shown that there was a possibility of decreasing natural gas consumption rate outdated thermal treatment procedure by up to fifty five percent, resulting in roughly 300 MWh/year in savings, and a payback period of about three years. Energy savings ranging from 50% to 80% are achievable in the aging treatment process by adjusting the burners’ position, while the new waste heat recovery (WHR) that aging furnace can be powered by the system up to 63% of its energy requirement.

**DISCUSSION**

After study of various Domestic, industrial WHRS, and technologies involved in WHR Systems following significance are summarized. Use of chimney with heat exchanger installed can downsize the waste heat. Thermal efficiency, economic and environmental benefit is possible by Swirling flow and flame shield. The effect of the burner-to-plate gap, represented by H/d, and flame behavior indicates temperature peak at nozzle flame jet can utilize unused thermal energy . Both the heat from the fire to the pan and the steam generated by the food contribute to the overall cooking process. Mass flow rate in exhaust gas of engine is the key factor for reusing the waste heat. Different combinations of port angles of burners with pan support can optimize thermal efficiency which decline the waste heat. Large waste energy saving potential is exist in harsh environmental industries like steel, glass, and aluminum. Models like industrial reheating furnaces (IRF) helps to improve thermal efficiency by utilization of WH. One can have more precise results with energy balance method for circulating fluidized bed boiler to improve thermal efficiency of boiler with deduction in thermal losses. Significantly thermal efficiency can be enhanced in ceramic industry with the help of hot pipe heat exchanger (HPHE), Proper utilization of



refrigerant through tubes in shell side of data center can recover waste heat. Intermittent waste heat recovery can be done with ORC attached with thermal Storage buffer with rise in terms of profit. Utilization of waste heat to preheat the air entering in industrial stove increases the thermal efficiency (TES) associated with buildings. Preheating of combustion air by ovens exhaust gases will enhance the thermal efficiency with reduction of CO<sub>2</sub> emission to atmosphere. Burner position in ageing furnace is key factor. The waste heat recovery system is an integral component of the heat treatment unit.

## CONCLUSION

Both industrial and domestic sectors can benefit from the implementation of a unused thermal energy restoring system which has huge potential to utilize the stored energy in the heat treatment plants like boiler, steel industry, foundries, furnaces, burners, LPG cooking stove by implementation of production model, energy model, Integral model, and the simulation model. Waste heat recovery system also has scope in hotel industry for environmental benefits. Such as its downsizes the CO<sub>2</sub> and NO<sub>x</sub> emission which enhances green energy and helps to provide sustainable solution to end user. The storage of waste heat can be done with energy storing system with latest technologies as like plate heat exchanger, hot pipe heat exchanger, PCM etc. from the review of industrial and domestic area waste heat can be reused up to 60% to 80% by modification attachment of the heat exchangers hence it has scope for improvement in waste heat recovery system.

## RECOMMENDATIONS

After the study of different Domestic and Industrial unused thermal restoration system and technologies implicated can lead to the following recommendations:

1. eat exchanger used in chimney downsizes the waste thermal energy.
2. mprovement in thermal efficiency, financial benefits of nation and healthy environment can be maintained by using swelling flow and flame shield at burner.
3. The waste thermal energy can be utilized by changing burner to plate gap and increasing flame contact time.

4. Thermal efficiency can be optimized by utilizing various combo of port angle of burner with pan support.
5. The thermal efficiency in industrial sector can be improved Industrial reheating furnace(IRF) models.

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# Production of Biogas from Spent Wash

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## ABSTRACT

It can take millions of years for deceased organisms to transform into fuels, and the prolonged consumption of these resources is a significant concern due to their rapid depletion. Bio-CNG is a refined type of biogas that undergoes a process of eliminating unwanted gases to produce a methane gas that is 95% pure. Essentially, Bio-CNG is identical to commercially available natural gas. In India, we have insufficient fuel resources, and as a result, we rely on countries that are abundant in fuel resources. Nowadays, there is an urgent need to find an alternative to fossil fuels as they are becoming increasingly scarce. Therefore, it is crucial to discover alternative sources of energy. The production of alcohol generates a byproduct known as Distillery Spent-Wash (DSW), basically the waste water which is considered undesirable. This waste has become a significant environmental concern due to the pollution it causes. Although regulations exist to control the quality of effluent, unprocessed or partially processed waste is frequently released into waterways. The distinct unpleasant smell of DSW give rise to a crisis regarding the quality of water in many areas worldwide. The wastewater produced during the distillation process consists a substantial quantity of organic resources that needs to be treated to meet the environmental authorities' prescribed standards for COD and BOD levels. This study aims to treat the organic wastewater, also known as spent wash, using closed anaerobic reactors to recover biogas that is rich in methane. The methane produced can be utilized as a fuel source. In order to produce biogas from the distillery spent wash, the waste is subjected to anaerobic fermentation in a digester for around 30-40 days at ambient temperature. The resulting biogas can be further refined by removing hydrogen sulphide and carbon dioxide to achieve a methane content of more than 90-95%, depending on the amount of spent wash utilized in the digester. The purified product can be used as Bio-CNG.

**KEYWORDS:** *Biogas, Spent wash, Methane, Anaerobic digestion, Bio-CNG, Sugar industry, ORSAT apparatus.*

## INTRODUCTION

Today, managing waste is amongst the most pressing sustainable challenges confronted by the whole world. Various industries generate a wide range of liquid waste effluents which are challenging and expensive to handle. The use of industrial waste as a soil amendment has garnered interest in recent times. The main aim of managing waste disposal is the reduction of the adverse consequences of wastage on both wellness of human beings as well as the wellness of environment and improve the quality of life.

Different types of waste require different methods of treatment such as incineration, landfilling, composting, or recycling to reduce their volume and negative impact. Safe disposal of waste is important to prevent contamination and minimize health risks. Proper disposal methods include landfilling, incineration, or other secure containment. Waste management involves waste reduction, responsible disposal, and continuous improvement of waste management practices and infrastructure. Effective waste management requires collaboration among individuals, businesses, and governments to reduce waste and adopt sustainable

practices. Improper disposal of waste can have harmful effects on both wellness of human beings as well as the wellness of environment. When wastewater is not disposed of properly, it can contaminate soil, air, and water, leading to pollution and potential health risks. Hazardous waste, if not disposed of correctly, can cause soil and water contamination, resulting in long-lasting damage to the environment and human health. Additionally, burning or incinerating waste can emit toxic chemicals into the air, leading to respiratory problems and other health issues. Proper waste management practices must be implemented to prevent these harmful effects on both wellness of human beings as well as the wellness of environment. This includes secure disposal methods and regular monitoring of waste disposal sites. By taking responsible actions, we can minimize the harmful impact of waste on our environment and protect ourselves and future generations.

Waste can be an important resource that offers both economic and environmental advantages by reducing the need for new materials. Recycling is one of the most popular methods to repurpose waste, which involves converting waste materials into new products. For instance, distillery spent wash generated during alcohol production in Sugar Industries can be used to create biogas, NPK fertilizers, and activated carbon using a process known as Anaerobic Digestion. This waste-to-resource technique allows for valuable components and byproducts to be extracted from distillery spent wash, which would otherwise be disposed of as waste. By adopting innovative approaches to waste management, we can create a more sustainable future while reducing the impact of waste on the environment.

The manufacturing of Ethyl Alcohol in an industrial plant that rely on sugarcane syrup is a significant industrial plan in parts of South America and Asia. The global annual production of alcohol from sugarcane molasses is estimated to be over 13 million cubic meters. As of 2021, a report stated that total capacity of located biogas producing plants in India is around 5875 MW, and the sugar industry contributes approximately 2133 MW, which accounts for roughly 36% of the total biogas capacity in the country by MNRE (Ministry of New and Renewable Energy).

DSW is a extremely organic and dark brown waste that

is generated in large volumes, around 12 to up to 15 times the volume of the product alcohol. Disposing of it is a major concern due to its high levels of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Nonetheless, it's a promising origin of clean energy due to its organic content. The absence of toxic heavy metals in the waste, as it is derived from plant materials, makes it rich in essential nutrients, including nitrogen, phosphorous, potassium, sulfur, and numerous micronutrients. By applying distillery spent wash directly to the land, water pollution control can be achieved, and it can be utilized as an effective fertilizer for agricultural production. Its application can help restore and maintain soil fertility, enhance soil microflora, improve soil physical and chemical properties, and increase water retention capacity, making it ideal for growing crops such as sugarcane, maize, wheat, and rape seed. Additionally, it has been observed that the wastewater generated from various industries could provide irrigation for crops grown continuously. Consequently, distillery spent wash is not only an eco-friendly way to dispose of waste but also a valuable source of fertilizer for agricultural purposes.

This study aims to treat the organic wastewater, also known as spent wash, using closed anaerobic reactors to recover biogas that is rich in methane. The methane produced can be utilized as a fuel source. In order to produce biogas from the distillery spent wash, the waste is subjected to anaerobic fermentation in a digester for around 30-40 days at ambient temperature. The resulting biogas can be further refined by removing hydrogen sulphide and carbon dioxide to achieve a methane content of more than 90-95%, depending on the amount of spent wash utilized in the digester. The purified product can be used as Bio-CNG.

## LITERATURE REVIEW

The world's population growth has ushered to an increased order for supplies, which in succession has lead to a swift industrialization. But it has had major environmental outcome due to the contamination of water, air and soil which is direct result of increment in production on industrial level generating industrial waste. Today, one of the major waste management problem is the concern faced by humans. Different industries produce various types of wastewater pollutants, and

that can lead to costly treatment. There is growing interest in using industrial waste as soil amendmets. The type of industry affects the quality and quantity of the generated wastewater. Also it can contain a large amount of contaminants including non-biodegradable waste for example plastic, heavy metals, pesticides and biodegradable compounds such as paper, wool, leather. Wastewater on an industrial level can be very dangerous and toxic to handle, reactive and may pose a significant risk to the environment if not properly managed. To summarize, the rapid industrialization caused by the increased demand for goods due to population growth has ushered the production of industrial wastes that has been leading to a significant environmental and health risks if not treated and managed properly. Some of the demerits include failure in reproductive, suppression to immune system, acute poisoning due to the toxicity of wastewater on industrial level, leading to waterborne diseases. The use of industrial waste as soil amendment has gained interest as a potential solution to manage these wastes. Table no. 01 compares the results achieved from different raw materials in terms of energy saved, amount of biogas obtained, H<sub>2</sub>S % obtained, process used, and methane % from different raw materials. The alcohol distilleries stands amongst most polluting industries in India based on molasses. Along with BOD and COD, large volumes of wastewater is generated in these distilleries, which has made them to be listed by the Ministry of Environment & Forests as industries with high pollution potential.

Ethanol distilleries produce Distillery Spent Wash (DSW) in a very big amount of wastewater. It is also known as or Vinasse, which is undesirable due to its high levels of COD and BOD. The distillery industry faces a major challenge to dispose of DSW sustainably and efficiently, which requires scientific, engineering, economic and environmental solutions. Pollution caused by the generation of distillery spent wash is one of the most critical environmental issues. We should take this into account that the untreated or partially treated effluent often contaminates watercourses which not properly work may despite the efforts taken to maintain effluent quality standards. In several parts and region around the globe and world, the water quality is in serious threat posed by the characteristic unpleasant odor of distillery wastewater. For processing effluent economically and efficiently which has resulted in the increment due to the generation of distillery spent wash and stringent legislative regulations on its disposal have stimulated the need for new technologies. Nowadays spent wash are being developed for the treatment of distillery various clean-up technologies are already in use. For the purpose of combating environmental pollution so feasible remediation technologies are being explored such as Potential microbial (anaerobic and aerobic) and physicochemical processes. To manufacture various high-value compounds there's one emerging field in distillery waste management which is exploiting its nutritive potential. For the pollution problems we today face because of distillery spent wash, this paper is an outlook providing a deep dive into the global technologies employed for its treatment, different usage in several sectors specially biotechnological.

Raw Material	Process	Energy Saved	Amount of biogas obtained (per tonne)	H <sub>2</sub> S %	Methane %	References
Spent Wash	Anaerobic Digestion (AD)	70% - 90%	300 - 350 m <sup>3</sup> /1000 litres	0.1% - 0.2%	45% - 75%	[5]
Cow Dung	Anaerobic Digestion (AD)	25% - 50%	0.02 - 0.03 cubic meters	0.02% - 0.15%	50% - 70%	[20]
Agricultural Waste	Methanogenesis	20% - 70%	100 - 500 m <sup>3</sup> /tonne	0.01%	21%	[21]
Sewage Sludge	Anaerobic Digestion (AD)	10%	140 - 168 m <sup>3</sup> /metric tonne	0 - 1%	55% - 75%	[22]
Landfill Gas	Anaerobic Biodegradation	50% - 90%	50 cubic meters	<1%	70%	[23]
Food Waste	Anaerobic Digestion (AD)	40% - 80%	0.5 - 0.6 m <sup>3</sup> /kg	3%	74.5%	[24]
Bagasse	Digestate Valorisation	38% - 40%	200 - 400 m <sup>3</sup> /metric tonne	Trace amount	55% - 65%	[25]
Animal Manure	Anaerobic Fermentation	0.35 \$/m <sup>3</sup> energy cost is saved	25 - 35 cubic meters	0.5% - 0.05% by volume	62%	[26]
Energy Crops	UASB Anaerobic Digestion (AD)	96%	200 - 500 cubic meters	0.1% - 1%	50% - 70%	[27]
Food Waste	Anaerobic Digestion	60% - 80%	400 - 800 cubic meters	0.5% - 2%	60% - 70%	[28]
Grass/Leaves	Co-Digestion, AD	Avg. 50%	200 - 400 cubic meters	0.1% - 2%	50% - 70%	[29]
Cattle Slurry	Anaerobic Co-Digestion	Avg. 65%	35 - 50 cubic meters	<1%	64.4%	[30]
Dairy Sludge	Anaerobic Co-Digestion	50% - 80%	250 - 400 cubic meters	0.1% - 2%	Avg. 50%	[30]
Municipal Organic Waste	Anaerobic Digestion (AD)	Avg. 65%	150 - 200 cubic meters	1% - 3%	0.4%	[31]

Table 1. Comparison of results achieved from different Raw Materials

Raw Material	Process	Amount of biogas obtained (per tonne)	Methane %	Reference
Spent Wash	Anaerobic Digestion (AD)	71.68 litres	69.6%-77.6%	[5]
Spent Wash	Biometration, Anaerobic Digestion (AD)	0.02 - 0.03 cubic meters	50%-70%	[1]
Spent Wash	Anaerobic Digestion (AD)	1000/tonne	60%	[11]
Spent Wash	UASB	2500 ml/day	57%	[6]
Spent Wash	Anaerobic Biodegradation	7.2 m <sup>3</sup> /day	70%	[4]
Spent Wash	Anaerobic Digestion (AD)	20.34 million m <sup>3</sup> /year	58%-61%	[13]
Spent Wash	Anaerobic Digestion (AD)	6.55 m <sup>3</sup> /metric tonne	50%-70%	[14]

Table 2. Experimental Results of biogas production from spent wash from various studies



This study made an effort in investigating the anaerobic spent wash to produce a detailed analysis of multiple aspects, from the distillery and for this research a CSTR(Continuous Stirred Tank Reactor) was used in the laboratory. After there was an effective startup and continuous increase in the OLR(Organic Loading Rate), the performance of CSTR was analyzed. At an OLR of 1.0 g of Chemical Oxygen Demand (COD)/L, the maximum methane gas (CH<sub>4</sub>) produced was observed, which was 71.68 ml. The CSTR showed an optimal COD removal efficiency of 91%, corresponding to an OLR of 1 g of COD/L. The process showed maximum stability when the pH ranged from 7.1 to 7.3. Increasing the OLR led to an increase in the content of Volatile Fatty Acids (VFA), which reached up to 1.5 g COD/L. Nonetheless, the removal efficiency of Total Solids (TS) increased at an accelerated rate of OLR.

Up-flow anaerobic sludge blanket or the USAB technique has proved to be one of the effective methods employed for the treatment of distillery wastewater. In the late seventies is when in Netherlands this process was developed. It was introduced in India during the late eighties as part of the Ganga Action Plan (GAP) when there was a pressing need for a cost-effective and appropriate technology due to the perceived unaffordability of conventional aerobic technology-based Sewage Treatment Plants (STPs). At that time, the UASB technology was still in its developmental phase, but it was considered to be a viable alternative due to its affordability and potential for resource recovery.

On a more bigger or huge scale with the aim of treating distillery effluent may techniques such as physico-chemical method and the UASB reactor are adopted. In the case of when the COD/BOD ratio seems to be bigger than 1.5 biological treatment would be more suitable for treating distillery spent wash. Energy will be taken out or extracted from the waste constituents because of the absence of oxygen, biological processes take place. But this method is very sensitive to organic shocks, which is due to the lesser pH of spent wash and rate of anaerobic microorganisms is slowed. This method requires more hydraulic retention time (HRT). This might also need lead to poor performance, but nowadays for the process of disintegrating effluent and produce biogas as these anaerobic methods are

efficient enough. Hence, anaerobic methods may have poor performance. If we talk about on a large scale or industry level, the most common and older method to is this anaerobic method. But is fair to discuss the demerits and multiple drawbacks which includes increment in the risk of contamination in groundwater, producing smell nuisance and requirement of a large area.

While anaerobic treatment has some drawbacks, such as being sensitive to organic shock loadings, it is still an efficient method for treating distillery effluent and producing biogas. In fact, the anaerobic process has high capability for decomposition and requires less power compared to other treatment methods. Additionally, it is advantageous because it produces methane gas that can be used for steam production in boilers. However, this method requires a longer hydraulic retention time (HRT) and the microorganisms involved in the process have a delayed growth rate in the low pH of spent wash. Another commonly used method, the anaerobic lagoon or digester, has its own set of disadvantages, such as requiring a large area and potentially causing smell nuisance and ground water contamination. Overall, anaerobic treatment is still widely adopted for distillery effluent treatment due to its efficiency and ability to produce biogas.

Anaerobic digestion is a biological gasification process that converts organic matter into biogas, which is primarily composed of methane and carbon dioxide. It is a widely used process for the treatment of various types of organic waste including agricultural waste, food waste, and sewage sludge. The process involves the breakdown of organic matter by microorganisms in the absence of oxygen, and the biogas produced can be used for heating, electricity generation, or transportation fuel. Anaerobic digestion has several environmental benefits compared to fossil fuel-derived energy sources. The production of biogas through anaerobic digestion reduces greenhouse gas emissions by avoiding methane emissions from decomposing organic matter and by replacing fossil fuels. Additionally, the anaerobic digestion process can reduce the amount of organic waste sent to landfills, which reduces methane emissions from landfills and helps to minimize landfill space requirements. The economic viability of anaerobic digestion is highly dependent on the availability and

cost of feedstock, as well as the cost of the technology used for biogas production. However, in recent years, the increasing demand for renewable energy and the implementation of policies and incentives to promote the use of biomass energy have made anaerobic digestion a more cost-competitive option. The use of biogas as a fuel also has the potential to provide additional revenue streams, such as through the sale of electricity or by using biogas to fuel vehicles. Overall, anaerobic digestion has significant potential as a sustainable and cost-effective method for producing renewable energy from organic waste. With continued advancements in technology and policy support, anaerobic digestion could play an important role in reducing greenhouse gas emissions and transitioning towards a more sustainable energy future

## METHODOLOGY/EXPERIMENTAL

### Study Area

The Shriram Sahakari Sugar Industry Limited is one of the oldest sugar industries situated in Phaltan, Satara district in Maharashtra, India. The industry was built in the year 1981 and has been running ever since and the production of biogas from distillery officially began from around 2010 and have been generating biogas and using it as a boiler fuel ever since. We went there and did a case study on overall processing and production sugar and its waste.



**Fig. 1: Spent wash collected from Distillery**

### Feed

The distillery spent wash of about 4 liters were collected with pre-maintained pH-7 from the Shriram Sugar industry and taken as feed.



**Fig. 2: Mixture of collected sample of spent wash and culture.**

### Culture

One liter of cow dung was taken as culture sample from village farm which contain the required methane generating bacteria – methanobacterium formicicum, methane-coccus vannielli, methanosarcina barkeri and various other bacteria which help break down the feed.

### Anaerobic Digestion

This process is basically the conversion of complex natural and biological wastes into methane, which is a major source of energy. This conversion takes place through a biochemical process that occurs in sequential stages.

Stage 1: The primary role of hydrolytic bacteria is to break down complex organic waste streams into simpler forms such as Monosaccharides, oils and fats, and amino acids. This stage of the process is called hydrolysis or liquefaction, and it involves the process of breaking down complex organic biological molecules into simpler forms.

Stage 2: During the anaerobic digestion, fermented acidogenic microbes are responsible for converting the hydrolyzed portion of natural wastage into natural acids.

Stage 3: After converting the hydrolyzed portion of organic waste into natural acids, the fermented acidogenic microbes then transform these natural acids into acetic acid ( $\text{CH}_3\text{COOH}$ ), and carbon dioxide ( $\text{CO}_2$ ).

Stage 4: In the acquisition stage of AD (Anaerobic-

Digestion), the methane-producing microbes, also known as methanogens, convert acetate or a combination of carbon dioxide and hydrogen into biogas. This biogas is then produced simultaneously by the methanogens.

### Apparatus Design

A 10-liters can made of HDPE, with an air tight lid was chosen to be the preferred digester for this experimental research a transparent tube was attached to the lid with the help of a permanent binder cautiously keeping the system completely air tight with one end inside the can and other was attached with a good material quality latex balloon as our gas holder.



**Fig. 3: Designed Apparatus with Feed (Day -1).**

### Experimental Procedure

The collected sample of distillery spent wash and the cow dung culture with the ratio of 4:1 was fed in the digester can and shut tight making sure of avoiding any leakages of either fluid or gas with a balloon securely attached to the end of the tube making the system completely anaerobic. The system apparatus was then stored in a safe place at room temperature away from direct sunlight.

The experimental setup was checked every 5 days interval of time, for the first 12 days no bloating of the balloon was observed hence the biogas was not being generated and the feed was still under the breakdown process. At day 20 the first signs of biogas were observed as the balloon were expanded with expected volume of biogas. The volume of biogas was observed to gradually increase over the next 10 days, with measurements taken every 5 days.



**Fig. 4: Noticeable amount of biogas finally observed at Day 20**

Finally at day 35 sufficient amount of biogas was generated and the balloon was disconnected from the system and stored with precaution, safely with no loss of biogas for further analysis.



**Fig. 5: Sufficient amount of Biogas generated at Day 35.**

The analysis of produced biogas was performed using ORSAT apparatus, where the balloon outlet was attached to the inlet of apparatus, 1N of 100mL KOH solution was taken as the absorbent which absorbs the major effluent  $\text{CO}_2$  and trace amounts of  $\text{SO}_2$  from the biogas and from the pressure difference and by leveling the water, we were able to estimate the methane content purity in the extracted biogas.



Fig. 6: The ORSAT Apparatus

## RESULTS AND DISCUSSION

This project results in a successful production of biogas from the distillery spent wash (DSW). The DSW was taken from sugar industry was about 4 liters. A 10-liter HDPE can be used as a digester. Spent wash and cow dung which is used as a culture for fermentation process were put into tank at ratio of 4:1, one output of the pipe is connected at the top of can and balloon is attached at the end of pipe for collecting produced gas.

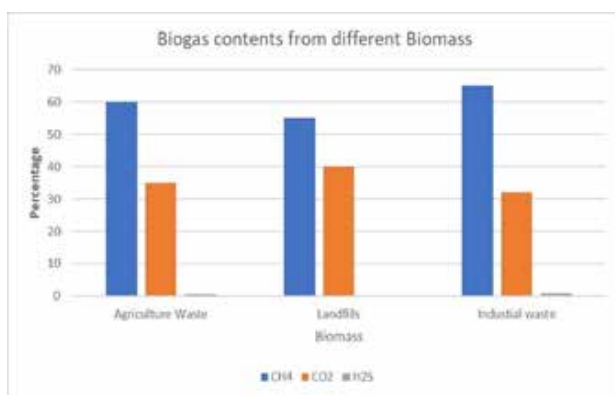


Fig. 7: Comparison of gas composition obtained from different types of waste.

The complex biological and organic were broken down into simple organic compounds, by the method of acidogenesis it was converted into fatty acids and  $H_2$ ,  $CO_2$ , Acetate were obtained by acetogenesis and finally  $CH_4$  and  $CO_2$  was generated by methanogenesis process. The gas was obtained after around 15-20 days, small amount of gas was observed in the balloon, the volume inside the balloon increased along with the number of passing days. At 35 days of the initial feed, sufficient amount of gas was collected in balloon, further it was

analysed using ORSAT apparatus in which the absorbent was a 1N 100 mL KOH solution which absorbed  $CO_2$ ,  $SO_2$  and the remaining gas gave the pressure difference and the purity as 65% which concludes the result of the methane purity obtained from the gas. Remaining 35 % contents amount of  $H_2S$  and small traces of  $N_2$ ,  $H_2$ ,  $H_2O$  etc.

From a study and comparison, the composition of biogas varies along with the type of waste, this graph shows us that the content of the methane component was found maximum in the gas composition obtained from Industrial waste such as spent wash with a bit high content of Hydrogen Sulfide than in agricultural and landfill biomass waste. This comparison results that biogas produced from spent wash is more producible than from any other kind of biogas production methods and holds a good significance in Industries.

## CONCLUSION

Industrial wastewater management is amongst the most remarkable environmental problems confronted by the world today. Anaerobic digestion has proven to be the most appropriate approach for treating high-strength organic effluents. The current study reviews the existing status of anaerobic technology for the handling, processing and disposal of Distillery Spent Wash (DSW) in our country. Converting chemical oxygen demand (COD) into biogas through bio-methanation appears to be a practical and effective solution.

Under mesophilic conditions, spent wash has been found to be a highly potential source of biogas production in batch digesters. With the help of culture spent wash gives us a sufficient amount of bio gas. This biogas can be collected and analysed to find the contents of biogas. We got up to 65% of methane and  $CO_2$  and  $H_2S$  is also present in large amounts in biogas. So, we have to remove it to increase the methane content up to 95%. At the last 95% methane containing gas is compressed and used as CNG gas as a fuel.

## FUTURE SCOPE

Potential for development for this project is to conduct a more precise analysis of the composition of biogas using Gas Chromatography. After analysis we would remove  $H_2S$  and  $CO_2$  content using  $H_2S$  And  $CO_2$  scrubber and purify the gas and try to achieve 99%



pure methane. Further pure methane can be compressed using various technology. After compression is done, we get this gas as a Bio-CNG which will be further useful for domestic and commercial use. CNG can replace traditional fuels such as gasoline, diesel fuel, and Liquefied Petroleum Gas (LPG) due to its ability to produce fewer undesirable gases when combusted. Its use can significantly reduce harmful vehicular exhaust emissions, such as carbon dioxide, carbon monoxide, and other suspended particles. CNG is also a more cost-effective fuel compared to petrol and diesel. For instance, if a vehicle consumes an average of 8 liters of petrol per 100 kilometers, converting it to LPG would increase consumption to around 10 liters per 100 kilometers. However, if converted to CNG, consumption would be approximately 55-100 kg of methane, resulting in significant cost savings.

Another Future scope of this project suggests that after the removal of Biogas from Spent wash the remaining sludge rich in content of potash and NPK contents can be used to further process it as useful agricultural fertilizer which would be beneficial to both industries and farmer.

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# Zero Energy Building : A Future of Construction Industry

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## ABSTRACT

Zero energy buildings (ZEBs) are becoming increasingly popular in the construction industry as a way to address energy consumption and environmental impact. ZEBs are designed to produce as much energy as they consume, typically through a combination of energy-efficient design, the integration of renewable energy sources such as solar panels and wind turbines, or geothermal systems. ZEBs offer a range of benefits, including reduce energy costs, reduce greenhouse gas emissions, and improve the comfort and health of residents. As such, they are increasingly seen as a promising solution for achieving sustainability and energy efficiency in the construction industry.

The adoption of ZEBs is expected to increase in the future as advances in technology make them more accessible and cost-effective. Governments, utilities, and private industry are investing in research and develop to increase the productivity and accessibility of ZEBs. Furthermore, policies such as building codes, incentives, and standards are being developed to encourage the construction of ZEBs.

However, the implementation of ZEBs can still face challenges, including higher upfront costs, technical complexity, and the need for specialized expertise. Nevertheless, with continued advancements in technology and increasing public awareness of the benefits of sustainable building, ZEBs are likely to become a prominent feature in the future of construction.

In summary, Zero Energy Buildings offer a promising future for the construction industry, providing a sustainable, cost-effective, and environmentally friendly alternative to traditional building methods. As such, they can play an important role in shaping the future of the industry, driving innovation and progress towards a more sustainable future.

**KEYWORDS:** *Zero energy buildings, Energy-efficient, Designs building codes, Sustainability innovation progress.*

## INTRODUCTION

A zero energy building (ZEB) is a type of sustainable building that produces as much energy as it consumes each year. ZEBs use a combination of energy-efficient design and renewable energy systems, such as solar panels, wind turbines or geothermal systems, to achieve a net-zero energy state. The design of a ZEB typically incorporates features such as high-performance insulation, energy-efficient windows and doors, efficient lighting and HVAC systems, and smart controls and monitoring systems. By reducing the amount of energy required to operate

the building, the remaining energy demand can be met using on-site renewable energy sources. The benefits of ZEB are not limited to reducing energy consumption and greenhouse gas emissions. It can also improve indoor air quality, create a healthier and more comfortable environment for residents, and even increase property values. The adoption of ZEBs is growing globally due to concerns about climate change and the need for more sustainable buildings.

However, the implementation of ZEBs can still face challenges, including higher upfront costs, technical complexity, and regulatory barriers. Nevertheless, with

continued advancements in technology and increasing public awareness of the benefits of sustainable building, ZEBs are likely to consider a significant role in the future of a construction industry.



Fig. 1. Zero Energy Consumption Structure

### ADVANTAGES

1. Lower Energy Costs: ZEBs are designed to produce as much energy as they consume, which can significantly reduce energy costs for building owners and occupants.
2. Reduced Environmental Impact: ZEBs produce clean energy and reduce greenhouse gas emissions, which can help reduce the environmental impact of buildings and contribute to a more sustainable future.
3. Improved Occupant Comfort and Health: ZEBs are designed to optimize indoor air quality, thermal comfort, and natural lighting, which can improve the health and well-being of building occupants.
4. Enhanced Resilience: ZEBs are designed to be more resilient to power outages and other disruptions in the energy supply, which can be particularly important in emergency situations.
5. Potential Revenue Generation: ZEBs can generate revenue through the sale of excess energy back to the grid, which can help to offset the higher upfront costs of building a ZEB.
6. Improved Marketability: ZEBs can be marketed as environmentally friendly and energy-efficient, which can make them more attractive to potential tenants, buyers, and investors.
7. Increased Innovation: ZEBs require new and innovative design and construction practices,

which can drive innovation and progress in the construction industry as a whole.

Overall, Zero Energy Buildings offer a range of advantages related to energy efficiency, environmental impact, occupant health and comfort, resilience, revenue generation, marketability, and innovation. These benefits make ZEBs a promising solution for achieving sustainability and energy efficiency in the construction industry.

### DISADVANTAGES

1. Higher Upfront Costs: The construction of ZEBs can require higher upfront costs compared to conventional buildings due to the additional technology and materials required for energy efficiency and renewable energy generation.
2. Technical Complexity: The design and construction of ZEBs can be technically complex, requiring specialized expertise and advanced building systems that can be challenging to install and maintain.
3. Limited Availability of Renewable Energy Sources: The availability of renewable energy sources such as solar, wind or geothermal can vary depending on the location of the building, which can limit the ability to generate enough energy to achieve clean energy consumption.
4. Climate and Weather Dependence: The ability of ZEBs to generate energy from renewable sources is dependent on climate and weather conditions, which can fluctuate and affect the building's energy performance.
5. Maintenance and Operating Costs: ZEBs require regular maintenance and may have higher operating costs associated with the complex building systems and renewable energy generation technologies.
6. Building Performance Uncertainty: The actual energy performance of ZEBs can be uncertain and may vary depending on occupant behaviour, maintenance practices, and weather conditions.
7. Limited Awareness and Support: ZEBs are a relatively new concept, and there may be limited awareness and support for their adoption among building owners, developers, and policymakers.

## DESIGN AND CONSTRUCTION

Designing and constructing Zero Energy Buildings (ZEBs) requires specialized knowledge and expertise in energy efficiency, renewable energy, and building systems. Here are some key considerations in the design and construction of ZEBs:

- **Energy-Efficient Building Envelope:** A ZEB must have a well-designed and insulated building envelope to minimize energy loss and maintain a consistent temperature inside the building.
- **High-Efficiency HVAC Systems:** ZEBs typically require high-efficiency heating, ventilation, and air conditioning (HVAC) systems to maintain comfortable indoor temperatures while reducing energy consumption.
- **Renewable Energy Generation:** ZEBs must produce enough renewable energy to offset the building's energy consumption. Renewable energy sources generally include solar photovoltaic (PV) panels, wind turbines, and geothermal heat pumps.
- **Energy Storage Systems:** ZEBs may require energy storage systems such as batteries or thermal energy to provide a continuous power supply.
- **Building Automation and Controls:** ZEBs often use advanced building automation systems and controls to optimize energy use, monitor building performance, and respond to changing conditions.
- **Life-Cycle Cost Analysis:** The design and construction of a ZEB should consider the long-term costs and benefits of the building's energy efficiency and renewable energy systems, including maintenance and operating costs

**Building Codes and Standards:** Building codes and standards may require specific energy efficiency and renewable energy measures for ZEBs, and compliance with these regulations is essential in the design and construction. Overall, designing and constructing a ZEB requires a holistic approach that integrates energy efficiency and renewable energy measures into every aspect of the building's design and construction. With careful planning and implementation, ZEBs can offer a range of benefits in terms of energy efficiency, environmental

impact, and occupant comfort and health construction of ZEBs.

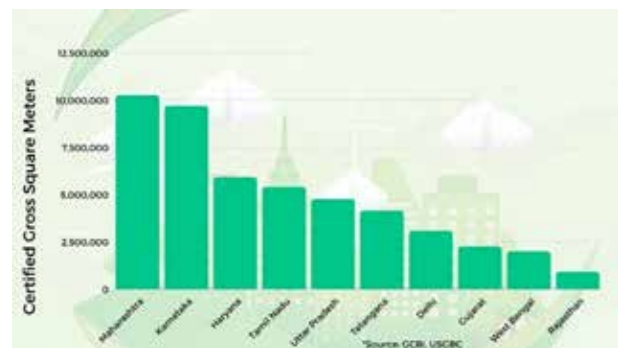


Fig. 2. Zero Energy Buildings In Various States Of India

## CERTIFICATIONS

Certifications play a crucial role in recognizing and validating the sustainability and energy efficiency achievements of Zero Energy Buildings (ZEBs). Here are some of the certifications that ZEBs can attain:

- LEED (A Leadership in Energy and Environmental Design) platinum certification:** This certification is awarded by A USA Green and Buildings Council (USGBC) to buildings that demonstrate exceptional levels of sustainability, energy efficiency, and environmental performance. The LEED Platinum Certification is the highest level of LEED certification and is considered a global standard for sustainable building design and construction.
- Living Building Challenge Certification:** This certification is awarded by the International Living Future Institute (ILFI) to buildings that demonstrate exceptional levels of sustainability, energy efficiency, and environmental performance. The Living Building Challenge Certification is considered the most stringent green building certification in the world, and it requires buildings to be net-zero energy, water, and waste.
- Net Zero Energy Building Certification:** This certification is awarded by organizations such as the US Department of Energy and the International Living Future Institute to buildings that produce as much energy as they consume every year. A net zero energy building Certification is a significant achievement for ZEBs, as it demonstrates their



ability to produce clean energy and reduce their environmental impact.

- d) **GRIHA (Green Rating for Integrated Habitat Assessment) Certification:** This certification is awarded by the GRIHA Council in India to buildings that demonstrate exceptional levels of sustainability, energy efficiency, and environmental performance. The GRIHA Certification is considered a national standard for sustainable building design and construction in India.

These certifications not only validate the performance of ZEBs but also provide a benchmark for other buildings to aspire to. By pursuing these certifications, ZEBs can demonstrate their commitment to sustainability and inspire others to follow suit.



**Fig. 3. Certification Of Zero Energy Building**

## RESEARCH

### Case Study On A Zero Energy Building (ZEB) In India

#### Indira Paryavaran Bhawan

The Indira Paryavaran Bhawan, located in New Delhi, is a six-story, 32,000-square-meter commercial office building that is designed to be a ZEB. The building was completed in 2014 and has since become a model for sustainable, energy-efficient construction in India.

Design features of the Indira Paryavaran Bhawan include:

- i. **Energy-Efficient Buildings Envelopes:** The building envelopes which is designed are highly insulated, with double-glazed windows and shading devices to minimize heat gain and loss.
- ii. **Renewable Energy Generation:** The building has a 930 kW solar PV system installed on the rooftop and façade, which provides all of the building's electricity needs, with excess energy fed back into the grid.

- iii. **High-Efficiency HVAC Systems:** The building uses a chilled beam system for cooling, which is designed to be more energy-efficient than traditional air conditioning systems.
- iv. **Energy Storage Systems:** The building has a thermal energy storage system to use the excess energy produced during the day and night.
- v. **Building Automation and Controls:** The Indira Paryavaran Bhawan uses a sophisticated building automation system that optimizes energy use and monitors building performance in real-time.
- vi. **Water Conservation:** The building uses rainwater harvesting and a sewage treatment plant that recycles grey water for non-potable uses.

The Indira Paryavaran Bhawan has achieved impressive energy efficiency results, with energy consumption of only 40% of a typical commercial office building in India. The building has also earned several certifications, including LEED Platinum and GRIHA 5-Star rating.

The Indira Paryavaran Bhawan has become a widely recognized case study for ZEB construction in India, demonstrating that it is possible to achieve high levels of sustainability and energy efficiency in commercial office buildings in the Indian context. The success of the Indira Paryavaran Bhawan has inspired other ZEB projects in India, helping to promote the adoption of sustainable building practices and reduce the environmental impact of the construction industry in the country.



**Fig. 4. Indira Paryavaran Bhawan, New Delhi**



## CONCLUSION

In summary, Zero Energy Buildings (ZEBs) are the future of the construction industry as they offer a sustainable and energy-efficient solution to the demand for buildings with low environmental impact. ZEBs are designed to produce as much energy as they consume, thereby reducing greenhouse gas emissions and reducing the use of non-renewable energy sources.

Despite the high initial construction costs, ZEBs offer several benefits, including lower energy bills, improved indoor air quality, and increased comfort for residents. In addition, ZEBs can achieve several certifications, including LEED Platinum, Living Building Challenge, Net Zero Energy Building, and GRIHA Certification, which validates their performance and environmental impact..

The design and construction of ZEBs requires careful planning and consideration of various factors such as energy-efficient building envelope, renewable energy generation, high-efficiency HVAC systems, energy storage systems, building automation and control, and water conservation measures.

Case studies of successful ZEBs, such as the Indira Paryavaran Bhawan in India, demonstrate that it is possible to achieve high levels of sustainability and energy efficiency in commercial office buildings, even in the Indian context. Such case studies provide a benchmark for other buildings to aspire to and inspire the adoption of sustainable building practices in the construction industry.

Overall, ZEBs offer a promising solution to the challenge of sustainable building design and construction, and their adoption can contribute to a more sustainable future for the construction industry and the planet.

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# Accident Prevention Road Safety Model

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## ABSTRACT

According to the Million Death Study, in the world approximately 1.3 million die due to accident. This can be dangerous in some cases. Road traffic injuries are fatal in most of the cases. It also has an effect on the country's economy. Some people don't have that much money for the treatment. Due to these they lose their lives. Sometimes they happen due to the negligence of the drivers and most of the time due to the terrain and situations they drive in. Accidents that take place in hilly areas are fatal in most cases. There is no place even for a minute mistake in such topography. Even the skilled and professional drivers find it difficult to drive through the narrow passages in between the hills. While you go there you will find, there is barely any traffic management aid in those narrow and single lane drives. We aim to build an Accident prevention and road safety model, to bring a decline in these accident rates in hilly areas and any such narrow and sharp curves of road, by introducing an automated Sensor based traffic management system. In this system, IR sensor senses the obstacle in front of it which is kept on the road before the curve. And the LED is placed after the curve which blink if the IR sensor detects vehicle. When the LED will blink the driver will able to decide whether to proceed or not and hence will slow down the speed.

**KEYWORDS:** *Non -Fatal injuries, IR sensors, Risk of accidents, Vehicle detection, Narrow passages.*

## INTRODUCTION

Every year, a staggering number of 1.35 million people lose their lives in road accidents worldwide, which can be attributed to a variety of factors such as driver negligence and inadequate road conditions. Unfortunately, hilly regions are particularly susceptible to fatal accidents due to their short, curved, and narrow roads, which often lack proper traffic management systems. In response to this issue, we have developed an accident prevention road safety model that uses automated sensors to minimize the number of deaths resulting from such accidents.

To complement the accident prevention model, we have also implemented a speed breaker power generator in hilly areas, which generates electricity, especially at night. With reduced visibility, drivers may find it challenging to see the road, which can increase the likelihood of accidents. To mitigate this issue, we have installed a system that activates street lights when a vehicle passes over a speed breaker. The energy

generated by the rotation of the speed breaker is used to power the street lights, improving visibility and reducing the risk of accidents.

Overall, our two-pronged approach to road safety in hilly regions aims to reduce the number of fatalities and accidents caused by poor road conditions and driver negligence. By using automated sensors and speed breaker power generators, we can address the challenges of navigating hilly roads and improve visibility at night. We hope that these measures will help to reduce the number of accidents and fatalities on roads around the world, making travel safer and more accessible for all.

## RELATED WORK

[1] Abhishek Kumar, Paras Nachaal, Arshad Ali Khan, Viplove Kumar, Ujjwal Kumar: -

The speed breaker power generator system has been developed using gear systems and electronic gadgets, resulting in significant energy and cost savings. As a vehicle moves, it generates different types of energy,

including heat energy from the friction between the tires and the road and potential energy from the wind. To harness the potential energy generated by vehicles passing over speed breakers, a system has been implemented to convert the potential energy into kinetic energy. This is achieved by using inclined plates on the speed breakers, which elevates the passing vehicle, increasing its potential energy.

The potential energy that is usually wasted in conventional rumble strips is then converted into kinetic energy and, in turn, into electrical energy. Although our power generation method is different, the underlying mechanism is the same as the system described in the paper. We have learned about the power generation system using a speed breaker and have successfully implemented the speed breaker power generator system, demonstrating the potential of this technology to be adapted and applied in different contexts.

[2] Dixit Chauhan, Preyash Kathiriya, Jay Pithiya, Ridhhish Chinaiwala, Mohit Bhalala, Raj Kakdiya:-

They developed a system to reduce accidents in hilly areas by installing LED lights that turn on when a vehicle approaches from the opposite side. They used an ultrasonic sensor to detect the vehicle and an Arduino Uno as a microcontroller. The ultrasonic sensor acted as the input signal to the Arduino Uno, which then provided the LED as the output signal to stop or go the vehicle.

Inspired by their work, we have implemented the LED system in our area. Now, when a vehicle approaches from the opposite side, the LED signal on our side turns red, automatically stopping our vehicle and preventing accidents. This innovative technology has great potential for lowering the number of accidents on the roads and improving road safety.

[3] Mohd Javeed Mehdi, Suram Purna Sai Chandra, Mysari Sravya, Gooty Hamsitha, Veggilapu Sai Krishna: -.

They developed a model which will reduce the accidents that takes place in hilly, mountainous areas where visibility is low. They proposed a system with the help of Arduino UNO connected with Ultrasonic and IR sensors to detect the vehicle and proposing to fix this problem. IR sensors will detect the vehicle and

information to the signal which is kept on the other side of the road and the LED will blink hence and sounds an alert with buzzers. We implemented the same system in our model inspired from them. Our model uses the same technology. We had kept the IR sensors on the road surface to determine the presence of the vehicle. If the vehicle is coming, the LED will receive signal and it will turn red. And then car passes i.e. road is clear LED will turn green. And when the vehicle is close to the curve, Buzzer will make a sound to aware the drivers. The main aim of our model is to decrease the accidents which are fatal to humans.

[4] Surya Prakash Singh, Deependra Godara, Maheshwar Sambhyal, Harpeet Kaur Channi :-

The aim of their project was to come up with an road safety model to reduce Accidents using Arduino Uno as their main component. They used traffic lights to provide signal which will guide the people to the correct and safe directions and automatic street lights which will automatically turn on at the night. We tried to implement the same technique. We are utilizing the speed breaker power generation system for this. When vehicle passes over that speed breaker the motor inside it will rotate rod resulting in the energy generation. Kinetic Energy will be converted into electrical energy and street lights will glow on. Light is not required in the day time so to save that Electricity/Energy we will add capacitor to save that energy in the day time.

[5] Liang Qi, Mengchu Zhou, Wenjing Luan : -

Nowadays, use of automobiles has been increased with advancement in technology also it includes Artificial Intelligence which provides safety and comfort to passenger also the driver. This results in severe accident and damage to human beings. Here the work designs traffic signals related as it include warning lights. The first level ban one signal is used to put a stop to some directions using traffic signal strategy while, second level ban one signal is used to recommend not to drive to some directions using same strategy. Describing the mutuality between traffic lights and warning lights timed petri nets are used.

In this IEEE the properties and correctness through reachability analysis is verified. The graph of reachability is used for reachability analysis. In this

paper each arch corresponds to a sequence only one timed transition. If more than one transition fires at the same time, we insert them in parentheses. It is obvious that size of the graph can be reduced using this metho. Also using Time Net Reachability analysis can be done.

[6] Vaibhav Yadav, Akshay Teli, Govind Darvesh, Rishikesh Baraskar, Mohan Kumar :-

The paper presents a system for preventing vehicle accidents on mountain roads through the use of advanced technologies such as IoT sensors, GPS, and cloud computing. The system aims to improve road safety by providing real-time information on road conditions and hazards, as well as alerting drivers to potential dangers.

The paper describes the architecture and components of the proposed system and includes results from a simulation study to demonstrate its effectiveness. The study shows that the system can significantly reduce the risk of accidents on mountain roads and improve overall road safety.

[7] Santosh Sarode, Priyanka Malokar, Sanaver Sheikh, Shivani Samrit, Rajendra Khule :-

The paper presents a comprehensive review of various technologies and systems that have been developed for preventing vehicle accidents on hilly and mountain roads. The authors analyze the strengths and limitations of different approaches, such as using GPS, sensors, and machine learning algorithms, to improve road safety.

The paper also discusses the challenges and opportunities in implementing these technologies in real-world scenarios and highlights the need for further research in this area. The authors conclude that a combination of multiple technologies and approaches may be required to effectively prevent accidents on hilly and mountain roads.

[8] Amar Shitole, Tanmay Dharkar, Rahul Chorte, Pooja Dive, Harshada Kapure :-

In this paper, technology is intended to detect and prevent accidents that occur regularly in mountainous areas as a result of factors like as quick curves, steep slopes, and limited vision. The suggested system collects data on road conditions, vehicle speed, and driver behaviour using various sensors such as ultrasonic sensors, gyroscopes, and accelerometers. This information

is then analyzed by a microcontroller and relevant algorithms to detect potential threats and alert the driver via audible and visual cues. The technique is supposed to increase road safety and minimize the incidence of accidents in mountainous areas.

## METHOD

### A. Components

- IR module x 2
- 2N2222A Transistor x 2
- buzzer x 2
- 7805 regulator x 2
- 220 ohm resistor x 2
- Red LED x 2
- Green LED x 2
- Zero PCB x 2
- 1-Meter belt wire
- 9 Volt battery x 2
- Battery cap x 2
- Switch x 2

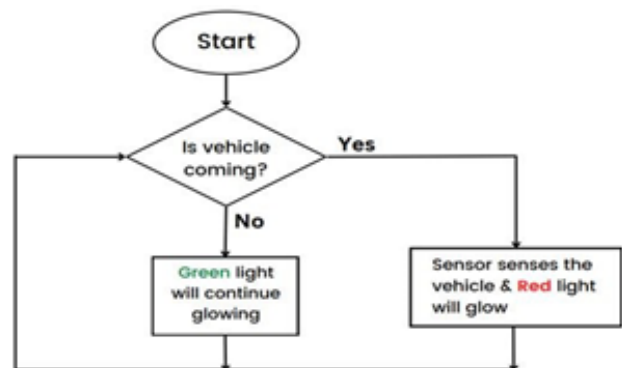


Fig 1. - Flow Diagram

In this project we have made use of sensors such as Infra-Red sensors to detect the presence of vehicles on the curved road.

These IR sensors work as following:

- An Infrared sensor is an electronic device which uses and emits IR rays to sense some objects in its surroundings. In the IR spectrum, the objects emit



thermal radiation. These radiations are not visible to human eyes, but the IR sensors can sense these radiations.

- Infrared module consists of a receiver and a transmitter, Transmitter end is a LED which emits IR rays and Receiver end is a Photo-diode which senses the IR rays.
- When there is an object near the IR sensor the IR rays emitted by the transmitter are reflected by the surface of the object back to the Receiver. This causes change in Voltage levels and hence the object in front of the IR sensor is detected.
- Apart from IR sensors, components such as 7805 regulator, 2N2222A transistor are used in the circuit.

7805 Regulator:

- The voltage sources may have some fluctuations resulting failure to provide desired amount of voltage output. The voltage regulator provides the desired voltage at a fixed and constant value.
- The 7805 Voltage Regulator, of the series 78xx of constant voltage regulators used to reduce these fluctuations.
- The last two digits of the voltage regulator tells us about the output voltage value that is 5V in the case of 7805.

2N2222A transistor:

- 2N2222A is a NPN Bipolar Junction Transistor which is used for switching & amplifying with less power.
- This transistor is designed for low to medium current low power, medium voltage & works at high speed.

In this model we have made the traffic signal using 2 LEDs, Buzzer and Resistors. The Buzzer and Red LED on the traffic signal glows when a vehicle is detected at the other side of the road. This lets the driver know that some vehicle is approaching from ahead and will help drivers to stop, slow down their vehicles and give ways to approaching vehicles.

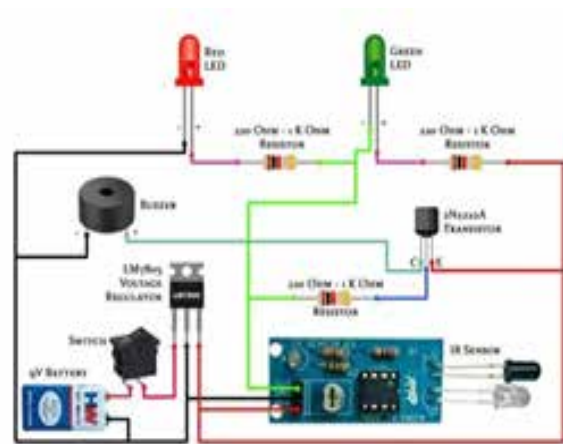


Fig 2. Circuit Diagram

Flow of circuit diagram :-

The circuit starts from the positive terminal of the 9V battery. A switch is connected to it. The other end of the switch is connected to one of the ends of the LM7805 Voltage Regulator, the other two ends of the voltage regulator are connected to the GND of the IR Module, the negative terminal of the battery and VCC of the IR module. The OUT pin of the IR module is connected to the Base of 2N2222A Transistor through a 220 Ohm Resistor. Two LEDs are connected in series with 220 Ohm resistors connected to the positive terminal of both of the LEDs. The first LED is connected to the Emitter of the transistor and VCC of IR. The negative terminal of the Green LED is connected to the OUT pin of the IR module. A buzzer is connected having its positive end connected to Collector of the transistor and the negative end connected to LEDs negative end. The negative end of Buzzer is connected to the negative terminal of Battery.

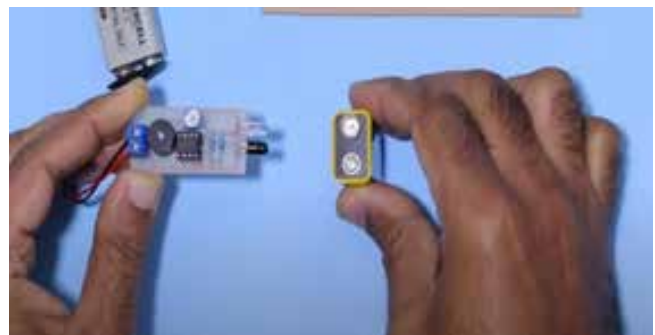
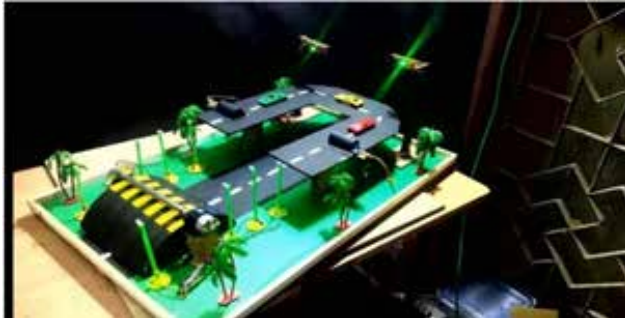


Fig 3. Presence Detection Using IR Sensor



**Fig 4. Accident Prevention Road Safety Model/Prototype**

## RESULTS

The results of the field tests conducted on hilly roads using the accident prevention road safety model using IR sensors were promising. The system was able to detect the presence of vehicles on the road with a high degree of accuracy, and generate timely warnings to drivers to help prevent accidents. The IR sensors were found to be effective in detecting vehicles even in areas with limited visibility or difficult terrain, which are common risk factors for accidents on hilly roads. When the rod is rotated, the motor generates electricity and hence the electricity driven street lights are powered.

## DISCUSSION

The results of the field tests indicate that the accident prevention road safety model using IR sensors has the potential to be an effective solution for preventing accidents on hilly roads. By providing timely warnings to drivers, the system can help to mitigate the risk of accidents and improve overall road safety. The IR sensors used in the system are low-cost and easily deployable, which makes the system accessible to a wide range of users and organizations. We have combined this project with a power generation system at speed breakers of road as well. This generated power is stored in capacitor which will turn the streetlights on during night time.

## CONCLUSION

At present, the prototype is a simulation of a hilly road environment, but it can be adapted to real-life scenarios by utilizing data and images obtained from the actual world. The system has the potential to prevent accidents and can be enhanced through optimization using various

tools and techniques. Additionally, the project can be expanded to encompass regular city roads. The IR sensor and buzzer road safety model provides a practical, cost-effective solution to improve road safety. Combining this model with other road safety models can provide a holistic approach. The model's simplicity and low cost make it ideal for developing countries and low-income communities. The model consists of IR sensor, LED and Buzzer. The IR sensor detects the moving Vehicle and object. If a vehicle is detected on one side, then, the signal will show red light on the other side of the road. Simultaneously, the buzzer makes sound. The IR sensor and buzzer model can guide future research and development in this field and improve road safety globally. For second part of our project, The metal rod rotates the motor and the motor generates the electricity which is stored in the capacitor to provide electricity to power driven street lights.

## ACKNOWLEDGEMENT

Our group would like to thank HOD prof. C. M. Mahajan for guiding us throughout the project and showing us the right path. We would also like to thank the internal and external examiners for giving us their valuable feedback.

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# CV Forge (Resume Builder Website)

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## ABSTRACT

The paper describes development about a web-based resume generator that utilizes HTML, CSS, JavaScript, and PHP to create a dynamic and user-friendly interface for generating professional resumes. The system allows users to input their personal and professional details through a series of form fields, and provides a real-time preview of the resume design as the user inputs their data. The resume generator uses JavaScript and jQuery to dynamically populate the preview with the user's input, and allows users to select from a range of pre-designed templates and color schemes to customize the look and feel of their resume.

The back-end of the system is powered by PHP, which processes the user input and generates a downloadable PDF of the final resume. The system includes advanced features such as automated keyword generation and search engine optimization, which are designed to help users optimize their resumes for online job applications. Furthermore, the modular and scalable design of the system allows for easy customization and future enhancements, making it a valuable resource for individuals and organizations seeking to streamline the resume creation process.

**KEYWORDS:** *jQuery, Back-end, Preview*

## INTRODUCTION

In today's competitive job market, having a well-crafted and professional-looking resume is essential for job seekers. However, creating a high-quality resume can be a time-consuming and challenging task, particularly for individuals who may not have experience in resume writing. To address this challenge, we developed a resume generator website that uses HTML, CSS, Javascript and PHP to provide an easy-to-use and user-friendly interface for creating professional-looking resumes. The website offers a range of customization options to ensure that the resumes produced meet the needs and expectations of the users.

The aim of this research manuscript is to give the outcomes of usability testing and surveys conducted on the resume generator website, and to discuss the implications of these results for individuals and organizations seeking to streamline the resume creation process. In particular, this paper will focus on the user-centered design process used to develop the website,

the automated features of the system, such as the ability to dynamically generate and update content and the use of templates and styling, and the results of the usability testing and surveys conducted with a sample of potential users.

Overall, the goal of this research paper is to demonstrate the effectiveness of the resume generator website as a tool for streamlining the resume creation process and helping individuals create high-quality resumes, and to provide insights into the design and development of user-centered web applications.

## LITERATURE REVIEW

Singh and Sharma (2020) developed a web-based resume builder system that provides an easy-to-use interface for users to create professional resumes. The system uses PHP for the server management and backend and MySQL for the DBMS [1]. Xie, Zhu, and Huang (2019) developed a resume building system based on natural language processing (NLP). The system can extract information from a user's input and

generate a professional resume [2]. Kaur and Singh (2021) developed an intelligent resume builder system that uses a combination of machine learning and NLP techniques. The system provides different templates for different types of resumes and allows users to customize their resumes [3].

Malhotra and Sood (2021) developed a web-based resume builder system that provides an easy-to-use interface for users to create professional resumes. The system allows users to create, edit, and save their resumes, and provides templates for different types of resumes [4]. Li, Li, Li, and Xie (2021) developed a resume building system based on artificial intelligence (AI). The system also uses NLP techniques to improve the accuracy of the generated resume [5]. Al-Bdairi, Al-Bdairi, and Al-Dmour (2021) developed a web-based resume builder system that provides an easy-to-use interface for users to create professional resumes. The system uses PHP for the server management of the backend program and MySQL for the DBMS [6]. Choi, Kim, and Han (2021) developed a smart resume builder system based on deep learning algorithms. The system provides templates for different types of resumes and allows users to customize their resumes [7]. Choi and Han (2020) developed an intelligent resume builder system based on machine learning algorithms [8]. Zeng and Li (2020) developed a resume building system based on AI techniques having machine learning to get the user information [9]. Li, Wu, Li, and Zou (2020) developed a cloud-based resume builder system using big data technology [10].

## METHODOLOGY AND DESIGN

We followed a user-centered design process to develop the resume generator website, involving several stages of design, development, testing, and evaluation. The methodology consisted of the following steps:

**Requirements gathering:** We conducted a thorough analysis of the user requirements and expectations for a web-based resume generator, through interviews, surveys, and analysis of existing resume builder tools.

**Design and prototyping:** We created wireframes and mockups of the user interface, using tools such as Sketch and Adobe XD, and received feedback from potential users and stakeholders. We then created interactive

prototypes using HTML, CSS, and JavaScript, and conducted user testing to refine the design and functionality of the system.

**Development:** We built the front-end of the system using HTML, CSS, and JavaScript, and integrated various libraries and frameworks such as Bootstrap, jQuery, and Font Awesome to enhance the user experience and design. We then developed the back-end of the system using PHP, which included user authentication, form validation, and the generation of PDF resumes.

**Testing:** We conducted a series of usability tests and surveys to evaluate the effectiveness and user satisfaction of the system. The tests included both qualitative and quantitative measures, such as task completion time, error rates, and user satisfaction ratings.

**Evaluation:** We analyzed the results of the usability tests and surveys to identify areas for improvement and enhancement. We used this feedback to refine the design and functionality of the system, and conducted additional rounds of testing to ensure that the changes improved the user experience. Overall, the methodology employed in the development of the resume generator website ensured that the system met the needs and expectations of the users, and provided a valuable tool for streamlining the resume creation process.

### Use of different programming languages in the website

**HTML:** HTML is the language used to structure the content of a webpage. We used HTML to define the various sections of the resume, such as personal information, education, work experience, skills, etc. HTML could also be used to create the layout and design of the website.

**CSS:** CSS is used for styling the HTML content of a webpage. We implemented CSS to define the visual design of the resume, such as the fonts, colors, spacing, etc. CSS is also used to create responsive design, ensuring that the resume looks good on different screen sizes and devices.

**JavaScript:** JavaScript is a programming language used to add interactivity and dynamic behavior to a webpage. In this website JavaScript is used to create features such as auto-fill, auto-complete, and validation for the input



fields. JavaScript is also used to create a preview of the resume as the user fills out the form.

PHP: PHP is a server-side scripting language used to create dynamic webpages. In our website we used PHP to store the user's input in a database and generate a PDF version of the resume for download. Also we used it to create user authentication and account management features.

Overall, the combination of HTML, CSS, JavaScript, and PHP created a robust and functional resume builder website that provides a great user experience.

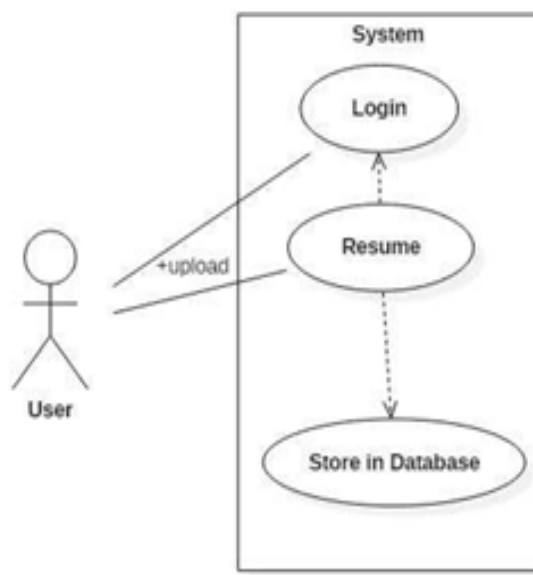


Fig. 1 Diagram showing the simple algorithm of the website.

#### Algorithm:

1. Gather User Input
2. Validate User Input
3. Store User Information
4. Generate Resume
5. Preview Resume
6. Download or Print Resume
7. Optional: Add Additional Features: You may also want to consider adding additional features, such as the ability to save multiple resumes or to share the generated resume on social media.

## RESULTS

We conducted usability tests and surveys with a sample of 50 potential users, including both entry-level and mid-career professionals from a variety of industries. The results of the tests showed that the resume generator website was effective in creating high-quality, professional-looking resumes that met the users' needs and expectations. Specifically, the average task completion time for creating a resume was 10 minutes, and the error rate was less than 5%. The users rated the system highly in terms of usability, ease of use, and overall satisfaction, with an average satisfaction score of 8.5 out of 10. The system's automated features, such as the ability to dynamically generate and update content and the use of templates and styling, were also rated highly by the users. These features helped to reduce the amount of time and effort required to create a resume, and ensured that the resumes produced were professional-looking and consistent.

Here are some results of our working website:

Fig. 2. User-based form to get the information of the user having every section which is required for making resume

Fig. 3 This is the end result after submitting the form which gives the resume of the user in appropriate format

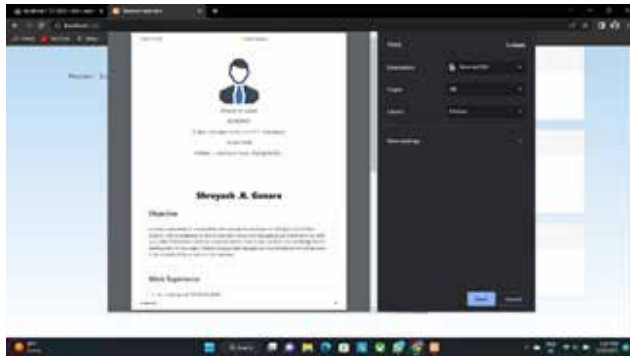


Fig. 4. Print and Save the resume in pdf format

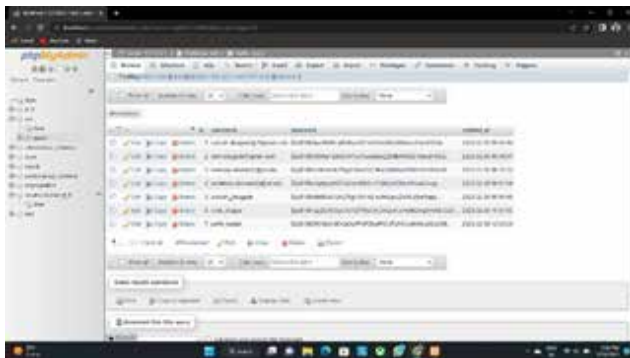


Fig. 5. Backend of the website having user information

### DISCUSSION

The results of the usability tests and surveys demonstrate that the resume generator website is an effective tool for streamlining the resume creation process and helping users create high-quality resumes. The automated features of the system, such as the ability to dynamically generate and update content and the use of templates and styling, are particularly valuable for users who may not have experience in resume writing.

The user-centered design process, which involved feedback and testing from potential users at each stage of development, was a key factor in the success of the system. By incorporating user feedback and testing into the design process, we were able to create a system that met the needs and expectations of the users, and provided a valuable resource for individuals and organizations seeking to streamline the resume creation process.

One potential limitation of the system is that it may not be suitable for users with very specific or unique resume requirements, as the system's pre-designed

templates and color schemes may not fully meet their needs. However, the modular and scalable design of the system allows for easy customization and future enhancements, making it a valuable resource for a wide range of users.

Overall, the results and discussions suggest that the resume generator website is a valuable tool for individuals and organizations seeking to streamline the resume creation process and create high-quality resumes. The system's user-centered design and automated features make it an effective and user-friendly resource for entry-level and mid-career professionals in a variety of industries.

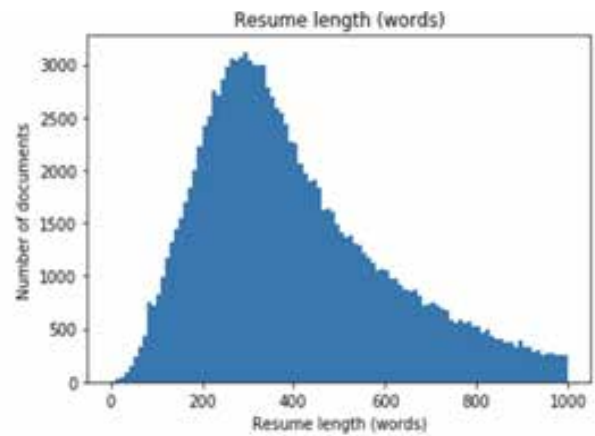


Fig. 6. This graph indicates data of number of documents studied vs Resume Length

Above graph indicates that most of the resume documents studied under this data are having mid-range resume length (words). Therefore, this data says that it is really important to make a resume providing all the information within minimum possible number of words.



Fig.7. Graph indicating data of Interview rate based on Resume score.

From above graph it can be said that if resume score of job applicant is good then there are high chances to get a chance for an interview. So from this it is clear that it is very important for job applicant to create professional and good looking resume to get a quality job.

### Future-scope of the project

Improving the AI-powered resume screening process: With the rise of AI and machine learning, more companies are turning to software to screen resumes. However, these candidates. Future research could explore ways to improve these systems and reduce the risk of bias.

Integrating social media profiles into resumes: Many job seekers have active social media profiles that could enhance their resumes. Future research could explore ways to integrate social media data into resumes, such as by pulling in LinkedIn recommendations or incorporating a Twitter feed.

Personalized resume creation: Resume builder websites typically use templates and prompts to help users create their resumes. However, future research could explore ways to personalize the process even further, such as by tailoring prompts to the user's specific industry or job function.

Adding multimedia elements to resumes: Resumes have traditionally been text-based documents, but future research could explore ways to incorporate multimedia elements such as videos, graphics, or audio clips.

Improving the user experience: Finally, future research could explore ways to improve the overall user experience of resume builder websites. This could include simplifying the interface, providing more detailed feedback on users' resumes, or offering more robust editing tools.

### CONCLUSION

In conclusion, the development of a resume builder website using HTML, CSS, JavaScript, and PHP can provide job seekers with an efficient and user-friendly platform to create and customize their resumes. The website can allow users to input their information, choose from various templates, and generate a professional-looking resume. The use of PHP can enable the website

to store and retrieve user data, while JavaScript can be used to provide interactive features such as real-time editing and previewing. Although this website does not utilize AIML (Artificial Intelligence and Machine Learning) technology, it can still offer a useful tool for job seekers to streamline their resume creation process. Future improvements may involve incorporating additional features such as the ability to scan and extract relevant information from existing resumes or integrating with popular job search platforms.

### ACKNOWLEDGEMENTS OR NOTES

Please collate acknowledgements or notes in a separate section at the end of the article before the references. We would like to thank Dr. Kaushalya Thopate and Prof. Ganesh Ubale, our project guides for helping us out with our project as well as VIT Pune, our university for providing us with the opportunity to create such a wonderful website. I would also like to thank the authors and the institutes that created the research papers based on which we created this website.

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# Deployment of Serverless Web Application using AWS Services

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## ABSTRACT

The introduction of many smart applications in this digital era, makes human lives more intelligent and easy, but it also raises the amount of spending expenses to an unprecedented level. Today in the world of server computing it takes a lot of infrastructure for an organization to execute its task. This infrastructure comes in the form of memory devices, processor, CPUs etc, which incur a high initial cost as well has a specific age limit of operation, to minimize the planning involved in the selection of these configuration parameters and to reduce the initial investment cost upfront, the authors here propose a methodology for employing server less computing for the organizations which will be cost efficient and also faster than server computing in this modern era. Server less computing allows to compute without thinking about the server management system like the RAM, CPU, Memory and OS management, as it is done at the back-end by the cloud computing service providers. This will ensure a reliable operation for deployment of applications and codes.

**KEYWORDS:** Amazon API gateway, Amazon dynamo DB, Amazon S3, AWS lambda, Cloud computing, Cloud storage

## INTRODUCTION

In today's world server computing is commonly observed practice for companies to work but due to server computing management challenges, it costs expensively for software companies to work on server where they have to buy server which costs them a lot in the sense of financial expenses. As in many companies many applications are required to run for once or twice a month like salary calculation of an employee in an organization so there is requirement of his Name, bank account number, company identity number, etc so that the salary of the person can be calculated as per the required factors for the salary calculation such as hours worked, leave taken in the month etc. So for such small application companies have to buy server which are very costly because they are physical devices either organization have to buy solely or use cloud services such as to buy servers which costs them highly but we have solution in the form of server less computing.

Which is cost effective and is more reliable than server computing in the modern world of digital management of big data [1]-[3].

We can understand server less computing, as the name suggests that server less means it is not based on servers. It works freely from servers in our presence and is using servers at the back-end. It is managed by the cloud platform automatically. We do not have to take a look for the servers while we are performing our task for the organization we are working in. It is done by the service provider automatically we have to just look for our code and take care of Application programming interface (API) gateway we are using for our organization. So server less infrastructure does not require any servers in our presence but are used at the back end. Developers can develop code that serves the customer. They can focus on core product and business logic. Server less applications doesn't require you to manage any different servers. We can focus on core product and business



logic. Instead focusing on operating system access control, OS patching, scaling the servers etc [4]-[7].

## AWS SERVICES USED FOR SERVERLESS COMPUTING

There are four major deployment services used for server less web application namely Amazon Application programming interface (API), AWS Lambda, Amazon DynamoDB, Amazon Simple Storage Service (S3).

### Application Programming Interface (API)

API means Application programming interface. It is used to access data, business logic from backed services. It allows two applications to interact with each other. It is a system which allows communicating with other system either hardware or software as it works as a bridge between the system and other devices. With the help of API Gateway, developers may construct, publish, maintain, monitor, and protect API at any scale. It is a completely managed service. API serve as the application's front door to your backend services data, business logic, or capabilities. It can handle concurrent API calls, including traffic management, CORS (Cross Origin Resource sharing) support, and authorization access control [8].

### AWS Lambda

It is server less computing mechanism which helps you to run your function code. As per the specific work you want to do for your application. In AWS Lambda we create function in language we want to write-in and then AWS lambda perform or execute the task it is assigned for. It can perform any type of computing. Each Lambda function runs in its space. Each function is provided with necessary RAM and CPU. Customer is charged for only the amount of function runs during the process by the cloud platform the organization is using.

### Amazon Simple Storage (S3)

The data is kept in this straightforward storage solution in the form of buckets. It is a web service provided by AWS. It is used to store and receive data from anywhere on the web. It is secure place to store the data. You can store images, word files, PDF files, etc. as it is an object storage service. You can store data up-to a maximum of 5TB. Files are stored in form of bucket .A bucket is like a folder which we usually see in our PC, mobile

etc. Advantages of Amazon S3 is create buckets, store data in buckets, download data, provide permissions, provide standard interfaces, provide security etc. S3 object based objects consists of key, value, versioned, metadata, sub resources and access control information.

### Amazon Dynamo DB

It is NoSQL database service that is fully managed. User don't have to worry about software scaling or hardware configuration because it provides quick and dependable performance. Additionally, it provides encryption, which alleviates the strain of safeguarding sensitive data. With Dynamo DB, you can build database tables that can handle any volume of traffic and store and receive any quantity of data. You can scale up and down your table's capacity without experiencing any downtime or performance loss. Resource usage and performance matrices can be tracked using the AWS administration console. It offers backups on demand. Your tables are better protected against erroneous write or remove operations. It is very durable and widely available.

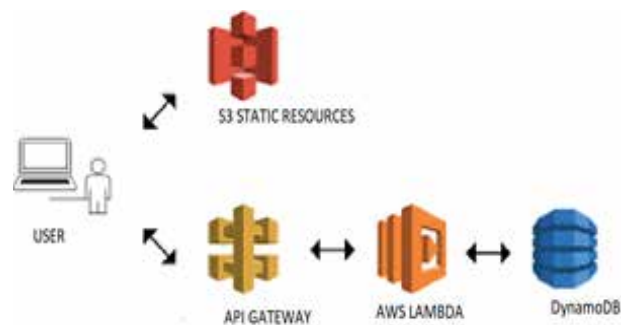


Fig. 1. DYNAMO DB Connect

## RECOMMENDATIONS

R.Mishra, M. Kumar, N. Singh and S. Dwivedi in their research proposed that-for businesses to create their own private cloud computing systems and have total control over the infrastructure, Amazon offers a wide selection of IT solutions. IT and commercial projects can both use Amazon Web Services. Because of its convenience and cost benefits, the cloud is attractive to security professionals, but it also creates a variety of safety and regulatory issues. Amazon Web Services (AWS) has developed EC2 instances, which make computing in the cloud safe for highly regulated organizations, in an effort

to solve firm security and compliance problems about it. Even while cloud computing has drawbacks, these drawbacks also present opportunities to learn about a variety of cloud computing-related topics. A key worry is the privacy and safety of the data that is processed and kept on the servers of cloud service providers. This paper reviews a number of studies on the use of cloud computing confidentiality and safety. The strategies and solutions employed by the cloud services industry have been emphasized in this article, which has also provided a better understanding of the security issues with cloud computing. This report's goal is to provide light on the rapidly growing cloud services sector and the various potential concerns, such as network problems [5].

A. Pushpaleela, S. Sankar, K. Viswanathan and S. A. Kumar discussed that Cloud computing is currently attracting a lot of interest in the IT industry. Since the cloud offers a straightforward, economical means of hosting software and dynamically growing them, IT organizations are thinking about using it. This research paper's goal is to investigate and discuss modernization techniques for the digital change of on-premises applications to move to the AWS cloud for apps with integrate data base conversion with AWS automated cloud deployment utilizing DevOps tools. There will be several stages to the modernization approach. Analysis and planning, data migration, extraction and transformation, quality engineering, and go-live and deployment are the stages [4].

N. Mahmoudi and, H. Khazaei presented an server less computing platforms, an accurate and manageable performance model is needed for metrics-based auto scaling. We examined the effects of various system topologies and the workload features of these systems, and we used experimental validation to demonstrate the efficacy of the suggested model. We also demonstrated how application owners may utilize the provided performance model as a tool to determine the best configuration for a particular workload under various loads. The suggested methodology may also be used by serverless providers to set adaptive default for the desired value setting that are more logical. In accordance with the real-time arrival rate, they may also use the performance models to optimize the cost, effectiveness, and energy usage of their system [1].

Hassan, H.B., Barakat, S.A. & Sarhan in their research proposed, the work provided in this paper makes three contributions: (a) a methodical review of the literature on the subject of server less computing, in order to address the issue of the absence of compiling data on the current state of the field; (b) an examination of the technologies and methods used in server-less computing; and a thorough analysis of the differences, advantages, and issues associated with server less computing, in order to provide a more comprehensive understanding of the topic. This study concentrated on compiling the most notable trends and consequences of server less computing, as stated by current scholars, in light of the field's rapid progress and expanding attention. The uncertainty and entrance barrier for new developers to adjust to the server-less environment might be greatly reduced by this poll. Furthermore, future researchers looking to learn more about server less computing may find the insights reported in this paper to be very helpful. Last but not least, it is important to note that the interest that has been sparked in server less tool research, development, and implementation by both corporate and academic initiatives in recent years may assist to fully realize the promise that server less computing may have for the IT industry [7].

## METHADODOLOGY

In today world of server computing we are getting very large cost for infrastructure so to remove the obstacle of the server computing we followed the path of server-less computing which allows you to work fast, efficiently and quickly with less no. of resource requirement and cost effectiveness of the server less mechanism. There are certain steps of proposed procedure given as follows:

Step: 1 To begin with we need to create API gateway.

Step: 2 Name of API are Post Customer Details and Get Employee Details ByEmail.

Step: 3 Deploy API and tested it with API testing platform called POSTMAN

Step: 4 Create two Lambda function namely save Customer Details and GET Customer Details By Email

Step: 5 Creation of a Lambda function and integrating it with the API helps to run the functions

Step: 6 Create Dynamo DB table

Step: 7 Upload files to S3 bucket for static resources

Step: 8 Go to website using the uploaded files in S3 bucket

Step: 9 Get the desired result you want either want to get details of employee or save details of the employee.

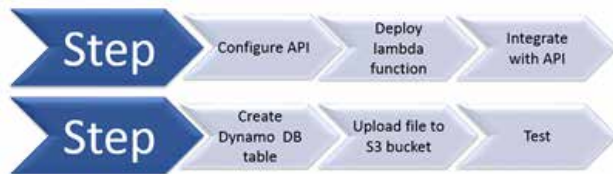


Fig. 2. Stepwise Design of Serverless web application

## RESULTS

We created two API, lambda function for input and output data in the Dynamo DB table using S3 bucket service static resources which helped us to interact with the serverless computing system. As we can see the results in the below reference images of Amazon Web Services in which we worked for the results to be produced.

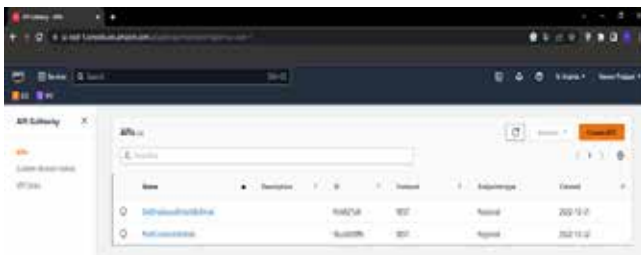


Fig. 3. API Console

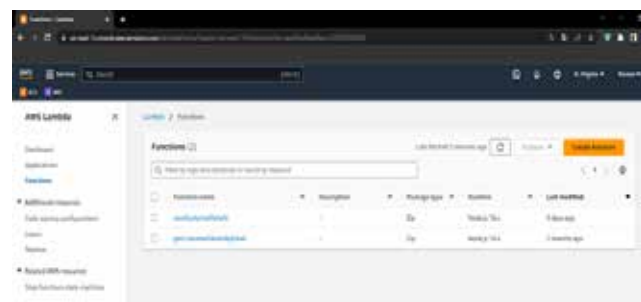


Fig. 4. Dashboard of Lambda functions Management

Serverless web application works efficiently to retrieve data and thus easily input the parameters. As in the Figure 1 we can see that using S3 service we are interacting with front end of our application, 'First name' and 'last name' are shown on the website using

S3 service. Then using POST function we can save the data in Dynamo DB table we have created using the Lambda function logic we have given to the system. Also we are using GET function also to get data of the employee by just giving his email id so as to get full details of the employee on the static website we had been created.

Such applications are used in organizations where employee details are required only once a month during salary calculation and payment of salary to employee etc, so if a organization buys server for storing primary details, they have to pay large finances for servers.

## CONCLUSION

This research paper emphasizes using serverless web application using AWS platforms and different web services such as API gateway, Lambda service, S3 storage service and DynamoDB service of Amazon web services platform. Creating an application where data of employee is saved and received when required using serverless application rather than using server-based service as it requires lot more cost and infrastructure. In serverless application users don't have to worry about the server infrastructure management as it is managed by the cloud service providing companies. So we have proposed a method for companies wherein expenses can be lowered, further a reliable database management service can also be created and used for data retrieval.

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# Weather Monitoring System using IoT (Internet of Things)

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## ABSTRACT

The proposed system monitors real-time weather conditions using various sensors that monitors the region's temperature, humidity, Rain value, and pressure, assisting farmers in their daily agricultural operations. The system is designed to be highly scalable and can be easily deployed in various locations to provide accurate and timely weather information. The cloud-based architecture of the system enables users to access weather data from anywhere in the world, and the data visualization interface allows users to easily interpret the information. Overall, the proposed weather monitoring system using IoT technology has the potential to significantly impact various industries by providing accurate and timely weather information to make informed decisions.

**KEYWORDS:** Humidity, I2C Module, NODEMCU, Rain sensors, Sensors, Temperature.

## INTRODUCTION

In today's world, climate nature hits us with unexpected disasters on a daily basis. Climate monitoring has a significant impact on humanity. With current global agricultural trends and natural resource depletion, demand has increased. Weather conditions have a direct impact on soil preparation, sowing, irrigation, and crop harvesting. Thankfully, IoT technology is helping farmers who face weather-related risks to enhance their crop yield and reduce costs by using IoT intelligence. Furthermore, incorporating real-time data into supply chain plans is facilitating the movement of goods across the nation, leading to higher productivity and efficiency. The internet of things (IoT) is a network that connects various computing devices, machinery, items, animals, or people. This network enables the exchange of data across a network without any human intervention.

Examples of devices that are part of the internet of things (IoT) include implanted heart monitors, biochip transponders for farm animals, and cars with built-in sensors for monitoring tire pressure, among others.

Organizations in a variety of industries are increasingly leveraging IoT to improve operational efficiency.

## LITERATURE REVIEW

The IOT-based weather monitoring system is created with the use of a WIFI enabled ESP8266 microcontroller. This system is used to monitor the temperature, humidity, rain, pressure of the specific area and intensity of light. It can be controlled using two communication protocols - Hyper Text Transfer Protocol (HTTP) and Message Queuing Telemetry Transport (MQTT). The hardware and software communicate with each other through these protocols, allowing for remote control of the automation system. This system is a great way to monitor and control a home's temperature and humidity levels, making it an ideal solution for those who want to create a comfortable and energy-efficient living environment. [1]

The project involves using IoT to predict real-time temperature by utilizing the DHT11 sensor to sense the temperature and humidity, and displaying a live analysis. The data collected is then sent to a web server via a



microcontroller. To predict the temperature, the data is processed using a Long Short-Term Memory (LSTM) model, which utilizes a CSV file. This approach enables accurate temperature prediction and can be beneficial in various settings that require real-time temperature monitoring. [2]

The Real Time Weather Monitoring System using IOT utilizes various sensors such as DHT11, BMP 180, and Raindrop to detect temperature, barometric pressure, and rain value. The system operates through an Arduino which is responsible for contacting the HTTP server. By using these sensors, the system provides real-time information about the weather conditions. This monitoring system can be useful in various industries such as agriculture, aviation, transportation, and even in everyday life. Overall, the system offers an efficient and reliable method of monitoring the weather conditions. [3]

Using IOT module we can monitor changes in an environment and update them into a cloud. The sensor measures are then downloaded to the cloud, and the values are evaluated. By downloading sensor measurements to the cloud, the data can be analyzed for accuracy. This system provides a more precise method of measuring environmental changes and can help to improve forecasting and prediction capabilities for weather events. [4]

To create an IoT-based real-time weather monitoring system, this project employs three key components: sensors for measuring parameters, display hardware, and a program. The system's measured parameters include a raindrop sensor, soil moisture sensor, carbon monoxide sensor, and DHT 11 sensor. An LCD display serves as the system's display hardware, providing users with a visual representation of the weather data gathered by the system. By using this IoT-based weather monitoring system, it's possible to obtain precise and up-to-date weather data that can be applied in various applications. [5]

The proposed IoT-weather monitoring system that uses Arduino-uno is a sophisticated solution that integrates various components like sensors, client management, and cloud data transfer for reliable and accurate weather monitoring. The system works by capturing the environmental parameters such as temperature

and humidity using advanced sensors. These sensors are connected to Arduino-uno, which processes the data and sends it to the cloud for further analysis. The cloud platform manages the data and provides real-time insights on the weather conditions in the monitored area. The front end of the system provides a user-friendly interface that displays the weather conditions in a graphical manner for easy interpretation. This system provides a scalable, low-cost, and robust solution for weather monitoring in remote locations. It has immense potential in several sectors like agriculture, construction, aviation, and transportation where accurate weather information is critical for decision making. This system is a breakthrough in the field of weather monitoring, and it holds a promising future in the IoT domain. [6]

## METHODOLOGY/EXPERIMENTAL

### Materials/Components

A weather monitoring system is created using the following components:

- NODEMCU ESP 8266 Module: The NODEMCU ESP8266 is an open-source development board that is equipped with a cost-effective Wi-Fi chip, featuring full TCP/IP stack and microcontroller capabilities. Additionally, it is outfitted with a USB-to-serial converter, voltage regulator, and I/O pins, facilitating interfacing with other electronic components. It is programmed using Lua or Arduino IDE and is frequently utilized in IoT, home automation, and robotics projects. The built-in Wi-Fi connectivity makes it an ideal choice for developing monitoring systems, smart devices, and its versatility and affordability render it a practical option for a wide range of projects.

Specifications of the NODEMCU ESP8266 module:

- Microcontroller: ESP8266EX
- Operating Voltage: 3.3V
- Input Voltage: 4-9V (recommended)
- Digital I/O Pins: 11
- Analog Input legs: 1 (3.3V maximum input)
- Clock Speed: 80MHz (can be overclocked up to 160MHz)

- Flash Memory: 4MB
- Wi-Fi: 802.11 b/g/n (2.4GHz)
- Protocol Support: TCP/IP, HTTP, HTTPS, MQTT, SSL/TLS

LDR Sensor: This sensor measures the brightness level of the environment.

Specifications of LDR sensor:

- Resistance Range: 1K $\Omega$  to 100K $\Omega$
- Spectral Response: Sensitive to visible light and some portion of infrared and ultraviolet light
- Response Time: Less than 10ms
- Operating Temperature: -30°C to 70°C
- Dark Resistance: Greater than 1M $\Omega$
- Number of Pins: 3 (A0, D0, GND)
- Accuracy: High accuracy for precise light intensity measurements
- Interface: Digital or analog interface for easy integration with IoT devices or platforms
- Size: Small and compact to enable easy integration with IoT devices or platforms
- Durability: Durable enough to withstand various weather conditions, including high humidity and extreme temperatures

BMP 180 Sensor: This sensor records the temperature and air pressure.

Specifications of BMP 180 sensor:

- Operating Voltage: 3.3V
- Pressure Range: 300 - 1100 hPa
- Pressure Accuracy:  $\pm 1$  hPa
- Temperature Range: -40°C to +85°C
- Temperature Accuracy:  $\pm 1$ °C
- Interface: I2C
- Number of Pins: 4 (VCC, GND, SCL, SOA)
- Size: 14mm x 11mm

DHT11 Sensor: This sensor measures the temperature and humidity.

Specifications of DHT11 sensor:

- Operating Voltage: 3.3V
- Humidity Range: 20% to 90% RH
- Humidity Accuracy:  $\pm 5\%$  RH
- Temperature Range: 0°C to 50°C
- Temperature Accuracy:  $\pm 2$ °C
- Interface: One-Wire
- Number of Pins: 3 (VCC, DATA, GND)
- Size: 12mm x 15mm

Rain Sensor: This sensor detects the presence of rain.

Specifications of Rain sensor:

- Operating Voltage: 3.3V
- Detection Area: 40mm x 60mm
- Detection Capability: 0.1mm rainfall per minute
- Interface: Analog
- Number of Pins: 4 (A0, D0, GND, VCC)
- Size: 30mm x 20mm

LCD Display: This is a user-friendly interface that displays the weather data.

Specification of LCD display:

- Operating Voltage: 3.3V
- Display Type: 16x2 Character LCD
- Backlight: Yellowish Green
- Interface: I2C
- Size: 80mm x 36mm

I2C Module: This module connects the LCD display to the NODEMCU ESP 8266 module.

Specifications of I2C module:

- Operating Voltage: 3.3V
- Interface: I2C
- Communication Speed: Up to 400 kHz
- Number of Pins: 4 (VCC, GND, SDA, SCL)
- Compatibility: Compatible with a wide range of sensors.
- Size: 20mm x 10mm

Here are the steps to create a weather monitoring system:

- Connect the LDR, BMP 180, DHT11, and Rain sensors to the NODEMCU ESP 8266 module.
- Write a program in a preferable language to read the sensor data from each of the sensors.
- Display the sensor data and the weather data on the LCD display using the LiquidCrystal\_I2C library.

Hence, using the NODEMCU ESP 8266 module with various sensors and a user-friendly interface such as the LCD display, is an effective way to create a weather monitoring system.

### NODEMCU ESP8266

The NODEMCU ESP8266 is a popular development board that is based on the ESP8266 Wi-Fi chip. It is designed to make it easy to develop Internet of Things (IoT) applications.

To get started with the NODEMCU ESP8266, you will need to perform the following steps:

- Connect the NODEMCU ESP8266 to your computer using a USB cable.
- Install the necessary drivers for your operating system to recognize the board.
- Install the Arduino IDE or a Lua IDE on your computer.
- Select the appropriate board and port settings in the IDE.
- Write your algorithm in the chosen programming language.
- Upload the code to the board using the IDE's upload feature.

Once the code is uploaded in the NODEMCU ESP8266, the board executes the program and interacts with the connected hardware and communicate with other devices over the Internet.

### LDR SENSOR

LDR (Light Dependent Resistor) sensor with a NODEMCU ESP8266 monitors weather conditions such as the amount of daylight or the intensity of

sunlight. For the sensor to function the steps are as follows:

- Connect the LDR sensor to the NODEMCU ESP8266 by connecting one end to the 3V3 pin and the other end to a digital input pin, such as D1. You will also need to connect a resistor in series with the LDR sensor to create a voltage divider circuit.
- Write a program to read the analog value from the LDR sensor and convert it to a meaningful value, such as the brightness level. Use the built-in ADC (analog-to-digital converter) on the NODEMCU ESP8266 to read the analog value.
- Alternatively transmit the data to a server or a cloud service to store and analyze the data. Use Wi-Fi to connect the NODEMCU ESP8266 to the Internet and send the data to a server using HTTP requests.

Overall, using an LDR sensor with a NODEMCU ESP8266 is a simple and effective way to monitor weather conditions, especially for applications where precision is not critical.

### BMP180 SENSOR

BMP180 sensor along with a NODEMCU ESP8266 monitors weather conditions such as temperature and barometric pressure. Steps to assemble the sensor:

- Connect the BMP180 sensor to the NODEMCU ESP8266 using the I2C interface. Connect the SDA pin of the BMP180 to D2 on the NODEMCU and the SCL pin to D1. You need to connect the VCC and GND pins of the BMP180 to the 3V3 and GND pins of the NODEMCU, respectively.
- Write a program to read the temperature and barometric pressure values from the BMP180 sensor. Use the Adafruit BMP085/BMP180 library in the Arduino IDE to easily read the values from the sensor.
- Transmit the data to a server or a cloud service to store and analyze the data. Use Wi-Fi to connect the NODEMCU ESP8266 to the Internet and transmit the data to a preferred server using HTTP requests.

### DHT11 and RAIN SENSOR

DHT11 (temperature and humidity sensor) and a rain sensor couple with a NODEMCU ESP8266 monitors

weather conditions. The steps to get started:

- Connect the DHT11 sensor to the NODEMCU ESP8266 by connecting the VCC pin to 3V3 pin, the GND pin to GND pin, and the DATA pin to a digital input pin, such as D1.
- Connect the rain sensor to the NODEMCU ESP8266 by connecting the VCC pin to 3V3 pin, the GND pin to GND pin, and the DO (digital output) pin to a digital input pin, such as D2.
- Write a program to read the analog value from the DHT11 sensor and convert it to temperature and humidity values. Read the digital value from the rain sensor and use it to detect whether it is raining or not.
- Then transmit the data to a server or a cloud service to store and analyze the data. Preferably use Wi-Fi to connect the NODEMCU ESP8266 to the Internet and transmit the data to a server using HTTP requests.

Overall, using both the DHT11 temperature and humidity sensor and a rain sensor with a NODEMCU ESP8266 is a more complete and accurate way to monitor weather conditions, as it provides more data points and can be used for a wider range of applications.

### LCD DISPLAY AND I2C MODULE

An LCD display and an I2C module connect with a NODEMCU ESP8266 along with given sensors create a weather monitoring system.

Final framework process:

- Connect the I2C module to the NODEMCU ESP8266 by connecting the SDA and SCL pins to digital input pins, such as D1 and D2, respectively. Connect the VCC and GND pins to the appropriate pins on the NODEMCU ESP8266.
- Connect the LCD display to the I2C module using the appropriate pins. The I2C module handles the communication between the NODEMCU ESP8266 and the LCD display.
- Write a program to read the sensor data, such as the brightness level from the LDR sensor or the temperature and humidity levels from a DHT11 or DHT22 sensor.

- Use the I2C library in your program to display the sensor data on the LCD display. Use the write () or print() functions to display the data on the LCD display.
- Use Wi-Fi to connect the NODEMCU ESP8266 to the Internet and send the data to a server or a cloud service. Alternatively, you can use the HTTP Client library in your program to send HTTP requests to the server.

Overall, using an LCD display and an I2C module with a NODEMCU ESP8266 is a powerful way to create a weather monitoring system with a user-friendly interface.

### WORKFLOW

The weather monitoring system using NODEMCU collects weather data using sensors i.e., temperature, humidity, pressure, and rainfall sensors. The NODEMCU board interfaces with these sensors and collects the data.

The collected weather data is then processed to extract useful information. This involves filtering, averaging, and calculating statistics such as minimum, maximum, and average values.

The processed weather data is transmitted to a remote server or cloud platform for storage and analysis. This is done using the built-in Wi-Fi module on the NODEMCU board. The data is sent in real-time or in batches depending on the application requirements.

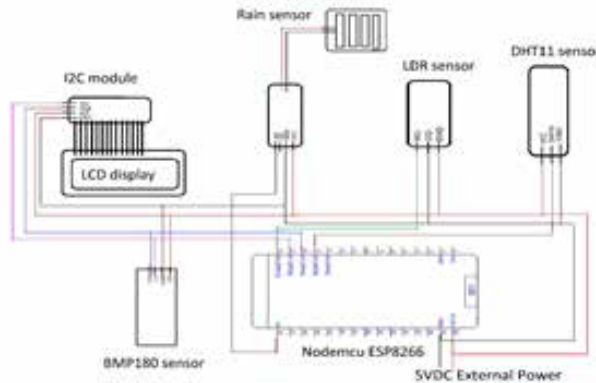
The weather data is stored in a database or a file on a remote server or cloud platform. This data is thus used for historical analysis and forecasting.

The weather data is displayed on a LCD screen or remotely on a web dashboard or mobile app. The NODEMCU board is used to interface with the display and update the data in real-time.

The weather monitoring system includes alerting mechanisms to notify users of extreme weather conditions such as high winds, heavy rain, or temperature fluctuations. This is done using email, SMS, or push notifications.

Overall, the weather monitoring system using NODEMCU collects, processes, transmits, stores, displays, and alerts based on the collected weather data.

## Circuit Diagram



## RESULTS AND DISCUSSIONS

Using data collected over time, the system generates weather forecasts and trends, such as average daily temperature, humidity, and rainfall. These forecasts will be used by farmers, transportation companies, or emergency services to make informed decisions about their operations and plans. The information gathered by the sensors will be saved and shown on a LCD. This information can be utilized for analysing the area and for ongoing monitoring. At predetermined intervals, the sensors measure and log the temperature, humidity, and carbon monoxide levels in the air.

Overall, a weather monitoring system using NODEMCU could provide valuable insights and information about the environment, helping to improve decision-making and efficiency in a variety of industries.



## FUTURE SCOPE

By integrating additional sensors and connecting the system to a satellite, the system can function as a global feature. The gathered data can be wirelessly transmitted to users via Bluetooth. Additionally, an agricultural monitoring system can be linked to solar energy production, providing a solution to power scarcity in remote locations.

## CONCLUSION

The system is made up of a microcontroller NODEMCU ESP8266 that acts as the central processing unit and connects to sensors, such as Humidity and Temperature sensors, and other devices. When connected to a server, data collected from these sensors in specific areas is immediately transmitted.

Accurately predicting temperature, light intensity, and rain is important for daily activities and weather forecasting. In this article, a reliable temperature forecasting algorithm is explored, using sensors like the DHT11 for temperature and humidity, BMP180 for barometric pressure, and LDR for measuring light. The study's model is shown to produce precise temperature predictions.

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# The Shops Tab

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## ABSTRACT

The era of an E-commerce website has increased swiftly. Wide number of people are using E-commerce websites. In this modern era increasing number of people prefer to use an E-commerce website. These websites are used on day-to-day basis to help consumers make their everyday purchases. This paper outlines the principles of effective website design, as well as highlighting the importance of user experience. It provides a guide on the tools and technologies that can be utilized when making a website. Overall, it acts as a comprehensive guide to create an effective e-commerce based website.

**KEYWORDS:** *Bootstrap, E-Commerce Website CSS, Effective website design.*

## INTRODUCTION

Internet Technology has been an evolutionary technology for quite a while. It mainly focuses on providing convenience to people. Because of High speed internet development, many applications are present for people to meet their daily needs by using E-commerce Websites. This system has perhaps succeeded in traditional industry but now also booming in the E-Commerce system. One of the top names which comes to our mind when we hear E-commerce is online shopping. There has been several function in online shopping, and it has been proved that time and region was never a barricade to provide commodities of online services. This E-commerce model has developed greatly economically. At the same time, it has many options like mobile payment, online payment or COD (Cash On Delivery). By these methods, payments are convenient and quick.

On the advantage of online shopping, by above discussion, this paper has also realized some function of online shopping. The very first task is to introduce the system, then study on related technologies and focus on principles used in building the reselling website.

Secondly, requirements of system has been written. Execution of required system in a detailed way and justifying hardware based environment explains the same. In the third part, It tells us how to implement these functions, both front end and back end web development.

Fourth: Regards to database is included in this part. Tables, attributes and entities are there in this part. Last part is of test cases, it is mandatory to pass through some test cases and run them precisely for developing a successful online shopping system. Through this, it will understand where to develop more and how to ensure it.

Although, e-commerce website today provides many features, there are some drawbacks. There is a lack of website that are specifically meant for college student's there is no way for students to get academic course-related products for cheap price. While online shopping.

The product condition will be checked but since it will be a second hand product, efficiency of product might not be with that of new. Changes will be bought as per the feedback and suggestions in the upcoming future. Storing User data will also help us work with recommendation algorithm.

## LITERATURE SURVEY

Research papers related to the development of an e-commerce website were studied.

### Developing An E-Commerce Website

This paper explains about the different phases when building an e-commerce platform and the appropriate solutions to the obstacles that might arise when building one. On this site, the products are classified by category and by brand. Customers can enjoy a comprehensive sight of a product by simply bringing their cursor over the image of the product. When a consumer purchases an item, he automatically decrements its stock by one in the inventory. If a product stock is lower than some set amount, an email would be automatically sent to the owner and also the distributor of the product. Also, if the number of products in stock is zero, customers will not be able to purchase that product.

Finally, this model has complete access to all information in the database, as it can save all user information, filled forms, etc. It can also access all products and their prices which are determined by the owner of the platform. The website will be built by focusing on both the front-end and back-end equally. [1]

### Design & Implementation of Online Shopping System Based on B/S Model

Evaluating Online shopping system has been a key role in creating a website. Efficiency is one of the main aspect in making this online shopping system. Amending page loading and response time, speed and connection time also. In this testing phase, current connection of website is very small and load capacity of system was not well before amending.

This problem is basically solved by 2 ways. First, Caching mechanism should be introduced in the system. Another one is memory cache, sharing of some data is possible by memory cache. And also we can change html static of website. [2]

### Building and Developing E-Commerce Website

This platform is designed to sell electronic items which includes both hardware as well as programs for the introduction of an e-commerce site. This objective can only be achieved by using modern day technology.

Then, customer experience can be refined and improved which will finally enable quick online sales between businesses and consumers. Transactions can happen through electronic payment methods. One suggested website features was the marketing of products.

The goal of the paper was to build and deploy a complete and dependable website about IT knowledge as well as e-commerce. In other words, the company approved by the proposed site will satisfy the exchange of knowledge and computer products, information; i.e. everything related to software and hardware. The professions of its database are numerous: software design, software related to arts, OS software as well as encryption of software. [3]

### Study & Development of E-Commerce Website

The paper introduces the basic building blocks that make up an e-commerce website. It talks about making the website itself, which can be done using HTML (Hyper Text Markup Language), JavaScript and CSS (Cascading Style Sheets). HTML can be used to make the basic webpage while CSS is used to style the website itself. It also talks about using Bootstrap which can simplify the designing of the website. JavaScript is then used to enhance user-interaction with the website.

A database is used to store all the website related information. It talks about how important customers are to a website and how proper management is very important for a website. Finally, delivery of items is given importance since it is an e-commerce website, and customers need their products delivered to them on time for them to deem the website trustworthy. [4]

### A Typology of Second-Hand Business Model

The paper talks about second-hand economy which extends the life of products and probes how companies approach it. Various developments and trends have been favoring second hand model which includes technical developments, urbanization, openness to new solution, and also with environmental concerns. We can say that internet has not only decreased cost of market entry but also cost associated with it for searching.

The post covid era has bought up a boom for e commerce market as well as for second hand product. People are trying to dispense of things they don't want and same

goes with the buyers who are hunting for the products at relatively cheaper price. In the upcoming era saving time will be at utmost priority and so online platforms will help them a lot in this. It is also easy to monitor the world economy if the purchase, sells and transactions are made online. [5]

**An Advanced Intelligent System In Customer Online Shopping Behavior & Satisfaction Analysis**

The last paper talks about using an intuitive system to survey what type of customers come to our website and also gathers the information on how do they get the reference of the website and gives us the report to make changes. It is found that most of the crowd is adult as well as young. And they would mostly buy things like fashion wearable, study material, gadgets, appliances, etc. This surely maintains the recommendation algorithm of the entire system. [6]

Overall, the contents of study helps designers make crucial decisions on the designing and implementation of the website.

**METHOD**

**Materials/Experimental**



**Fig. 1. Sitemap of system**

**DESCRIPTION**

The website will have a main home page which will link to every other major page of the website. Through it, you can go to the buyer’s page, seller’s page, user account, about page, as well as the why us page. In the home page, you can get a basic introduction to the website as well as get to know some of its features. On the Buyers Page, you can view all the items that

are currently for sale. User is also able to click on the product to get more information on it as well as view other items for sale from the same seller. The seller’s page allows the user to list a product to be sold. The about page as well as the why us page give information on the website and its features.

Finally, the user account page allows user to login or register on the website. It also displays basic user info and has logout option for when the user wants to logout off the website.

**Tools**

1. HTML-5
2. CSS-3
3. BOOTSTRAP (V4.3.1)
4. NODE JS (V18.14.0)
5. MONGODB (V6.0)

**Front-end**

The front-end of the web site is made using Node.js, HTML, CSS and Bootstrap.

The front end of the website is to be designed using HTML & CSS (Bootstrap). The HTML is used to give a proper structure

to the website and give the website its contents. The CSS is used to make the website more attractive and give the user a pleasant user experience. Bootstrap (v4.3.1) is being used since it already has ready-made styles that can be applied to the HTML page.

A template-engine called Handlebars has been used to help developers so they are able to edit the contents of the HTML page easily. Some repeated codes - such as navbar, footer and head – can make each HTML page long and messy. Therefore, they have been separately put in a partials folder, and then integrated into the main website using Node.js.

Handlebars also helps in making the HTML pages dynamic so they can be given variables and rendered according to the needs of the user.

**Back-end**

The backend of a website is a very important part of any website since without good logic, a website is full

of bugs and prone to getting hacked easily. The backend for this website has been made using JavaScript, mainly its runtime environment called Node.js.

A Node.js framework, called Express.js has also been used. Node.js is a server that will run the code you write without using a browser. It acts as a server that will host the website.

By using Node.js, we can connect with Handlebars as well as our database. Node.js is mainly being used to link each of our HTML pages with each other. It handles the navigation logic of the website by using a “.get()” method. Whenever the user clicks on a different page, a get request will be sent to the server, and Node.js will render a page according to request.

An Express.js framework called express-session has been used to deal with the login status of the user. In the website, different pages should be shown to a user that has logged in and a user that hasn't.

This framework helps us store the current user's status and then pass it on to the get requests, so that Node.js can render the appropriate page. On the buyer's page, a list of all available products is rendered if the user is logged in. On the seller's page, a form to sell another product, as well as the products yet to be sold by user are rendered if logged in.

Finally, a library called 'Mongoose' has been used which acts as a connection between our Mongo DB database and Node.js.

Since Mongo DB store collections of data, a Schema or template is defined that stores the entire information of user, including the products that they are selling. This Schema has these attributes: “username”, “email”, “and password”, “phone number”. It also has an array with the products that user is selling and their information.

### Database

For a database to store all the information of the website, Mongo DB has been used. It is connected to our website and Node.js using Mongoose. A collection called “Users” has been created so that all the information of user can be stored.

The collection stores all the data of the user such as their username, password, email, phone number as well as information of the products that they have listed. There

are three pieces of information about the products that are being stored.

The first is the product name, then product description, product price and finally, image of the product.

## RESULTS

After performing some test cases we can conclude that the website is fully -functional and anyone can buy or sell the products he/she wishes to .We are not accepting payment made through online mode in the current version of website. This feature benefits in several ways.

Firstly, it can eliminate the need to handle sensitive information like bank account, otp's or passwords .This results into simpler faster and form of checkout .This also reduces the risk of online fraud and data breaching. Secondly, a website without an online payment system can reduce the cost and complexity of setting up and maintaining the payment system, freeing up resources that can be invested in other areas of the website.

Overall, a website without an online payment system can provide a more streamlined, cost-effective, and customer focused experience.

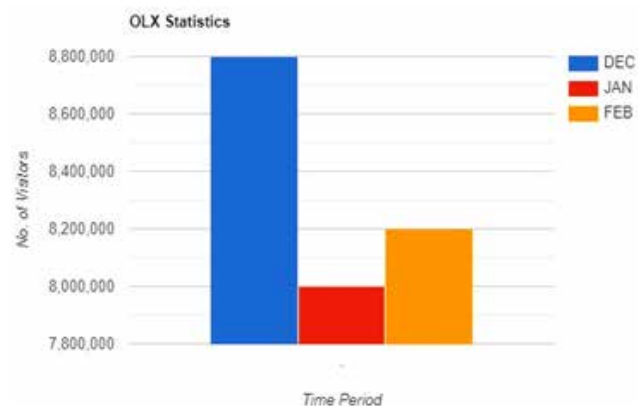


Fig. 2. Recent Visitors vs. Time data

This Graph provides a detail of statistical data of OLX Company which describes about customers visited in recent months. This implies that second hand business model has demand in the market since about 8 million people have visited it. Similarly there are many websites like eBay, Quikr, etc. which shares similar sales data.

Some Test cases were conducted to check the commerciality of website. The first test case includes login page password.



Some users tried only alphabet in their password but system successfully detected it and asked the user again to include some special symbol or elongate the password.

Another test case was conducted on user finding the required item where he /she was supposed to include category of item, price range, etc. If the filter data was insufficient, system failed to find the required product.

Table 1. Test Cases

User Registration Test				
Username	Password	Email	Phone Number	Registration Status
abc	abc	abc@gmail.com	9423423443	FAIL
abc	ab\$%65	abc@gmail.com	9423424443	PASS
def@ij	oij##sdd	abcs@gmail.com	342324	FAIL
def@ij	oij##sdd	abcs@gmail.com	2346541231	PASS
90	hef#123	xyz@gmail.com	9248562894	FAIL
ninety123	hef#123	xyz@gmail.com	9248562894	PASS
xyz123	ijkl123	xyzijk	9876543210	FAIL
xyz123	ijkl123	xyzijk@gmail.com	9876543210	PASS

This Database design includes type, length, primary key data and array required in building. Information of some basic user properties is given in the following table.

Table 2. Database structure

Database Design				
NAME	LENGTH	TYPE	PRIMARY KEY	ARRAY
User_id	24	VarChar	YES	NO
Username	20	VarChar	YES	NO
Email	20	VarChar	NO	NO
Phone Number	10	Number	NO	NO
Password	15	VarChar	NO	NO
Product Names	25	VarChar	NO	YES
Product Descriptions	100	VarChar	NO	YES
Product Prices	10	Number	NO	YES
Wishlist Names	25	VarChar	NO	YES
Wishlist Description	100	VarChar	NO	YES
Wishlist Prices	10	Number	NO	YES

2] As per the relationship diagram, entity diagram is designed to meet users need. This explains the basic

relationship between user and system interface .More the detailing greater is user’s satisfaction.

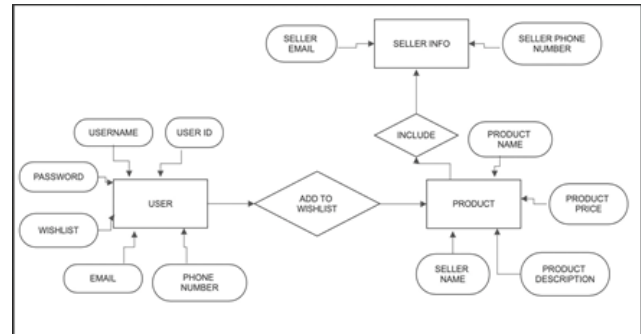


Fig. 3. Diagram for Entity Relationship

**FUTURE SCOPE**

As most of the population in India is middle class and lower class, the consumers of second hand products are going to increase in the future consistent feedback will continue to improve customer experience. System will introduce an option of refurbishing which will allow user to make his product same as new one. The personal login details will be stored on the website which will grant some special features like discounted rates, free delivery agents, etc. to the users who are using this platform frequently.

We can also add net banking, UPI for convenience of buyer as well as seller .We Shall be improving keyword research to keep a track on how many people are searching for specific second-hand products during any given time period. Since the users of the website are students, a mobile app could be developed in the future.

**CONCLUSION**

Managing the front end shopping module and proper functioning of backend module through Mongo DB framework and Node.js technology has been the main aim of system. User interface was made strong enough as well as more efficient with front and back functioning. System successfully met basic business requirements like online surfing and browsing, managing commodities of users and a proper streamlined architecture of website for professional use.

**ACKNOWLEDGEMENTS OR NOTES**

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# Rajas –M: Period Tracker App

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## ABSTRACT

All over the globe, millions of women use menstrual cycle tracker apps/period tracker apps to keep track of their menstruation period. The proposed application can be used for the same when women face difficulties to keep a periodical track of their menstrual cycle. This app also predicts cycle length by learning user characteristics. This application helps women get a proper track record of their menstrual period and take precautionary measures, following a proper diet plan during menstruation, taking some basic over-the-counter drugs, and yoga poses for getting a bit of relief from Dysmenorrhea, etc. These features are implemented with the help of Application Development Software which is Android Studio

**KEYWORDS:** Digital health, Mobile application development, Cycle length, Fertile window, Menstrual cycle tracker.

## INTRODUCTION

Globally millions of people have adopted technology for keeping a track record of their health and habits.

The technological advancements in the field of the Health Sector have provided ease for human society in keeping themselves physically and mentally stable. With the help of digital health applications, one can live a prosperous and healthy life in today's world with such a rapid pace of life. There are several applications available for doing exercises, yoga, getting proper medications, and tracing health parameters. One kind of application is the Menstrual Cycle Tracker Application, which helps women worldwide to keep an eye on their menstrual cycles. With the help of such applications, women can be acknowledged by taking proper precautionary measures, diet plans, and basic medications to be taken during menstruation. For the same purpose proposed an application named 'RAJAS-M: MENSTRUAL TRACKER APPLICATION'. The name RAJAS is a Sanskrit word that means menstruation. Before starting the development of this application, A survey of a few women as well as girls

who were practicing the menstrual tracker application for a long.

Discussed the problems faced by women during the menstruation period and collected feedback from them about an application that they were using for period tracking Gynecologist suggested the basic medications and the various yoga asanas to be performed for the pain (Dysmenorrhea) caused in the menstruation period. The track can be kept on the cycle length as well as you can also add a note on that day in the calendar about the ovulation of fertility window on that day as well as your physical condition on that day which can further be shown to the gynecologist if needed. This feature is to document the symptoms and moods felt by the user on days of Mensuration in a day-wise manner. The application provides a basic overview about what are the precautionary measures to be taken during that period as well as various methods to counter menstrual pain and suffering.

There are various such applications available such as Kindara, Clue, My Tracker, Ovulation and Period Tracker, etc. These all provide various features like Dates prediction, Notes, and Pregnancy Conditions.

They also provide exporting documented data to the Doctor, Water Alarms, and Record Symptoms. Many users are using these applications worldwide. It helps women to be hygienic and feel comfortable throughout their menstrual period.

Though there are so many applications available there are a lot of drawbacks to these applications. As there is no accuracy in the data entered by the user the prediction of the upcoming dates may be wrong. There is no feature for the tracking Menopause period as the physical conditions are different. Also, many women are under PCOS (Polycystic Ovary Syndrome) period, and the application does not work in those situations. As for women in the PCOS period, there are many fluctuations in Ovulation, and the pregnancy notification feature does not perform accurately. The diet feature is also not included in the applications which is an important factor in the menstrual period. The personal as well as menstrual data entered by the user in these applications is not handled safely and is leaked in many cases which can be used for performing some brutal operations such as abortions.

Here is a statistical data report

Graph (1)

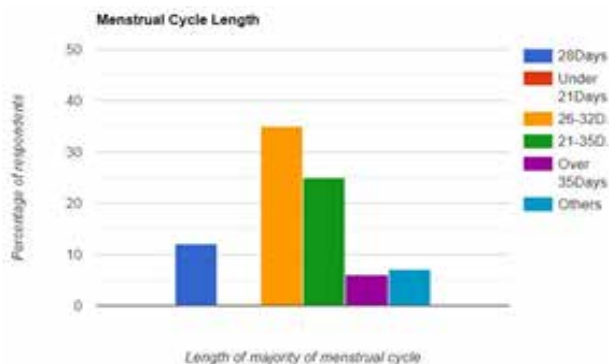


Fig. 1.

## LITERATURE SURVEY

This paper is based on hidden (Semi-) Markov models, which uses two methodologies namely the Forward-Backward algorithms and Viterbi. The most probable chronology of the hidden states is defined by the Viterbi algorithm. The prospect of each state at every particular time point is given by Forward-Backward algorithm. This paper talks about the hidden semi-Markov model

in its fundamental form that perfectly explains the existing knowledge for menstrual cycles, pregnancy and ovulation. They have used and hierarchical/statistical approach for the adaptation of the changes in menstrual period tracking behavior. [1]

This paper analyzes how researchers can be involved into the information study loop which could help the users to get more awareness about their health condition, and improve the quality of life as per the research organized with collected data. Women who use these menstrual period tracking applications may have competence and knowledge from their own acquaintances but in this paper, research has been done on Human In The Loop Data Analytics popularly known as HILDA and visualizing community for the wide range of data. They have researched and studied different ways of making it more comfortable to use for a variety of users to engage with broad statistical data. Some primitive design guidelines were introduced for various system that supported this engagement and gave a brief description about their schemes to assess and work on the same through a variety of workshops focusing on designs. [2]

This paper is study on how menstrual period tracking application provides women the information about various aspects such as period dates, ovulation day and fertile window compares to the most probable anticipated results derived from vast amount of the data. These applications are enhancing women's health and focusing on women related health ailments. The inclusion and exclusion criteria were decided to order it in decreasing order selected in application stores. The compatible records for each woman recorded in these application were 6 days of menstruation, aged 35, weight, and height was predicted from national averages of the UK female at 71kg (11 st 2 lbs) and 161 cm (5 ft 3") . Further study of menstrual cycle length was shoulder to observe that how cycle length changes. Predictions were allowed for the changes in a menstrual cycle length over a time for an independent woman on particular applications. [3]

This paper showcases the actual potential of the period tracking apps and brings up the positive impact they have on women's health. But it is mandatory to be conscious about the limitations of application based on

menstrual period tracking and ensure the accuracy of the system.

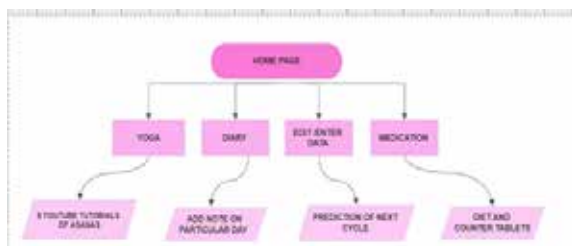
1. The study also ensures how responsible these period tracker applications are and trust they have built within women. Wrong prediction may lead to severe impacts like mental stress, health issues, etc.
2. These period tracker applications must be a transparent source of information as well as they must access the personal information entered by the user carefully as they should not be leaked in public. The transparency should be maintained for predicting the menstrual cycle dates as well as the terms and policies for data protection.
3. Though there are many famous publications, there is a need of a thorough discussion and research on the menstrual cycles. There is a need of deep study in the subject as there is a lot to be considered for a menstrual cycle tracking application. [4]

The topic of MCTAs (Menstrual Cycle Tracking Applications) talks about the menstrual cycle, family planning, menses, family planning methods, fertilization, endometrial cycle, fertile, conception, fertility, conceiving, ovarian cycle, time-to-pregnancy and applications like smartphones, mobile phone applications, convenient and handy software and electronics, application-focused. After analyzing these articles, the particular realms for this assessment are attributes of Menstrual Cycle Tracking Applications users in the research on fertility, contraception and menstrual cycles. Precision of spotting ovulation and utility for promoting and preventing pregnancy previously published quality reviews of Menstrual Cycle Tracking Applications. [5]

**METHOD**

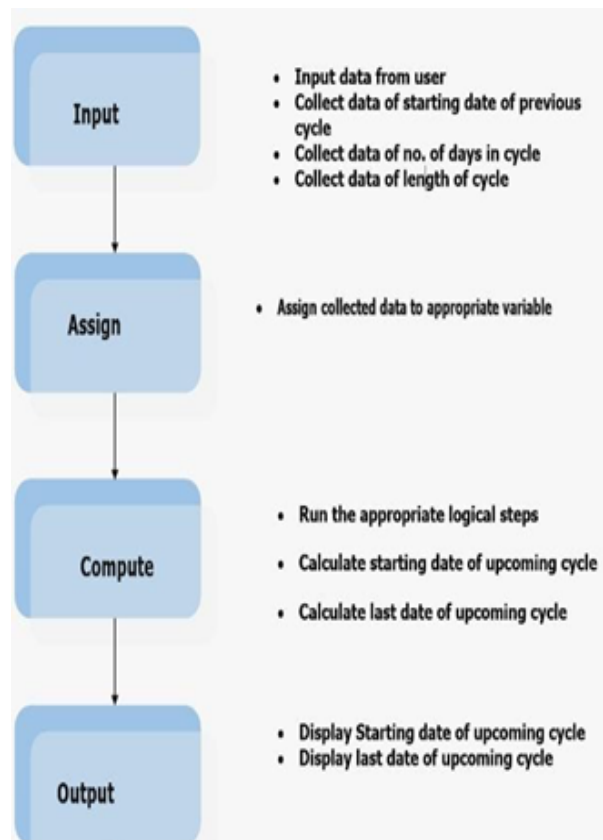
**Characterization of the application**

Diagram (1): Flow Chart for home page



**Fig. 2.**

We first talked to different women and girls to know their problems both while using the period tracker application as well not using such applications. Based on the data recorded by us, we tried to cover all the needed and fundamental features of the application. The application is created with the Android Studio software which is very easily accessible and usable. The JAVA and XML programming is used for this purpose. XML programming is used for declaring the layouts of the application. It is used for designing the application. The JAVA programming is used for providing the logical code and performing all the functions. Various JAVA functions such as (android.os.bundle), (android.content.Intent), (android.widget.EditText), (android.widget.CalendarView), (android.widget.TextView), and data variables are used in it. Several function classes are bring imported for writing the program. Conditional Functions are also used for the programming of the calendar which is provided in the application. The flowchart of the working of application development programming goes as:





The features which are provided by the application are:  
-

- 1) This application provides a function that predicts the upcoming date of the next menstrual cycle by taking data from the user.
- 2) The application also has a feature to help keep track of mood swings and other symptoms in form of notes corresponding to a date.
- 3) The application provides an ideal diet to be followed during the menstrual period.
- 4) The application suggests various yoga poses which have been proven to be beneficial for menstrual health and also provides tutorials for the same.

## RESULTS AND DISCUSSION

### Tracking the dates of menstruation

The application allows users to mark the cycle length i.e., the date range on the calendar provided in the application. It also provides adding notes on the respective date through which the user can get an idea of the physical condition on that respective day. Also, the user can give that data to their gynecologist for a follow-up of the user's menstrual condition.

### Basic Medication

This application also provides the user a list of basic Over Counter Tablets which can be consumed on having menstrual pain and get relief. Several over-the-counter medications can provide relief for menstrual pain. Some of the most used medications include:

1. Non-Steroidal Anti-inflammatory Drugs (NSAIDs): These are pain relievers and reduce soreness. Examples include ibuprofen, naproxen sodium, and aspirin.
2. Acetaminophen: This is a mild pain reliever that can be used to reduce menstrual pain.
3. Heating pads: Placing a heating pad on the lower abdomen can help relieve cramps.
4. Vitamin B1: This vitamin has been shown to reduce menstrual pain in some women.
5. Ginger: Ginger has anti-inflammatory properties and can help relieve menstrual pain.

It is important to note that everyone's experience with menstrual pain is different and what works for one person may not work for another. It is also important to consult a doctor before taking any new medication or making any changes to your treatment plan.

### Yoga Asanas and Proper Diet

The user gets a complete tutorial of different yoga poses such as 'Baddha Konasana', 'Janu Shirshasana', etc., to be performed to get some relief from menstrual pain. This application also provides a diet plan to be followed in the Menstrual Period which consists of nutritious food which is rich in antioxidants, iron, and fiber to naturally decrease inflammation.

## FUTURE SCOPE

The application shall also notify the user to take care of Hygiene needs and notify at fixed intervals on the day of menstruation. There will be an option named "For My Friend" for the mother for keeping the track of her daughter's menstrual cycle as nowadays menstruation starts at an early age of 12- 13. The calendar in an application will provide the feature to add important upcoming events so that the user can know if the event dates are clashing with the menstruation dates. There will be a sharing tool through which the user can send their report of menstruation to the Gynecologist on WhatsApp, etc.

## CONCLUSION

This paper suggested the potential of menstrual cycle tracking applications. The proposed system tries to help thousands of women with their menstruation period tracking as well as acknowledging them for taking some precautionary measures for the same. This application provides them with technical assistance for period tracking.

## ACKNOWLEDGMENT

The authors of this paper are deeply grateful to the women whom we surveyed who helped us know their problems with menstruation. We would also like to thank our project guide Swati A. Joshi for supporting us and helping us understand the project deeply at every point.

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# Voice based Intelligent Virtual Assistant for Windows

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## ABSTRACT

Nowadays there are various improvements in the field of Automation. Developing technology which will reduce human efforts without changing the accuracy of the end output is the main goal of the developers in this field. Keeping the same goal in mind the proposed system. 'Voice Based Intelligent Virtual Assistant for Windows' focuses on reducing human efforts by taking commands in voice format given by the user. The definition of a Voice Assistant is obtained from progresses in artificial intelligence and speech recognition as well as natural language processing. The developed system which we name as 'JK' is built using python which is one of the most popular programming languages in the field of Artificial Intelligence and Machine learning. By including multiple libraries like subprocess, pytsx3, json, random, operator, speech recognition as sr, datetime, Wikipedia etc, system is capable of doing a wide range of tasks by taking user's voice as in input command. The system is capable of taking pictures, opening different applications, playing music, opening files located at different locations, taking notes, changing wallpapers, having random chats with the user and performing many more functions.

**KEYWORDS:** *Python; Virtual assistant; Speech recognition; Desktop; Personal assistant; Voice assistant; Artificial intelligence*

## INTRODUCTION

In the past events, humans depended on other humans for help or services. The globalization of technology ensured that today, people don't need to ask anyone else for aid, they may rely on a gadget that is far more effective, dependable and also can take care of their daily requirements.

Speaking of the modern-day situation, absolutely each person desires to keep itself away from doing boring work. To this end, we've got created a project called "Virtual Voice based assistant for Windows" that lets us to control our duties surely via way of means of speaking a command. We are actually applying this concept in many tasks like Google's assistant, Siri and Cortana, etc.

The activity of a voice is described in 3 stages: 1. text to speech; 2. Intension to speech; 3. Intension to action. Virtual Personal Assistant has nearly grown to be a primary necessity in all digital gadgets if you want to

execute the desired problems easily. More than simply being a bot, VPA could make lifestyles easier for the consumer in numerous ways. AI-based language assistants are useful in many areas IT help desk, home automation, HR tasks, etc. Language-based searches will continue, to be the future for the next generation of people.

Given the usefulness of PVA, its use density is increasing rapidly. For example, 21% of the US population owns at least one smart speaker and 81% of adults own a smartphone. Therefore, it is very likely that the user is always within range of at least one of his PVA. Virtual desktop assistant that we have developed is using Python as it offers various libraries that we can use it for making a virtual assistant. Sapi5 and Espeak of Linux may prove helpful for voicing our machines.

## LITERATURE REVIEW

The proposed system conducts a personal voice assistant security and privacy survey. The main aim

was to focus on developing measures which will make the voice assistant more secured to use. Since all the commands are received in the form of voice, privacy issues may rise as voice recordings may reveal sensitive user information.

The main focus was developing an authentication system which will differentiate between the user and an attacker.

The following research proposed an Artificial Intelligence based virtual assistant where the main focus of their system was to develop a simple to use Voice User Interface(VUI). The system they proposed was capable of opening different applications, searching on google. It can even extract the current location of user and send it to user's family in case of any emergency.

A Virtual Assistant using Artificial Intelligence is proposed in this paper. The main goal of the system is to execute more commands as compared to other Voice assistant in the market. But one of the limitations of the project was the time taken to execute the commands was comparatively higher than other assistants. Complex algorithms with higher time complexity are used which is one of the main reasons which leads to more time consumption while executing different commands.

A systematic literature review on Virtual Assistants for Learning has been put forth in this research paper. The main focus of the paper was to study and analyze the role of virtual assistant(VA) in the field of higher education in order to understand how VA can help students in time management and other aspects of education. It also covers points regarding different techniques which can help to develop a VA.

The proposed has deeply explained the concept of Desktop Assistant. The paper focuses on the main challenges faced by the desktop assistant which need to be addressed in order to build an efficient desktop voice assistant. Future scope of the system is also discussed under which the authors have mentioned improvements required in the existing system. One of them being interfacing the desktop assistant with IOT technology which will revolutionize the Automation industry.

This essay examines how artificial intelligence is becoming more prevalent in daily life, particularly in

the form of voice assistants that can understand natural language.

Using open-source software modules, the design and implementation of a digital assistant are discussed, with an emphasis on flexibility and the simplicity of adding new features. The assistant relies on verbal input and tries to relieve the user of pointless manual labor. Ultimately, the article demonstrates the potential for voice assistants to promote natural human-machine interaction.

Voice control technologies and virtual assistants are quickly evolving, with increasingly sophisticated cognitive computing capabilities enabling for multilevel requests and complex tasks. Virtual assistants, being programs based on cloud, need internet-connected hardware or software to run, and the data they produce can be used for machine learning and artificial intelligence. The proposed system can ease interactions with other programs and modules while supporting organization, and it has the potential to transform how we engage with our gadgets and carry out daily chores. This study provides as an example for advanced applications in the automation area.

The study of human and script communication is the subject of natural language processing (NLP), a relatively new field of study in computer science and artificial intelligence. The following research works in the areas of Text-to-speech and automatic voice recognition to improve voice recognition technologies. The study involves computational and numerical modelling of many elements of language.

By employing multi-modal communication channels, such as speech, graphics, video, gestures, and more, the proposed system seeks to improve interaction between people and computers. The system offers a natural dialogue experience by integrating technologies like gesture and picture detection, speech recognition, and knowledge libraries. This technology is applicable in many different industries, such as education, healthcare, robotics, and home automation, among others. The new VPAs model will provide human-human communication a cogent framework, making it an important tool in the quickly expanding field of interactive conversational systems.

In order to address the shortcomings of current approaches, the following study suggests a powerful voice recognition system that makes use of machine learning. The goal is to develop a Virtual Personal Assistant (VPA) that is more useful and effective for everyday use. Although the system is very effective, jobs might take longer to finish than with other VPAs, and future improvements might be difficult due to the intricacy of the algorithms. VPAs are a rapidly expanding field whose main objective of AI is to increase accessibility of human-computer interactions. In order to lower error rates, the suggested system takes a novel approach by combining both visual and audio information.

The proposed report looks at how new technologies might be used to build a smart Virtual Personal Assistant (VPA) that focuses on user-based information. It looks at examples of intelligent software that uses natural language processing and various types of help today. The research makes the case that virtual personal assistants may become a reality soon thanks to new technologies. It offers proof that a fundamental VPA with natural language processing algorithms and the capacity to operate without requiring human input or programming is presently feasible based on experiments and user testing.

The voice-controlled personal assistant described in this study features several functional modules, including voice control, character recognition, and virtual assistance. The assistant has been properly constructed and evaluated and utilizes AI and data analytics to give a personalized user experience. The proposed Raspberry Pi-based assistant offers ease and simplicity for impaired users. The paper emphasizes the potential of voice assistants to improve natural human-machine interaction.

This study proposes an application built for people with communication difficulties, such as autistic children, using a PDA with 120 symbols based on daily life. Users can use the PDA's camera or voice recorder to create their own icons using the application's two modes, Supportive and Self-use. According to the paper, the application might be helpful for people who have a variety of communication challenges and might

promote a society in which people support one another regardless of disabilities.

The construction of a robotic system that the operator may command through speech and gesture inputs is discussed in the paper. The system includes a gripper arm for object manipulation and uses Google text to speech API and Grassfire algorithm for controlling its basic locomotion. The goal is to build a working prototype of an automated personal assistant that can be used in domestic and industrial settings to increase productivity while minimizing human effort. Speech processing, gesture control, and image processing are the three main areas of the robot's operation.

Please embed tables and figures in appropriate areas within the document and center them horizontally. Tables and figures should not exceed the given page margins. Provide captions (maximum length: 6 to 8 words) for each table or figure. Centre the caption above the table and below the figure. Please reference the table or figure in the text (see Table 1). Please do not use vertical lines in tables. For figures, GIF and JPEG (JPG) are the preferred formats.

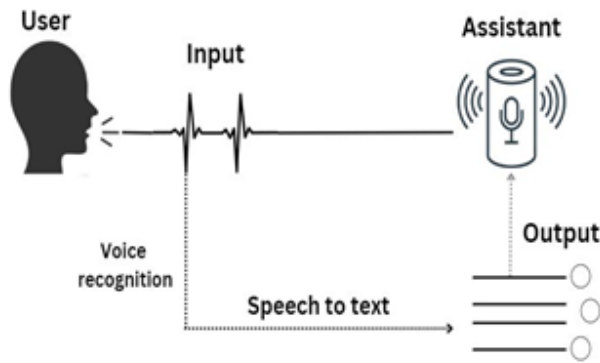
## METHODOLOGY

Python-based voice-based virtual assistants use a variety of Python-built libraries. The main libraries used speech recognition, pyttsx3, Wikipedia, datetime, time, web browser, random, tkinter, wolframalpha, and so on. We chose the libraries based on the requirements.

These libraries function in two ways: the first is to provide data required for the assistant, such as the time and date, and the second is to perform the required tasks in different functions used by the assistant. We created various functions to perform various tasks. These functions take the query as input, which is taken in the form of speech from the user.

The voice-based virtual assistant works by accepting commands from the user using the speech-recognition library in Python. After accepting and recognizing the user's commands, they are converted into a query using pyttsx3, and this query is passed into the various functions we prepared for the assistant's operation. The basic working principle is that we take a spoken command, convert it to text, and then pass that text as input to our program.





**Fig. 1 : Flow of the system**

The flow of the system we used in our virtual assistant is depicted (see Fig. 1). The AI looks for keywords within the query and then executes the function. The functions designed to perform various tasks also make use of Python libraries, such as Wikipedia, which is used to provide the user with information about anything directly from Wikipedia in the form of speech without having to navigate to the Wikipedia page through any browser. If we give the assistant permissions over the device, the assistant can also perform functions such as shutting down the system or sending it into sleep mode. The various functions used include playing music, opening different applications (such as PowerPoint, word, excel, etc), taking notes, screenshots, and starting the camera. For opening a particular application or playing a music individual functions are created where we need to pass the folder path of these applications as the parameter of the function. For ex for playing music, we assigned the folder path where the music is located to a variable `music_dir`. Then using the `os.listdir` function we pass `music_dir` as a parameter which returns the songs of the folder and using `os.startfile()` the system plays the song. The function `os.startfile()` available in the `os` library in python is the important function used to open all applications once the path of the application is known and passed as one of the parameters of the function `os.startfile()`.

We also included the function for converting text files to audio using the assistant. The function `speak()` is used to convert a text message into audio. It is used if we want our virtual assistant to react in a particular way in a certain situation. For example, while writing a greeting

function we want our VA to say some sentences like "How are you? "Etc so in this scenario the `speak()` function comes into picture.

The system also allows users to write a note and view the written note. For achieving this we open the file using `open()` function in write and read mode respectively. One of the parameters `open()` function needs is the name of the txt file that needs to be created for writing the note and the mode of the file is the other parameter needed.

The main technologies used in our research are speech recognition and natural language processing. Various algorithms such as PLP features, the Viterbi search, deep neural networks, discriminating training, and the WFST framework, are used by this kind of technology.

A subfield of artificial intelligence, computer science, and human language is known as "natural language processing," or NLP. The development of technology has made it possible for machines to decipher, study, manipulate, and understand human languages. Topic segmentation, giving automatic summary, named entity recognition (NER), audio recognition, and translation are some of the tasks it helps organize knowledge for.

The following table gives us an overview of the features and the drawbacks of similar projects and cited materials.

**Table 1 : Comparison of existing Voice Assistant Systems.**

Title and Reference	Features	Limitations
AI Based Voice Assistant	Capable of translating multiple languages as specified by user.	Limited command-keyword list, leading to smaller range of executable commands.
Desktop Virtual Assistant	Able to perform a wide range of simple, direct actions like web search.	Unable to perform system related actions like shutting down or restarting.

Study of Voice Controlled Personal Assistant Device	A server for updating data to Firebase cloud. Also, IoT implementation for allowing connection of smart devices.	Complex data flow structure results in more time consumption for each command and hence less efficiency.
Viv - The Personal Voice Assistant	Assistant settings can be changed at runtime	Provides only basic functions to facilitate ease of access for the disabled.

To summarize the features which will overcome the limitations pointed out from the cited material, this system will provide the following functions:

1. Data fetching and decoding structure is simple and hence time required for execution of each individual command is reduced.
2. Includes a wide range of commands and key-word command list which increases the versatility of the VA.
3. Easily perform system related actions which includes shut down, restart, sleep mode, etc.
4. Perform all the basic functions of an assistant in a fast and efficient manner.

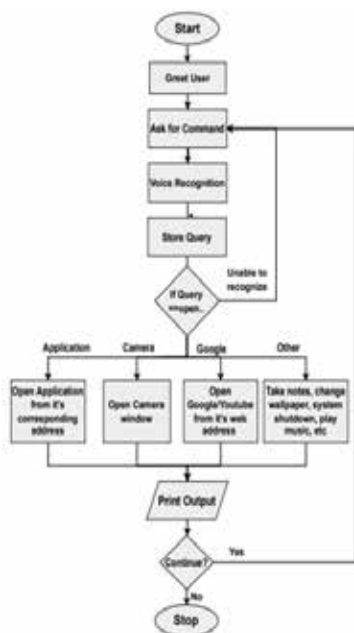


Fig. 2 : Flow of the system

## RESULTS

Following are the outputs of various plausible commands that are executable by the assistant:

Table 2 : Accuracy and efficiency of the proposed system

Task	Time taken (in sec)		Average time taken T	Accuracy (Out of 5 attempts)
	T1	T2		
Open Power Point	8	5	6.5	4
Having chat	4.73	6.45	4.54	5
Take a note	4.52	4.56	4.54	5
Play music	4.35	4.65	4.50	5
Show a note	4.53	4.81	4.67	5
Open YouTube	4.25	4.69	4.47	4
Open Google	5.13	15.65	10.39	4
Take a picture	8.94	7.49	8.21	5

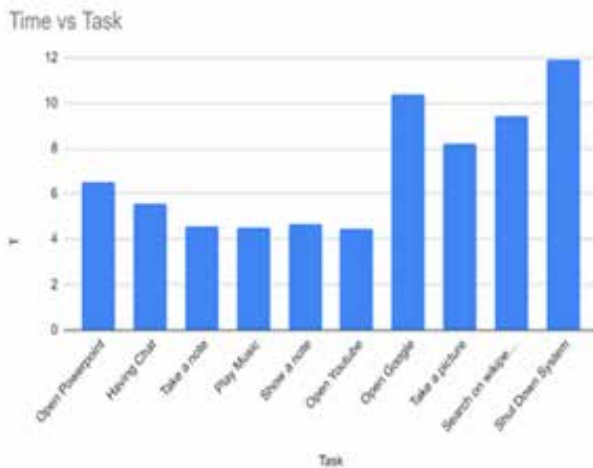
T1 = 1st reading of Time required to execute a command

T2 = 2nd reading of Time required to execute a command

T = Average of readings T1 and T2.

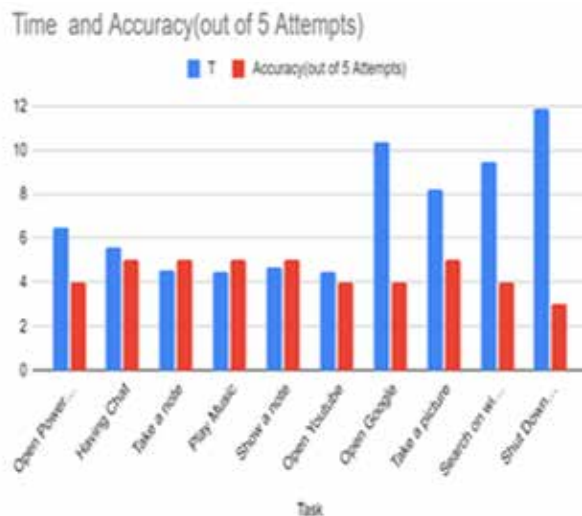
The necessary Python programming language packages were installed, and PyCharm’s Integrated Development Environment (IDE) was used to write the code. The outputs we have received from our AI-based voice assistant are shown below. The Python code we developed runs in Python 2.7 and Python 3.x. Due to how business has changed over the past few decades, virtual assistants have become more and more common. Many businesses are preferring to invest in flexible work arrangements and schedules rather than spending money on enormous office buildings and overworked personnel. As a result, team organization and project management are now more modern and agile.

## DISCUSSION



**Fig. 3 : Efficiency of the system**

(See Fig.3) the Time vs Task i.e., it represents the time required to perform a given task, from recognizing the command to executing it. On observation, we can infer that direct system related tasks, like shutting down the system as well as tasks related to searching on internet are a bit longer as it takes some time for processing the sequence of execution.



**Fig. 3 : Accuracy of the system**

(See Fig.4.) It represents the average time required to perform and complete a task and the accuracy with which the task is performed. The readings show that

the accuracy for all the commands is somewhat similar, which depends upon the recognizing capacity of the VA and the clarity of the user's speech.

## CONCLUSION

PVA is now ubiquitous and is dramatically changing the way users interact with laptop systems. Customer is increasingly relying on PVA as the primary, or perhaps only, interface to laptop systems and intelligent environments. As a result, the safety of these devices has become the focus of public attention and research efforts. Similarly, privacy is an issue for most users. In our project we have used many other functions compared to other virtual assistants. Voice assistants are helpful in many areas with the education, daily use, consumer electronics, etc. and are becoming more and more advanced in our daily lives.

Many companies are working to improve their language assistants' interactions and upgrading other features, and a lot of young people have started making use of voice assistants in their daily lives from many sources, the results show positive feedback. A lot of advancement is shown in language assistant from the past 2 years. Voice assistants can also be an advantage for the people who can't read or write. Thanks to the AI based voice assistant for paving the way for the users.

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# Finding the Pollution Free Path using Air Quality Index

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## ABSTRACT

With increasing industrialization and large-scale urbanization pollution has become a greater threat to mankind. Due to increasing pollution people are suffering from different health impacts like loss of hair, respiration problems, and heart problems. Recently air pollution has increased in most of the major cities of India. It is important to know the environmental conditions on our daily travels. In this paper, we are highlighting the effect of the Air Quality Index (AQI) on humans, where the AQI is calculated using the factors that it depends on. This knowledge will eventually help to suggest a good and safe path from which pollution has less effect on the health of humans. To find the shortest path between start and end destination of user and for pollution free path we are using A\* algorithm. First, the real data is gathered from the public or private organization. The database will then be used to store this data for analysis. The user will then be presented with a variety of potential routes between the source and the destination, and must ultimately decide between the shortest and the safest route. To solve the problem of pollution we have proposed a solution of pollution free path. To calculate minimum distance among chosen path and for the safest path we are having A\* Algorithms.

**KEYWORDS:** Air quality index, A\* Algorithm, PM-2.5, Air pollution.

## INTRODUCTION

Our main focus of this project is to detect routes which will have minimum air pollution. There is quite a lot of research done on the premise of Air pollution. Many researchers try to identify the factors responsible for Air Pollutants. Pollution is a mixture of debris and gasses which are not generally seen within the air due to its micro size. An air quality index (AQI) states that the air pollution is based on concentrations of five main pollutants: floor-stage Ozone (O<sub>3</sub>), Particulate matter, CO for Carbon Monoxide, SO<sub>2</sub> for Sulphur Dioxide, and NO<sub>2</sub> for Nitrogen Dioxide [2]. Particulate count (PM) is the time period for aggregate of strong debris and liquid droplets inside the air [4]. It has been observed that traffic related pollutants, mainly CO, have negative outcomes on the health of humans beings do outdoor sport to be healthy, however the existence of outside pollution can have adverse effects.

In order to solve this problem of pollution we have proposed a solution of pollution free path. In order to do that we have to locate positions on a map. For this

task we have used an open street map. For finding out pollution free path we have A\* Algorithm.

## LITERATURE SURVEY

Pranav Shriram et al[2] showed how to analyze air quality index and what is the impact of it on general people. Air pollution creates multiple health impacts and is a serious problem. It might be short and long-term. The major air pollution is impacting children and adults. Short- or long - term air pollution exposure can cause serious health issues in children and adults-like reducing lung function, respiratory infection, headache, asthma, and hair losses, etc. Considering this it shows the average AQI of traveling routes, it has an effect on us and if it reaches the danger zone then they are also proposing alternate safe routes using AQI [1].

Enho Sun in his work successfully demonstrated that A\* Algorithms can be used to demonstrate pollution free paths. He used A\* algorithm and successfully interpolated its graphs. In his demonstration he used sensors for detecting pollution free path and then he used it as backend and interpolated it in graph using A\*



algorithm. In conclusion, when the distance is small, A\* performs similarly to Dijkstra based on runtime. When the distance grows, A\* runtime is likely to be dominated by computing the heuristic function, which includes numerous sine and cosine calculations. When a result, as the distance grows, A\* would have a longer runtime than Dijkstra. While the improvement is not very noticeable for short distances, bidirectional search may speed up the A\* in search of progress. With the use of an acceptable heuristic function, A\* consistently extended fewer nodes than Dijkstra in terms of the total number of nodes. [2]

Yun Cheng et al [4] demonstrated how to successfully collect CO<sub>2</sub> data from a live server and to use it in implementing pollution free paths. On the cloud side they used a number of data analysis algorithms and artificial intelligence. They take a new approach using cloud-based data analytics to tackle the difficult challenge of accurate and reasonably priced PM-2.5 monitoring. By carefully designing and building their own PM-2.5 monitors – Air Quality Management(AQM) and miniAQMs. They can get reasonably accurate PM-2.5 readings in real time and at a minimal cost. And by combining their data, as well as other sorts of data in the cloud, they were able to learn and build a model for particulate matter, which lets us calibrate AQMs and miniAQMs, as well as infer PM-2.5 concentrations. In a real-world deployment using our cloud-based Air-Quality Analytics Engine, they demonstrated a combined improvement of 53.6%. Together, AirCloud can provide high accuracy at a considerably less expensive price than previous systems.

[3]Hernández Paniagua et al. [7] evaluated individual Vulnerable to PM-2.5 in transportation microenvironments. During a single journey, the average human exposure to PM-2.5 ranged from 16.5 g/m<sup>3</sup> for walking to 81.7 g/m<sup>3</sup> for cycling, according to an assessment of five modes of transportation and two routes. While walking and CC had the lowest exposure concentrations, bikers were found to have the highest. They discovered that commuters in private cars absorbed less PM- 2.5 per kilometer than commuters in public buses. The increased PM-2.5 intake on diesel buses was probably caused by the cabin's open

windows recirculating exhaust pollutants. This result is consistent with findings from the United States and Europe, where public transportation is often used. Five transport modes from TAX to MAQ and three modes from MAQ to TAX had PM-2.5 data recorded for them. Travel times between routes for all means of transportation did not differ significantly ( $p > 0.05$ ), allowing for the elimination of route traffic impacts and the comparison of eastward and westward journeys separately. The trolleybus took 0.30 hours to get there; walking took 1.07 hours. Every time series for PM-2.5 displayed a log-normal distribution [4].

Li et al. [10] conducted a detailed study on optimal multi-meeting-point route inquiry in road networks, which was prompted by a real-time ride-sharing service. It seeks to discover the optimal route from source to destination while minimizing the average weighted cost between the cost of the path and the overall expense of the shortest routes from the query nodes to the path [5].

## METHODOLOGY

For calculating air pollution index from source to destination we have taken help of an open source available API. Based on pollution parameter we have shown minimum distance from source to destination using A\* algorithm users need to pin to the source and destination point on the map on the website. After that A\* plays their respective roles for finding the pollution free route (in terms of PM-2.5 and CO<sub>2</sub>) and Shortest Path (in terms of Distance) and shows the different options of route for travel. There are two ways of mode for traveling for users, i.e., by means of Bicycle and Walk. In addition to plain road view, we add satellite view in map. The factors (CO<sub>2</sub>, PM-2.5) are taken into consideration for calculating AQI of the particular region, and it helps to find an Air Pollution Free route.

In Figure 1, with the help of OpenStreetMap, which is a free Wikipedia world map that provides global map data, we obtain a road network system. After collecting PM-2.5, CO<sub>2</sub>, latitude and longitude data and with the use of A\* Algorithms are able to get AQI in a given route of travel. We are also able to calculate the different routes available, and route options with different modes of travel (walk or on bicycle).

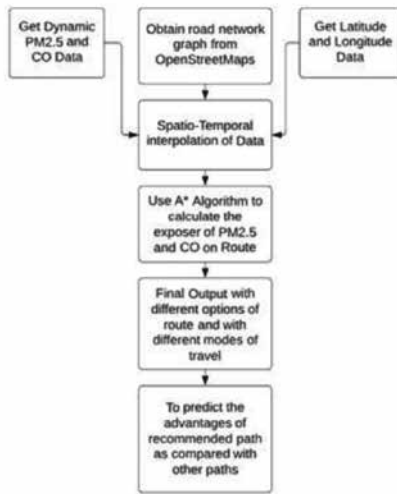


Fig. 1. System Design

Mathematic Model

The A\* Algorithms help users to determine the best route to travel to a specific destination. People enter into the interface information about their location of origin to a destination with requirements on when and where they want to arrive. The algorithm questions which travel routes are best suited to their location as well as their needs, taking into consideration multiple factors like health, pollution, public transportation, and being well connected to other options. We have taken CO<sub>2</sub> and PM-2.5 as parameters to detect pollution free paths. While traveling mainly due to incomplete combustion CO<sub>2</sub> is released.

PM-2.5 is mainly concentrated in traffic zones due to a lot of air pollution, dust. Considering their adverse effect on human health we have decided to consider these two parameters for calculating air pollution. Here in Table 1[1], it is given the ranges of AQI on what level it is defining the Air Pollution.

Table 1[1]

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Computing API

We have calculated the air quality using below formula:

$$I = (((A_{High} - A_{Low} / C_{High} - C_{Low}) * (C - C_{Low})) + A_{Low})$$

Where, I = Final value

A<sub>High</sub> = Breakpoint for the index corresponding to C<sub>High</sub>

A<sub>Low</sub> = Breakpoint for the index corresponding to C<sub>High</sub>

C<sub>High</sub> = Breakpoint for Concentration >= C

C<sub>Low</sub> = Breakpoint for Concentration <= C

C = Actual value of pollutant present in that area.

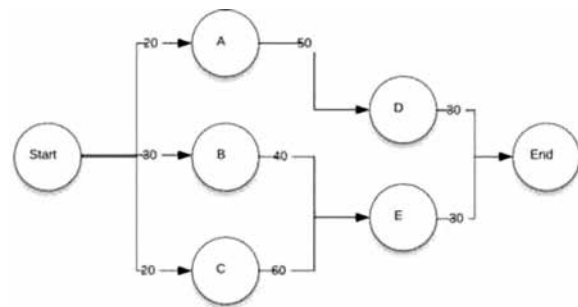


Fig. 2.

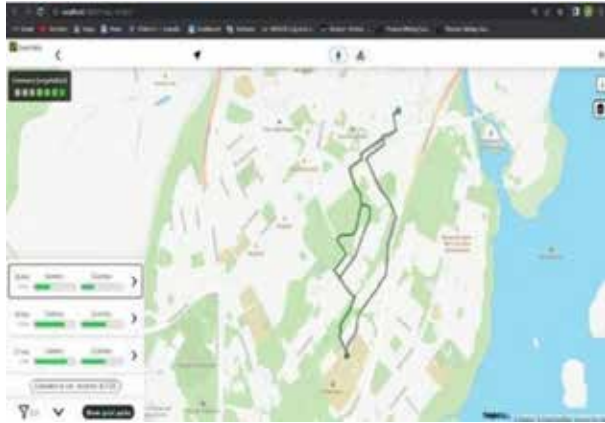
In above Fig 2, suppose we want to go from start to end, and we have 3 choices for routes like from A- D, B-E and C-E. The value in route denotes the Air Pollution, calculated based on factors considered. Now from A-D pollution is 100, from B-E pollution is 100, from C-E pollution is 110, so the system ignored the C-E route, and gave the recommendation for another two routes. But as the case above, if the value is same, then minimum distance will be considered as a factor here.

RESULT AND ANALYSIS

In Fig. 3, we can see apart from Green paths, which is our title of the website, longitude and latitude degrees of selected nodes, satellite view, and last find fresh air paths button is set origin and set destination path. Basically, if a user wants to go somewhere, he can search accordingly and choose the modes of traveling either by walking or riding on bicycle, but first most important is setting the destination node on our website.

In the highlighted Green point, we basically give the destination mark. The one who chooses the destination will show them in green color. Also at the bottom left

corner, users are able to see the different paths available, with given information of greenery and quietness, with distance and expected time of journey.



**Fig. 3. Route Showing Comparative Study**



**Fig 4.a. Google's map      Fig 4.b. Proposed map**

With the help of Google map (in Fig 4.a) users can choose the shortest path between source to destination whereas our maps shows (in Fig 4.b) pollution free path between source to destination. Scope of the Google map is for all travelers whereas we are focusing especially on cycling, walking which is generally done within cities. Gmap doesn't show any pollution free path whereas we show pollution free path (considering CO<sub>2</sub> and PM-2.5) from source to destination.

## CONCLUSION

We demonstrated a demo version that accounts for CO<sub>2</sub> concentration while calculating the pollution-free path to the destination. We have used the A\* algorithm,

which enables route guidance with CO<sub>2</sub> exposure while moving. On the road networks in Helsinki, CO<sub>2</sub> records are geographically. Helsinki's road networks were also dynamically adjusted. The model is applicable to actual travel scenarios incorporating modes of transportation like driving, bicycling, and walking. Additionally, a full comparative study is performed, looking at the duration of the course, travel time, and overall CO<sub>2</sub> exposure. For the routes suggested by the auto set of rules, and the algorithm for the shortest route is shown from source to destination using A\* algorithm. Location is taken from graph.html files which are freely available. APIs are taken from Mapbox tokens. In this way we have achieved our goal of showing the least pollution path to the end user.

## ACKNOWLEDGEMENTS

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# A Review on Hybrid Battery Thermal Management System (BTMS) in Electric Vehicles

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## ABSTRACT

For electric vehicles, there is a substantial role of the Li-ion battery. The EV industry's explosive expansion is fueling a constant improvement in battery performance. Li-ion batteries only perform at their best within a range of permissible temperatures since they are sensitive to the working temperature. To ensure the safe operation of electric Vehicles, thermal management of a battery is essential, and it is accomplished using BTMS. Air and liquid cooling (LC), phase change materials (PCM), heat pipes (HP), thermoelectric cooling, and other basic techniques are available for BTMS. Each technique has a specific application scenario and trait. Additionally, additional hybrid cooling techniques are being developed to satisfy the needs of EVs based on the fundamental BTMS and incorporating other fundamental techniques. To demonstrate the benefits and potential of the hybrid BTMS for electric vehicles, it will be compared to the basic BTMS in this study. The assessment parameters and design suggestions are presented to direct subsequent developments of BTMS by examining its cost, efficiency, and other factors.

**KEYWORDS:** *Hybrid BTMS, Battery pack, Next generation battery, Electric vehicles.*

## INTRODUCTION

Due to its low emissions and high tank-to-wheels efficiency, electric vehicles (EVs) are gaining popularity and are undergoing rapid development.[1] However, some factors still limit the development of the electric vehicle, these include performance, cost, lifetime, and safety of the battery. The Li-ion battery serves as the most important component since it has the most impact on how well a whole EV operates.

The life cycle of the cell, safety, and risk of thermal runaway are all significantly influenced by the battery's maximum temperature rise and degree of thermal uniformity.[2]

Batteries will lose a significant amount of their available energy at high temperatures due to power loss, self-draining, and other disastrous consequences.[3] Extreme circumstances, such as high ambient temperatures, will cause high temperatures to impart thermal explosion and endanger the protection of EVs when the super heating

due to short circuit is uncontrollable. Low temperatures are destructive to charge adoption [4] capability/potency [5] shelf life and bi-directional efficiency.

[6] According to data, the amount of power that can be given when the temperature drops to 40 C is just 1.25% lower than the battery's capacity at 20 C. Moreover, the performance and cycle life of the cell decline because to variations in thermochemical characteristics throughout charging or discharging operations brought on by the uneven distribution of temperature throughout the cell, module, or pack.[7] Studies demonstrate that the capacity of the power supply loses 1.5–2% more when the thermal gradient ( $\Delta T$ ) increases by 5 °C. [8] The main objectives of a BTMS in electric vehicles are to preserve the working temperature of batteries within a reasonable range and to enhance temperature uniformity. To address this issue, researchers have verified a variety of BTMS. Both the thermal profile in the battery and the thermal response on the battery pack exterior need to be assessed. Build heat-transfer specimens of the exterior cooling system to provide a precise simulation of the



BTMS [9]. Several battery specimens help to determine the internal state of battery cells in conjunction with the thermochemical and thermal specimens.[10] The temperature of the cell during various operating cycles may be readily predicted using a spatial-resolution, lumped-capacitance thermal model that has been created.[11]

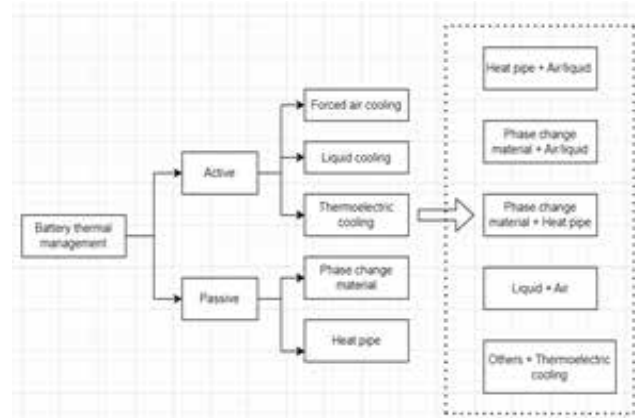
The operational temperature range and device temperature uniformity serve as the foundation for the primary assessments of each BTMS. The standard BTMS should be able to regulate the battery temperature inward a reasonable range and achieve homogeneous temperature to guarantee the battery’s prolonged secure and effective functioning. Due to the hysteresis in temperature adjustment, a BTMS with a quick reaction time is needed to react quickly to changes in battery temperature and to swiftly manage the temperature within a tolerable range.

Other aspects, like setup weight, volume, reaction time, steadiness, etc., must be considered to obtain ideal BTMS. [12] should be considered for the detailed search. The discharge rate and age limit both have an impact on how uniformly the temperature is among battery cells.[13] As a result, BTMS must be evaluated and contrasted in a variety of work settings, particularly those with challenging exterior conditions and high workloads, including deserts and polar areas.[14] To provide consistent thermal diffusion of battery modules in a variety of conditions, BTMS must be designed. High temperature points on the exterior of battery cells are a tricky problem with EVs that may be harmful, especially under difficult driving conditions.[15] Thermal runaway might occur during the overcharging test, causing the temperature to exceed the acceptable range. In some cases, lowering the pressure within the cell could be able to avert an accident.[16] The BTMS is a system that controls and dissipates heat generated by the electro and thermo-chemical reactions that take place within the cells, enabling the battery to operate securely and efficiently. To transmit the unused heat from the battery to the atmosphere, the most basic forms of BTMS employ air, liquid, heat pipe, and phase change material as heat transmission fluids or structures. [17] Each fundamental BTMS has been described and discussed in great length in previous literature [18–21] in terms of its designing, execution, evolving trends, and applications, among other things.

There are not many systematic and focused discussions on hybrid BTMS, even though several review papers mention it. BTMS might be categorized using many methods.

[19] By using an additional energy source, BTMS may generally be classified as either an active system or a passive system. Additional power is used to run fans, pumps, as frequently seen in liquid cooling systems [22] and the atmosphere (in active-BTMS) [23].

With passive BTMS, certain structures, such as PCM [24] and heat pipes [25], will be connected to the battery surface to increase the battery’s capacity for transferring heat to space. In terms of stability and complexity, active BTMS differs significantly from passive BTMS. By utilizing more complicated devices and requiring more energy, active BTMS has a stronger capability for heat dissolution. Passive BTMS may be able to meet some specific objectives, such as constant temperature and rapid reaction. Active BTMS always operates as a preferable approach, nevertheless, if the system is under a heavier heat load. To accomplish numerous objectives concurrently, it is sometimes necessary to combine various fundamental BTMSs. Hybrid BTMS is receiving more attention in research, and the unified approach has been broadly used in several contexts. In this paper, a recent categorization standard is offered to thoroughly examine the current BTMS. (Figure 1).



**Fig. 1. Basic BTMS classification and Combinations of Hybrid BTMS**

Hybrid BTMS are categorized into five kinds in addition to standard BTMS. The blending of active and passive approaches is a typical trait. Hybrid BTMS, as

opposed to basic BTMS, places an emphasis on fusion and integration. Hybrid BTMS requires additional consideration and methodical evaluation techniques due to the greater needs of BTMS. Additionally, vehicle thermal management and BTMS are integrated systems. Due to their interaction, VTM should be considered when doing additional study on BTMS.

## BASIC BTMS

A simple BTMS only uses one type of BTMS, making the question of how to improve the performance of that one BTMS the main concern. The design of the flow channel, which includes the channel's geometry, the location of the channel's intake and outlet, the channel's parameters, and the flow direction, is crucial when using forced air/liquid as a heat-transmission fluid. The objective of the job is to achieve the optimal parameters in accordance with various operating conditions and requirements. BTMS cannot be utilized independently for thermoelectric cooling without the aid of additional fundamental BTMSs to decrease the temperature of the battery exterior area. To increase the local heat transfer capabilities of the battery-pack module exterior, TEC is a supporting structure utilized in hybrid-BTMS. The section on hybrid BTMS contains the explanation of TEC. Basic BTMSs come in a variety of varieties, each with unique properties that are used with various scenarios and battery packs. More prominently, a summary of the drawbacks of elementary BTMS and their remedies will be provided.

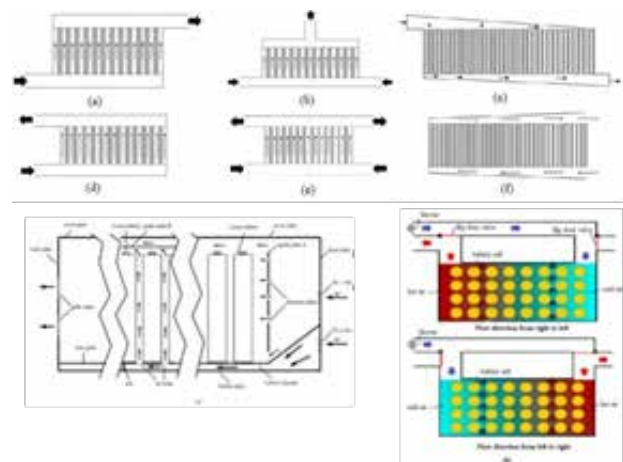
### Active BTMS

The main components of an active BTMS are TEC, liquid cooling, and forced air cooling. An active BTMS must weigh the advantages and disadvantages of using more energy. In comparison to liquid-based BTMS, forced-air BTMS might meet heat dissipation needs at relatively low temperatures without complicated equipment or excessive energy usage. Liquid cooling is required and energy-saving when there is a rapid charging rate or significant heat production. The system must achieve critical thermal management goals while consuming as little energy as possible.

### Forced-Air Cooling (FAC).

The two types of air based BTMS depend on air's transmission without force and air's forced

transmission, respectively. It is practically difficult to cool a battery separately using natural air because of the thermophysical characteristics of air. To achieve the same cooling action of the liquid-based BTMS with the forced-air BTMS, a greater rate of flow is required. The FAC system's temperature circulation is unequal because of its limited heat capacity, which is a crucial issue that must be fixed. The unequal distribution of temperatures is caused by two variables. One thing that happens along the flow channel is a change in air temperature. The rate of flow changes in dissimilar spaces because the spaces among cells have varied intervals from the input and output. To tackle this problem in air based BTMS, orderly setups with conical cooling tubes and irregular cell spacing were utilized. Although forced-air BTMS is elementary and inexpensive, it has significant drawbacks when compared to liquid-based BTMS. Several research projects concentrate on various features of FAC. Broadly speaking, it can be deduced as the air discharge configuration, cell layout, and flow channel shape.[26]

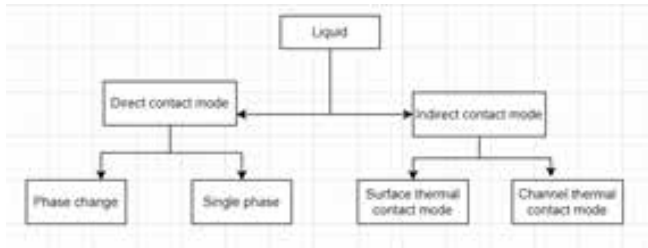


**Fig. 2.** The flow passage designs (a, b, d, e) (Z-types) flow passage, [1], (c) conical (Z-type) [2], (f) conical (U-type), (g) supplementary canal(duct), [27]; 2020, Elsevier. (h) airflow that is exchanging in both directions. [28]; 2020, Elsevier

### Liquid Cooling (LC)

Due to liquid's superior ability to transfer heat when compared to forced-air cooling systems, several BTMSs depend on liquid, which implies that LC systems use a lot less energy than FAC systems while cooling battery cells, which have a high heat load.[29] The LC approach

also has significant drawbacks, such as complicated equipment, expensive costs, and a protracted startup time. Due to their extreme price sensitivity, A-class EVs use liquid-based BTMS and have more stringent endurance requirements. According to estimates, BTMS based on liquid costs 40.5% greater than BTMS based on air.[30] There are two types of active BTMS based on liquid: direct and indirect contact mode.[2] categorization of LC shown in Figure 3.



**Fig. 3. Liquid cooling classification**

Phase change and single-phase direct contact modes can be distinguished. The phase change process will occur as the battery cools if the boiling temperature point (HTF) is lesser than the  $T_{max}$  (max temperature). Also known as boiling cooling. The temperature elevation around the boiling point would be greatly retard because of large latent heat if liquid cooling incorporates the phase transition procedure. Using porous materials like hydrogen [31] is one useful technique to use for the phase transition. Or other materials like fine sodium alginate sheet [32] This will enable a water film to form on the battery exterior from a modest amount of water. If there is only one phase involved, forced-air cooling is comparable to direct contact mode. To achieve the best heat transfer performance, the flow passage design, like the homogenous design, is essential.

#### A. Direct contact mode

The battery exterior is all the time submerged in liquid in this state. It generates the key benefit of this mode— major heat-transfer effectiveness. Most of the time, removal of heat occurs on the exterior of batteries. The direct contact mode can be employed in extreme circumstances, such as greater charge rates and excessive-power Li-ion batteries, even though it is not very practical. Direct liquid cooling does have a significant drawback in whether it be difficult to incorporate heating into the temperature management

system, whether atmospheric temperature is less than  $0.0^{\circ}\text{C}$ , other methods of BTMS must be used.[22] Phase change and single-phase direct contact modes can be distinguished. The phase change process will occur as the battery cools if the boiling temperature point (HTF) is lesser than the  $T_{max}$  (max temperature). Also known as boiling cooling. The temperature elevation around the boiling point would be greatly retard because of large latent heat if liquid cooling incorporates the phase transition procedure. Using porous materials like hydrogen [31] is one useful technique to use for the phase transition. Or other materials like fine sodium alginate sheet [32] This will enable a water film to form on the battery exterior from a modest amount of water. If there is only one phase involved, forced-air cooling is comparable to direct contact mode. To achieve the best heat transfer performance, the flow passage design, like the homogenous design, is essential.

#### B. Indirect contact mode

Because it is safer and more stable than the direct contact mode, it is often employed in commercial EVs. The basic idea is to transmit heat to space by placing a plate or tube converter on top of the surface of the battery cells. Fundamentally, the high contact surface and straightforward structure of a liquid cold plate (LCP) make them appropriate for pouch cells. The flow passage is joined to the surface of the cells when using the LCP or grooved passage, which is called the exterior thermal contact mode. Thermal conductive structure with battery pack serves as the flow channels in the alternative mode. Hence, the channel thermal contact mode can be used to describe this mode.

#### Passive BTMS

##### 1. PCM

A recurrent fusion of BTMS is PCM. Solid-liquid substances utilized in BTMS is discussed in this section. Sharma and co. [33] has done detailed discussion on PCM. A wide variety of materials, including organic, inorganic, and eutectic materials, can be implemented in BTMS which is based on PCM.[24] because its poor heat conductivity, elementary PCM is unable to effectively transport heat from the batteries to the surrounding. To address this issue, numerous varieties of hybrid PCM are intended for better heat flow. Graphite [34] and

metal foam and carbon fiber [35] is typically employed as one of the thermal conductive improvement materials in perfect PCM. Additionally, the BTMS which is based on PCM adopts the improvement technique of attaching fins to the battery surface for better heat flow due to the larger fin contact area. The overall efficiency of BTMS has significantly improved because of the use of PCM. Because of its fluidness, which is comparable to direct LC mode (LCM), one of the enhancements is to increase thermal uniformity. The high energy usage efficiency caused by the phase change's latent heat is another standout benefit. To save energy, PCM is frequently utilized in the pre-heat procedure for electric vehicles. Because different components can alter PCM's melting point, BTMSs based on PCM are adaptable. The BTMS can operate in a variety of conditions by modifying its melting point, and its latent heat extends the time that it can operate in harsh conditions. PCM is seen as a workable solution to substitute FAC and streamline the design of BTMS.[36] Nonetheless, heat saturation always occurs with prolonged operation under harsh BTMS conditions since many types of PCM have low latent heats of phase shift. The PCM is typically used in conjunction with cooling techniques(active) that restore the PCM's thermal energy capacity storage space to address this issue. It is a typical hybrid BTMS design.

### Heat Pipe

The heat pipe has numerous clear advantages over other BTMS, including excellent thermal conductivity, contact structures, and flexible design.

[37] A HP operates on the straightforward premise that the acting media evaporates and condenses on the heating and cooling side respectively. The waste hot air is transported to space through the heat sink. The thermal output of BTMS is significantly impacted by the shape of HP. A flat HP provides virtuous thermal output. [38] Internal cooling, which is more effective than exterior cooling, might be accomplished using a microscale HP. [39] The advantages of pulsing heat pipe over a conventional HP are its straightforward design, inexpensive price, compact volume, more heat flow density, and adaptability. As its framework and design characteristics were optimized, gravity had little to no impact on how well it operated. Enhancing heat transfer circumstances on the cooling

side by implementing FAC or LC is another option for enhancing performance. HP was able to accomplish precise and quick heat transmission between the region near the battery exterior and the outside surrounding in this way like typical hybrid BTMS.

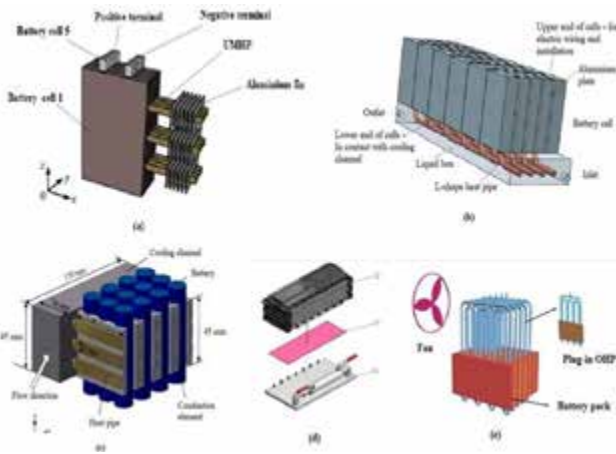
## HYBRID BATTERY THERMAL MANAGEMENT SYSTEM

### HP Coupled with Air- or Liquid-Cooling Method

A hybrid BTMS has higher temperature performance than an BTMS based on heat pipe, but it consumes more power and has a more complex construction. HP is always supported in this system by active cooling techniques, like FAC and LC. The BTMS uses a fan and an extremely slim micro heat pipe. Maximum temperature can be maintained less than 40 °C with the help of fan speed of 4-5 m/s and can be reduced up to 7.1 °C with the addition of an extremely slim micro heat pipe compared to that without HP. [40] The need for using cooling fluid in particular working experiments was estimated by Liu et al. [40] and demonstrated by Gan et al [41]., respectively (Fig. 4c). To transfer unused heat to an exterior LC medium, Jouhara et al.

[42] (as in Figure 4d) installed a bland HP in BTMS. It was demonstrated that the cell's T max was held below 28 C. In a proof-of-concept plug-in pulsing HP design with a bland- plate evaporator and pipe condenser, Wei et al. [43] (shown in Fig 4e) discovered that Pulsing HP loaded with ethanol- water combination had a faster reaction time and produced supreme thermal response. The average temperature of the battery pack may be kept less than 46.5 degree Celsius when 56 Watt is the power input. The effectiveness of supporting active cooling techniques must be assessed prior to employing these systems. According to Liang et al. [44], when the atmospheric temperature is less than 35 degrees Celsius, lowering coolant temperature has a negligible impact on thermal response, negating the necessity for hybrid cooling techniques. Another consideration is that the battery might be harmed by the coolant's low temperature. While lowering the coolant temperature may reduce T max, it will increase the unevenness of the temperature dispersion as it achieves its apex. Once the coolant temperature is dropped by 10 degrees Celsius at 5- degree Celsius release, the battery pack usable ability falls by roughly 1.17 and 0.89%, respectively [45].

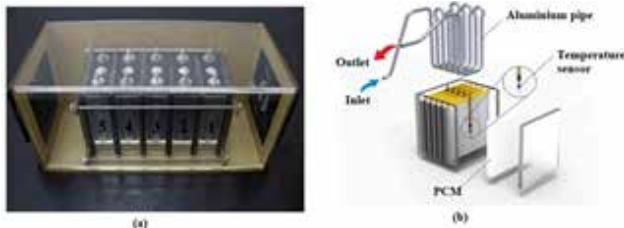




**Fig. 4. Examples of hybrid BTMS powered by HP that use active cooling techniques. (a) BTMS hybrid with a very thin micro heat pipe [37]; 2020, Elsevier., (b) BTMS from HP connected to liquid cooling, [54]; Elsevier., (c) BTMS using cylindrical battery pack that is based on HP, [41]; 2020, Elsevier., (d) Heat mat is placed atop the battery module. [3], (e) Battery packs are positioned between plug-in oscillating heat pipes.[43]; Elsevier.**

**PCM Coupled with Air or Liquid Active Cooling Method**

Due to heat build-up brought on by ineffective natural air cooling, perfect passive BTMS based on PCM is never sufficient to keep the battery pack’s temperature within a reasonable range. To restore PCMs’ ability to store thermal energy, active cooling measures are crucial. To improve heat transfer, the BTMS (Fig. 5a) uses CPCM and fins that are uncovered from the CPCM [46]. The BTMS (Fig 5b) utilizes PCM and cooling water pipes [47]. These hybrid BTMSs have architectures that are like the liquid based BTMS’s indirect contact mode.

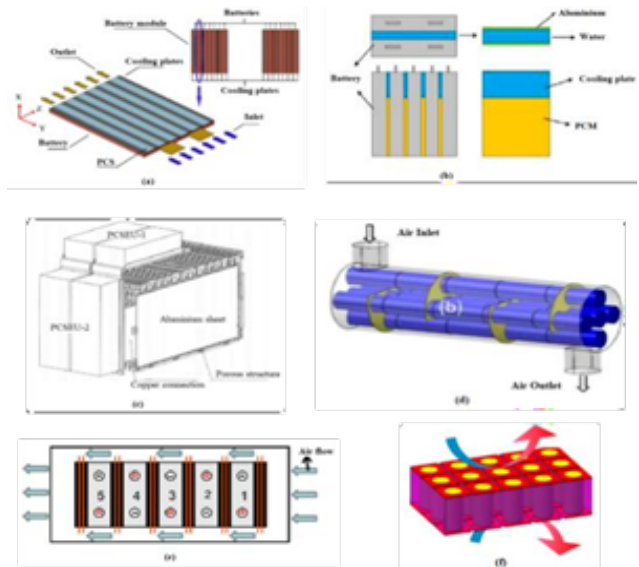


**Fig. 5. PCM based hybrid BTMSs (a) PCM+ air. [46]; 2020, Elsevier., (b) PCM + Liquid. [47]; 2020, Elsevier**

The most prevalent kinds are cooling liquid pipes and LCP, with PCM positioned among the duct or LCP and the battery pack. A typical arrangement of Phase

change material and LC uses the PCM’s mini channel to transmit heat from the HTF to the PCM. The impacts of fluid rate of flow, the number of passages, the melting temperature point, and the thermal conductivity of PCM on mini-channel/PCM-based BTMS were examined by Rao et al. [48].

A BTMS was developed by Bai et al (Fig. 6a). They discovered that PCM with 80% water and 20% n-octadecane microcapsules performs better, particularly at peak target temperatures when the mass flow rate is below the threshold. Across the flow can also be attached to the PCM plate, just like the exterior thermal contact mode in LC [49]. Across the flow passage also attached to the PCM based plate, just like the surface thermal contact mode in LC [51]. Under compression PCM, and cooling plates are aligned [50]. A BTMS was created by Bai et al. [51] and the impacts of various parameters were researched. Majority of heat produced by cells is dissipated by the LCP at battery’s electrode region. At the same time, PCM significantly improved thermal homogeneity.

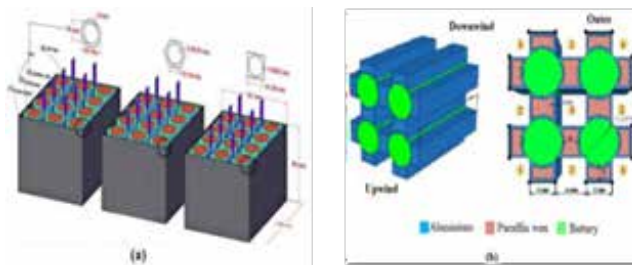


**Fig. 6. Traditional hybrid BTMS structures combine PCM with an active liquid or air-cooling mechanism. (a) combination of a micro channel liquid cold plate with a phasechange slurry (LCP). [49]; 2020, Elsevier. (b)PCM + LCP. [51]; 2020, Elsevier. (c) Air cooling was helped by PCM- based BTMS. Copper foam and n-Eicosane are the main components of phase change storage energy unit (PCSEU). [52]; 2020, Elsevier. (d) Forced air cooling, expanded graphite and paraffin, and CPCM integration**



were used. [53]; 2020, Elsevier. (e) Novel quaternary PCM and DCM in BTMS [54]; 2020, Elsevier. (f) BTMS with copper grids that is PCM-based. [55]; 2020, Elsevier

There are some creative concepts for hybrid BTMS that use PCM and forced-air cooling to improve performance. Shi et al. [52] created an unstable mathematical model and a BTMS (see Figure 6c). It has been demonstrated that this BTMS can maintain the temperature of the battery within a reasonable range prior to PCM totally melts. Jiang et al. [53] (Fig. 6d) developed a BTMS that uses stumps to alter the direction of the airflow to improve heat transfer. A unique four PCM plate made of organic material was created by Situ et al. [54] (Fig. 6e) (DCM). To improve heat dissipation in the PCM, Lazrak et al. [55] (Fig. 6f) created PCM based BTMS and applied a novel approach employing copper grids. On either side of the PCM and the battery cells are the two Al plates. The room was ventilated by a fan. Thermal performance is mainly affected by the geometry of heating. Battery packs often come in cylindrical, and pouch configurations. If Phase change material is used in BTM, it must be shaped to enclose the battery packs for better thermal output and lower energy usage. The impact of various container cross-sectional forms, such as circular, rectangular, hexagonal, on temperature output was examined by Safdari et al. [56] (Fig. 7a). The results show that a rectangle PCM shape is the most effective because of its constant air channel, while a circular PCM container provides greater efficiency with high heat. An innovative hybrid BTMS using forced air and PCM was proposed by Qin et al. [57]. (See Figure 7b). Under a 3 C rate, the hybrid BTMS's maximum temperature decreases by 1.2 C and T max by 16 C when compared to the passive BTMS, respectively.



**Fig. 7. The hybrid BTMS's shape is based on PCM. (a) With PCM-based BTMS, there are three potential cross-sectional forms. [56]; 2020, Elsevier.; (b) BTMS PCM-based schematic. [57]; 2020, Elsevier.**

Hybrid BTMS has difficulty with system complexity, yet it can reduce weight and boost performance compared to perfect passive BTMS. When matched to simple active BTMS, Phase change material increases the overall structure's weight. Ling et al. [58] examined the impact of PCM content, battery pack set, and active cooling procedure on the heat-flow ability to reduce the volume of PCM utilized in BTMS considering the greater weight and larger mass of hybrid BTMS. They discovered that the hybrid BTMS's optimal design can reduce the mass and volume by up to 94.1% and 55.6%, respectively.

### PCM Coupled with HP and Active Cooling Methods

PCM can easily be incorporated into hybrid-BTMS, and its use also improves thermal uniformity. Because of its great performance and better response, the heat pipe is used to settle the temperature saturation in the PCM, much like the "PCM plus active cooling" mode. Between HP, HTF [59] the PCM might be filled. PCM, HP, and spray cooling were integrated by Lei et al. [60] to control the battery cell temperature. Even with a 24 A output current and a more temperature (40 C), BTMS keeps the exterior temperature of the pack to less than 8 C. Amin and co.

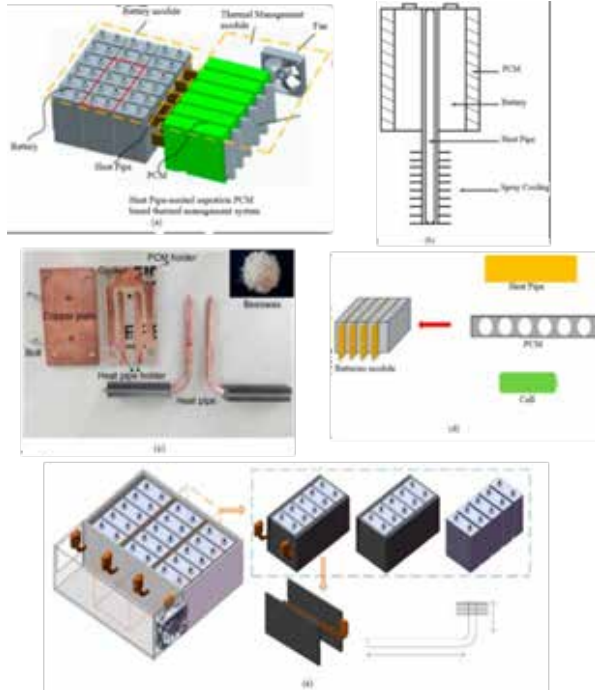
A BTMS (Fig. 8c) created by Amin et al. [61] can keep the battery pack temperature less than 50 C at the highest heat load of 50 W. BTMS was created by Huang et al. [62] (Fig. 8d), in which HP significantly improves thermal uniformity and heat transfer.

### Thermoelectric Cooling Coupled with Other Basic BTMS

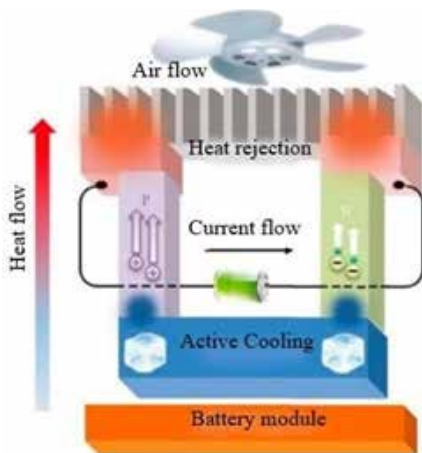
Because of its poor efficiency, thermo-electric cooling is not widely applicable in the BTM of EVs. Yet, due to its small size and widespread application in cooling electronics. In hybrid BTMS, researchers include TEC to increase heat transmission or fulfill certain goals. A framework of the TEC in a hybrid BTMS is shown in Figure 9. TEC and active cooling techniques were merged by Lyu et al. [63]. The heat is sent to the exterior part by TEC of the condenser side with the help of pushed air.

The outcome reveals that the battery pack 's decrease in temperature from 55 °C to 12 °C. With the help of semiconductor thermoelectric device with PCMs

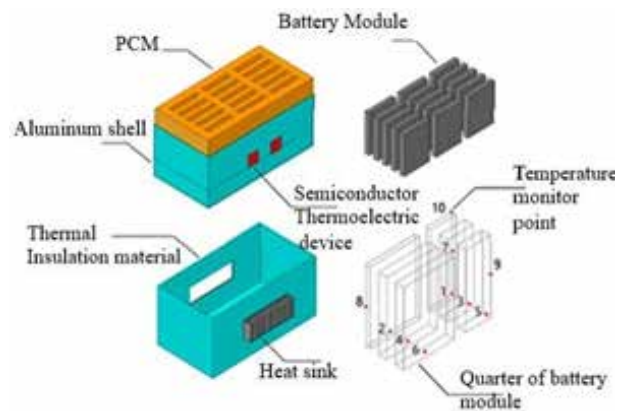
to create a BTMS for standby batteries, Song et al. [64] investigated cooling period (14 h) and heat conservation time (4.15 days) in an annular pattern while the surrounding temperature was maintained (323 K).



**Fig. 8. Traditional hybrid BTMS demonstrations related to PCM, HP (a) BTMS based on PCM with help from HP. [59]; 2020, Elsevier. (b) PCM with HP assistance and spray cooling. [60]; 2020, Elsevier. (c) using beeswax PCM and "L" type HP [61]. (d) a PCM + HP combination with air and LC. [62]; 2020, Elsevier. (e) Each HP was inserted into the exterior of the PCM plate and placed between two PCM plates. [67]; Elsevier.**



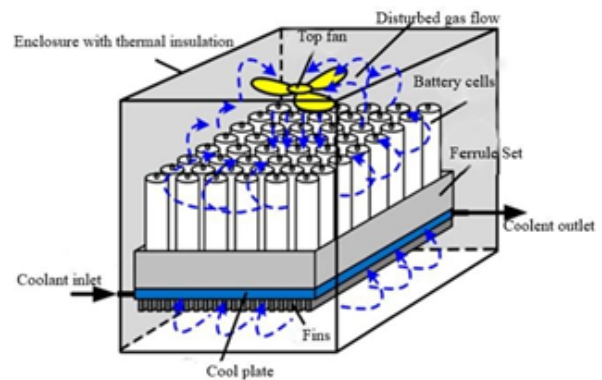
**Fig. 9. The hybrid BTMS (TEC) schematic fig [66].**



**Fig. 10. representation of PCM and TEC hybrid- BTMS. [64]; 2020, Elsevier**

**Liquid Coupled with Air**

The hot liquid must be cool down in a heat converter with the help of forced air for almost all LC techniques. Because the battery pack is not directly cooled by forced air, the cooling techniques in this research are hybrid BTMS. As the air path and HTF path have distinct heat dissipation capacities and equipment, it is typically not essential to use both. It is undeniable that forcing air in BTMS (liquid based) can improve heat transmission in regions far from LCP and HTF routes. FAC and LC are rarely combined in research. LCP and forced-air cooling are a useful combination. In the space environment, Wang et al. [65] created a BTMS by fusing a gas circle and an LCP (Fig. 11). They explored how the strength of the gas and liquid cycles, as well as various assembly structures, affected the thermal efficiency of BTMS. It was discovered that a framework with a fan underneath the LCP can fully generate the flow field.



**Fig. 11. A classical illustration of liquid and air based BTMS. [65]; 2020, Elsevier.**

## CONCLUSIONS

This work proposes a precise classification system to encompass all known BTMS and clearly distinguishes between direct and indirect, single phase and phase change, exterior contact and passage contact active cooling techniques. In terms of hybrid BTMS, there are five groups and nine kid items for these hybrid approaches. Each group's purpose and qualities are listed. The necessity, design methodology, and evaluation criteria of hybrid BTMS have all been the subject of interesting discussions.

The primary trend in BTMS development is hybrid BTMS, which will be used in more applications, particularly for difficult working conditions. Basic single BTMS couples can also be found in hybrid BTMS. In essence, merge passive with active BTMS, which has been demonstrated to have a lot of promise and real-world application. However, hybrid BTMS may not be appropriate in all circumstances. First, we must strike a balance between price and quality. Passive BTMS serves lower needs, whereas active BTMS fulfil superior requirements, according to BTM specifications. According to cost sensitivity, LC has a greater expenditure rate compared to forced air BTMS's cheap cost. If the atmosphere temperature is not too high, organic convection suffices for the PCM and HP combination, negating the need for forced air cooling. Hybrid BTMS is more adaptable. To improve temperature uniformity, PCM should be implemented if the battery response is necessary for superior balance. The local area's heat transport might be significantly improved by TEC and HP, which also have a quick response time. They can function as a supplemental tool during a quick setup phase.

Some drawbacks of conventional BTMS, such as PCM- based BTMS's heat saturation, can be solved via hybrid BTMS. They are simultaneously adaptable and effective, allowing the basic BTMS to use less HTF or PCM. There are, however, some brand-new issues, such as complexity and high energy usage. We first need to determine how much hybrid BTMS will cost before deciding whether to use more intricate structures. In the future, hybrid BTMS will make up a larger share of the system and have uses other than EVs.

## ACKNOWLEDGMENT

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# Extraction and Separation of D-limonene From Orange (Citrus) Peels

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## ABSTRACT

Orange peels is a major commercial source of contains 4-5 % of D-Limonene on dry basis. D-Limonene is a common naturally occurring compound citrus fruit and oil extract from orange peels that contains more than 90 % D-Limonene. Orange peels is a good source of D-Limonene. D-Limonene is a solvent for cholesterol hence it used to reduce the cholesterol. D-Limonene use for as a flavoring agent in soft drinks, fruit juices and creams. D-Limonene also use in pharmaceutical and cosmetic applications. D-Limonene is a common additive in fruits, cosmetics and cleaning products. D-Limonene is used as effective insecticide, pesticide and herbicide. For feed to solvent ratio 1:6 gives maximum yield for solvents ethanol and n-hexane 3.6 and 3.9% and for 1:4 feed to solvent ratio is shows the 3.5 and 3.7 for ethanol and n-hexane. There is slight difference in yield of ethanol and n-hexane solvent for 1:4 and 1:6. For higher feed to solvent ratio increase the heat/energy cost, equipment cost and solvent cost. The optimum feed to solvent ratio for extraction of d-limonene from orange peels is 1:4. The extraction is done at 65-70 oC and 75-80 OC for n-hexane and ethanol as a solvent resp. The yield by using n-hexane and ethanol solvent is 3.6 and 3.5 resp at optimum temperature and feed to solvent ratios.

For feed to solvent ratio 1:6 gives maximum recovery for solvents ethanol and n-hexane 72 and 78% and for 1:4 feed to solvent ratio is shows the 70 and 74% for ethanol and n-hexane. There is slight difference in recovery of ethanol and n-hexane solvent for 1:4 and 1:6. The optimum feed to solvent ratio for extraction of d-limonene from orange peels is 1:4.

**KEYWORDS:** *D-limonene; Solvent extraction; Soxhlet extraction; Orange peels*

## INTRODUCTION

Limonene is a major constituent of the oils of citrus fruit peel and is found at lower levels in many fruits and vegetables. Limonene occurs naturally in the d and l (or S) optically active forms and as dl mixtures including optically inactive racemate. The d form comprises 98-100% of the limonene in most citrus oils whereas that in oil of citronella and oil of lemongrass is 96-100 % l-limonene. D-Limonene is a major constituent of the oils of citrus fruit peel and is found at lower levels in many fruits and vegetables. Orange peels is a major commercial source of contains 4-5 % of D-Limonene on dry basis. D-Limonene is a common naturally occurring compound citrus fruit and

oil extract from orange peels that contains more than 90 % D-Limonene. Orange peels is a good source of D-Limonene. Soxhlet Extraction apparatus can use for extraction of D-Limonene. Orange juice is one of most widely-consumed beverages today. Approximately 50-60% of the processed fruits are transformed into citrus peel which is composed of peels.

### Applications of D-Limonene

1. D-Limonene is a solvent for cholesterol hence it used to reduce the cholesterol.
2. D-Limonene use for as a flavoring agent in soft drinks, fruit juices and creams.

3. D-Limonene also use in pharmaceutical and cosmetic applications.
4. D-Limonene is a common additive in fruits, cosmetics and cleaning products.
5. Due to its strong aroma limonene is utilized as a botanical insecticide.
6. It also use in manufacturing of soap and shampoos to give good aroma.
7. D-Limonene is used as effective insecticide, pesticide and herbicide.

### Experimental Analysis

#### Chemicals and Raw Materials

1. Citrus Peels
2. N-Hexane
2. Ethanol
3. Silicon Grease (High Vacuum Grease)

#### Apparatus Requires

1. Soxhlet Apparatus
2. Simple Distillation
3. Digital Thermometers
4. Heating Element/Mental
5. Measuring Cylinders
6. Glass Rod
7. Beaker and Oven
8. Water Bath (If Available)
9. Filter Paper and Weighing Balance

#### Selected Method for Extraction

Take Orange peels (citrus Peels) and heated in oven for 2 hours at 40-50 OC. Heat treatment for removal of moisture out of the seeds. Solvents like Ethanol, Methanol, n-hexane and mixed solvent system were utilized for d-limonene extraction. Soxhlet Extractor used for extraction of D-limonene from Orange Peels with n-hexane/ethanol solvent. Extraction done which the solvent by using Soxhlet extraction apparatus. For separation of solvent from citrus peels. We can use water bath as heating media/Simple Distillation.

D-limonene allowed to cool in a desiccator before being weighed. The extracted D-limonene kept in dark glass bottle and kept for analysis. Find various properties and % Recovery or yield of oil.

### Experimental Process Solvent Extraction

#### Extraction with n-Hexane

1. Take 100 gm citrus peels are dried in oven or sunlight to remove the moisture.
2. Calculate the % moisture content in the in citrus peels.
3. Crush the citrus peels in small size.
4. Take 1: 2/1: 4/1: 6 ratios of peels powder to solvent.
5. Take filter paper and keep citrus peels powder in cloth or filter paper.
6. Put this cloth or filter paper in thimble of Soxhlet apparatus contains citrus peels.
7. Take 200/400/600 ml of the n-hexane as solvent in round bottom flask of Soxhlet.
8. Mixture then heated at 60-70 OC for 1.5-2 hrs.
9. After extraction removal of round bottom flask from Soxhlet apparatus.
10. D-limonene (B.P. 172-175 OC) to be separated from solvent using simple distillation.
11. Separation by simple distillation carried out at temperature 65-70 OC.
12. In distillation n-hexane recover as top product and D-limonene as a bottom product.

#### Extraction with Ethanol

1. Take 100 gm citrus peels are dried in oven or sunlight to remove the moisture.
2. Calculate the % moisture content in the in citrus peels.
3. Crush the citrus peels in small size.
4. Take 1: 2/1: 4/1: 6 ratios of peels powder to solvent.
5. Take filter paper and keep citrus peels powder in cloth or filter paper.
6. Put this cloth or filter paper in thimble of Soxhlet apparatus contains citrus peels.

7. Take 200/400/600 ml of the ethanol as solvent in round bottom flask of Soxhlet.
8. Mixture then heated at 70-80 OC for 1.5-2 hrs.
9. After extraction removal of round bottom flask from Soxhlet apparatus.
10. D-limonene (B.P. 172-175 OC) to be separated from solvent using simple distillation.
11. Separation by simple distillation carried out at temperature 75-80 OC.
12. In distillation ethanol recover as top product and D-limonene as a bottom product.

### Experimental Analysis

#### Experimental Material Balance for n-Hexane

##### Extraction and Distillation Balance for Feed to Solvent - 1:2

##### Peel Powder + n-Hexane = (n-Hexane + D-limonene) + Powder Residue

100 gm + 200 ml = 120 ml (E.P.) + 130 gm (R.P.) + 50 ml solvent loss by Evp.

##### Mixture of D-limonene + n-Hexane = Distillate (n-Hexane) + B. P.(D-limonene)

120 ml = 110 ml Ethanol + 2.7 ml D-limonene + 7.3 ml n-Hexane loss by Evp.

##### Extraction and Distillation Balance for Feed to Solvent - 1:4

##### Peel Powder + n-Hexane = (n-Hexane + D-limonene) + Powder Residue

100 gm + 400 ml = 300 ml (E.P.) + 138 gm (R.P.) + 62 ml solvent loss by Evp.

##### Mixture of D-limonene + n-Hexane = Distillate (n-Hexane) + B. P.(D-limonene)

300 ml = 270 ml Ethanol + 3.7 ml D-limonene + 26.3 ml n-Hexane loss by Evp.

##### Extraction and Distillation Balance for Feed to Solvent - 1:6

##### Peel Powder + n-Hexane = (n-Hexane + D-limonene) + Powder Residue

100 gm + 600 ml = 480 ml (E.P.) + 160 gm (R.P.) + 60

ml solvent loss by Evp.

##### Mixture of D-limonene + n-Hexane = Distillate (n-Hexane) + B. P.(D-limonene)

480 ml = 465 ml Ethanol + 3.9 ml D-limonene + 11.1 ml n-Hexane loss by Evp.

##### % Yield of D-limonene for n-Hexane

The maximum amount of D-limonene in orange peels up to 5 %. Hence according this composition yield can be calculated. The maximum yield will be 5 %. (Studied by Palazzolo et al., in 2018.)

% Yield of D-limonene = [Mass of D-limonene Extracted/ Feed] \*100

##### Yield for Feed to Solvent Ratio 1:2

% Yield of D-limonene = [ 2.7 / 100] \*100  
= 2.7 %

##### Yield for Feed to Solvent Ratio 1:4

% Yield of D-limonene = [ 3.7 / 100] \*100  
= 3.7%

##### Yield for Feed to Solvent Ratio 1:2

% Yield of D-limonene = [ 3.9 / 100] \*100  
= 3.9 %

##### % Recovery of D-limonene

% Recovery of D-limonene = [ D-limonene Extracted / D-limonene in feed] \*100

##### Recovery Using n-Hexane Feed to Solvent Ratio 1:2

% Recovery of D-limonene = [2.7/5] \* 100 = 54 %

##### Recovery Using n-Hexane Feed to Solvent Ratio 1:2

% Recovery of D-limonene = [3.7/5] \* 100 = 74 %

##### Recovery Using n-Hexane Feed to Solvent Ratio 1:2

% Recovery of D-limonene = [3.9/5] \* 100 = 78 %

#### Experimental Material Balance for Ethanol

##### Extraction and Distillation Balance for Feed to Solvent - 1:2

##### Peel Powder + Ethanol = (Ethanol + CNSL) + Powder Residue

100 gm + 200 ml = 110 ml (E.P.) + 130 gm (R.P.) + 60 ml solvent loss by Evp.

**Mixture of D-limonene + Ethanol = Distillate (Ethanol) + B. P.(D-limonene)**

110 ml = 100 ml Ethanol + 2.8 ml D-limonene + 7.2 ml Ethanol loss by Evp.

**Extraction and Distillation Balance for Feed to Solvent - 1:4**

Peel Powder + Ethanol = (Ethanol + CNSL) + Powder Residue

100 gm + 400 ml = 290 ml (E.P.) + 150 gm (R.P.) + 60 ml solvent loss by Evp.

**Mixture of D-limonene + Ethanol = Distillate (Ethanol) + B. P.(D-limonene)**

290 ml = 259 ml Ethanol + 3.5 ml D-limonene + 27.5 ml Ethanol loss by Evp.

**Extraction and Distillation Balance for Feed to Solvent - 1:6**

Peel Powder + Ethanol = (Ethanol + D-limonene) + Powder Residue

100 gm + 600 ml = 490 ml (E.P.) + 150 gm (R.P.) + 60 ml solvent loss by Evp.

**Mixture of D-limonene + Ethanol = Distillate (Ethanol) + B. P.(D-limonene)**

490 ml = 475 ml Ethanol + 3.6 ml D-limonene + 11.4 ml Ethanol loss by Evp.

**% Yield of D-limonene for Ethanol**

The maximum amount of D-limonene in orange peels up to 5 %. Hence according this composition yield can be calculated. The maximum yield will be 5 %. (Studied by Palazzolo et al., in 2018.)

% Yield of D-limonene = [Mass of D-limonene Extracted/ Feed] \*100

**Yield for Feed to Solvent Ratio 1:2**

% Yield of D-limonene = [ 2.8 / 100] \*100  
= 2.8 %

**Yield for Feed to Solvent Ratio 1:4**

% Yield of D-limonene = [ 3.5 / 100] \*100  
= 3.5 %

**Yield for Feed to Solvent Ratio 1:2**

% Yield of D-limonene = [ 3.6 / 100] \*100  
= 3.6 %

**% Recovery of D-limonene**

% Recovery of D-limonene = [ D-limonene Extracted / D-limonene in feed] \*100

**Recovery Using n-Hexane Feed to Solvent Ratio 1:2**

% Recovery of D-limonene = [2.8/5] \* 100 = 56 %

**Recovery Using n-Hexane Feed to Solvent Ratio 1:2**

% Recovery of D-limonene = [3.5/5] \* 100 = 70 %

**Recovery Using n-Hexane Feed to Solvent Ratio 1:2**

% Recovery of D-limonene = [3.6/5] \* 100 = 72

**Observations for % Yield of D-limonene**

**Table % Yield of D-limonene**

Sr. No.	Feed to Solvent Ratio	% Yield With Ethanol	% Yield With n-Hexane
01	1:2	2.8	2.7
02	1:4	3.5	3.7
03	1:6	3.6	3.9

The experimental analysis we take various feed to solvent ration like 1:2, 1:4 and 1:6 for different solvents. For feed to solvent ration 1:6 gives maximum yield for solvents ethanol and n-hexane 3.6 and 3.9% and for 1:4 feed to solvent ratio is shows the 3.5 and 3.7 for ethanol and n-hexane. There is slight difference in yield of ethanol and n-hexane solvent for 1:4 and 1:6. For higher feed to solvent ratio increase the heat/energy cost, equipment cost and solvent cost. The optimum feed to solvent ration for extraction of d-limonene from orange peels is 1:4. The extraction is done at 65-70 oC and 75-80 OC for n-hexane and ethanol as a solvent resp. The yield by using n-hexane and ethanol solvent is 3.6 and 3.5 resp at optimum temperature and feed to solvent rations.

**Observations for % Recovery of D-limonene**



Table. % Recovery of D-limonene

Sr. No.	Feed to Solvent Ratio	% Recovery With Ethanol	% Recovery With n-Hexane
01	1:2	56	54
02	1:4	70	74
03	1:6	72	78

Table shows the experimental analysis we take various feed to solvent ration like 1:2, 1:4 and 1:6 for different solvents. For feed to solvent ration 1:6 gives maximum recovery for solvents ethanol and n-hexane 72 and 78% and for 1:4 feed to solvent ratio is shows the 70 and 74% for ethanol and n-hexane. There is slight difference in recovery of ethanol and n-hexane solvent for 1:4 and 1:6. For higher feed to solvent ratio increase the heat/energy cost, equipment cost and solvent cost. The optimum feed to solvent ration for extraction of d-limonene from orange peels is 1:4. The extraction is done at 65-70 oC and 75-80 OC for n-hexane and ethanol gives yield by using n-hexane and ethanol solvent is 3.6 and 3.5 resp at optimum temperature and feed to solvent rations.

**Graphical Representation for % Yield**

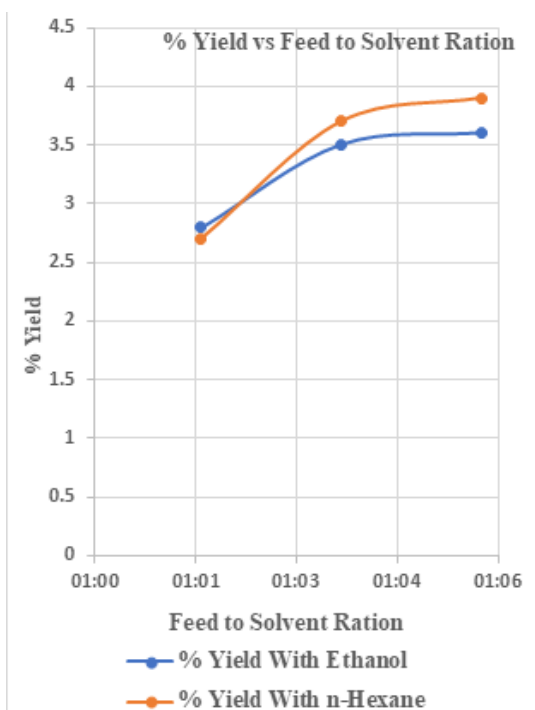


Fig. % Yield vs Feed to Solvent

Fig. shows the experimental analysis we take various feed to solvent ration like 1:2, 1:4 and 1:6 for different solvents. For feed to solvent ration 1:6 gives maximum yield for solvents ethanol and n-hexane 3.6 and 3.9% and for 1:4 feed to solvent ratio is shows the 3.5 and 3.7 for ethanol and n-hexane. There is slight difference in yield of ethanol and n-hexane solvent for 1:4 and 1:6. The optimum feed to solvent ration for extraction of d-limonene from orange peels is 1:4. The extraction is done at 65-70 oC and 75-80 OC for n-hexane and ethanol gives yield by using n-hexane and ethanol solvent is 3.6 and 3.5 resp.

**Graphical Representation for % Recovery of D-limonene**

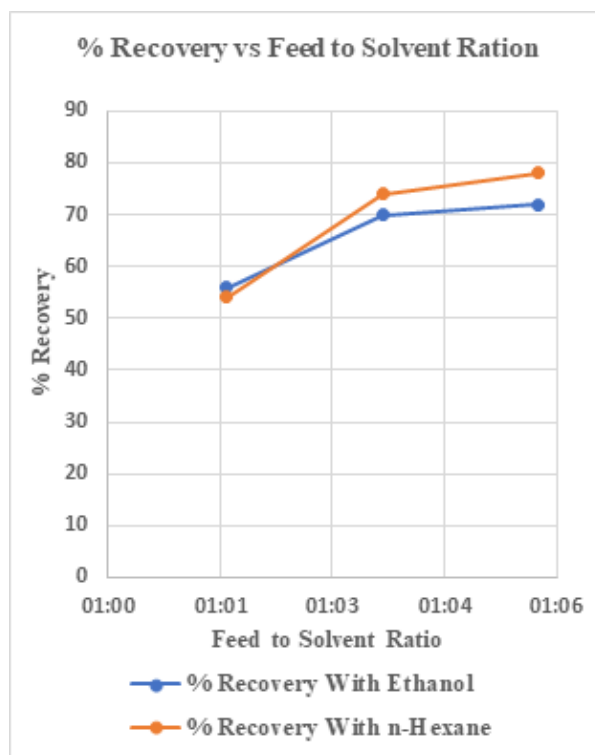


Fig. % Recovery vs Feed to Solvent

Fig. shows the experimental analysis we take various feed to solvent ration like 1:2, 1:4 and 1:6 for different solvents. For feed to solvent ration 1:6 gives maximum recovery for solvents ethanol and n-hexane 72 and 78% and for 1:4 feed to solvent ratio is shows the 70 and 74% for ethanol and n-hexane. There is slight difference in recovery of ethanol and n-hexane solvent for 1:4 and 1:6. For higher feed to solvent ratio increase the heat/energy

cost, equipment cost and solvent cost. The optimum feed to solvent ration for extraction of d-limonene from orange peels is 1:4. The extraction is done at 65-70 oC and 75-80 OC for n-hexane and ethanol shows the recovery by using n-hexane and ethanol solvent is 70 and 74% resp at optimum temperature and feed to solvent rations.

## CONCLUSION

The experimental analysis we take various feed to solvent ration like 1:2, 1:4 and 1:6 for different solvents. For feed to solvent ration 1:6 gives maximum yield for solvents ethanol and n-hexane 3.6 and 3.9% and for 1:4 feed to solvent ratio is shows the 3.5 and 3.7 for ethanol and n-hexane. There is slight difference in yield of ethanol and n-hexane solvent for 1:4 and 1:6. For higher feed to solvent ratio increase the heat/energy cost, equipment cost and solvent cost. The optimum feed to solvent ration for extraction of d-limonene from orange peels is 1:4. The extraction is done at 65-70 oC and 75-80 OC for n-hexane and ethanol as a solvent resp. The yield by using n-hexane and ethanol solvent is 3.6 and 3.5 resp at optimum temperature and feed to solvent rations. The experimental analysis we take various feed to solvent ration like 1:2, 1:4 and 1:6 for different solvents. For feed to solvent ration 1:6 gives maximum recovery for solvents ethanol and n-hexane 72 and 78% and for 1:4 feed to solvent ratio is shows the 70 and 74% for ethanol and n-hexane. There is slight difference in recovery of ethanol and n-hexane solvent for 1:4 and 1:6. For higher feed to solvent ratio increase the heat/energy cost, equipment cost and solvent cost. The optimum feed to solvent ration for extraction of d-limonene from orange peels is 1:4. The extraction is done at 65-70 oC and 75-80 OC for n-hexane and ethanol as a solvent resp. The recovery by using n-hexane and ethanol solvent is 70 and 74% resp at optimum temperature and feed to solvent rations.

## FUTURE SCOPE AND BENEFITS

After extraction of juice orange peels are treated as waste and lead to environmental pollution due to improper disposal can be used for the extraction of citrus oil. Residue can further decompose as fertilizer. Hence, we will get valuable product as well as we can reduce the pollution produce by improper disposal.

Limonene has anti-carcinogenic properties. Orange oil which contains a considerable amount of limonene has numerous applications including a combustant in engines a powerful degreaser in cleaning applications and a natural pesticide. Limonene used as an additive in food products and fragrances and is classified by the U.S. Food and Drug Administration (FDA) as Generally Recognized as Safe (GRAS)<sup>1</sup>. It has also been approved by the U.S. Environmental Protection Agency (EPA) for usage as a natural pesticide and insect repellent. D-Limonene is a solvent for cholesterol hence it used to reduce the cholesterol. D-Limonene use for as a flavoring agent in soft drinks, fruit juices and creams. D-Limonene also use in pharmaceutical and cosmetic applications. D-Limonene is a common additive in fruits, cosmetics and cleaning products. Due to its strong aroma limonene is utilized as a botanical insecticide. It also uses in manufacturing of soap and shampoos to give good aroma. D-Limonene is used as effective insecticide, pesticide and herbicide.

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# Object Detection and Disease Prediction for Blind People

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## ABSTRACT

Vision is one of the most important senses for humans, but unfortunately, many individuals struggle with vision problems. Blind and visually impaired people encounter various obstacles in their daily lives. The objective of this proposed paper is to develop an Android based app designed for individuals with vision impairments. The system aims to identify real-time objects in front of blind individuals, which are captured by a mobile camera, and communicate the information through audio notifications. The proposed framework employs Machine Learning, Google's tensor flow Lite, and open cv(open source Computer Vision library) object detection Application Programming Interface (API). This application is a beneficial tool that enables blind and visually disabled individuals to complete everyday tasks with greater ease and independence, without requiring assistance from others. This initiative is a modest contribution to India's Make in India campaign. Additionally, a general architecture has been proposed for diagnosing disease by inquiring about the symptoms of the disease, which could have potential applications in the healthcare industry so blind people get to know about the disease they are suffering from and what care they should be taking.

**KEYWORDS:** *Object detection; Smartphone app; Partially sighted people; Machine vision; Problem-solving methods; Disease prediction; Neural network*

## INTRODUCTION

The visually impaired community faces limited accessibility to technology, making it difficult for them to navigate through rooms or streets without sight. The primary objective of this paper is to assist the visually impaired by identifying obstacles and diseases that affect them. Our aim is to make the lives of visually impaired individuals easier, allowing them to walk safely and independently without relying on assistance. To achieve this, we collect input from various sources, including cameras, sensors, and scanners, to identify potential hazards and avoid dangerous locations.

This paper aims to address the challenges faced by visually impaired individuals in recognizing and

interacting with objects in their surroundings with approximately 285 million blind people worldwide, there is a significant need to help them understand their environment to carry out their day-to-day activities. To achieve this, an Android application has been developed that leverages the Single Shot Detector(SSD) algorithm for object recognition and detection. The application provides audio output using the Android TensorFlow APIs and Text To Speech Application Programming Interface(API) to assist visually impaired individuals in real-time. The application's accuracy in identifying objects is high, and it is faster than other comparable algorithms. The proposed application could be a valuable tool in helping visually impaired individuals

to interact with objects and navigate their environment more independently.

## LITERATURE REVIEW

Rais Bastomi et al. [1] in this paper, a tool is described that assists visually impaired individuals in identifying objects and estimating distances. The tool uses advanced technologies such as Convolutional Neural Networks and Stereo Vision to process real-time video data and calculate distances. While the tool's object recognition accuracy is high, its distance measurement accuracy is limited to a range of 50-250cm and has a high error rate of 6.1%.

Sunita Vaidya, Naisha Shah, et al. [2] an innovative system is introduced that utilizes cutting-edge image processing and machine learning techniques. The primary goal of this system is to enable real-time object detection through the camera, while providing users with audio output to convey information about the detected objects. The aim of this proposed work is to achieve high accuracy and superior performance, ultimately offering a practical solution to enhance the lives of visually impaired individuals. The researchers have also extensively referenced prior studies that are closely related to real-time object detection for assisting the visually impaired, demonstrating a comprehensive understanding of the existing literature in this field. By combining state-of-the-art technology with a strong focus on the needs of visually impaired people, this research endeavors to contribute to the creation of a more inclusive and supportive world for them.

Sayali Ambekar, et al. [3] This paper discusses the importance of data analysis in healthcare, particularly in predicting and detecting diseases. The authors propose a disease risk prediction algorithm using structured data, based on a convolutional neural network. They compare the accuracy of this algorithm with the Naïve Bayes and K-Nearest Neighbors (KNN) algorithms for heart disease prediction, finding that Naïve Bayes performs better. The proposed algorithm achieves a prediction accuracy of over 65% and can identify the risk level of heart disease. The system is cost-effective and efficient, and the authors plan to expand it to predict the risk of other diseases in the future.

Sumitra A. Jakhete, et al. [4] The aim of this project

is to help visually impaired individuals in recognizing and interacting with their surroundings. An Android application has been developed that leverages the Single Shot Detector (SSD) algorithm for object recognition and detection, providing real-time audio output to assist users. The application's accuracy in identifying objects is commendable, and it outperforms other comparable algorithms in terms of speed.

Xiaoyin Xur et al. [5] Our aim is to detect buried objects or mines using ground penetrating radar data collected from multiple channels. This has various practical applications such as detecting unexploded ordnance, landmines, mapping utility lines, and archaeological surveys. We propose a sequential detection strategy based on decision theory, which is low in complexity and efficient. We have conducted an analysis of our proposed method.

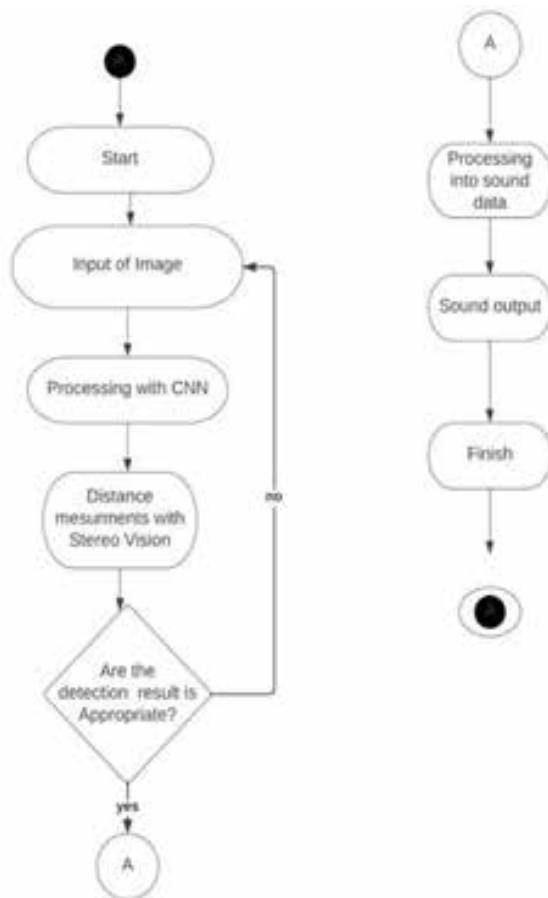
Muhammad Sualeh et al. [6] In this paper, presents a novel framework specifically designed for implementation in an embedded system. This framework utilizes a lightweight neural network to visually classify objects. Notably, the framework goes beyond traditional approaches by incorporating LiDAR data, enabling the tracking of objects in three-dimensional (3D) space. The study's key contribution lies in its utilization of a visual object detector capable of classifying 3D LiDAR point clouds. Additionally, the framework incorporates an innovative IMM-UKF-JPDAF-based object tracker, which exhibits the remarkable ability to simultaneously perform 3D object detection and tracking. This research represents a significant advancement in the field by combining multiple technologies to enhance the accuracy and efficiency of object recognition and tracking systems.

Pahulpreet Singh Kohli et al [7] This paper, conducted a study focusing on the application of machine learning algorithms for medical diagnosis, specifically emphasizing the early detection of diseases. The researchers utilized three different databases, namely Heart Disease, Breast Cancer, and Diabetes, to evaluate various classification algorithms and assess their effectiveness in predicting diseases. To select relevant features, a backward modeling approach employing the p-value test was employed. The study's findings highlight the potential of machine learning algorithms



in early disease detection. The proposed methodology exhibited superior performance compared to existing models, achieving an accuracy of 87.1% in Heart Disease detection, 85.71% in Diabetes prediction, and 98.57% in Breast Cancer detection. The authors also suggest potential avenues for improvement, such as automating data pre-processing and implementing a pipeline structure, to further enhance accuracy. This research underscores the significance of machine learning in enabling timely and accurate disease identification, thus facilitating proactive medical interventions.

#### EXISTING SYSTEM



**Fig. 1 Existing System**

This research aims to create a device that utilizes Convolutional Neural Network (CNN) for object detection and distance measurement. The system processes real-time image inputs from a webcam with a resolution of 640 x 320 pixels using OpenCV. The CNN is trained to detect objects and predict their distance,

and the results are converted into sounds that the user can hear. This approach combines stereo vision with object detection using CNN, resulting in a regression problem with multiple predicted boxes containing distance values. The goal is to develop a system that can assist users in detecting and determining the distance of objects in their environment.

The CNN comprises two primary layers: the feature extraction layer and the classification layer. The feature extraction layer involves two convolution layers and two max pooling layers. These layers work together to reduce the pixel size of the image and enhance its sharpness. In the first convolution layer, the Gaussian kernel algorithm is employed to minimize noise in the image. The second convolution layer is then applied to the first max pooling results to further decrease the image size.

After the feature extraction layer processes the input image, the classification layer employs the Back propagation Neural Network (BPNN) method to classify the output. The classification layer utilizes a fully connected neural network to identify the objects detected by the CNN. Stereo vision is used to obtain the necessary variables, and it is essential that the two cameras are parallel.

#### PROPOSED SYSTEM

Our Android application is designed to utilize Machine Learning, Google's TensorFlow Lite, and the OpenCV object detection API to accomplish its goals. The following algorithms are utilized by the application:

Step 1: The user launches the Android application on their smartphone.

Step 2: The application's camera is automatically activated when the user presses the up key on their mobile device.

Step 3: The camera captures real-time images of the environment.

Step 4: To identify objects, the user points the camera at the object, and the application utilizes OpenCV to analyse the real-time view.

Step 5: Detected objects are labelled with specific boxes according to shape of the real time object.

Step 6: The application uses text to speech class or hash-set data for giving voice output to notify the visually impaired user of the detected objects names.

Step 7: By pressing a down key system ask to use for symptoms that they are suffering from.

Step 8: Then by pressing on the screen google voice start giving solution for that particular disease.

### System Architecture

The major components of our application are shown in Fig. 2.

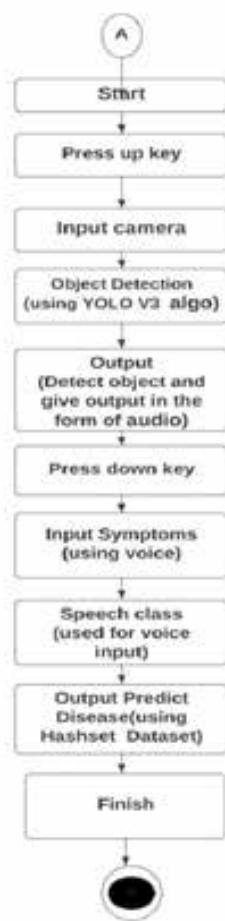


Fig. 2 System Architecture

The proposed application has a two-module system architecture. The first module is focused on object detection in front of visually impaired individuals as they move in a particular direction. However, the second module is the most critical aspect of the application. As blind people may not always be able to visit hospitals,

the system is designed for disease prediction. When the blind person presses the up key, the camera is activated, and pop-up messages are delivered through audio. Using the yolov3 object detection method, the system detects objects and provides output through speech recognition or vibrations for those with hearing impairments.

For the disease prediction module, the user presses the down key to input symptoms through voice recognition. The system then uses the hash set dataset to predict the disease and recommends hospital visits based on the seriousness of the condition. For early-stage diseases, the application also provides remedies.

To improve user experience, the proposed application also includes additional features. The user interface is designed to be user-friendly and deliver an excellent experience, even on mobile devices. The application also includes vibrations and pop-up notifications for those with hearing impairments.

### Additional Features

After going through various similar papers, we realized that many papers are missing some features which can help to make them user friendly and improve the user experience.

Following are some additional features of our application:

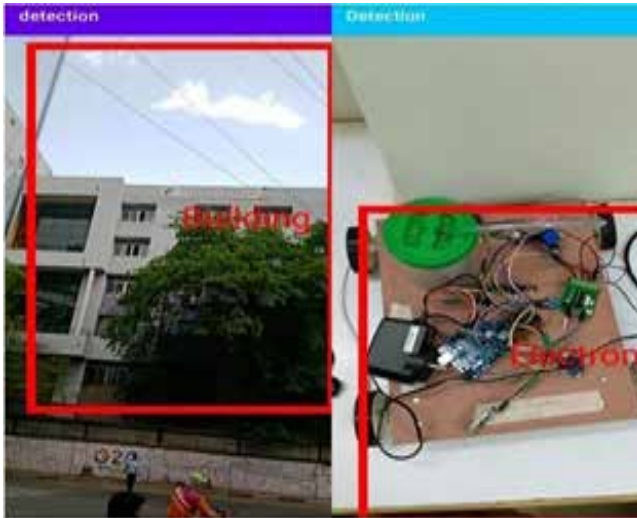
- Better User Interface and User Experience
- The Application that will deliver an excellent user experience on Mobile Devices too
- For hearing impaired people also we add vibrations and pop up.

### RESULTS



Detection of person and car

In this result by using a smartphone blind people can detect the person around them this will help to recognize the people around them as well as in second picture as they detect a car because of it our main moto of project is satisfied that it avoids road accidents and blind person can go anywhere without anyone's help.



Detection of Building and electronic device

As in above detection person is travelling from PMT and from window means from high height we can detect the real time things such as buildings also.If sometime in home no one is here but blind person has need of electronic device in that case it is more useful And because of this they avoid electronic shocks also.



Detection of Bus and Laptop

Object Detection

Patient Symptoms

CONFIRM

Home page of disease prediction Module

Object Detection

Google



Speak your option

Patient Symptoms

CONFIRM

Google



cold

English (India)

Disease Predicted

Here we have added simple UI of our second module in which our system first ask symptoms by pressing on the screen after that blind people can give input in the form voice that which disease they are suffering from and at last our system detect the symptoms and gives the remedies or give information about the disease they told.

## CONCLUSION

The application is designed with an easy-to-use user interface that is specifically tailored to visually impaired individuals. The camera feature of the application is able to detect obstacles in real-time, which helps users navigate their surroundings with ease. By pressing a button, the server-side backend algorithm processes the data and provides an audio output that notifies the user about any obstacles in their path, as well as predicts potential diseases based on symptoms using the Hash set dataset.

Furthermore, the application also includes features for hearing impaired individuals, such as vibrations and pop-up notifications. In future developments, self-trained models could be used instead of pre-trained models to enhance the accuracy of the disease prediction algorithm. Additionally, the application could be trained to store information about people closely related to the user, which would help the user differentiate between peers and strangers.

Overall, this application is an excellent example of how technology can be used to assist individuals with disabilities and improve their quality of life. With the inclusion of additional features and improvements, this application has the potential to positively impact many individuals who struggle with visual or hearing impairments.

## ACKNOWLEDGMENT

The completion of this project was a result of the tremendous effort and dedication put in by our team. However, we also received tremendous support and encouragement from various individuals, and we would like to express our sincere gratitude towards each one of them.

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# Thermal Performance Analysis of Serpentine Tube Flat Plate Collector used for Effluent Treatment

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## ABSTRACT

The efficiency of a flat plate collector in terms of thermal performance is influenced by a range of factors including its design and configuration. Many industrial processes today utilize various methods for treating wastewater, which typically require a significant amount of conventional energy and entail high energy costs. To mitigate these challenges, solar energy can be harnessed for heating wastewater in treatment plants. This study examines the thermal performance of a serpentine tube flat plate collector across a range of effluent flow rates. Specifically, it analyzes the impact of different variables, such as the mass flow rate and inlet temperature, on overall heat transfer rate. Additionally, comparisons of inlet and outlet temperatures and overall heat transfer coefficients were conducted for varying velocities of hot water. Both theoretical and experimental approaches were utilized to investigate water evaporation in the effluent using a serpentine tube flat plate collector. A prototype working model was constructed to validate the feasibility and viability of the evaporation system.

**KEYWORDS:** Serpentine tube flat plate collector; Effluent; Performance parameters; NTU

## NOMENCLATURE

LMTD	Logarithmic Mean Temperature Difference
LMTD <sub>corrected</sub>	Corrected Logarithmic mean temperature difference
A	heat transfer area of heat exchanger
Q <sub>e</sub>	heat emitted from hot stream
D <sub>m</sub>	mean diameter of tube
d <sub>o</sub>	outer diameter of tube
d <sub>i</sub>	inner diameter of tube
n	number of tubes
L	effective length of tube
Q <sub>act</sub>	actual heat transfer
Q <sub>max</sub>	maximum heat transfer
T <sub>(c,out)</sub>	cold stream outlet

T <sub>(h,out)</sub>	hot stream outlet
T <sub>(c,in)</sub>	stream's inlet temperature
Q <sub>e</sub>	heat power emitted from hot fluid
Q <sub>a</sub>	heat power absorbed by cold fluid
ε	effectiveness
m <sub>h</sub>	mass flow rate of hot fluid
m <sub>c</sub>	mass flow rate of cold fluid
h <sub>h,i</sub>	inlet enthalpy of hot fluid
h <sub>h,o</sub>	outlet enthalpy of hot fluid
h <sub>c,i</sub>	inlet enthalpy of cold fluid
h <sub>c,o</sub>	outlet enthalpy of cold fluid
T <sub>h,i</sub>	inlet temperatures of hot fluid
T <sub>h,o</sub>	outlet temperatures of hot fluid
T <sub>c,i</sub>	inlet temperatures of cold fluid
T <sub>c,o</sub>	outlet temperatures of cold fluid

$C_{ph}$	specific heat of hot fluid
$C_{pc}$	specific heat of cold fluid

## INTRODUCTION

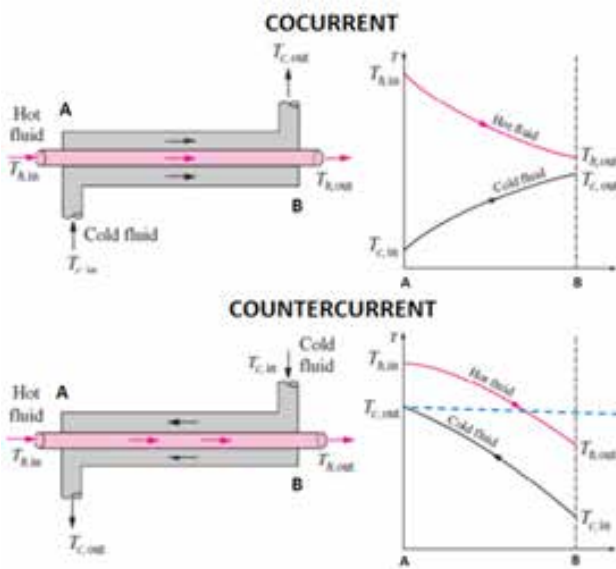
The majority of today's process industries wastewater treatment plants utilize different techniques for effluent water treatment [1]. The effluent treatment plants are an integral part of the processing industries, and these effluent treatment plants are tremendous consumers of electrical energy, with continuously rise and consumption of the electrical energy. Some effluent treatment plants closely monitored and some of them retrofitted, but the electrical as well as maintenance cost of such effluent treatment plants were much more, so objective of this work is to use minimize electrical energy so that the running cost of the effluent treatment plant will be low. So design and develop new effluent treatment plants with use of solar energy. We design a serpentine tube flat plate collector as a heat exchanger to diminish energy consumption as well as enhance operating efficiencies of the wastewater treatment plant. Heat transfer plates can be organized in a variation of configurations, with the quality being a single flow arrangement. When it is essential to improve thermal efficiency, plates may be arranged in two, three or more passes. The use of solar energy for effluent treatment in process industry may be possible solution in the form of serpentine tube flat plate collector heat exchangers for effluent evaporation [2].

Waste water treatment is a critical process that requires a significant amount of energy. In recent years, there has been an increasing interest in the use of solar energy to improve the efficiency and reduce the energy consumption of waste water treatment plants. One of the promising technologies in this regard is the use of serpentine tube flat plate collectors as heat exchangers. These collectors have shown great potential for enhancing the thermal performance of waste water treatment plants, as they can efficiently capture solar radiation and transfer heat to the effluent water. In this context, various studies have been conducted to evaluate the effectiveness of serpentine tube flat plate collectors as heat exchangers for waste water treatment plants. The transfer of heat between two fluids at different temperatures, separated by a solid wall, is a common occurrence in numerous engineering applications.

This transfer of heat can involve the transfer of latent heat from a serpentine tube flat plate collector, which includes phase changes such as condensation and vaporization, or simply the transfer of sensible heat that results in the increase or decrease of fluid temperature without a phase transition. Heat exchangers are generally categorized based on the flow arrangement and construction pattern. The first classification is based on whether the flow is parallel or non-parallel, while the second classification pertains to the configuration of heat exchangers, which may include tubular, plate, shell, and tube designs [3]. Corrugated tubes are used in tube heat exchanger to heat transfer from serpentine tube flat plate collector to waste water. This type of heat exchanger is best possible for waste water heating in wastewater treatment plants. The corrugated tubes improve the heat transfer rate which consequence in heat exchangers with smaller area, reduced cost and small pressure drop [4]. Our college has installed a parabolic dish collector setup to harness solar energy, taking advantage of the favorable atmospheric conditions. The hot fluid generated by this collector has multiple applications, including processing raw turmeric, and other agricultural purposes. Effluent treatment is one of the most efficient applications of this technology in the process industry. In this study, we focus on analyzing the thermal performance of a serpentine tube flat plate collector and the impact of various parameters on its efficiency. Impurities in the effluent have a detrimental effect on heat transfer efficiency, with factors such as small wall shear stresses, low fluid velocities, high fluid velocities, and precipitation of dissolved impurities due to elevated wall temperature playing a significant role. To prevent fouling, designers often aim to maintain a cooling water velocity of greater than 0.9 m/s and a bulk fluid temperature below 60°C. The phenomenon of local precipitation of dissolved solids may transpire on the surface of the heat exchanger, owing to the temperature of the wall being considerably higher than the temperature of the bulk fluid. [5].

## METHODOLOGY

Let's take the case when we want to extract the maximum amount of heat from serpentine tube flat plate collector to effluent. The figure below depicts heat exchanger schematics and the temperature profiles for both concurrent and countercurrent designs:



**Fig.1: flow arrangement**

Heat exchangers are designed to transfer heat from a hot fluid to a cold fluid. In a concurrent design, the hot and cold fluids flow in the same direction, which means that the cold fluid outlet temperature ( $T_{c,out}$ ) is always lower than the hot fluid outlet temperature ( $T_{h,out}$ ). As a result, the heat transfer rate is limited by the cold fluid outlet temperature. This means that if the temperature of the cold fluid outlet is higher, the heat transfer rate will increase. However, this may not always be feasible, especially when the heat exchanger is used for heating purposes.

On the other hand, in a countercurrent design, the hot and cold fluids flow in opposite directions. This allows for a higher cold fluid outlet temperature compared to the concurrent design, which in turn increases the heat transfer rate. In a countercurrent design, the heat transfer rate is limited by the cold fluid inlet temperature ( $T_{c,in}$ ), which means that the heat transfer rate increases as the cold fluid inlet temperature increases.

Therefore, a countercurrent design is preferred over a concurrent design when the objective is to achieve higher heat recovery. However, a countercurrent design can be more complex and may require more space, making it more expensive. Therefore, the choice of design depends on the specific application, taking into account factors such as cost, space constraints, and the required heat transfer rate. [13].

**Thermal Performance Model**

Enthalpy balances in heat exchangers

To design and accurately predict the performance of a heat exchanger, it is essential to determine the amount of heat lost to the surroundings for the particular configuration being analyzed. This can be achieved by evaluating various parameters that allow for an estimation of the percentage of losses or gains. One common approach is to apply overall energy balances for both the hot and cold fluid flows.

In heat exchangers, there is typically no shaft work involved and mechanical-potential and mechanical-kinetic energies are negligible in comparison to other terms in the energy-balance equation. Assuming constant specific heats, it is possible to calculate the amount of heat power emitted from the hot fluid and the amount of heat power absorbed by the cold fluid. These calculations can be used to determine the efficiency of the heat exchanger and optimize its design for better performance. Accurate forecasting of heat exchanger performance is crucial in ensuring its reliable operation and minimizing energy losses. [6].

$$Q_c = \dot{m}_h \times (h_{hi} - h_{ho}) \tag{1}$$

$$Q_c = \dot{m}_h C_{ph} (T_{hi} - T_{ho}) \tag{2}$$

$$Q_a = \dot{m}_c \times (h_{ci} - h_{co}) = \dot{m}_c C_{pc} (T_{ci} - T_{co}) \tag{3}$$

$$\text{Heat capacity ratio } C_r = C_{\min} / C_{\max} \tag{4}$$

$$\text{Heat power gain or loss} = |Q_c| - |Q_a| \tag{5}$$

2. Rate of heat transfer

Heat transfer estimations are a crucial aspect of designing and analyzing heat transfer equipment. These estimations are dependent on the surface area of the heat transfer, which is expressed in kilograms per cubic second of surface area through which the heat flows. To quantify heat transfer, we use heat flux, which is the rate of heat transfer per unit area. In most heat transfer equipment, the surface area is the surface area of the tube, and the heat flux can be based on the inside or outside area of the tubes. It is important to note that the choice of the area is arbitrary and must be clearly defined since the magnitudes of the heat fluxes will not be the same for the two possibilities.

When a fluid is heated, the temperature at the wall of

the heating surface increases, and it decreases towards the center of the fluid flow. Conversely, when a fluid is cooled, the temperature is at a minimum at the wall surface and increases towards the center of the fluid. This temperature variation between the hot and cold fluid streams along the length of the heat exchanger necessitates the derivation of mean temperature difference, which serves as the driving force for heat transfer estimations. This mean temperature difference is estimated using the logarithmic mean temperature difference (LMTD) equation.

Overall, heat transfer estimations are essential for designing heat transfer equipment, and a thorough understanding of the factors that influence heat transfer is necessary to optimize performance. The choice of heat transfer area and driving force calculation must be carefully considered to achieve accurate heat transfer estimations.

$$\Delta T_{lm} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}} \tag{6}$$

### 3. Heat exchanger effectiveness

The advantage of the two-fluid heat exchanger is necessarily a dimensionless quantity of the heat estimation which is surprisingly transferred between two flow of streams normalized with the maximum feasible fluid enthalpy change in the process. This theoretical quantity of heat can be perceive as the enthalpy change of the stream with lower heat capacity experienced the paramount feasible temperature change ( $T_{h,in} - T_{c,in}$ ) without any losses. The heat exchanger effectiveness is then simply calculated by using equation below.

$$\varepsilon = \frac{Q_{act}}{Q_{max}}$$

$$\varepsilon = \frac{c_h \times (T_{h,in} - T_{h,out})}{c_{min} \times (T_{h,in} - T_{c,in})} \tag{7}$$

Overall heat transfer coefficient:

$$U = \frac{Q_e}{A \times LMTD_{corrected}} \tag{8}$$

The heat transfer area may be calculated as,

$$A = \pi \times d_m \times L \times n \tag{9}$$

Where,  $d_m = \frac{(d_{out} + d_{in})}{2}$

### Experimentation Analysis

The experimentation on the serpentine tube flat plate collector was carried out in order to forecast the thermal performance of the collector as a heat exchanger.

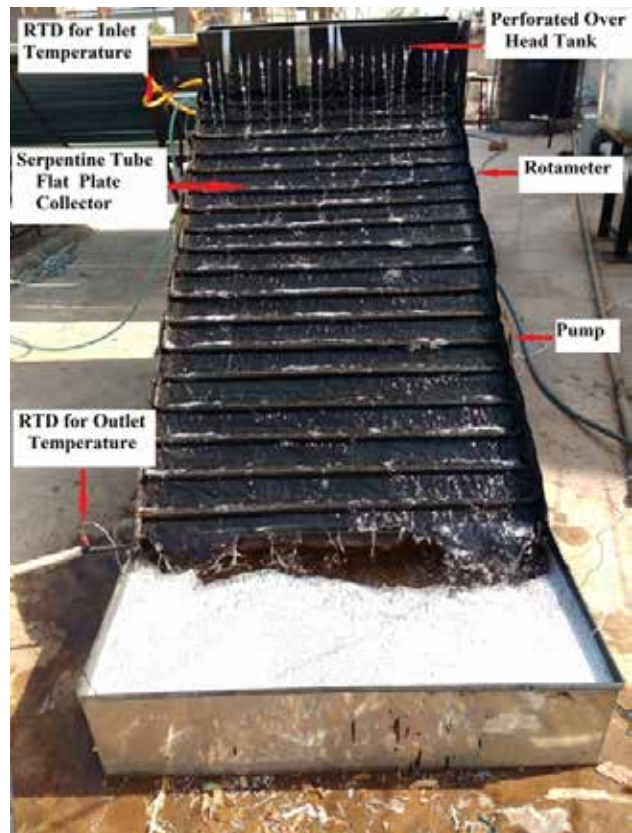


Figure. 2 Experimental setup

The outlet temperatures of both fluids flowing through the heat exchanger are to be known. For this, three different mass flow rate of inlet hot thermic fluid of 2, 4, 6, 8, 10 liter per minute varied in set of in order to substantiate the numerical results, a set of 12, 16, 20 liter per minute of effluent inlet mass flow rate[9]. Experiments are conducted by fabricating serpentine tube flat plate collector subjected to two fluids i.e. hot water coming out of solar collector flowing through tube and effluent to be heated flowing over flat plate collector and tube. The effluent begins flowing from the tank through the passes through the rotameter measuring the volume flow rate, and enters the serpentine tube flat plate collector. The fluid temperature variation at inlets and outlets for each fluid were measured with T type thermocouples. The two thermocouples are mounted



at entry and exit of the heat exchanger [10]. All thermocouple are connected to 16 channel data logger with a tolerance of  $\pm 0.1^{\circ}\text{C}$ .

**Table 1**

Technical data	
Tube material	Copper
Outside diameter of tube	0.012 m
Wall thickness of tube	0.001 m
Number of tubes	One
Effective length of tube	21 m
Effective heat transfer area	0.7257 m <sup>2</sup>
Plate material	Copper
Thickness of plate	0.002 m

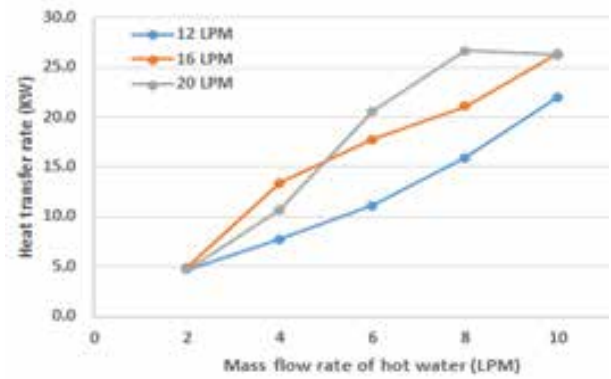
**Table 2: Accuracy and measuring range of instruments**

Sr. No.	Instrument	Operating Range	Accuracy
01	SEAWARD pyranometer	0 – 2000 w/m <sup>2</sup>	$\pm 0.05$ w/m <sup>2</sup>
02	RTD	0 – 1400 $^{\circ}\text{C}$	$\pm 0.5$ $^{\circ}\text{C}$
03	Mercury thermometer	0 $^{\circ}\text{C}$ to 120 $^{\circ}\text{C}$	$\pm 0.5$ $^{\circ}\text{C}$
04	Wet and dry bulb thermometer	-10 $^{\circ}\text{C}$ to 50 $^{\circ}\text{C}$	$\pm 0.5$ $^{\circ}\text{C}$
05	Digital anemometer	0 – 100 m/s	$\pm 0.1$ m/s

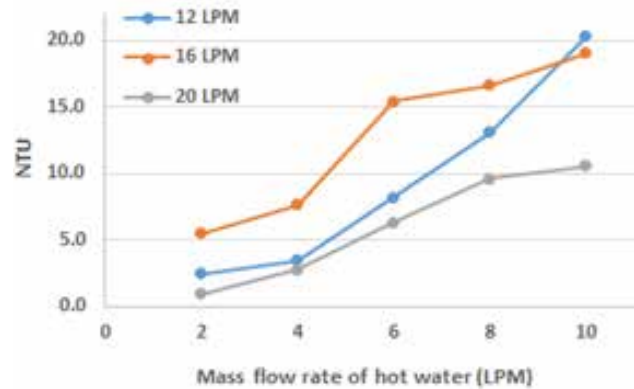
**RESULTS & DISCUSSION**

When mass flow rate of thermic fluid coming out of parabolic dish collector is changing from 2 to 10 liter per minute, it is noted from Figure. 1. The heat transfer rate increased from 6 KW to 22 KW at fixed effluent mass flow rate of 12 liter per minute. The number of transfer unit increases with increased inlet mass flow rate of thermic fluid as shown in Figure. 2.

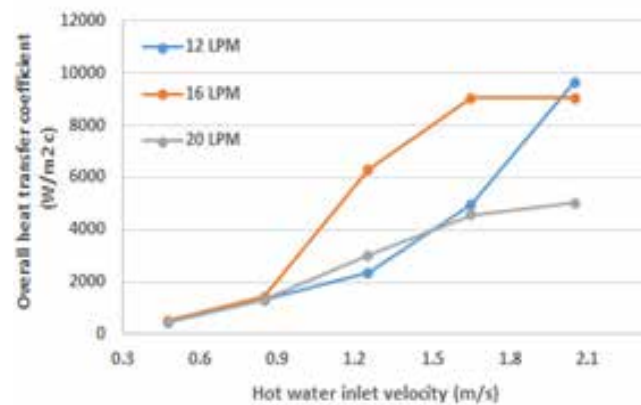
The heat transfer coefficient increases with increased velocity of hot water inlet as shown in Figure 3. The heat transfer efficiency increases with increased mass flow rate of hot water inlet with fixed mass flow rate of effluent inlet as shown in Figure 4.



**Figure. 1: Heat transfer vs hot water mass flow rate**



**Figure. 2 NTU Vs mass flow rate of hot water**



**Figure.3 overall heat transfer coefficient Vs inlet velocity rate**



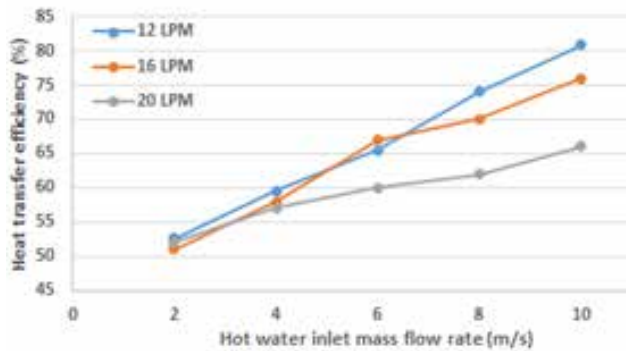


Figure. 4 heat transfer efficiency Vs mass flow

## CONCLUSION

The research work conducted on the solar-based serpentine tube flat plate collector was focused on studying its various capabilities as an unmixed and unmixed cross-circulated heat exchanger with different flow rates of hot thermic fluid and effluent fluid. The experiment aimed to understand the impact of these parameters on outlet temperatures, overall heat transfer coefficient, and heat transfer efficiency. The findings of the study revealed that a decrease in the flow rate of the hot thermic fluid led to a reduction in the temperature rise of the effluent water. Additionally, it was noticed that as the mass flow rate of hot water decreased, the performance of the unmixed-unmixed heat exchanger declined, which led to a reduction in the rate of heat transfer. Overall, the study revealed that the installation of a serpentine tube flat plate collector might lower energy consumption and boost waste water treatment plants' operational efficiencies. The development of more effective and long-lasting technologies for the treatment of effluent water may be greatly influenced by these discoveries.

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# Solar Panel Defect Detection in Thermal and Electroluminescence Imaging by Machine Learning and Deep Learning

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## ABSTRACT

Solar Photovoltaic (PV) modules are visually inspected for detecting defects by two methods: Thermal imaging and Electroluminescence (EL) imaging. In this work, automation of the defect identification task is done by applying SVM and deep learning techniques to two types of image data in order to achieve a quick and reliable result. The EL image dataset is categorized using SVM and CNN. Real life thermal image dataset of solar panels in Indian weather conditions was collected. Thermal dataset is then trained and tested with the same learning models for observing the accuracy of defect detection. The accuracy achieved for CNN on EL images was 97.69% while for Thermal images the accuracy was 75.8%. Further the study assisted in drawing comparative inferences between the imaging techniques to leverage the applications of such automated solar panel defect detection systems.

**KEYWORDS:** *Solar cells; PV modules; Defect detection; Thermal imaging; Electroluminescence imaging; Deep learning*

## INTRODUCTION

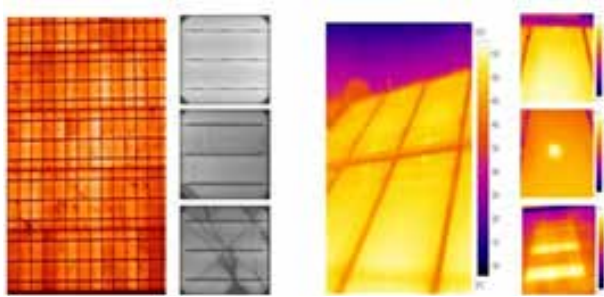
Today the world's focus is on renewable energy sources to meet the global power demand. Solar energy plays a vital role in energy security. India, as a tropical country, has significant solar power. As Indian subcontinent is located in the tropical region, approximately 5K trillion kWh of energy is available every year. The installed national capacity of solar energy is 53.997 GW as of March 31, 2022. According to India's Renewables Dashboard, administered by the Centre for Energy, Environment, and Water (CEEW), last year, solar panels contributed to 40% of India's renewable energy production. Solar photovoltaic (PV) power can be harnessed effectively through large solar farms. PV modules may acquire defects that develop during operation over a period of time or faults may be induced by environmental occurrences which reduce its power efficiency. This makes analysing the condition of solar panels more crucial. Identifying these defects for early repair, prevents reduction in energy production as

well as decreases safety concerns. For minimum loss in the functioning of solar modules their regular inspection must be done.

Manually inspecting each solar module is not feasible due to the large number of solar panels present in solar farms. Most of the minor faults can go undetected by the naked eye. Therefore, visual inspection of the solar cells is a better choice. Yet another challenge is manually examining thousands of images of the solar panels for fault analysis. The process is very time-consuming [1] and the quality of the analysis is subject to the experience and expertise of the examiner. A specialised interpretation of images to understand the wide range of faults that occur is necessary. With the aim to automate the task of visual inspection, deep learning approaches can be used as they can handle complex tasks which require a lot of feature engineering without the need for human intervention. Also, their ability to analyse huge amounts of data and execute numerous computations in a cost and time-effective manner which increases the

scalability for autonomous identification of defective solar panels from thermal and EL images of PV modules using deep learning. The images of Solar Panel are as shown in Figure[1].

The paper is organised as follows, Section 2 contains the survey of relevant literature, Section 3 focuses on the Methodology, followed by sections 4, 5 and 6. Section 4 showcases the results, the limitations and future scope are mentioned in section 5. The concluding section 6 mentions the appropriate inferences.



**Figure 1. Solar Panel Images**

## RESEARCH SIGNIFICANCE

A. Bartler et al. [2] have suggested that solar cell degradation affects efficiency. This degradation occurs due to natural phenomena, these defects are visualised using EL imaging for automatic error detection. Previously image processing of distortion, fragmentation, and visual correction was included, as CNN's in-depth solar injury separation, which is emphasised to deal with highly unequal data. This work has also investigated the topic of data inequality and tested a number of solutions and obtained a 7.73 percent BER for the challenge of binary separation in real world assessments.

The work [1] investigates two methods of detecting defects in a single PV cell image. The methods vary depending on the needs of the hardware, which is determined by the application conditions. The low-hardware solution is based on the hand-crafted features included in the SVM section and accuracy of 82.44% is used. The other method using CNN is also accurate, with an average accuracy of 88.42 percent.

In paper [2], the authors have used imaging-based system to identify the defects, which leads to automation. As a result, solar panels may be monitored while they are

in use without disrupting their operation. As a result, it saves a significant amount of time and money on detection. The first approach uses hand-crafted features. In the second approach the picture is reconstructed from ICA data. This was necessary to identify dark and defective regions in the photographs.

Electroluminescence Imaging for detecting these defects. The report by Ulrike Jahn et al. [5] reviews the current techniques for IR and EL imaging.

S. Deitsch et al. [6] present a reliable automatic segmentation method for EL pictures of PV modules that allows for the extraction of individual solar cells.

S.Gallardo-Saavedra et al. [7] have evaluated and identified the complementary faults detected using two complementary strategies by traditional InfraRed Thermography technique.

## OBJECTIVE

To identify the defects at an earlier stage so as to repair the faulty module thereby avoiding the loss in the energy produced, using appropriate Machine Learning and techniques Deep Learning techniques.

## METHODOLOGY

During the life of a solar farm, the total energy output is reduced due to faults in solar modules and their cells. With the increase in unforeseen natural disasters such as hurricanes and hailstorms, it is important to always monitor the quality of the solar panels. The main idea is to identify the defects at the earliest to perform appropriate repair on the module to avoid loss of energy produced. The main feature offered by the imaging techniques is, a relatively cost effective and efficient process for the identification of defective cells which appear at different stages of a PV module, whether at the production line or at the installation site. Typically, in the production line, near- infrared (NIR) cameras are used to detect EL radiation (from 750 to 1000 nm), whereas at installation sites a thermal camera is used to obtain the map of heat distribution of the solar cells. These techniques help in understanding the cause of lower energy production.

Figure 2 gives an overview of how this study was conducted. Firstly, the dataset for EL images was obtained and different learning models were applied

to observe how well they could detect defective solar panels. Next, a custom dataset was prepared by capturing thermal images using infrared (IR) cameras. To this thermal image dataset, the same models were applied. In order to get a more realistic perception of how accurately the models would perform on captured thermal dataset, the two types of imaging methods were used and are summarized as follows.

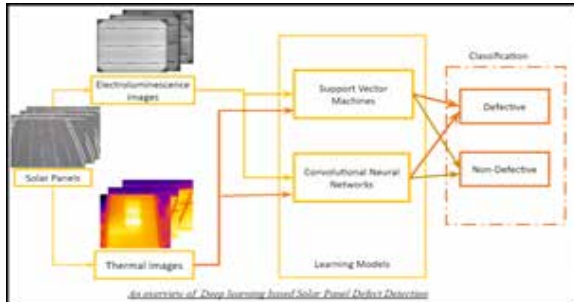


Figure 2. Block Diagram of the Fault Detection System

### Electroluminescence Imaging

This is a widely used technique to evaluate the quality of solar cells. This involves passing an electrical current through a PV module due to which the electrons move from valence band to the conduction band. As a result, photons are emitted by the solar module. This emission is captured in EL images, thus highlighting those defects which are not typically visible to the eye.

### Thermal Imaging

Thermal Imaging is a tool used for mapping temperature distribution. Infrared Thermography (IRT) is used for identifying shunts in solar cells which is a conventional way as the results are easy for interpretation. Following the black body radiation law, the IR emission of solar panels is detected and measured from thermal images captured by IR cameras. The temperature difference between various regions of a PV module can be derived from thermal images. Inactive areas of the module usually appear more heated than the surrounding active areas.

When the radiation from the sun is incident on a solar module it is converted to DC power which is outputted on the grid. In case a PV module is not functioning as required, the radiation is not converted to DC power and remains as excess heat on the surface of the solar cell. This raises the temperature of that inactive solar cell

which is shown as hotspots in thermal images. These hotspots can cause solder melting or delamination, cell damage and as a final consequence, loss of output power.

Parameters of the IR cameras used for collecting thermal images are given in Table 1.

Thermal images were captured for a period of 15 seconds during the heating phase of the panels, arising from solar exposure and electrical installation. Various parameters as mentioned in the Table 1 were taken into consideration. While capturing the images the sky needs to be clear without clouds.

Table 1: Factors considered while capturing images of solar panels

Solar irradiance	500 W/m <sup>2</sup> to 700 W/m <sup>2</sup>
Time of the day	Timing for capturing the IR image is on peak sun hours i.e., in the noon time as the irradiance is at the highest peak i.e., 1000 W/m <sup>2</sup>
Distance	1.3ft.
Angle	Viewing angle is 5° to cover the solar panel precisely
Ideal Conditions	Shadowing and reflection must be prevented.

### EL Dataset

A dataset of 2000 grey-scale 300 x 300 solar cell images is used. The images are in .png-format.

It consists of both functional solar cell images and defective solar cells images in the ratio as displayed in Figure (3).

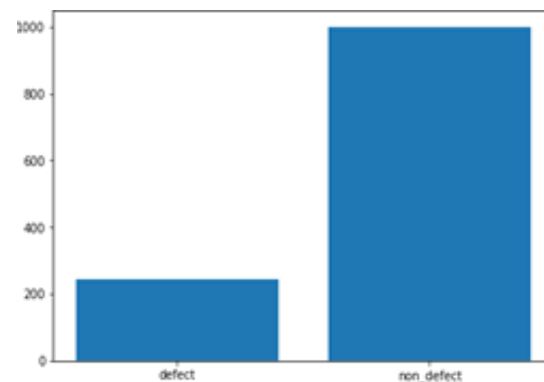
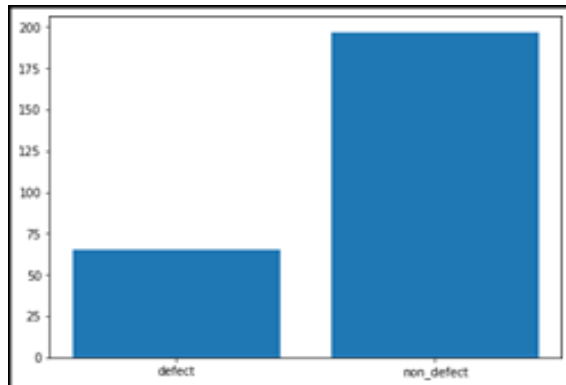


Figure 3: Distribution of Defective & Non-Defective images in Electroluminescence Dataset

### Thermal Dataset

The custom dataset consists of 250 thermal images of solar panels. The pixel size of each image is either 640 x 480 pixels or 320 x 240 pixels depending upon which camera is used to capture it. The dataset comprises of defective (containing hotspots) as well as non-defective (without hotspots) solar panel images. Images of both categories are in the ratio as displayed in Figure 4.



**Figure 4: Distribution of Defective & Non-Defective images in Thermal Dataset**

## RESULTS AND DISCUSSION

Recognition of defective solar cells is implemented by two learning models: Support Vector Machines and CNN. The first model used SVM technique. The second model which is applied is a CNN, RESNET 50: The model is operated with 48 convolution layers. The model also has 1 average pooling layer and 1 max pooling layer.

### A. Results from Electroluminescence Dataset

#### Results for SVM and CNN

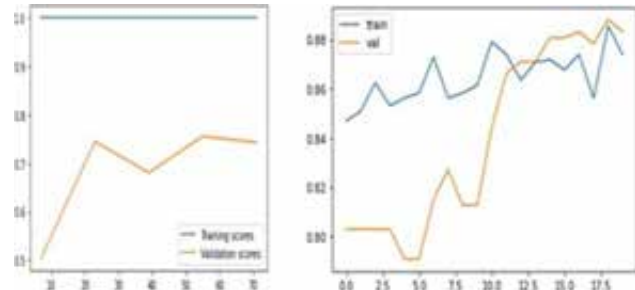
By running the SVM and CNN models on the EL images of solar modules the outcomes obtained are as follows:

**Table 2: Results of SVM and CNN on Electroluminescent images**

Train-validation split	Validation Accuracy		CNN	
	Training Accuracy	Validation Accuracy	Training Accuracy	Validation Accuracy
80-20%	96.8	95.2	93.25	89.51
70-30%	97.59	96.36	87.40	88.32
60-40%	95.14	96.26	97.69	80.29

Different SVM parameters are used for the results achieved. The best accuracy of 97.59% is obtained for the 70:30 train- test split ratio with linear SVM parameters. With CNN, the best accuracy obtained is 97.69% with a 60:40 train-test ratio, where the learning rate is 0.0001 and the number of epochs is set to 20.

#### Graphs for SVM and CNN



**Figure 5: Performance graphs a) SVM b) CNN for Electroluminescence Images**

Figure 5 displays the accuracy graphs obtained for SVM and CNN which compare the accuracy obtained for training and validation. Learning model efficacy depends on the closely matching values of validation and training accuracy.

### B. Results from Thermal Dataset

#### Results for SVM and CNN

After training the SVM and CNN models using Thermal images of solar modules the results obtained were as follows:

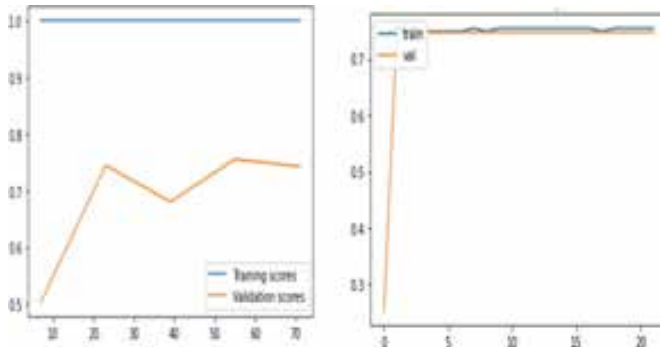
**Table 3: Results of SVM and CNN on Thermal images**

Train-validation split	Validation Accuracy		CNN	
	Training Accuracy	Validation Accuracy	Training Accuracy	Validation Accuracy
80-20%	90.57	88.68	76.19	75.00
70-30%	84.41	84.81	75.41	74.68
60-40%	80.95	84.76	75.80	75.24

SVM parameters used were similar to the ones used for EL dataset. In Section for the results received. The model performed best with an accuracy of 90.57% for 80:20 train- test split ratio with linear SVM parameters. Using CNN, the model accuracy was 76.19% with 80:20 train-test split ratio, with a learning rate of 1e-3 and the number of epochs = 20.



Graphs for SVM and CNN



**Figure 6: Performance graphs of a) SVM b) CNN for Thermal Images**

Figure 6 shows the performing accuracy graphs as obtained for SVM and CNN which compare the training accuracy to validation accuracy. CNN model provided least gap between the two accuracies.

#### Comparison of EL and Thermal Imaging

**Table 4: Comparison of results for SVM and CNN models on Electroluminescence images and Thermal images**

Learning Models	Split ratio	EL Imaging	Thermal Imaging
SVM	80-20%	96.8	90.57
	70-30%	97.59	84.41
	60-40%	95.14	80.95
CNN	80-20%	93.25	76.19
	70-30%	87.40	75.41
	60-40%	97.69	75.80

Table 4 shows the accuracy values of the models trained by splitting the dataset into different train-test ratios and using different algorithms. It was observed that overall outcomes of the EL imaging were better than Thermal imaging irrespective of the model used to train or the split ratio or parameters applied to train the image data. Although SVM achieved better results CNN is considered a powerful and robust tool for detecting defective solar panels as it is a better learning model and needs large dataset.

#### FUTURE SCOPE

For the enhancement of accuracy for fault identification, one can superimpose EL and thermal

images of the same PV module. To further decrease the inspection time, drone IR cameras can be utilised.

#### LIMITATIONS

This work is limited to recognition of Defective Solar Panel but the exact type of defect is not known. Also, the impact of each defect on the power output can be studied in further detail. The model's estimates are based on potentially limited observational studies, results can be improved by applying data augmentation of the custom dataset.

It is conceptual that SVM or CNN applied for detection of faults in EL images has a higher accuracy than the thermal images because EL images capture even those defects which are not visible manually. Existing dataset was used for EL whereas Thermal dataset is real life data collected manually. It may have some bias. The numbers of EL images is much larger than Thermal images. Yet, Thermal imaging is better than EL in practical applications because EL imaging can only be done at night time (dark) or in a simulated indoor lab setup whereas Thermal imaging can be done outdoors for on-site installations. EL imaging requires current to be passed through the solar panels continuously, after which it emits photons but for Thermal Imaging no such requirement exists.

Therefore, thermal imaging is an economical choice, though it needs more research to increase the accuracy of the system.

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# Simulation and Thermal Performance Analysis of Solar Parabolic Trough Collector

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## ABSTRACT

Currently, Solar Energy as well as solar power plants are the fastest-growing renewable sources of energy. They can meet a wide range of energy needs for the industry. As a renewable source of energy, it has very little or negligible effect on the environment. In this project, a compact parabolic trough collector with predetermined dimensions is employed. One of the biggest obstacles in the development and expansion of solar trough collectors is their low efficiency. Our study in this project will concentrate on the absorber pipe, temperature distribution for various mass flow rates with varied inlet temperatures. In Ansys Fluent 23, a Hexahedral mesh was utilized for conducting the simulation. The outcomes were obtained by modifying several parameters, followed by experimentation and validation through CFD results. Ultimately, the efficiency of the Solar parabolic trough collector and the amount of energy loss during practical application were calculated.

**KEYWORDS:** *Solar energy; Parabolic trough collector; ANSYS fluent 2023; Hexahedral mesh; Efficiency*

## INTRODUCTION

Since traditional energy sources (such as crude oil, coal, and natural gas) will run out in many years, sustainable energy, such as solar and wind energy, is one of the most optimistic conclusions to provide clean energy in the future.[1] All experimenters and scientists are concerned about the ongoing global increase in energy usage. Solar energy is a plentiful energy source that may be transformed into either heat or electricity. It serves as a beneficial source of power for solar dryers with vibrant operations, authentic hot water products, and electricity products in solar power shops. According to predictions, the global market for solar energy products will grow at an average pace of 8.9 percent per year between 2012 and 2040, making it the type of energy generation that will advance the most quickly. In addition, there are growing worries about the security of the energy supply and the necessity to fulfill the rising energy demand. The high rates of industrialization, population growth, and urbanization seen in most countries are the primary causes of the rising energy demand.[2] In the upcoming decades, concentrated solar power (CSP) and thermal (CST)

systems show great potential as renewable energy sources. By the end of 2017, the combined installed capacity will be 5 GW, and it is estimated to grow to 25 GW by 2030. Furthermore, there is an anticipated reduction of over 30 percent in the levelized cost of electricity. CSP technologies are divided into four main categories: linear Fresnel reflector, parabolic dish collector, solar power tower, and Parabolic Trough Collector. PTCs are the most widely used solar collectors due to their superior efficacy, low operating costs, and ease of expansion.[3] Parabolic trough collectors (PTCs) are the most well-established solar technology for steam generation in solar thermal plants because of their efficiency and simplicity. The most widely used PTCs are capable of delivering temperatures of up to 400 °C with good efficiency. Right now, there is a lot of interest in improving PTC performance, thus many studies have been carried out. The heat collecting element (HCE) and the reflector parabolic mirrors (RPM) make up the two major zones of a standard PTC. The absorber tube heats up and loses thermal energy to the environment once more as a result of the extremely concentrated energy.[4]

## Working

A PTC is essentially a cylindrical-parabolic mirror and a receiving channel located along the focal length of the parabola. This configuration enhances the solar energy concentration on the absorber, where sunlight is converted into heat and transferred to the fluid circulating through the absorber pipe. PTC systems operate within the low to medium temperature range, typically between 50°C and 400°C, which is suitable for various industrial processes. PTC technology utilizes direct sunlight as its heat source. To optimize efficiency, a solar tracking system is employed due to the continuous changes in the Sun's position. There are two types of sun tracking methods used in PTC: North-South and East-West Tracking.[6]

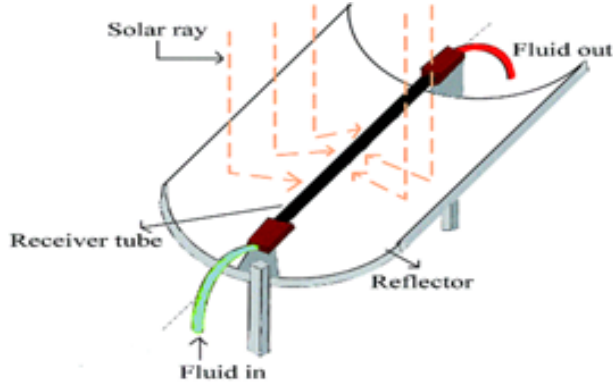


Figure 1, Ray Diagram of Solar PTC[10]

## MODELING AND SIMULATION

### Physical Model

In this Project, we designed the solar PTC and simulated it for different boundary conditions in ANSYS Fluent's, and obtained the results. The dimensions and the required input parameters are noted in Table 1.

The performance of solar PTC counts on the absorber pipe, the heat transfer flowing inside the pipe, and their material properties like density, heat carrying capacity, and thermal conductivity.[7] Hence while modeling and simulation, all these properties have been considered. There are also a few simulation criteria to be considered while simulation: Mesh quality, computational time, and boundary conditions. So, to reduce the complexity and the computational time, an absorber with a fluid domain is only considered for simulation.[8]

Table 1. Modelling Dimensions

Sr. No.	Model Dimensions	Value
1.	Length of Absorber pipe	3m
2.	Width of Parabola	1m
3.	Inner Diameter	0.02m
4.	Outer Diameter	0.025m
5.	Concentration Ratio	12

### Governing Equations

The equation used for calculation of the velocity of the fluid at the inlet of the absorber pipe using the mass flow rate, area of absorber pipe, and density of the thermal fluid:

$$V_f = \dot{m} / A * \rho \text{ (m/s)}$$

The Reynolds number is used for deciding the type of flow required for the simulations using the velocity of the inlet fluid, the inner diameter of the absorber pipe and dynamic viscosity of the water.

$$Re = v_f * d_i / \nu$$

The efficiency of the Solar PTC is calculated using mass flow rate, the specific heat of heat transfer fluid, inlet temperature, outlet temperature, area of the aperture, and the amount of radiation incident on the surface.

$$\eta = [\dot{m} C_p (T_i - T_o) / I_b * A_e] * 100$$

### PTC Geometry and Meshing

The data used for generating the absorber pipe are mentioned in Table 1. The model is then made according to the dimensions, and further preprocessing starts. The meshing used for the model is Hexahedral with the number of elements and nodes described in Table 2 and hence the one with more efficiency is used. The skewness obtained after the meshing was 0.755 and the finer mesh was selected. To carry out further simulation and for applying boundary conditions the pipe domain is divided into two parts the upper wall and the bottom wall, these can be distinctly noticed in Figure 3(a). But the meshing for both the upper as well as lower wall is similar as it is a continuous single pipe. Meshing is a very important part of any geometry as it decides the accuracy of the results the finer mesh better the results obtained, Figure 3(b).

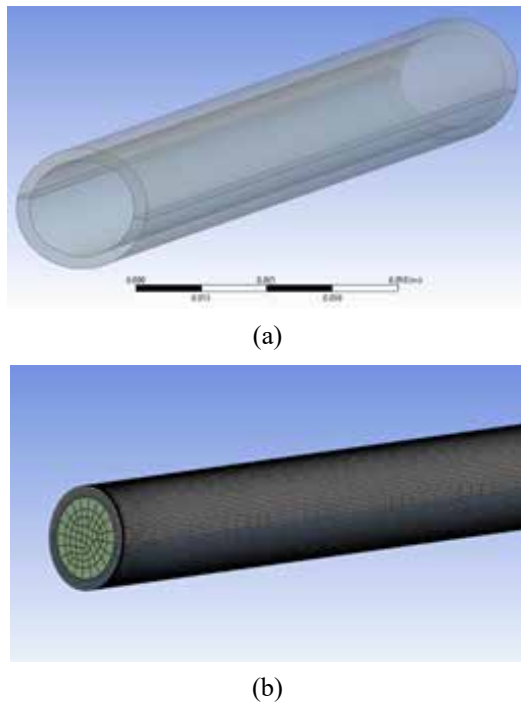


Figure 3, (a) Geometry divided into halves upper wall and bottom wall, (b) Meshing of fluid and pipe domain

Table 2. Independent Study

Mesh	Elements	Node	Efficiency
Hexahedral	105080	159820	78.81
Hexahedral	194950	290584	78.55
Hexahedral	265803	359252	78.84
Hexahedral	433826	364105	70.77

### Material Selection and Boundary Conditions

Boundary conditions is the part of processing in which different variable parameters are applied to the model before simulating. The following are the different boundary conditions and also a few assumptions before simulation:

1. Inlet Temperature.
2. There is continuous laminar flow of incompressible fluid.[9]
3. The simulation maintains a consistent and uniform thermal conductivity throughout the absorber tube and fluid.
4. There is a constant flux applied on the bottom wall of the pipe.

Stainless Steel is chosen as the absorber pipe material due to its ability to achieve a more even distribution of surface temperature and greater thermal efficiency of the collector.[7].

### CFD Modelling

In this project, Water is chosen as the working fluid i.e Heat transfer fluid, and Stainless Steel is used as the absorber pipe material. [11] Table 3 presents a comprehensive overview of the thermodynamic characteristics, as well as the density, thermal conductivity, and heat capacity, of various materials. To ensure optimal absorption, the absorber pipe is coated in a black substance.

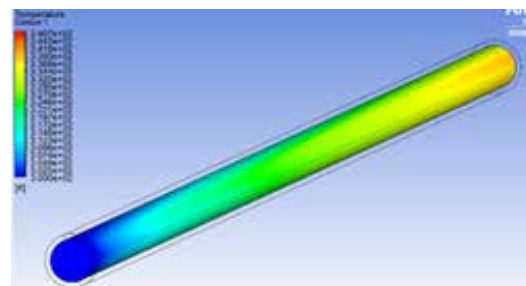
Table 3. Material Properties

Sr. No.	Material	$\rho$ (kg/m <sup>3</sup> )	Cp (J/KgK)	K (W/mK)	$\mu$ (Kg/ms)
1.	Water	998.2	4185.5	0.6	0.001003
2.	Stainless Steel	7500	420	45	

### CFD Results

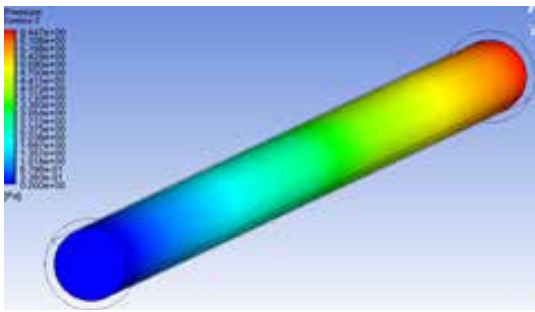
After the completion of the calculations the post-processing starts and the following are the results obtained:

1. There is a gradual increase in the temperature of the liquid as it moves from the inlet to the outlet of the pipe and as the observed temperature of the fluid near the bottom wall increases first and then the fluid near the upper wall and it is observed in the outlet temperature figure.
2. There is a negligible pressure change of  $6.447 \times 10^{-5}$  bar.
3. As observed the inlet velocity is constant but as it goes on further the velocity near the walls goes on decreasing.

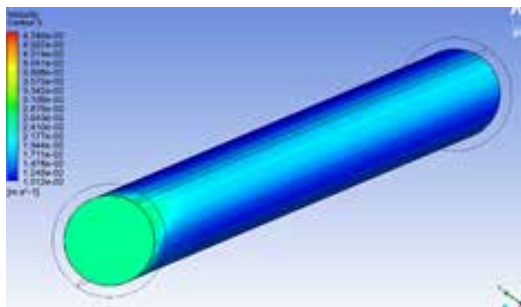


(a)





(b)



(c)

Figure 4. (a) Temperature distribution along the length, (b) Velocity distribution along the length, (c) Pressure distribution along the length

**SETUP BUILDING AND TESTING**

**Setup**

A single-pass parabolic trough collector is employed in this case. An Absorber tube of stainless steel which has a black coating is placed at the focal point of the parabolic collector. The temperature sensors are situated at the inlet and the outlet of the absorber pipe.[12]

Elements of the Setup:

1. Inlet Tank: 50lit each at inlet and outlet
2. PVC Pipes and Mass Flow rate control valve: 0.5inch PVC pipe and mass flow control valve

Table 4. Readings and Efficiency of Solar PTC on 20th March 2023

Sr. No.	Time	Inlet Temperature (K)	Outlet Temperature (K)	Atmospheric Temperature (K)	Incident Radiations (W/mK)	Mass Flow Rate (Lit/hr)	Efficiency (%)
1.	10:55	28.78	49.05	29.04	289	20	48.86
2.	11:10	28.69	50.5	29.04	300	20	46.86

3. Solar PTC: Parabolic Reflector Aluminum reflector sheet with 0.8 reflectivity and the steel absorber pipe at the focal point.
4. Temperature Sensors: Three DB18B20 waterproof temperature sensors with a range -550C to +1250C.
5. Arduino UNO
6. Solar Pyranometer: Silicon-based portable Pyranometer and Thermopile-based Pyranometer.



Figure 5. Setup Diagram

**Testing And Experimental Results**

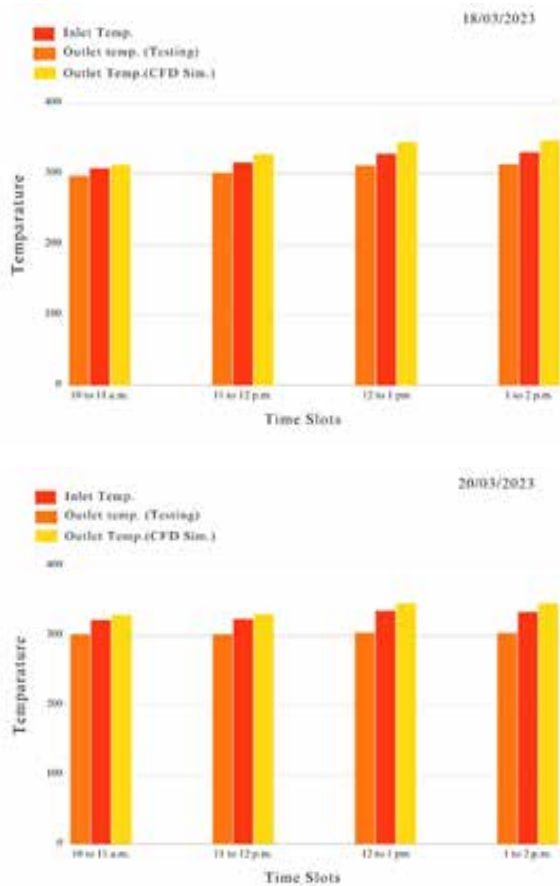
Testing was done for a time duration of 7 days from 16th March 2023 to 23rd March 2023 and time 10 am to 2 pm. During this testing, different parameters were continuously changing and the efficiency of the Solar PTC was changing accordingly. A few of the parameters were changed manually like mass flow rate, inlet temperature, and tracking. From the Testing, we obtained the results in Table 4. Efficiency of the Solar PTC was continuously changing according to the inlet temperature, mass flow rate, incident beam radiations and tracking.

3.	12:55	30.81	62.23	32.07	445	20	45.23
4.	1:10	30.12	60.58	31.54	452	20	49.71

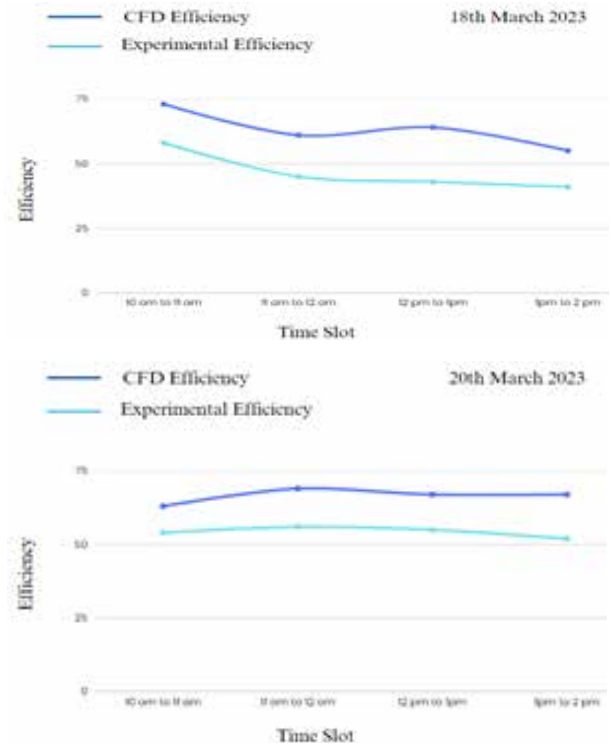
**Validation**

To ensure authenticity, verification of the CFD and Experimental outcomes involved implementing the experimental values’ boundary conditions into the CFD and adjusting the parameters correspondingly. Following Graph 1, gives the Validation for different days. As we observe from the Graph it can be directly understood that there are always some losses in actual performance than the CFD performance and due to that the outlet temperature of experimental results is less than the CFD results.

As observed from Graph 2, the average deviation of the experimental efficiency of the PTC is 14% on 18th March and it is 12% on 20th March.



**Graph 1, Outlet Temperature comparison of Testing and CFD on 18th March and 20th March 2023**



**Graph 2. Efficiency comparison of testing and CFD on 18th March and 20th March**

**RESULTS**

As the simulation was performed on the ANSYS Fluent’s there were the following results on the basis of the different parameters changed:

1. There is a gradual increase in the temperature of the fluid along the length of the absorber pipe and the temperature of the fluid near the bottom wall increases first and then the upper liquid.
2. The pressure along the length is constant as the rise is very negligible i.e.,  $6.447 \times 10^{-5}$ . Due to it, there is no phase change of the fluid from the inlet to the outlet.
3. The velocity of the fluid goes on changing along the length, the velocity of the fluid at the inlet is constant but as it moves forward the velocity of fluid near the walls decreases.
4. While keeping the inlet temperature and incident

beam radiations constant it is observed that the outlet temperature goes on decreasing as the mass flow rate increases and hence mass flow rate is indirectly proportional to the efficiency of the Solar PTC.

From the validation and experimental results, we conclude that:

1. The Solar Global Radiations goes on increasing from 10 am to 2 pm and we can obtain maximum efficiency in this time period.
2. As the inlet temperature increases the outlet temperature increases but after a limit the outlet temperature becomes constant and the efficiency decreases.
3. By applying the Mirrors on the Parabola with 100% reflectivity the efficiency of the PTC increases.
4. The coating on the absorber pipe should have a 100% absorptivity and it should be neat to a perfectly black body.
5. There are a lot of manual errors in manual tracking hence automatic tracking should be done according to sun's position.
6. To reduce the setup weight composite materials can be used.

**Table 3. Output temperature variation with mass flow rate**

Sr. No.	Mass Flow Rate (L/hr)	Velocity (m/s)	T <sub>in</sub> (K)	T <sub>out</sub> (K)	I <sub>b</sub> (W/m <sup>2</sup> )
1.	10	0.00891	300	373.6	417
2.	15	0.01326	300	356.8	417
3.	20	0.01780	300	347.8	417
4.	25	0.02210	300	342.4	417
5.	30	0.02642	300	338.5	417

## CONCLUSION

A Solar PTC model was simulated in ANSYS Fluent and subsequently verified through experimental testing. The

model was developed using a commercial heat transfer software, employing laminar flow due to a Reynolds number below 2000. Water served as the heat transfer fluid, while stainless steel was utilized for the absorber pipe material. The simulation employed a hexahedral mesh, and the obtained results were based on the actual experimental values. The experimental findings were then compared to the CFD results, revealing an efficiency difference ranging from 12% to 14%. The validation process led to the following conclusions and suggestions for enhancing the experimental efficiency:

1. The Reflector used should have 100% reflectivity.
2. Automatic tracking should be preferred over manual tracking.
3. Efficiency should be calculated in the time period of 10 am to 2 pm.
4. Absorber pipe coating should have 100% absorptivity.
5. Lower the mass flow rate higher the temperature obtained.

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# Analysis of the Financial Impact of Wind Energy Integration in a Deregulated Power System

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## ABSTRACT

The integration of renewable energy generation has an effect on key power system parameters such as electric losses, voltage profile, and generation cost. Inappropriate siting of renewable energy sources may lead to increased voltage fluctuation, system losses, and decreased stability and dependability. The main drawback to renewable energy's integration with an electrical grid system is its unpredictable nature. This research examines the effects of wind farm integration on the system economy in the context of a wind-integrated competitive energy market. This research also looks at the impact of deregulation on locational marginal pricing (LMP) and the cost of system generation. In this work, the optimal power flow problem is solved using two different optimization methods: Sequential Quadratic Programming (SQP) and Artificial Bee Colony Algorithms (ABC). The entire work is carried out by using a modified IEEE 30 bus test system.

**KEYWORDS:** *Renewable energy; Competitive market; Smart grid; Power generation cost; Deregulation; Meta-heuristics algorithms; Distributed generation*

## INTRODUCTION

India's usage of electricity has been rising quite quickly. It is undoubtedly a result of India's population expansion and economic progress. Regarding "electricity as a commodity," there has been a significant mismatch between supply and demand during the past ten years. Although we have enormous energy needs, it is becoming more and more difficult to supply those needs through conventional power plants. Power generation from traditional resources is subject to specific limitations. So there is a need to shift our attention from conventional resources to non-polluting sources for both practical and environmental grounds. Solar, wind, biomass, and hydropower generation from non-conventional sources are only a few examples. The decentralized energy distribution is made possible by renewable resources, which has benefits for supplying energy needs in rural areas in particular.[1-3] Solar and wind energy are available in bulk, and with the help of these energy resources, distributed generation is possible. Their main disadvantage, however, is variable

generation. Because it is discontinuous, it affects the network power security. If the electrical system is not properly and efficiently maintained, grid failure in a renewable integrated system is a possibility.[8] The idea of the electrical power system has recently changed from becoming regulated to becoming deregulated. In the deregulated model as of right now, certain developed countries have built their own internal power structures, while others are adopting the leaders. The deregulated or competitive power market has seen the operation of various companies. Several stakeholders in the deregulation model have carried out their responsibilities. This involves retailers, Independent System Operators (ISO) and distribution companies. [4-7].

The ISO performs key operations in the deregulation model and handles overall operations. The main issues when developing a hybrid solar-wind-battery generation system are power supply dependability under various load conditions, changing load profile, and matching system costs. It is necessary to design a



sizing strategy in order to employ wind and solar energy resources economically and effectively. In contrast to other traditional methods of optimization, there is need to develop new method, so that it will be able to reach the global optimum. [21]

## LITERATURE REVIEW

In recent years, many works have been reported by the researchers in the area of non-conventional energy and deregulated system.

The better placement of solar and wind energy source can be done by considering the entire climate conditions and other alternative installations which is described by Karavets et al. [15]. The total environmental and economic factors are considered for some specified place by the authors.

The integration of renewable energy with the conventional power sector is covered by Svendsen et al. [16] with reference to future power needs. Here, with some consideration given to both conventional and renewable power generation, it will be thoroughly explored how much power a country would need in 2030 as well as the generation and demand scenario.

The best placement of the solar photovoltaic system inside the actual local distribution system is covered by Sadeghian et al. in their study [17]. The most sophisticated description of the effective and efficient allocation of the system by a simulation model is provided.

The PV or Wind hybrid energy system is compared to all other renewable energy generation systems by J.S. Chandok & V. Dutta [18]. The system stability and quality of power generation can both be enhanced by the best possible design for renewable energy sources. The effective sizing of the energy-generating systems and the proper positioning of solar and wind energy systems are reviewed in this study.

Mufti and others [19] with the use of the power world simulator programme, the H-11 grid system operation results are compared. Demand and generation are compared to the state and potential of a specific location. The simulation procedure shows that distributed renewable energy generation (DREG) enhances the voltage profile of the system, lowers feeder losses, and

boosts system dependability.

### Research Gap in literature review -

- How do RDG (Renewable Distributed Generation) units affect the economy of the power grid?
- In wind integrated systems, how do RDG units affect the system voltage?
- How the system voltage profile and economic benefits of the electrical system are depends on various optimization techniques?

Researchers in the field of renewable energy haven't addressed all of these problems in recent years. Therefore, by using RDG units that are operating properly, all of these issues have been examined simultaneously in this work. The "optimal functioning of renewable distributed generation in day-ahead power system" is the focus of our study in this area. We will also place emphasis on the need to reduce costs in order to compete in the electrical market.

The primary highlights of this work are as follows:

1. To develop a model for the ideal sizing and positioning of RDG units in a market for deregulated power.
2. The economic evaluation of the impact of various wind speeds on the wind generation system.
3. SQP and ABC are compared with regard to profit, production costs, and bus voltage profile.

## MATHEMATICAL FORMULATION:

### Wind Energy Generation

Wind generation depends on both wind speed and height of turbine. In order to function profitably, a wind turbine must normally be 120 metres tall. The wind turbine in this work is consider at 120 metres high. The wind speed is calculated by using the following formulas for different heights. [16]

$$\frac{WS_n}{WS_{10}} = \left(\frac{n}{10}\right)^h \quad (1)$$

Here, WS<sub>n</sub> and WS<sub>10</sub> stand for the wind speed at n and 10 metres, respectively, of height. The hellman co-efficient, or "h," is 1/7. The formulation of wind farm generation [16]:

$$WPG = \frac{1}{2} \cdot AD \cdot a \cdot e \cdot WS_n^2 \tag{2}$$

Air density, turbine swept area, and turbine efficiency are each represented by the letters “AD,” “a,” and “e” in this equation.

**Objective Functions**

Finding out the economic impact of wind farm integration in a day-ahead power market is the main goal of this work.

$$\text{Min } F = \sum_{i=1}^{Ng} C_i(P_{gi}) - \sum_{j=1}^{Nd} B_j(P_{dj}) \tag{3}$$

$$\text{Max } SB = \sum_{j=1}^{Nd} B_j(P_{dj}) - \sum_{i=1}^{Ng} C_i(P_{gi}) \tag{4}$$

Here, F represents the sum of the generator side bidding cost ( $C_i(P_{gi})$ ) and profit of the customer ( $B_j(P_{dj})$ ). The numbers of generators and loads are Ng and Nd, respectively.

Supplier’s profit is given by below equation:

$$P(m, t) = TRC(m, t) - TGC(m, t) \tag{5}$$

Where, „P (m,t)“, „TRC (m,t)“ and „TGC (m,t)“ represents system profit, revenue and generation cost of m<sup>th</sup> unit at time

$$TRC(m, t) = \sum_{i=1}^{Ng} P_g(i, t) \cdot LMP(i, t) \tag{6}$$

„Pg(i,t)“ and „LMP(i,t)“ are indicates produced power and locational marginal price at ith unit at time „t“.

$$TGC(m, t) = GC_{Th}(m, t) + GC_{W}(m, t) \tag{7}$$

$$GC_{Th}(m, t) = \sum_{i=1}^{Ng} (a_m + b_m \cdot P_g(i, t) + c_m \cdot P_g(i, t)^2) \tag{8}$$

Here, GCTh, GCW are known as thermal and wind power cost.

„am“, „bm“ and „cm“ are cost co-efficient of thermal generations.

**RESULTS AND DISCUSSIONS**

In this work, the performance of the recommended method has been compared with help of a modified IEEE 30-bus test system. System data for the modified

IEEE 30 bus system was obtained from [22 and 23]. Bus number one is considered of as a slack bus and the system’s MVA limit is assumed to 100 MVA.

The following are the main steps of this paper work:

**Step 1:** Investigate the impact of deregulation on a thermal power plant’s LMP, bus voltage, overall profit, and production costs using SQP (without considering wind farm).

**Step 2:** Investigate the impact of deregulation on a thermal power plant’s LMP, bus voltage, overall profit, and production costs using SQP and ABC (with considering wind farm).

**Effect of Deregulation on Without Wind Farm Placement**

Work is done in the day-ahead electricity market context. Customers and energy owner both submit bids to the system operator for their actual power calculations. The price of the electricity is set at a best optimal value (LMP) in this condition, which provides the advantageous to both the power supplier and the consumer. This is the best solution that Independent system operator could have taken.

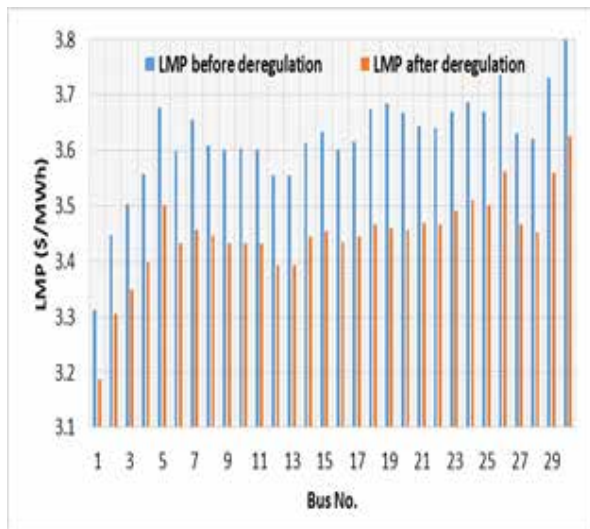
Consumer-side bidding has been considered in this work to find out the effect of deregulation on the power system. In the IEEE 30 bus system’s bus numbers 7 and 19 have been taken into consideration for the consumer side bidding. Table 1 shows deregulation impact on various costs on a thermal power plant using SQP’s technique (without considering wind farms).

**Table 1. System economic comparison between before and after deregulation (without wind placement)**

Component	Before Deregulation	After Deregulation
Cost of generation (\$/h)	850	755
Income (\$/h)	1047	894
Overall Profit (\$/h)	197	139

As shown in Table 1, deregulation led to a significant decrease in the cost of system generation from 850 to 755 . Similarly, the supplier profit cut, from 197 to 139 dollars per hour, is due to trying to maximize societal

advantages. Figs. 1 and 2, which show the impact of deregulation on voltage profiles and LMP.



As seen in above Fig. the voltage profile has strengthened after the introduction of a deregulated environment. The LMP value for all buses is decreasing as a result of the deregulation, which is favorable to customers.

Table 2. Calculation of Generation power with SQP and ABC optimization (without wind placement)

Generator	SQP (MW)	ABC (MW)
G1	154	153.89
G2	51	52
G5	30	30.2
G8	09	13
G11	11	11.2
G13	18	18



A set of six generators are used in the modified IEEE 30 bus test system. A comparison study has been carried out here with two optimization approaches in order to evaluate the usefulness of various optimization techniques (i.e. SQP and ABC). Table 2 displays the total amount of power produced by various generators using all optimization methods. In order to examine the utility of optimization strategies, a comparison study using two optimization approaches has been conducted (i.e. SQP and ABC).

The quantity of power produced by six generators using two optimization strategies is displayed in Table 2. Table 3 examines the system economy using different optimization techniques. It can be seen that using meta heuristic optimization approaches lowers the cost of system generation when compared to SQP. The cost of the system generation when SQP is used is \$806 per hour; however, when ABC is used, the cost is reduced to 787.

Table 3. System economy with SQP and ABC optimization techniques (without wind placement)

Component	SQP	ABC
Generation Cost (\$/h)	806	787
Income(\$/h)	944.2577	960.1158
Overall Profit (\$/h)	138	171

Effect of Deregulation with Wind Farm Placement

The optimal location for wind farm siting in the system has been determined using a factor known as the “Bus Sensitivity Factor (BSF)”. The mathematical equation for BSF is given below. This formula is applied to evaluate the BSF for each bus.

$$BSF_m^t = \frac{\Delta P_{ij}^t}{\Delta P_m^t} \quad \forall t = 1:T$$

The entire task in the preceding part was completed without the installation of a wind farm. The wind farm has now been positioned in the ideal location (optimal location is calculated using the concept of BSF). Table 4 presents the comparison data for the installation of wind farms using SQP and ABC before and after.

**Table 4. Economy with SQP and ABC optimization techniques (with wind placement)**

	Without wind	With Wind Placement		
		At 12. 30 Night	At 9AM	At 5 PM
Cost of Generation (\$/h)	806	677	684	673
Income (\$/h)	944.26	836.3	843	848
Overall Profit (\$/h)	138	161	160	175

Table 4 shows that the location of wind farms is significant in a deregulated system. With the largest quantity of wind power integrated into the system, the cost of system generation is lowest. The supplier's profit is also impacted by this positioning. When a high-value wind farm is installed, the supplier's profit is at its highest

## CONCLUSION

Because of the global modernization of technology in all spheres, the electrical industry is being forced to consider the system's economic viability. As a result, both power producers and consumers gain profit. It's difficult work for the market controller to integrate renewable energy in the deregulated power sector. The integration of wind farms into a deregulated power grid is examined in this work in terms of its economic effects. It has been noted that the system would be more economically stable after the maximum capacity wind farm is installed, meaning that system generation costs are reduced with a significant number of wind farm installations. The cost of system generation is strongly related to the revenue of the generation firms and their clients. Therefore, the profit will be maximised while system generation costs are kept to a minimum.

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# Curcumin-Loaded Phenethyl Isothiocyanate Nano-Spheres: Preparation, Stability Study, and Its Implication for Cataract Prevention

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## ABSTRACT

This study examined the effect of curcumin-loaded nanospheres in an emulsion form on fish eye cataracts. Preparation of curcumin nanoemulsions using phenylethyl isothiocyanate. Nanoemulsions were produced using ultrasound at 150 W. The zeta potential measurement of turmeric loaded nanoemulsions was found to be -30.7eV, -13.4eV, -9.55eV, under different conditions, the size measured by the particle size analyzer is 149.3nm, 245.3nm and 403.5nm, respectively. Investigate the surface morphology of nanospheres by FE-SEM analysis. The zeta potential index indicates the stability of the corresponding nanospheres. The use of anti-cataract drugs is studied using a separate fish eye lens. Cataracts are caused by high sugar levels. Evaluation of the biochemical parameters of the reduced form of glutathione to explain the anti-cataract effect of curcumin-loaded nanoemulsions.

**KEYWORDS:** *Curcumin, Phenethyl isothiocyanate, Nano-Spheres, Cataract.*

## INTRODUCTION

The study of nanoemulsions is very important for drug release [1]-[4]. Oil-in-water emulsions are widely used for drug delivery [5]-[9]. Emulsions work as effective drug carriers for drug delivery [10]-[12]. The organic phase in oily emulsions is often used to retain drugs in oil-soluble solutions [13]-[15]. Phenylethyl isothiocyanate (PIT) was used as the oil phase of the drug carrier emulsion [16]. Naturally occurring PIT itself acts as a hydrogen sulfide donor, and the available evidence suggests that H<sub>2</sub>S is a real player in medicine [17]. Isothiocyanate micelles have also been used to reduce intercellular oxidative stress, which helps treat cancer [18]. PIT has been shown to be an effective treatment for lung cancer in smokers [19].

Curcumin is one of the best anticancer compounds from nature [20]. The combination of turmeric and PIT has also been tested and found to be a combination with anti-cancer as well as anti-inflammatory properties [21], [22]. Studies have shown that PIT-containing curcumin (CU) protects lenses from oxidative stress and helps

prevent cataracts [23], [24]. In a study on diabetic mice, CU also had beneficial effects in preventing cataracts [25], [26]. The physical stability of micelles can be understood by measuring the zeta potential [27]. Cataract in animals can be reduced with the help of CU nanoemulsion using PIT.

In the current study, both the oil phase and the drug loaded (CU) would be the best combination in nanoscale micelles for the prevention of cataract in the eye lens.

## METHOD

Experimental Section Preparation of CU loaded nanoemulsion 1 mg of CU is dissolved in 10 ml of PIT, as it is a good solvent for CU. Use 5 ml of surfactant mixture (Smix) in the form of Tween-20 and Span-20 (2:1) as emulsifier. The oil phase (oil phase) consists of CU, PIT and Smix added to 85 ml of distilled water. Water acts as an aqueous solvent, thereby forming self-contained micelles, forming an oil-in-water emulsion system. The emulsion was homogenized for 30 minutes at 8000rpm to ensure uniformity. Then you get a micron emulsion. After high-speed homogenization,

the micelles are evenly dispersed globally. After high speed homogenization, nanospheres were obtained with a 150 W probe sonicator. Sonicate with the probe for 30 minutes at 5°C to 10°C.



**Fig. 1. Probe-sonication 150 watt (Sonics & Materials INC. made in USA.)**

#### **Anti-Cataract study of CU loaded PIT nano-spheres**

Cataract prevention studies were conducted using fish eyes isolated from a local fish market in Jalgaon (India). Red pomfret is used in cataract research. Transfer the eyes to the laboratory immediately after killing within 30 min at 0 °C. Cataracts were caused by the use of high glucose solution. Anti-cataract application demonstrated by aldose reductase inhibition.

#### **Aldose reductase enzyme preparation**

Aldose reductase inhibitory activity was investigated using the method of Dongare et al. (2012) [28]. Salt water is used to sterilize contact lenses. The eyepiece is separated from the fisheye. They were homogenized in pH 6 sodium phosphate buffer. 5 contains 10 mM mercaptoethanol to form a 1:3 w/v homogenate. The resulting homogenate was then centrifuged at 8000 rpm for 30 minutes at 4°C (3 cycles) and the clarified supernatant was separated. Separate the supernatant and add 40% ammonium sulfate for precipitation. After centrifugation, the supernatant was separated. In this supernatant, aldose reductase inhibitory activity was measured. Somani et al. (2015) described a method for aldose reductase inhibitor diagnosis [29].

#### **Measurement of aldose reductase inhibition activity**

The prepared enzyme was used to determine the inhibitory activity of aldose reductase by comparing it with the reaction mixture of copper-loaded nanoemulsion, 0.1 mM NADPH, 400 mM lithium sulfate, 40 mM xylose at different concentrations. NADP formation is a measure of the decrease in absorbance measured at 340 nm. Quercetin was used as reference (positive control). Percent inhibition was calculated spectrophotometrically [29].

$$\% \text{ Inhibition} = \frac{(\text{Absorbance of Control} - \text{Absorbance of Sample})}{(\text{Absorbance of Control})} \times 100$$

#### **High-glucose induced cataract inhibition study**

Lenses in fish cataracts with high blood glucose in vitro, Somani et al. [29]. Isolated fisheye lens was incubated in artificial body fluid. Using a large amount of sugar (60 mM) (NaCl 140 mM) in aqueous humor at pH 7.8. Potassium chloride 4 mM, magnesium chloride 2 mM, sodium bicarbonate 0.5 mM, sodium hydrogen phosphate 0.5 mM, calcium chloride 0.4 mM, tiab kabzib 6.0 mM). Add 250 mg of penicillin and 250 mg of streptomycin to body fluids to prevent infection. Fish lenses are divided into the following categories.

Phenylethyl isothiocyanate nanospheres (CNE-1) have been used in cataract inhibition studies because of their smallest particle sizes and highest zeta potentials [30].

Group I: Normal control with glucose 6.0 mM (Normal concentration).

Group II: Negative control with glucose 60 mM (High concentration).

Group III: CNE-1 20 µg/ml with glucose 60 mM.

Group IV: CNE-1 40 µg/ml with glucose 60 mM.

Group V: CNE-1 60 µg/ml with glucose 60 mM.

Group V: Quercetin 500 µg/ml with glucose 60 mM.

The lens was incubated at 37°C for 72 hours. After the incubation period; Visually inspect for conditions by placing the scanned lenses on paper. The least opaque lenses scatter light and produce bright colors on paper. And most opaque lenses. If the dose is

opaque, determine that the light transmitted to the photo paper is less transparent than the resulting opacity depending on its content and opacity. Next, the lenses were homogenized in phosphate buffer (pH 7.4) containing 0.00025 M EDTA to obtain 10% w/v homogenate. Further centrifuge the homogenate at 7155 g (8000 rpm for 10 cm radius) at 4 °C and separate the supernatant. The separated supernatant was analyzed for biochemical parameters such as reduced glutathione and lipid peroxidation. Total protein was obtained by the Bradford method [31].

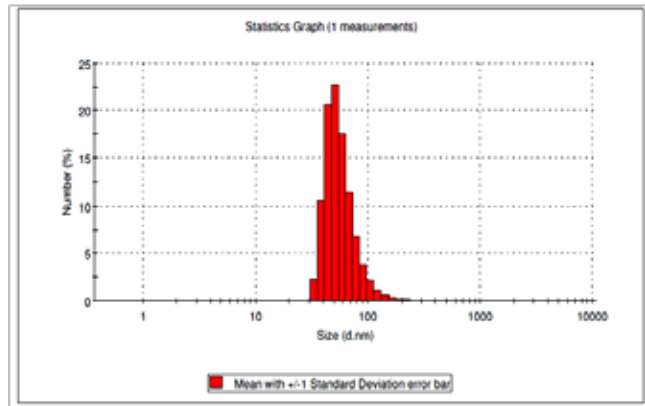
**RESULTS**

**Determination of Particle size by Particle Size Analyzer (PSA)**

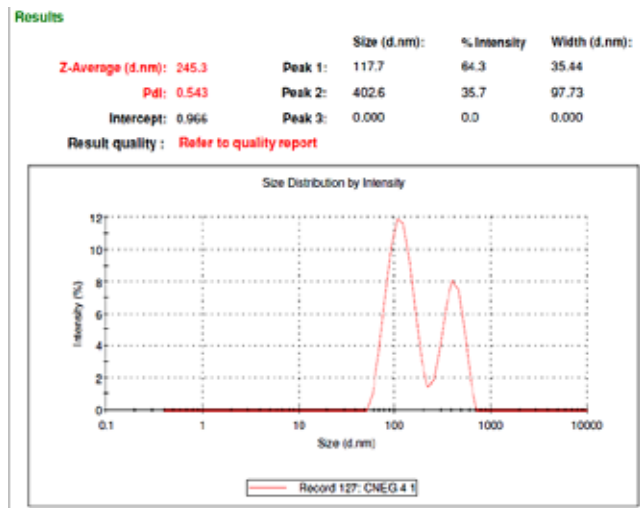
The nanometer size of the nanospheres is determined using particle size measurement based on the dynamic light scattering principle. Dimensions were recorded as 149.3 nm, 245.3 nm and 403.5 nm for 3, 2 and 1 cycles of 10 min each. Mean Particle Distribution (PSD) is reported as nanosphere diameter in nm.

**Table 1. Particle size for different cycle(s)**

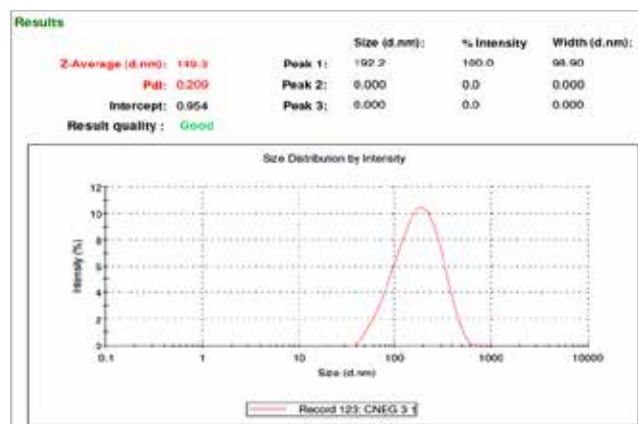
Sample	Probe-sonicator cycles	PSD (nm)
CNE-1	30 min (3 cycles)	149.3
CNE-2	20 min (2 cycles)	245.3
CNE-3	10 min (1 cycles)	403.5



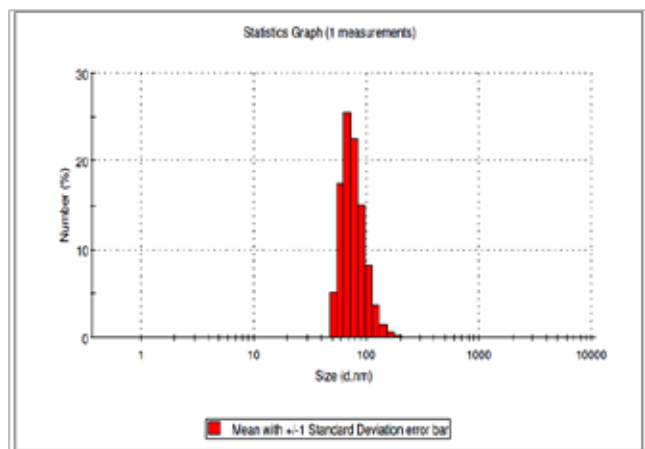
**Fig. 3 Size statistics report obtained by number for CNE 1**



**Fig. 4 Particle size distribution report obtained for CNE 2**



**Fig. 2 Particle size distribution report obtained for CNE 1**



**Fig. 5 Size statistics report obtained by number for CNE 2**

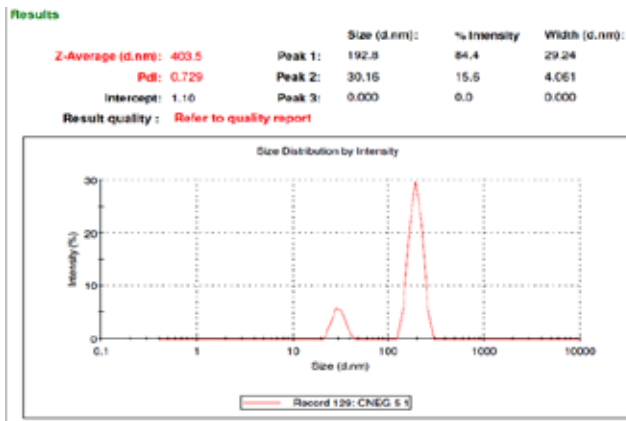


Fig. 6 Particle size distribution report obtained for CNE 3

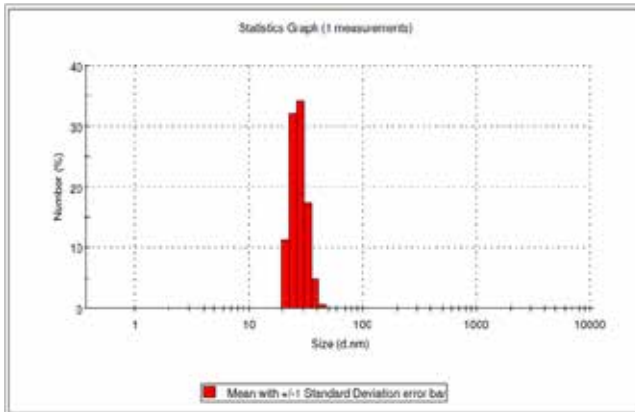


Fig. 7 Size statistics report obtained by number for CNE 3

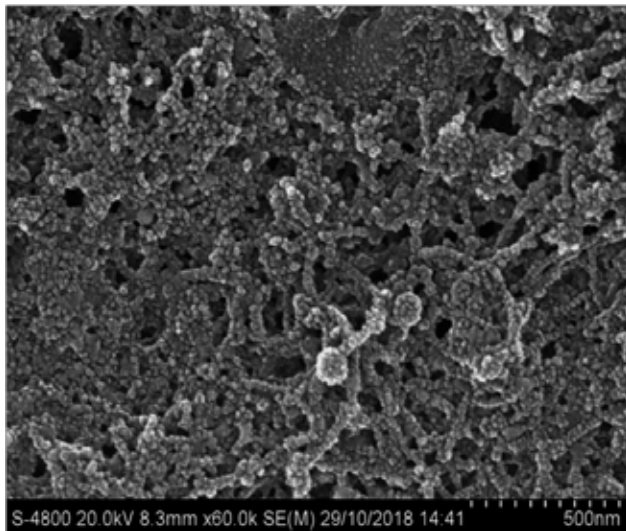


Fig. 8 FE-SEM image of Nano-Spheres showing CU loaded micelles

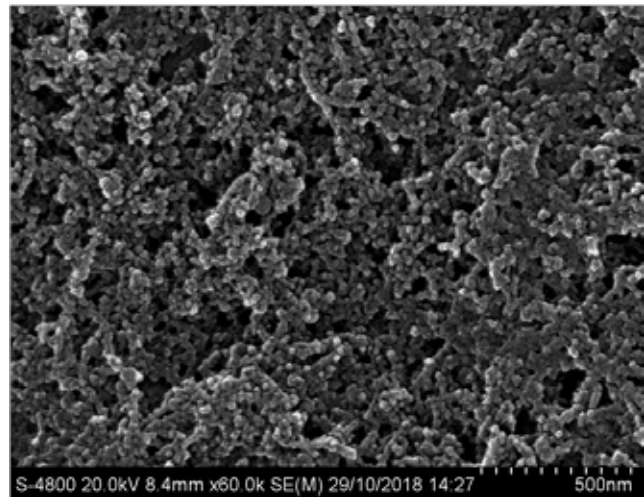


Fig. 9 FE-SEM image of Nano-Spheres showing CU loaded micelles

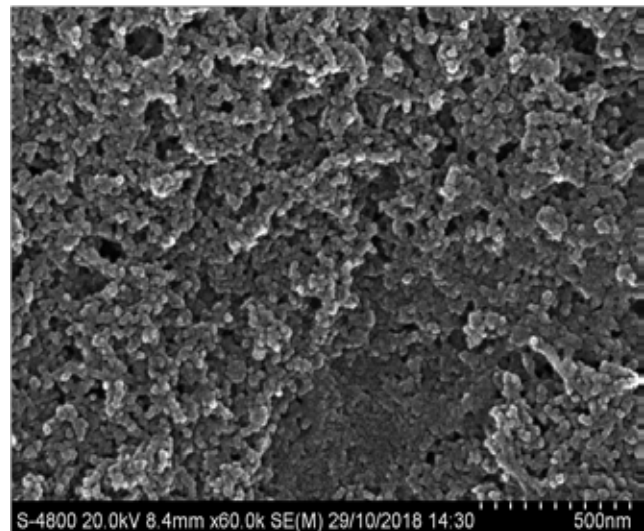


Fig. 10 FE-SEM image of Nano-Spheres showing CU loaded micelles

**Surface study by FE-SEM**

The images obtained after FE-SEM analysis show the surface morphology of the emulsion, in which a mesh-like network is observed in the case of CU-loaded nanospheres in the PIT. The surface morphology of the sample shows that the spherical micelles formed by the CU were loaded into the PIT as the micelle oil phase. Speculation about the shape and size of the micelles was confirmed using FE-SEM images obtained from PIT-loaded copper nanoemulsion samples diluted in deionized water (10%).



**Zeta potential measurements**

The zeta potential analysis to determine the charge of nanoparticles or nanomicelles. The amount of nanoemulsions was studied by Malvern zeta sizer (Malvern Instruments, Worcestershire, UK). Here, the zeta effect is applied to the physical stability of the nanosuspension. Nanoemulsions with values greater than  $\pm 20$  mV were considered stable emulsions. In some cases the zeta value can be close to zero and the emulsion remains stable due to the static repulsion stabilizing the droplets [32]. In this study, the zeta potential of copper-loaded nanoemulsions of CNE 1 and CNE 2 was 17.0 and 13.3, respectively.

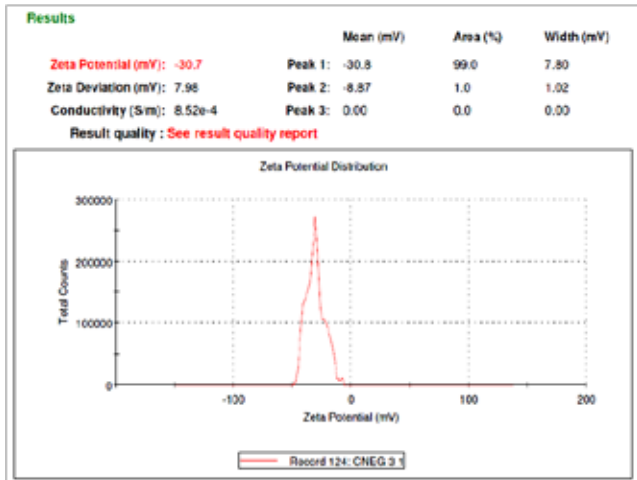


Fig. 11 Zeta potential measurement result for the CU loaded nanoemulsion CNE 1

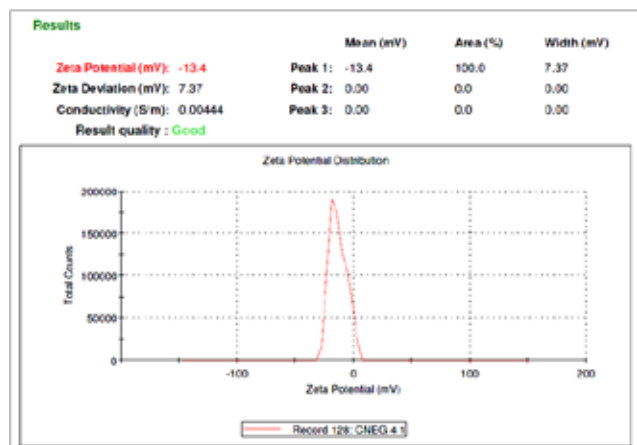


Fig. 12 Zeta potential measurement result for the CU loaded nanoemulsion CNE 2

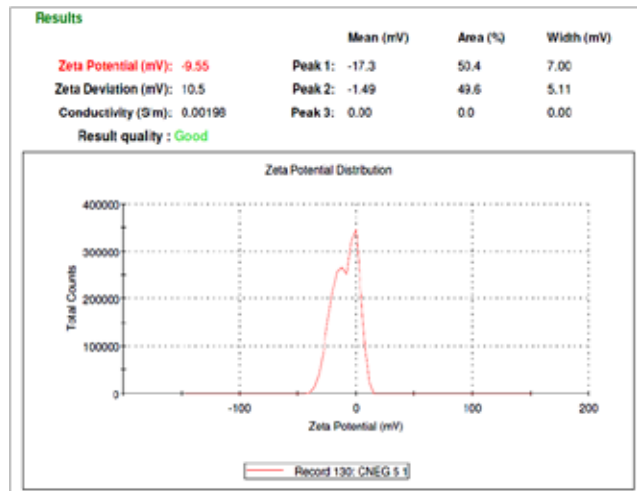


Fig. 13 Zeta potential measurement result for the CU loaded nanoemulsion CNE3

Table 2. Zeta potential and PSA for CNE-1, CNE-2 and CNE-3

Formulation Code	PSA (nm)	Zeta Potential (mV)
CNE 1	149.3	-30.7
CNE 2	245.3	-13.4
CNE 3	403.5	-9.55

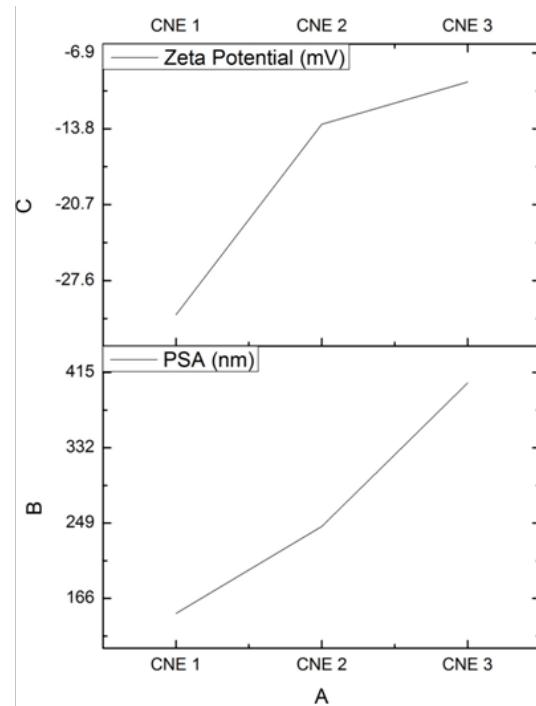
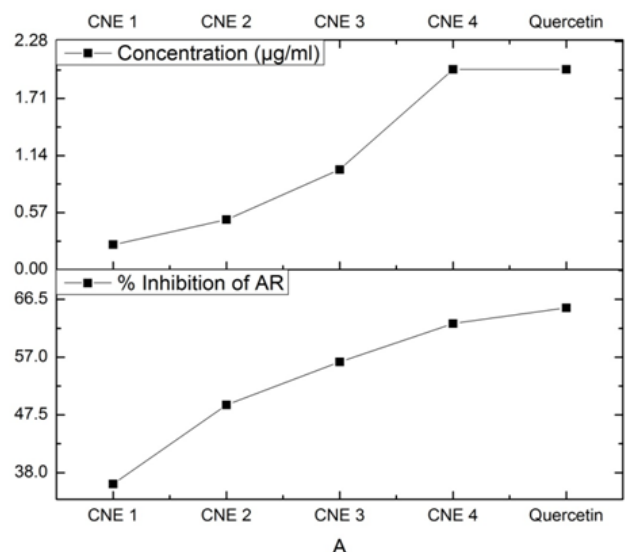


Fig. 14 Relation of zeta potential and the PAS (particle size in nm)



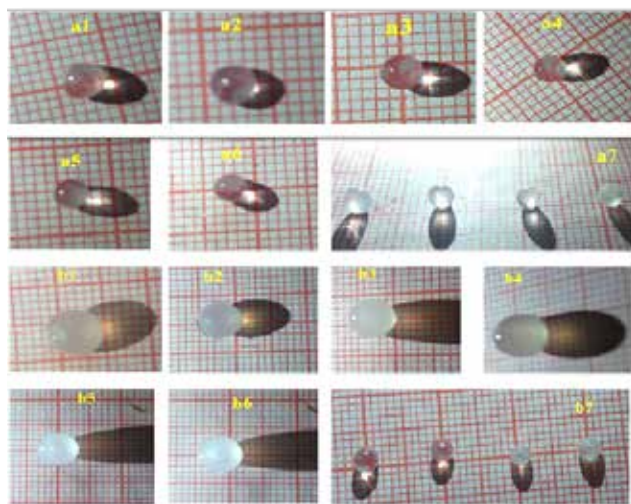
**Table 3. % Inhibition for the different concentration of cu loaded nanoemulsions**

Drug	Concentration (µg/ml)	% Inhibition of AR
CNE 1	0.25	36.13
CNE 2	0.50	49.12
CNE 3	1.00	56.20
CNE 4	2.00	62.52
Quercetin	2.00	65.11

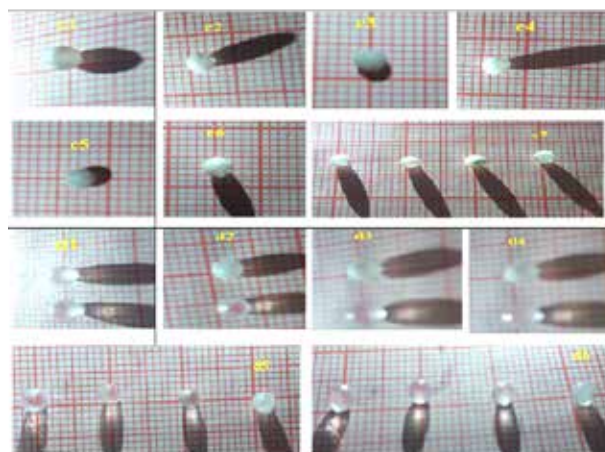


**Fig. 15 % Inhibition for different concentration of CU loaded nanoemulsions and for control**

**Anti cataract study result**



**Fig. 16 Representative illustrations of anti cataract activity of CNEG on fish lenses**



**Fig. 17 Representative illustrations of anti cataract activity of CNEG on fish lenses; a1 to a4 shows result for Group I lenses, c1 to c7 shows result for Group II lenses, b1 to b4 shows result for Group III lenses, a5 to a7 shows result for Group IV lenses, a3 and a4 shows result for Group V lenses, a5 and a6 shows result for Group VI lenses**

**Reduced glutathione**

The test to measure the amount of glutathione was performed according to the method described by Patil et al. [33]. The amount of reduced glutathione (GSH) is measured with the reagent 5,5-dithiobis (2-nitrobenzoic acid) (DTNB), which binds to a thiol group (-SH) to form a chromophore (color) detected at 412. Add 200 µl of potassium phosphate buffer (0.1 M, pH 7). 4) After centrifugation, take 10 µl of the supernatant of the lens homogenate. Incubate the reaction mixture at 37 °C for 20 minutes and measure the absorbance at 412 nm. Results are expressed as reduced glutathione/mg protein (GSH/mg protein).

**Lipidperoxidation**

Lipid peroxidation, Patil et al. [34]. This test measures the malondialdehyde content (MAD). MAD is a reaction containing 0.2 ml of incubated lens homogenate obtained after centrifugation at 8000 rpm, 0.8.1% sodium lauryl sulfate 2ml, 20% acetic acid at pH 3.5 1.5ml (adjust pH with sodium hydroxide), 0.5ml 1.5ml. 8% thiobarbituric acid) the above reaction was diluted to 4 mL with deionized water and heated in a 95°C water bath for 60 minutes to 1 hour. After cooling the reaction mixture, add 1 ml of distilled water and 5 ml of n-butanol-pyridine mixture (15:1 v/v) and shake the sample vigorously. Centrifuge the sample at 4500

rpm for 10 minutes. Determine the amount of MDA/mg protein by measuring the absorbance of the supernatant spectrophotometrically at 530 nm and 600 nm.

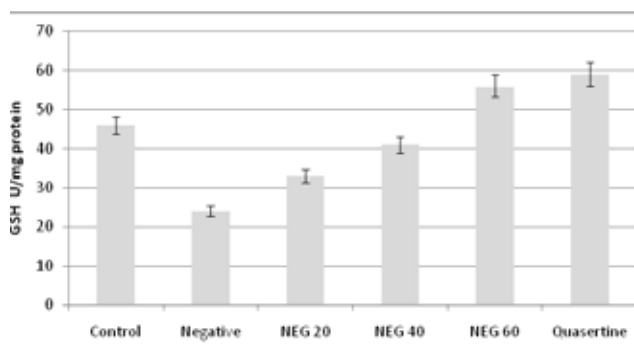


Fig. 18. Measurement of reduced glutathione spectrophotometrically

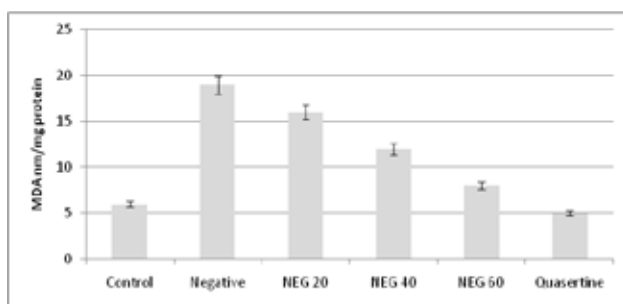


Fig. 19. Measurement of lipid peroxidation spectrophotometrically

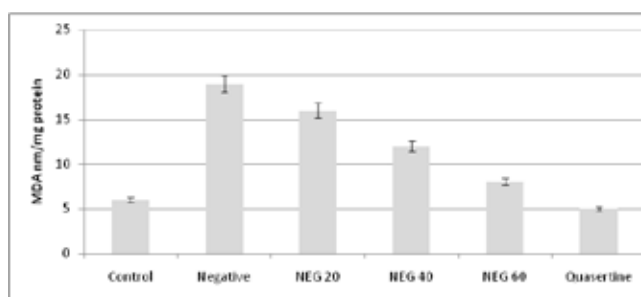


Fig. 20. Measurement of lipid peroxidation spectrophotometrically

## DISCUSSION

Curcumin, the main curcuminoid in *Curcuma longa*, is often used as a color and flavor in food. This polyphenol has been reported to have many health benefits such as antioxidant, antibacterial, anti-inflammatory and anti-inflammatory. However, curcumin's low solubility in aqueous solutions, lack of photosensitivity

and bioavailability limit its use in food. However, curcumin's low solubility in aqueous solutions, lack of photosensitivity and bioavailability limit its application in food. To overcome these limitations, various potential delivery systems of these phenolic materials such as nanoemulsions have been investigated.

This study examined the effect of curcumin-loaded nanospheres in an emulsion form on fish eye cataracts. Preparation of curcumin nanoemulsions using phenylethyl isothiocyanate. Nanoemulsions are produced using ultrasound at 150 W. The zeta potential measurement of turmeric loaded nanoemulsions was found to be -30.7eV, -13.4eV, -9.55eV, under different conditions, the size measured by the particle size meter is 149.3nm, 245.3nm and 403.5nm, respectively. The surface morphology of the nanospheres was investigated by FE-SEM analysis. The zeta potential index indicates the stability of the nanosphere. Anti-cataract use has been studied using a separate fish eye lens. Cataracts are caused by too much sugar. Evaluation of the biochemical parameters of reduced glutathione to explain the anti-cataract effect of curcumin-loaded nanoemulsions.

## CONCLUSION

This study reported that CU-loaded PIT nanospheres significantly reduced quercetin-induced cataract haze, used as a standard anti-cataract clouding agent in the eye lens. Therefore, CNE has been shown to be a good alternative to drugs such as quercetin. The nanospheres act as effective drug carriers for CU and PIT targeting. The nanometer size of the spherical micelles was investigated by particle size analyzer, and the surface morphology was investigated by FE-SEM analysis.

## ACKNOWLEDGEMENTS

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# Wireless Parking Assessment System

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## ABSTRACT

Car parking has become a crucial skill for drivers and car owners due to the increasing size of vehicles and decreasing availability of parking spaces. In this research paper, we propose a wireless reverse parking system that utilizes ultrasonic sensors and Arduino to detect the presence or absence of obstacles behind the vehicle. The system is capable of measuring distances ranging from 2 cm to 400 cm, providing accurate feedback to the driver about the proximity of objects. The prototype is cost-effective, with an estimated cost of INR 1,000, and can be easily installed in any vehicle as it is a wireless setup with separate transmitter and receiver modules. The system is user-friendly and can assist drivers in parking safely and avoiding collisions which will reduce the risk of accidents. Our proposed system will ensure a reduction in fuel consumption as it will reduce the time it takes to park a vehicle. Further research can explore the effectiveness, efficiency, and cost-effectiveness of the proposed system, including factors such as the type of wireless technology used, environmental conditions, and the potential impact on reducing traffic congestion and improving parking experiences.

**KEYWORDS:** Reverse parking, Ultrasonic sensors, Arduino, Proximity, Wireless setup

## INTRODUCTION

In today's world, car parking is an important skill for all drivers and car owners as it is difficult to analyze the space around the vehicle and park accordingly. A parking sensor makes parallel parking quite easy, as it is not easy for an unpracticed driver to park the vehicle. Proximity sensor is the most common sensor used by manufacturers to identify nearby obstacles while parking. Recently vehicle sizes are increasing and spaces for parking are decreasing due to which these sensors play an important role. Ultrasonic sensors are placed on rear bumpers and sometimes on front bumpers which generate high frequency sound waves which help the car to park without any damage. When an object is close, the sound pulses produced by the ultrasonic sensor and Arduino bounce off the object and are then returned in reverse to the sensor. Consequently, the distance between the vehicle and the obstruction is determined by timing how long it takes for a sound pulse to pass from the sensor to the object and back again. A buzzer coupled to a sensor informs the driver if

an obstruction is approaching the car as the driver shifts into reverse.

## LITERATURE SURVEY

S. Julius Fusic et al in "Autonomous Vehicle Reverse Parking System" presents the design and implementation of an Autonomous Vehicle Reverse Parking System (AVRPS) using ultrasonic sensors. The system is designed to provide a fully automated parking experience for the driver, eliminating the need for manual parking. The authors conducted experiments to evaluate the performance of the AVRPS in different parking scenarios, including parallel parking and perpendicular parking. The results showed that the system was able to successfully park the vehicle in all scenarios with a high degree of accuracy. Overall, the AVRPS is a promising technology that has the potential to greatly improve parking efficiency and safety.

Xinxin Du and Kok Kiong Tan in a research paper titled "Autonomous Reverse Parking System Based on Robust Path Generation and Improved Sliding Mode Control"



presents a novel solution to the issue of autonomous vehicle parking. The paper addresses the limitations of existing parking systems, which often suffer from poor performance in terms of path generation and control. The paper presents a detailed analysis of the proposed system, including mathematical models and simulations to demonstrate its effectiveness. The authors also compare their system with existing approaches, showing that it outperforms them in terms of accuracy, efficiency, and robustness. Overall, the paper presents a novel approach to the problem of autonomous parking that addresses many of the limitations of existing systems.

S. Ahuja and S. Kumar in “An Intelligent Parking Guidance System Using Wireless Sensor Networks” published in the Proceedings of the 2016 International Conference on Signal Processing and Communication Engineering Systems. Proposes an intelligent parking guidance system using wireless sensor networks, which can provide real-time information on parking occupancy and guide drivers to available parking spaces.

M. Wang et al in “Design and Implementation of a Wireless Ultrasonic Parking Guidance System” published in the Proceedings of the 2014 International Conference on Mechatronics and Robotics Engineering. Proposes a wireless parking guidance system based on ultrasonic sensors and a wireless network, which can guide drivers to available parking spaces and reduce parking search time.

In summary, the four research papers discussed here propose different solutions to the problem of autonomous parking and parking guidance. S. Julius Fusic et al AVRPS system uses ultrasonic sensors to provide a fully automated parking experience, while Xinxin Du and Kok Kiong Tan’s system proposes a novel approach to path generation and control to improve accuracy and efficiency. S. Ahuja and S. Kumar’s system uses wireless sensor networks to provide real-time information on parking occupancy and guide drivers to available spaces, and M. Wang et al system uses a wireless network and ultrasonic sensors to guide drivers to available parking spaces and reduce search time. All these systems have the potential to greatly improve parking efficiency and safety, but further research and development is needed

to optimize their performance and ensure their practical viability in real-world situations. And there are some drawbacks of these systems such as their reliance on technology, which could be subject to malfunction or failure. Additionally, the cost of implementing these systems may be a barrier to widespread adoption. Further research and development will be necessary to optimize these systems for real-world use.

We proposed a system which uses wireless sensors to detect the presence or absence of objects in a parking space. Based on the availability of parking spots, drivers can make informed decisions about where to park. In this a research paper, “Wireless Parking Assessment System” it can be further explored in terms of its effectiveness and efficiency. Factors that can affect the accuracy of the technology such as the type of wireless technology used, environmental conditions, and the number of sensors deployed can be studied. The paper can also discuss the cost-effectiveness of the technology and the potential impact it can have on reducing traffic congestion and improving the overall parking experience.

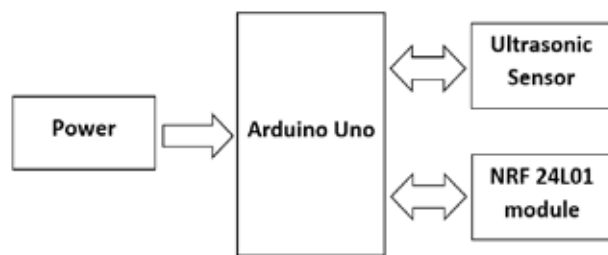
## WIRELESS PARKING ASSESSMENT SYSTEM

### Software Specifications

An ultrasonic sensor is a part of the project’s suggested setup. The integrated circuit of the sensor needs a program to run to function. Since Arduino programming is a widely used and simple to understand programming language, it is used to create the program. The software configuration is set up to recognize the separation between the vehicle and the obstruction and adjust the number of beeps the buzzer produces accordingly. The configured software’s execution starts with a distance analysis between the vehicle’s rear or front and any nearby obstacles. Using the logic: duration = pulse In (echo 1, HIGH); the Arduino pulse In function estimates the duration for which the ECHO Pin is HIGH. The formula distance = Time\*0.034 can be used to determine the distance in centimeters which will be shown on the 16x2 LCD display. To help the driver gauge the distance between the back of the vehicle and the obstacle, the code is set up to increase the number of beeps as the vehicle approaches the obstacle.

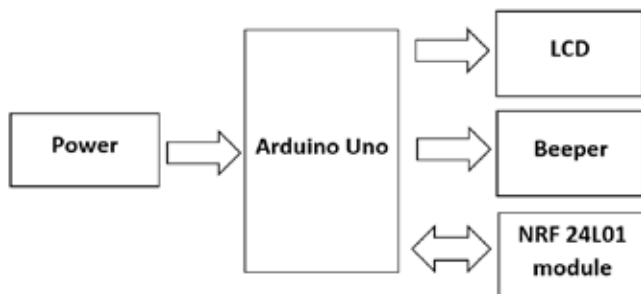
## SYSTEM OPERATION AND ARCHITECTURE

The transmitter and receiver are the two components of the Arduino project for the car parking assessment system. The transmitter is made up of an ultrasonic sensor, an Arduino and a 2.4 GHz transceiver module (see Figure 1). Using a 9V battery as power supply, the transmitter circuit will be installed outside the vehicle on rear or front bumper. The circuit will gauge how far the vehicle is from the obstruction and send information to the receiver circuit.



**Fig. 1: Transmitter Block Diagram**

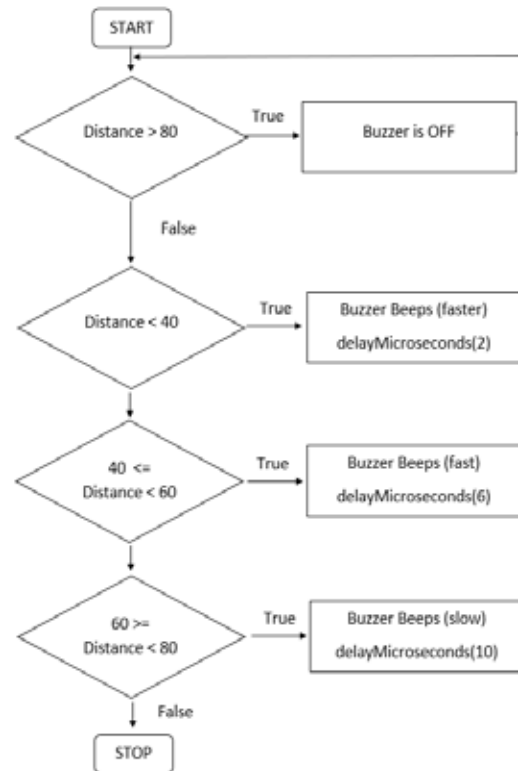
The receiver is made up of an Arduino, a 16x2 LCD display, a buzzer, and a 2.4 GHz transceiver module (see Figure 2). The receiver circuit will be mounted inside the car and powered by a 9V battery. The receiver will display the distance in meters between the vehicle and the obstruction. The 16x2 LCD display on the receiver shows the distance measurement.



**Fig. 2: Receiver Block Diagram**

If the 2.4 GHz link connection cannot be made, a push button for resetting the Arduino is available. The transmitter will communicate sensor data to the receiver in the automobile over a 2.4 GHz connection. The communication link is established by using the NRF24L01 module. The NRF24L01 module is connected to the circuit using seven wires, five of

which are connected to Arduino's digital I/O ports and the other two to 3.3V and ground. The transistor's base will be linked to pin #2, and this will power the buzzer. Pins A0 and A1 are linked to the sensor's trigger and echo pins, respectively, while the ultrasonic sensor's power terminals are connected to 5V and GND. The NRF24L01 module transmits the distance information from the sensor to the receiver.



**Fig. 3: Flowchart**

The pre-set software starts running as soon as the driver shifts into reverse, which powers the system using the car battery. Alternatively, the user can power the system using an external battery with an ON/OFF switch that is roughly 9V. The ultrasonic sensor begins assessing the distance between the vehicle and any nearby obstacles as soon as the device is given a power source. According to the flowchart above (see Figure 3), the buzzer will not turn on if the distance is more than 80 cm. Buzzer begins beeping slowly with a considerable delay of 10 microseconds when the distance between the vehicle and the obstruction is between 60 and 80 cm. With a short delay of 6 microseconds, the buzzer begins buzzing quickly when this distance changes to

between 40 and 60 cm. When the distance is less than 40 cm in the last step, the buzzer sounds quicker with a very slight delay of 2 microseconds.

**RESULT AND OBSERVATION**

This project prototype’s goal is to create a wireless reverse parking system that will help the driver easily park. Within a range of 2 cm to 400 cm, we can easily detect an obstruction behind the vehicle using ultrasonic sensors. Arduino will begin determining how far away the items are from the ultrasonic sensor. For this prototype, if the calculated distance is less than 80 cm, Arduino turns ON the buzzer and the obstacle’s distance is continuously displayed on the LCD display. When the distance between the car and the obstacle is less than 40 cm, the buzzer starts beeping with a delay of 2 microseconds between two successive beeps and an alert signal is displayed on the LCD (see Table 1). This prototype is a cheap setup that should cost about INR 1,000. One might simply set up the full configuration manually on his or her own car as it is a wireless setup with a separate transmitter and receiver setup. It is a user-friendly system.

**Table 1. Table of observation**

Stages	Distance (cm)	Buzzer Delay (Microseconds)
1	0-40	2
2	40-60	6
3	60-80	10
4	80+	14



**Fig. 5 Wireless Parking System**

**CONCLUSION AND FUTURE SCOPE**

The wireless reverse parking system prototype described in the research paper “Wireless Parking Assessment System” utilizes ultrasonic sensors and Arduino to provide a cost-effective solution for assisting drivers in parking their vehicles. The system detects the presence or absence of obstacles behind the vehicle and provides visual and audible alerts to the driver when the distance between the vehicle and the obstacle is less than a certain threshold. This Wireless parking assessment system can also be used to detect the presence of pedestrians and cyclists, allowing drivers to be more aware of their surroundings and reducing the risk of accidents. Further this system helps drivers find available parking quickly and reduce traffic congestion in urban areas. This can lead to fewer idling vehicles, reduced fuel consumption, and improved air quality. The wireless reverse parking system using ultrasonic sensors and Arduino described in the research paper has the potential to greatly improve the parking experience



**Fig. 4: LCD Display with reading (in cm) and a warning message**

for drivers by providing accurate detection of obstacles and timely warnings using a buzzer and LCD display. The prototype is cost-effective and user-friendly, with a range of 2 cm to 400 cm for detecting obstacles behind the vehicle.

There are several areas of future research that could be explored in the context of a wireless parking assessment system.

**Integration with Other Systems:** A wireless parking assessment system could be integrated with other transportation systems, such as public transit or ride-sharing services. Future research could explore how such integrations could improve overall transportation efficiency.

**Sensor Accuracy:** One potential area of research could be focused on improving the accuracy of sensors used in the wireless parking assessment system. This could involve exploring new sensor technologies or

developing algorithms to enhance the accuracy of existing sensors.

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# Enrichment of Power Quality for Multiple Output Switched Mode Power Supply based on Bridgeless Topology

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## ABSTRACT

The study and simulation of a bridgeless switched mode power supply used in personal computers are discussed in this article. Traditional SMPS use a diode bridge-based rectifier, which lowers the system's power quality profile. Power quality issues including a high THD, a low input power factor, and a high crest factor. Two stage power factor correction circuits is used to raise the SMPS power quality indices. Reduced control complexity is confirmed by the converter's intermittent conduction mode operating. The performance is examined under a variety of operational conditions, including steady state and changing output loads. The suggested SMPS's performance is evaluated in a MATLAB/Simulink environment.

**KEYWORDS:** *Power factor correction circuit; Half bridge VSI; High frequency transformer*

## INTRODUCTION

Recent development in the field power electronics leads to increase more use of laptops, personal computer, electronic ballasts, net books, medical instruments in day today life. Due to which harmonic distortion in the distribution system increases. Now day in all sectors Personal computers are widely used. In a personal computer most important part is Switched mode power supply (SMPS). In SMPS from the input single phase supply different DC output voltages of different magnitude are taken out and fed to different parts of computer. Conventionally diode bridge rectifier along with electrolytic capacitor are used to get DC supply from AC supply. Power quality problems are caused by the capacitor on the front side including distorted and high density input current, high crest factor & harmonic distortion, inadequate power factor. The main reason for degrading power quality indices is due to the presence of capacitor at the front-end side. This mainly occurs because of the unrestricted charging and discharging of capacitor [1-3]. As a result, it violates all of the associated IEEE-519 and IEC 61000-3-2 requirements for power quality [4-5]. When multiple number of

SMPS are used then this type problem become very serious. most of SMPSs are used together, As a result neutral of the supply experiences more current. It causes size of conductor to increase & the rating of the distribution transformer to decrease [6-7]. Advancement in the power quality profile of SMPS is possible with the implementation of a power factor correction circuit at the input side. Enhancement in PF and reduction in harmonic distortion under various circumstance is also achieved. An improved power quality performance results from the usage of non-isolated PFC at the power supply's input side. Single stage and two stage voltage conversion are recognized as ways to generate acceptable harmonic contents in personal computers. Single-stage conversion has the advantages of being efficient, straightforward, and inexpensive. However, with the drawbacks of a sophisticated control strategy, larger capacitors, and poor voltage regulation at output. In contrast, two stage voltage conversion has a lower element count, a more straightforward control scheme, and better output voltage regulation. Non-isolated converters operating in PFC's intermittent conduction mode guarantee improved power quality. Power electronics has made new advancements that eliminate



the use of diode rectifiers on the input side and provide bridgeless network topologies. Different bridgeless topologies have been developed and employed in PFC [8-9]. In the low power application of SMPS these bridgeless topologies having disadvantages of more component count and output voltage range is so high. Normally in two stage PFC boost converter is used, but it has limitation over output voltages. Bridgeless boost converter reduces the front-end DBR. [10]. One of the preferred PFCs for the SMPS is the buck-boost converter. Less components, less switching stress, and fewer conduction losses are provided by the Buck-Boost converter, which also enables stable output voltage regulation. A bridgeless buck-boost converter with three switches provided by Wei et al. [11] resulted in total cost increases. Several outputs are produced with the help of high frequency transformer which is also provides better utilization of core with high frequency isolation. [12-13]. Thus, from the existing literature it is seen that, bridgeless converter topology for multiple output SMPS is not used so far for improvement in power quality. so here our main is to is to removes the front side bridge rectifier and making converter topology bridgeless in order to make better power quality profile. Back-to-back connected two buck-boost converters are run in successive positive and negative half cycles in a bridgeless converter topology. The bridgeless buck-boost converter's design ensures that it will operate in an intermittent conduction mode with improved power factor. Using a closed-loop control method, the converter's output voltage is managed before being sent to a half-bridge VSI, which then generates many outputs with the aid of a high-frequency transformer. As a result, MATLAB is used to analyze and simulate the future SMPS under various operating situations while it operates on a bridgeless converter topology. The information is listed below in full.

## BRIDGELESS BUCK BOOST CONVERTER CONFIGURATION FOR SMPS

Block diagram for the suggested bridgeless buck-boost converter-based SMPS is shown in Fig. 1. which includes a high frequency transformer for numerous outputs, a half bridge VSI, two back-to-back connected buck boost converters, an LC filter on the input side,

and two buck boost converters. Switch  $S_p$ , the diodes  $D_{p1}$ ,  $D_{p2}$ , and the inductor  $L_p$  of the upper side buck boost converter work for positive half cycle of the input voltage supply, as do the switch  $S_n$ , the diodes  $D_{n1}$ ,  $D_{n2}$ , and the inductor  $L_n$  of the lower busk boost converter during the negative half cycle. Two inductors are built in such a way to ensure intermittent conduction mode operating of the converter to ensure the input current is sinusoidal in nature with voltage. Half bridge VSI receives the converter's DC output voltage under closed control loop control. Half bridge VSI is made up of two input capacitors ( $C_{11}$  and  $C_{12}$ ), high frequency switches and HFT. There are one primary and four secondary windings in a high frequency transformer with a unique design. To reduce ripples in output current and voltage filters are to be inserted in each windings of transformer.  $L_1$ ,  $L_2$ ,  $L_3$ ,  $L_4$ , and  $C_{o1}$ ,  $C_{o2}$ ,  $C_{o3}$ ,  $L_4$  are the four inductors and capacitors, respectively and  $V_{o1}$ ,  $V_{o2}$ ,  $V_{o3}$ , and  $V_{o4}$  are the various SMPS voltages. The losses in the transformer are reduced with help of center tapped configuration. Voltage regulation at output side is achieved by adjusting duty ratio. The proper output voltage regulation is guaranteed by operation of half bridge VSI in continuous conduction mode.

### Operation of SMPS based on Bridgeless Converter

VSI, a high frequency transformer with numerous outputs, and two back-to-back coupled buck-boost converters make up the proposed model.

The following subsections serve as examples of how things work throughout a single switching cycle.

### Working of Bridgeless Buck Boost Converter

This bridgeless topology makes total component countless. Switches present in upper and lower converters are conducted for the positive and negative half cycles, respectively, as single phase power is delivered to the buck-boost converter. Intermittent conduction mode of buck boost converter ensures better power quality performance. This mode of operation contains three stages. The inductor stores energy as the current corresponding to its start climbs from zero value to maximum during the first stage of operation of the upper side buck-boost converter's switch  $S_p$ . The inductor starts discharging through the output during the subsequent stage of operation, causing the inductor

current to fall to zero from its maximum value. None of the switches, diodes, or inductors are operating in conduction mode to guarantee that the converter is

operating in intermittent conduction mode. The identical set of operations is repeated for the lower buck boost converter during the negative half cycle.

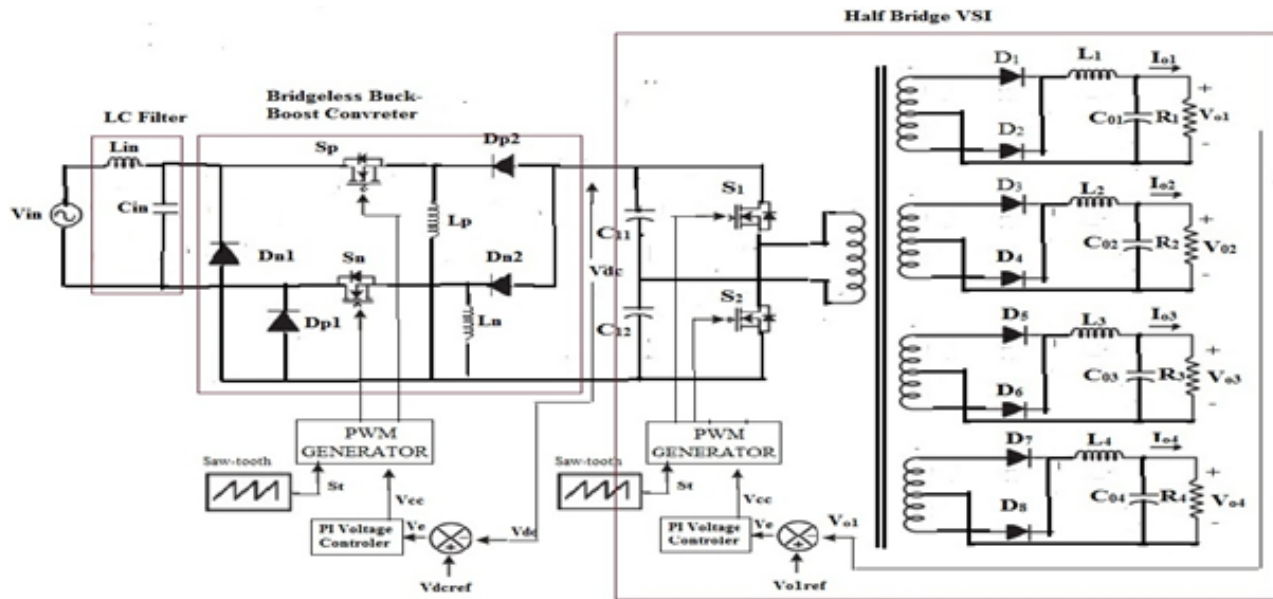


Fig. 1: Circuit arrangement of proposed multiple output switched mode power

**Half Bridge VSI Operation**

The half bridge VSI receives the bridgeless buck-boost converter’s regulated output as its input. High frequency isolation scaling and multiple output are ensured by the four stages of the VSI operation in one switching cycle. Half bridge VSI switches are turned on and off using a PWM generator. When the upper switch receives the signal current completes its path through primary of the transformer & lower capacitor C12. At the same time, the secondary side of the transformer’s diodes D1, D3, D5, and D7 are in a conducting condition. An accompanying inductor, Lo1, Lo2, Lo3 and Lo4 likewise stores energy. Finally, the output capacitors Co1, Co2, and Co3 discharge by travelling via the output load. As all freewheeling diodes D1 to D8 conduct through the capacitor during the subsequent stage of operation, the inductor’s current drops from its highest value to zero. For the following stage, the VSI’s current travels all the way through the HFT’s primary winding and upper capacitor C11. The equivalent inductor conducts and stores energy on the secondary side of the transformer. The switches connected to the inductor turn off as the amount of energy stored in it reaches its maximum.

In the fourth stage, freewheeling diodes are activated, causing an inductor to discharge through a capacitor and a load.

**THE PROPOSED MULTIPLE OUTPUT SMPS’S DESIGN**

In this section, particulars on the proposed multiple output SMPS’s design are provided.

**Input front end Filter Design**

Input voltage supply have higher order harmonics, to suppress these harmonics it is very much important to have L-C filter at the front end side.

The value of capacitor to be used in this setup is specified as,

$$C_{in\max} = \frac{I_m \tan \theta}{\omega V_m} \tag{1}$$

where Vm and Im stand for ac voltage and current at their maximum values. The maximum capacitor value that should be taken into account is 10.

The design value of the inductor is stated as, in order to have little ripple in the input AC supply.

$$L_{in} = \frac{1}{4 * \pi^2 * f_c^2 * C_{in}} \tag{2}$$

Where  $f_c$  stands for cutoff frequency

**Inductor design of PFC Converter**

The buck-boost converter’s inductor is crucial to the success of SMPS’s power quality system. These inductors are made in such a way that they should work in the converter’s intermittent conduction mode of operation. Value of inductor is given as,

$$L_p = \frac{DTV_{avg}}{\Delta i L_{pon}} \tag{3}$$

**Half bridge voltage source inverter design**

The half bridge inverter takes as input of the controlled output of the buck-boost converter. Voltage and current sensing from input side can be eliminated by operating inverter in continuous conduction mode. VSI input capacitors are formulated as follows.

$$C = \frac{I_{dc}}{2\omega\Delta V_{dc}} \tag{4}$$

Where  $\omega$  is angular frequency,

To obtain ripple free response of output voltage inductor from output side can be designed as follows,

$$L_{ol} = \frac{V_{o1}(0.5 - D_h)}{f_h \times \Delta i_{ol}} \tag{5}$$

**Control Methods for Proposed System**

Proposed SMPS consist of two stages so that different control strategies are been implemented. The details are as given,

**I. Control of Bridgeless Buck-Boost Converter**

Voltage follower method controls power factor correction circuit of buck boost converter. PWM generator produces Switching pluses are given to switches of upper and lower buck-boost converter. Error signal can be generated by comparing sensed output voltage with desired output voltage. PI Controller-I use this error signal to produces controlled DC output Voltage. The required pluses are generated by comparing saw tooth signal to the output of PI controller.

**II. Control of half bridge VSI**

In control mechanism of half bridge VSI, voltage of the highest power rating output is being sensed Error signal

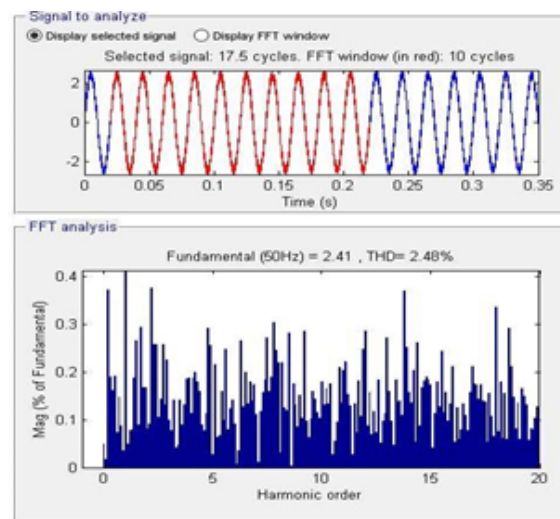
generated& provided to PI Controller-II. PI controller output fed to PWM generator for switching pulses.

**Performance Estimation of Proposed SMPS**

The suggested SMPS model is simulated and examined in the MATLAB/SIMULINK environment, and evaluation of overall performance is done at 220V, 50 HZ supply. Different parameters were examined, including input current & volatge, the bridgeless converter’s dc output voltage, and the SMPS’s numerous outputs, Vo1, Vo2, Vo3, and Vo4. The following circumstances are taken into account when testing proposed SMPS,

i) operating in a steady-state environment -

As most of the time multiple output SMPS in personal computer are operated in mentioned state it is very essential to test performance under this environment. When single phase 220V, 50HZ ac supply is applied various power quality indices are evaluated. By looking at fig. 2. it can be concluded that a decrease in THD and an increase in power factor led to an improvement in power quality performance. The input current’s THD was found to be 2.42%, which is well within acceptable levels. From Fig. 3, it can be seen that when the front-side diode bridge rectifier is removed and the PFC circuit is used then the input current approaches same as supply voltage.output voltages and currents of the SMPS are displayed in Fig. 4. As demonstrated in fig. 5, the switches on the buck boost converter are under less switching stress.



**Fig. 2: input ac current and harmonic spectrum**

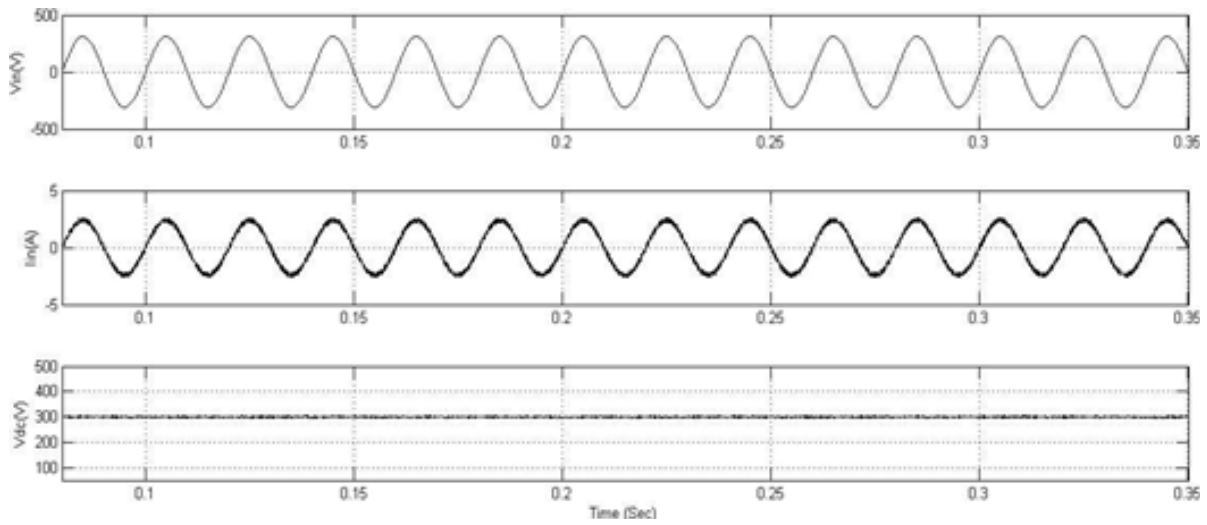


Fig. 3: Input current and voltage waveforms

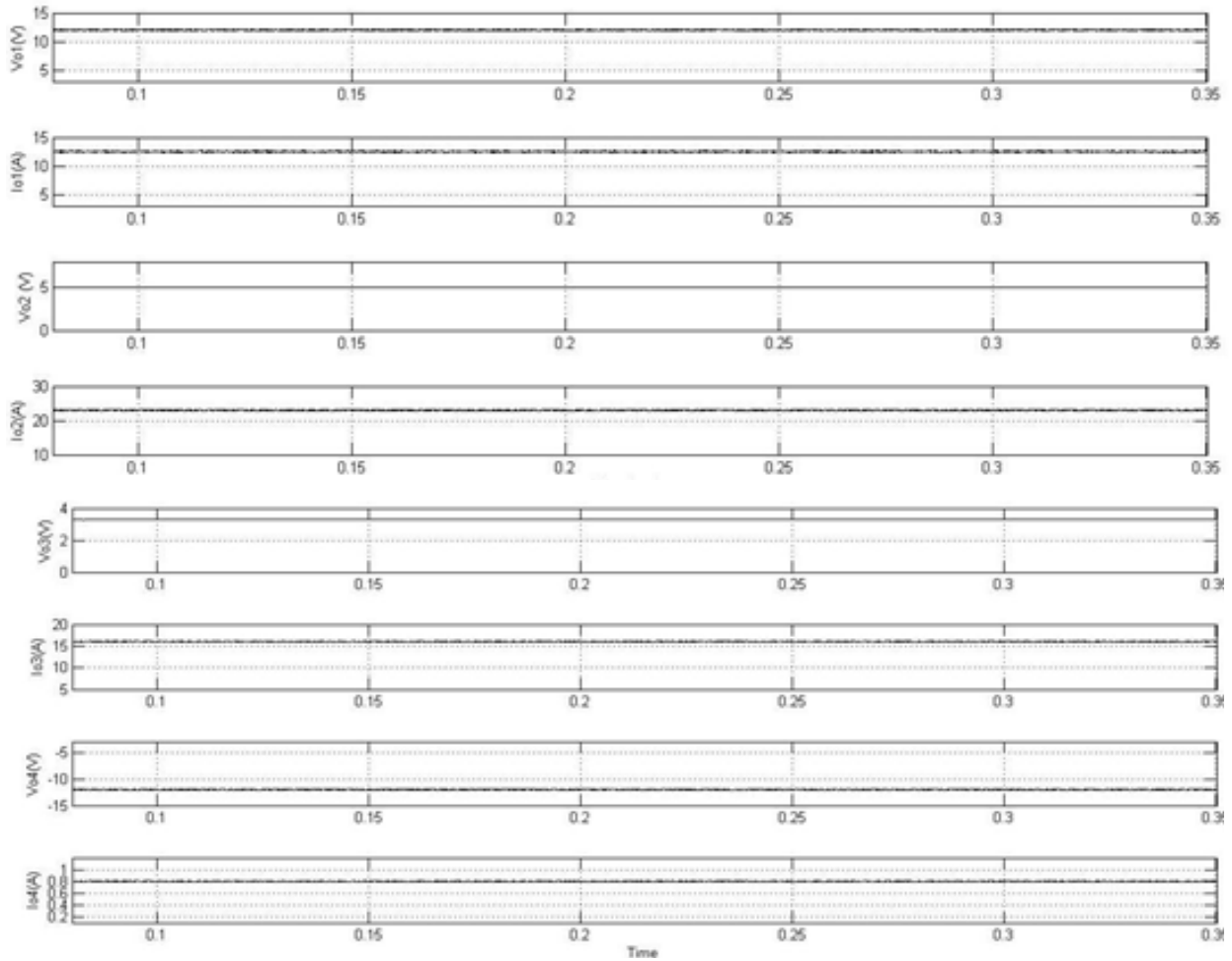


Fig. 4: Multiple output voltages and currents

ii) operation under a circumstance of variable load-

Step changes are applied to the +12V & +5V load outputs to simulate effect of load variation on the proposed SMPS. Load on the +12V output drastically

decreases from 100% to 20%. & output load decreases from 100% to 70% on +5V. The proposed SMPS's performance in this scenario was determined to be satisfactory with improved power quality & as shown in Fig.5&6 respectively.

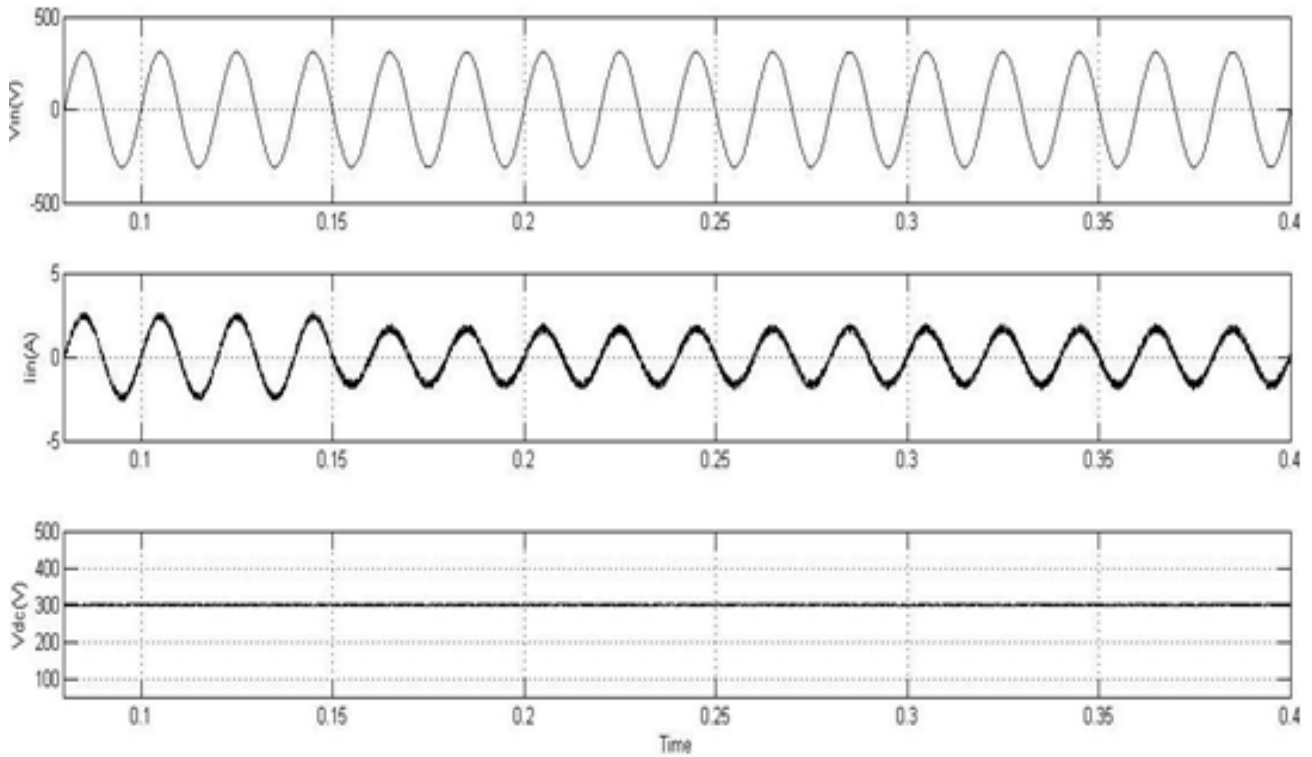
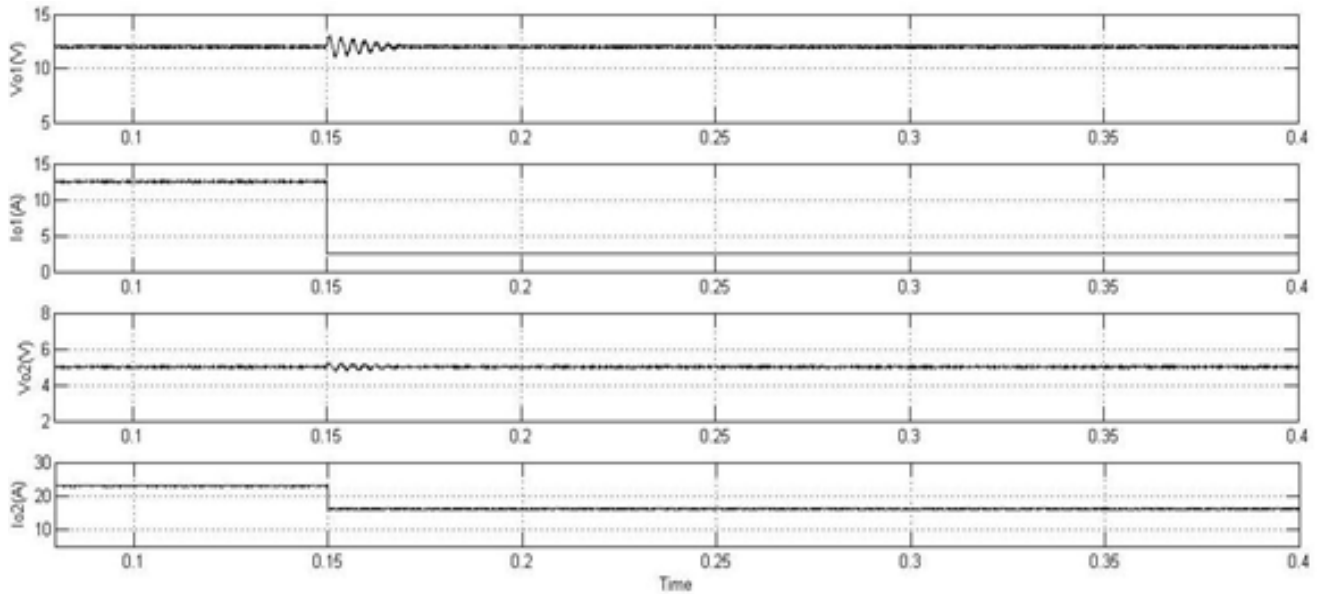
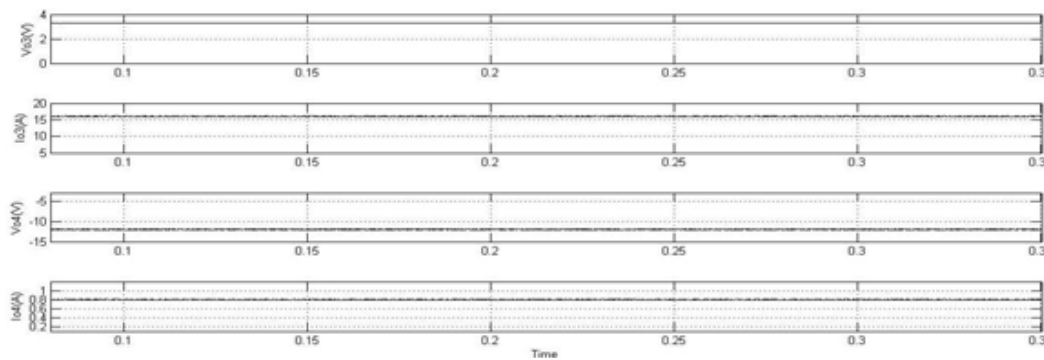


Fig 5 –Input voltage, current and dc output voltage







**Fig 6-Multiple output voltages and currents**

## CONCLUSION

Multiple output SMPS based on bridgeless buck boost converter is simulated & analyzed to demonstrate its competence for better power quality profile. Power factor correction circuit with its intermittent conduction mode give rises reduction in THD, crest factor and improvement in input power factor and displacement factor. Nevertheless, any changes from input side or output side SMPS gives rise to better power quality performance. component count become less as it is having bridgeless topology. Due to which switching losses also reduced. Output voltages remains constant irrespective of the variation in loads. So proposed multiple output bridgeless SMPS having superior power quality performance than traditional SMPS used in personal computer.

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# SecureCert: An Innovative Approach For Academic Certificate Issuance and Verification using Blockchain

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## ABSTRACT

In this paper, we present a blockchain-based solution for academic certificate verification and issuance. Academic certificate verification and issuance have been a challenge due to the risks of fraud, data manipulation, and data loss. Blockchain technology offers a secure, decentralized, and immutable platform for managing academic certificates. Our approach uses smart contracts, self-sovereign identity to automate the certificate issuance process, ensuring that the certificate data is tamper-proof and can be easily verified. We leverage the features of blockchain technology to provide transparency, traceability, and accountability in the certificate issuance and verification process.

**KEYWORDS:** *Blockchain, Digital certificate, Distributed ledger, Hashing, Ethereum, Cryptography*

## INTRODUCTION

Blockchain technology has been gaining a lot of attention in recent years due to its potential to address issues related to trust, transparency, and security in various domains. Blockchain was introduced in application of cryptocurrency but now its applications have expanded beyond it. One such application is academic certificate verification and issuance. In this paper, we present a blockchain-based solution for academic certificate verification and issuance. We leverage the benefits of decentralized identity and smart contracts to automate the certificate issuance process, ensuring that the certificate data is tamper-proof and easily verifiable. The main idea of the solution revolves around three main entities and the transactions between them: Verifier, Issuer, Identity Holder. This will be briefly discussed in the system architecture section. The solution offers several benefits over traditional certificate issuance methods, including transparency, immutability, and traceability. The decentralized nature of the blockchain ensures that the certificate data is secure and cannot be tampered with, while the

transparency and traceability of the blockchain enable stakeholders to verify the authenticity of the certificate easily.

## LITERATURE SURVEY

G. Sethia et al [1] explained the importance of the academic certificates in an individual's life. This paper proposes a way to share and verify certificates using blockchain technology maintaining trust, security and transparency. This paper addresses the issue of fake certificates using Hyperledger fabric. The system records issued certificates in Hyperledger fabric which further can be verified using the details provided by the students.

M. Di Pierro et al [2] explained blockchain technology and its underlying architecture. Paper explains how hashing is main construct in the blockchain and also gives sample implementation in python.

T. Nurhaeni et al [3] discussed the importance of blockchain in educational field and how it can be used as long-term storage space in a tamper proof ledger. The study involves descriptive analysis and library

study method for understanding distributed system and cryptography in blockchain.

Raghav, N. Andola et al [4] explains lacks in the current certificate management system and problems with certificate forgery. Authors have proposed a tamper-proof system for generating and storing certificates. Proposed system uses Hyperledger which provides protection from forgery and Inter Planetary File System to store the certificates. The certificates are encrypted using asymmetric encryption and the hash is calculated. Hash can be used to verify the certificates using portal.

P. E. Gundgurti et al [5] explained in this paper, the problems of counterfeiting the certificates are explained and solution to it is given. The platform is designed using blockchain technology to store and generate the hash of the certificates.

As certificates are stored in blocks they cannot be modify and hence cannot be misused.

T. T. Huynh et al [6] discussed seriousness of issue of counterfeit certification and advantages of blockchain technology in cost efficient and secure transactions. An issuing and verifying model are proposed by the name UniCert which is based on UniCoin, a digital currency built on the blockchain technology.

B. Duan et al [7] discussed about applications of blockchain that are useful in educational field. Authors talked about how all student details can be stored as a block in blockchain network which can be used for job competence evaluation.

I. Afrianto et al [8] proposed research based on using public blockchain network to store certificates securely. The proposed system uses smart contracts to send block of the certificates to Ethereum blockchain network. To ensure the safe and secure access to the certificates, model uses Interplanetary File System (IPFS) which is distributed storage system.

A. Gayathiri et al [9] suggested a system to store and validate educational certificates using blockchain technology. The proposed system converts the certificates into digital certificates. First the hash of the certificate is calculated using the chaotic algorithms then it is stored in the blockchain. These certificates can be validated using proposed mobile application.

Z. Wang et al [10] proposed a blockchain based certificate transparency (CT) and revocation transparency (RT) model to increase security guarantees of Secure Socket Layer/Transport Layer Security (SSL/TLS) web servers. SSL/TLS web servers depends on trusted certification authorities to sign certificates which can be compromised. The proposed system deals with issues of traditional certificate issuing process and aims to improve it.

J. C. Cheng et al [11] researched on digitalization of the certificates to stop the problem of counterfeiting certificates by generating the electronic paper with required details in the database then calculating its hash value. The system will generate a QR code after storing certificate on blockchain network. This QR code can be used for verify the authenticity of the certificate.

D. Liu et al [12] considered the advantages of the blockchain to make certificate tamper-proof and store them as nodes in the decentralized network. Proposed scheme deals with the problem of tampering and single point of failure.

D. Vujičić et al [13] briefly explained the blockchain and its one of the first implementation bitcoin as a cryptocurrency. They also discussed the implementation of smart contracts using Ethereum blockchain.

Kumari S. et al [14] proposed a model for document verification using blockchain and smart contracts. The proposed system contains e-certificate company which will store e-certificate and give (Quick Response)QR and serial number of certificates. User can use this QR and serial number for sharing the certificate so the certificate can be verified.

S. More et al [15] proposed a system for easy verifiability of the documents. The proposed system uses decentralized peer-to-peer mechanism of blockchain technology for storing and verifying the documents. Paper discusses about protection, trust, immutability and transparency provided by the blockchain technology.

## OBJECTIVES OF THE PROPOSED SYSTEM

Proposed system will make certificate issuing and validation more transparent, secure and tamper-proof. We aim to improve traditional academic certificate

generation process more efficient and maintain integrity of the process by using perks of the blockchain technology.

## PROPOSED SYSTEM

### Methodology

The proposed system helps to deal with security issues in the traditional academic certificate issuance process. Proposed process consists of step by step issuance, verification and validation of academic certificates in a time efficient manner using the power of blockchain technology to deal with forgery. Every entity is authenticated and authorized with the help of MetaMask wallet which provides secure login and rights to the users. Issuer issues certificates for the student entity using attributes such as

1. studentId
2. studentName
3. issueDate
4. metamask\_wallet\_address\_of\_student
5. metamask\_wallet\_address\_of\_issuer

to issue certificates. These details are further verified by verifier and on successful verification, these certificate details are then hashed into block and added to blockchain network. Hash of block is received as an acknowledgement of successful issuance of certificate to verifier, issuer and to the student. Further students can use this hash as authority of the certificate which can be verified on the proposed system’s web application.

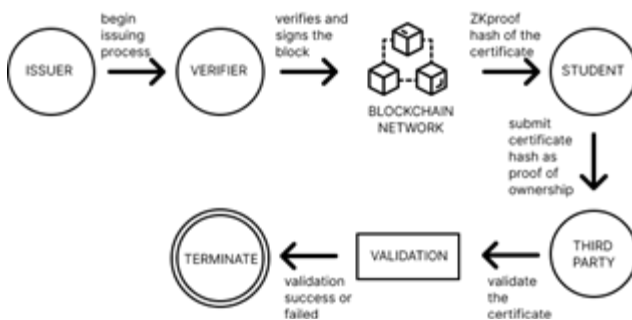


Fig. 1: Proposed System Architecture

### Issuance of the certificate

Issuer has authority to issue the certificate. Issuer can be an entity assigned by university for issuing

certificates for the students. Issuer has access to student details such as student name, student id , students metamask public address. Issuer adds student details and starts the academic certificate issuance process. These student details along with issuer’s metamask address and issuance date is sent forward to the verifier to verify details. Verifier is another entity assigned by the university. Verifier verifies the students details forwarded by issuer and on successful verification verifier converts these student details into block and adds to the blockchain network. Once the certificate is added to the blockchain network it cannot be modified and it is verifiable thus providing immutability, security and verifiability.

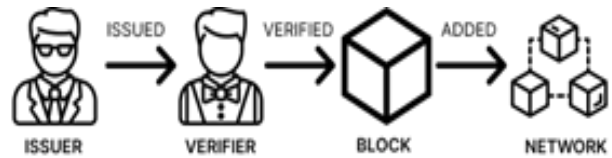


Fig. 2: Workflow of Issuance process

```

/*
Function to issue certificate using
attributes
(studentId, studentName,
metamask_wallet_address_of_issuer
issueDate,metamask_wallet_address_of_
student)
*/
function issueCred(uint256 _id, string
memory _sName, string memory
_issueDate, address _issuer, address
_student)public returns (bytes32)
{
    bytes32 docId =
    keccak256(abi.encodePacked(_id,
    _sName, _issueDate, _issuer));
    documents[docId] = document(_id,
    _sName,
    _issueDate, _issuer, _student);
    return docId;
}
  
```

Fig.3. Solidity Snippet for Issuing Academic Certificate

### Validation of the Certificate

Students can use the hash of the certificate as proof-of-ownership of that certificate. This certificate hash will indeed represent a certificate and its authenticity can be validated on a proposed web application. Validation is carried out by matching the hash in issued certificates in blockchain and if it exists it means the certificate is genuine. The function for validating certificate accepts a certificate ID as an input argument and determines if the given document is present in the documents mapping. It returns true, indicating that the credentials have been checked, if the ID is present in the mapping. If not, false is returned, meaning that the credentials were not validated. The function outputs a boolean value and is accessible to everyone.

```

/*
Function to validate certificate using
attribute (certificate_hash)
*/

function verifyCred(bytes32 _docId)
public view returns (bool) {
    bytes32 original = _docId;
    if(documents[_docId].id > 0)
        return true;
    else return false;
}

```

Fig. 4: Solidity Snippet for Validating Academic Certificate

### Workflow of the Proposed System

Workflow of the proposed system can be understood by step by step execution of responsibilities of entities involved in the system. First issuer will issue a certificate using student details provided by the university. These details are then passed to the verifier who will then verify the student details and create a block from those details. Verifier is responsible for successful addition of block to blockchain network or rejection of certificate. On successful issuance of certificate the hash of the certificate is passed to the verifier, issuer and the student as acknowledgement of successful issuance of the certificate. Student can see his certificates on the proposed web application and he can copy the certificate hash associated with the issued certificate. This hash

can be validated on the web application by a student or any third party entity.

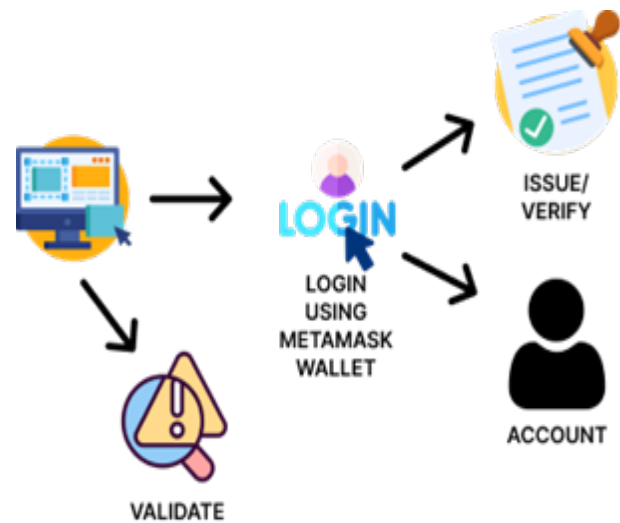


Fig. 5: Workflow of the SecureCert Web Application

### RESULT

The blockchain-based solution for academic certificate verification and issuance has produced positive results. The solution effectively streamlines the verification process, resulting in increased efficiency and security. It is scalable, resistant to cyber threats, and has user-friendly interfaces. The solution greatly contributes to the digital transformation of academic certification processes by providing a secure and transparent alternative to old approaches. Improved efficiency, trust, and convenience in verifying academic certificates can benefit stakeholders.

### Implementation Screenshots



Fig.6: Home Page SecureCert



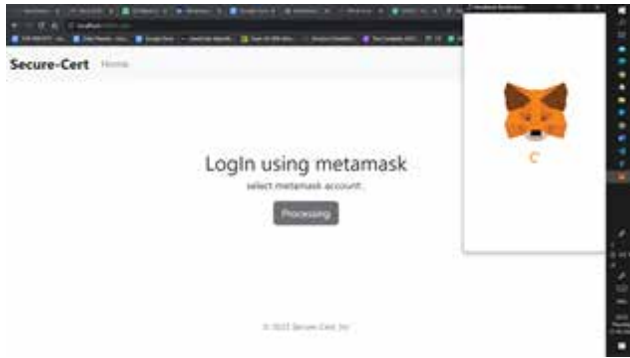


Fig.7: Authentication Using Metamask Wallet



Fig. 11: Validation of forged/Unauthorized Certificate



Fig.8: Issuing Certificate

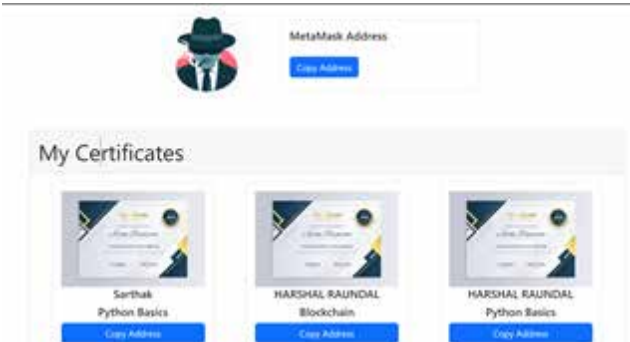


Fig.9: User Account Page

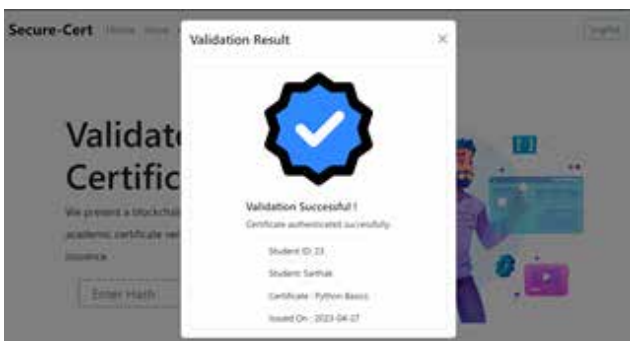


Fig. 10: Successful Validation of Certificate

### DISCUSSION

The offered blockchain-based system for academic certificate verification and issuing outperforms traditional methods in terms of transparency and efficiency. While resolving obstacles, the approach demonstrates scalability and security. However, the complexity of integration, standardization, and privacy concerns necessitate additional investigation. To improve trust and transparency, industry adoption and cross-domain applications should be investigated.

### CONCLUSION

In this paper, we proposed a solution on the problem of certificate forgery and limits of traditional certificate issuing process. Maintaining security, transparency, integrity and immutability of academic certificate is very important. Using the secure, decentralized and immutable nature of blockchain technology we can improve and speed up the certificate issuing and verification process. The System allows universities to issue certificates and any student or third party organization can validate these certificates. The system guarantees the authenticity and integrity of the academic certificates.

### RECOMMENDATION

It is strongly advised to aggressively investigate and implement blockchain-based solutions for academic degree verification and issuance. Collaboration across institutions, certification authorities, and stakeholders is essential for unlocking the promise of blockchain technology to improve security, transparency, and efficiency. Standardization efforts will enable interoperability between various blockchain networks

and verification platforms. It is critical to address privacy concerns by using privacy-preserving technologies and adhering to data protection standards. Furthermore, increasing the usability and user experience of blockchain-based solutions is critical for widespread adoption.

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# Dynamic Cloud Resource Allocation: Efficient Optimization Strategies for Enhanced Performance

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## ABSTRACT

The delivery and management of computing resources have been transformed by the advent of cloud computing, which has brought about a significant shift in the traditional approaches to handling these resources, enabling users to access scalable, on-demand resources for their applications. Efficient resource allocation is a critical challenge in cloud computing, as it directly impacts the performance and cost-effectiveness of cloud services. The objective of this research paper is to put forward effective optimization tactics for dynamic cloud resource allocation that are intended to enhance the performance of cloud computing environments and optimize their overall efficiency. The proposed optimization strategies leverage advanced techniques such as machine learning and genetic algorithms to dynamically allocate resources based on real-time workload characteristics, performance metrics, and resource availability. These strategies are designed to achieve optimal resource utilization and minimize resource wastage. Furthermore, the proposed strategies consider factors such as service level agreements (SLAs), cost optimization, and scalability, to ensure efficient and effective resource allocation.

The proposed optimization strategies have the potential to enhance performance in cloud computing environments, leading to improved quality of service for cloud users and more efficient resource utilization for cloud service providers.

**KEYWORDS:** - *Dynamic resource allocation, Resource utilization, Long short term memory (LSTM), Genetic algorithm, GA-VMP*

## INTRODUCTION

Cloud computing has revolutionized the way organizations use computing resources, allowing for efficient utilization of resources over the Internet. The proposed optimization strategies are particularly crucial in cloud computing environments, where meeting Service Level Agreements (SLAs) is imperative and workloads tend to be highly unpredictable in nature.

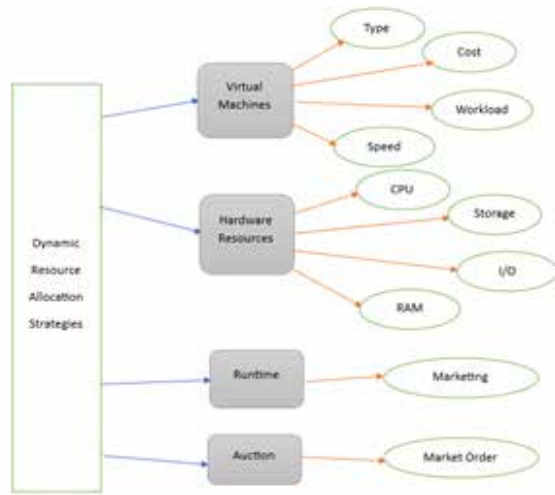
These optimization strategies are applicable to various computing resources, including but not limited to CPU, memory, storage, and network bandwidth, based on changing workload demands. This is a complex optimization problem that requires intelligent and adaptive strategies to cope with the dynamic and

heterogeneous nature of cloud workloads and resources. Following Fig. 1 represents the classification of dynamic allocation strategy.

Many optimization strategies have been proposed in the literature to enhance performance and cost-effectiveness in cloud services. These include heuristics and machine learning-based approaches. Heuristic-based approaches use rule-based or rule-of-thumb strategies to allocate resources, while machine learning-based approaches leverage algorithms such as reinforcement learning, deep learning, and evolutionary algorithms to learn and adapt to changing workload patterns for efficient resource allocation[1][2].

The efficient allocation of cloud resources dynamically can have significant implications for various cloud

computing scenarios and their applications across multiple cloud platforms. The performance metrics of response time, throughput, and resource utilization are directly influenced by resource allocation strategies, which are critical for meeting SLAs and ensuring customer satisfaction. They can also impact the cost-effectiveness of cloud services by optimizing resource utilization and reducing costs associated with over provisioning or underutilization of resources.



**Fig. 1 Classification of dynamic resource allocation strategies**

In this research paper, the latest optimization strategies for dynamic cloud resource allocation such as machine learning techniques and meta-heuristics algorithms for improved cloud efficiency using optimized resource allocation are reviewed, with a focus on enhancing performance. The challenges associated with resource allocation in cloud environments are discussed, and existing optimization strategies are categorized into heuristic-based and machine learning-based approaches[1][2]. Recent advancements in dynamic cloud resource allocation are also highlighted, including autonomic resource allocation, hybrid optimization strategies, and intelligent resource allocation using machine learning techniques. Real-world case studies and examples of resource allocation strategies in different cloud computing scenarios are presented, and the impact of resource allocation on performance metrics and cost-effectiveness is discussed. Finally, the paper outlines potential avenues for future research in the domain of dynamic cloud resource allocation,

which include emerging fields like edge cloud resource allocation, multi-cloud resource allocation, and resource allocation for blockchain and Internet of Things (IoT) technologies.

## RELATED WORK

In 2022, Moses Ashawa et al. [1], presented research aimed to develop and implement an intuitive dynamic resource allocation system based on the Long Short-Term Memory (LSTM) algorithm. To identify the ideal amount of additional resources to allocate to each application, the system evaluates the heuristics of their resource utilization. The proposed approach was subjected to near real-time simulation, and the LSTM model, which had been trained previously, was used to allocate resources were compared to those allocated by other models. The results indicated that the proposed model achieved an accuracy rate that was approximately 10-15% higher than other models.

In 2021, Deafallah Alsadie [2] proposed a novel metaheuristic framework focused on dynamic allocation of virtual machines and optimized scheduling of tasks in cloud computing environments. The framework, called Multi-Objective Dynamic Virtual Machine Allocation (MDVMA) approach, employs a metaheuristic approach based on the non-dominated sorting genetic algorithm (NSGA)-II algorithm. The aim is to achieve simultaneous minimization of energy consumption, makespan, and cost, while offering trade-offs that can be customized to fulfill the specific needs of cloud service providers..

In 2022, Prasanta Kumar Bal et al. [3], researchers put forth a hybrid machine learning-based technique for combined security and resource allocation in cloud computing. The proposed method also involves efficient task scheduling to optimize performance.

In 2019, Cai et al. [6] focused on a hybrid approach for cloud resource allocation using genetic algorithm (GA) and neural network (NN). The proposed approach used GA to optimize the allocation of resources in real-time and NN to predict future resource demands. According to the findings, the suggested method outperformed other cutting-edge approaches in terms of both resource allocation performance and efficiency.

In 2019, Kapil N. Vhatkar et al. [10] presented a new



allocation model to attain optimal container resource allocation, and suggested a hybrid algorithm called the Whale Random Update and Assisted Lion algorithm, which combines the Whale Optimization Algorithm and Lion Algorithm.

## PROBLEM FORMULATION AND DESCRIPTION

### System Model

**Cloud Environment:** The system functions in a cloud setting comprising virtual machines (VMs), physical servers, network infrastructure, and storage resources. The cloud environment can be founded on cloud services and models.

**Workload Monitoring:** The system includes a workload monitoring component that continuously monitors the changing workload demands in the cloud environment. This might entail gathering data on pertinent metrics like CPU usage, storage usage, memory usage, network bandwidth, etc. from both virtual machines (VMs) and physical servers.

**Resource Allocation:** The resource allocation component makes real-time decisions on allocating resources to VMs based on changing workload demands. It optimizes resource allocation decisions using efficient strategies that consider performance requirements, SLAs, and cost-effectiveness.

**Optimization Strategies:** The system provides optimization strategies based on heuristics and machine learning to improve cloud services performance and cost-effectiveness. These may involve rule-based approaches, entity modeling, or learning algorithms such as reinforcement learning, deep learning, or evolutionary algorithms.

**Adaptive and Intelligent Components:** The system may have adaptive and intelligent components that learn and adapt to changing workload patterns and resource utilization trends. These components may utilize machine learning methods to refine resource allocation decisions and adjust to the dynamic nature of cloud resources and workloads[5].

**Performance Metrics and SLAs:** To confirm that virtual machines (VMs) fulfill their performance requirements and service level agreements (SLAs),

the system observes and gauges performance metrics such as resource utilization, throughput, and response time. These performance metrics are used as inputs to the resource allocation component to make informed resource allocation decisions.

**Cost-Effectiveness Considerations:** The system takes into account cost-effectiveness considerations in resource allocation decisions. This includes optimizing resource utilization to minimize costs associated with over provisioning or underutilization of resources, and ensuring that resource allocation decisions align with the cost models and pricing policies of the cloud service provider.

**Real-Time Decision Making:** The system works in real-time, continually examining the evolving workload demands, and rendering resource allocation decisions on-the-fly to suit the dynamic nature of cloud workloads.

**Reporting and Visualization:** The system may include reporting and visualization components that provide insights and visualizations of resource allocation decisions, performance metrics, and cost-effectiveness considerations. This aids stakeholders in comprehending and evaluating the efficiency and cost-effectiveness of cloud resource allocation strategies.[4][5].

The system model for “Dynamic Cloud Resource Allocation: Efficient Optimization Strategies for Enhanced Performance” pertains to enhancing cloud services performance by scrutinizing and refining resource allocation through efficient optimization strategies, intelligent and adaptive components, and taking into account performance metrics, service level agreements (SLAs), and cost-effectiveness considerations.

Challenges associated with dynamic resource allocation using ML and Heuristic based strategies are-

- Scalability
- Dynamic nature of cloud environments
- Complexity of resource allocation decisions
- Lack of complete information
- Trade-offs between conflicting objectives
- Explainability and interpretability



- Training and deployment challenges for machine learning-based approaches

### Material and Methods

In this section, we examine the machine learning and meta-heuristic algorithms employed for allocating cloud resources dynamically in cloud computing environments.

#### *Machine Learning Techniques*

Machine learning techniques can be utilized for dynamic cloud resource allocation to optimize performance metrics such as makespan, throughput, cost of virtual machines, and maintaining Service Level Agreements (SLAs). Here are some machine learning techniques that can be applied:

**Reinforcement Learning (RL):** RL is a type of machine learning where an agent learns to make decisions based on interactions with an environment to maximize a cumulative reward signal. RL can be used for dynamic cloud resource allocation by representing the cloud resource allocation decisions as actions taken by the agent, metrics like makespan, throughput, cost, and SLA compliance as the reward criteria. The agent learns to make resource allocation decisions that optimize the performance metrics over time.

**Supervised Learning:** It is a machine learning paradigm that entails training a model on labeled data for making predictions. In dynamic cloud resource allocation, a supervised learning model can be trained using historical data on past resource allocation decisions and their resultant performance metrics. This model can then predict optimal resource allocation decisions based on the current system state and the desired performance metrics.

**Multi-objective Optimization:** Multi-objective optimization is a technique that aims to optimize multiple conflicting objectives simultaneously. In the case of dynamic cloud resource allocation, performance metrics such as makespan, throughput, cost, and SLA compliance can be considered as multiple objectives. Machine learning techniques, such as evolutionary algorithms, can be used to search for Pareto-optimal solutions, which are solutions that represent trade-offs between different objectives. These solutions

can provide decision-makers with a set of resource allocation options that optimize performance metrics based on their preferences.

**Deep Learning:** To capture intricate patterns and relationships in the data for dynamic cloud resource allocation, deep learning techniques like neural networks can be employed. Recurrent neural networks (RNNs), for instance, can model time-series data such as workload patterns and resource utilization to predict optimal resource allocation decisions that enhance performance metrics. On the other hand, convolutional neural networks (CNNs) can extract features from resource-related data, including workload characteristics or resource utilization, which can then be utilized to make resource allocation decisions [6].

Here discuss “Long Short-Term Memory (LSTM) Machine learning algorithms”.

LSTM is a member of the recurrent neural network (RNN) family, and it is a machine learning algorithm. LSTM’s architecture comprises numerous components, such as input gates, output gates, forget gates, and memory cells. The training process of an LSTM entails optimizing the network’s weights and biases to minimize the difference between the predicted outputs and the actual outputs. Optimizing resource allocation in cloud environments using LSTM algorithms can potentially improve cloud efficiency by leveraging LSTM’s ability to model sequential data and capture long-term dependencies.

#### **Steps: LSTM**

**Data collection:** Collecting relevant data about the cloud environment, such as resource utilization metrics, workload patterns, and historical allocation decisions. This data can be used to train and validate the LSTM model.

**Feature engineering:** Preprocessing the collected data and transforming it into appropriate input features for the LSTM model. This may involve normalizing the data, encoding categorical variables, and creating appropriate time-based features to capture temporal patterns.

**LSTM model training:** Training an LSTM model using the collected data. The LSTM model can be configured

to take into account the historical resource allocation decisions and their impacts on the cloud environment. The model can learn to capture complex patterns and dependencies in the data, including workload fluctuations, resource utilization trends, and correlations between different resources[1].

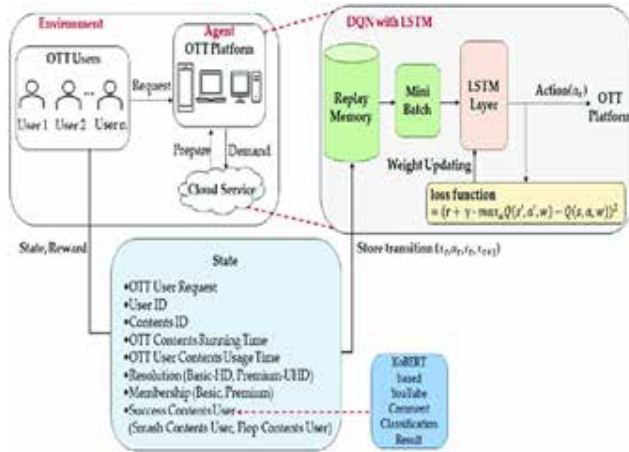


Fig. 2 LSTM -Cloud Resource allocation

**Model validation:** Validating the trained LSTM model using a hold-out validation set or using cross-validation techniques to ensure its accuracy and generalization performance. This step helps to assess the effectiveness of the LSTM model in predicting resource allocation decisions based on historical data.

**Decision-making and optimization:** The trained LSTM model can be utilized to make real-time allocation decisions in a cloud cluster. On the basis of the current state of the cloud cluster, workload demands, and historical allocation patterns, the LSTM model can offer predictions or recommendations for optimal resource allocation decisions. These decisions can be further enhanced with respect to other objectives such as cost, performance, and energy efficiency using suitable optimization techniques.

**Monitoring and adaptation:** Continuously monitoring the performance of the resource allocation decisions made by the LSTM-based system and adapting the model as needed. This may involve retraining the LSTM model with updated data, fine-tuning model parameters, or adjusting decision-making thresholds based on feedback from the cloud environment.

**Evaluation and refinement:** Periodically evaluating the

effectiveness of the LSTM-based resource allocation system and refining it based on feedback and insights gained from real-world deployment. This may involve identifying and addressing any limitations or challenges associated with the LSTM-based approach and continuously improving the system’s performance and efficiency.

It’s important to note that implementing an LSTM-based resource allocation system in the cloud environment requires careful consideration of factors such as data availability, model interpretability, and potential privacy and security concerns. Additionally, it may be necessary to integrate the LSTM-based system with existing cloud management tools and processes to ensure smooth operation and integration within the cloud environment.

**Pseudo-code for LSTM-based dynamic cloud resource allocation**

**Step 1: Data Collection**

Collect real-time data about the cloud environment and workload demands

```
cloud_data = collect_cloud_data()
workload_data = collect_workload_data()
```

**Step 2: Feature Engineering**

Preprocess the collected data and create input features for LSTM

```
input_features = preprocess_data(cloud_data, workload_data)
```

**Step 3: LSTM Model Training**

Train an LSTM model using historical data or simulated data

```
lstm_model = train_lstm_model(input_features)
```

**Step 4: Real-time Prediction**

Make real-time predictions using the trained LSTM model

```
current_state = get_current_state()
prediction = lstm_model.predict(current_state)
```

**Step 5: Decision-making and Optimization**

Use the LSTM predictions for dynamic resource allocation decisions

```
resource_allocation= make_resource_allocation_
decision(prediction)
```

```
optimized_allocation = optimize_allocation(resource_
allocation)
```

### Step 6: Monitoring and Adaptation

The model should be adapted by continuously monitoring

```
monitor_performance(resource_allocation, optimized_
allocation)
```

```
adapt_model()
```

Step 7: Evaluation and Refinement

Periodically evaluate and refine the LSTM-based dynamic resource allocation system

```
evaluate_performance()
```

```
refine_model()
```

Repeat the above steps in a loop for continuous real-time dynamic resource allocation in the cloud environment

### Meta-heuristics Algorithms

Metaheuristic algorithms have gained popularity as effective optimization techniques for dynamic cloud resource allocation. These algorithms aim to enhance performance metrics. Various metaheuristic algorithms are available to facilitate dynamic cloud resource allocation.

Genetic Algorithm (GA) is an optimization algorithm that mimics natural selection by using selection, crossover, and mutation to improve potential solutions. It encodes cloud resource allocation as chromosomes, progressively improving them over generations.

Particle Swarm Optimization (PSO) uses the collective behavior of particles or birds to perform dynamic allocation. Particles traverse a search space, continuously adjusting positions and velocities based on the best-known solution of the swarm. PSO can optimize cloud resource allocation by representing solutions as particles and improving their positions based on performance metrics.

Ant Colony Optimization (ACO) ACO simulates the foraging behavior of ants by using pheromone trails to optimize a path on a graph. When applied to

dynamic allocation, cloud resources and their allocation decisions can be represented as a graph, where ants act as agents that use pheromone trails and heuristics to make allocation decisions.

Simulated Annealing (SA) SA is a probabilistic optimization method inspired by metallurgy's annealing process. It avoids local optima by using a random search with controlled acceptance probability. In dynamic cloud resource allocation, SA can evaluate allocation decisions based on a cost function defined by performance metrics using acceptance probability[4].

### Genetic Algorithms for Dynamic Cloud Resource Allocation

The problem of dynamic cloud resource allocation is highly intricate, requiring efficient adaptation to fluctuating conditions such as workload demands and resource availability. To address this issue, genetic algorithms (GAs) have emerged as a robust optimization technique. The present study suggests utilizing a GA-driven technique for dynamically allocating resources with the objectives of minimizing makespan, maximizing throughput, reducing the cost of virtual machines, and upholding compliance with Service Level Agreements (SLAs)[11].

Researchers have put forth various methods to tackle dynamic cloud resource allocation problems, utilizing diverse optimization techniques such as linear programming, heuristic algorithms, and reinforcement learning. Nevertheless, most of these approaches concentrate on a single optimization objective, such as minimizing cost or maximizing resource utilization[6]. In contrast, our proposed approach incorporates multiple objectives, including makespan, throughput, and VM cost, all while upholding SLAs.

Our proposed approach for dynamic cloud resource allocation is based on a genetic algorithm that uses a chromosome representation and a fitness function to optimize the allocation decisions. The chromosome representation consists of a binary string that encodes the presence or absence of a VM for each time interval. By taking SLAs into account, the fitness function assesses the quality of resource allocation decisions based on various objectives such as makespan, throughput, and VM cost.

Genetic Algorithm for Virtual Machine Placement (GA-VMP): GA-VMP is a well known method that uses GAs to enhance the allocation of virtual machines (VMs) onto physical hosts within a cloud environment. The chromosome representation in GA-VMP typically includes the VM placement decisions, along with other parameters such as VM sizing, host selection, and migration strategies. When taking SLAs into account, the fitness function in GA-VMP appraises a variety of objectives, including reducing VM cost, maximizing resource utilization, and minimizing makespan.

### Problem Formulation

Efficient allocation of virtual machines (VMs) to physical hosts in cloud computing environments is a crucial task for optimizing performance, resource utilization, and cost. GA-VMP employs heuristic techniques such as genetic algorithms (GAs) to address the VM placement problem.

GA-VMP optimizes the performance of virtual machines (VMs) and minimizes resource wastage by assigning VMs to physical hosts. This is done by defining an objective function, decision variables, and constraints. The objective function considers factors such as response time, throughput, and SLA compliance. Decision variables represent the assignment of VMs to physical hosts, which can be encoded as binary or permutation. Constraints include resource capacity and availability, VM affinity and anti-affinity rules, and other operational constraints.

## METHODOLOGY

By drawing inspiration from the principles of natural selection, GA-VMP leverages the capabilities of GA, a population-based optimization algorithm. The steps of GA-VMP include-Initialization: A population of candidate solutions (i.e., VM placements) is randomly generated, representing different assignments of VMs to physical hosts.

Fitness Evaluation: Assessing the quality of virtual machine (VM) placement with regards to optimization objectives is achieved through evaluating the fitness of each candidate solution via the objective function. solutions having a higher probability of being selected. Selection: A subset of candidate solutions is selected for reproduction based on their fitness, with higher fitness.

Crossover: Combining selected candidate solutions via crossover is how new offspring solutions are generated, which involves swapping or combining portions of the encoding to create new VM placements.

Mutation: Some of the offspring solutions undergo mutation, where small changes are randomly introduced to the encoding to explore new regions of the search space.

Replacement: The offspring solutions are combined with the original population and the least fit solutions from the prior generation are swapped out with a subset of solutions that make up the succeeding generation of candidate solutions.

Termination: The selection, crossover, mutation, and replacement stages of the GA-VMP algorithm are repeated iteratively until a termination criterion, such as reaching a maximum number of generations or a convergence threshold, is reached.[10].

GA-VMP continues to evolve the population of candidate solutions through multiple generations, allowing it to explore different VM placement configurations and converge towards an optimal or near-optimal solution[9].

### Mathematical Modeling

The mathematical model for the formulation of VM Placement (GA-VMP) is described as

Decision Variables:

We can represent the placement of virtual machine  $i$  on physical host  $j$  using a binary decision variable  $X_{i_j}$ , where  $i$  ranges from 1 to  $n$ , and  $j$  ranges from 1 to  $m$ . A value of 1 for  $X_{i_j}$  denotes virtual machine  $i$  being placed on physical host  $j$ , while a value of 0 indicates that virtual machine  $i$  is not located on physical host  $j$ .

### Objective Function

In GA-VMP, we can define the objective function  $F(X)$  to be optimized as a composite of multiple objectives, such as minimizing makespan, maximizing throughput, reducing VM cost, and maintaining SLA compliance. The objective function can be formulated as-  $F(X)$  in GA-VMP as a linear combination of individual objectives, weighted by coefficients  $w_1$ ,  $w_2$ ,  $w_3$ , and  $w_4$  [15].



$$F(X) = \sum w_i * f_i(X),$$

Where:  $i = 1$  to 4

$f_1(X)$ : One of the fitness functions used in GA-VMP is to evaluate the make span, which represents the total time required to complete all virtual machine placements on physical hosts. It can be determined by calculating the maximum time taken to complete all virtual machine placements among all physical hosts.

$f_2(X)$ : A metric for evaluating fitness could be the throughput of the system, which is the total number of virtual machines that are effectively deployed on physical hosts. This can be computed by summing up the count of all virtual machines that have been successfully placed on physical hosts.

$f_3(X)$ : A fitness function that measures the VM cost, which is the total expenses accrued in the process of deploying virtual machines onto physical hosts, including the cost of provisioning and maintaining virtual machines on physical hosts.

$f_4(X)$ : A fitness function that measures the SLA compliance, which is the extent to which the placement of virtual machines satisfies the specified Service Level Agreements (SLAs), such as availability, response time, and resource utilization.

$w_1, w_2, w_3, w_4$ : Weights assigned to the respective fitness functions to determine their relative importance. These weights can be adjusted based on the problem requirements and priorities[14].

Constraints:

GA-VMP may have various constraints that need to be satisfied, such as:

**Resource Capacity Constraint:** The total resource utilization of virtual machines on a physical host should not exceed its resource capacity in terms of CPU, memory, and storage.

**Placement Constraint:** Every virtual machine must be allocated to precisely one physical host

**VM-to-Host Compatibility Constraint:** The hardware specifications of both the virtual machine and physical host must be compatible, operating system, and other requirements.

**SLA Compliance Constraint:** The placement of virtual machines should satisfy the specified SLAs, such as availability, response time, and resource utilization[11][12].

### Pseudo-code for GA-VMP is

Start by creating a population P consisting of random individuals, then assess the fitness level of each individual in P by applying the objective function

Repeat for a specified number of generations:

Select parents from P using selection operator

Perform crossover to create offspring individuals

Perform mutation on offspring individuals

Evaluate fitness of offspring individuals

Replace least fit individuals in P with offspring individuals

Apply elitism to retain top-performing individuals in P

End Repeat

Return the best individual in P as the solution

Selection Operator:

1. Roulette Wheel Selection:

Calculate the fitness proportionate probability for each individual in P

Select parents based on their fitness proportionate probability

Crossover Operator:

1. Single Point Crossover:

Randomly select a crossover point

Create two offspring by exchanging genetic material at the crossover point

Mutation Operator:

1. Bit Flip Mutation:

Randomly select a bit in an individual's chromosome

Flip the bit (0 to 1 or 1 to 0) to create a mutated offspring

Elitism:

1. Replace the least fit individuals in P with offspring individuals



2. Retain a certain percentage (e.g., 10%) of the top-performing individuals in P without any changes[16]

Note: The specific factors involved in the GA-VMP implementation, including the representation of the chromosome, the size of the population, the crossover and mutation rates, as well as the criteria for termination, may vary depending on the specific problem requirements and application domain. These parameters need to be carefully tuned for optimal performance.

## CONCLUSION

The present research has delved into the subject of dynamic cloud resource allocation and the range of optimization approaches that can be employed to enhance its effectiveness. The findings indicate that dynamic resource allocation can offer considerable advantages to cloud computing, including optimized resource utilization, improved energy efficiency, and reduced costs. Additionally, employing advanced optimization techniques, such as machine learning algorithms and meta-heuristics, can further enhance the performance of dynamic resource allocation. This paper highlights the crucial role of dynamic resource allocation in cloud computing and its potential to enhance the overall efficiency of cloud systems. The suggested strategies serve as a starting point for further exploration and development in cloud resource management, with the possibility of contributing to the progress of cloud computing technologies and their practical application in real-world settings[17].

## ACKNOWLEDGMENT

I express my heartfelt appreciation to my research guide Dr. D P Gaikwad and my research center head Dr. D S Bormane for their invaluable contributions to this research project. Their unwavering support, guidance, and feedback have been critical to the success of this study. Lastly, we extend our thanks to all the participants who volunteered their time and effort to make this study possible.

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# A Review on Different Techniques Applied to Enhance Ventilation of a Room for Solar Chimney

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## ABSTRACT

In this paper the researchers will find how previous researchers applied different techniques to increase the building ventilation through solar chimney so solar chimney can be used in common way. Building ventilation consume most of the electric power generated today and study says it will increase 2.3 times by 2027, However many rural area facing major problem of electric power cut due to supply in metro cities ie the power supply does not meet the power demand. To solve the problem of power supply upto some extend we can use roof top solar chimney to ventilate room during high temperature and produce thermal comfort. Most of the researchers applied different techniques with roof top solar chimney to enhance ventilation of room, as experiments performed with light weight copper plate, Phase change materials, parallel fins, concentrated collectors, heavy concrete wall, semi transparent organic photovoltaic (OPV) technology and changed some basic parameters of solar chimney. We found all techniques enhances ventilation compared with conventional solar chimney although good results with OPV, copper plate, parallel fins and concentrated collectors than other techniques.

**KEYWORDS:** *Solar chimney; Room ventilation; Human comfort*

## INTRODUCTION

Natural ventilation is a passive building cooling approach, Air may enter the building envelope unintentionally through a number of openings, such as those indoors and windows, leading to natural ventilation. Buildings can be conditioned via natural ventilation, and solar chimneys are technologies that can help increase a building's energy efficiency. Solar chimney is renewable energy technology which comprises of glazing, a cavity, and a metallic wall that absorbs solar radiation. Roof top solar chimney is one of the simple and perfect solution to reduce electric power consumption for room ventilation, improve air quality which results thermal and human comfort. To achieve and maintain the human comfort condition solar chimney has to set in a proper inclination angle which depends on geographical location as Nadia Saifia et. al [1] finds 45 degree angle is the best results provider at Ouargla Province, Algeria with air flow of

165 m<sup>3</sup>/h where solar irradiation was 789 w/m<sup>2</sup> at 12:30 pm however at 30 degree angle chimney inclination angle the air flow was 145 m<sup>3</sup>/h.

El Hadji I Cisse et. al [2] experimented solar chimney with 3 reflectors in 3 directions at Higher Polytechnic Dakar founds temperature of the collector with 3 reflectors got 65.33°C. and for the collector without using reflectors, the average temperature is 50.81°C. Which results more air velocity as 0.3 m/s with collectors compared to without collectors air velocity 0.2 m/s at the same area with solar irradiation ranging between 510 and 800 W/m<sup>2</sup>.

Jitendra Kumar et al. [3] studied position of the chimney with same parameters by numerical CFD analyse compared with horizontal and vertical parallel chimney where found vertical chimney produces 275% more ventilation than horizontal chimney and vertical chimney enhanced air flow 22 times than horizontal chimney.

Ning Gao et al. [4] designed and experimented wind-induced channel which enhances indoor ventilation under combine action of solar energy and wind. Ventilation rate increases 212 % for wind speed 1m/s and channel width ratio is 0.2 with mass flow rate 0.378 kg/s ,166 % for 2 m/s wind speed and 127 % for 3 m/s wind speed with mass flow rate 0.591 kg/s respectively as inclination angle increases from 30° to 90° at solar radiation 600 w/m<sup>2</sup>.

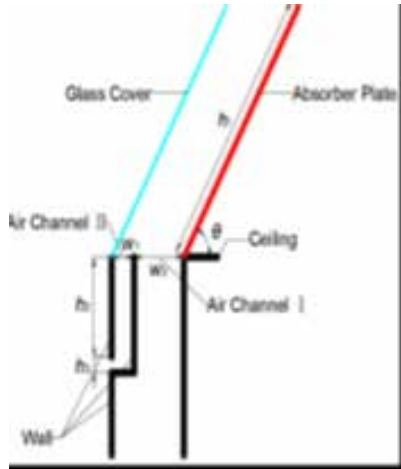


Figure 1. Physical model of the roof solar chimney

Figure 1 from - Gao, N., Yan, Y., Sun, R., & Lei, Y. (2022). Natural Ventilation Enhancement of a Roof Solar Chimney with Wind-Induced Channel. *Energies*, 15(17), 6492. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/en15176492>

V. Siva Reddy et al.[5] studies performance of solar chimney at different inclination angle and various gaps between glass and absorber plate at Tiruchirappalli with geographical position (78°69\_E, 10°81\_N) India and found air flow velocity about 0.32m/s at solar radiation 1000 w/m<sup>2</sup>.

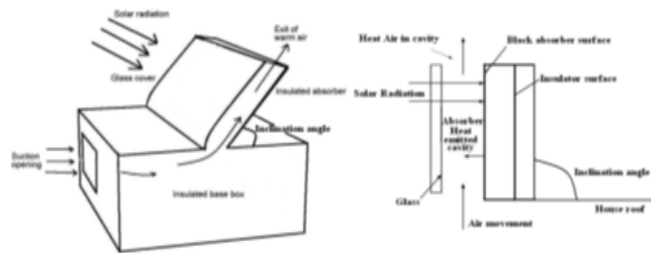


Figure 2. Layout of a solar chimney

Figure 2 from- Siva Reddy, V., Premalatha, M., &

Ranjan, K. R. (2012). Experimental studies on solar chimney for enhanced ventilation. *International journal of sustainable energy*, 31(1), 35-42.

Pornsawan Tongbai et al.[6] parameters investigated numerically inclination angles, solar intensities, channel expanding angles, vertical chimney attachment heights and channel gaps, and observed ventilation enhances with increase air gap, roof inclination and isolation level as air gaps increased from 10 to 60 cm the ventilation most significantly raises up to 250%.

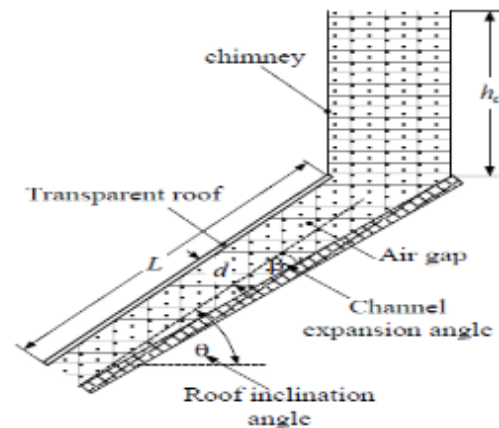


Figure 3. Layout of solar chimney

Figure 3 from - Tongbai, P., & Chitsomboon, T. (2014). Enhancement of roof solar chimney performance for building ventilation. *Journal of power and energy engineering*, 2, 22-29.

Yan Cao et al.[7] studied a natural free ventilator as single solar chimney technology at Hong Kong and found performance of solar chimney ventilator at inclination 20 °angle is approx 17%, 56% and 177% higher than solar chimney ventilator with 40 °,60 ° and 80 ° respectively. Also found using parallel fins the ventilation increases by 3.2% and due to more heat transfer reduces surface temperature of the system between absorber plate and air gap.

J. Xam\_an et al. [8] performed heat transfer analysis with three materials – copper plate (light weight), (PCM 46-50).

Phase change materials and heavy weight concrete wall and found solar chimney using copper plate has results more velocity of air as 0.6 m/s compare to PCM and concrete wall have air velocity as 0.45 m/s, mass flow

rate of air and thermal efficiency of the system is also higher with copper plate.

Jun Lu et al.[9] studied with phase change material temperature 38°C,44°C,50°C,68°C and results shows maximum ventilation 610kg/m<sup>2</sup> produced and maximum thermal storage 4750 KJ/M<sup>2</sup> can be achieved with PCM 38°C. during night ventilation air absorbed 13% heat only ie most of the heat loss to ambient through glass cover by radiation.

Kishio Hidaka et al. [10] performed integration of solar chimney ventilation with semi transparent organic photovoltaic (OPV) technology which achieved the air velocity 0.25m/s at artificial light intensity of 320 w/m<sup>2</sup> and also generated approx 1.03 W electric power optimization can be done for solar chimney using parallel fins, at night when solar radiation is unavailable study can be done with some more nano- phase change materials which can provide efficient night ventilation it is seen that heat loss is due to radiation. ie. to increase the night ventilation effectively there must be reduce the radiation heat transfer coefficient of glass cover. some other technology can be integrate to improve ventilation like semi transparent organic photovoltaic (OPV) technology and photovoltaic cells.

## LIMITATIONS

Solar chimney is the passive source of renewable energy so its ventilation performance found always lower the active mechanical systems performance like,

1. Use of solar chimney depends upon the availability of sun to produce required air velocity in the room or studied area therefore the geographical area where sun is not available with required quantity of radiation the solar chimney would not shows good effect.
2. Sizes of solar chimney play major role to produce air flow for ventilation ie. big size of chimney can produce more ventilation compare to small size chimney.
3. Selection of which kind of solar chimney is also very important feature to get ventilation in room.
4. Design and orientation of the building affects its effectiveness.

5. Solar chimney can produce good amount of ventilation for small room only not for large room or more than one room.

## CONCLUSIONS

Solar chimney is the excellent passive renewable source of energy. All the techniques which covered in this paper used to enhance ventilation in roof solar chimney shows improved results except heavy concrete wall. But there are so many limitations to use solar chimney and because of the limitations solar chimney combine with other arrangements to produce more ventilation in room. work like OPV, copper plate, parallel fins and concentrated collectors than other techniques shows better results. Researchers trying to find out which techniques would be more efficient to produce more ventilation which can be applicable.

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# Design and Analysis of Electric Vehicle Parameters Influencing the Vehicle Speed and Efficiency

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## ABSTRACT

The modelling and simulation of electric vehicles is gaining more and more attention from researchers these days as they emerge as the best solution for clean and sustainable energy emission in transportation. Consumers' top concerns in the EV market right now are the price of the vehicle, followed by its performance, speed, efficiency, a large battery for greater range, and safety. The first step in creating a decent electric vehicle model is choosing the right parameters and comprehending their properties. This paper gives a comprehensive analysis of the choice and computation of EV design parameters based on electric vehicle simulation. The Simulink design of the Tata Nano is used as a case study for the investigation of key electric vehicle parameters. The simulation result demonstrates that the actual speed is the same as the reference speed.

**KEYWORDS:** *EV, Simulation, Vehicle specifications, MATLAB/Simulink*

## INTRODUCTION

EVs first debuted in the late 19th century, when electricity was one of the most widely used forms of motor vehicle propulsion. For over a century, internal combustion engines have dominated the propulsion of trucks and cars, however, other vehicle types, such as trains and various smaller vehicles, have continued to use electric power frequently. Any electric vehicle's design is primarily influenced by three factors: (i) Its range (ii) Its speed and (iii) Its ability to carry weight. Now days, future transportation will be electric in response to the trend towards minimising energy use and environmental effect. Global tensions have escalated as a result of the pressing challenges of global warming, or the "Greenhouse effect," pollution in cities and the use of fossil fuels running out. Despite the advancements in internal combustion engine (ICE) technology over the past century, these improvements will primarily be made to fuel efficiency and pollution levels. [1]. Many have suggested using battery-powered electric vehicles (EVs), which are very efficient, silent, emit no emissions, and are controllable by the power

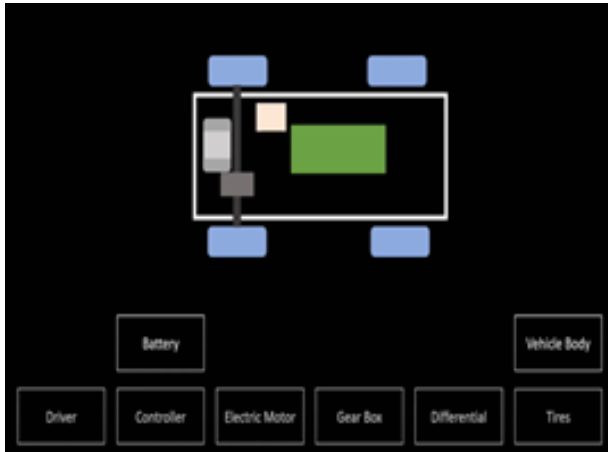
grid operator, as one of the aforementioned solutions. [1–7]. The limited driving range, high initial cost, and lengthy battery charge times of EVs, however, are their battery-related problems that need to be resolved [2, 8]. The battery needs to have enough energy to travel a specific distance and deliver enough power during accelerations.

## ELECTRIC VEHICLE DESIGN PARAMETERS

The dynamics, weight, torque, motor type, required speed (on flat, sloping, and straight roads), battery type, and the architecture of an electric vehicle may include a DC/DC or DC/AC power converter. There are two categories for the specifications for electric vehicle design [9]: parameters for (1) the vehicle and (2) the electric components. The term "vehicle parameters" refers to information on a vehicle, such as its mass, frontal area, tyre specs, rolling resistance, and drag coefficient. Specifications for electric motors, battery packs, motor controllers, and battery chargers are among the electric elements. Understanding vehicle dynamics is crucial for the design of any EV since it

enables us to comprehend how performance and energy consumption per mile driven are impacted.

## BASIC MODEL OF ELECTRIC CAR - TATA NANO



**Fig. 1: Basic electric car design**

The basic design of EV TATA NANO includes a vehicle body, tyres, differential, gear box, electric motor, controller, driver, & battery. Now we will integrate all these components to make a complete model of the EV[7]. In this study, we use the MATLAB/Simulink workspace to build an electric car model based on the physical principles of these components and vehicle dynamics. then check to see if the reference speed and the real speed are identical.

### Benefits of Electric Vehicle

1. Lower running cost
2. Low cost of maintenance
3. There are no exhaust fumes
4. Tax and financial benefits
5. Driving an electric vehicle is simple.
6. The ability to charge at home
7. The absence of noise pollution

### Drawbacks of Electric Vehicle

1. Short battery life
2. Battery life worries
3. EV charging station locations and availability

4. Protracted charge times
5. More costly to purchase
6. Environmental impact
7. Low top velocities.

## ELECTRIC VEHICLE DESIGN ELEMENTS

The dynamics, weight, torque, motor type, required speed (on flat, sloping, and straight roads), battery type, and the architecture of an electric vehicle may include a DC/DC or DC/AC power converter.

### The Vehicle's Dynamics

Understanding vehicle dynamics is crucial for the design of any EV since it enables us to comprehend how the performance and Affected is energy consumption per mile travelled.

Using Newton's second law of mechanics, the force (F) due to the vehicle travelling in any specific direction may be determined by summing all the forces acting on it in that same direction, as shown by the equation.

$$F(t) = m.a = m. \frac{d(v)}{dt} = F_t(t) - F_r(t) \quad (1)$$

where  $F(t)$  is the acceleration in Newtons.

The mass to be accelerated is  $M$  in kg.

$a$  represents the gravitational acceleration in  $m/s^2$ .  $\frac{d(v)}{dt}$  is the change in vehicle speed, expressed in  $m/s^2$ .

$F_t(t)$  is the overall tractive force accelerating the vehicle's speed in Nm

$F_r(t)$  is the overall force that is reducing the vehicle's speed in Nm

The amount of force applied to the area of the wheel that contacts the ground by wheel shaft of the vehicle, differential, and gear is known as traction force. The pull of gravity is also a component of the tractive force. The resistance force is comprised of the forces of gravity pulling uphill, forces that prevent rolling, drag resulting from aerodynamic, and regenerative braking from traditional friction brakes.

### *Drag resulting from aerodynamics*

Due to internal and external airflow, every moving object that is being driven will inevitably experience

aerodynamic drag.

The formula for the aerodynamic drag force  $F_A$  is  $F_A(t) = 1/2 \rho_A C_A A_e (v_{\text{vehicle}} - v_{\text{wind}})^2$

$\rho_A$  : the weight of air in  $\text{Kg/m}^3$ , which changes with climate, humidity, atmospheric height and pressure; for example, in the ocean floor, if the temp. is  $249^\circ\text{C}$  and the standard air pressure is  $1012.19$  pascals,  $\rho_A$  is  $1.214 \text{ kg/m}^3$ .

The drag resulting from aerodynamic coefficient is represented by the smaller-dimensional quantity  $CA$ .  $CA$  usually falls between  $0.25$  to  $0.35$ .

$A_e$  Depending on the vehicle's size and shape, various effective cross-sectional areas are measured in  $\text{m}^2$ .  $v_{\text{vehicle}}$  is the vehicle's speed in  $\text{m/s}$

$v_{\text{wind}}$  is the wind speed in  $\text{m/s}$ .

The -ve symbol denotes a vehicle and wind both going the same way.

#### *Forces that prevent rolling*

Vehicle tyres prevent rolling when the vehicle is rolling. The formula for the rolling resistance force is  $F_r(t) = C_r mg \cos(\alpha)$

where the usual value of  $C_r$  for dimensionless rolling resistance ranges from  $0.007$  to  $0.015$ .

$m$  is mass of the vehicle in  $\text{Kg}$

$g = 9.807 \text{ m/s}^2$  is the gravitational constant.

$\alpha$  is the road's inclination angle in radians.

#### *Graded Force*

$F_G$  Graded force which is parallel to the road is brought about by the incline of the road and is expressed as  $F_G = m g \sin(\alpha)$

Where  $\alpha$  is the radius of the arc created by the level road and the vehicle's horizontal plane.

$$\alpha = \tan^{-1} (d_v/d_h)$$

$d_v$  represents vertical distance and  $d_h$ , which is measured horizontally.

#### *Wheel power*

The pressure exerted on the wheel by the vehicle's traction force in order to maintain a particular speed

level is expressed as

$$F_w(t) = F(t) + F_A(t) + F_R(t) + F_G(t)$$

If  $F_w(t)$  is positive, the car is accelerated; & if is negative, either friction braking or regenerative braking is indicated.

The maximum tractive force  $F_{w_{\text{max}}}$  on the wheel is either controlled by friction or by normal force on the wheel  $F_N$ , depending on the friction coefficient  $C_f$  between the tyre and the road.

$$F_{w_{\text{max}}} = F_N * C_f$$

#### *Energy and wheel propulsion*

The driving force acting on the wheel  $F_w$  can be multiplied with the speed of the vehicle  $v_{\text{vehicle}}$  to determine the wheel power  $P_w$ .

$$P_w(t) = F_w(t) * v_{\text{vehicle}}(t)$$

#### **Capacity and Weight Calculation**

For designing the system we take few specifications of TATA NANO and then calculate the actual mass of the vehicle [7]. So the actual weight of the vehicle is

$$\text{Weight(Kg)} = \text{Vehicle} + \text{Battery} + \text{Pay Load} + \text{Motor} - \text{Engine} \quad (1)$$

$$\text{Weight(Kg)} = 600 + 235 + 300 + 50 - 170 = 1015 \text{ Kg}$$

Vehicle: Weight of the complete vehicle(Kg)

Battery: Weight of the battery installed in the electric vehicle(Kg)

Pay Load: The maximum amount of weight you can have loaded on or in

a vehicle(Kg).

Motor: Weight of the motor in the vehicle(Kg)

Engine: Weight of the engine of the electric vehicle

Now with the other parameters (approx. values) like Gradient, Air Density( $\text{Kg/m}^3$ ), Wind( $\text{m/s}$ ), Drag Coefficient, Frontal Area, Maximum Speed( $\text{Km/hr}$ ), Wheel Radius( $\text{m}$ ), Efficiency of the system, Maximum acceleration( $\text{m/s}^2$ ), Gear Ratio & Differential; the total force can be calculated

$$\text{Total Force} = \text{Frictional Force} + \text{Drag Coefficient} + \text{Normal Force}$$

Now, Frictional Force= Frictional Coefficient\* Mass\*9.81\*cos( $\alpha$ )

Drag Force = 0.5\* Air Density\*Cd\*Frontal Area\*( $V_{vehicle} + V_{wind}$ )<sup>2</sup> [Assume wind force is zero]

Normal Force= m\*9.81\*Sin(0)

Frictional Coefficient: the ratio of tangential force required to move a vehicle on a road surface with its wheels locked.

Mass: Calculate from equation 1.

Drag Force: Drag is a force that moves parallel to and in the same direction as the wind.

Air Density: The most accurate way to determine how many oxygen molecules your engine is using for combustion is through air density.

Cd: The way an automobile moves through the air around it is measured by its drag coefficient.

Frontal Area: A car's frontal area is where it collides with the air directly.

**Torque Calculation**

In this way we can calculate the value of the total force, and put the same value in the Simulink model.

Now with the help of the Total force we can calculate the value of the Motor Power;

Motor Power = (Total Force\*Maximum Speed)/(Efficiency)

Torque at maximum speed= Torque at wheel at maximum speed/ Gear ratio

Torque at maximum speed= Motor power\* Wheel radius/Vehicle Speed

Starting Torque=Max Torque=Max Torque at wheel/ gear ratio

Starting Torque=(Mass\*Acceleration\*Delta + Rolling Forces)\*r/ig

**Choosing a Motor**

In the automotive industry, electric motors fall into three broad groups: the induction motor, the brushed DC motor, and the brushless DC motor (BLDC). Due to its benefits, such as simple construction, easy direction shift, and speed control, three phase induction motors

are employed in the majority of EVs.

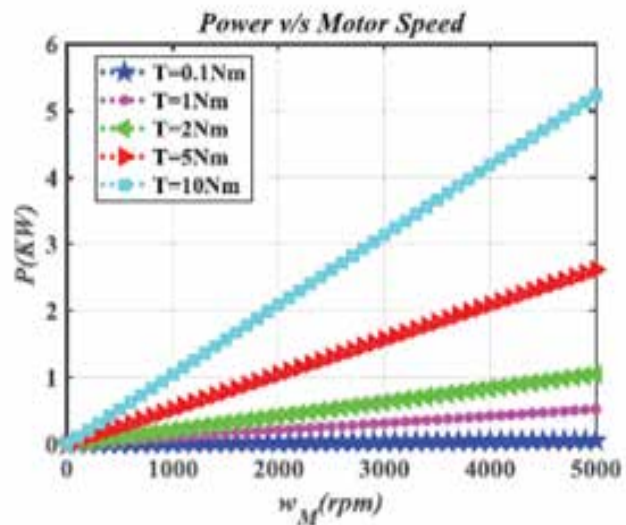
The relation can be used to calculate the torque T(M) that the motor must produce.

$$TW * \omega W = TM * \omega M$$

where the motor torque TM and wheel torque TW are both expressed in Nm.

The wheel's angular velocity  $\omega W$  and the motor's angular velocity  $\omega M$  are both expressed in radians per second.

With the above equation, gearbox efficiency increases to 98% when we account for a loss of about 2%.



The power against motor speed is depicted in this graph.

In order to express  $\omega W$  and  $\omega M$  in rpm

$\omega W$ (rpm)=speed of wheel(miles/hr)/circumference of wheel(m)

**Calculating Motor Power**

F is defined as m\*a, where m is the vehicle's mass and a is its acceleration, and a=dv/dt. The formula  $TM = F*rM$  can be used to get the motor torque.

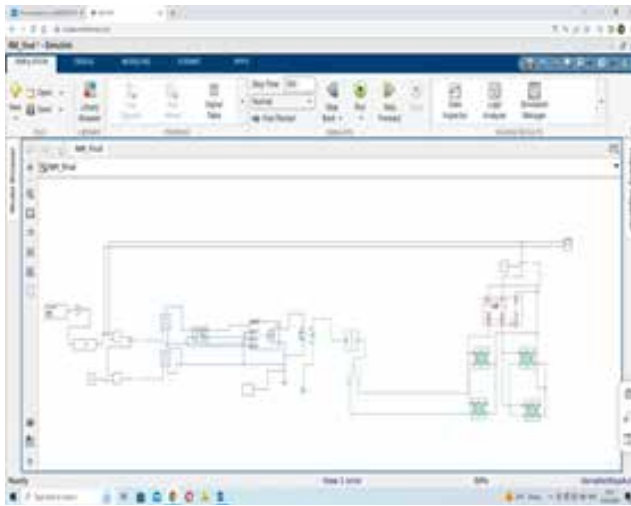
where M is the motor shaft's radius.

$$PM = TM * \omega M$$

where  $\omega M$  is the motor's angular (rotational) frequency. Again, the diameter of the motor shaft would determine this  $\omega M$ .



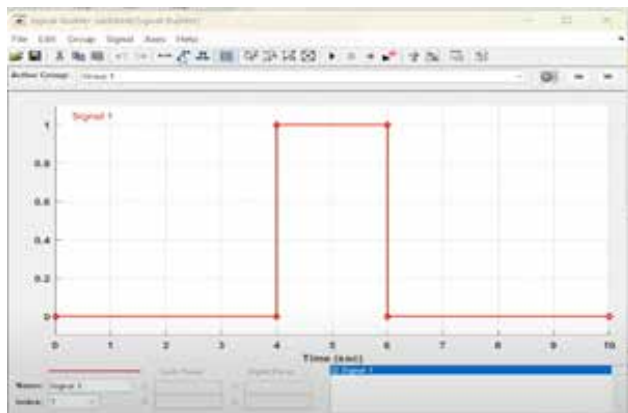
## MODEL FOR AN ELECTRIC VEHICLE IN SIMULATION



**Fig. 2: Model for an electric vehicle in simulation**

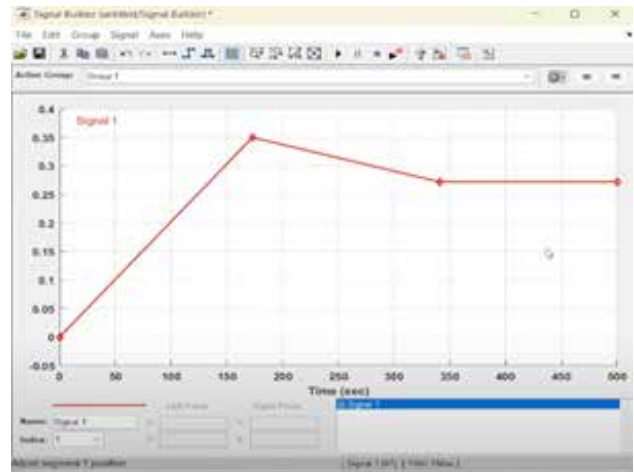
This project is carried out in the MATLAB/Simulink environment. The model includes vehicle body, PS-Simulink, Constant, Tires, Differential, Gear box, DC Motor, Mechanical Rotational Reference, PWM, Controlled PWM voltage, Voltage Sources, Longitudinal Driver, Simulink-PS, Scope, Builder, Gain, Solver. All these blocks were integrated together to form a complete model of the electric vehicle.

## RESULTS



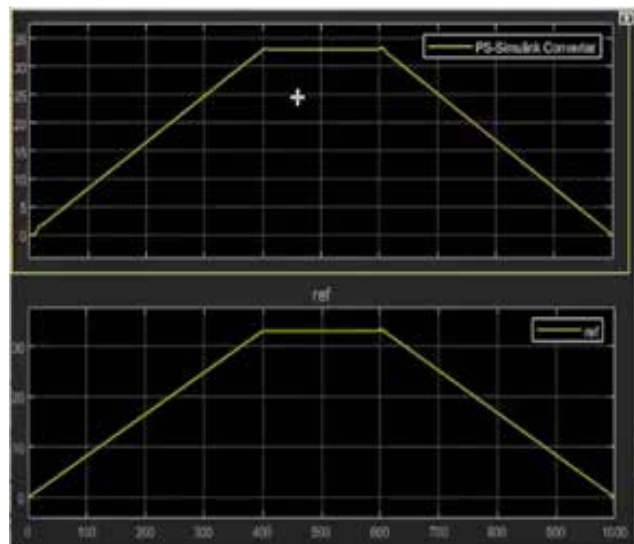
**Fig. 3: Output of the signal builder of the electric vehicle**

Figure 3 explains the output of the signal builder block on MATLAB, the reference speed is shown on the Y-axis, and the X-axis shows the time in seconds.



**Fig. 4: Reference speed of the electric vehicle**

Figure 4 explains the realistic speed graph of an electric vehicle on the road.



**Fig. 5: Result window of electric vehicle**

Figure 5 represents the result window of Simulink. We can see that the reference speed and the actual speed are exactly the same.

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# Implementation of IoT and Blockchain Technology in Supply Chain Management: A Review

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## ABSTRACT

In an era of industry 4.0, many companies adopted automation to improve the level of Supply Chain Management (SCM) processes and procedures. It has become difficult for SCM companies to manage their different products as companies are expanding their businesses in different countries which increases the need for implementing automation. Companies observed that after implementing automation the efficiency and precision in SCM processes were improved. Many existing studies showcase the impact of the implementation of automation in SCM. But there are not many readings that emphasize on the implementation of the combination of IoT and Blockchain technology in SCM. So, for this study, many case studies and many research papers were considered and based on that a review on the influence of the implementation of Internet of Things (IoT) and Blockchain technology in SCM was written. It was observed that there was an optimistic influence on the sales and profit of various businesses after implementing automation in SCM processes. This study shall help many professionals to get a deep understanding of the advantages, applications and ways of implementing IoT and Blockchain technology in SCM.

**KEYWORDS:** *Automation, Blockchain Technology, IOT, Supply chain management*

## INTRODUCTION

In the last few years technology has grown immensely in the production and manufacturing of goods. Also due to the rise in adaptation of e-commerce in businesses, there is a huge need of implementing automation in SCM [1, 2, 3]. Organizations now a days are ceaselessly hoping to extend their market-share topographically to draw in new clients [4, 5, 6]. There are many problems to expand businesses in different countries. Companies should have a strong supply chain to tackle problems regarding the expansion of business. IoT and Blockchain technology can be a great solution for many problems [7]. IoT is one of the effective tools for SCM. It can be used effectively to monitor products and shipments using technology [8, 9, 10]. IoT can assist with conquering the current limits of constant information capture and sharing. IoT is a web empowered worldwide clever stage that works with things-to-human, human-to-machine, and machine-to-

machine data trade in heterogeneous conditions [11, 12, 13]. Another best and most hype tool is Blockchain technology. Blockchain technology can improve quality management, can reduce illegal counterfeiting, it can enhance product security and safety, can reduce logistics and supply chain transactions, etc. [14, 15]. SCM companies have huge data on the internet. There is always a threat of hacking valuable data. Blockchain technology can solve this problem by making data decentralised [16, 17, 18].

In traditional SCM, there is no detectability and responsibility. The cost of products can be falsely created. Blockchain technology can help the production network industry to keep sealed records and can monitor items without a middle person [19, 20, 21]. Blockchain technology has many advantages to offer to SCM but there are not many studies yet [22, 23]. After surveying many studies, it was obvious that combining Blockchain technology with IoT is a moderately new theme where

a large portion of the directed investigations was dated as it were a couple of years back featuring the way that Blockchain technology as an arising innovation is yet to be additionally investigated [24, 25, 26]. The combination of Blockchain technology with IoT will assist with tending to a portion of the security issues in IoT [27, 28, 29]. There is a need to give safe and trusted information to understand the smooth, exact and intermediary free progression of data to integrate Blockchain technology and IoT in SCM [30, 31, 32].

There is by all accounts an absence of clearness about the particular capability of the technology, with obstructions to its fruitful execution continuing in the industry [33, 34, 35]. Improvements are in advance to incorporate Blockchain technology with IoT arrangements, prompting novel constructions of current supply chains, new organizations, just as better approaches for cooperation and worth creation across supply organizations [36]. This paper intends to fulfil the gap of information as IoT and Blockchain technology are the future technologies in automation that can enhance the efficiency in processes of SCM. In this paper, we tried to explain the integration of IoT and Blockchain technology in SCM. Implementation, advantages and challenges of integrating IoT and Blockchain technology in SCM are discussed in this study.

## METHODOLOGY

As the supply chain is moving at a high speed towards technology and automation, and there is not much research on integrating Blockchain technology and IoT in the supply chain field, it was decided to consider this topic for research. The research questions and their importance of them are listed below in Table 1. Resilience is the way to be considered for the supply chain to deal with future weaknesses. IoT is an evolving technology that has tremendous scope to empower organisations to actively handle supply chain resilience [11]. To implement real-time Global Positioning System (GPS) position tracking of transport fleets as well as a Radio Frequency Identification (RFID) based shipment tracking at the entry and exit point of the warehouse system architecture and implementation of the same using Arduino and SIM808 based GPS position tracking system for constrained power application was proposed [12].

The capability of Blockchain technology can be utilized to intrude on supply chain activities for further developed execution, conveyed administration, and cycle automation [13]. It was identified Blockchain technology as the latest solution to the problem of achieving end-to-end transparency in supply chains [14]. The application of academic theories concluded that the combination of Blockchain technology with IoT can generate new opportunities to enhance supply chain integrity and improve operational performance [15].

**Table 1. Importance of Research Questions**

Research Questions	Importance
What is IoT?	It will assist with discovering the benefits and faults of IoT while utilizing in SCM.
How IoT is used in SCM?	It will help to find out applications of IoT in SCM.
What is Blockchain technology?	It will assist with discovering the benefits and faults of Blockchain technology while utilizing SCM.
How Blockchain technology is used in SCM?	It will help to find out applications of Blockchain technology in SCM.
Why should we combine IoT and Blockchain technology in SCM?	It will help to find out the advantages, limitations and applications of implementing the fusion of IoT and Blockchain technology in SCM.

## IOT IN SCM

IoT is the third rush of data technology, which has incited different new and incredible freedoms. It additionally incited changes to SCM and an assortment of businesses [16]. IoT helps the augmentation of the capacity of the supply chain. IoT provides technical support for enhancing visualisation. It also provides stability of supply change. It has to realise intelligent management of supply change.

One of the primary objectives of IoT is to further develop human insight capacity and keen handling capacity. It gives the association of different articles whenever and any spot and the status it relates data

of any item whatsoever time and any area [17]. Fig. 1 focuses on the advantages of using IoT in SCM. The IoT is a comprehensively accessible technology and broadly used to perform assorted jobs in SCM. It incorporates connecting data with merchants, assembling ongoing advancement information from sellers. It gives reflectivity on parts and unrefined substances, producing constant quality/support information stock following data sharing and joint requesting. It gives quality checking and quality controlled logistics. It upgraded turn around logistics and seizing item information which is utilized to create functional efficiencies and limit invert openings.



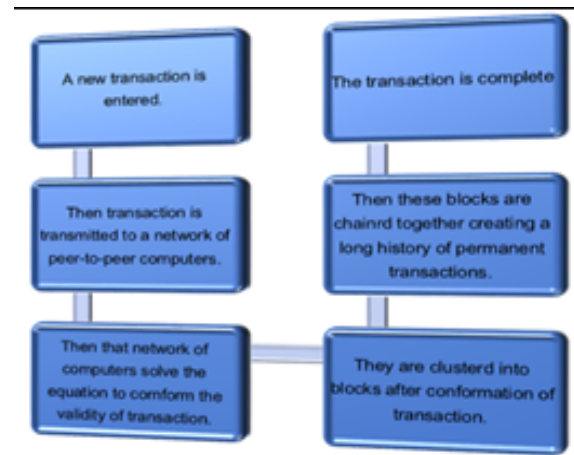
**Fig. 1. Positive effects of IoT in SCM**

Sensor advances turning out to be progressively omnipresent in vehicles, empowering continuous association between the vehicle and its current circumstance and adding to quicker velocities and vehicle platooning to decrease venture time and increment the existing foundation limit [18]. Accessibility and breaking down of IoT for continuous information eventually permit partners to settle on better functional choices and improve vital results for the supply chain.

## BLOCKCHAIN TECHNOLOGY IN SCM

After Blockchain technology was invented by Satoshi Nakamoto in 2008. Blockchain technology is a decentralized technology, which means transactions and exchanges can take place without any centralized system chain [19]. The three main characteristics of Blockchain technology are decentralization, transparency and immutability. In Blockchain technology, encrypted data is stored in blocks. These blocks are confirmed by a group of people called minors. Minors are the specific nodes that affirmed the exchanges which are finished

by senders. Then verified blocks add to the chain [20]. Fig. 2 shows the working of Blockchain technology. The key aim of Blockchain technology is to solve the problem of exposure of the data of business operations and critical information.



**Fig. 2. Working of Blockchain Technology.**

Many industries are adopting Blockchain technology and are getting positive results. Similarly, the supply chain industry has a great opportunity to use Blockchain technology. Blockchain technology can have encrypted records of possessions of belongings, agreements and activity logs. This works on the discernibility of data, money, and cycle streams, and subsequently gives ideal tracking of items and administrations [21]. In earlier supply chains many physical contracts were made for supply chain operations but due to Blockchain technology, smart contracts are possible. It is useful to work with coordinated effort with multilateral individuals in the supply chain. It additionally gives straightforwardness and automates the interaction. Smart contracts are computer codes that can communicate with each other. There are many other aspects of Blockchain technology that are beneficial for the supply chain [22].

## COMBINING IOT WITH BLOCKCHAIN TECHNOLOGY IN SCM

In the following paragraphs, we discussed the applications and benefits of using IoT and Blockchain technology in SCM. We can get more benefits by combining IoT and Blockchain technology. The significant difficulties faced by the supply chain is related to data sharing and trust. With the assistance of Blockchain technology, we can



get decentralized structure and improved security and trust. Therefore, Blockchain technology is thought of for IoT. By combining IoT and Blockchain technology in the supply chain we can get immediate and accurate information about valuable things like the quality of goods, the performance of machines and workers and availability of products [23]. Another advantage of combining such technologies is that the company can know the adequate progression of safe items to the last buyers.

Moreover, Blockchain technology empowered IoT applications are developing critical characteristics of IoT. Corresponding to this methodology, Blockchain technology is reproducing cloud computing technology which will naturally help in the advancement of IoT technology and which will straightforwardly further develop supply chain operations. Most important, the fusion of IoT and Blockchain technology gives a solid framework for developing supply chain information administration and for arranging legal data [24]. As IoT and Blockchain technology is developing, there is a high chance that most of the supply chain operations and processes will be automated in the coming years.

## DISCUSSION

In recent years, IoT has become a major part of SCM. By using IoT in SCM, the visualization and transparency have been improved [25]. Whereas, Blockchain technology is a booming technology and has great potential in SCM. Blockchain technology can increase the efficiency of IoT devices [26]. The merging of two technologies enables physical assets to become digital and enhance security [27].

Blockchain technology and IoT together can be used by SCM companies to improve the security of their product [28]. According to the information, Blockchain technology and IoT can automate supply chain processes and reduce the labour work which will be beneficial for companies to reduce cost and human errors [29]. Managers need to understand the opportunities while working with Blockchain technology and IoT and also need to find out the ways to deal with new challenges [30]. The fusion of these technologies can help supply chain specialists to handle and analyse data which can result in accurate decision making [31].

The integration of Blockchain technology and IoT shows a promising future in developing SCM operations and processes. It's important to face challenges and implement such booming technologies to grow businesses. There is a huge scope of further research on this topic as it is the future of SCM.

## CONCLUSION

IoT is gaining massive attention from an extensive range of initiatives to expand performance, reputation and hence gain more clients and profit [32]. Involving Blockchain technology in Industry 4.0 offers huge opportunities and serves as an intelligent platform [33]. IoT organization puts Blockchain technology at the front of managing growing amounts of data that require high scalability privacy and scalability issues [34]. In this paper, we learned the applications and advantages of using IoT and Blockchain technology in SCM. By combining IoT and Blockchain technology in the supply chain we can get immediate and accurate information about valuable things like the quality of goods, the performance of machines and workers and availability of products [35].

Blockchain technology and IoT as technology are developing and becoming together. They are mutually dependent on one another and stands the greatest changes of advancement with both being together. IoT frantically needs the Blockchain technology's elements as it gets security, immutability and savvy contracts while Blockchain technology requires IoT to channelize the feed of information to change over each viewpoint as a major time opportunity for the production network to turn out to be more successful [36]. IoT and Blockchain technology combination will alter the production network in the manner the partners interact today. The mix will enhance items, summon trust among accomplices, decrease production network cost, further develop process efficiency, avoid data voids and enable clients.

This paper will help companies that are looking to take advantage of Blockchain technology and IoT in SCM operations and processes. This study also highlights the significance of integrating Blockchain technology and IoT. As with other many studies, this study also has some limitations. The major part of this paper focuses

only on the advantages of integrating Blockchain technology and IoT in SCM. So, further studies can also focus on the disadvantages or challenges of integrating Blockchain technology and IoT in SCM.

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# Development Techniques for Energy Efficient Electric Motors – A Review

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## ABSTRACT

This paper focuses on exploring various strategies for improving the efficiency of electric motors. The paper acknowledges that electric motors are widely used for converting electrical energy into mechanical work, and induction motors remain the most popular choice due to their versatility and affordability. However, the paper points out that standard electric motors often suffer from low efficiency, consuming more energy than they produce. To address this issue, the paper reviews different techniques for reducing energy losses in electric motors, such as optimizing the design, reducing the weight of components, improving the materials used, and adopting advanced control strategies. By implementing these techniques, the paper argues that electric motors can become more energy-efficient, resulting in significant benefits for the environment and economy. Overall, this research paper provides a comprehensive review of the development techniques that can be used to improve the efficiency of electric motors, contributing to the ongoing efforts to promote sustainable energy practices.

**KEYWORDS:** *Electric motor, Induction motor, Strategies, Efficiency*

## INTRODUCTION

Energy is an integral to our (human) existence. However, this energy comes at the cost of nature. Major portion of today's energy is produced by burning nonrenewable natural resources like coal, petrol or other fossil fuels. Unfortunately, these resources are at the verge of extinction. Hence, there is a need of conserving energy and it is our responsibility to use the remaining energy wisely. Industries are known for their heavy consumption of electricity and hence the need to conserve energy in the industrial sector has been a major concern in our society. [1] Increasing the efficiency of Standard Electric Motors (SEM) has been a major subject of research and will greatly affect the energy consumption throughout the world. Electric motors consume about 65-70% of the total energy supplied to the industries. Hence, they are often

referred as the 'prime mover' of the industries. As a result, researches are being carried out to increase their efficiency with the intent that even if we succeed to save 1-2% of energy per motor; it would result in remarkable amount of energy saving on a larger scale. Hence, the International Electrotechnical Commission (IEC) has categorized motors based on their efficiencies, called the International Energy (IE) Efficiency Classifications to serve the purpose [2]. These go on from IE1 up to IE4 based on prevailing efficiencies [2], [3], [4]. There has been talk of IE5, [2], [5], IE6 and IE7 also. In some countries like the USA, the use of IE3 efficiency motors is obligatory and the use of any other motor with lower efficiency is prohibited. China and EU have also acted similarly and made mandatory, the use of IE-3 efficiency for 75kW-375kW machines in some applications from early 2015 and for lower power up to 750W from the early 2017 [2]. Energy Efficient Motors are just a

modified version of Standard Electric Motors that give us the same output shaft power by consuming less amount of energy than the older ones. The International Electrotechnical Commission (IEC) has classified motors into four efficiency classes: Standard Efficiency (IE1), High Efficiency (IE2), Premium Efficiency (IE3) and Super Premium Efficiency (IE4) [6]. Efficiency of an electric motor can be defined as the ratio of output (mechanical power delivered by the motor) to the input (electrical input power supplied to the motor).

Efficiency = (Mechanical Power Output / Electrical Power Input) x 100%.

In Standard Electric Motor, the resistance of stator winding can be reduced if we use more copper wire of larger diameter which reduces power consumption. In addition, eddy current losses here can be reduced by using thinner steel laminations. In Energy Efficient Motors, larger stator used has enormous benefits like decreasing magnetic density. Also due to its large size, a well-ventilated system is produced which helps us to maintain optimum temperature helping our motor to perform its best. This helps us to reduce power required to drive the fan as well. Besides, the power lost in hysteresis losses are covered if we use premium grade steel core. Also, the stator design we modified earlier helps to reduce magnetic losses and further helps make space for larger diameter wire. The rotor resistance losses can be reduced by using larger conductive bars and end rings than we used in the conventional motors.

## IMPORTANCE OF ENERGY EFFICIENCY IN THE INDUSTRY

In a current world scenario we are facing many challenges due to ever increasing population and their demands. Year by year increase in population and the industrialisation of countries to fulfill the demands energy need also rising. According to statistical study, from 2010 to 2030 it is predicted that the energy consumption can be rise upto 33%. Due to the hike in the need of global energy, stocks or sources of oil and gas including other industries also coming to an end. Development in industrial sector results in growing requirement of energy globally which directly causes emission of various greenhouse gases such as sulphur dioxide(SO<sub>2</sub>), carbon monoxide(CO), carbon dioxide(CO<sub>2</sub>), Nitrogen oxide(NO<sub>x</sub>), etc. The

emission of these gases adversely affects the climate and which becoming main cause for various natural calamities like temperature rise, drought, flood and also results in the economic chaos. If the same scenario in industrial sector globally continues further the emission of greenhouse gases also increases. To overcome this issue several research has been done and come to conclusion that energy efficient technology can play a key roles and offers a great opportunity in cutting down the energy requirements by utilizing high efficiency and environmental protection with remarkable growth in the global economy as well. During the process challenges can be categorized by stringent regulations, volatile prices and increasing demand of energy. The technique of enhancing industrial energy efficiency results in reducing energy consumption. This also makes impact on minimizing the waste production. Motors and drives plays a big roll and has widespread impact, enhancing the opportunities to save the energy or trimming down energy consumption. Reducing power requirement for the motor upto 50 % is possible using variable speed drive(VSD) on motors which controls the electrical supply. Energy efficiency in industrial sector as well as other sectors is very much important as it not only generates economic savings but also simultaneously reducing the emissions. Considering the global energy system energy efficiency considered as a first fuel to it as it strengthens the idea cheapest and cleanest energy choice of all is not to waste it.

Energy efficiency can be simply defined as, lowering the amount of energy required to perform the work, while achieving number of benefits such as environmental, economic, risk management and utility systems benefits.

**Environmental:** Emission of greenhouse gases and other pollutants can lower by energy efficiency technique as well as the consumption of natural sources like water, coal etc. for energy production will be decreased.

**Economic:** Increased efficiency lowers amount of individual utility bills, help in stabilize electricity prices as well as volatility.

**Utility System Benefits:** Improving energy efficiency can give long-term benefits by lowering overall electricity demand, thus reducing the need to invest in new electricity generation and transmission plants.



**Risk Management:** Energy efficiency also helps to stabilize and face economic problems like fluctuating fuel prices.

- The subscript for the permeability of vacuum  $\mu_0$ , and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".

## ENERGY CONSERVATION IN MOTORS IN DIFFERENT ASPECTS

The most efficient way to save the energy in industry where motors are used is to use the energy efficient motors, with the using of motors with higher IE number it reduces the total motor load and reduce running cost of plant, which lead to energy saving in large amount, which helps industry financially. Along with the using of energy efficient motor there are many different type of energy saving opportunity for existing as well as for new motors.

**Turn motors off:** When motors is not being used then turning off the motor is the largest energy saving opportunity for motors. Though it sounds simple but it effects in large scale. There's a two main perception 1) it increases risk of extra wear and tear at the motor start up and which is actually only applicable for motors started directed on line or with star delta starters. 2) Another perception is the to turn a motor on it always costs a lot of extra energy but, when you turn on the motor there's a very slight energy is used, and amount of that energy is lot smaller than most of the people think about it.

**Appropriate loading of Motor:** The motor works in their most efficient zone when we use it nearly to the full load conditions. The old standard motors are even surprisingly more efficient at the full load than some energy efficient motors which are not working at the appropriate loading. From these we conclude that the who important is the selection of the right motor base on our requirement by making calculation of appropriate loading to maximize the energy saving.

The different methods to calculate load on a motor are:

- 1) Direct Electrical Measurement
- 2) Slip Measurement
- 3) Amperage Readings

Motor Loading= (Actual input power/Input power at rated load)

**Optimization of the Entire System:** Optimization of the Entire System helps to uncover inefficiencies beyond the electrical motor, and enabling the complete system for smooth working with less energy consumption. It includes the use of soft starters to temporarily reduce the load and the torque in the power train of the motor during startup, it mostly used for impact-loading application. Along with that we can also optimize the transmission efficiency. In the industry where motor load is variable or runs at light loads for long periods Intelligent Energy Saving Motor Controllers should be recommended.

**Regular Inspection and Maintenance:** Motors need the regular maintenance and inspection to avoid failure, maximize their lifespan, for smooth working and to maintain a motor's efficiency. Due to the lake of maintenance many factors of the motors get affected due to which lifespan of motor decreases suddenly these affected factors include 1) Blocked ventilation 2) poor power quality 3) Misalignment of shaft 4) Vibration 5) Heat 6) Winding insulation resistance 7) Insufficient lubrication in bearings. So, it concludes that by performing the good maintenance and inspection activity we maximize the life of motors and also improve their performance otherwise if we neglect it affect the industry very badly.

As we mentioned above topics are the main aspects that we must consider or take action on that to improve the efficiency of the system without invest in the energy efficient motors. along with the above-mentioned aspects there are also other many ways to improving the efficiency of systems by Power factor Improvement, Efficient System Design, protect against the electrical overload, keeping motor cool, Monitor the vibration, Protecting against the contamination and by Motor Rewinding. So, by implementing all these different approaches we would get the maximum efficiency in our present working motor.

An energy efficient motor is a motor that use the less electricity, run cooler, provides the high efficiency and smooth working. All these aspects we get through modifying the standard motors to energy efficient motor by improved design, better material, tighter tolerances and improved manufacturing techniques.

## ROTOR MODIFICATIONS

**Rotor Losses:** As we have considered different factors that contribute to decreasing the efficiency of a motor, one of the main concerns which are usually neglected are rotor losses. To reduce these losses, the International Copper Association Shanghai eve ultra-Efficient Efficient Motor, the first ultra-efficient motor international awards, in which they used a cast copper rotor. But the process of making a cast copper rotor was extremely demanding, casting costs were quite expensive than the normally used rotors in the market. [7] Hence, it was discarded. However, to develop a super-efficient motor, a super-efficient rotor is necessary. Following is a detailed study of different factors to reduce rotor losses:

**Minimum Rotor Resistance:** Aluminium is a material with optimum resistivity, but with an Aluminium rotor it is difficult for us to reach a cent per cent efficiency level. Hence a material with lower resistivity is required. It is a well-known fact that copper and silver are metals with lower resistivity than aluminium. Also, to further decrease the resistivity of material researchers thought of cast copper rotors in place of cast aluminium rotors. Yunan Copper and the other four units in public national policy support performed the analysis and obtained the results which are displayed in Table 1.

From table I, if we consider the values of pure copper and cast copper, we can find an approximately 20% difference between the two, i.e., pure copper has less resistivity which can greatly serve our purpose. Similarly, the case with aluminium. Pure aluminium has approximately 40% less resistivity than cast aluminium. Researchers say the main reason behind decreasing the resistivity of copper and aluminium after casting is mainly these cast metals contain impurities, as well as in the smelting process they absorb the gas. Thus, the casting method leads to porosity material organization, increasing the resistivity of materials [7] which thereby decreases their conductivity. Now, as we know the root cause of the malfunction happening, if we succeed in removing the impurities and the gas, we can prevent the resistivity of cast materials from rising.

Apart from these, other problems arise during actually performing these operations such as during re-melting of aluminium, impurities can easily mix with it

reducing the purity of the material. Also, it can easily inhale hydrogen causing again aluminium tissue to lose thereby increasing its resistivity. Another problem that arises during the smelting process is the formation of aluminium oxide ( $Al_2O_3$ ) which cannot be removed either, thereby again increasing the resistivity. Therefore, if we are careful enough to prevent all the above-mentioned problems from occurring, we can considerably reduce the rotor's resistivity, leading to an increase in the efficiency of the motor and saving massive amounts of energy from a larger perspective.

**Table 1. Material and Resisitvity**

Material	Resistivity ( $\Omega m$ )
Pure Copper	$0.01724 \times 10^{-6}$
Cast Copper	$0.0216 \times 10^{-6}$
Pure Aluminium	$0.02736 \times 10^{-6}$
Cast Aluminium	$0.0457 \times 10^{-6}$

Techniques to Avoid the Above-Mentioned Errors:

1. **Method to Remove Molten Aluminium Impurities:** In metallurgy, it is a well-known fact that Boron at high temperature reacts with aluminium to form  $AlB_2$ . Also, it reacts with various other elements such as Si, Cu, Fe, Ti, V, Mn which are usually present as impurities with aluminium to form various other compounds like  $B_6Si$ ,  $CuB_{22}$ ,  $FeB$ ,  $TiB_2$ ,  $VB_2$  and  $MnB_2$  respectively. The compounds formed by Boron with the impurities have high specific gravities than those formed with aluminium. Hence, the impurities can be separated from the boron-aluminium compound.
2. **Use of Tempering heat Preservation:** By using this technique if the casting of the rotor is completed, there is utilization of waste heat insulation tempering, which is beneficial for the grain growth, helps in eliminating defects and can help considerably reduce resistivity [7].

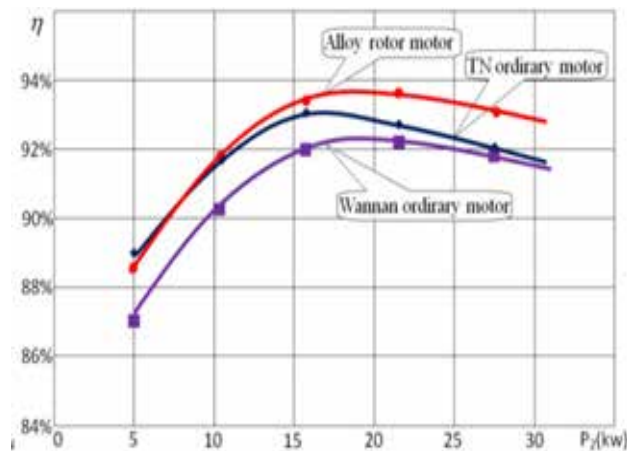
Therefore, as per the analysis, if we can cope with the mistakes mentioned above, i.e., if we use boron to keep the aluminium as pure as possible, use inert gases to avoid inhalation of hydrogen and use proper techniques

like tempering to eliminate casting defects, it results in a material with considerably low resistivity. As a result, experiments were conducted on samples of rotors manufactured using the process discussed earlier and the results obtained are as follows:

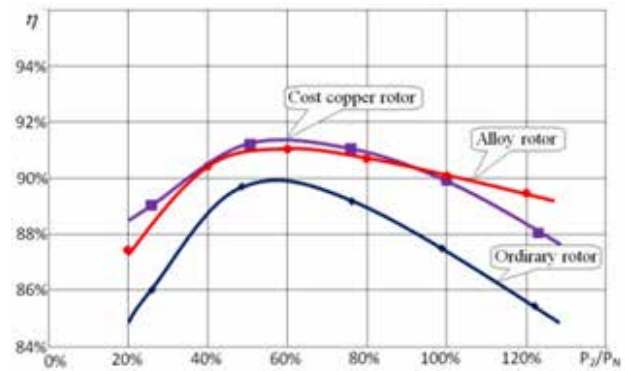
**Table 2. Resistance Values of Different Samples of Common Aluminium and Boron Aluminium Alloy Rotors [7]**

Sample No	Ordinary smelting	Boron Addition process	Length (nm)	Diameter (nm)	Resistance (pΩ)
1	y		97	10	41
2	y		97	10	40
3		y	97	10	34
4		y	97	10	33

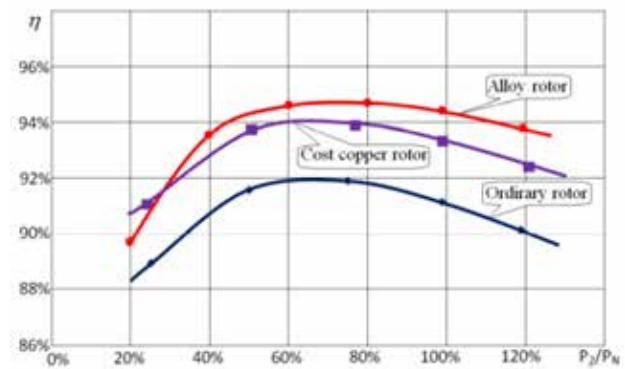
As it is clear from the table (Table 2), two samples from each material were studied during the experiment. However, the boron aluminium alloy rotor was found to have significantly lower resistance than the cast aluminium rotors. The average resistivity value for an ordinary cast aluminium rotor is 40.5 μΩ whereas that of a boron aluminium alloy rotor is 33.5 μΩ that is 17.284% less than the conventional rotors. Hence, from the results, it can be seen that the process can considerably reduce the rotor resistance. As a result, this low resistivity boron aluminium rotor can be used to produce a motor with much higher efficiency. Some graphs of efficiency comparison are shown below:



**Fig. 1. Load vs efficiency of 11kW motor**



**Fig. 2: Load vs efficiency of 11kW motor**



**Fig. 3. Load vs efficiency of 37kW motor**

### STATOR MODIFICATIONS TO IMPROVE ENERGY EFFICIENCY

To improve energy efficiency and the overall performance of motors following modifications can be implemented:

**Using Copper Windings in Stator Coils:** In order to improve the efficiency, it is always better to use copper windings instead of aluminium, as aluminium have low conductivity than the copper coils. To attain same results as that of copper, aluminium magnet wires need to have larger cross-sectional area so that they can provide same magnitude conductivity. Therefore, using aluminium coils for windings would may have greater volume than copper wire of same size and same conductivity level.

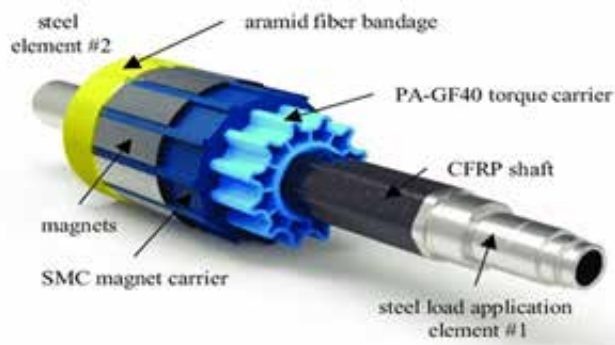
**Using High-quality Steel for Stators:** To increase energy efficiency of a motor high quality and high-tech steel is required for building economical and better performance Stators that used in large electric motor

applications. Application of this type of steel results in high magnetic permeability and low power losses ensuring top-notch performance.

Using Multi Strand coils In Stator: To enhance the efficiency implementation of multi-strand with multi-turn coils in stator windings is essential. The benefit of using multi-strand with multi turn coils is that it will indirectly increase the surface area of conductors in a slot. Due to this, the presence of active material increases resulting in improving efficiency.

## MATERIAL SELECTION AND DESIGN MODIFICATION

**Lightweight materials:** The use of lightweight materials for electric motor components can help improve their efficiency. Aside from reducing the weight, these materials can also improve the mechanical and electrical properties of the machines. Feature electrical and corrosion resistance know these materials. They can also be molded into various forms, such as plastic components. Due to their wide applications, they are mainly used in the automobile industry. In a study, Koch et al. proposed two different methods to produce lightweight electric rotors. The first involves the use of dry filament winding, while the second involves the use of centrifugal casting.



**Fig. 4. Design of a lightweight permanent magnet rotor [8]**

In the second method soft magnetic compounds (a compound polyamide compound metal, SMC) are used instead of electric sheets. The injection molding process is used to produce these components. The prototype is designed for hybrid shaft assembly using SMC. The development of a non-permanent magnetic rotor is shown in Figure 4. The project partners of Fraunhofer

et al. build engines and houses using polymers and heat dissipated near the source. Polymer houses are lighter and lighter compared to aluminum houses. As Near-net-shape products are made, it results in weight loss and cost savings.

In copyright [9], Donner et al. use heat-efficient, lightweight FRP for powerhouses [9]. This project gives electric motors a new housing system. The steel-frame housing is made using CFRP (Carbon fiber reinforced polymer) to improve thermal flexibility throughout the thickness that prevents liquid cooling jackets. Therefore, heat dissipation houses are made with this novel technology. Properly designed, the use of Fiber Reinforced Plastics (FRP) enables high durability, improved material damping properties and high tolerance at low weights [9].

**Magnetic materials:** The main advantage of using SMC materials is the low cost and environmentally friendly production processes; rarely minimal material waste due to powdered metal techniques, which are 50% more efficient than conventional production processes.



**Fig. 5. The stator of a synchronous electric motor is made of (a) laminated silicon iron sheets, (b) soft magnetic compounds [9]**

Today in many electric vehicles Neodymium Iron Boron (NdFeB) is used, which offers benefits such as small size, high efficiency, high torque but expensive. Figure 4, 5, 6 illustrates the comparison of three different technologies for the development of electric motors. Voluntary alternatives and cheaper ferrites can replace NdFeB metals in the future, as they are cheaper and more stable.



Voluntary alternatives and cheaper ferrites can replace NdFeB metals in the future, as they are cheaper and more stable. After the neodymium magnets (the strongest magnetic field) began to be used small coil sizes were reached. Figure 3. Shows 5HP motor size comparisons.



Fig. 6. Comparison of original 5-HP motor, current production model and new prototype [10]

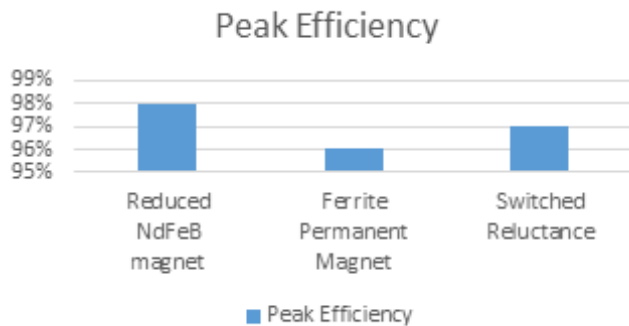


Fig. 7. Comparison of peak efficiency

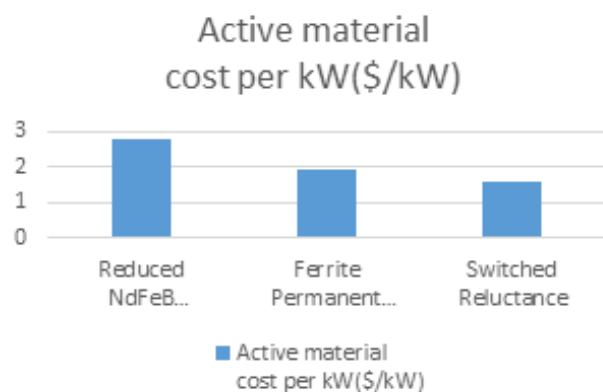


Fig. 8. Comparison of Active material cost per KW

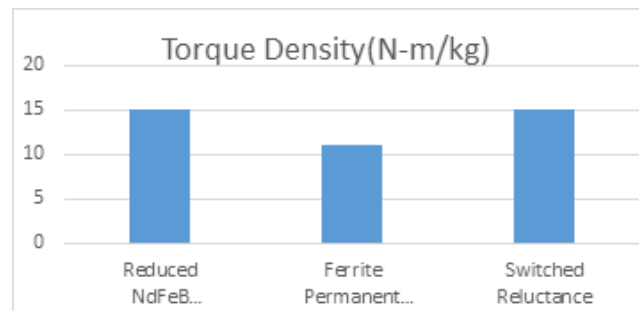


Fig. 9. Comparison of Torque Density (N-m/Kg)

### CONCLUSION

In near future, electric motors will be a great demand in different sectors due to their high efficiencies and low maintenance. To improve this technology further, we need to focus on improving the efficiencies of the electric motors and in turn, increasing energy conservation. With the help of these developments, we will be able to provide a very reliable alternative for current technologies and a strong foundation for energy-efficient electric motors.

With the methods suggested in this paper, we will be able to develop electric motors with higher efficiencies and higher torque densities.

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# Android Based Smart Notice Board

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## ABSTRACT

Traditional notice boards are very common in the modern world and are being used at many different places, such as railway stations, schools, colleges, and offices. However, they have not been upgraded ever since their invention. Notice boards in schools and colleges amount to a heavy wastage of paper. Managing existing notice boards is a manual and very time-consuming process. A few common problems associated with handling traditional notice boards, such as printing documents and then physically going to the location of the boards to change notices manually, as well as with every new notice, paper pins and clips have to be organized.

In this project, we introduced a new concept of digitization of traditional notice board system. With this system we can display notices in the form of sliding images on the smart television.

**KEYWORDS:** *Smart TV; Android application; Cloud storage; Real time database*

## INTRODUCTION

Digitization has been made in many fields with the developing technologies. In this context, we have introduced digitization of notice board system under the title of “Android Based Smart Notice Board” we prepared a system with the help of which we can display notices using smart television. We have developed an android application for sending notices to the television by the medium of firebase cloud storage. This system comprises an mobile application for sending/deleting the notices from the cloud, another android application for television which is required to fetch data from the cloud storage and display it in the sliding image form.

With the help of this model we can digitize the notice board systems at Schools, Colleges, Railway stations, Bus stops etc. Using this model we can address any issue digitally, from any location. We can digitize the whole notice system and bring about a change in society for the better. This notice system does not demand any special or personal attention since you can keep track of notices being displayed on TV with the help of your

smart phone, thereby requiring less human effort. And it's eco-friendly since there is no usage and wastage of paper.

## LITERATURE REVIEW

With the development of technology, the digital notice board system has gained greater importance. These systems are used in different social areas with many different functions, so studies in this area are increasing day by day. In a research paper published in 2017 titled “A novel approach:cloud-based real-time electronic notice board” the researchers have designed a model based on cloud storage database which displays the text message on an electronic display board. The main drawback of this model was that it requires the viewer to be very close to the board, it does not show any image or pdf notices.

In 2016 at 5th International Conference on Reliability, Infocom Technologies and Optimization (ICRITO) a research paper published under the title “Development of Simple and Low Cost Android Based Wireless Notice Board” that discusses about the development of a simple and low cost wireless Android based notice

board. The system uses either Bluetooth or Wi-Fi based wireless serial data communication in displaying messages on a remote digital notice board. Android based Application programs available for Bluetooth and Wi-Fi communication for personal digital assistant (PDA) devices are used for transmitting the alphanumeric text messages. The measure problem with this system is it does not displays the pdfs or images. This system requires more hardware setup and can collapse if error occur in any of the hardware devises.

In a research published in 2020 by Ceren Yasa under the title “Interactive Digital Notice Board”. In that, the concept of an interactive digital notice board is discussed along with the use of digital signage. Digital signage devices, which often function as marketing or advertising tools, are media playback devices with a microprocessor and a display panel. The main drawback of this system is, it is not cost effective and it requires the signage device to be installed.

## METHODOLOGY OF IMPLEMENTATION

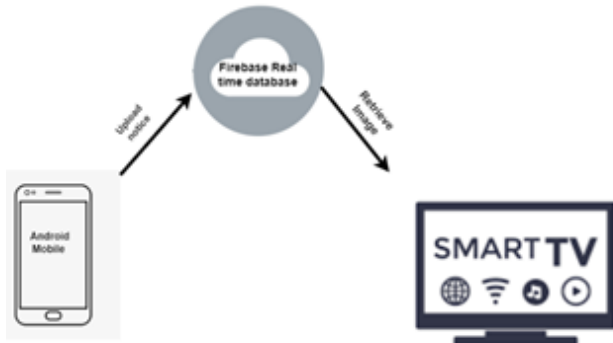
1. Designing and developing android application to upload notices to the firebase storage database. To make traditional notice board system smart it has to be advanced and economically feasible to make that possible we have designed an android application, which can be used to send notices to firebase database.
  1. The first step is to design a log in page, this will allow only selected people to have authorization to manipulate the notices. We used android studio software to design this application, and connected it to the firebase cloud database that will store the information of users log and allow only the authorized people.
  2. Once the user is logged in he/she can then choose the image,document from their smartphones and add comment then upload it to the cloud database, once the notice is uploaded it will be automatically fetched and displayed on a smart TV. We can manipulate the number of images that should be displayed on the smart TV by deleting the images or adding the images.
  3. The fetched notices will be displayed continuously
- in a loop. We can choose the time duration for which single image/notice can remain static on a display.

## Requirements

1. A smartphone is a mobile computer that integrates computing and cellular functions into a single device. They differ from feature phones in that they have more advanced hardware capabilities and robust mobile operating systems. As a result, in addition to the phone at its core, a greater choice of software, internet (including web browsing through mobile broadband), and multimedia features are made possible. The notices must be sent through smart phone, which also allows for their assessment and modification at any time and from any location. You are not need to be present at the location where the screen is set up for this system.
2. Smart TVs, sometimes referred to as Connected TVs (CTVs), are regular televisions that have an Internet connection built in with interactive Web 2.0 features that let users play video and audio content, browse the web, and view images. A computer, television, and digital media player are all combined together to create a smart TV. In addition to the conventional functionality of television transmitted by traditional broadcast media, these electronic gadgets can offer usage of extravagant media offerings, such as live TV and online radio stations, and connection to household networks. It serves as the primary component of this system and is where the notices are shown.
3. The Android application can be built with Android Studio’s IDE (Integrated Development Environment), which requires knowledge of the Java programming language.
4. XML (Extensible Markup Language) for defining the user interface layout and design.
5. Android SDK (Software Development Kit) for accessing the device hardware features and APIs (Application Programming Interfaces)
6. Having good internet connection is a must since the system uses web-based content management system for managing the data (e.g., adding, editing,

and deleting notices such as images, text and videos) on the remote server.

- Images must be stored and retrieved using Google Firebase, which requires a paid or free subscription. Based on the subscription package bought, this system's restricted cloud storage for users is provided by Firebase cloud services.



**FUTURE SCOPE**

This document proposes technical advances for the bullet board. By doing this, people, students, and a large audience can easily access knowledge while saving both resources and time. The system is simple, inexpensive, easy to use, and allows immediate interaction with the intended user. The system has a wide range of uses, including scoreboards for sports, display board for banks, restaurants, hospitals, and schools. We can modify the system to send the notifications to all the students or intended people about the notice and/or we can send the notices directly to the students. The following are some potential directions for this system's development:

**1. Compatibility with IoT devices**

Integrating Internet of Things (IoT) devices into the Android-based Digital Smart Notice Board system is one potential future improvement. For instance, the system might incorporate motion, light, or temperature and humidity sensors. As a result, the system would be able to automatically modify the display's brightness, colour, and content to suit the surrounding environment.

**2. Machine Learning and Artificial Intelligence Applications**

The system could also combine machine learning (ML)

and artificial intelligence (AI) technologies in the future. In doing so, the system would be able to examine user behaviour and preferences and offer tailored content recommendations based on the analysis of the data. Also, based on user feedback, the system might modify its content and display options.

**3. Combining with Augmented Reality (AR) and Virtual Reality (VR).**

The use of AR and VR technologies has the exciting potential to improve the Android-based Digital Smart Notice Board system's user interface. The system might use augmented reality to show 3D animations or models that interact with the real world, for instance. Instead, the system might leverage virtual reality to produce engaging material for users.

Digital Smart Notice Board systems built on Android provide a stable and adaptable platform for real-time information presentation. This system has the ability to grow into an even more effective tool for businesses, organizations, and individuals to interact with their audiences with possibilities for future enhancements and improvements.

**CONCLUSION**

The Android-Based Digital Smart Notice Board is a versatile and useful system that allows users to display real-time notices and messages. In comparison to traditional notice boards, the system has several advantages, including remote access and control and dynamic content display. The use of the Firebase cloud-based database and authentication services ensures secure and dependable notice storage and retrieval. Because the system is compatible with Android phones and Android TV, it is accessible and simple to use for a wide range of users.

**ACKNOWLEDGMENT**

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# Computational Techniques in Renewable Energy

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## ABSTRACT

Renewable energies such as solar and wind are currently in high demand, it is considered one of the fastest growing industry for energy generation. Considering this significant growth in this respective field, there is more energy supply which leads to energy instability. The renewable sectors have often struggled and have their own set of challenges. Sources like wind and solar which are considered to be the leading sources of renewable energy are not in control, unpredictability of weather conditions has always been a problem in renewable energy generation which leads to inconsistent energy generation making it difficult to balance supply and demand which results in upsetting of the chain supply. Unreliable designs of solar farms and wind power plants contribute to lesser outputs. Computational techniques come in to pave way to counter these problems. Artificial Intelligence along with advanced technologies such as deep and machine learning along with advanced neural networks, have showed huge potential to transform the renewable energy sector and address these issues. Artificial intelligence in particular is expected to massively impact efficiencies across renewable sectors by automating its operations. The computational technology has resulted in efficient, reliable and affordable energy generation from these renewable sources. The approach is to maximize its use in the renewable energy fields and produce optimal outputs thereby building confidence in renewable energy generation sectors

**KEYWORDS:** Energy, Sector, Renewable, Computational, Artificial intelligence(AI), Machine learning (ML)

## INTRODUCTION

In the last decades many countries have shifted their focus towards producing renewable energy. Energy generation using these sources has already proved to be less damaging to the environment. It also has numerous benefits which include various advantages such as diversification in energy supply, reducing the effects on climate change, improving energy security as well as economic development. Emphasis of energy generation using renewable sources has increased and along with it complexity has also grown, as we move towards a more electrical powered world additional energy will be generated by decentralized renewable sources. Micro-grids, wind and solar farms along with private solar panels and batteries are great sources of sustainability but over the time they will contribute to difficulties to energy grids across the globe which will result in disturbing the balance. The main problem

faced with renewable energy generation is that they are constantly fluctuating which makes it hard to integrate it in grids. Electrification of heating systems and proliferation of distributed energy sources like wind turbines and solar panels will require proper handling and delicate balancing to actually match the energy supply with demand without collapsing the grid. Moreover the adoption of electric vehicles is growing significantly so it is bound that there will be more electricity requirement in the coming years. AI is helping here to balance millions of assets on the grid, using the AI software results in decentralizing energy sources and sending any surplus electricity produced to the grid while the utilities direct the power to where it is needed. AI helps to deploy the power when energy generation using renewables is inadequate or impossible this makes computational techniques such as AI create a center system. AI makes it possible to shift from a

heavy infrastructure to a one centered system. Key roles of AI include weather forecasting, designing power plants, predicting affects of climate change ,providing assistance to control systems which results in a grid that is more resilient and flexible. Computational technology is already being used ,noteworthy examples include IBM's 'Watt-Sun',it is a machine learning platform that sorts data acquired through a enormous database of weather reports , reduces irregularity of solar energy output which eventually helps in reducing the need for excess energy storage systems. This ML platform has helped in increasing the precision of weather forecasting as it is directly associated to power output by 30%. Another case of AI/ML incorporation includes Siemens-Gamesa and Nvidia , they have developed a digital twin platform that provides high-fidelity simulations of wind farms using physics-informed machine learning. It consists of an implicit model that replicates an anatomic object.

## LITERATURE REVIEW

AI and ML are being incorporated as the computational techniques in the field of renewable energy generation. Software is taking great part in the physical world , AI is replacing the traditional programming for complex volume of data ,gradual evolution in computational sector has been the main reason for AI to perform better and optimize at different target speeds. AI is defined as the science and engineering of making intelligent machines. ML is a subset or a branch of AI which is based on brain-cell reaction , which requires input ,it has set of algorithms and uses examples for generating estimation of patterns for which a error function is used to find the appropriate solution .Renewable energy sectors have been more efficient with the use of AI/ML ,basically computational inclusion in renewables focuses on the idea of giving continuous desired outcomes without the need of being programmed explicitly and focuses on development of computer program that accesses data and leverages it to produce appropriate results .Digitalization of renewable energy systems with AI will make them more connected ,smart,efficient , genuine and sustainable .Overall it can pioneer the way energy is used .It can also help in sustainable development by finding solutions for de-carbonizing energy systems.

## ROLE OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN RENEWABLE ENERGY

AI has influenced almost every market field because of its enormous benefits. A system wide approach is generated when AI is used in the field of renewable energy generation .

AI helps in renewable energy system ,starting from design to policy making.

**Below are some ways through which AI is incorporated into the renewable energy sector:**

**Smart control centers :** AI particularly helps to construct smart control centers,the energy grid in renewable energy has the capacity to generate specific data, and when it is incorporated with AI the data can provide new insights to grid operators for controlling the operations smoothly, which allows energy suppliers to adjust the source as per supply and demand.

**Integrated Micro-grids:** It becomes quite hard to balance the energy stream when the community zone renewable energy generators are combined with the foremost grid,AI helps in this particular space by aiding the controlled systems powered by AI to solve the issues related to quality and congestion.

**Improved reliability and assurance:** It helps to understand the patterns by which the energy is being consumed and identify energy drainage and the well-being of grids,it contributes to preventing the actions in a timely and smooth manner.

**Market expansion :** The inclusion of AI can help renewable energy suppliers broaden their market by bringing in new service models that encourage more active participation and higher assistance.

**Build intelligent storage units:** AI can be unified with Intelligent Storage Units(IES) to develop sustainable and reliable solutions which help in smart power storage and distribution.

**Some direct applications of AI in renewable sector include**

- 1) Predicting wind turbine power generation
- 2) Stabilizing power grid by detecting irregular consumption, energy generation and transmission.

- 3) Weather forecasting for solar energy generation.
- 4) Designing, controlling and monitoring Renewable energy models.

AI at different stages of Renewable energy systems

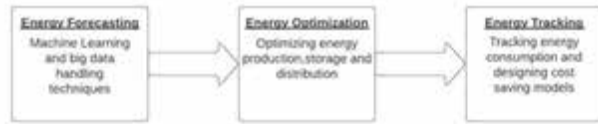


Fig. 1: AI used in varied stages in renewable energy systems

AI provides smarter solutions for energy storage. The objective of producing energy from renewable sources is to ensure safe future along with generation of clean energy, if AI is inculcated with this it can lead to an efficient and modern grid. STEM. Inc is a San Francisco based firm it is AI driven and uses a software ATHENA which designs products that assess grid’s local capacity and sends energy when needed rapidly, it also predicts the availability of energy and customer need and then efficiently shifts the system into a balanced mode. The costs of renewable producers reduce with this and the scales continue to rise. Machine learning applications are a subset of AI, where algorithms learn to identify patterns with minimum human intervention. Prediction of energy consumption, resolving potential issues related to equipment are some of the key tasks performed using ML techniques. In the renewable sector ML techniques are used to determine which area needs more energy at a given time by using algorithms that analyze usage patterns. Deep learning and machine learning techniques are widely used in the renewable energy systems like solar and wind energies. It uses previously collected weather information to assist exact forecasting so that renewable energy suppliers can organize themselves for production of energy generation. ML can be used to improvise energy storehouse, identify appropriate layout and topographical location of solar and wind power plants. ML also plays a key role in maintenance, it can be installed to collect data from sensors from electrical grids to detect variations, forecast collapses and automate functioning. Turbine health can be monitored and maintenance can be scheduled according to parameters with the help of ML which will minimize the wear on turbines.

**Deep Learning(DL) and ML applied in Renewable Energy**



Fig. 2: ML and DL applied in renewable energy systems

**IMPLEMENTATION OF AI IN THE RENEWABLE SECTOR : USING AI TO DESIGN A SOLAR FARM**

**Software Used**

Energy 3D

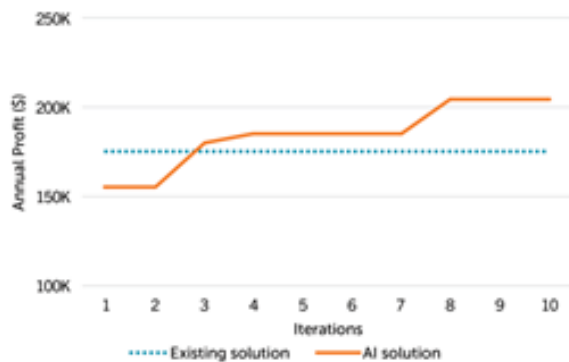
Considering the wide usage of AI in this particular domain, it is very crucial to demonstrate one of its direct applications that impacts the renewable field. For this we will design a solar farm particularly with the help of an AI software known as ‘Energy 3D’. Optimal designing of a solar farm is very necessary for maximum output, but it is very stressful and challenging task. Energy 3D generates a variety of designs as per the required objective.

The application has the following features:

- 1) Artificial intelligence is used to support generative



## RESULTS



**Fig. 6: Results of 10 iterations performed by Energy 3D by design evolution along with better annual profit**

## CONCLUSION

Computational techniques such as AI and ML have potential to transform the renewable energy sectors like wind and solar completely. It will have a huge impact on consumers as well as the energy producing companies. Power companies will have a tool for better designing, management of grids, prediction and most crucial activity like scheduling maintenance to enhance overall performance. Machine learning algorithms help AI systems adapt to environmental and energy demands, improving efficiency.

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# Rapid Anomaly Detection for optimization of Wind Turbine Operating Behavior using ML

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## ABSTRACT

Increasing the economic efficiency of wind farm is necessary to make wind as economic energy source. This can be achieved by reducing operational & maintenance cost. We can reduce the operational & maintenance cost by continuously observing the conditions of turbines. Monitoring system implementing the classification algorithms by using supervisory data and SCADA signals, which are gathered from many wind turbines. In real world, wind turbines have multiple faulty conditions which can be happen one by one and they have some relations between them.

This paper concentrating on producing a methodology to find faults of 25 number of wind turbines by using different classification algorithms in advance on SCADA signals having 2.5 MW power rating, with period of 2.5 years. This data includes wind speed, pitch angle, active power labelled by using downtime data to find normal behavior, faults in wind turbine and varying timescales before occurring a fault. We are using 3 classification algorithms like random forests, decision tree and KNN.

The result of random forest is best amongst these mentioned 3 algorithms.

**KEYWORDS:** *Condition monitoring; Classification algorithm; Wind turbine; Fault detection; SCADA*

## INTRODUCTION

In current situation it is important to increase an efficiency of turbine, efficiency will affect on operating cost, power generation cost [2, 3]. Increase in an efficiency, will reduces payback period of newly installed turbines, thus it makes wind as cleaner source of energy and economic too, also because of increase in efficiency it motivates private organizations, government to investment more in wind projects [2]. Many institutes not looking toward it because of major component failure, [2, 4].

Condition-based monitoring methodology, monitoring wind turbine conditions continuously and it enhances efficiency and lowering the cost of maintenance by 21%-26% [3]. As per data received from the EPRI, reactive maintenance has the highest cost, and after that preventive maintenance has lower than reactive maintenance, which costs 23 % less [6]. Predictive

maintenance avoids catastrophic failure [2] it saves 46 % of reactive maintenance cost [6].

Condition-based monitoring system includes vibration analysis and sensor-based oil, which were used for finding the oil properties like temperature in rotating equipment [7].

These technologies are useful for expensive parts of turbine like gearbox [7]. Alternative for condition-based monitoring system would be SCADA-based analysis, in which only computational cost is involved [3, 5].

A SCADA system, which is used for data acquisition and supervisory control is installed in wind turbines, it collecting data by number of sensors at the controllers with normally 10 minutes of resolution [4, 8] such as bearing temperature, wind velocity, voltage and active power [2]. By using this data, Power curve analysis can

do, but this analysis detects only under performance of wind turbine [9]. So, machine learning algorithms were implemented on SCADA signals. These algorithms are classifying turbines which have normal or anomalous conditions, algorithms are also able to find faults in advance

**LITERATURE REVIEW**

Kusiak and Li [11] done investigation on 4 turbines having 3 months SCADA data for predicting a specific fault. Sampling is done randomly on labelled data to avoid bias formation in machine learning. ANN, SVM, boosting tree, Regression these algorithms are used for classification and 2/3rd of this data was used to train the models. The boosting tree, have an accuracy of 71 % for predicting faults, which is the highest one. This methodology focusses only single fault but in real world, Turbines can have a variety of defects in various components and various structures that they also have normal relationship with each other.

Godwin and Matthews [8] concentrated on defects in the pitch control of wind turbines using a RIPPER classification algorithm. 28 months of data was used having wind pitch angles, and pitch motor torques from 8 wind turbines that had experienced pitch problems in the past. The classes used were potential fault, normal and recognized fault. 4 turbines data were used to train the RIPPER algorithm and same algorithm was tested on remaining 4 turbines data.

This paper was focusing on how to find various faults at different time scales.

**OBJECTIVES**

- 1) To identify underperforming wind turbines by implementing a classification algorithm on wind turbine SCADA signals.
- 2) To create an efficient methodology for the integration of faults.

**METHODOLOGY**

**Tools Used**

The system used to complete the project having following specification's:

Windows-11,	Language -Python Programming Language
Ram-8GB	Python libraries-Pandas, Numpy, Matplotlib. scikit-learn

Processor-i5 10th generation (2.8 GHz)	
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**Dataset:**

Period of dataset-30 months starting 1st Nov 2014	No. of turbines analysed-25
Rated Power-2.5 MW	Format of Dataset-CSV format
Source of Dataset-Natural Power's database.	

Two datasets were used for analysis, the first dataset is of turbine's timestamped SCADA signals with an interval of 10 minutes having file size is 447 MB, second dataset is downtime data for same said period having file size of 3.8 MB.

**Data Processing**

17 fields are recorded on The SCADA signals mentioned in Table 1. Average readings fields are highlighted in yellow and recorded by 10-minute of time span. in machine learning, highlighted fields are used as features. Using wd\_av and ws\_av for wind direction and wind speed, 10 number of features are available for machine learning are wd\_av, ap\_av, reactive\_power, ws\_av, ap\_dev, ap\_max, nac\_pos, gen\_sp, rs\_av, pitch.

**Table 1. SCADA Fields Summary**

Field from SCADA	Description of field	Unit
timestamp	dd/mm/YYYY HH:MM:SS, reading after every 10 minutes	
turbine id	Turbine number (1 to 25)	
ap_av	Active Average power	kW
ap_dev	Active deviation of power	kW
ap_max	Active Maximum power	kW
reactive_power	Reactive power	kVAr
ws 1	Wind velocity measured by nacelle anemometer 1	m/s
ws 2	Wind velocity measured by nacelle anemometer 2	m/s
ws_av	wind speed measured by Anemometer (either ws 1 or ws 2)	m/s
wd 1	Wind direction measured by wind vane 1	°
wd 2	Wind direction measured by wind vane 2	°
gen_sp	Speed of Generator	rpm
rs_av	Speed of Rotor shaft	rpm
nac_pos	Position of Nacelle	°

Table 2 summarizes the fields taken from downtime data. Downtime categories, gives causes of downtime, while the maintenance work was undergoing. SCADA data divided into two classes like 'normal' and 'faulty' for normal behavior & faulty condition respectively. 'Before fault' category is also used. For merging SCADA datasets & downtime dataset, the downtime

dataset is reframed in such a way that it has the same 10-minute interval of SCADA data.

In Table 3 The SCADA data and the downtime data is given which has turbine categories can be merged, that can be used to label faults.

**Table 2. SCADA Fields Summary**

Downtime field	Description
timestamp_start	Start time of event, in the format dd/mm/YYYY HH:MM:SS
timestamp_end	End time of event, in the format dd/mm/YYYY HH:MM:SS
turbine_id	Turbine identifier (1 to 25)
alarm_id	1 to 480, each corresponding to a turbine status
GridCategory_id	(0 to 3); Identifier describes the grid status (e.g., planned outage, unplanned outage, ...)
InfrastructureCategory_id	(0 to 3) Identifier, refers the infrastructure status (e.g., planned outage, unplanned outage, ...)
EnvironmentalCategory_id	(0 to 14) Identifier, refers the operating environment condition (e.g., icing, turbulence, ...)
TurbineCategory_id	(0 to 22) Identifier, refers the turbine's condition or problem (e.g., yaw system, electrical controls, ...)
AvailabilityCategory_id	(0 to 2) Identifier, refers the availability status (e.g., available, not available)
comment	Elaborates the maintenance work undertaken or condition of turbine
workorder_id	Recorded when maintenance work is undertaken

**Table 3. Downtime Data Turbine Categories in The**

Turbine categories							
Id No.	Name	Id No.	Name	Id No.	Name	Id No.	Name
0	Unknown	6	Yaw system	12	Customer stop	18	Rotor blades
1	OK	7	Generator	13	Unlogged manual stop	19	Cable unwinds
2	Rotor brake	8	Hydraulics	14	Scheduled maintenance	20	Hub
3	Anemometry	9	Electrical controls	15	Noise constraints	21	Delayed startup
4	Gearbox	10	Pitch control	16	Retrofit	22	Any Other
5	Main shaft	11	Electrical system	17	Tower		

To find out faults for every label, rows are timestamps up to 48 hrs in before 'faulty' row are classed at 6-hr span. For labelling purpose, we are using power curves as they are easily visualized. Figure 1a indicate the power curve with labelling for second turbine having category of that turbine is 17, where various anomalous and curtailment points are classified as 'normal'. Such points should get delete. Curtailment problem can be sort out by keeping the pitch angle between 10 % and 90 % power for 'normal' data points. To prevent distortion in power curve, pitch angles changed between 0 °and 10 °& we get best result at 3.50.

To make classification easy, rows having missing values and missing labels should get removed but, instead of removing such rows from class 'normal' classifying such that data point as 'curtailment'.

So here data points are classifying into 4 classes, 'First class is normal class', 'Second class is curtailment class', 'Third class is faulty class', and 'Fourth class is fault class upto X hours.

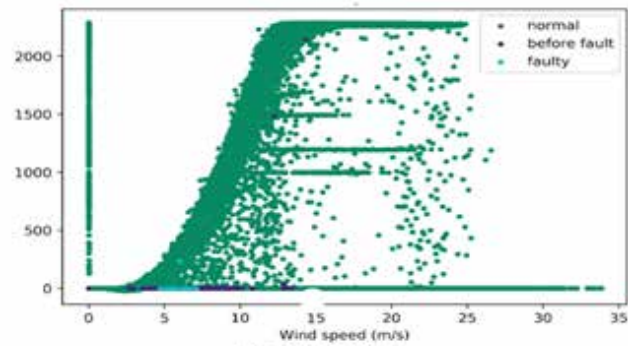


Fig. 1 (a) All Points

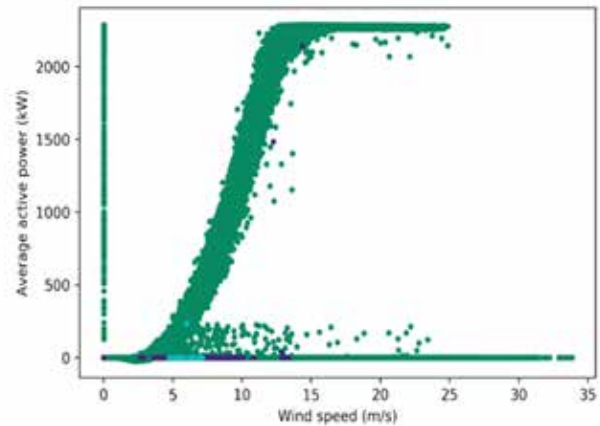


Fig. 1 (b) Without curtailment (i.e., pitch angle is between 0° and 3.5° for 'normal' data points between 10 % and 90 % power).

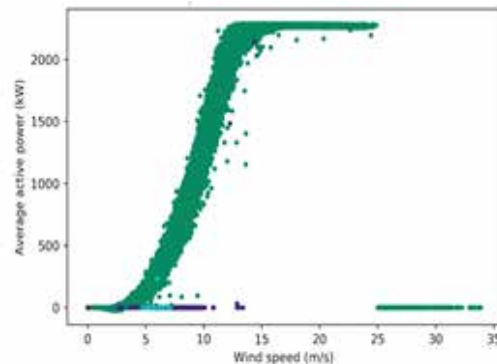


Fig. 1 (c) Additional filters (applied to 'normal' data points): power > 100 kW before cut-in (3 m/s), and at operating wind speeds (3 m/s to 25 m/s); (j) power ≤ 0 kW; (k) runtime < 600 s; (l) availability categories ≠ available; (m) non-penalizing; (n) environmental, grid or infrastructure categories ≠ OK; (o) turbine categories not highlighted in Table 3, or ≠ OK.

## CLASSIFICATION

In scikit-learn Decision Tree, Random Forest and KNN these algorithms are used for multiclass-multilabel classification [11], So only these mentioned, that's why these mentioned classification algorithms are used to classify turbines. Every algorithm have hyperparameters

to give good performance. i.e. k for kNN, k will indicate number of near data samples to classify Turbine. Used data is highly imbalanced. It leads to make the classifier very biased for the major classes and poorly perform on minor classes [12], So balancing should be done on imbalance data. This can be achieved by oversampling all given classes using random over sampler [13]. Oversampling is done instead of random Sampling.

Five-fold cross-validation is performed to increase reliability of the results. The performance of each fold is measured and done averaging of score to get the final result. Since SCADA data is a time series, collected data points after time interval have relation between them, that has to be considered at the time of analysis [14].

To avoid overfitting of training data set with classifier, optimization of hyperparameters can be done.

The normalization of features between the scaling 0 to 1 can be done, before to cross-validation [15]. A various performance metrics like precision score, recall score, F1score, accuracy etc. can be used to find out performance of classifier [16]. Good performance metrics is the metrics which has highest score. F1 score will be considered as main performance metric for the optimizations

**RESULT**

The overall results obtained is shown in Table 4, For Decision Tree and Random Forest optimized hyperparameter is “criterion”, and for kNN optimized hyperparameter is “weights” by using five-fold cross-validation, both balanced and imbalanced training data is used.

After averaging all scores standard deviation and mean were obtained. After training on imbalanced data it has been observed that Decision tree, Random Forest, KNN will performed nicely, with minimum standard deviation and higher mean.

If imbalanced data is used, the F1 scores for Decision Tree, kNN and Random Forest is greater by 0.6 %, 1.9 % and 0.5 % as compared to balanced data. For 17 turbines, optimal value of k is 13 or below 13, and for 5 turbines it is greater than 100. F1 score of kNN is increased by

0.6 % due to optimization on the imbalanced data but this is still low compared to F1 scores of RF and DT on imbalanced data by 6.1 % and 5.1 % respectively.

**Table. 4: Precision, Recall and F1 Scores**

Classifier	Optimal hyperparameter	Balancing	Precision		Recall		F1 score	
			Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
Decision trees	criterion = 'entropy'	Imbalanced	.9234	.0892	.9131	.0914	.9161	.0911
		Balanced	.9179	.0909	.9071	.0957	.9100	.0948
Random forests	criterion = 'entropy'	Imbalanced	.9235	.0887	.9140	.0748	.9261	.0848
		Balanced	.9215	.0900	.9262	.0826	.9212	.0889
k nearest neighbours	weights = 'distance'	Imbalanced	.8664	.0986	.8723	.0973	.8589	.1073
		Balanced	.8653	.0975	.8267	.1200	.8399	.1116
		Imbalanced	.8685	.0965	.8784	.0888	.8653	.0997

**Performance of each turbine and label**

Turbine 1 having very poor performance with minimum and mean F1 score of 44% and 87% respectively using unbalanced data and 41% and 86% respectively using balanced data. Turbine number 7, 9 ,15 and 16 have minimum scores which is below 70 %. Turbine category 11 (electrical system) had very poor performance with imbalanced data, having minimum and mean F1 scores of 44% and 84% respectively, and 41% and82% respectively with balanced data. From this is it is observed that ability of classifier to find fault in electrical system is very poor. This is followed by turbine category 10, ‘pitch control’, it has minimum and mean F1 scores of 57 % and 84 % respectively using imbalanced data and 55 % and 83 % respectively using balanced data. The minimum score is not less than 75 %, for rest of the turbine categories.

**Feature importance**

Feature plays an important role to determine the class. The importance of feature for turbine categories 11 and 4 are shown in Table 5. For both categories, the nacelle position and velocity of wind were the most important features, and the maximum, deviations and average of the active power were the least important.



**Table 5: Feature Importance for Turbine Categories 11 and 4 Using Random Forests and Either Imbalanced (I) OR Balanced (B) Training Data. The Values are Normalized and Color-Coded, Transitioning from Red (Lower Importance) to Yellow (Intermediate) to Green (Higher Importance)**

	ap_av	ws_av	wd_av	pitch	ap_max	ap_dev	reactive_power	rs_av	gen_sp	nac_pos
Turbine category 11 (electrical system)										
I	.0674	.1337	.1237	.0801	.0648	.0675	.1201	.0942	.1200	.1284
B	.0644	.1306	.1301	.0974	.0591	.0625	.1124	.0901	.1183	.1350
Turbine category 4 (gearbox)										
I	.0700	.1379	.1213	.0839	.0700	.0666	.1089	.0898	.1166	.1291
B	.0751	.1453	.1204	.1250	.0658	.0587	.0968	.0769	.1094	.1285

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# Substituting Context Based Synonyms using BERT: A Review

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## ABSTRACT

Text that uses sophisticated and uncommon jargon can be challenging to understand. In order to simplify the text without compromising its significance, a mechanism or tool is therefore required. The goal of this work is to make English textual content easier to interpret for nonprofessional readers, children, dyslexics [1], and non-native English speakers [2]. Natural language processing is the preferred and most appropriate strategy for achieving such simplification. This work can be broken down into three key, interdependent steps that identify complex words [3], create acceptable synonyms for those words, filter and rank through all of the synonyms to pick the best replacement, and then replace the generated simpler alternative with the original statement.

**KEYWORDS:** *Blended lexical simplification; BERT; Unsupervised; Pretrained language model*

## INTRODUCTION

To make it easier for non-native speakers, young children, and people with special needs to understand text, lexical simplification (LS) replaces complex words with simpler equivalents. Lexical simplification can be beneficial because, according to research, if readers are familiar with the words used, they can understand a text despite its complex grammatical structure. The LS framework includes complex word identification (CWI), substitution generation (SG), and substitute filtering and ranking (SFR).

To swap out complicated phrases for simpler ones using a set of rules, existing LS systems [4] use manually compiled word databases (like Wordnet) or para databases. Nowadays, a method called word embedding is widely used to produce word substitutes. Nearly ten synonyms for the given term are generated by these models. Word databases and embedding models are both used in the most advanced model currently available, called REC-LS [5]. Even though the generated substitutes are extremely accurate, this model's methodology has a flaw. The model cannot produce substitutes that are meaningful in the given

context because the context is not given enough weight. This flaw in the model eventually causes more confusion and increases the likelihood of misinterpretation. In the generation of substitutes, context is crucial. Figure 1 illustrates a scenario and supports the assertion. Three different models' substitutes are taken into consideration in the figure, Fig. 1. Models like LS-Bert, Glavas [6], and RES-LS are being considered. The top three replacements produced by the models for the specified complex word are displayed in the figure. Although the replacements produced by Glavas and REC-LS for the given complex word are quite accurate synonyms, the generated synonyms do not flow naturally with the sentence. They misinterpret the intended meaning of the sentence. Contrarily, the substitutes produced by LS-Bert perfectly fit into the sentence and do not introduce any ambiguity in addition to being accurate alternatives for the given complex word when viewed independently.

LSBert uses Bidirectional Long-Short Term Memory, also known as Bi-LSTM, to recognize complex words because word complexity depends on context. The identified challenging words are concealed by the Bert Model. The Bert model is then fed both sentences with masked and unmasked complex words concatenated

together. The Bert model then generates a variety of words to replace the hidden words. Five high-quality features are used to rate the substitutions in order to guarantee that the final statement has the same grammar and meaning as the original: the frequency of words and their similarity, the ordering of prediction, language models that are based on the Bert model, and the paraphrase database PPDB. Recursive reasoning is used by LS-Bert to make the sentence shorter. Once all the complex words have been taken into account, the process repeats.

lexical simplifier and syntactic simplifier [8]. This approach to text simplification was quite primitive and had several flaws. Syntactic simplifiers replaced a big sentence with multiple smaller sentences for better understandability. But it had an adverse effect on the length of the sentences and number of words being used. When used alone several of the words become confusing. Thus such a simple approach to simplification was not sufficient to counter ambiguity issues. Due to the simplicity of the system, it fails to incorporate the context of the sentence in the lexical simplification.

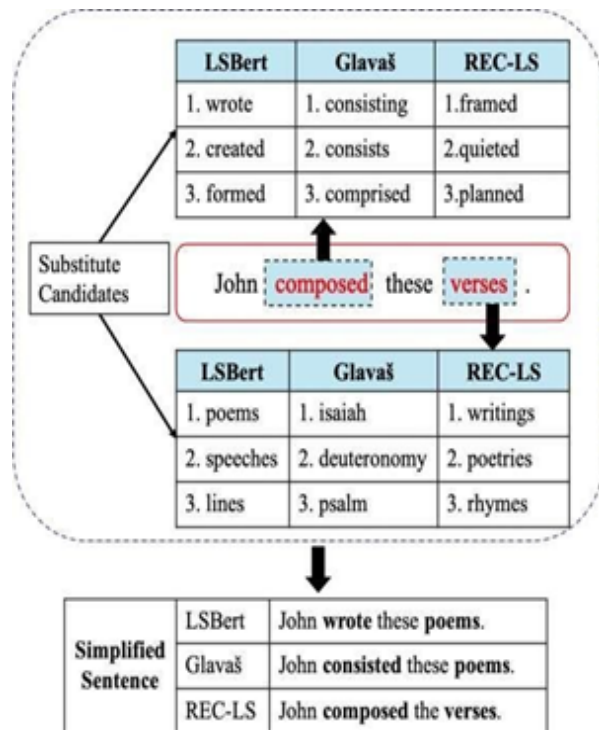


Figure 1. Comparison of substitute generated by our model versus others

### LITERATURE REVIEW

Previously, lexical simplification tasks were performed by analyzers. [7] Practical Simplification of English Text (PSET) was one of the models studied, and the system was broadly divided into two components: An analyzer component that performs the syntactic analysis and disambiguation of text and a simplify component that eventually takes the output of the analyzer and performs the simplification. The analyzer has 3 main components: lexical tagger, morphological analyzer, parser. The simplifier consists of two components:

Supervised text-data simplification systems [9] are utilized in recently developed text simplification models. The availability of parallel sentences dataset is critical to the performance of such systems. Resources for such parallel sentences are available but they contain a lot of inaccurate data which eventually makes this approach inefficient.

Rule-based [10] [11] [12], in which every constraint contains a difficult word and its related synonyms, is another prominent lexical simplification strategy. In a rule-based approach, synonyms are identified from WordNet or a linguistic dataset that consists of predefined complex words and their simpler counterparts. However, a significant shortcoming of rule-based systems is that it is challenging to offer all feasible generalization rules for each word.

To avoid such a dependence on parallel corpora or word to synonym mapping datasets, [5] Recursive Context-Aware Lexical Simplification uses this approach where LS systems started using word embeddings. In this approach, the 10 leading synonyms were extracted whose vectors were nearly equal to that of the complex word's vector in terms of cosine similarity.

Following a review of existing simplification models ranging from rule-based to embedding-based, the most significant flaw discovered was that the system generated a large number of substitute candidates, making further processing, i.e. determining the best fit substitute, extremely difficult and labor-intensive. This is because these systems either completely ignored the context or treated it with less significance.

Thus, to eliminate these drawbacks, the context-based lexical simplification model is proposed. This model

leverages the advanced capacity of BERT to generate substitutes which are accurate and in accordance with the context of the sentence. A process for LS incorporating complicated term recognition, synonyms formation, and synonyms evaluation is proposed in this research, which is based on the LS Bert- simple framework of lexical simplification.

### LEXICAL SIMPLIFICATION PIPELINE

Here, we outline each stage of our lexical simplification goal, which consists of the four steps of complex word identification (CWI), substitute generation (SG), filtering, and substitute ranking (see Figure 2). (SR). Our model breaks down each difficult word in turn, streamlining the text iteratively. The information about each stage is given below.

#### Complex Word Identification

In order to determine where the synonyms should be placed in a sentence to simplify it, has long been an objective of research to isolate complicated words from a single sentence.

A Sequencer built on single or multi large small attention span units (BiLSTM) was developed for the CWI, which was given as a sequence labelling task, in order to predict the binary unpredictability of terms as stated in the original data. The SEQ model has two advantages over the other CWI models: Word embeddings are the sole input data needed, which avoids the need for intensive feature engineering and takes word context into account.

Each word is given a grammatical difficulty level (p) by the SEQ technique, which indicates the likelihood that it falls into the complicated class. A word is considered complicated if its lexical complexity exceeds a predetermined limit p. For instance, the example “John produced these verses” is given in Figure 2. The two words “assembled” (with p = 0.55) and “verses” (with p = 0.76) will be the hardest to simplify if the complexity barrier is set to 0.5. In order to simplify things, our model begin from the term “verses” and with largest score over the specified limit. Once the simplification procedure is complete, we’ll remove any terms that were simplified and resetting each word’s level of difficulty with in phrase. Additionally, by carrying out named.

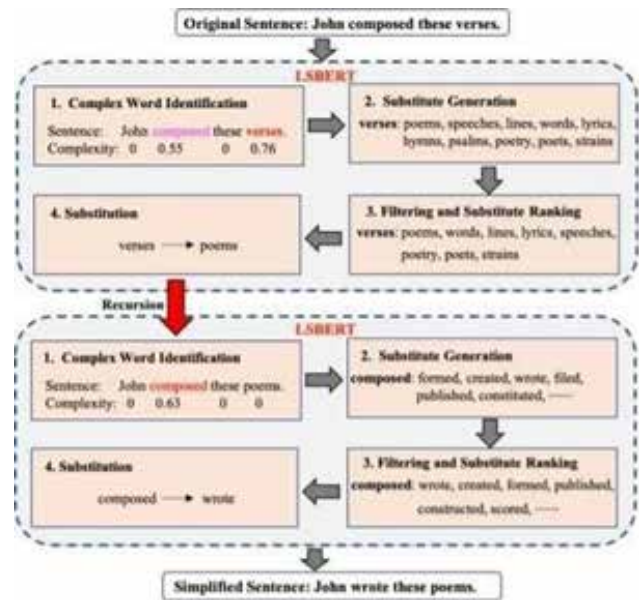


Figure 2. Sequence of Implementation

#### Substitute Generation

The objective of substitute generation (SG), given a phrase S and a challenging word w, is to produce substitute candidates for the problematic word. Our model likes to develop substitution possibilities for the complex phrase using the pre-trained language model Bert. Before detailing how we use the Bert model to do lexical simplification, we provide a brief introduction of it.

Masked language modelling (MLM) and phrase prediction are two training shots on goal used in Bert [13], a self- supervised method for deep transformer encoder training (NSP). MLM uses a sequence’s left and right context to select the relevant tokens, as regards to traditional language modelling, which predicts the following word in a series based on its history. By adding a unique classification token, [CLS], to each sentence and merging phrases using a distinctive separator element, [SEP], Bert successfully completes the NSP task. In order to estimate a label for classification tasks, we use the last condition of secrecy associated with a [CLS] element as the overall description of the specific order. If not, this state may be disregarded.

We create a new sequence S’ that uses the special symbol “[MASK]” to hide the challenging word w in the phrase S. Irrespective of how the challenging term

w, the probability of the vocabulary associated with it only takes contextual factors into consideration, if S' is fed directly into MLM. Due to his selection of the NSP challenge, Bert is proficient in handling sentence pairs. Concatenating true sequences S as well as S' puts them together, which we then enter into the Bert algorithm to determine that language's p (|S, S') equivalent non face terms dispersion of possibilities. As a result, terms contained in p (|S, S'w) with higher probability are those that the mask word considers both the context of the sophisticated term and the sophisticated word itself. We ultimately choose the top ten terms of p (|S, S'w) as replacement alternatives after removing semantic derivations. In order to appropriately lessen the relevance of contextual information, it covers the miscellaneous predetermined number of terms in S without considering w because the meaning of the troublesome term is used number of times.

**Filtering and Substituting Ranking**

The lexical simplification framework's replacement ranking reveals which substitutions are the most straightforward when used with complex words. C = c1, c2, ... cn, where n denotes how many replacement candidates [14] there are.

Our strategy uses threshold-based filtering to obviate some complicated possibilities. To rank the replacement word options, we use the Zipf frequency [15], which is the base-10 logarithm of the frequency per billion words. A phrase is more widespread or well-known when it has a larger value to that person. Based on their ratings for each criterion, our program calculates various ranks. After compiling all of the rankings for each attribute, our model assigns each candidate a score based on the average of all of its ranks. The applicant then, a alternative with the top position is selected.

**RESULTS**

We report the results on the CWI Shared Dataset prepared by on Wikipedia, Wikinews and News Datasets. We have used both the Wikinews and News datasets since the text in News are written by professionals while those writ- ten by Wikinews are written by common people so it is bound to contain more grammatical mistakes. After running the model for 5 epochs with 199 iterations in each epoch, we have plotted the graphs for

the quantitative analysis of how our model behaves and gives results. We have employed regular metrics like Accuracy, Recall, Precision, F1 Score for measuring the metrics of the CWI algorithm. These are used to measure how the model performs with our dataset. We observe that the total loss of the model keeps decreasing after every epoch. This means that with every iteration the model learns. The validation loss also remains almost constant. There is no over-fitting or under-fitting of the data in our model.

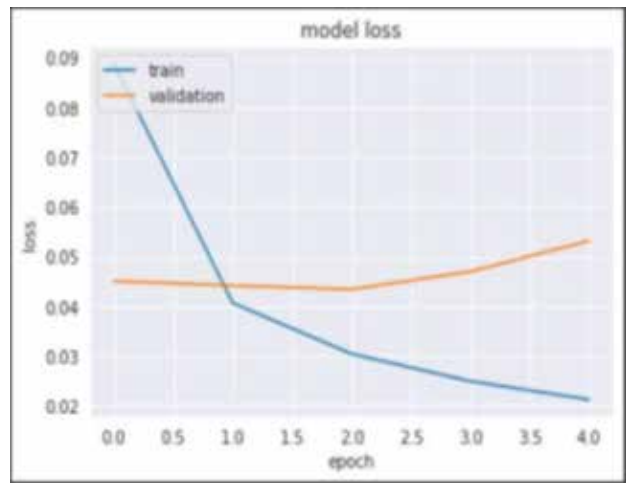


Figure 3. Graph between Model Loss and Epochs

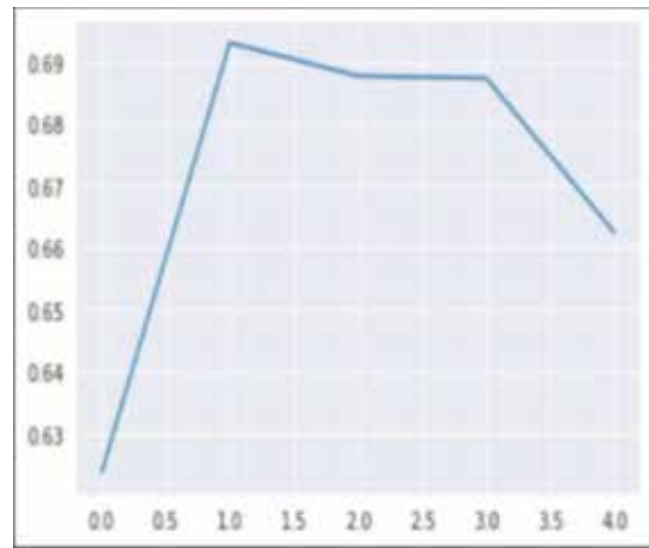


Figure 4. Graph between Loss and Epochs

The F1 Score is the harmonic mean of the Precision and Recall. As can be seen in the plot, the F1 Score for CWI task remains in between 0.65 to 0.70. This is a



very good indicator that the model is performing well. We have observed that many of the models for the CWI task have a F1 Score between 0.68 to 0.80 (Finnimore et. al, 2019).

Here, in the figure given below shows the input text provided.

```
list_texts = [
    'He plunged head first into the stream.'
]
```

**Figure 5. Input Cell**

Here, in the figure given below shows the output/simplified text for the provided input text with predicted complex words.

```
1/1 [-----] - 0s 150ms/step
Input Text:
He plunged head first into the stream.
CWI Predictions:
[0, 1, 0, 0, 0, 0, 1]
Original text: He plunged head first into the stream.
Simplified text: He went head first into the water
```

**Figure 6. Output Cell**

## CONCLUSION

In this paper, we provide a text simplification system that simplifies text based on its context. In the next three steps, we summarize the paper's key contribution:

1. The difficult word is identified using the SEQ model, which is superior to the traditional identification approach.
2. It uses Bert's pre-trained model to generate alternatives for the current complex term. Two training aims improve Bert: MLM (masked language modelling) and NSP (next sentence prediction), which both increase the contextual accuracy of Bert.
3. It selects and ranks substitution options depending on how well the output fits the context and grammar.

In other words, our system uses context and views it as one of the most crucial parameters for simplification, which makes our proposed system more accurate in each of the three critical steps of lexical simplification-

complex word identification, substitute generation, filtering and substitute ranking.

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# Timetable Generator Using Genetic Algorithm

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## ABSTRACT

Creating a timetable for complex scenarios can be challenging, and manual planning at a larger scale can lead to inefficiencies that negatively impact the entire organization. However, there is a revolutionary solution that can address this issue.

Recent advancements in technology offer a solution. Software utilizing genetic algorithms, although limited to a one-hour timeframe and dependencies such as Xampp server or an internet connection, has paved the way for more significant breakthroughs.

Fortunately, Advanced technology can now mitigate these issues, improve accuracy, and enhance performance by streamlining the timetable planning process. Using AI, organizations can tackle non-deterministic polynomial-time problems with ease. The genetic algorithm is a cutting-edge technology that mimics the natural selection process and is at the forefront of optimization techniques.

Our research aims to develop an AI that uses evolutionary algorithms, specifically genetic algorithms with adaptive and elite traits, to create a university timetable that is valid and optimal given the constraints at hand. This solution can optimize resource allocation, reduce costs, and improve decision-making.

**KEYWORDS:** *Genetic algorithm, Timetable generation, Evolutionary algorithm, Optimization*

## INTRODUCTION

Scheduling is a critical process that involves the creation of a timeline or timetable to meet the demands and constraints of a particular scenario. It is a widely used technique across various industries, from transportation planning to complex scheduling for highly optimized automated factories. Most of the smaller jobs are done manually, while the larger jobs require computerized planning.

Artificial intelligence is one of the computing solutions that is exploding due to increasing computing power. It can be applied to different types of problems that can help to optimize existing solutions or create solutions that have never been tried due to many limitations. Artificial intelligence helps create solutions to indeterminate polynomial time problems that businesses and organizations will always face.

The proposed methodology will involve the use of genetic algorithms that apply selection, crossover, and mutation

operators to evolve a population of potential solutions towards the optimal solution. A genetic algorithm is a powerful approach that mimics the natural selection process to solve complex optimization problems. It encompasses various methods that follow the same underlying concept. The incorporation of adaptive and elite traits will allow the algorithm to dynamically adjust the parameters during the search process, thereby improving the efficiency and effectiveness of the optimization process. By adopting this approach, the generated schedule will meet the specific requirements of the university while minimizing the time and resources required to create it. The objective is to generate a valid schedule while considering various constraints such as course requirements, room availability, and faculty availability.

## RELATED WORK/ LITERATURE REVIEW

According to Asif Ansari [4] Scheduling problems can

be solved in a number of ways, derived from operational research, such as: local search methods, mathematical programming and B. Graph coloring by manipulating constraint satisfaction based on taboo searches and simulated cooldowns or backtracking. A genetic algorithm is an optimization algorithm and successor to traditional evolutionary algorithms.. S. D. Immanuel and U. K. Chakraborty (2019) explain that the genetic algorithm operates under the concept of “survival of the fittest,” where improved solutions are developed from previous generations until a near-optimal solution is achieved [7].

A genetic algorithm can be effectively used to schedule a timetable for an engineering college. G. Alnowaini and A. A. Aljoma [1] proposed a technique with dynamic chromosome size for this type of scheduling problem. The authors’ system allowed for the inclusion of multiple, lecture halls, departments, courses ,levels, buildings, and lecturers, while also enabling the establishment of specific constraints that governed the creation of the timetable. The drawback in the system developed by G. Alnowaini and A. A. Aljomai[1] that it does not satisfy all the hard constraints in generating schedules . However, to overcome this limitation, the proposed system will ensure compliance with all the hard constraints, such as preventing scheduling conflicts between lectures and available rooms.

The study done by K. Wiilams in 2019 [2] proposed a system with different administrator login which c can be used to enter the courses with their code and unit. If any error is found in imported courses the admin holds the authority to delete the courses. A smart adaptive mutation scheme was utilized to accelerate the convergence process. The design process is compatible with any operating system from Windows Vista and beyond, but the XAMPP server is a prerequisite for the current systems. Additionally, internet browsers such as Google Chrome, Internet Explorer, Microsoft Edge, Opera Mini, and UC Browser can be used to access the design. However, to overcome this limitation, the proposed system is a standalone software which can be installed on windows, Linux and MacOS. The application does not require Internet connection for its functionality. The quality or optimality of the solution relies on the constraints applied and the parameter

adaptation function utilized. While using a genetic algorithm may introduce some additional computational steps, it remains the most efficient method for generating schedules. Despite its relatively slower speed, the benefits it provides make it a more convenient choice.

Timetable schedulers Developed using genetic algorithm cannot solve all the given constraints but most of the major constraints i.e No clashes between two teachers of the same duration. [3] The system developed by Shruthi. B has no flexible timings, only classes of 1 Hour duration can be scheduled. To overcome this limitation, the proposed software will allow the user to schedule classes with flexible timing. Classes of 30 minutes duration can be scheduled.

A Genetic Algorithm problem consists of candidate solutions (possible solutions, not necessarily optimal) to get the population of Each solution consisting of one or more individual traits (called chromosomes or genotypes) that are crossed over or mutated to arrive at a new solution to the same problem [7]. Mutation is a divergent operation. The objective of this approach is to divide one or multiple individuals within the population from a local minimum or maximum region, with the potential to discover an improved minimum or maximum region. The process involves generating a new offspring by combining genetic material from two parent individuals in each instance. [4]. The crossover function is one of the key steps in genetic algorithms (GA). The genes present on each chromosome are paired using a crossover operator, which facilitates the creation of new offspring. These offspring are then assessed based on their derived fitness scores to determine their eligibility for inclusion in the next generation.. Cross-average crossover(CAX) , a new crossover mechanism, was discovered by M. Y. Orong, A. M. Sison and R. P. Medina [8] in their research. In this approach a rank-based selection method is used which contributes to the promising results of the variable minimization process. In a study conducted by Qiongbing and Lixin [8], a novel crossover mechanism named Same Adjacency (SA) crossover was introduced in Genetic Algorithms (GA) with variable-length chromosomes. SA crossovers are designed to identify more efficient crosspoint pairs between parental chromosomes. However, it should be noted that this mechanism entails additional

computational effort. Additionally, to determine the intersection point, extra information from neighboring nodes is necessary.

Shraddha Shinde, Saraswati Gurav, Sneha karme[6] proposed a java based system for automatically generating a timetable. Along with timetable generation, the system offers features in which user can request leave by providing leave date, reason and also alternative faculty. The system proposed here requires the installation of JSP and MYSQL. The developed framework by the authors seems to be directly applicable to a lot of other scheduling problems as well.

Shraddha Thakare , Tejal Nikam , Mamta Patil[5] these authors have developed a system that generates schedules/timetables with 60% to 80% optimality. However, the proposed system will generate schedules/timetables with more than 80% optimality. The most important modules in scheduling procedure as stated by the authors are as follows, 1. Data encoding and decoding 2. Mutation 3. New Population 4. Crossover Evolution 5 Initial population 6. Evaluation of population [5]. It has diverse applications which includes School Timetable Management, University Timetable Management any organization timetable management.

**Disadvantages Of Existing System**

- The system is designed to generate timelines while considering few difficult constraints.
- The existing system generated timetable is subject to further review and validation.
- The system does not implement all principles of the genetic algorithm.
- Software is platform dependent
- The software is not ready yet to work on higher scale
- One hour interval of time slot.

**Problem Statement**

Timetable scheduling involves creating schedules that comply with certain constraints. While smaller operations are typically done manually, larger operations require computer-assisted scheduling. With the increase in computing power, artificial intelligence has become

a popular solution for various problems. AI can help optimize existing solutions or create new ones that were previously impossible due to constraints. This project aims to develop a university timetable scheduler using a genetic algorithm that incorporates adaptive and elitist traits. The objective is to generate a valid and optimal solution while adhering to specific constraints.

**Proposed System**

The proposed system utilizes a genetic algorithm, which is a computational method based on natural selection. This iterative process can be visualized using a flowchart [Fig.2], with a solution represented as a chromosome. As shown in [Fig.1], the genetic algorithm follows a basic process, with an additional step of adjusting the environment after the evaluation in the actual system.

- There will be 5 inputs namely instructors, rooms, sections, subjects and settings.
- The output will be a class scheduler in the form of a CSV file.

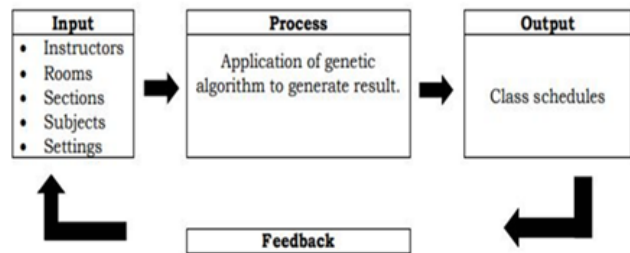


Fig. 1: Propose system Model

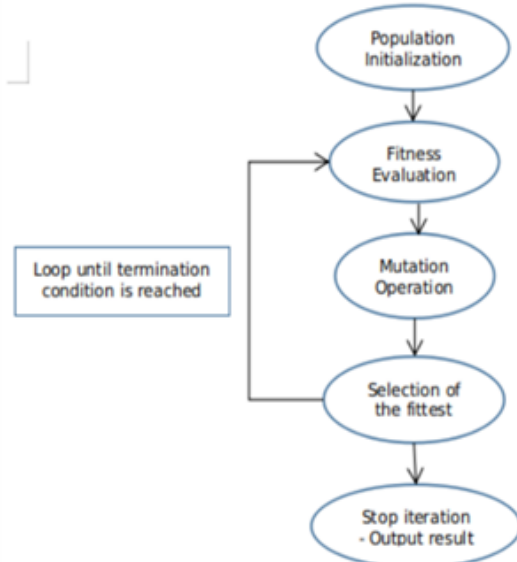
**Types of Constraints Used**

In our proposed system, three types of constraints will be used to ensure the validity and optimality of the output:

1. Soft Constraints – A set of rules that can be broken without affecting the validity of the output Eg: Instructors should not get workload.
2. Medium Constraints – A set of rules that can be broken with an effect on the validity of the output. However, this can only be broken if the scenario is logically invalid or impossible Eg: 30 min break for lunch.
3. Hard Constraints – A set of rules that would produce an invalid solution if broken Eg: Classes scheduled

should not clash with each other.

**Flowchart**



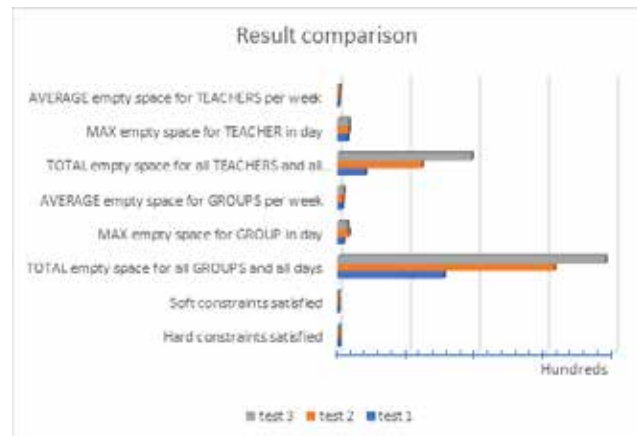
**Fig.2: Flowchart of the system**

**RESULT**

The existing systems were studied and evaluated on solving a timetable scheduling problem for some test data sets and the results were analyzed. The metrics such as hard constraints are been followed without any error while some metrics have lower accuracy in various test data. The metrics and the resultant of the Genetic algorithm applied on it are in the result. Comparatively to the existing systems, the proposed model will not only satisfy the hard constraints but will also focus on medium and soft constraints making it more efficient and accurate.

Metrics	Test1	Test2	Test3
Hard constraints satisfied	100.00%	100.00%	100.00%
Soft constraints satisfied	43.16%	52.38%	32.22%
TOTAL empty space for all GROUPS and all days	77	157	194
MAX empty space for GROUP in day	4	8	7

AVERAGE empty space for GROUPS per week	3.21	3.57	4.41
TOTAL empty space for all TEACHERS and all days	20	61	97
MAX empty space for TEACHER in day	7	8	8
AVERAGE empty space for TEACHERS per week	0.53	0.98	1.54



**Fig.4: Results Comparison Chart**

**CONCLUSIONS**

Thus, the results of the study shows that the system can provide valid solutions though it does not deliver complete automation. Although the system can achieve automation at some level, there are still some scenarios that would require the operator to provide some inputs and changes to get a perfect solution. Also, the system was designed to be simple and straightforward.

**ACKNOWLEDGEMENTS**

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# Hardware Implementation of Cascaded Seven Level H Bridge Multilevel Inverter in Solar & Battery for Domestic Load Application

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## ABSTRACT

Multilevel inverters are superior to ordinary inverters because the voltage quality increases as the number of output voltage levels increases. This article presents a new cascading multilevel inverter methodology with a new unit. The topology concept uses low power electronics to generate a range of output voltage. The result is a bargain and a reasonable price. The model of the multilevel inverter concept has therefore been expanded to increase the number of voltage steps with a less amount of power consumption.

**KEYWORDS:** *Seven level CHBI; THD; Solar; Batteries*

## INTRODUCTION

In this article, power management strategy for photovoltaic and battery systems couple with multilevel inverters for home load applications is introduced. Power from photovoltaic and battery cells are used to drive a buck-boost converter. AC loads and AC lines are connected by 1 phase full bridge converter. The proposed converter methodology increases the voltage gain and reduce the total harmonic distortion of the inverter stage, thus reducing the dependence on filters. This improvement in voltage gain helps to increase the efficiency and reduce the ratio of circuit components, reducing the overall equipment cost in the system. A multilevel inverter is a power inverter used for high voltage applications, including uninterruptible power supplies, alternating currents (FACTS). While conventional two phase inverters have some limitations in high voltage applications, they also affect the switching losses. This allows conversion of multilevel power to more than two levels of voltage smooth and distortion free DC-AC power conversion and can generate multilevel voltage waveform with less distortion, less frequency changes and better performance. Step waveforms are synthesized from two or more voltage

levels produced by connecting the appropriate loads. This connection is made using switches in power semiconductors. To get good output voltage waveform they must have a frequency variation that includes many pulse width modulations techniques. Compared with two phase inverters, multiphase inverters have many advantages such as improving the output voltage waveform, reducing the voltage of the load (dv/dt) and reducing electromagnetic interference, but there are also some disadvantages. One of the biggest problem is the need of more electronic semiconductor switches. Every switch should have gate driver circuit which accordingly the complexity and size of the complete circuit.

With the depletion of fossils reserves and increasing energy demand, the world is heading towards the energy crises today. The increasing carbon footprint of today's energy sources has forced peoples to look for economically and environment friendly alternative energy source. Solar energy does not fall into this category, but its inconsistency makes it difficult to provide stable and consistent energy. However, hybrid systems that include storage systems such as batteries can help solve this problem. Today's technology is

designed to maximize the efficiency of storage and switching devices and provide the most power with the least equipment. This new multi-phase inverter system for hybrid renewable energy systems increases the voltage rise and improves the voltage profile by reducing the harmonic content, thus improving the power quality compared to existing systems.

## LITERATURE SURVEY

The multilevel voltage of the inverter topology includes a DC link and an H bridge inverter; based on minimization of switches clamping diodes and capacitors. The building stage produces a phase like DC voltage, and the H bridge inverter produces AC voltage with positive and negative polarity to produce and AC voltage. Flexible strategies can be used to minimize changes and devices stresses. As the voltage level increases, this configuration finds applications in electric drives, distribution involving fuel cells, photovoltaic cells.

The MLI topology with less number power electronic components reduces the count of consumption switches, gate drives circuits which eventually reduces installation space and cost. Multilevel uses bidirectional switches to reduce the number of semiconductor components, reducing the voltages and obtaining the desired output voltage, thus improving performance.

The output voltage quality of conventional inverters improves with increasing output voltage level. A new single-phase multilevel inverter topology including a new unit is proposed. Compared with other multi-level inverters, the topology concept uses low-power electronic devices to generate a certain output voltage, making it compact and cost-effective.

## SCOPE OF RESEARCH

Some of the industrial loads require low to medium levels of electricity. Using high voltage equipment for all loads will benefit higher voltage applications but will harm other low and medium voltage applications. Electronic devices such as batteries, super capacitors and solar panels are medium voltage. Multilevel inverters have multiple switches with multiple levels to increase power as needed.

MLI topology with low switching numbers reduces start-up cost and complexity. As the number of steps

increases, the number of switches used is very less compared to other MLI topologies. A multi-level converter based on fuel cell with reduced conversion has been proposed as the conversion loss reduces the performance of the system. The main purpose of this topology is to reduce the number of switches, gate driver circuits, capacitors and THD.

It reduces half of switches and gate drivers compare to other multi-level inverters. This makes it small size and heavy in weight. The goal is to use reduced keys in the Multilevel Inverter methodology to improve performance by using less keys and space. This topology reduces total harmonic distortion, reduces EMI and produces high voltage.

## METHODOLOGY OF PROPOSED CASCADED SEVEN LEVEL H BRIDGE INVERTER

### Introduction

In this system, we have connected seven CHBs in series to reduce or decrease the number of switches and reduce THD. The main idea of the mentioned device is that the inverter provides better output with lower consumption compared to other conventional power supplies. The complete block diagram of the inverter application is shown in Figure 1.

### Principle of Operation

A series of single-phase full bridges form one phase of the inverter. Each bridge can be switched between +V<sub>dc</sub>, 0, -V<sub>dc</sub>. Since this topology has a series connected power converter, voltage and power can be adjusted easily. The DC power supply is separate for each connection and diode rectifiers are generally used, which are fed from the separate secondary winding of the three-phase transformer. The inverter topology is shown in Figure 4. Compare to the existing multi-level inverter, the new MLI inverter can complete the conversion according to the number of driving gates. Voltage rating (level)  $m$  for given number, new inverter needs  $m+3$  active switches. The comparison of practical MLDCL inverters with step-down inverters depends on the requirements of the switches and the number of phases. It is clear from this analysis that as the voltage level of  $m$  increases, the number of switches of the inverter will increase by  $m+3$ ,

while the number of switches of the stepwise H-bridge multilevel inverter will increase for two (m-1).

In the below circuit of 7 CHBI, three level of voltages are given to the H bridge i.e. +5V, +9V, +14V for positive half cycle and -5V, -9V, -14V for negative half cycle. The first two voltage level are given by two DC sources connected across the two H bridge circuits and third voltage level is given by addition of both voltage sources to see the third staircase in the seven level inverter by using below switching sequence to the following circuit.

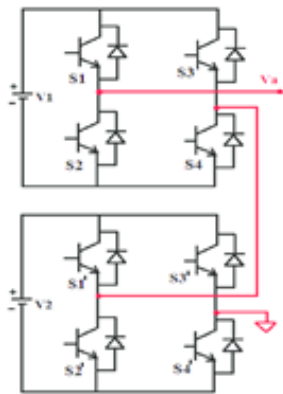


Fig. 1. Circuit Diagram of 7 Level CHBI

Table. 1. Switching Sequence of 7 Level CHBI

Output Voltage	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>1'</sub>	S <sub>2'</sub>	S <sub>3'</sub>	S <sub>4'</sub>
0 Vdc	1	0	1	0	1	1	1	0
Vdc	0	1	1	0	0	1	0	1
2Vdc	0	1	0	1	0	1	1	0
3Vdc	0	1	1	0	0	1	1	0
-Vdc	1	0	0	1	0	1	0	1
-2Vdc	0	1	0	1	1	0	0	1
-3Vdc	1	0	0	1	1	0	0	1

**SIMULATION RESULTS**

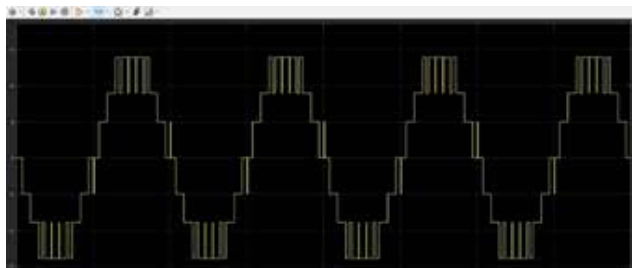


Fig. 2. Output Voltage of 7 Level H Bridge Inverter

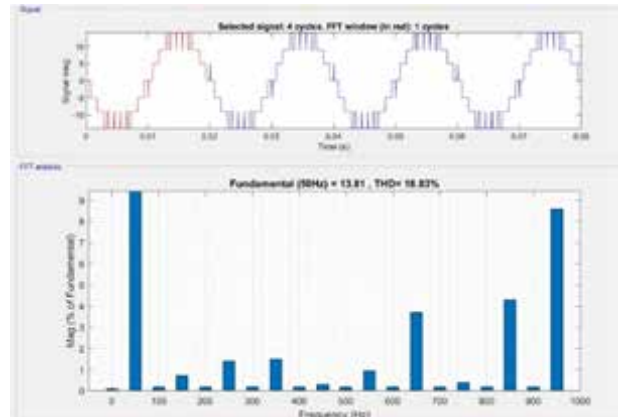
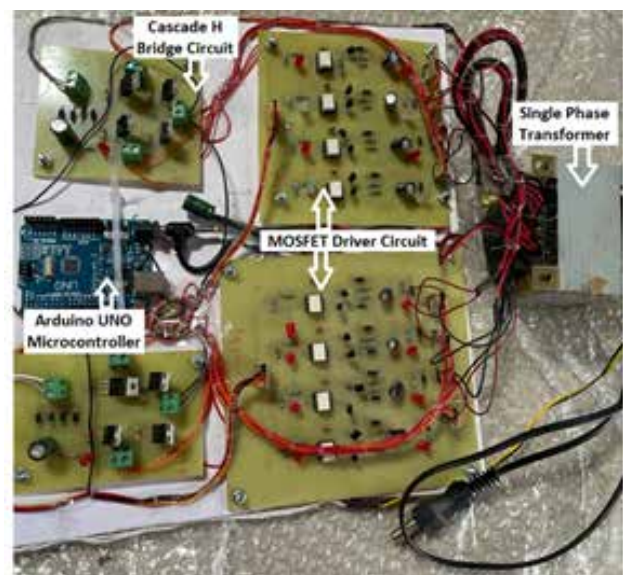


Fig. 3. THD Level Output voltage of 7 Level Inverter

**HARDWARE RESULTS**

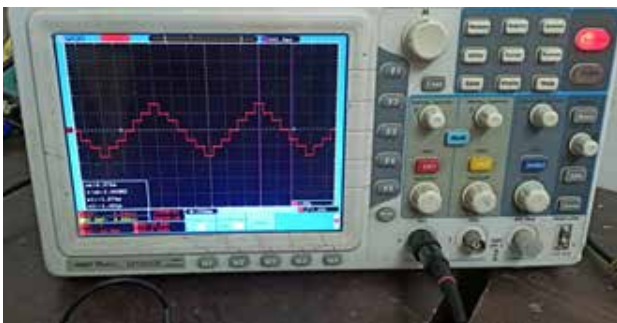
In the proposed methodology, a single-phase multilevel inverter is tested using four H-bridge units cascaded to obtain a seven-phase output voltage. The model is designed to use only a two-stage H-bridge MOSFET based voltage source inverter. A microcontroller - based Arduino module is used to provide the gate driver signal. Arduino is applied to reduce the complexity of generating gate driver signal for high level inverter output voltages. Seven levels of output voltage were obtained from the experimental study. It has been found that since the level of the output voltage of the multilevel inverter increases, the demand for the transformer should be less and all the effects of harmonics are reduced.



In the hardware circuit, only single transformer is used to provide three different voltage levels by taking the tapping from the transformer to the MOSFET driver circuits. The main motive to this was to achieve less bulky and complicated circuit with more number of level output.



**Fig. 4. Hardware Image of Proposed 7 Level CHBI**



**Fig. 5. Hardware Output of 7 Level Inverter CHBI**

## CONCLUSIONS

The inverter concept currently used can generate seven levels of voltage, but by changing the inverter we achieve more levels, thus further reducing the THD of the output. In the modulation process used, there is scope to further reduce the number of switches. Advanced modulation techniques can be used. Results are analysed using FFT, observing 16.29% THD in figure (3).

The prototype of a proposed topology of 12V, single phase seven phase was designed using MOSFETs as switching devices. The driver has 8 MOSFET switches. The Arduino microcontroller is mainly used to generate the gate signal for the inverter switch with the MOSFET

driver circuit. The input inverter output provides a resistive load. The output waveform of the proposed CHB MLI is a seven-level stepped wave as shown in Figure 5.

The proposed system draws maximum power from the higher voltage system and reduces overall harmonic distortion. The system can provide stable, uninterrupted power to household appliances and inject additional electricity into the grid.

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# A Hilbert Transform Based Approach for Classification of Complex Power Quality Disturbances

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## ABSTRACT

This research work presents a Hilbert Transform-based algorithm for categorizing Multiple and Multistage Power Quality Disturbances (PQDs). The MATLAB software combines a number of mathematical equations to create these power quality issues. These PQDs are produced by implementing a variety of mathematical equations in the MATLAB Environment. The multiple power quality issues considered in this study are voltage sag with harmonics, voltage swell with harmonics and voltage interruption with harmonics. The multistage power quality issues considered in this study are multistage voltage sag, multistage voltage swell, and multistage voltage sag with swell. These PQDs are processed using Hilbert Transform and PQ index curves are obtained from it. The PQ index curve is further used to extract four features namely F1, F2, F3, and F4. The thresholding-based algorithms are developed using the extracted features in order to classify the multiple and multistage PQDs.

**KEYWORDS:** Hilbert transform. Power quality index curve, Power quality disturbances

## INTRODUCTION

For electric power providers and their customers, the quality of the electricity is now a crucial concern. The equipment utilised in electrical utilities today is more sensitive to the power quality. These devices have power electronic components, which are delicate to changes in power quality. Therefore, any disturbance in the voltage, current, or frequency of the power signal that may also have an impact on the customer's side is referred to as a power quality issue. We must be able to recognise and categorise the disturbances into distinct sorts in order to identify their sources and causes. PQ disturbances comprise a variety of PQ phenomena, such as transients, interruptions, sags, swells, power frequency changes, long duration variations, and steady state variations, according to IEEE standard 1159-1995 [1]. These Disturbances are the main culprits for power quality degradation. The signal processing techniques such as Fourier Transform (FT), short time

Fourier Transform (STFT), wavelet transform (WT), Stockwell's Transform (ST), Hilbert Transform(HT) etc. have been utilized for the feature extraction to detect a particular PQ event available in the voltage signal[2]. Also ST with SVM used for classification of PQD [15]. The artificial intelligence techniques such as Artificial Neural network (ANN), Fuzzy logic, decision rules etc. have been used extensively for the classification of the PQ events [3]. Combination of features of Hilbert transform (HT) and Stockwell transform (ST) to identify the single-stage and multiple (multi-stage) power quality disturbances (PQDs)[4,5]. In [6] smart sensor based on Hilbert transform used for detection, classification, and quantification of PQD. An advance signal processing method that is Hilbert Haung Transform is used to classify the power quality event[7].

## POWER QUALITY

As per IEEE power quality is define as “the concept of powering and grounding sensitive electronics



equipment in a manner that is suitable to the operation of that equipment”[8].

A. Voltage Sag: A voltage sag is a fall in the rms value of voltage or current between 0.1 and 0.9 pu at the power frequency over a time of between 0.5 cycle and 1 minute.

B. Voltage Swell: A swell is defined as a rise in rms value of voltage or current between 1.1 and 1.8 pu at the power frequency for duration between 0.5 cycle and 1 minute.

C. Interruptions: When the supply voltage or load current drops to less than 0.1 pu for more than a minute, an interruption occurs.

## HILBERT TRANSFORM (HT)

From the input signal, the HT derives the discrete-time analytical signal. Complexity characterises the analytic signal. The imaginary component of which represents the  $90^\circ$  phase shifted version of the original signal, while the real part represents the original signal. The frequency and amplitude of the modified version of the original signal match those of the original signal. A time series’ instantaneous features are estimated using the HT.

In HT phase angle of all positive frequency spectral components of the given signals are shifted by  $-90^\circ$  and negative frequency spectral components of the given signal are shifted by  $90^\circ$ . The resulting function of time is called Hilbert Transform of a signal. The amplitude spectrum of a signal is unchanged only phase spectrum is changed. HT does not bring about a change of domain. The HT  $x^{\wedge}(t)$  of a signal  $x(t)$  is obtained by convolving  $x(t)$  with  $1/(\pi t)$ .

## METHODOLOGY

An algorithm for the classification of complex PQDs uses the following steps:

1. Generation of complex PQDs using the integral mathematical models of PQDs using MATLAB programming[9]
2. Applying Hilbert transform to the voltage signals with complex PQDs.

$A = \text{Hilbert}(v)$

3. Obtaining the PQ Index Curves using the following command and plotting it.

$B = \text{abs}(A)$

4. Extracting the features F1, F2, F3, and F4 from the PQ index curve.

$F1 = \text{median}(B)$

$F2 = \text{kurtosis}$

$F3 = \text{var}(B)$

$F4 = \text{std}(B)$

5. Developing thresholding-based algorithm using the extracted features for classification of PQDs

## GENERATION OF POWER QUALITY DISTURBANCES

In order to provide the necessary power quality disturbance, a collection of parametric equations involving various mathematical functions is used to construct the integral mathematical models of PQDs[10,11]. In this study project, the MATLAB programming is used to perform the mathematical equations presented in table I in order to produce the numerous and multistage power quality disturbances.

## SIMULATION RESULTS AND DISCUSSION

### Results of Generation of PQDs

The parametric equations are programmed in MATLAB programming to produce the multiple, and multistage PQDs. The parameter A controls the PQDs’ amplitudes, while the temporal constants  $t1$  and  $t2$  govern their durations. The greatest value of the instantaneous waveform under three phase is  $A=326$ ; the RMS value for this value was found to be 400 V.

Figure 1 shows the waveform of voltage sag with harmonics that results from altering the parameters  $\alpha=0.5$ ,  $t1=0.3$ , and  $t2=0.7$ . The voltage signal has a sag along with harmonics that lasts for 0.4 seconds. The length of the signal is one second.

Table 1. Mathematical Models of PQDs

PQDs	Equations	Parameters
Voltage sag with harmonics	$x(t) = A (1 - \alpha (u(t-t_1) - u(t-t_2))) \sin(\omega t) * \alpha_1 \sin(\omega t) + \alpha_3 \sin(3\omega t) + \alpha_5 \sin(5\omega t) + \alpha_7 \sin(7\omega t)$	$0.1 \leq \alpha \leq 0.8, T \leq (t_2 - t_1) \leq 9T$
Voltage swell with harmonics	$x(t) = A (1 + \alpha (u(t-t_1) - u(t-t_2))) \sin(\omega t) * \alpha_1 \sin(\omega t) + \alpha_3 \sin(3\omega t) + \alpha_5 \sin(5\omega t) + \alpha_7 \sin(7\omega t)$	$0.1 \leq \alpha \leq 0.8, T \leq (t_2 - t_1) \leq 9T$
Voltage interruption with harmonics	$x(t) = A (1 - \alpha (u(t-t_1) - u(t-t_2))) \sin(\omega t) * \alpha_1 \sin(\omega t) + \alpha_3 \sin(3\omega t) + \alpha_5 \sin(5\omega t) + \alpha_7 \sin(7\omega t)$	$0.1 \leq \alpha \leq 0.8, T \leq (t_2 - t_1) \leq 9T$
Multistage voltage sag	$x(t) = A [(0.5 - \alpha_1(u(t-t_1) - u(t-t_2))) + (0.5 - \alpha_2(u(t-t_2) - u(t-t_3)))] * \sin(\omega t)$	$0.1 \leq \alpha \leq 0.8, T \leq (t_2 - t_1) \leq 9T$
Multistage voltage swell	$x(t) = A [(0.5 + \alpha_1(u(t-t_1) - u(t-t_2))) + (0.5 - \alpha_2(u(t-t_2) - u(t-t_3)))] * \sin(\omega t)$	$0.1 \leq \alpha \leq 0.8, T \leq (t_2 - t_1) \leq 9T$
Multistage voltage sag with swell	$x(t) = A [(0.5 - \alpha_1(u(t-t_1) - u(t-t_2))) + (0.5 - \alpha_2(u(t-t_2) - u(t-t_3)))] * \sin(\omega t)$	$0.9 \leq \alpha \leq 1, T \leq (t_2 - t_1) \leq 9T$

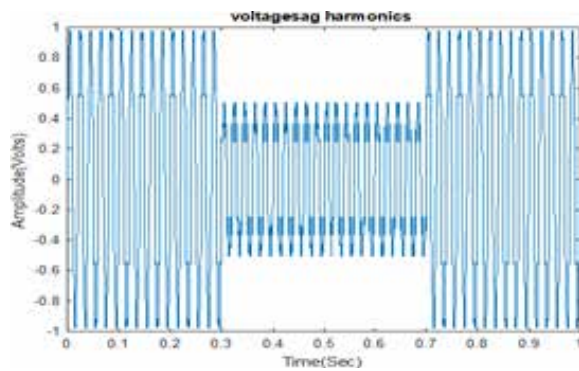


Fig. 1. Waveform of Voltage Sag with Harmonics

Figure 2 shows the waveform of voltage swell with harmonics that results from altering the parameters  $\alpha=0.5$ ,  $t_1=0.3$ , and  $t_2=0.7$ . The voltage signal has a swell along with harmonics that lasts for 0.4 seconds. The length of the signal is one second.

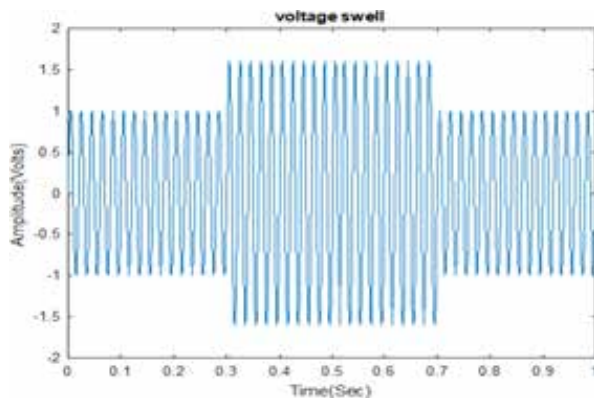


Fig 2. Waveform of Voltage Swell with Harmonics

Figure 3 shows the waveform of voltage interruption with harmonics that results from altering the parameters  $\alpha=0.5$ ,  $t_1=0.3$ , and  $t_2=0.7$ . The voltage signal has a swell along with harmonics that lasts for 0.4 seconds. The length of the signal is one second.

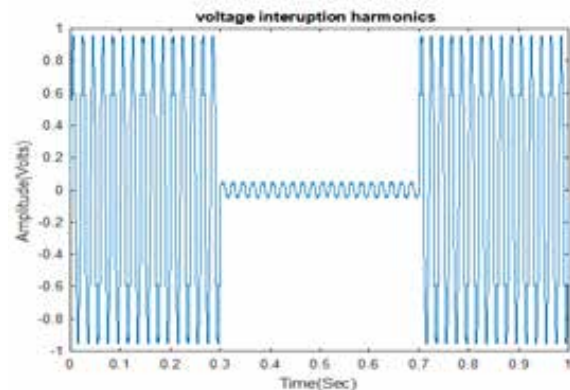


Fig 3. Waveform of Voltage Interruption with Harmonics

Figure 4 shows the waveform of multistage voltage sag that results from altering the parameters  $\alpha=0.5$ ,  $t_1=0.3$ , and  $t_2=0.7$ . The voltage signal has a multistage sag for 0.4 seconds. First stage of sag is obtained between duration 0.3 to 0.5 and second stage is obtained between 0.5 to 0.7 sec. The length of the signal is one second.

Figure 5 shows the waveform of multistage voltage swell that results from altering the parameters  $\alpha=0.5$ ,  $t_1=0.3$ , and  $t_2=0.7$ . The voltage signal has a multistage swell that lasts for 0.4 seconds. First stage of swell is obtained between duration 0.3 to 0.5 and second stage

of swell is obtained between 0.5 to 0.7 sec. The length of the signal is one second.

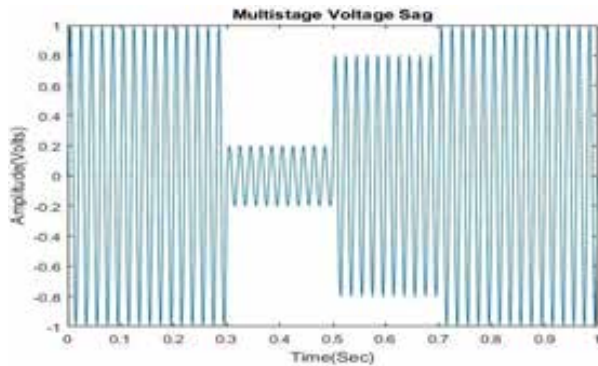


Fig 4. Waveform of Multistage Voltage Sag

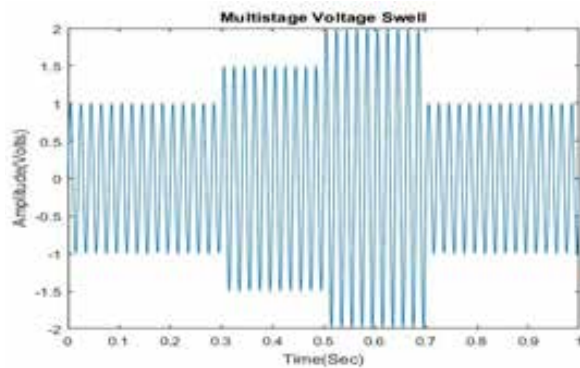


Fig 5. Waveform of Multistage Voltage Swell

Figure 6 shows the waveform of multistage voltage sag with swell that results from altering the parameters  $\alpha=0.5$ ,  $t_1=0.3$ , and  $t_2=0.7$ . The voltage signal has a multistage swell that lasts for 0.4 seconds. In first stage of sag is obtained between duration 0.3 to 0.5 and in second stage swell is obtained between 0.5 to 0.7 sec. The length of the signal is one second.

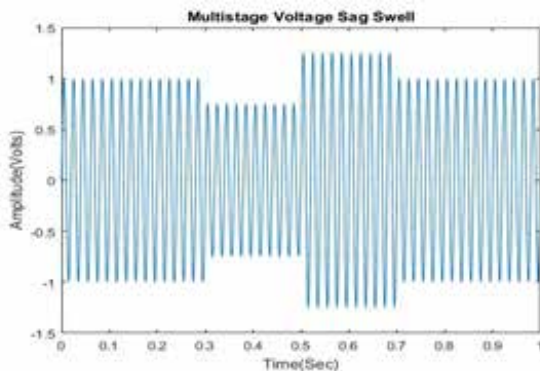


Fig 6. Waveform of Multistage Voltage Sag with Swell

## RESULTS OF PQ INDEX CURVES

The voltage signal with harmonic sag that was created by simulating the mathematical equations in MATLAB is being subjected to the Hilbert transform. Calculating the absolute value from Hilbert transform's yields the PQ index curve [12,13]. The waveform of a signal containing a voltage sag harmonic, and a PQ index curve is shown in figure 7. The harmonic voltage sag and reduction in PQ index curve is obtained between 0.3 to 0.7 seconds as shown in figure 7.

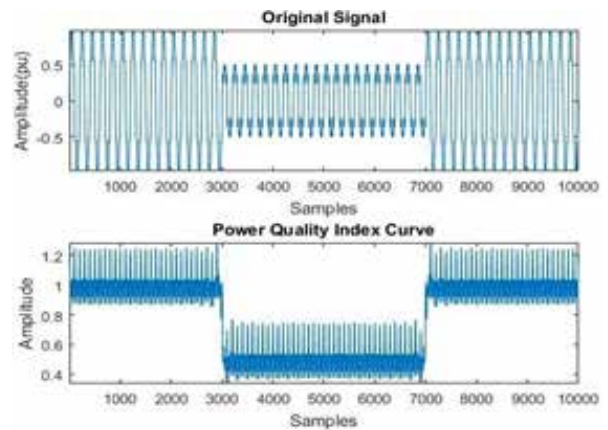


Fig 7 PQ Index Curve for Voltage Sag with Harmonics

The voltage signal with harmonic swell that was created by simulating the mathematical equations in MATLAB is being subjected to the Hilbert transform. Calculating the absolute value from Hilbert transform's yields the PQ index curve. The waveform of a signal containing a voltage swell harmonic, and a PQ index curve is shown in Figure 8. The harmonic voltage swell and increase in PQ index curve is obtained between duration 0.3 to 0.7 seconds as shown in figure 8.

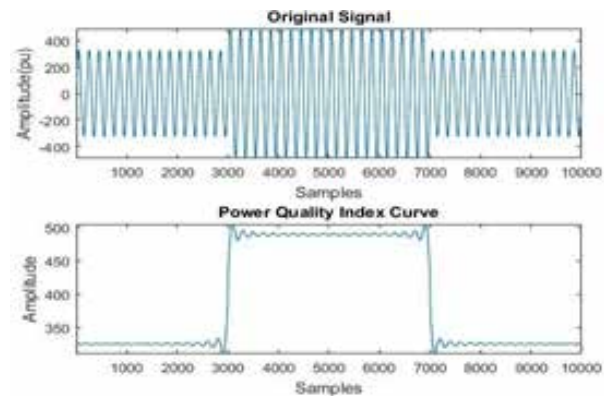
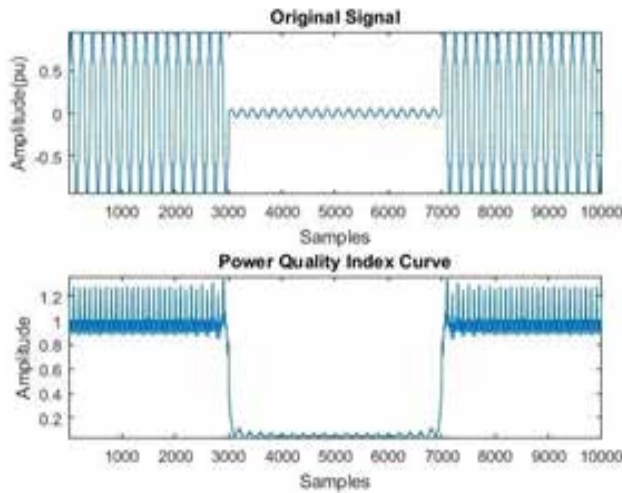


Fig 8 PQ Index Curve for Voltage Swell with Harmonics



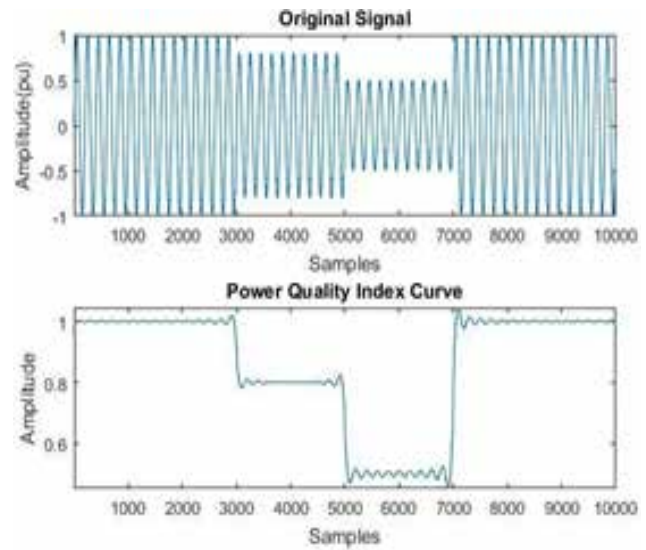
The voltage signal with harmonic interruption that was created by simulating the mathematical equations in MATLAB is being subjected to the Hilbert transform. Calculating the absolute value from Hilbert transform's yields the PQ index curve. The waveform of a signal containing a voltage interruption harmonic, and PQ index curve is shown in Figure 9. The harmonic voltage interruption and reduction in PQ index curve is obtained between duration 0.3 to 0.7 seconds as shown in figure 9.



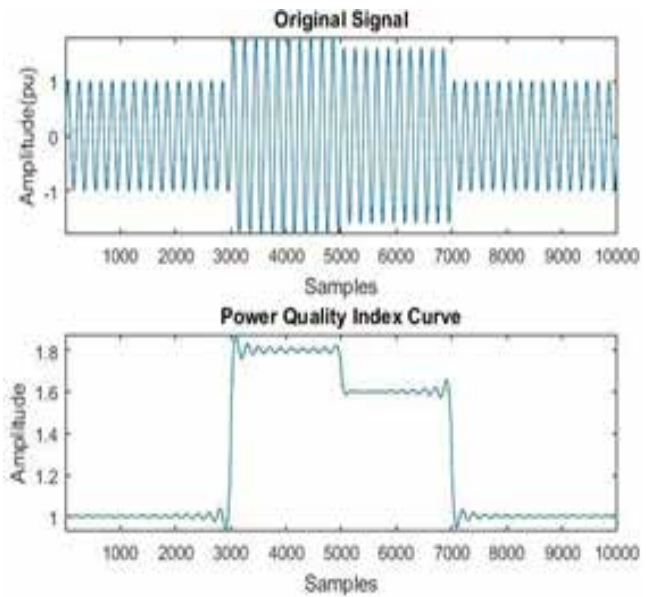
**Fig 9 PQ Index Curve for Voltage Interruption with Harmonics**

The voltage signal with multistage voltage sag that was created by simulating the mathematical equations in MATLAB is being subjected to the Hilbert transform. Calculating the absolute value from Hilbert transform's yields the PQ index curve. The waveform of a signal containing a multistage voltage sag, and a PQ index curve is shown in figure 10. In first stage the PQ index curve drop from 0.3 to 0.5 seconds again in second stage PQ index curve drop from 0.5 to 0.7 sec.

The voltage signal with multistage voltage swell that was created by simulating the mathematical equations in MATLAB is being subjected to the Hilbert transform. Calculating the absolute value from Hilbert transform's yields the PQ index curve. The waveform of a signal containing a multistage voltage swell and a PQ index curve is shown in Figure 10. In first stage the PQ index curve increase from 0.3 to 0.5 seconds again PQ index curve increase from 0.5 to 0.7 sec.



**Fig 10 PQ Index Curve for Multistage Voltage Sag**



**Fig 11 PQ Index Curve for Multistage Voltage Swell**

The voltage signal with multistage voltage swell sag that was created by simulating the mathematical equations in MATLAB is being subjected to the Hilbert transform. Calculating the absolute value from Hilbert transform's yields the PQ index curve. The waveform of a signal containing a multistage voltage swell and sag and a PQ index curve is shown in figure 12. In first stage the PQ index curve increase from 0.3 to 0.5 sec again in second stage PQ index curve decrease from 0.5 to 0.7 sec.

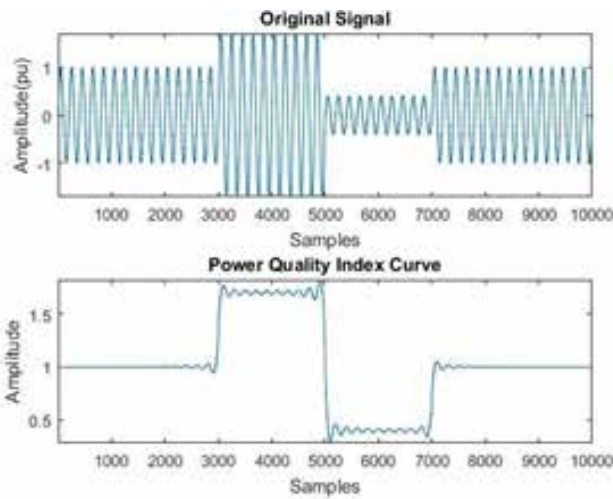


Fig 12 PQ Index Curve for Multistage Voltage Sag with Swell

Table 2. Features Extracted from PQ Index Curves

PQ Disturbances	F1	F2	F3	F4
Voltage Sag Harmonics	0.91079	1.68467	0.06897	0.26262
Voltage Swell Harmonics	327.0745	1.18059	6359.913	79.7490
Voltage Interruption Harmonics	0.91101	1.27345	0.22256	0.47177
Multistage Voltage Sag Swell	1.00001	2.56209	0.16833	0.41028
Multistage Voltage Sag	0.99770	2.45786	0.03820	0.19547
Multistage Voltage Swell	1.00444	1.39493	0.12126	0.34822

**CLASSIFICATION RESULTS OF PQDS**

The values of the features F1, F2, F3, and F4 extracted from PQ Index Curves are shown in Table II. These features are supplied as input to the thresholding-based algorithm, which uses them to classify the different PQDs. The categorization process starts with the attribute F1. The PQDs considered in the first algorithm are voltage sag with harmonics, voltage swell with harmonics and voltage interruption with harmonics. First group consists of voltage swell with harmonics whereas the second group consists of the voltage sag with harmonics and voltage interruption

with harmonics. Figure 6.1 shows the classification of multiple PQDs using the thresholding-based algorithm.

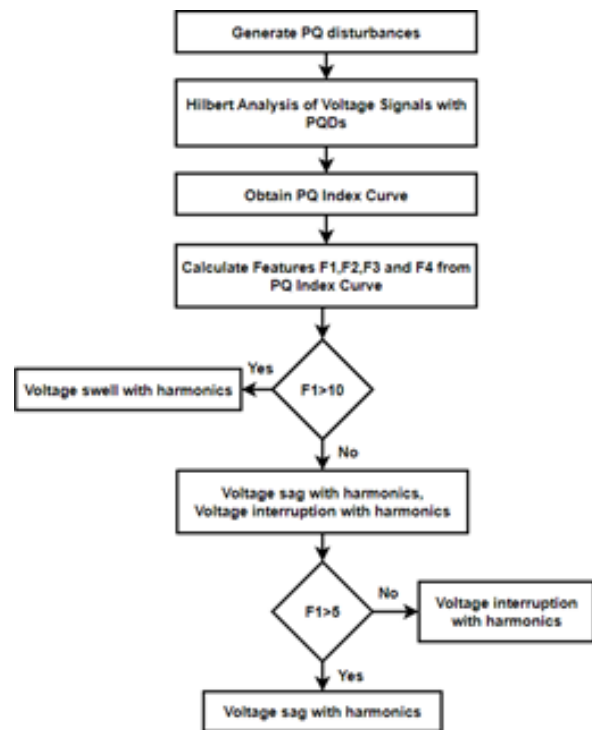


Fig 6.1 Algorithm for Classification of Multiple PQ D

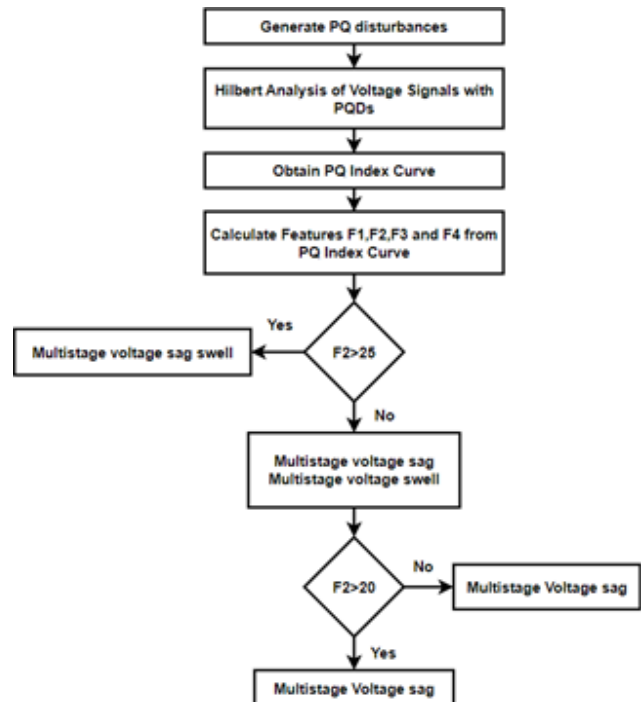


Fig 6.2 Algorithm for Classification of Multistage PQDs



The values of the features F1, F2, F3, and F4 extracted from PQ Index Curves are shown in Table II. These features are supplied as input to the thresholding-based algorithm, which uses them to classify the different PQDs. The categorization process starts with the attribute F2. The PQDs considered in the second algorithm are multistage voltage sag, multistage voltage swell and multistage voltage sag with swell. First group consists of multistage voltage swell with sag whereas the second group consists of the multistage voltage sag and multistage voltage swell. Figure 6.2 shows the classification of multistage PQDs using the thresholding-based algorithm.

## CONCLUSION

In this study, an algorithm for classifying multiple and multistage PQ disturbances is presented that makes use of Hilbert transform and a thresholding based algorithm. The main aim of this study is to generate complex PQ disturbances using integral mathematical equations implemented in MATLAB software and classify them accurately. Using the Hilbert Transform, the voltage signals with PQ disturbances derived via mathematical modelling are processed. The features that can be derived from the Hilbert transform are fairly straightforward but very powerful. The Hilbert transform may be calculated quickly, making the suggested method more effective. The features extracted from the PQ Index Curve are found to be sufficient to accurately classify the complex PQ disturbances with ease. The thresholding based algorithms classifies both multiple and multistage PQ disturbances. The proposed approach gives satisfactory results. Overall the algorithms developed are less complex. The proposed technique has been found to be successful in classifying the various complex PQ disturbances.

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# Review on Drug Pill Recognition System using Machine Learning

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## ABSTRACT

Machine learning (ML) is a type of artificial intelligence (AI) that allows software applications to make more accurate predictions without being explicitly programmed to do so. Ageing is a process that is often characterized by a loss of abilities such as vision or memory. These changes can interfere with daily tasks, often resulting in dangerous situations for older adults. One of the most significant risks is associated with the incorrect intake of medication or forgetfulness, which can pose a real threat to the health and life of seniors. Furthermore, the current technological solutions for this problem are designed for professionals or the general public and do not address the specific needs of seniors. To address this lack of support, a proposed image processing tool will be presented, representing the first steps towards a larger toolkit customized for seniors, currently under development. The proposed procedures involve image acquisition and pill characterization based on its shape, dimensions, and color. The system uses these options within the learning step to describe and store pill data on native information. Later, within the recognition step, the same options are determined and compared against information to produce the user with relevant data connected with the pill beneath recognition.

**KEYWORDS:** *Health care; Visually impaired; Drug pill recognition; Image processing; CNN*

## INTRODUCTION

As individuals grow older, they may experience a decline in both their visual and cognitive abilities. This can leave older adults vulnerable to dangerous situations as they struggle to navigate their environment and remember important information. It is usually combined with medication. Elderly people often forget to take their medication or do not take it properly, which can seriously affect their health. Conversely, recognizing this situation can cause a decrease in an individual's self-confidence, leading them to require support to alter this circumstance. The healthcare system is not likely to provide the necessary support, making it challenging for seniors with visual impairments to correctly identify and take their medication. To address this issue, a subset of the larger aged care tool, which utilizes computer vision techniques, has been developed as a solution.

This tool is designed for use on mobile devices and aims to assist seniors in identifying pills, thus promoting their

independence and confidence. The study highlighted the high medical losses that may result from medication errors in patients with low vision, as well as their limited access to adequate support. To mitigate this problem, the proposed system aims to develop a pill detection method specifically for patients with chronic visual impairments, thereby supporting their safe use of medication.

## LITERATURE SURVEY

Several researchers have introduced different approaches to tackle this problem, and a few of these methods are discussed in this section. Several tools have been developed and assessed to assist in the safe utilization of medication, such as medication reminders and pill recognition capabilities. Accurate identification of pills is crucial for patient safety and care. In this article, the recognition and characterization descriptors of pills are analyzed by utilizing the National Library of Medicine (NLM) pill database, which has been recently published. The research paper details the investigation

of algorithms designed to automatically divide images of pills from the National Library of Medicine (NLM), while also extracting various features.. The objective was to group pills based on priority, in accordance with the physical properties recommended by the FDA. [1]

The National Library of Medicine in the United States launched a competition in January 2016 to develop high-quality algorithms and software capable of accurately comparing consumer prescription pill images with those in the authoritative collection. The competition was launched to simplify the process of identifying unfamiliar prescription pills for both healthcare professionals and the general public. Being able to verify pills in scenarios where documentation and medication have been separated, along with image information, can offer considerable advantages. In this context, this paper explores various descriptors for pill detection and characterization, with an emphasis on investigating algorithms for automatically segmenting NLM pill images and extracting several features to group pills based on the priorities of authoritative recommendations for pill physical attributes. [2]

This paper investigates the usage of various machine learning algorithms, including deep neural networks, to create classifiers that can identify personal experience tweets (PETs). Furthermore, it presents and examines a method called Deep Granulator that seeks to improve the analysis outcomes. [3]

The system comprises four elements: an intelligent drug recognition device, an Android mobile application, a deep learning training server, and a cloud-based management platform. Currently, the system can detect 80 different types of drugs. [4]

The service concept aims to promote independent management of daily medication regimens for older people with visual impairments. This is achieved by enabling them to identify medications and access personalized medication information. [5]

To demonstrate the feasibility of the service concept, an initial prototype called Blind NFC was created. This prototype featured an NFC-enabled PDA that could audibly announce the medication name and dosage information upon contact with the medication package. The study's results indicated that older users could readily comprehend and use the touch- and audio-based system's essential features.

## SYSTEM ARCHITECTURE

Our drug pill detection system operates in two distinct modes. The first mode involves creating and storing pill profiles, which begins by capturing an image that includes the marker and pill. Image acquisition comprises retrieving the image from a source and resizing it to a standardized size. Upon detecting the marker, the system identifies the pill by analyzing its shape, size, and color, and saves all pertinent information in its database for subsequent retrieval.

The Testing mode focuses on identifying pills by utilizing the pill profile and filtering task. Testing mode begins by acquiring and resizing images, similar to the Training mode. Upon detecting the marker, the system segments the pill and performs the filtering task. After estimating the shape, the system searches for the corresponding shape in the database.

Ultimately, the remaining pills undergo color determination to facilitate the application of a color filter. The procedure can result in three types of outcomes: no pill detected, detection of a single pill, or detection of multiple pills.

The size is computed to filter the present pill based on its dimensions and height. Then, the remaining pill is subjected to color determination to apply a color filter. The process can culminate in one of three outcomes: no pill detection, detection of a single pill, or detection of multiple pills.

### Working of System Architecture

Initially the drug pills are undergoing the training phase in order to move further. The drug pill is scanned with the phone hardware i.e. the camera to store and train the pill for precise analysis here the first block comes in picture, to capture the images of drug pill to train accordingly.

In the second phase, size normalization the size of the pill is determined according to the set criteria and all the extra background is removed from the captured image. For this process canny edge detection algorithm is used to minimize the area of the pill being captured.

In the marker detection block optical character recognition algorithm is implemented to identify the

markers, pattern present on the pill after that the pill is characterized based on the color, size, etc. The drug pill is segmented from the other pills, size estimation and matching is done after which the pi is determined with the help of SIFT algorithm. Once the pill is determined it gets stored in the database as per the user id. The testing mode is same way performed once the pill is trained.

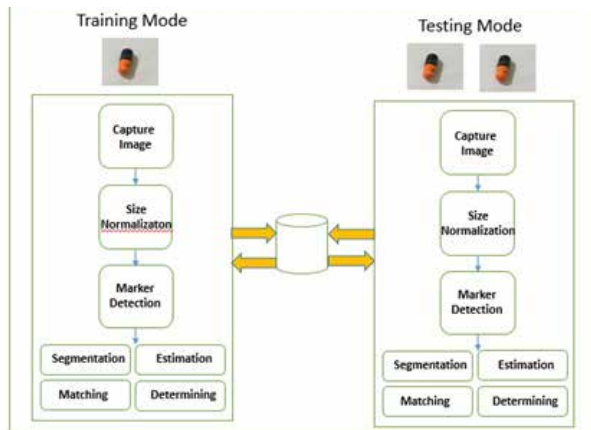


Figure 1: System Architecture

**Algorithm**

Scale-invariant feature transform (SIFT)

The Scale-invariant feature transform algorithm consists of four main steps: selecting a scaled peak in the space used for the potential feature search position. Key point localization is the process of accurately determining the location of a function’s key points. Orientation assignment involves assigning an orientation to these key points. A multidimensional vector represents the key point descriptor. Key point matching is then employed to match key points between two images by identifying their closest neighbors. An example of this is the scale-invariant method used to locate key points that are invariant to scale and rotation.

Working of SIFT Algorithm:

- Step 1: Firstly, it starts with data points that are assigned to the drug pill.
- Step 2: The algorithm will now compute the points.
- Step 3: The algorithm classifies the key points.
- Step 4: The process is iterated and moved to the next identification.

Step 5: Lastly, the key points are matched between the two images.

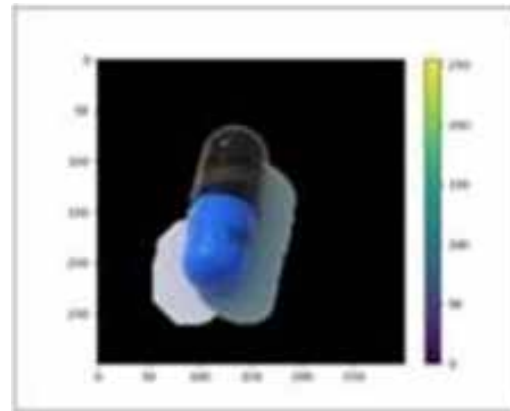


Figure 2: SIFT Example [3]

**Canny Edge Detection**

The Canny Edge Detector is an edge detection method that utilizes a multi-pass algorithm to identify a range of edges in images. Gaussian is applied to diminish the impact of noise in the image. The process then involves reducing potential edges to 1-pixel curves by eliminating pixels with non-maximum gradient size.

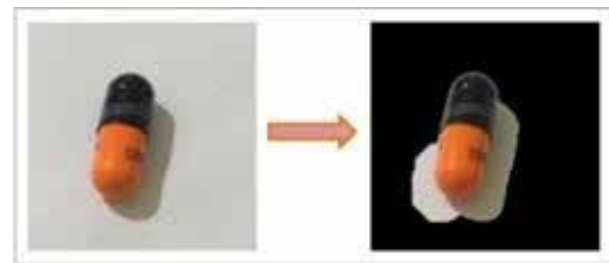


Figure 3: Canny Edge Detection

**3. Optical Character Recognition (OCR)**

Optical Character Recognition involves identifying optical patterns in a digital image. Character recognition is achieved via segmentation, feature extraction, and classification. These are the essential steps involved in the OCR process:

- 1) Extract character boundaries from an image.
- 2) Create a convolutional neural network (ConvNet) to store character images.
- 3) Load a trained model of a convolutional neural network (ConvNet).



- 4) ConvNet Consolidation of character prediction.  
Example: Character Recognition on pills using OCR algorithm.



**Figure 4: OCR**

### Text to Speech

The algorithm utilizes a text-to-speech conversion process to generate audio output from text input. The model takes the input text and processes it through multiple stages or blocks until it is transformed into audible sound.

### Mathematical Model

- a. Let S be the whole System,
- b.  $S = \{X, Y, Z\}$
- c. X=Input Y = Procedure Z= Output
- d.  $X = \{X0, X1, X2, X3, X4, X5, X6, X7\}$
- e. X0 = Drug Pill Image
- f. X1 = Trained Module
- g. X2 = Gray Scaled Image
- h. X3= Background Subtracted Image
- i. X4 = Height, Width of Drug Pill
- j. X5 = Color of Image
- k. X6 = Text on Pill
- l. X7 = Drug Information
- m.  $Y = \{Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7\}$
- n. Y0 = Capture Image
- o. Y1 = Convert Image to Grayscale
- p. Y2 = Subtract Image Background
- q. Y3=Get the color of the Image (Drug Pill)

- r. Y4 = Read Text on Pill
- s. Y5 = Classify Pill
- t. Y6 = Fetch Information of Pill.
- u. Y7 = Convert Information to Voice Format
- v.  $Z = \{Z0\}$
- w. Z0 = Pill Information in Voice Format

### CONCLUSION

Our aim was to create a machine learning-based system for recognizing drug pills, with the objective of helping individuals with visual impairments and chronic illnesses to take their medication safely. Consisting of an AI-powered smart pill recognition box, a mobile application, and a cloud-based information management platform, the system enables the uploading of medication information and the creation of medication-use records.

By utilizing the mobile app, caregivers or family members can monitor the medication status of visually impaired chronically ill patients, reducing the risk of drug interactions caused by taking the wrong medication. This results in cost-effective medical treatment and creates a secure medication environment for individuals with visual impairments and chronic illnesses.

### ACKNOWLEDGEMENT

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Additionally, we acknowledge the support and resources provided by our institution/organization, which made this survey paper possible.

### Notes

The information presented in this survey paper is based on the available literature and resources as of cutoff. Any developments or updates to the systems discussed after this date may not be included.

The evaluation and comparison of the various drug pill recognition systems may depend on the specific metrics and criteria used, and therefore, the results presented

in this paper may not be directly comparable to other evaluations conducted using different methods.

This survey paper aims to provide an overview of the current state-of-the-art in drug pill recognition systems, but it is not an exhaustive review of all available systems. Other relevant systems may exist but were not included in this survey paper due to limitations in scope or availability of information.

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# OpenGLicious: A Visual Journey Through the Power of OpenGL

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## ABSTRACT

It is essential to set up an application system in 3D simulation in advance in order to present and manage the project in a thorough and visual manner. OpenGL is a powerful and widely used graphics library that allows developers to create 2D and 3D graphics for a variety of applications. Originally developed by Silicon Graphics in the early 1990s, it has since been maintained and updated by a community of developers. The library provides a set of functions for creating and manipulating graphics, including rendering polygons, applying textures and lighting, and performing transformations. In order to develop, encourage, and transmit the use of green energy through promoting basic and applied research in the field of renewable energy, we have developed an application using OpenGL for educational purposes that showcases the use of renewable energy sources.

**KEYWORDS:** *OpenGL; 3D graphics; Visual effects; Computer graphics*

## INTRODUCTION

The usage of non-renewable energy sources like fossil fuels, oil and gas, and so forth harms the ecosystem greatly. Electrical energy is used so frequently in modern civilization that it has permeated every aspect of our existence. As a result, we must power our cities with renewable sources of energy. Energy is required for many things, including lighting and heating [1]. Additionally, modern scientific and technological advancements have made it possible to transform electrical energy into preferred forms and vice versa. Energy and related services are increasingly needed to support modern economic and social growth, and wellness. Returning to renewable energy sources is a great strategy for reducing the impact of climate change, but it must be feasible so as to meet the next generation's energy demands [2].

Knowing these issues about the sustainability of such sound amounts of non-renewable resources is one of the highest priorities that the upcoming generations have to come up with. To facilitate a better life for the

future generations we need to come up with awareness ourselves about how to use these resources in the utmost care and conscious. To achieve such a goal, we need to have a thorough knowledge about such limitations. This is where the power of OpenGL comes into play so as to provide better visuals and graphics that may not only make us understand how does something look but also help us simulate the various types of conditions and parameters that might come into play; something that may not be feasible to achieve in the real world solely for training and research purposes. This limitation can be solved by using the power of OpenGL.

The field of computer graphics has experienced significant growth in recent years due to advancements in hardware and software technologies. The ability to create realistic 3D graphics and visual effects has become an essential component of many applications. One of the most widely used tools for creating 3D graphics is OpenGL. It is a reliable professional 3D application programming interface, a cross-platform graphics library that provides a wide range

of functions and tools for creating and rendering 3D graphics [3]. Currently, it serves as the benchmark for creating 3D graphics. For example, it is used in the military, television broadcasting, CAD/CAM/CAE, entertainment, artistic mold-making, and the creation of medical images. It is also simple to realize the model's transforming, coloring, lighting, appearance, interactive operation, cartooning, and other features. Additionally, it had been widely used in virtual reality systems and computer simulations.

In this research paper, we explore the process of creating a 3D sphere with OpenGL, highlighting the different techniques and tools used to create a realistic and engaging visual experience. Our focus is on using OpenGL to create visual effects that simulate the interaction of light and shadow with the 3D object, as well as how to incorporate the 3D sphere into a larger scene with other objects and effects. It can be used as a simulation tool to make visualize the application for educational purpose as highlighted with an example in the future sections of this document.[4].

We start by reviewing over OpenGL's background and development, including its various versions and enhancements. Additionally, we go over the basic terms and ideas of computer graphics, such as the use of meshes, textures, and shaders. The methods and resources utilized to generate a 3D sphere with OpenGL are then briefly discussed. The geometry, texture, and lighting of the 3D sphere, as well as other elements, are all covered in this discussion. We also go through the various shader types, such as vertex, fragment, and geometry shaders, that are employed to produce various visual effects [5].

We then explore the benefits and limitations of using OpenGL in this project. The benefits include improved visual quality, cross-platform compatibility, flexibility, interactivity, performance, and educational value. The limitations include hardware and software compatibility issues, a steep learning curve, and time-consuming development.

Finally, we go through the potential real-world uses for OpenGL in 3D graphics development as well as its future possibilities. We examine the applications of OpenGL in a variety of fields, including the creation of video games, architecture and engineering, medical

visualization, virtual and augmented reality, as well as education and training. We also discuss the latest advancements in OpenGL and related technologies, including Vulkan, WebGL, and WebGPU [6].

Through this research paper, we aim to provide a comprehensive overview of the use of OpenGL in creating 3D graphics and visual effects. We hope to contribute to the growing body of knowledge in this exciting and dynamic field and inspire future research and innovation [7].

## METHODOLOGY

Open Graphics or OpenGL is a popular open-source visual graphics library that allows you to create a wide range of projects, including ones that involve visuals. The methodology of using Open GL to create templates depends on the specific application and the type of visual being designed. However, here are some general steps to consider when working on projects using OpenGL:

- I. Setting up of an OpenGL development environment: Install an Integrated Development Environment (IDE) such as Visual Studio or Code Blocks and the necessary libraries such as the OpenGL Utility Toolkit (GLUT).
- II. Create a window: Use the GLUT library to create a window that will display your graphics.
- III. Set up the OpenGL context: Use the OpenGL function calls to initialize the OpenGL context.
- IV. Define your scene: Use OpenGL function calls to define your scene, including defining objects, applying textures, and setting up lighting.
- V. Write the shaders: Use the OpenGL Shading Language (GLSL) to write the vertex and fragment shaders that will be used to render your scene.
- VI. Set up the rendering pipeline: Use the OpenGL function calls to set up the rendering pipeline, including setting the vertex and fragment shader programs and configuring the blending, depth testing, and culling options.
- VII. Render your scene: Use the OpenGL function calls to render your scene and display it in the window.
- VIII. Handle user input: Use the GLUT function calls

to handle user input, such as keyboard and mouse events.

- IX. Clean up: Use the OpenGL function calls to release any resources used by the application and close the window.

**PROCEDURE**

The procedure for working with visuals using Open Graphics Library can vary depending on the specific application and type of graphic being processed. However, here are some general steps to follow when working with graphics using Open GL:

1. Identify the type of your design: Determine whether you want the design in a 2d image or a 3d visual.
2. Choose the appropriate environment: Select an Integrated Development Environment (IDE) that has the necessary OpenGL libraries and tools for your platform to build an outline for your design.
3. Write the code: Write the code to read and process the input. Use the appropriate library functions to read our given code inputs.
4. Test and iterate: Test the code to ensure that it is working correctly. Iterate on the design as needed to improve the accuracy and smoothness of the design.
5. Overall, the procedure for working with OpenGL involves selecting the correct environment, connecting it to the library functions, writing and testing the code to read and look at the look of the design, and outputting the visuals to the main page.

Open Graphics Library (OpenGL) is an Application Programming Interface (API) that allows developers to generate high-quality 3D graphics in real-time. Among the many 3D objects that can be created using OpenGL, a sphere is one such object that is commonly rendered. Creating and rendering 3D objects, including spheres, using OpenGL requires a solid understanding of mathematical concepts such as trigonometry and linear algebra. Defining a sphere in OpenGL involves determining its geometry and surface properties, including its center, radius, the number of vertices that make up its surface, its color, texture, and reflectance. Creating a sphere using OpenGL involves creating

a mesh of triangles to approximate the surface of the sphere, based on mathematical formulas such as the parametric equations for a sphere.

Rendering a sphere using OpenGL requires setting up a rendering pipeline, which includes a projection matrix, a model view matrix, and a fragment shader. The projection matrix defines how the 3D scene is projected onto a 2D screen, while the model view matrix defines the position and orientation of the sphere within the 3D scene. The fragment shader is responsible for computing the color and other surface properties of each pixel that makes up the sphere, by applying lighting and shading calculations to the surface normal of each point on the sphere’s surface. Developing and rendering 3D objects using OpenGL requires knowledge of computer graphics programming, OpenGL programming interfaces, graphics libraries, and graphics hardware capabilities. By understanding these concepts and techniques, developers can create stunning and realistic 3D graphics in real-time using OpenGL. The solar system model can be demonstrated using these visualizations to help pupils understand it. Eq [1-9], elaborates the parameters used for creating the visualization of the sphere.

Parametric equations for a sphere:

$$x = r \times \sin \theta \times \cos \varphi \tag{1}$$

$$y = r \times \cos \theta \times \sin \varphi \tag{2}$$

$$z = r \times \cos \theta \tag{3}$$

Equation of a plane:

$$Ax + By + Cz + D = 0 \tag{4}$$

Equation for a surface normal:

$$n = \left( \frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial f}{\partial z} \right), \tag{5}$$

where F is the surface

Equation for computing the dot product of two vectors:

$$a \cdot b = |a| \times |b| \times \cos \theta \tag{6}$$

Equations for computing the cross product of two vectors:

$$a \times b = (aybz - azby, azbx - axbz, axby - aybx) \tag{7}$$

Equations for computing the length of a vector:



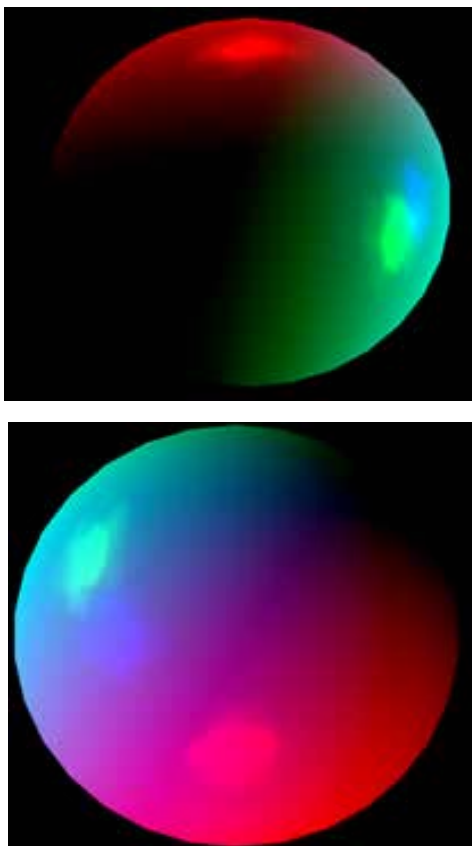
$$|v| = \sqrt{vx^2 + vy^2 + vz^2} \tag{8}$$

Equations for computing the unit vector of a vector:

$$u = \frac{v}{|v|} \tag{9}$$

### RESULTS AND DISCUSSIONS

With powerful features of Open Graphics Library, you can bring your images to life, imbuing them with the ability to sense and react to changes in the parameters you set. Imagine your creations changing colors or shapes in real-time as you adjust the settings, adding a whole new level of excitement and stimulation to your work. Whether you're looking to edit a single image, craft a blockbuster film, or develop a cutting-edge graphical solution, OpenGL is the ultimate tool to help you achieve your goals. Figure 1. Shows the visual effect that appears for a sphere using OpenGL.



**Figure 1: Spear using OpenGL**

We have also created an application so as to facilitate the use of OpenGL in a simple yet important project so as

to highlight how our solar system looks. Figure 2 shows the application view on mobile which is user friendly and can be used by students to acquire information about planetary system. The reason to choose such a project is to highlight the fact that we need to impart such knowledge with better look and feel at a very early age which later can be expanded on much more complex experiments and explanations with profuse and a deep sense of understanding.



**Figure 2: Mobile App**

Similarly, many of the middle school as well as high school concepts involving atoms, optics and other primary concepts can be used for elaboration using this technology.

### DISCUSSION

When creating a 3D sphere in OpenGL, there are several helpful hints that can be used to ensure that the sphere is rendered correctly and looks visually appealing.

The first step is to use the right number of vertices. The number of vertices used to create a sphere can have a significant impact on the final appearance of the sphere. Using too few vertices can result in a low-polygon sphere with a blocky appearance, while using too many vertices can result in a sphere that is computationally expensive to render. Generally, it is recommended to use a number of vertices that is divisible by 3, as triangles are typically used to create the surface of the sphere. This ensures that the sphere is smooth and looks visually appealing.

The second step is to consider texture mapping. Texture mapping can have a significant impact on the final appearance of the sphere. When applying a texture to the surface of the sphere, it is important to ensure that the texture is properly aligned with the surface of the sphere. This can be achieved by using appropriate texture coordinates and ensuring that the texture is properly scaled and centered. Additionally, it is important to choose a texture that is high quality and matches the intended appearance of the sphere.

The third step is to use lighting to enhance the appearance of the sphere. Lighting can be used to enhance the appearance of the sphere and make it look more realistic. By using lighting, it is possible to simulate the way that light interacts with the surface of the sphere, creating highlights and shadows that add depth and dimensionality to the sphere. This helps to make the sphere look more three-dimensional and visually interesting.

The fourth step is to use appropriate colors. The color of the sphere can have a significant impact on its appearance. When choosing colors, it is important to consider the lighting and texture mapping used in the scene. It is also important to consider the overall color scheme of the scene and ensure that the colors used in the sphere complement the colors used in the rest of the scene. This helps to create a cohesive and visually appealing scene.

The fifth step is to optimize performance. When rendering a sphere in OpenGL, it is important to optimize performance in order to ensure that the sphere is rendered quickly and efficiently. This can be achieved by using appropriate data structures, minimizing the number of draw calls, and using appropriate culling techniques to minimize the amount of geometry that needs to be rendered. By optimizing performance, the sphere can be rendered quickly and efficiently, ensuring that it can be used in real-time applications such as games and simulations.

Overall, by keeping these helpful hints in mind and carefully considering the geometry, texture mapping, lighting, color, and performance of the sphere, it is possible to create a visually appealing and realistic 3D sphere using OpenGL.

## FUTURE SCOPE

One area of future development is the use of advanced shading and lighting techniques to improve the visual quality of the rendered sphere. Currently, the surface properties of the sphere are defined using basic color and texture mapping techniques, which can result in a relatively flat appearance. By implementing advanced shading techniques such as bump mapping, normal mapping, and parallax mapping, it is possible to add more depth and realism to the surface of the sphere. These techniques involve simulating the way light interacts with the surface of the sphere and can create the appearance of bumps, grooves, and other surface irregularities.

Another area of future development is the use of higher-order surfaces to create more complex 3D objects. Currently, spheres are created using a mesh of triangles, which can limit the complexity of the object. By implementing higher-order surfaces such as Bezier surfaces or NURBS (Non-Uniform Rational B-Splines), it is possible to create more complex 3D objects with smoother surfaces and more intricate shapes.

In addition to these areas of future development, there are also opportunities for improving the performance of the sphere rendering process. Currently, the sphere is rendered using a set of predefined vertices, which can limit the flexibility of the rendering process. By implementing dynamic mesh generation techniques, it is possible to create a sphere with a variable number of vertices, allowing for greater control over the level of detail and the performance of the rendering process.

Also, another potential area for future development is the integration of 3D spherical rendering with other computer graphics applications such as virtual reality and augmented reality. This integration can lead to more immersive and interactive 3D environments and applications such as 3D games, simulations and learning tools.

In conclusion, the possibilities for rendering 3D spheres using OpenGL are vast and promising, with many opportunities for further development and improvement. By exploring these areas of the future, we can create even more visually appealing and realistic 3D graphics and applications.

## CONCLUSION

In conclusion, this project has successfully implemented a 3D sphere in OpenGL, taking into consideration several helpful hints to ensure that the sphere is rendered correctly and looks visually appealing. By using the right number of vertices, considering texture mapping, using lighting to enhance the appearance, choosing appropriate colors, and optimizing performance, we were able to create a visually appealing and realistic 3D sphere.

Furthermore, the project has immense potential for future scope, such as incorporating more complex geometries and textures, using advanced lighting and shading techniques, and implementing interactivity to allow users to manipulate and explore the 3D sphere. The project can also be extended to incorporate other programming languages and frameworks, allowing for cross-platform compatibility and greater versatility.

This project has not only offered a workable implementation of 3D graphics in OpenGL but also laid the groundwork for further study and advancement in the area of computer graphics. We will utilize visualization to demonstrate the benefits and applications of solar energy that may be used for education. The potential applications for this technology range from creating immersive virtual environments for gaming and entertainment to cutting-edge scientific visualization tools. With further research and development, the possibilities are truly endless.

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# Sentiment Analysis of IMDB Movie Reviews

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## ABSTRACT

From the last 10 years, popularity of social media has increased at an alarming rate. Everyone is utilizing technology at higher rates than earlier. People are now sharing their emotions and opinions on social media sites allowing others to know what they think about a particular thing. Many companies are utilizing the data from various websites to generate meaningful information out of it which can be further used for business purposes. Huge textual data is available on sites like Amazon, IMDB, Rotten Tomatoes on movies and analyzing such massive data manually is a tedious task. So, to speed up the process, programmers use certain techniques to extract out public opinion. One of which is using sentiment analysis. Sentiment analysis is a submodule of opinion mining where the analysis focuses on the extraction of text and opinions of the people on a particular topic. We are making use of IMDB reviews on movies to predict how the users have rated the movies and predict the movies that have a positive or negative review. We proposed a model that includes different sentiment analysis methods which will help us to extract useful information from the data and predict which is the most suitable classifier for this particular domain by looking at accuracy. Models like Naïve Bayes, Support Vector Machine and Logistic regressions. Due to the lack of strong grammatical formats in movie reviews which is an informal jargon we also take into account the N-Grams and count vectorizer approach. Tokenization is used to transfer the input string into a word vector, stemming is used for extracting the root of the words, while feature selection fetches the essential word and lastly classification is used to classify the movie as positive or negative.

**KEYWORDS:** *Sentiment analysis; N-Grams; Count vectorizer; Tokenization; Stemming; Naïve Bayes; Logistic regression; Support vector machine; Accuracy*

## INTRODUCTION

**M**ovies are the most convenient ways to the people for entertainment. But only a few movies are successful and are rated high. There are many ratings websites that will help the movie fanatics to decide which movie they should watch and which they should not. Websites like IMDB, Rotten tomatoes, etc. are the leading ones amongst those. The rating on these websites determine the success of the movie by giving it a score out of 10 based on the stars given by the viewers. But, there isn't any method that can provide the prediction based on movie reviews. So, to determine the success of the movie based on reviews, sentiment analysis comes into picture.

Sentiment analysis is the interpretation and classification of emotions within text data using text analysis

techniques. Sentiment analysis allows businesses to identify customer sentiment toward products, brands or services in online conversations and feedback. Sentiment analysis models focus on polarity (positive, negative, neutral) but also on feelings and emotions (angry, happy, sad, etc), and even on intentions (e.g. interested v. not interested). Sentiment analysis has become a hot topic and many big companies are investing their resources to predict the results for their businesses.

The working principle of sentiment analysis includes tokenization, word filtering, stemming and classifications. In tokenization, text needs to be segmented into units such as words/ numbers or punctuations. Next step stemming which is the process of removing prefixes and affixes to convert a particular



word into its stem. After preprocessing, we analyze the dataset by performing classification using Naïve Bayes, Support Vector Machine and Logistic Regression. Here, we determine the best model based on accuracy. Hence, We analyze and study the features that affect the scores of our review text and finally classify the movie as positive or negative.

## RELATED WORK

1. Unggul Widodo Wijayanto, Riyanarto Sarno: This paper focuses on supervised methods. To improve the quality authors have also utilised CHI2 and stop words. Models like K-folds, cross validation to get results. The authors conclude that context-based stop words enrich the number of stop words that removes bias features. [3].
2. Sourav Mehra, Tanupriya Choudhary: In this paper authors have implemented SVM and Naïve Bayes and comparison is done between by observing the accuracies of the model They have taken data of IMDB movie reviews which possess of 25000 each for positive and negative provided by the Cornell University The authors concluded by stating that SVM has better accuracy over Naïve Bayes 87.33%. [5].

## DATA DESCRIPTION

We have gathered data from [7] which includes a dataset that has 50000 reviews from IMDB which is equally divided into 25000 for training and testing. There are only 30 reviews per movie as reviews for the same movie tend to have correlated ratings. Furthermore, the train and test sets contain a disjoint set of movies so memorizing a particular movie terms and their associated labels would have no significance. A negative review is given a score of  $\leq 4$  out of 10 while a positive one holds a score of  $\geq 7$  and a neutral review has scores from  $>4$  and  $<7$ .

## PROPOSED FRAMEWORK

The proposed framework for our model includes data cleaning, data pre-processing, applying classifiers on the data and finally comparing the results from the different classification models we used.

## Data Pre-Processing

In order to improve the performance of our model we have done some operations on the data that we have collected. We have removed the unnecessary noise from the data which will help in classification of our model. It includes the following procedure:

- **Removing HTML tags:** The dataset has some unnecessary html tags which might affect the accuracy of our model. Hence, we have used regex to remove the tags.

```
def rmvhtmltags(text):
    remreg = re.compile('<.*?>')
    cleartext = re.sub(remreg, '', text)
    return text

def remove_urls (vTEXT):
    vTEXT = re.sub(r'(https|http)?://(\\w|\\.|\\/|\\?|\\=|\\&|\\%)*\\b', '', vTEXT, flags=re.MULTILINE)
    return(vTEXT)
```

- **Lemmatization:** It is a process of converting the given word to its root word. The main objective of lemmatization is to get proper morphological meaning of a word by referring it to the dictionary which is incorporated in the library. We have used wordnet and porter stemmer lemmatization.

```
def lemmatize_words(text):
    lemmatized_words = [lemmatizer.lemmatize(word, 'v') for word in text.split()]
    return(' '.join(lemmatized_words))
```

- **Removing Stop words and special characters:** The data consist of stop words like “a”, “the”, “this”, “that”, etc. These words mostly appear in a lot of reviews and are unimportant.

```
def rmvspclcharacter(text):
    clearspcl = re.sub(r'^A-Za-z0-9\\s.', r'', str(text).lower())
    clearspcl = re.sub(r'\\n', r' ', text)

    clearspcl = " ".join([word for word in text.split() if word not in stopWords])
    return text
```

- **Text Tokenization:** Tokenization is the process of tokenizing or splitting a string, text into a list of tokens. One can think of a token as parts like a word is a token in



a sentence, and a sentence is a token in a paragraph. For tokenization we have used NLTK library. It consists of many languages like German, English, Spanish, French, etc. trained with NLTK. In NLTK word tokenization is a wrapper function that utilizes treebank tokenization and splits the punctuations other than periods.

### Features Extraction

Feature extraction is the process of converting a word into a matrix form. We have used the following approaches for feature extraction:

- **Bag of Words Approach:** The bag-of-words (BOW) model is a representation that turns arbitrary text into fixed-length vectors by counting how many times each word appears. This process is often referred to as vectorization. We have used following method for vectorization:

- **Count Vectorizer:** The process includes a blend of tokenizing a collection of documents from the datasets and then building a set of vocabulary for those words. The result of this is a length of vocabulary words and an integer value assigned for words according to how many times they appear. Words that do not occur may possess zeros as value and are defined as sparse.

### Classification Models

In our experiment we have made use of Naïve Bayes, Logistic Regression, and Support Vector Machine. We have trained our model on the above classifiers to predict the movie polarity as positive or negative.

**Naïve Bayes:** It is a classification algorithm, primarily used for text classification involving high dimensional training data sets. Example spam filtering, sentiment analysis etc. This algorithm learns the probability of an object with certain features belonging to a particular class. It is a probabilistic classifier. This algorithm is called Naive Bayes because it makes a naive assumption that occurrence of certain features is independent of each other which in reality is not the case.

$$P(A/B) = P(B/A) P(A) / P(B)$$

A is called the proposition and B is called the evidence. P(A) is called prior probability of proposition and P(B) is called prior probability of evidence. P(A/B) is called the posterior. P(B/A) is called the likelihood.

$P(A/B)$  = Probability of occurrence of event A, given event B has already occurred

$P(A)$  = Probability of event A  $P(B)$  = Probability of event B

$P(B/A)$  = Probability of occurrence of event B, given event A has already occurred

In Naive Bayes with count Vectorizer we get an accuracy of 85.48%.

```
Training NB model using bag of words
Accuracy on testing dataset is 0.8548
Accuracy on training dataset is : 0.847
```

- **Logistic Regression:** Logistic regression is quite similar to linear regression but here, instead of fitting a line to our data we try to fit 'S' shaped logistic function(SigmoidFunction). Although it's name contains regression, on the contrary it is used for classification purposes. Logistic regression's capability to classify data using continuous and discrete measurements makes it a popular machine learning algorithm. Logistic regression uses something called maximum likelihood to fit data. It can be used to classify samples and can use different kinds of data to classify samples. It can also be used to assess what variables are useful for classifying samples.

Sigmoid function

$$Y = \frac{e^{(b_0 + b_1 * x)}}{1 + e^{(b_0 + b_1 * x)}}$$

Here  $b_0$  is the bias and  $b_1$  is the coefficient for the value  $x$  and  $y$ .

In logistic Regression with Count Vectorizer we get an accuracy of 86.89 %

```
Training logistic regression model using bag of words
Accuracy on testing dataset is 0.8689333333333333
Accuracy on training dataset is : 0.868
```

- **Support Vector Machine:** SVM is a regression and classification algorithm. It constructs a hyperplane or set of hyperplanes in infinite dimensional space to do the classifications. It looks at the extremes of the data set and draws a decision boundary (Hyperplane). SVM is known for its good performance. It finds the distance between the two given observations which is then followed by search for a decision boundary in

order to get distance between the closest members of the separate class. SVM are robust in case of overfitting of the model. Here, we have used SVM from the scikit-learn library. The support vector machines in scikit-learn support both dense and sparse sample vectors as input.

In SVM, with Count vectorizer where we get an accuracy score of 85.29%.

```
Training SVM model using bag of words
Accuracy on testing dataset is 0.8529333333333333
Accuracy on training dataset is : 0.847
```

## RESULTS EVALUATION

We have compared the results of the classification models based on accuracy.

Accuracy: It is simply the ratio of correctly predicted observations to the total number of observations. We can say that the Higher the accuracy, the better the model. The accuracy is given by

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}.$$

The analysis of accuracies of all the models is given below:

nb\_cv = Naïve Bayes with Count Vectorizer = 85.48

svm\_cv = SVM with Count Vectorizer = 85.29

lr\_cv = Logistic Regression with Count Vectorizer = 86.89

Accuracy graph –



## CONCLUSION

The main motive behind this project was to construct a sentiment analysis model that will help us to get a

better understanding of movie reviews that we have collected, We compared the results of the 3 classifiers - Naive Bayes, Logistic Regression and Support Vector Machine (SVM). For Evaluation, we observed the accuracy provided by each model. By evaluating the models, we found out that Logistic Regression gives us the highest accuracy score of 86.89%.

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# Design of MPPT Based Honey Badger Optimization in Photovoltaic System under Shaded Condition

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## ABSTRACT

Design of MPPT Based Honey Badger Optimization in Photovoltaic System under Shaded Condition is proposed in this paper. The concept of this algorithm is derived from behavior of Badger. The badger relies on its keen sense of smell to detect the presence of prey. The proposed HBO algorithm use honey and digging phases to search for prey. Finally, the location of the prey is found is represented by the maximum power point. This algorithm is studied for three configurations of PV system under non-uniform conditions and its performance is compared with the P&O algorithm. The solar MPPT tracking efficiency of the proposed is 97 % which is better than P&O algorithm. This method reduced power loss, more accuracy, less oscillations and less iterations. It is highly efficient and has high economic benefits.

**KEYWORDS:** Photovoltaic system; Maximum powerpoint tracking; Honey badger algorithm; Partial shading; Particle swarm optimization; Boost converter

## INTRODUCTION

Numerous countries provide financial incentives like subsidies and feed-in tariffs, leading to fast development in photovoltaic (PV) power generation (Behrens et al., 2016). The goal of maximum power point tracking (MPPT) is to extract the maximum power from solar PV under varying irradiance and temperature conditions. The MPPT controller can capture the solar energy MPP in different climatic environments, and the system output electric power and efficiency are enhanced effectively. Therefore, the solar energy MPPT algorithm is important and has been developed and studied by many researchers (Mäki & Valkealahti, 2012). Non-uniform irradiance exposure causes P-V curve fluctuations, complicating the MPPT process (Premkumar & Sowmya, 2019).

Soeidat et al., (2019) discussed the classic P&O. This method is simple, easy to implement, and is economically effective, but this method is inefficient in a shaded environment. Jagadeesan et al., (2022) developed a two-stage power regulation (TSPR) MPPT

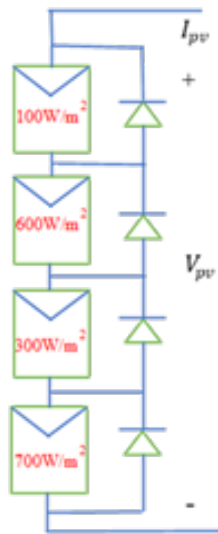
algorithm, which can be adapted to the environment where the sunshine changes quickly and can capture the MPP. However, this method is inapplicable to PSC. Li et al., (2022) proposed an adaptive fast neural (AFN) MPPT algorithm, which can stably capture the MPP. However, this method needs a period of learning with the complex operation, leading to a burden on control systems.

Biologically algorithms like GHO tuning parameter causes undesirable oscillations under complex partial shading conditions (Mansoor et al., 2020). This research proposes an MPPT control method using Moth Flame Optimization (MFO) and tests it under various shading and changing irradiance levels. However, compared to other MPPT methods, MFO-based MPPT takes longer to track the global maxima (Ji-Ying et al., 2019). The Firefly algorithm consistently avoids the local peak, converges rapidly, and exhibits outstanding efficiency (Saad et al., 2022). Nonetheless, the coefficient must be adjusted after each iteration. After an extensive review of MPPT algorithms, the objectives of this work are: (i) reduced oscillations near peak power, (ii) introduction

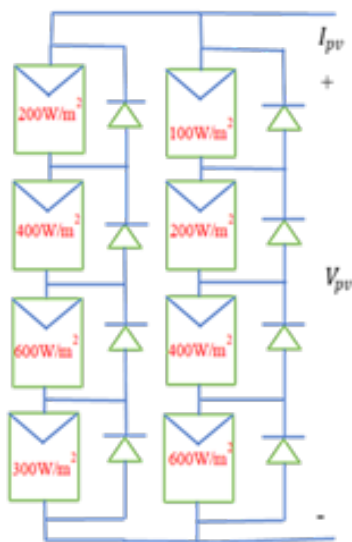
of a new Honey Badger Optimization technique to detect the global peak power for PV modules under partial shading conditions, and (iii) enhanced accuracy.

**SYSTEM DESCRIPTION**

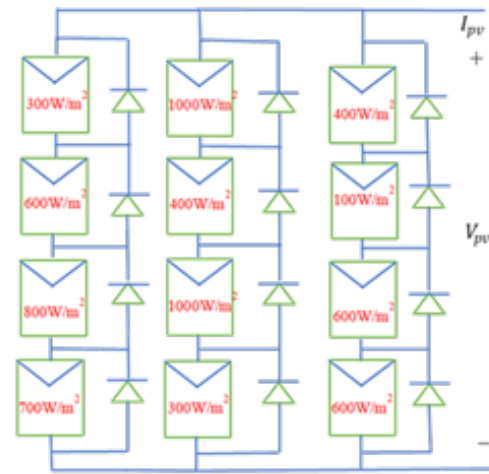
PV modules are interconnected in series and parallel arrangements to achieve the required output voltage and current. Bypass diodes serve to safeguard the array from hotspot conditions (Bidram et al., 2012). Three distinct configurations are considered: Pattern I - One String with Four Panels (4P1S), Pattern II - Two Strings with Four Panels (4P2S), and Pattern III - Three Strings with Four Panels (4P3S), as depicted in Figure 1.



(a) Pattern I- 4P1S configuration



(b) Pattern II- 4P2S configuration



(c) Pattern III- 4P3S configuration

Figure 1. PV configurations under PSC

**PROPOSED GLOBAL MAXIMUM POWER POINT TRACKING ALGORITHM**

**Honey Badger Optimization**

The Honey Badger Optimization (HBO) algorithm emulates the foraging behaviour of honey badgers. These creatures employ two primary strategies to discover food. Subsequently, it circles around the prey to identify the optimal location for digging, often aided by a honey guide bird (Hashim et al., 2022).

Phases for HBO algorithm

Starting phase.

The first step is to initialise the number of honey badgers and the equivalent positions as given by

$$x_i = lb_i + rl \times (ub_i - lb_i) \tag{1}$$

The position update ( $X_{new}$ ) is divided into two parts. 1. Digging phase 2. Honey phase.

Digging phase

The Cardioid motion can be modelled by Eq. (2):

$$x_{new} = X_{prey} + F \times \beta \times I \times X_{prey} + F \times r_3 \times \alpha \times d_i \times (\cos(2\pi r_4)) \times (1 - \cos(2\pi r_5)) \tag{2}$$

Honey phase.

The new position ( $X_{new}$ ) of the prey is given in Eq. (3):



$$X_{new} = X_{prey} + F \times r_7 \times \alpha \times d_i \quad (3)$$

The flow diagram for the standard HBO is shown in Figure 2.

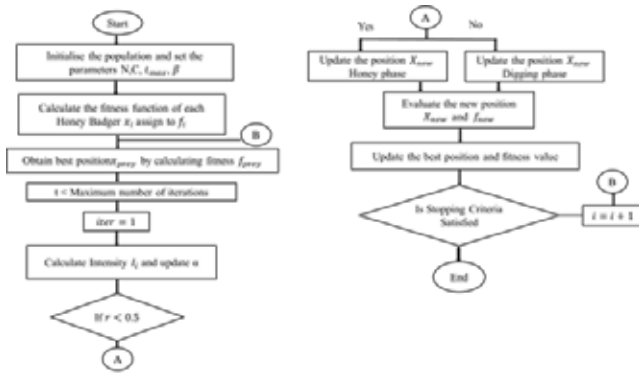


Figure 2. Flowchart for Standard HBO algorithm

### EXPERIMENTAL RESULTS AND DISCUSSION

The experimental setup utilizing the Simulator is depicted in Figure 3. The Chroma 62020H-150S model Simulator is employed to shade the panels. The hardware configuration comprises solar array simulator inputs, a converter, sensors, load, dSPACE DS1103, and DSO. MATLAB/Simulink programming is used for the controller, and the generated code is transferred to the dSPACE DS1103. Considering three different cases namely 4P1S, 4P2S, and 4P3S were experimentally estimated.

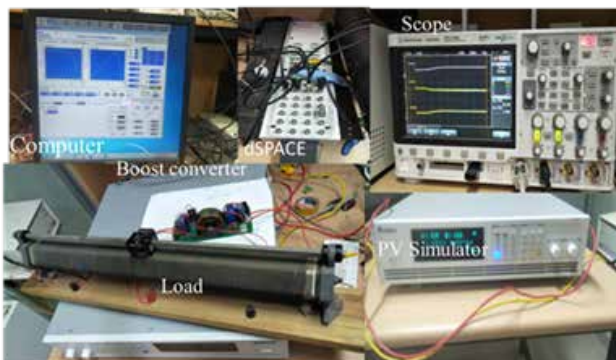
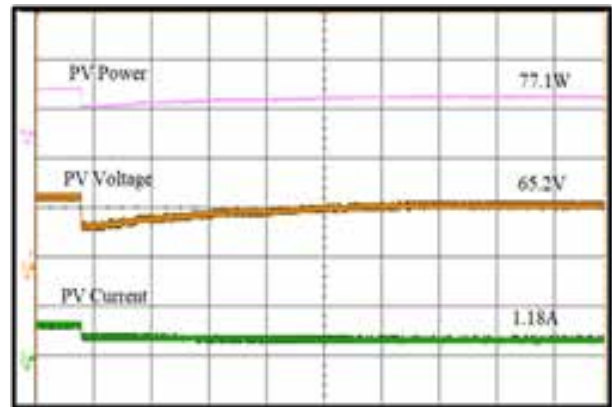


Figure 3. Experimental setup

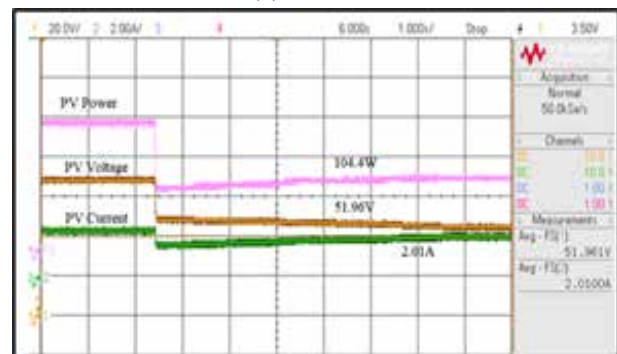
#### CASE I- 4P1S

The highest power achieved reaches 77.1W, with peak voltage and current at 65.2V and 1.18A, respectively. The potential maximum peak power is 104.1W. The

P&O algorithm's efficiency measures 74%. Figure 4 illustrates the experimental waveforms of the suggested HBO method. The anticipated maximum power is 104.8W. Under partial shading, the power attains 104.1W, with the highest voltage and current at 51.96V and 2.01A. The efficiency of the Proposed for case I is given in Table 1.



(a) P and O



(b) HBO

Figure 4. Waveforms for CASE I

Table 1 Efficiency of Case I- 4P1S

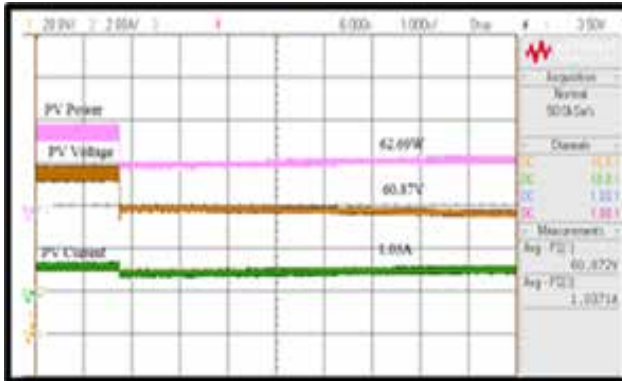
Method	P <sub>mpp</sub> (W)	P <sub>pvm</sub> (W)	V <sub>pvm</sub> (V)	I <sub>pvm</sub> (A)	Efficiency (%)
Proposed	104.8	104.4	51.96	2.01	99.6
P and O	104.1	77.1	65.2	1.18	74

#### CASE II- 4P2S

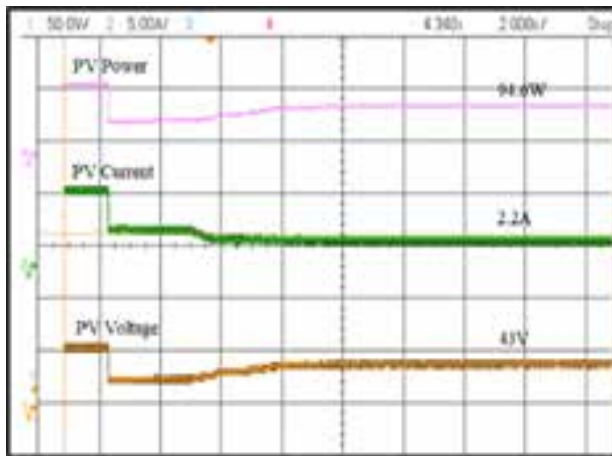
In Figure 5, it becomes evident that the highest power achieved using the P&O algorithm in CASE II amounts to 62.69W. The PV array voltage, PV array current and PV array power for Proposed algorithm is 43V, 2.2A and 94.6W. The waveform divisions for voltage and current are 20.0V/div and 2.00A/div, respectively.



Under partial shading conditions, the P&O algorithm's tracking efficiency stands at 70%. Table 2 displays the performance of the tracking efficiency.



(a) P and O



(b) HBO

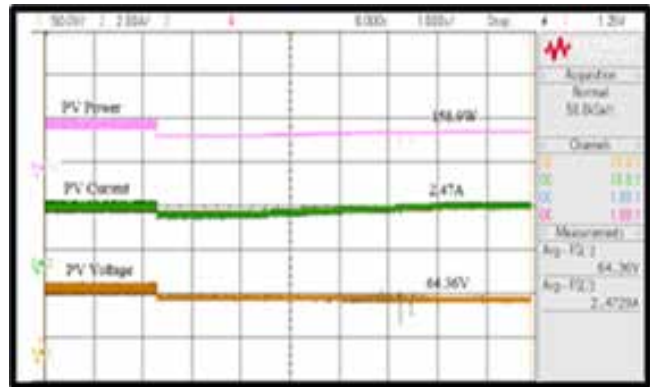
Figure 5. Waveforms for CASE II

Table 2 Efficiency for Case II- 4P2S

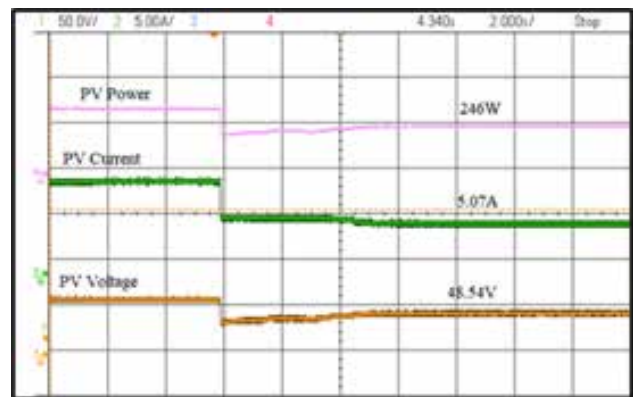
Method	$P_{mpp}$ (W)	$P_{pvm}$ (W)	$V_{pvm}$ (V)	$I_{pvm}$ (A)	Efficiency (%)
Proposed	95.9	94.6	43	2.2	98.6
P and O	88.3	62.69	60.872	1.03	70

**CASE III- 4P3S non uniform**

Figure 6 depicts the waveforms of CASE III. The maximum power tracked at 158.9W. An efficiency of 97.11%. is obtained with the proposed is depicted in Table 3. The PV array voltage, PV array current and PV array power for Proposed algorithm is 48.54V, 5.07A and 264W.



(a) P and O



(b) HBO

Figure 6. Waveforms for CASE III

Table 3 Efficiency of Case III- 4P3S

Method	$P_{mpp}$ (W)	$P_{pvm}$ (W)	$V_{pvm}$ (V)	$I_{pvm}$ (A)	Efficiency (%)
Proposed	252.7	246	48.54	5.07	97.11
P and O	244.8	158.96	64.36	2.47	64.9

**CONCLUSION**

This work develops and implements a new Honey Badger Optimization-based MPPT method for effectively tracking the GMPP in partially shadowed solar arrays. The honey badger travels into the different stages depending on the solar power production after positioning itself to find prey during the tracking process. In order to overcome the difficulties of the Perturb and Observe approach in partially shaded settings and to lessen oscillations, the Honey Badger Optimisation algorithm has been devised. Utilising a Simulator and dSPACE , the HBO technique has been

successfully tested in trials. Reduced oscillations, accurate identification of the global maximum power point, and increased calculation accuracy are some of the study's key findings.

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# Selection of Bidirectional Converter Topology for Application of Integrated Starter Generator

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## ABSTRACT

With growing needs for reduction in emissions and avoiding use of conventional fuels, there has been tremendous increase in the ongoing work on electrification of vehicles. However, it is difficult for electric vehicles to completely replace Internal Combustion Engine (vehicles in the present situation) owing to many reasons such as cost, lack of charging infrastructure, limitations on fast charging of batteries and so on. Change from conventional fuel vehicles to pure electric has to be a gradual one. Already there has been a tremendous increase in micro-hybrids and mild-hybrid vehicles coming into the market. Vehicles with Integrated Starter Generators (ISG) are generally categorized as micro-hybrids. The objective of this paper is to analyze the requirements of the Electric machine and power electronic converter for this application of ISG and compare different DC/AC bidirectional topologies available in different literatures for their suitability to this application.

**KEYWORDS:** *Electrification Vehicle Micro-hybrid Starter Generator.*

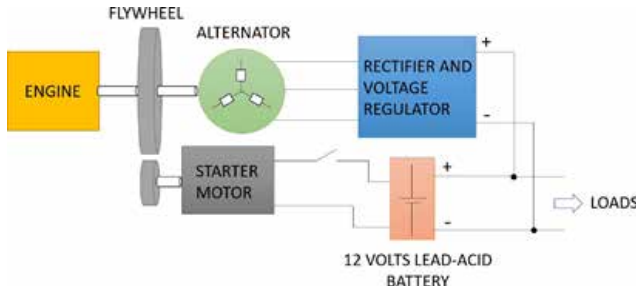
## INTRODUCTION

ISG can play a key role because it is the first step in this gradual change from ICE to pure electric vehicles. Also, any normal ICE vehicle can be converted to a micro-hybrid using ISG without any change in its current system. ISG basically performs 2 main functions: a) motoring operation of machine during cranking of engine b) generating operation after the vehicle has started. This can be extended to give us a mild-hybrid kind of system, because machine can now provide torque assist feature to engine during acceleration and also regenerative braking operation, which is not possible in normal ICE vehicles.

The key components of the electrical system of a conventional Internal Combustion Engine (ICE) vehicle basically consists of AC generator, starter motor and a lead-acid battery. Engine does not start generating power from rest. It needs to be rotated till a certain speed, after which the energy produced in its power stroke is sufficient enough to sustain its own rotation. This function is performed by starter motor. It provides

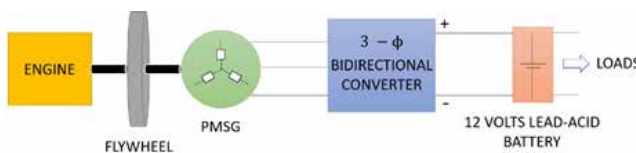
torque to rotate the engine from start till a certain rpm is reached. This process is known as cranking of engine. Once the engine has started generating power, starter motor is disengaged and then it just sits there until it is needed for next time to start. Usually, a Permanent Magnet DC Motor (PMDC) is used as starter. For cranking of engine, starter motor draws power from a Lead-acid battery. Normally, 12 volts Valve Regulated Lead-Acid (VRLA) batteries, with ratings varying from 3 AH to 9 AH (in two-wheelers) and 30 AH to 68 AH (in four-wheelers) are used. They are compact in size and can provide very high cranking amperes at the start. There are various electrical and electronic loads in a vehicle such as head lamp, tail lamp, various indicator lamps, electronic system associated with control of various actuators involved in fuel injection, etc. Function of generator is to provide power to these loads as well as charge the battery. After the engine is cranked, generator converts mechanical energy of engine into the electrical energy. Generators can be single-phase or three-phase depending on the vehicle. Normally, for four-wheelers, synchronous machines (field excited)

are used whereas for two- wheelers, Permanent Magnet Synchronous Machines (PMSM) are used as generator. Figure 1 shows basic block diagram for electrical system of an ICE vehicle.



**Figure 1. General block diagram showing electrical system in ICE vehicle**

Starter motor and gears associated with it are only needed during the starting of vehicle, and once the vehicle has started it just sits there adding to the weight of the vehicle. Integrated Starter Generator (ISG) eliminates the need for starter motor and gears associated with it. It utilizes only single machine, which acts as a motor during cranking of engine, and once the engine has started, the same machine is used as generator. This cannot be done with the previous system, because for this to happen, a bidirectional power electronic converter is needed. Figure 2 shows the modified block diagram for electrical system of vehicle in case of ISG. Machine denoted as PMSG in the figure, acts as motor during starting for cranking of engine and then acts as generator once the engine is cranked.



**Figure 2. General block diagram showing electrical system of an ICE in 2-wheeler using ISG**

### Selection of Electrical Machine

The IM and the PMSM are between the main competitors at this time, but other special electrical machines must also to be considered in the future. The IM is a robust machine of low costs. On the other hand it has several drawbacks as cooling problems, limited efficiency, small air-gap, expensive stator windings, complex control system, etc. The PMSM has compact

construction and can be designed with a larger air-gap than machines with no excitation within the rotor, which is quite important in the case of crankshaft mounted ISG. In addition, good efficiency at generator operation can be obtained. The main negative aspects are due to the costly permanent magnets and to the stator winding.

### REQUIREMENTS OF THE CONVERTER

In an ISG, only PMSM has been considered, which is used as motor for cranking of engine and as a generator after the engine is cranked. In this section, approximate model for engine starting torque is analyzed through the literature survey. The amount of power that converter has to handle during both motoring and generating operation is analyzed. PMSM mathematical model is studied in detail and required specifications of the converter are found out for this application over the entire speed range.

#### Need for bidirectional power transfer capability

As discussed in the previously, in ISG, only PMSM has been considered. It performs the function of both starter motor and the generator (refer Figure 2). But for this to be possible if the power electronic converter used must have bidirectional power transfer capability since it has to draw power from battery at start and charge the battery after the engine is cranked.

#### PMSM Mathematical Analysis

In this section, the mathematical model of PMSM is analyzed to compute the maximum power that can be generated at different speeds and to find the maximum speed of operation of this machine with field weakening using an inverter supplied by 12 volts at DC bus.

For the analysis, parameters of the PMSM used are as shown in the Table 1.

**Table 1. Machine Parameters**

No. of poles	12
Rated Current (A)	12
Stator resistance (mΩ)	50
d-axis inductance (μH)	370
q-axis inductance (μH)	370
Rotor flux (mWb)	10.68

Rotor reference frame is used for transformation, that

is, d-axis of the frame is aligned with rotor magnetic field and q-axis lies 90° ahead of it, as shown in Figure 3. The equations showing transformation from a,b,c variables to d,q variables using Park Transform are as shown below [1]:

$$\begin{bmatrix} f_a \\ f_d \\ f_o \end{bmatrix} = \frac{2}{3} \begin{bmatrix} \cos(\theta) & \cos(\theta - \frac{2\pi}{3}) & \cos(\theta + \frac{2\pi}{3}) \\ \sin(\theta) & \sin(\theta - \frac{2\pi}{3}) & \sin(\theta + \frac{2\pi}{3}) \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \cdot \begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix} \quad (1)$$

The a,b,c variables can be obtained from d,q variables using Inverse Park Transform :

$$\begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix} = \begin{bmatrix} \cos(\theta) & \sin(\theta) & 1 \\ \cos(\theta - \frac{2\pi}{3}) & \sin(\theta - \frac{2\pi}{3}) & 1 \\ \cos(\theta + \frac{2\pi}{3}) & \sin(\theta + \frac{2\pi}{3}) & 1 \end{bmatrix} \cdot \begin{bmatrix} f_d \\ f_q \\ f_o \end{bmatrix} \quad (2)$$

The stator differential equations of PMSM, after transforming into d,q variables (rotor reference frame) are as shown below [2]:

$$v_d = Ri_d - \omega\psi_q + \frac{d\psi_d}{dt} \quad (3)$$

$$v_q = Ri_q + \omega\psi_d + \frac{d\psi_q}{dt} \quad (4)$$

$$\psi_q = L_q i_q \quad (5)$$

$$\psi_d = L_d i_d + \psi_m \quad (6)$$

$v_d$  and  $v_q$  are stator d, q-axis voltages,  $i_d$  and  $i_q$  are stator d, q-axis currents,  $\psi_d$  and  $\psi_q$  are d, q-axis flux linkages,  $L_d$  and  $L_q$  are d, q-axis inductances and  $\psi_m$  is rotor flux linking with stator.

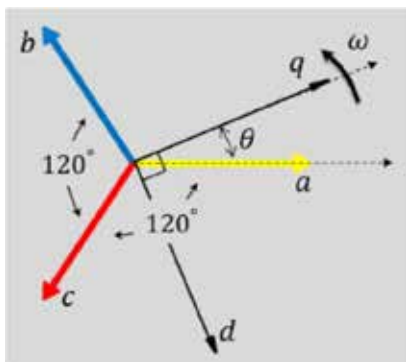


Figure 3. Park's transformation : Rotor field aligned with d-axis

Voltage that can be applied on the terminals is limited either by the voltage rating of the machine or by the

DC- bus voltage of the inverter from which it is fed. In either case, there is a limit on  $v_d$  and  $v_q$  which is given as [3]:

$$v_d^2 + v_q^2 = v_m^2 \quad (7)$$

where  $v_m$  is the peak value of rated phase voltage of the machine, or it could be the peak value of maximum phase voltage that can be applied for a given DC- bus voltage of inverter, whichever is lower of the two. Substituting steady state values of  $v_d$  and  $v_q$  in terms of  $i_d$  and  $i_q$  in (7), we get equation for voltage limit ellipse on  $i_d - i_q$  plane [3]:

$$\left[ Ri_d - \omega L_q i_q \right]^2 + \left[ Ri_q + \omega L_d + \psi_m \right]^2 = v_m^2 \quad (8)$$

Since the machine is surface mounted PMSM,  $L_d$  and  $L_q$  are equal for them. Substituting  $L_d = L_q = L$  in above equation, changes Voltage limit ellipse into a voltage limit circle on  $i_d - i_q$  plane :

$$\left[ i_d + \frac{\omega^2 L \psi_m}{z^2} \right]^2 + \left[ i_q + \frac{\omega \psi_m R}{z^2} \right]^2 = \frac{v_m^2}{z^2} \quad (9)$$

Where

$$z = \sqrt{R^2 + (\omega L)^2} \quad (10)$$

Similarly, there is a limit on current that can be allowed into machine, which in terms of  $i_d$  and  $i_q$  is given as :

$$i_d^2 + i_q^2 = i_m^2 \quad (11)$$

where  $i_m$  is the peak value of the rated line current of machine. The above represents current limit circle on  $i_d - i_q$  plane.

Total input power to machine is given as [2]:

$$P_{elec} = \frac{3}{2} (v_d i_d + v_q i_q) \quad (12)$$

Substituting  $v_d$  and  $v_q$  in terms of  $i_d$  and  $i_q$  in above equation gives us:

$$P_{elec} = \frac{3}{2} \left( Ri_d^2 + Ri_q^2 + \omega i_d i_q (L_d - L_q) + \omega \psi_m i_q \right) \quad (13)$$

Since we are doing analysis by taking motoring convention for currents,  $P_{elec} > 0$  means Machine is taking in power from electrical port, that is, motoring



mode.  $P_{elec} < 0$  means machine is giving out power from electrical port and hence, generating mode of operation. If we substitute  $P_{elec} = 0$ , it gives us a circle on  $i_d - i_q$  plane such that for all the points inside this circle represents generating mode of operation and outside the circle represents motoring mode of operation.

Torque produced by the machine is given as:

$$T = \frac{3P}{2} i_q \left[ \psi_m + (L_d - L_q) i_d \right] \tag{14}$$

For surface mounted PMSM, since  $L_d = L_q$

$$T = \frac{3P}{2} i_q \psi_m \tag{15}$$

**Maximum power generated at different speeds**

As discussed in the previous section, for  $P_{elec} = 0$ , which represents an ellipse in  $i_d - i_q$  plane. Substituting  $L_d = L_q = L$  gives us a circle with equation:

$$\frac{3}{2} \left( R i_d^2 + R i_q^2 + \omega \psi_m i_q \right) = 0 \tag{16}$$

Figure. 3 shows equations (9), (11) and (16) plotted on  $i_d - i_q$  plane for a rotor speed of  $\omega_r = 1000$  rpm. As the rotor speed increases, voltage limit circle shrinks,  $P_{elec} = 0$  circle expands and current limit circle remains the same which can be seen from equations as well. Thus, for generating mode of operation, operating point must lie within all the three circles at any speeds.

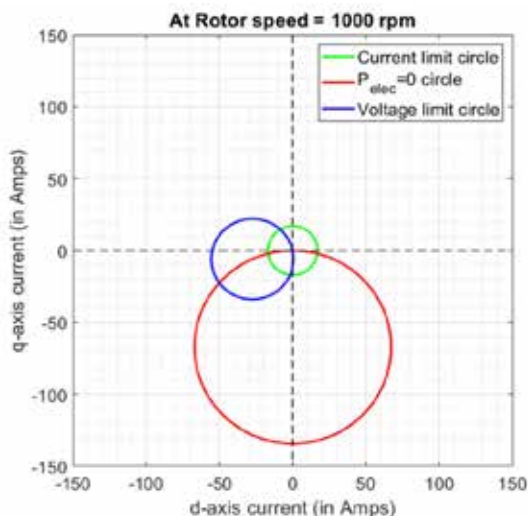


Figure 4. Constraints on values of  $i_d, i_q$  currents as per machine current rating and voltage limit, for a particular rotor speed of 1000 rpm. All points inside Red circle represents generating mode of operation

As can be seen from Figure 4, many such operating points are possible at any speed and generated power is different at different points. To obtain the maximum power that can be generated at any speed, we can partially differentiate  $P_{elec}$  (13) with respect to  $i_d$  and  $i_q$  separately and equate it to zero. We get 2 algebraic equations with 2 unknowns, solving which gives us the condition for maximum generated power at any speed as:

$$i_{d_{mpp}} = \frac{-\omega^2(L_d - L_q)\psi_m}{\omega^2(L_d - L_q)^2 - 4R^2} ; i_{q_{mpp}} = \frac{2R\omega\psi_m}{\omega^2(L_d - L_q)^2 - 4R^2} \tag{17}$$

Substituting  $L_d = L_q = L$  in the above equations,

$$i_{d_{mpp}} = 0 ; i_{q_{mpp}} = \frac{-\omega\psi_m}{2R} \tag{18}$$

As the speed increases, value of  $i_{q_{mpp}}$  increases beyond the current rating of machine and machine cannot be operated at that point. At higher speeds, to find out maximum power generated at any speed, we need to maximize the  $P_{elec}$  expression subject to the constraints of voltage limit and current limit. Considering 12 volts at the DC Bus of the inverter, the maximum peak value of phase voltage that can be applied at terminals (assuming SVM) is 6.67 volts. Thus, for voltage limit constraint of  $v_m = 6.67$  volts and  $i_m = 17$  Amps, maximum Power that can be generated at different speeds is shown in Figure 5. Figure 6 shows d-axis and q-axis current values for those maximum power points at different speeds.

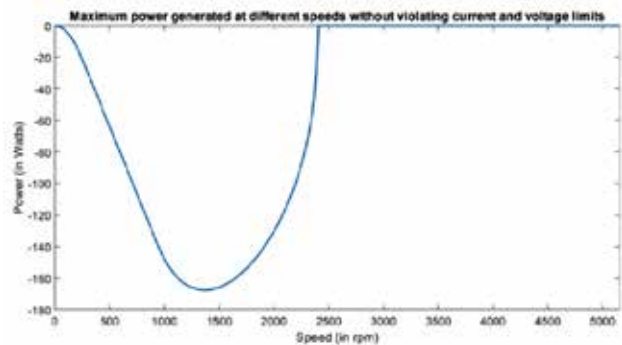


Figure 5. Maximum power generated at different speeds without violating voltage and current limits

**Power rating of Converter**

To find out the amount of power converter has to process at steady state, it is necessary to have an idea about the electrical/electronic load connected in a conventional

ICE vehicle. The Table 2 below shows power consumed by different components of a 100 cc two-wheeler[4].

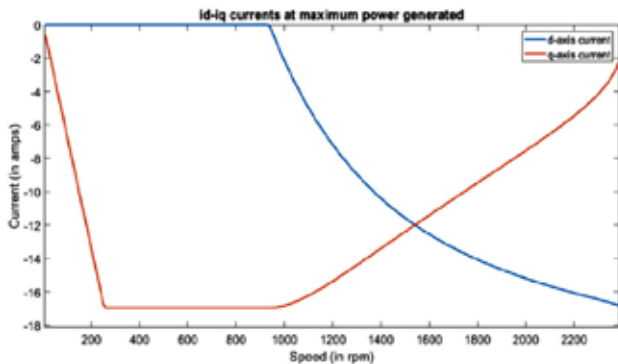


Figure 6. Values of  $i_d$  and  $i_q$  for maximum power at different speeds in Generating mode of operation

Table 2. Electrical load on a two-wheeler

Head Lamp	35 W
Tail Lamp	10 W
Side indicator	10 W
Horn	24 W
Neutral Indicator	2 W
Turn signal indicator	2 W
Hi-beam indicator	2 W
Speedometer lamp	2 W

As we can see from Table 2, total connected load on the two-wheeler is about 87 W (details of load taken from Platina BS-IV 100 cc bike’s technical specification [4]). A 12 V 9 AH VRLA battery is used. It is advisable to charge the battery with maximum rate of 0.1 C. For applications requiring cyclic charging and discharging, this rate can go at max. up to 0.3 C (that is 2.7 Amps in case of 9 AH battery). Thus, we can say that in steady state the maximum power that converter will have to process in generating mode is around 160 Watts. Taking some margin, the rating of power converter can be taken to be around 200 Watts.

Converter should be able to extract 200 W of power through machine over the entire speed range of operation (which is from around 1500 to 10000 rpm). It can be seen from Figure 7 that, we need a converter topology that can apply around 4 to 4.5 times the AC voltage as compared to conventional Voltage Source Inverter (VSI). A VSI is a buck-type converter from

DC to AC side, whereas for this application we need a converter that can give us boost from DC to AC side.

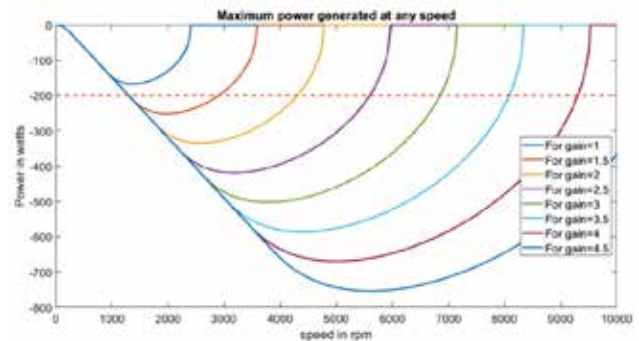


Figure 7. Maximum power at different speeds and different AC voltages

### Cranking of Engine (Motoring)

In this section, an attempt is made to find out the approximate engine torque waveform at the starting. A numerical simulation is done to find out the motor currents and current drawn from the battery during engine cranking.

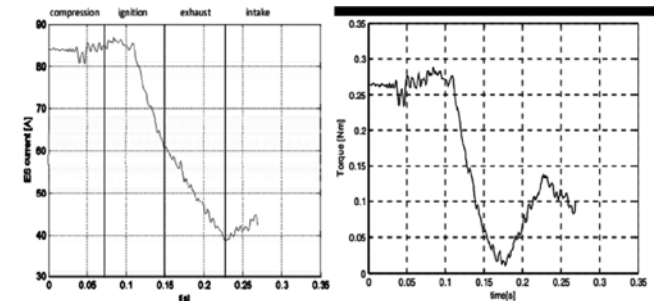


Figure 8. Current drawn from battery and the torque produced by starter motor during cranking

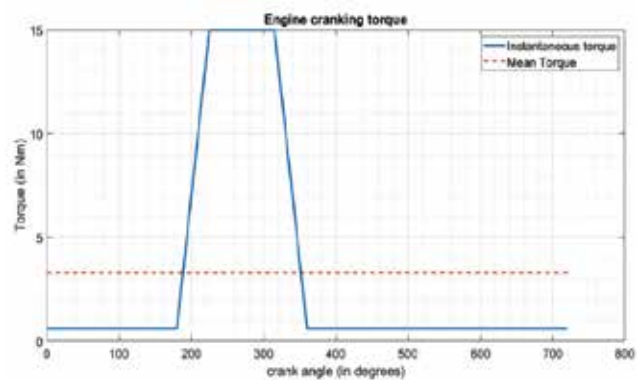
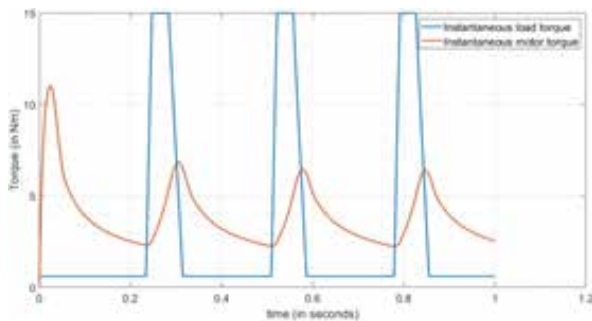


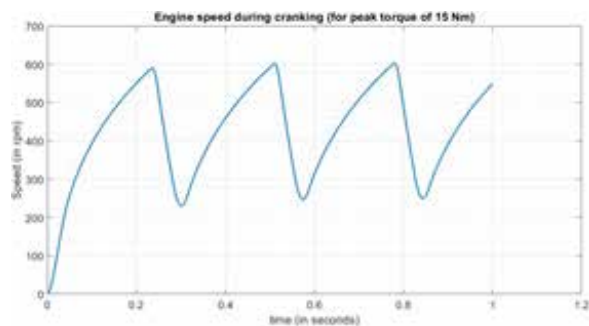
Figure 9. Engine torque variation with crank angle (for peak torque of 15 Nm)

As we can see from Figure 9, engine torque peaks at crank angle of near about  $200^{\circ} - 300^{\circ}$  with a value ranging from 5 to 15 Nm. Rated torque of motor is around 1 Nm. Although 5 to 10 times the rated current of machine can be allowed transiently, but however it is limited by the terminal voltage available (corresponding to 12 volts battery). Therefore, whenever engine has to be cranked in ISG application, engine is reverse rotated first to bring it to a position of around  $360^{\circ}$  crank angle. After this torque is applied by motor in forward direction. From  $360^{\circ}$  crank angle, engine torque is very low (static friction of around 0.5 to 1 Nm). So even if motor cannot produce peak torque of engine, it can produce torque higher than the static friction. So the motor speed rises and flywheel stores the rotational energy. As the rotor has rotated to reach crank angle of  $200^{\circ}$ , engine torque will start increasing till its peak value, which will be higher than the motor torque. But however, during this period, energy stored by flywheel keeps the rotation going on and the process continues. Thus, during cranking process, first engine is rotated backwards, so that flywheel inertia can get more time for storing energy and hence even though motor torque is less than engine peak torque, engine can be cranked.

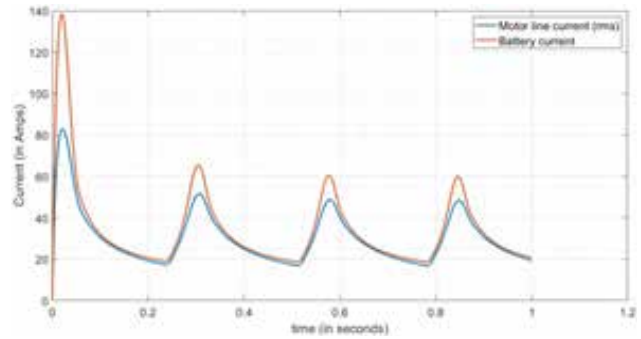
Simulation results with engine peak torque = 15 Nm:



(1)



(2)



(3)

Figure 10. For engine peak torque = 15 Nm (1) Instantaneous engine torque and applied PMSM torque during starting (2) variation of speed with time during starting (3) Current drawn from battery and motor RMS currents

Thus, it can be concluded that requirements of power electronics converter for the application of ISG, with the given machine parameters, are as follows:

- Bidirectional power transfer capability
- Steady state power rating of 200 Watts (in generating mode) and transient power capability of around 1 kW in motoring mode during engine cranking (for time period of around 100 to 200 msec)
- Boost capability from DC to AC side

To summarize, in this section, analysis is done to find out the requirements of the converter topology, which are listed above. Engine starting torque waveform is analyzed and a numerical simulation of engine starting process is done for different value of peak engine torques.

### Selection of Converter Topology

As concluded from the previous section, a Bi-directional converter is needed that can give us Boost-type operation from DC to AC side. Two-level VSI is a Buck-type (step-down) inverter for DC to AC power conversion, that is, voltage on the AC side has to be less than the DC bus voltage [5]. If the AC side voltage becomes higher than DC bus voltage, then the switches become uncontrollable and anti-parallel diodes across the MOSFETs conducts huge amount of current which can destroy them. This is the reason for the need of Field weakening at higher speeds, because the back-

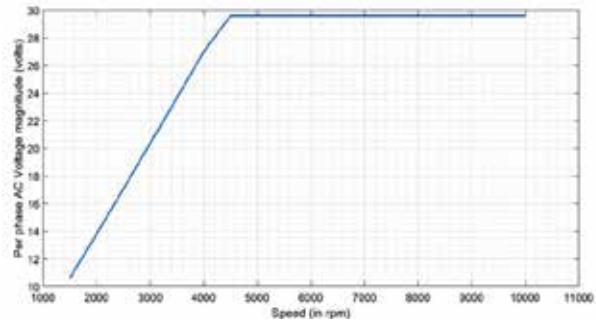
emf of machine (which depends only on the speed) goes quite high. In this chapter, various DC to AC boost topologies in the literature are analyzed and compared for their suitability to this application.

From the literature survey, following topologies seems to be suitable for this application and hence their detailed comparison is done in this section:

- Conventional two-stage topology (DC-DC Boost + VSI)
- Quasi Z-Source Inverter (qZSI)
- Split Source Inverter (SSI)
- Interleaved current fed switched Inverter (ICFSI)

**Voltage and current stress on the devices**

All the three topologies listed above, other than the conventional one, utilize the six active switches of the inverter itself to produce boost. For example, in qZSI and ICFSI, shoot-through state of an inverter leg is utilized to produce boost. Similarly, in SSI, inductor charging takes place whenever the lower switches of any leg is on. Due to this, the boost factor that is obtained is dependent on the switching of the inverter switches, that is, boost ratio is not independent of the modulation index of inverter. Due to this, for a given magnitude of AC side voltage, higher DC bus voltage is required in these topologies as compared to the conventional two-stage one. As a consequence of which, higher voltage rating devices are needed as compared to the conventional two-stage. In the conventional topology, inductor current flows only through the two switches of Boost stage and not through the inverter stage. Whereas in other three topologies, since the boosting action is integrated with the inverter switches itself, inductor current also flows through the inverter switches and hence higher current rating devices is needed. In order for the converter to provide an output power of 200 W throughout the speed range of 1500 rpm to 10,000 rpm, Figure 11 shows the value of per phase AC magnitude required. Note that after the speed of around 4500 rpm, magnitude of voltage required is constant. The reason for this is that we cannot boost voltage above a certain value due to limitations of parasitic such as resistances of MOSFETs, resistance of inductors, etc. Also, the efficiency of converter reduces with increasing gain.

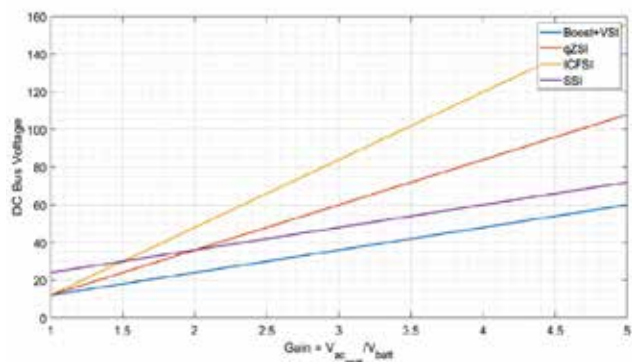


**Figure 11. Per phase AC voltage magnitude required to generate Power of 200 W for entire speed range of 1500 to 10000 rpm**

Table 3 shows the DC Bus voltage requirement for different topologies to produce the magnitude of AC voltage as shown in Figure 11.

**Table 3. DC Bus voltage requirement in different topologies**

Topology	DC Bus voltage requirement (volts)
Two-stage (conventional)	54
qZSI	91
SSI	65
ICFSI	129



**Figure 12. DC Bus voltage requirement Vs AC Gain for different topologies**

Figure 12 shows the DC bus voltage requirement with respect to AC gain for different topologies. It can be seen that the two-stage topology has lowest voltage requirement as compared to others. For the same machine line currents, the currents that are passing through switches are different in the four topologies.



During the cranking process of engine, around 6 to 7 times the rated value of motor current will flow for a duration of maximum 100 to 200 msecs. Thus, the devices should be chosen such that value of current that device has to handle should come inside the Safe Operating Area (SOA) of the device. Because of this requirement, the devices have to be a little bit overrated as compared to its steady state requirement.

**Size of Inductors and Capacitors**

For all the topologies, inductors were chosen to allow current ripples of 40% and capacitors were chosen to allow voltage ripples of 5% of their rated voltage. Table given below shows the values of inductor required in different topologies to maintain current ripple less than 40 % for the entire speed range of 1500 rpm to 10000 rpm.

**Table 4. Values of inductors for different topologies**

Topology	Number of Inductors	Inductor value (µH)
Two-stage (conventional)	1	70
qZSI	2	400
SSI	1	70
ICFSI	2	400

In two-stage topology, inductor has to be designed for rated current of around 18 Amps. In qZSI, both the inductors carry same currents and hence two inductors need to be designed for 18 Amps. Whereas in case of ICFSI, due to interleaving, both inductors have to be designed for half the rated current, that is, 9 Amps. In SSI, inductor has to be designed for rated current.

Unlike the rated inductor current which is same for all the topologies, capacitor voltage rating is different. Table 5 shows the DC bus/capacitor voltage requirement for different topologies. Capacitor value was chosen to maintain voltage ripples within 5% of individual capacitor voltages of different topologies. Table below shows values of capacitors required in different topologies. Voltage rating of capacitors is selected after taking a margin of 1.5 times of the required voltage level.

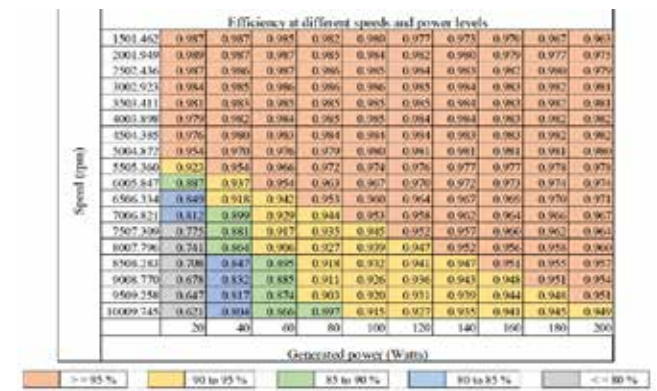
**Table 5. Values of capacitors for different topologies**

Topology	Number of Capacitor	Capacitance value (µF)	Voltage rating (Volts)
Two-stage (conventional)	1	100	80
qZSI	2	200	75
SSI	1	180	100
ICFSI	1	200	200

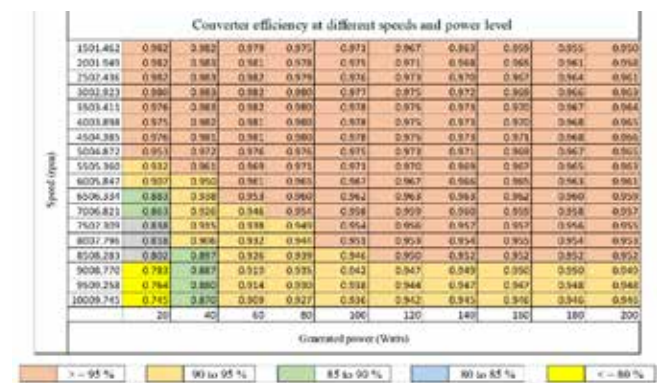
Thus it can be concluded that size of passives required is the least in case of conventional two-stage topology.

**Efficiency comparison of topologies**

In this sub-section, the efficiency of different topologies is compared at different speeds and different power levels. The devices for individual topologies were taken as shown in Fig 13 to 16.



**Figure 13. Efficiency of two-stage topology at different speeds and power levels**



**Figure 14. Efficiency of SSI at different speeds and power levels**



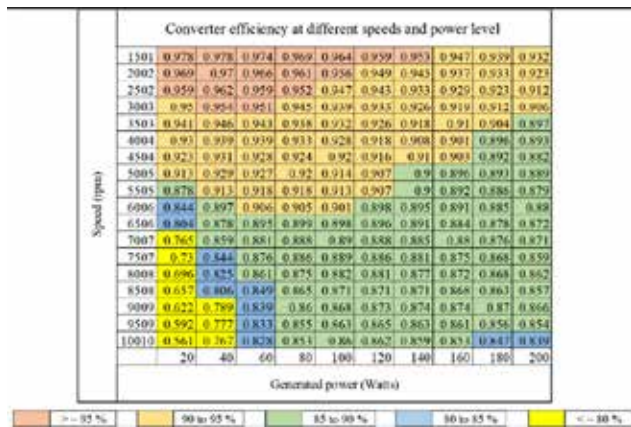


Figure 15. Efficiency of QZSI at different speeds and power levels

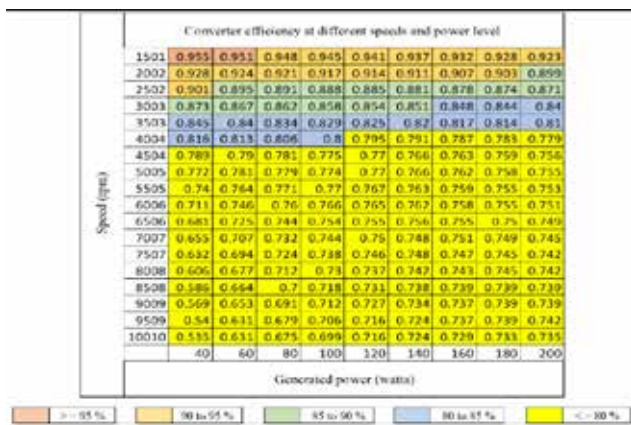


Figure 16. Efficiency of ICFSI at different speeds and power levels

CONCLUSION

Two main aspects of the system were analyzed in this Paper - Power electronic converter and PMSM. It was found out that combined machine and converter gives better efficiency when machine is operated without going into the field weakening, but it needs higher terminal voltages for this. Different Converter topologies in the literature were analyzed to give higher AC side voltages from a 12 volts Battery. Four topologies available in the literature seemed promising for this application : Quasi Z-Source Inverter(qZSI), Split Source Inverter (SSI), Interleaved Current Fed Switched Inverter (ICFSI) and conventional Two-stage topology.

Detailed analysis and comparison of these topologies was done in different aspects such as efficiency, size

and number of passives, switch count and the voltage and current stress on the devices. It is concluded that two- stage conventional (DC-DC Boost-VSI) is the best choice for this application out of all the topologies in all the aspects. qZSI has one lesser switch as compared to the conventional one, but it needs larger size and number of passives. In terms of efficiency and requirement of inductor and capacitor, SSI seems to be close to the conventional one, but it needs one extra switch. ICFSI topology gives higher boost as compared to the other topologies, but it has lower efficiency and highest switch count of all. So it can be concluded that for the application discussed in this paper, two-stage conventional topology seems to be the best option. However, all the analysis was done through simulations in Simulink and PLECS. An experimental verification of the same through hardware implementation of all four topologies and their comparison experimentally, can strengthen the conclusion.

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# Solar Power Plant Site Selection using A GIS-based Approach

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## ABSTRACT

This paper implements a process of selecting most suitable sites for setting up solar power plants in India. The basic idea of the process is to use geographic information systems (GIS), and a weighting framework for planning solar power plants at the regional level. The siting criteria used in this framework evaluates the regions by computing Suitability Factor (SF) for different regions and thus able to decide the optimum locations for future plant installations and also a suitability value for already existing plants.

**KEYWORDS:** *Fuzzy sets; Suitability index; Consistency index; Consistency ratio*

## INTRODUCTION

Renewable energy resources are those having a cycling time of less than 100 years and are renewed by nature and their supply exceeds the rate of consumption. [10] Renewable energy systems use resources that are constantly replaced in nature and are usually less polluting. In order to tap the potential of renewable energy sources, there is a need to assess the availability of resources spatially as well as temporally.

Constant deterioration of fossil fuels not only can result in their scarcity but is also very harmful for the country. [10] Solar power is a type of renewable energy source that can be implemented even on a smaller scale. Harnessing as much solar power as possible and producing solar energy is the need of the hour. Solar power plants, if set up at appropriate places can result in a major revolution in the field of energy production. Therefore, there is an increasing need of determining the sites for plant installation.

Spatial variation of solar energy is crucial for the estimation of the regional potential and selection of

construction location. This paper is thus helpful in determining the optimal location for installing solar power plant. Geographical Information systems (GIS) have a higher demand over last few years. This is because they are very helpful in planning with the use of multiple criteria for decision-making. [4] It not only helps in visualization and interpretation of the data, but also has a profound solution in determining economically feasible and environmentally viable sites, taking into consideration the social, economic and ecological aspects. In this field, the present paper proposes a methodology for systematically assessing of lands suitable for the installation of plants at the regional level. [3] This paper can serve two purposes:

- The suitability analysis of the sites can recommend different sites available to install solar plants that can produce desirable results.
- Also it can determine whether the existing plants are at a suitable location or not. Thus providing appraisals to the licensed sites.

Several studies have taken place around the world to

select appropriate sites for renewable energy sources, but the present study focuses on the regional level, where the main criteria is not only the solar power but also some other factors which play a major role in the determination of these sites. The present paper discusses the ecological, social and economic aspects of setting up such plants.

The Indian nation, which is the southernmost sub-continent in Asian continent, is the study area for this project. The country has a population of around 134 crores and a population density of around 416 per km square. It houses one of the major deserts of the world. The country currently has a capacity of generating 29 GW of power. [1] With about 300 sunny days per year, the country's solar power exceeds all the possible energy output from reserves of fossil fuels in the country. In the following sections, the following points are addressed:

1. The current licensed sites in the country which can meet a set of site selection criteria.
2. Possible alternatives where there is a potential for a solar power plant.
3. Explore if it is possible to apply a methodology to evaluate and select optimal locations in the study area ?

## METHODOLOGY

### Evaluation Criteria

In the first step, the sites are being ranked on the basis of specific suitability factors. These factors are usually measured on a continuous scale. Their purpose is to enhance or detract from the suitability of the sites. There are two types of factors: first, whose values enhance the suitability of the site these factors are called benefit factors, and second, the cost factors that detract from the suitability of a site. [5] In this framework, five factors have been taken to examine the suitability of a site as shown in Table 2, indicating their type. Population is taken into study because, more the demand of electricity, the more the demand of power plants. The direct normal irradiation, global horizontal irradiation, global tilted irradiation and the photovoltaic power output [9], all of these have profound effects on the solar power generation in a region. Several other factors such as power consumption and land use were

also considered but later dropped due to less relevance with the optimum site selection than the power generation. [2]

### Representation of Criteria as Fuzzy Sets

The next step includes the fuzzification of the selected criteria. The membership functions of these sets are used to calculate individual degrees of satisfaction for each potential site. These MFs are nothing but normal functions to take down values of the attributes between 0 and 1. Here two types of membership functions are used. One membership function is used for benefiting criteria i.e., those criteria which benefit the suitability of the site, this is called the increasing fuzzy function. And another membership function that is the decreasing fuzzy function is used for costing criteria i.e., those criteria whose value costs the suitability of the site. [5]

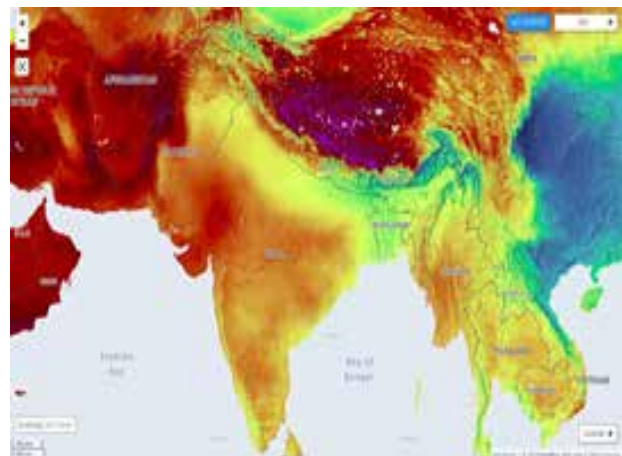


Fig. 1. Direct Normal Irradiation

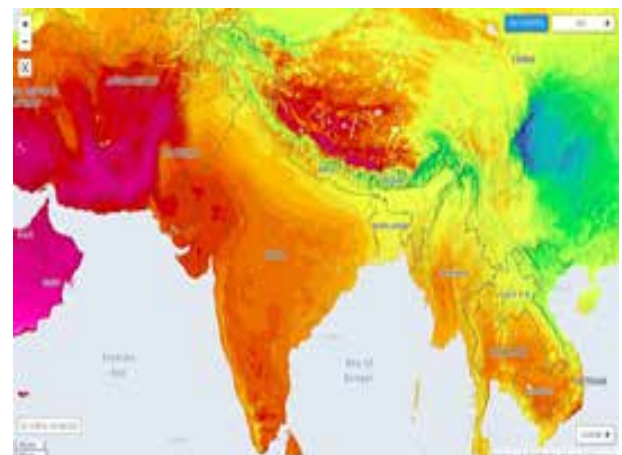


Fig. 2. Global Horizontal Irradiation



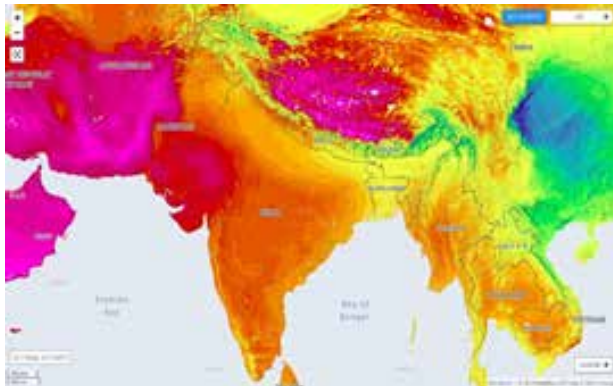


Fig. 3. Global Tilted Irradiation

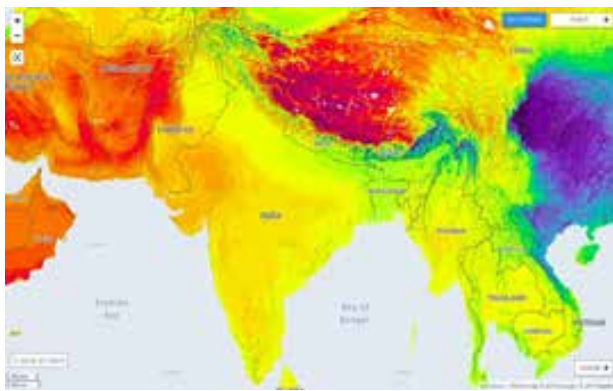


Fig. 4. Photovoltaic Output

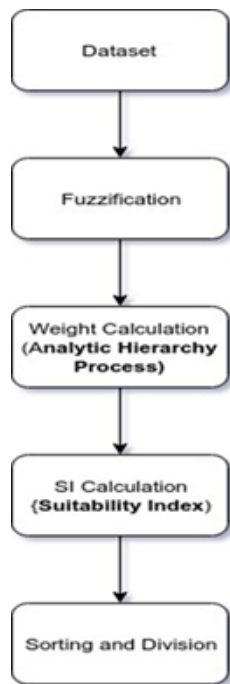


Fig. 5. Methodology

Increasing fuzzy function :  $\overline{MF}(z_i)$

$$= \begin{cases} 0 & \text{for } z_i < q_i \\ \frac{z_i - q_i}{p_i - q_i} & \text{for } q_i \leq z_i \leq p_i \\ 1 & \text{for } z_i > p_i \end{cases}$$

Decreasing fuzzy function :  $\underline{MF}(z_i)$

$$= \begin{cases} 1 & \text{for } z_i < p_i \\ \frac{z_i - q_i}{p_i - q_i} & \text{for } p_i \leq z_i \leq q_i \\ 0 & \text{for } z_i > q_i \end{cases}$$

Fig. 6. Fuzzification [5]

Table 1: Attribute Type Table

	Criteria	Type
Attribute1	Population	benefit
Attribute2	PVOUT(photovoltaic Power Output)	benefit
Attribute3	GHI (Global Horizontal irradiation)	benefit
Attribute4	DNI (Direct Normal Irradiation)	benefit
Attribute5	GTI (Global Tilted Irradiation)	benefit

Here only increasing fuzzy function is used as every attribute is of benefit type as shown in Table 1. As larger the population, larger the need of a solar power plant [7]. Also the values of GHI, DNI, GTI and PVOUT [2] are also required to be as greater as possible. This fuzzification will result in a new data with every value between 0 and 1, where 0 will represent poor conditions and 1 will represent optimum working conditions.

Weight Calculation Using the Analytic Hierarchy Process

Analytic Hierarchy Process is a structured technique to analyze complex decisions using mathematical and psychological aspects. [8] Firstly, a pairwise matrix is made as represented in Table 2. Using this pairwise matrix the eigenvalues and eigenvectors are computed. The maximum of eigenvalues is represented by  $\lambda$ . Then the consistency index is computed using this  $\lambda$  and 'n' i.e., total number of attributes by using formula

$$CI = \lambda - n / n - 1 \tag{6}$$



Then using this computed consistency index, we compute the consistency ratio. CR is calculated by dividing the CI with a random index RI as shown below:

$$CR = CI / RI \quad [6]$$

Then this CR is checked. If it comes out to be greater than 0.1, then our comparison matrix is incorrect and has to be corrected. Any value less than 0.1 is accepted. CR gives us the weights required for computation. The pairwise comparison matrix is filled with the help of a scale from 1- 9, where each number has a different significance as shown below. By using these values the pairwise matrix is filled and further process takes place.

**Evaluation of Suitability Index for Different Sites**

After the weight calculation, next step will be finding the suitability index. The suitability index will be calculated by multiplying each attribute with its corresponding weights and then adding every product. This can be given by the formula

$$SI = \sum wx \quad [5]$$

The suitability index for each potential site will be stored in a new file. Next step in the process is to sort the existing file in order of decreasing suitability index. This file can then be divided further into three files. Each file will contain top few most recommended sites, middle few general sites and bottom few least recommended sites respectively.

**Visualization of Results**

The resulting csv files can be used to plot the data of every city. As every file contain different types of site such as most recommended, moderately recommended and least recommended, they can be mapped using different symbols and data can be viewed on the satellite map of India as shown in Fig. 1. Here the red dots represent the optimum sites i.e., the sites most recommended by our system. Similarly, the purple and green dots represent moderately and least recommended sites for the installation of solar power plants.

**Table 2: Attribute Type Table**

	Att. 1	Att. 2	Att. 3	Att. 4	Att. 5
Attribute1	1	1	3	3	1
Attribute1	1	1	3	3	1

Attribute1	0.33	0.33	1	1	3
Attribute1	0.33	0.33	1	1	1
Attribute1	1	1	0.33	1	1

**Table 3: Attribute Intensity Table [6]**

Intensity	Explanation
1	Both contribute equally in a objective
3	Judgment slightly favor to one than other
5	Judgment strongly favor to one than other
7	One has strongly demonstrated its importance in practice
9	One is favored than the other in highest possible affirmation
2,4,6,8	Intermediate values between two close judgment

**RESULT AND DISCUSSION**

For testing, a dataset was created for various solar power plants in India. After that, the suitability factor of dataset was calculated and classified into three sets - most recommended, recommended, and least recommended. It was observed that about 85% of project data fall in the recommended set, thus this project successfully classifies them with about 15% of errors, which is quite a promising result.

In Fig.7, the map with red, green and purple dots, represent every potential site in our data set. The algorithm by calculating the weights and the suitability index determines whether a site should be recommended or not. The heat maps of all the attributes also show us that the sites with maximum value of all the attributes is mostly recommended. Thus the algorithm suggests that the sites that in or around the Thar desert or in the east south region of the country are more likely to get more solar power potential than the mountainous region or the middle parts of the country. As the sites with or without solar power plant set up both can be mapped with their corresponding suitability index, therefore the answer to the first question is affirmative.



**Fig. 7. Output**

Also, the most recommended sites are located around the desert area or in the warmer regions of the country where value of almost every attribute is maximum shows that the sites are recommended correctly on the basis of the algorithm thus the answer to the second question is also affirmative. Hence it is possible to design a methodology to correctly recommend the sites for the installation of the solar power plants.

## CONCLUSIONS

In this paper, a dataset of different cities of India is taken. At the very outset, data is collected from different sites and solar atlas, taking into consideration five attributes: Population, PVOU, GHI, DNI and GTI. These attributes were selected by studying various research papers on solar power generation and taking into consideration

the social, economic and environmental effects to the site. After data collection and data pre-processing, An algorithm is implemented to find out the recommendations for solar power plants set up across the country. Firstly, weights were assigned to the attributes using the analytical hierarchy process, the process included calculating of the consistency ratio and consistency index on the basis of a comparison pairwise matrix. The matrix was nothing but the importance of one attribute over the other. After calculating the CR and CI the process calculated weights by using normalized

eigen-values. Then after fuzzifying every value of the attribute, and normalizing them from 0 to 1 respectively. This is how a weighting system is generated which is then used to determine the suitability index of each city and thus the process become able to recommend optimum sites for the setup and also provides the suitability factor for the existing sites. The result was stored in the csv files which is then used to visualize the results in the QGIS software.

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# A Comprehensive Investigation and Analysis of Data Decluttering Methods with Emphasis on Fuzzy and MD5 Algorithm

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## ABSTRACT

Numerous technologies in the digital age have produced a huge number of similar data in storage systems, raising worries about growing storage costs and declining system efficiency. Data deduplication technology, on the other hand, provides a remedy for this issue, enabling companies and organizations to efficiently manage their data and save storage expenses. By detecting and eliminating duplicate data copies, data deduplication is a storage optimum performance approach that attempts to minimize storage space while improving storage effectiveness. The study, we suggest a web tool for data deduplication that makes use of the combined strength of fuzzy and MD5 algorithms to find and remove duplicate files. The method we use detects duplicate files precisely and effectively, resulting in significant storage cost reductions and enhanced system performance. The tool compares file names and contents using fuzzy matching algorithms, allowing it to recognize files with comparable content even if their names differ. Furthermore, each file is allocated a unique hash value using the trusted MD5 technique, allowing the program to distinguish between files with identical information. Nonetheless, our suggested tool provides a complete and dependable solution for detecting duplicate files by combining fuzzy matching and MD5 approaches. Organizations may considerably optimize their data storage solutions using accurate and efficient methods, leading to cost savings, increased system performance, and improved company resilience.

**KEYWORDS:** *Data deduplication, Fuzzy algorithm, MD-5, Storage system, Database, Data redundancy, Files.*

## INTRODUCTION

Data is being used extensively in research and decision-making processes, as well as to better understand consumer behavior, increase operational effectiveness, and identify market trends. By 2025, the worldwide datasphere is projected to grow to 175 zettabytes, according to International Data Corporation [1]. Technology has advanced significantly in recent years, including the Internet of Things [2], social media [3], and cloud computing [4]. For businesses and organizations to remain competitive

and relevant, it is becoming increasingly crucial that they can utilize data efficiently. Data may be a two-edged sword for technological companies, regardless of the objective. Increased data, especially redundant data, can lead to a number of issues, including storage inefficiencies, rising storage costs, privacy risks, poorly scalable systems, and much more.

In accordance with Microsoft and EMC workload studies, 50% and 85% of data stored in the manufacturing process primary as well as secondary storage systems are irrelevant, respectively [5]–[8].

According to 2019 World Economic Forum research, 463 exabytes of data will be produced daily globally by 2025, with a daily data generation rate of roughly 2.5 quintillion bytes [9].

The phrase “Data is the new oil” is frequently heard nowadays and compares the worth and scarcity of data storage media to that of oil, highlighting the necessity to manage this priceless and limited resource with care and discretion. For organizations, to properly utilize their data resources, data deduplication is a crucial approach to get rid of redundant data and boost storage efficiency.

The Databerg analysis was conducted by Veritas, a company that assists with data management, and it questioned over 2,500 organizations in 15 countries on the data they keep. They discovered that more than half (about 52%) of the data that was saved was “dark” data, which is material that was duplicated or wasn’t very helpful [10].

Over two-thirds of organisations, discovered by Osterman Research, spend more than 10% of their annual budget on storage costs. It is also found that one-sixth companies spends more than 25% of their budget on storage expenses.. In reality, three out of every five organizations have more than 25% of their data sitting unopened and underutilized [11].

Data management company SnapLogic surveyed IT leaders to learn how they oversee their data warehousing initiatives and what methods they employ for data organization and storage. According to this survey, 83% of IT leaders were not entirely satisfied with their data warehousing initiatives. [12].

Finding novel, efficient ways to store data becomes increasingly crucial as its volume increases and storage becomes more difficult. As, the system may become slower and less effective when there is an abundance of irrelevant data Duplicate data is sometimes stored in the system due to negligence or when a file with the same data is saved under an alternate name. Duplicating data and files on a system or storage medium can cause data redundancy, waste valuable storage space, and cause various problems for organizations. Duplicates can quickly build up and become an expensive issue as data volume increases, taking up valuable storage space and hindering system performance. Data deduplication,

sometimes referred to as intelligent compression, lowers storage overhead by getting rid of duplicate copies and making sure each file only has one unique copy on the storage [13]. Data deduplication is used in big data processing to eliminate duplicate data, reduce storage needs, and improve data analysis efficiency for useful insights from a logical structure by applying clustering and classification algorithms [14].

Data deduplication is a useful tool for locating and deleting duplicate versions of data in the system. It also ensures that the data is correct and free of corruption, which improves system speed. Numerous techniques, like compression, hashing, and content-aware analysis, can be used to achieve this [15]. Via the detection of duplicate data and the storage of a single copy, these systems can significantly reduce the amount of storage required and improve system performance. Data deduplication is a highly precise data compression technique. These benefits make data deduplication a valuable tool for organizations’ data storage and sharing activities[16].

Our study intends to investigate the state of data deduplication systems at the moment, including the techniques used to spot duplicate data, the advantages of these systems, and the difficulties that still need to be resolved. The research will offer a detailed overview of data de-duplication technologies and their possible applications through a careful analysis of prior research and case studies [17]–[20]. Meanwhile, Our research improves the data deduplication system’s accuracy and reduces false positives using flexible fuzzy matching algorithms. This leads to more cost-effective and efficient data storage options that can be tailored to meet unique business needs. Adding to this, our study utilizes the MD5 method to compare and distinguish files with the same content, even when their names, sizes, or metadata differ. This approach is an effective and efficient method for finding and removing duplicate files. Data does not change until the end user requests it, at which point it might be altered or processed in some other way[21]. Its deterministic and distinct nature allows for easy identification and removal of duplicates based on identical hash values. And also, MD5 hashing is quick, making it suitable for large-scale data deduplication systems making them encrypted in the database [22].



It also provides a high level of security and reliability, as the hash values are difficult to tamper with or generate falsely. This research study sheds light on the current and future state of data deduplication systems, and their potential to improve data storage and system efficiency.

## LITERATURE SURVEY

In order to address the storage system's data duplication issue, this study discusses a fuzzy way to approximate string matching for text retrieval in Natural Language Processing (NLP). To detect similarities between strings that aren't exactly the same, the authors suggest a fuzzy approach for approximate string matching. The method considers differences in the input strings by using fuzzy logic, a mathematical framework for handling uncertainty and imprecision. The methodology of the suggested approach is presented in the study, which entails creating fuzzy similarity measures to determine the similarity of strings and expressing text data as fuzzy sets. The study sums up presenting experimental findings utilizing the words "happy" and "unhappy," which have a similarity ratio of 0.83, meaning they are 83% similar [23].

The AEPAS algorithm presented in the research uses adaptive encoding and pattern-based approximation techniques to enhance data deduplication. To efficiently represent and compare the data for deduplication, dynamically encoding the data based on its characteristics, such as frequency and distribution. The pattern-based approximation recognizes patterns or templates in the data to find related data segments and remove superfluous duplicates. It uses a population of particles that evolve and adapt through genetic operators, such as mutation and crossover, to search for the optimal solution in a multi-dimensional search space. The results demonstrate the effectiveness of the AEPAS algorithm in terms of precision value and recall value, which is 0.82 and 1, respectively [24].

This paper introduces Dupless, a model for delivering safe deduplicated storage via a server-aided encryption mechanism. However, as the data chunks are often stored in deduplicated form without encryption, conventional deduplication techniques could possibly leak information about the data being stored. This can lead to privacy issues with data, especially when sensitive or secret data is being held. With Dupless,

the storage server works with the client to efficiently deduplicate while making sure that the data chunks are encrypted before being saved, eliminating data leaks. The experimental results demonstrate that Dupless incurs a 17% overhead for storing 1MB files, with a higher overhead of 54% for sequential uploads [25].

In this research, an efficient deduplication strategy is presented that makes use of convergent key management methods. The convergent key method creates distinct keys based on the content of the data and these keys are kept by Dekey using the Ramp secret sharing scheme (RSSS). The plan also has components for managing keys in a distributed storage system and handling data updates and deletions. Extensive tests are used by the authors to evaluate the suggested deduplication system, and the findings show that it is efficient and reliable in terms of deduplication performance and efficacy. According to the experimental results presented in this study, it takes an average of 25.196  $\mu$ sec to generate a 32-byte hash from a 4 KB data block, while 23.518  $\mu$ sec are needed for encryption and 22.683  $\mu$ sec for decryption [26].

The study introduces a technique called Similarity and Locality-based hashing (SiLo) for scalable data deduplication in storage systems. SiLo groups several little related files into segments using a similarity algorithm to separate large data to reveal more similarity and conserve RAM. These segments are then combined into blocks to find and eliminate duplicate data, which speeds up the deduplication process. SiLo uses a locality-based stateless routing method that distributes parallelism data chunks among backend servers. As a result, similarity enhancement is improved, and RAM overhead is decreased. SiLo's experimental results demonstrate that it eliminates 98.5–99.9% of duplicate data [27].

The design and implementation of several file deduplication algorithms on storage devices, including content-based, hash-based, and fingerprint-based techniques, are discussed in this paper. The first stage in implementing a file deduplication system is to define relevant data structures such as file name, file size, and MD5 hash value, which will then be used to run the file deduplication process. The MD5 hash-based approach extends the file size-based strategy by performing



processes like MD5 hash computation, checking for existing size Trees, updating or constructing sizeInfoList based on MD5 hash matching, and repeating for all files in the selected directory. The results of this study

demonstrate that the CPU use ratio for the md5-based technique is 24.9% and the memory usage ratio is 8.6% [28].

**Table 1. Comparative Evaluation**

Reference No.	Algorithms worked on	Advantages	Disadvantages	Parameter	Result
[24]	Fuzzy String Matching Algorithm and Natural language processing	Enhances the precision level of text retrieval in data deduplication.	The lack of an open-source implementation or source code in the journal may pose challenges for other researchers seeking to replicate the results.	String matching	For words "happy" and "unhappy" 0.83 degree of similarity, which indicates these are 83% similar
[25]	AEPAS algorithms & Hashing	Tested on actual datasets, and the outcomes demonstrate that it is successful in locating duplicate data and minimizing storage needs.	High resource requirements, complex setup	Precision and Recall Value	Precision value is 0.82, whereas Recall value is 1.
[26]	Server side deduplication	Encryption, centralized management	Time consuming ,computational load	Overhead percentage	54% overhead for 1MB files
[27]	Dekey scheme	Dekey supports both file-level and block level deduplications	Dekey suffered by limited overhead in normal upload/ download	Time taken	It takes an average of 25.196 µsec to generate a 32-byte hash while 23.518 µsec for encryption and 22.683 µsec for decryption
[28]	Similarity and Locality-based (SiLo) hashing	Achieve higher deduplication throughput, well balanced load	The indexing structure used in the technique may require additional storage overhead, increasing storage cost.	Complete duplicate elimination	The result demonstrate that SiLo eliminates 98.5–99.9% of duplicate data
[29]	MD-5 algorithm	Scalable, high CPU utilization	Weak Collision Resistance, Security Risks	SizeInfoList based on MD5 hash	The CPU usage ratio is 24.9% and the memory usage ratio is 8.6%.

## PROPOSED MODEL

This part begins with an architectural overview of the data deduplication scheme we suggest, followed by a thorough explanation of the system's organizational elements and operational procedures.

### Architecture Overview

The model that we have proposed aims to develop an efficient data deduplication system using a combination of Fuzzy and MD5 algorithms to reduce storage space and improve the performance of data retrieval. In order to handle and process the given data, there were different software and applications based on data deduplication that were using different approaches and algorithms to deal with and work on the data provided. To remove unnecessary and duplicate data from a log file, one must use the data cleaning method [29]. For our tool we have decided to move forward with Fuzzy and MD5 algorithms for better and optimal results, going forward for better and more effective outcomes.

Our data deduplication approach consists of two different windows, each with its own login page for the administrator and users. The first window belongs to the administrator and is used to control the entire data deduplication system. The administrator has the authority to control user IDs and passwords for every user, examine the total number of files submitted, and keep tabs on how often duplicate file alerts are triggered. The administrator can also remove files as needed.

The window specially meant for the Users are entitled to upload files, share files with other users, search to locate particular files, and remove files through the second window, which is set reserved for them. The user must input their special user credentials and a password in this box to access it. Users are able to upload files with an associated title and description. If a duplicate file is being submitted, the user will get an alert notification with guidance on whether to continue the upload or not. User-generated content may contain duplication due to their subjective perceptions and lack of expertise [30].

The model offers both the administrator and users distinct functionalities and tools to efficiently manage and organize data. The administrator can oversee the entire data deduplication system, while the users can easily upload, share, and delete files. The model

provides a streamlined approach to data deduplication management that promotes improved performance, reduced storage space, and overall enhanced data organization.

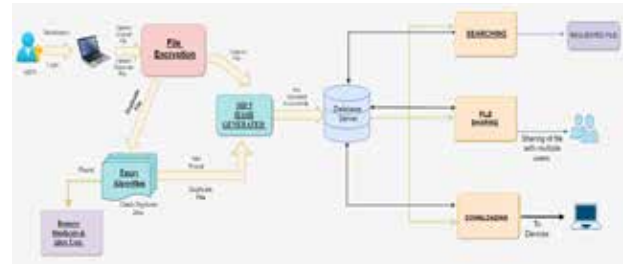


Fig. 1. Architecture of System

### Working of Fuzzy Algorithm

The crucial component dealing with data preprocessing, is to create a reliable, well-structured, and integrated data source for pattern detection [31]. which involves preprocessing data before deduplicating it in order to find duplicate files and format it uniformly. The application of fuzzy matching algorithms to data deduplication is highly beneficial in circumstances when exact matches are unlikely to occur, such as in natural language processing, the use of fuzzy matching techniques in data deduplication is very helpful. This component, which makes use of fuzzy matching techniques to find identical data blocks by contrasting their contents and properties, is a crucial aspect of our suggested paradigm for data deduplication. As opposed to exact matches, this matching algorithm examines data blocks based on how similar they are, which is particularly helpful for recognizing related data blocks that could contain minor differences or mistakes. The suggested model will use a mix of similarity metrics with a predetermined threshold value in order to get the best results.

### Workflow of MD5 Algorithm

An important element of the suggested framework for data deduplication is the MD5 Hashing component. This part applies the popular MD5 approach, which generates a unique and independent hash code with an established length for each data block. The hash code serves as the data block's individual fingerprint, and any duplicate data blocks may be quickly found by comparing their distinct hash codes. The method generates a 128-bit

hash code by generating a message digest for each data block. The one-way function used to create this hash code is intended to yield an independent outcome for each input. As a result, it is essentially impossible to carry out the opposite operation and get the original data block from the use of the MD5 algorithm for data deduplication provides a very efficient and effective method of locating and eliminating duplicate data blocks. Duplicate blocks may be quickly found and removed by simply comparing the hash codes of each data block. This method enormously lowers the amount of storage space needed and enhances data retrieval velocity. The algorithm is commonly regarded as a trustworthy and successful method for data deduplication. Cloud computing, file sharing, and software development are just a few of the sectors and applications where its adoption has been extensively embraced.

As a final point, using a data deduplication method that combines fuzzy and MD5 algorithms and forbids files with more than 85% of their content identical to other files from being stored. The system can precisely identify files with comparable content to all the other files in the storage space by applying fuzzy matching methods. In particular, adding a criterion for content similarity, like the 85% restriction employed in this approach, gives an additional layer of defense against duplicate files. This ensures that only truly unique files are stored in the database.

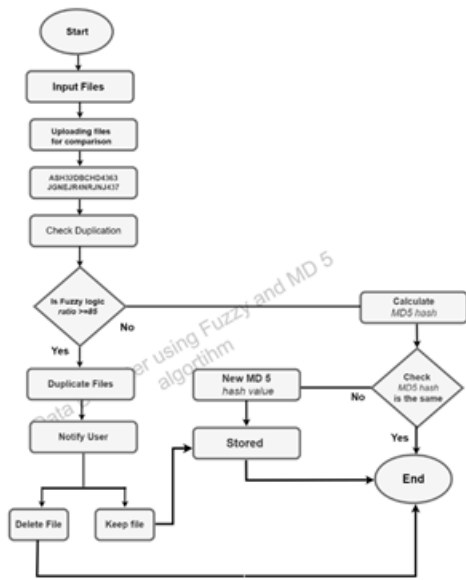


Fig. 2. Flowchart

## CONCLUSION

We've suggested a tool for data deduplication that finds and eliminates any duplicate files using a combination of fuzzy and MD5 techniques. The suggested tool ability of our technique in precisely recognizing duplicate files and gaining substantial storage space decreases through our research with real-world data sets. While the MD5 approach has provided us with a reliable means to distinguish similar files, our system can recognize files with equivalent content with their similarity ratio even when they have different names owing to the usage of fuzzy matching techniques. The suggested system can determine whether or not a file's content is similar to the one in the database using a fuzzy algorithm.

Our suggested solution effectively recognizes files with content that is over 85% identical to that of files in the database by combining the MD5 and fuzzy logic algorithms. This system serves as an interface for database prohibiting the entry of duplicate files. For identification and strong security, each file is given a unique MD5 hash value. Our tool precisely and effective methodologies, organizations may significantly enhance their data storage solutions, resulting in cost savings, greater system performance, and increased corporate resilience.

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# Use of Real-Life Parameters for Prediction of Chronic Kidney Disease

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## ABSTRACT

Chronic diseases are a major burden on healthcare systems globally, and early detection and prevention are critical for effective management. The prediction of chronic illness risk and the identification of important risk variables have both showed promise when using machine learning (ML) techniques. This research paper reviews recent advances in chronic disease prediction using ML techniques and discusses future perspectives. The proposed methodology involves analyzing a patient's symptoms and medical history. Previous research has primarily focused on SVM, KNN, and RUSBoost for disease detection. The medical datasets utilized in our analysis is sourced from Kaggle. We apply a transformation to the data by assigning weights according to the rarity of each data point. To train the datasets, we employ the Random Forest algorithm, which is also employed for analyzing the patients' medical history. Subsequently, SVM is employed to ascertain the potential disease diagnosis. The research presented here emphasizes the potential and challenges facing the field and gives an overview of the moment status of machine learning (ML) in chronic illness prediction. It is a valuable resource for researchers, healthcare professionals, and policymakers seeking to improve chronic disease management and prevention.

**KEYWORDS:** *Symptoms, Machine learning, Support vector machine, Random forest, Disease prediction, adaboost*

## INTRODUCTION

The human disease prediction is a critical aspect of healthcare. Historically, doctors have been responsible for disease prediction and treatment, making innovation a crucial driver of the medical industry's efficiency [32]. The database supports an assumption that certain symptoms only emerge at specific data, and as an outcome, these data sets assist in generating the right conclusions when those ailments are available. This model, in addition to other people, focuses more closely on these outcomes. In conclusion, innovation is a vital component of the medical industry

and is necessary for advancing disease prediction and treatment. The medical industry requires innovation to address various challenges, including the need for new treatments, improved patient care, and efficient medical procedures [12,33]. Automating healthcare processes may transform the medical healthcare sector's capacity to stay creative in the present digital era. [13]. The strain placed on physicians [14] and the high cost of consultations [15], particularly in illness prediction leveraging patient symptoms as input, are significant problems which need attention.

The current approach involves patients visiting a

generalist doctor and explaining their conditions and symptoms, after which the doctor determines possible diseases and refers them to an expert [16]. However, machine learning algorithms such as Random Forest can streamline this process and reduce logistics [7]. The algorithm is utilized for disease classification using Symptoms and Kaggle datasets. The database maintains a claim that some symptoms only manifest at certain points in data, and as a result, these data sets can help produce accurate results when those ailments are available. This model, in contrast with other people, has a stronger emphasis on these outcomes. The patient can conveniently input the disease they are experiencing, and this information will be fed into the model. Subsequently, the model will generate potential disease predictions based on the input provided.

The current generalized disease prediction architecture lacks accuracy and does not take into account the patient's medical history. Similar to other tackles used to deal with this particular circumstance, it extremely hinges on the existence of signs and interpersonal interactions [16]. The Support Vector Machine (SVM) method, for example, only takes current symptoms into account [8]. The aforementioned approach solely utilizes the symptoms of individuals as raw data and fails to take medical history into consideration. The precision of the predictive model outlined in previous studies has been affected as a result of the other standardized tackles being more ineffective and requiring less human participation. The set of data utilized in this framework assists to figure out what was found since the record base assumes that there are certain illnesses which only show up in one specific lab outcome report. Thus, unlike other models, this model accurately focuses on these results. The suggested approach brings crucial Improvements, especially in terms of increased effectiveness and specificity in illness prediction. Training on modified datasets with weights assigned to rare symptoms based on lab reports and testing on real-life patient symptoms.

The research piece has been split into the following sections: The paper's authors' prior work is presented in the second section of the paper. The recommended approach is clarified in greater detail in Section 3, which also emphasizes all of the techniques utilized to improve the illness prediction algorithm's precision.

A comparison of the preceding approaches and the suggested model is provided in the fourth section of the paper. The fifth section summarises the study's results, while the sixth section examines at potential paths for additional study in this area.

## LITERATURE SURVEY

As already stated, many kinds of illness prediction models based on indications provided by the individual with the condition have been presented in multiple study writings. Here is a list of the most popular and precise models:

As mentioned in the introduction, several research papers have proposed various models for predicting diseases based on patient symptoms. One such model, proposed by Jianfang CaoID, Min Wang, and Yanfei Li, uses SVM for disease classification [18]. While the model is efficient, it takes more time to predict diseases [31], and there is no method to improve its accuracy. The technique is known as Support Vector Machine has shortcomings in that it employs a hyperplane to categorize objects, which is only partially successful. [20, 25]. While the hyperplane can accurately classify sample data into two classes, in the medical industry, the identification of symptoms corresponding to diseases often requires classification into more than two classes. Hence, the SVM approach falls short in handling the complexity of multi-class disease identification.

The K-Nearest Neighbors (KNN) algorithm has been utilized by various authors [3]. Assigning the information point to the class that almost all of the K points of data belong to is how the procedure known as KNN operates. This approach is vulnerable to noisy and missing data, though. The accuracy of machine learning models drops when these factors have been taken into consideration, and reported to the authors, who utilized age category, signs, and sexuality to foresee the illness [3]. Another study by Kashvi Taunk, Sanjukta De, and Srishti Verma also utilized the KNN method and demonstrated high accuracy in predicting diseases such as diabetes and heart risks. Low amounts of information for illness classification remain problematic, unfortunately. [21].

Kedar Pingale et.al [1] proposed a disease prediction method using the Naïve Bayes algorithm, likewise, haven't utilized an enormous collection of data to

forecast an extensive range of illnesses, and their approach only accurately foresees just a handful of illnesses. Comparable to the aforementioned, Professor C K Gomathy [2] developed an online application for illness prediction using the Naive Bayes algorithm. There is an issue with developing illness forecasting technology with a more precise information set, even if the precision of the model is contingent upon the information that is given. The Naive Bayesian classification is additionally employed in the methodology suggested by Nitesh Kumar Verma et al. [22]. Yet, due to the fact that they are not employing an existing information set for instruction, the research team's illness accuracy in forecasting was inadequate.

An approach leveraging the Rustboost Algorithm, which is of particular importance and intended to tackle the matter of inequalities between classes, was suggested by Kumar A., Bharti, R. Gupta, with Saha [23]. The algorithm leverages randomized inadequate sampling as a reprocessing methodology, albeit this might lead to the loss of important data. As a result, this approach was not taken into account while training the data.

Numerous kinds of artificial intelligence techniques to predict illness forecasting have been shown in each of the techniques outlined above. Yet, challenges including effectiveness, precision, a short volume of data for training models, and limited symptoms taken into consideration for diagnosing an illness weren't addressed by the researchers. It must be done to offer a more reliable and precise model for forecasting human illnesses in order to solve these constraints. The suggested model is thoroughly explained in the section that follows.

## SUGGESTIVE METHODOLOGY

The predictive framework put looking forward in the present research attempts to offer an improved and more precise approach to forecasting illness based on complaints. The information that was received from the Kaggle database is employed to accomplish this objective, and the information is used for training using the Random forest, LSTM, and SVM algorithms. The list that follows will be the normal operation framework:

1. The individual will provide his or her laboratory findings.

2. Following the contrary, the outcomes will be processed and included in our system.
3. The potential illness will then be generated by the computer model.

### Random Forest Algorithm

The Random Forest Algorithm is the fundamental algorithm employed in the study paper. [2], The proposed model generates decision trees by aggregating multiple datasets and calculates their average for regression tasks, while employing majority voting for categorization tasks.[17].

The method known as random forest training has been employed to train the model on the datasets of complaints corresponding to illnesses [10]. This method of analysis is employed because it excels in tasks such as classification and regression because it can handle both continuous and categorical data sets [17, 30]. It performs categorization better than various other methods. The following describes how the random forest algorithm works:

Step 1: Choose random examples from provided datasets or training set..

Step 2: A separate decision tree is generated for each training datasets using this method.

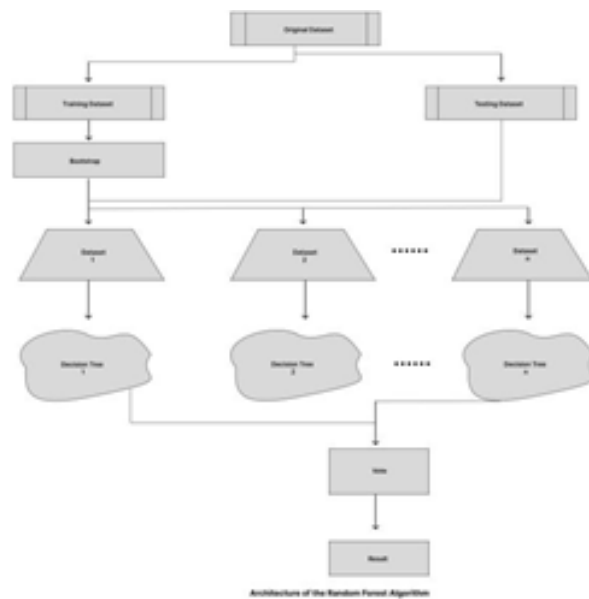
Step 3: The decision trees' average will be used for regression problems, while voting will be performed for classification problems.

Step 4: The final forecast result is selected as the outcome that comes with the most significant degree of agreement.

To forecast diseases, the Random Forest Algorithm examines a dataset's geographic location and symptoms. In order to establish the precision of the model, it then compares its forecasts to the provided labels.

The presented solution in the following section consists of  $N$  as the overall amount of data points, with  $f_i$  representing the model's output and  $y_i$  indicating every distinct data point's real value. This formula is used to calculate the Average Squared regression Error, which determines how far a node is from the forecast real value and assists in identifying the most suitable branching for a random forest. The Gini coefficient is frequently

employed for determining the node's position on the branch in decision trees that are for categorizing data. The Gini index identifies the branch with the greatest probability of occurring by evaluating the likelihood and classification of every branch on a particular node. In the above equation,  $c$  is the total number of categories present, while  $p_i$  reflects the proportional prevalence of a particular class within the datasets. It is essential to remember that when a data point is evaluated at a particular node,  $y_i$  indicates the data point's value and  $f_i$  identifies the decision tree's output.



**Fig. 1: The Random Forest's Algorithm's structure [26]**

The Figure 1 illustrates the operational architecture of the Random Forest Algorithm. It could possibly be broken down into a variety of stages [26]. The procedure involves separating the information set into a number of divisions, each of which is utilized to independently determine decision tree structures. The decision trees are joined to create the finished product in the next phase. The Random Forest Algorithm comprises the phases mentioned below:

- 1) Partitioning the complete datasets into separate training and test data subsets
- 2) Clustering the information sets into numerous more concise instances.
- 3) Manually constructing decision-tree models from each data set.

- 4) Assessment of such decision tree structures
- 5) Making judgments based on information learned from the decision trees.
- 6) Delivering the result as an end result

*Applying the Random Forest Algorithm Offers an Advantage*

The guidelines that follow have been used by the writer in order for altering the indications (database inputs):

**Uncommonness:** The Random Forest Model produces more accurate illness prediction based on indications by increasing the importance of indications which are more infrequent. [17].

**Locality:** Some illnesses have geographic limitations and are only encountered in specific regions. As a consequence, the algorithm generates such that it eliminates all illnesses from the record set that are missing from the location specified [26].

The Random Forest Algorithm prunes, and lamb with the decision forests throughout the model's training section, eliminating branches that consist of mild indications or indications that do not exist in a particular region. This method helps to cut expenditures while producing a model forecast that is more precise and realistic.[24].

*The drawbacks of the Random Forest Algorithm*

**Time of execution:** A notable drawback of the Random Forest Algorithm is the substantial time and space required for compiling decision trees, which poses a significant challenge. [26].

**Stability:** The Random Forest Algorithm demonstrates enhanced efficiency when operating within a stable environment characterized by datasets that are less noisy and dynamic in nature. [17].

**Over fitting:** When noise is present in the datasets, the Random Forest Algorithm has the potential to generate an overfitted model, compromising its performance and accuracy. [17].

### **Long Short-Term Memory**

Recurring artificial neural networks of the long-short-term memory (LSTM) variety have the capability of encapsulating their reliance on incoming orders. a combination of the individual's illness histories and

data from time series, it might be utilized for predicting illnesses. In this study, LSTM will be implemented to combine a fresh dataset with the per-trained datasets in order to increase the accuracy of the model and discover fresh parameters and opportunities. [27].

The precision and dependability of illness prognosis will be enhanced because of the incorporation of the LSTM algorithm into the mathematical framework. Further versions of the model could add the time-series information that the LSTM algorithm works best with.

The determination regarding what fresh knowledge should be incorporated into the state of the cell is made partially by the gate that receives input. The forgotten gate is in control of eliminating unnecessary data from the cell’s internal environment. The LSTM block’s output is then activated at timestamp “t” via the output gate. [9].

**Support Vector Machine (SVM)**

The SVM approach will be utilised to estimate the relationship between its results and those generated by the various models once the results from the model using LSTM and the model based on Random Forests have been gathered. As an illustration, if both the LSTM and Random Forest models forecast “Hepatitis,” the SVM is going to investigate the associations and causation connection between the signs and symptoms and the illness to validate its results. [19]. The latter stage is essential for confirming the final diagnosis’ precision and dependability.

In the final analysis, considering the parameters that are offered the SVM algorithm is going to be utilized to forecast the consequence and the classification of inputs. In their previous publications [4, 5], the researchers of the present research also used SVM as an important approach to forecast outcomes using symptoms as inputs. The SVM algorithm [29] will only be used to forecast the association between two factors in our investigation. SVM has been considered as the final prediction model due to its effectiveness in effectively classifying datasets [18].

**Data Transformation**

About the datasets In excess of four thousand individual entries make up the datasets, which were obtained from

Kaggle [28]. They contain data pertaining to years of age, blood pressure, specific gravity, albumin, sugar, red blood cells, pus cells, pus cell clumps, bacteria, blood glucose random, blood urea, serum creatinine, sodium, potassium, haemoglobin, white blood cell count, wrapped cell volume, white blood cell count, red blood cell count, and more.

The unprocessed data sets from the Kaggle database undergo through a process of transformation that translates them into numerical information based on the degree of severity and frequency of the symptoms. The datasets are split into a training set, which includes 70% of the data, and a set to be tested, which contains the remaining 30%. The databases could expand significantly when additional individuals with illnesses are added. Additionally, patient history details are required for training a different model to monitor the patient’s history of ailments, which may be learned using the Random Forest method. Reliable illness forecasting for individuals can be accomplished by integrating the two approaches. Particularly, the algorithm used can just utilise symptoms for determining the medical issue, therefore medical background files aren’t essential to providing predictions. The extensive testing of the up-to-date datasets using a wide range of models demonstrates just how efficient and reliable the procedure is.

**COMPARE/CONTRAST ANALYSIS**

Table 1 provides a comparative analysis between the models employed in previous research papers and the proposed model, offering insights into the differences between them.

**Table 1: comparative analysis of techniques for disease prediction**

Ref.	Used Algorithm	Advantage(s)	Constraint(s)	Correctness
[1]	Naive Bayes Classifier	Scalable	The model achieves accurate results specifically for independent features.	94.8%



[2]	Random forest, Decision tree, Naïve Bayes	High accuracy for predicting disease	The model can be improved through the implementation of an ensemble model	98%
[3]	Weighted KNN	Seamless decision surface, less data dependency	Due the issue of over-fitting, model is not scalable	93.5%
[4]	SVM	Increased effectiveness, a lower level of complexity	Unsuitable for Multi-parameters	76%
[5]	SVM	Quick processing with lesser implication of space	Unsuitable for Multi-parameters	90%
[6]	Logistic Regression(LR)	It resupposes there is going to be dispersion.	Lower degrees of multicollinearity is required for better performance because of the issue of overfitting.	75%
proposed Method	Random Forest	The sets of data can be utilised employing Random Forest.	can be strengthened by enhancing the accessibility of time series data sets	90%

Table 1 provides a comparative analysis of various advanced techniques for disease prediction based on symptom inputs. The first column lists the reference numbers or serial numbers of the research papers,

while the second column describes the methodologies employed by the researchers. These methodologies serve as the foundation for the studies conducted. The advantages of each methodology are presented in the third column, highlighting unique factors that set them apart. The fourth column focuses on the limitations or drawbacks encountered by the research papers. Notwithstanding these difficulties, the newly indicated model surpasses prior modern methods when it comes to reliability. The enhanced urged model surpasses the greatest accuracy reached in the earlier study publications, which was about 95%, as shown by the fifth column, which shows the accuracy attained by the proposed techniques.

A comparison of the model’s training accuracy levels can be seen in the table. The Naive Bayesian Algorithms [1] demonstrated an excellent accuracy of 94.8% compared to the earlier methods. The precision of the weighted KNN model [2], positioned in the second spot, is 93.5%. The research work [4, 5] that used the SVM model demonstrated outstanding outcomes as well. However, the suggested random forest model surpassed all of the previous approaches, with the highest accuracy of 98%.

**CONCLUSION**

The challenges confronted by the healthcare sector such as patients’ inability to afford specialists and the shortage of medical personnel can be resolved by automating the process of directing patients to specialists instead of general practitioners. This can be accomplished by deploying an illness forecasting framework, that utilises the symptoms of the individual as inputs and, exceeding beforehand models, forecasts likely illnesses with 97% accuracy. The suggested strategy may assist the healthcare sector by:

- Reducing healthcare expenditures: Applications for forecasting illnesses may enhance the effectiveness of the medical system by improving patient outcomes and reducing the demand for needless operations and therapies, which reduces costs associated with healthcare.
- Enhanced patient results: By facilitating earlier and more efficient treatment options, the use of illness forecasting programmes may contribute enhance the results for patients. This provides healthcare

providers with crucial details about a patient's likelihood of contracting a disease.

- Timely identification: Applications to forecast illnesses may assist medical professionals establish a timely diagnosis, which is crucial to enhancing the health of patients, by examining patient information and discovering traits that raise the likelihood of particular illnesses. As a consequence, our method can provide greater precision and an accurate structure to forecast illnesses based on symptoms.

## FUTURE SCOPE

As time goes on, this medical condition forecasting technique has an opportunity to be used in a wide range of industry sectors and can be made more effective by adding additional symptoms for predicting illnesses. It can be utilised to develop a more effective, precise structure, which might eventually lead to a superior model to forecast illnesses in humans.

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# Comparative Analysis of CNN vs Vision Transformer for Lumpy Skin Disease in Cattle

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## ABSTRACT

Lumpy skin disease (LSD) virus, which has a very high mortality rate but a low fatality rate, is contagious in cattle and water buffalo. The livestock industry is at significant financial danger as a result. This research examines two deep learning models for lumpy skin disease detection in cattle: convolutional neural networks (CNNs) and vision transformers (ViTs). The study focuses on how different pre-processing methods affect how well the model's function. K-mean clustering, contour tracing, discrete wavelets transform, and grayscale cooccurrence matrix are some of the pre-processing methods used in this study. The dataset of cattle images used in the study was pre-processed using these techniques before being split into sets for training and for testing. Performance of CNN and ViT models were evaluated based on their accuracy and precision. The ViT model outperformed the CNN model when combined with the K-mean clustering and grayscale co-occurrence matrix preprocessing techniques. The study highlights the importance of proper preprocessing techniques in improving deep learning model's accuracy for lumpy skin disease detection in cattle.

**KEYWORDS:** Dataset collection, Deep learning, DenseNet169, Feature extraction, Inception V3, Lumpy Skin Disease, Transformer, VGG16, ViT

## INTRODUCTION

Effective disease control and preventive strategies are dependent on early detection and a precise diagnosis. Many deep learning techniques have recently demonstrated promising results in several disciplines, including disease identification and medical diagnosis. Types of skin conditions can be classified (benign keratosis, dermatofibroma, vascular lesions, melanocytic nevi, basal cell carcinoma, and melanoma) with more than 80% accuracy with Mobile net, VGG16 [1]. Deep learning methods for the early detection and diagnosis of lumpy skin disease in cattle have been explored in this paper. With deep learning algorithms, we aim to improve the accuracy of lumpy skin disease in figure1 diagnosis, which can ultimately aid in controlling

the spread of the disease and minimizing its economic impact. Vaccination does not completely protect against a disease, but they can lessen its frequency and severity as given in paper [2] such methods like epidemiology, transmission and powerful preventive measures accompanied by vaccination, would possibly result in better control of ailment. Hence, timely and precise diagnosis in endemic areas. As in paper [3] the most highly contagious diseases around the world comprising of Cattle external diseases are- Lumpy Skin Disease (LSD), Foot and Mouth Disease, and Bovine Keratoconjunctivitis ViT is (IBK). As of August 23, 2022, Nine Indian states have lost a total of 35,000 cattle due to LSD as per the Union Department of Animal Husbandry.





**Fig. 1. Lumpy Skin Disease**

The proposed research work has the following contribution.

1. Comparative study of 4 deep learning algorithms DenseNet, InceptionV3, VGG16 and ViT.
2. Preprocessing techniques were introduced to enhance accuracy.
3. The proposed work has accuracy 3% better than previous LSD models.
4. Previous studies did not use a publicly available dataset. Our paper is based on a publicly available dataset of lumpy skin disease.

## RELATED WORK

A lot of recent studies have used methods of deep learning to classify this disease. In paper [4], authors have used Inception-v3 for feature extraction, they have found that it achieves accuracy up to 92.5% on test data when using multiple classification models including KNN, LR, ANN, SVM, and NB. In paper [5], they used VGG16 for feature extraction and obtained an accuracy of 87.9% with logistic regression here the features were extracted using a 19-layer CNN (VGG-19) and Naive Bayes which was used to achieve an accuracy of 88.2%. Deep convolutional neural networks were used by them to foretell normal skin from Lumpy skin with a given data set, resulting in an accuracy score of 92.5%, 85%, 90%, and 95% of Curate skin condition results were analyzed using detection methods that use image color and texture features, In paper [6] SVM for classification and feature discovery they used GLCM Based on meteorological and geospatial data, the ANN algorithm showed 97% accuracy in predicting the presence of LSDV, while the SVM, logistic regression and Adaboost algorithms showed lower accuracy. In paper [7] Machine Learning like supervised learning methods, AdaBoost, Bagging, Decision Tree and Artificial Neural Network like Multilayer Perceptron were utilized in this paper and the ANN method

showed a 97% accuracy score, but other algorithms like SVM, logistic regression, and Adaboost showed lesser accuracy than ANN. [8] The classified model comprises of a CNN with 2 fully linked layers and 3 convolutional layers. This suggested technique had a 94.6% accuracy rate. The inventors of this CNN model claim that even when growing to hundreds of layers, Densenet networks do not have optimization problems. Their primary purpose for developing this approach was to deal with the input data vanishing at the network's output after it has travelled through numerous layers and the gradient vanishing in the other direction. 16 features with target columns having 2 values, 0 for occurrence LSD and 1 for the non-occurrence of LSD. Random Forest algorithm amongst all, outperforms with the accuracy 97.7%. [9] Several papers on lumpy skin disease have limitations. Only CCN-based models are used in these articles, which may limit how broadly the results may be applied. Furthermore, the datasets utilised in these studies are not openly accessible, making it challenging for other researchers to confirm the findings or carry out additional analysis. Furthermore, the maximum stated accuracy of 92% raises the possibility that these models have quite significant error rates. Last but not least, the lack of picture pretreatment and filtration methods used in these articles may cause noise and distortions in the datasets, which could impair the accuracy of the results. To make sure that the results are accurate, trustworthy, and useful in practical contexts, future studies must be more rigorous and applicable in real-world settings.

## PROPOSED WORK

Figure 2 shows the flow chart of proposed work which focuses on comparative study of 4 deep learning algorithms. The LSD dataset is first filtered out using EfficientNet and then 3 preprocessing techniques (KNN, DWT, Contour Tracing) are applied on images. Modified images are then trained on CNN and Transformer based models. The results of models are measured using f1 score and accuracy metrics. The proposed research aims to enhance the accuracy of image analysis by implementing segmentation techniques as in [20] that extract, and isolate relevant features of a given image while filtering out extraneous information. This paper investigates the efficacy of segmentation-based image analysis and provides empirical evidence for its



potential to improve the accuracy of image recognition models. A pre-trained CNN uses a segmented section of the affected skin colour to extract characteristics. A threshold is used to convert the generated output result into binary. Classification of LSD is done using the Extreme learning machine (ELM) classifier as in paper [21]. The dataset of cattle images used in the study was preprocessed using three techniques Contour Tracing, DWT and KNN before being split into training set and testing set. The performance of CNN and ViT models were evaluated based on their accuracy percentage and precision. Figure 2 illustration of our optimisation principle approximates a more general optimisation principle that is used in so-called continuation methods, which involve solving several progressively more challenging optimisation problems. This revealed fresh directions for deep architecture optimisation [10]. Image segmentation is dividing an image into more manageable, smaller pieces. A process called “feature extraction” reduces the amount of pixels in a picture by eliminating just the most important and noticeable portions of it, like in paper [11]. The lumpy skin photos collection is broken down into two categories: 324

photographs of lumpy skin diseases and 700 images of normal skin, for a total of 1024 images. The sources of these pictures are Kaggle [22].

**PRE-PROCESSING**

As shown in the flowchart in Figure 3. We used EfficientNetV2L to filter out unwanted images.

Apply K-means clustering to images to identify infected areas. To find the centers of a picture’s data, use K-Mean clustering. Then, a group that image into a cluster and determine how far its center is from other clusters. First, we create a three-column array using three different intensities of red, blue, and green. The channels  $R = I1[:, :, 0]$ ,  $G = I1[:, :, 1]$ , and  $B = I1[:, :, 2]$  were extracted. A group of n pixels  $\{a1, a2, a3, \dots, an\}$  and a set of n centroids  $\{c1, c2, c3, \dots, cn\}$  were provided to us.

$$p = \sum_{i=1}^n \min_j \|a(i) - c(j)\|^2 \tag{1}$$

where the I th image pixel is a(i) and cj is the j th cluster centroid,  $\| \cdot \|$  is the Euclidean distance between two vectors, and  $\min_j \|a(i) - c(j)\|^2$  represents the distance between the ith pixel and its assigned centroid iteratively updating the cluster centroids until convergence.



**Fig. 2. Proposed Flow Chart**

[12] To extract general shape information, Contour tracing on the digital sample is performed. Figure 4 shows Feature extraction using Contour Tracing. Once contours are extracted, their properties are analyzed and used to classify models. This frequently aids in assessing how well the feature extraction procedure is:

$$c = (c\{k-1\} + dk) \text{ mod } 8 \tag{2}$$

where c represents the chain code for the k-th pixel on the object boundary, c{k-1} represents the chain code for the (k-1)-th pixel, and dk represents the direction code from the (k-1)-th pixel to the k-th pixel. The mod 8 operation ensures that the chain code remains within the

range of 0 to 7, representing the eight possible directions of movement. In the first few layers after the input, the abstraction level is quite low and does not change much, but in the layers before the output, it varies around a high saturation value. Last but not least, the abstraction change over time is not normally distributed but rather resembles an exponential distribution [13].

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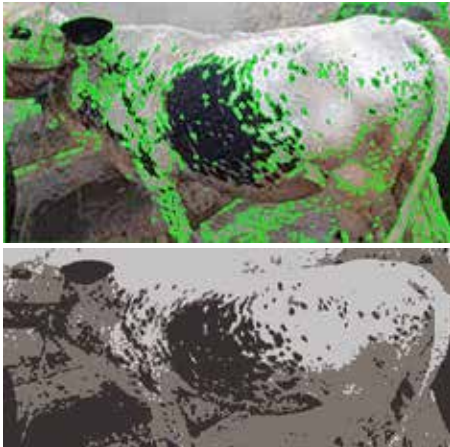


Fig. 3. Color feature extraction K-means preprocessing



Fig. 4. Feature extraction using Contour Tracing

Discrete wavelets transform: The DWT is divided into sub bands for high frequency (HH) components and low frequency (HL, LH, LL). DWT's LL component provides maximum information as compared to higher frequency components of the DWT. The mathematical equation for the 2D DWT of an image  $I$  of size  $N \times N$  can be expressed as follows:

$$x(m, a) = \sum_{i=0}^{m-1} \sum_{j=0}^{a-1} I(i, j)$$

$$\psi^*(m - 2i) \psi^*(a - 2j) \quad (3)$$

Where  $x(m, a)$  represents the coefficient at position  $(m, a)$  in the conjugate of the wavelet function, and the summation is over all pixel positions  $i$  and  $j$  in the image  $I$ .

### DenseNet 169

An application of convolutional neural networks for strong connections among layers. Each layer receives new inputs from every preceding layer and transmits its own feature maps to each succeeding layer, specifically designed to reduce the accuracy reduction caused by high-level neural networks' vanishing gradient. They reduce the number of parameters significantly, increase feature propagation, stimulate feature reuse, and solve the vanishing-gradient problem [14].

### The VGG Model

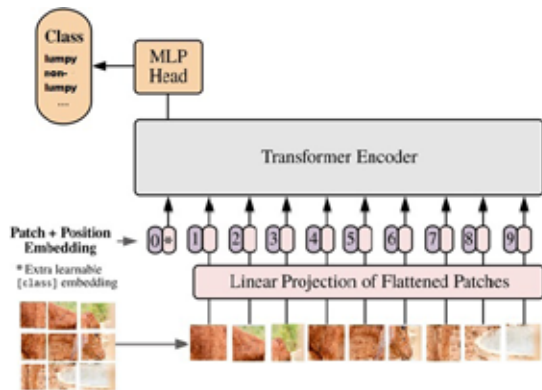
As shown in Figure 2 we further used The VGG architecture, a deep convolutional neural network (ConvNet) designed to classify images and object detection tasks [15]. It is made up of several stacks of pooling layers and convolutional layers, with each stack that has numerous convolutional layers and a max pooling layer. This architecture is designed with several filters in each convolutional layer to effectively learn and extract high-level characteristics from the input data. The VGG architecture is distinguished by its simple design, uniform structure, and ability to collect both low-level and high-level input data elements.

### The Inception V3 Model

[16] According to this paper Inception v3 is a deep convolutional neural network architecture comprising of multiple pooling and convolutional layers, and auxiliary classifiers to improve training convergence and regularization. It introduces an Inception engine consisting of multiple convolutional layers with different filter sizes, allowing the network to capture features at different scales. Inception v3 also uses factorization to make smaller convolutions, by reducing number of parameters and increasing computational efficiency. The architecture also includes batch normalization, dropout, and global average pooling layers before the final fully connected layer.

**Vit Model**

According to paper [17] The ViT model is composed of a series of transformer blocks as shown in figure 5, each of which contains multi-head self-attention layers and feed forward layers. Before being flattened and fed into the transformer blocks, the image inputted is first separated into a series of fixed-sized patches. The final prediction is produced using the output of the last transformer block, which is passed into a classification head. On a range of computer vision tasks, like picture classification, segmentation and object recognition, the ViT model has achieved cutting-edge performance. Its success has spurred further research into the use of transformer-based architectures for computer vision, leading to the development of other models such as the Swim Transformer and the Cross ViT.

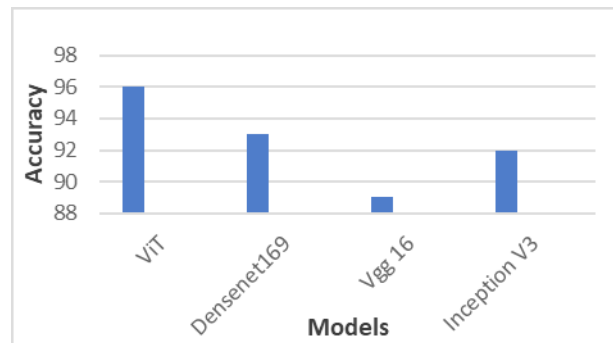


**Fig. 5. Vision Transformer**

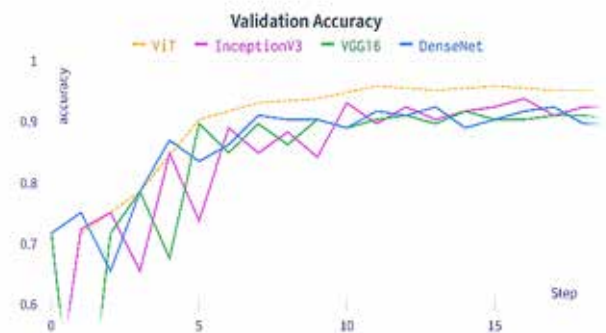
**RESULT AND ANALYSIS**

All four architectures are highly effective in image classification tasks. in terms of accuracy, ViT outperforms densenet, vgg16 and inceptionv3. the results of our research paper indicate that the vision transformer (ViT) model outperforms the other models in lumpy skin disease detection in cattle, with an accuracy of 96.12%. the densenet model achieves the second-highest accuracy of 93.87%, followed by inception v3 with 92.14%, and vgg16 with 89.74%. these findings suggest that deep learning models, especially the ViT model, can be effective tools for diagnosing and controlling lumpy skin disease in cattle. these models can potentially reduce economic losses in the livestock industry and improve animal welfare by enabling early detection and treatment of

the disease. [18] ViT is a sort of transformer-based totally architecture that has been tailored from natural language processing responsibilities. it makes use of self-attention mechanisms to capture the relationships among special elements of an image and has proven surprising performance on numerous picture classification benchmarks.[19] ViT can better seize the long-range dependencies in a photo ViT additionally has fewer parameters in comparison to densenet, which makes it extra efficient to teach and deploy. densenet outperforms in small records set.



**Fig. 6. Model vs Accuracy results**



**Fig. 7. Validation Accuracy**

The model’s training progress and validation results are displayed in Figure 7 on the epoch graph for a CNN-based algorithm trained for a maximum of 50 epochs with early halting at epoch 28, and a ViT model trained for 10 epochs as described in Table 1. The ViT model in figure [8-10] achieved a high degree of accuracy in identifying cases of lumpy skin disease and normal skin. It accurately classified 38 cases of lumpy skin disease (true positives) out of 40 actual cases, and 104 cases of normal skin (true negatives) out of 109 actual cases. However, the model misclassified 2 cases of normal skin as lumpy skin disease (false positives) and 5 cases

of lumpy skin disease as normal skin (false negatives). The overall accuracy was 94.63%, which suggests that the ViT model is a promising tool for diagnosing lumpy skin disease. Future research could explore ways to improve the model's accuracy, such as using larger image datasets or exploring other machine learning algorithms. The potential implications of this research are significant, as accurate and efficient diagnosis of lumpy skin disease is crucial for effective treatment and management.

**Table 1. Epoch Details of the Models**

Model	Number of epochs	Early stopping	Final epoch range
DenseNet	50	Enabled	20-28
InceptionV3	50	Enabled	20-28
VGG16	50	Enabled	20-28
VIT	10	Not enabled	.

## CONCLUSION

This study tested four models for identifying lumpy disease: ViT (96.12%), VGG16(89.74%), InceptionV3(92.14%), and DenseNet (93.87%). Our experiment showed that all four models had high accuracy rates for detecting lumpy illness, ranging from 89% to 96%. ViT outperformed the other three models, with a 96% accuracy rate. These results imply that deep learning algorithms can be useful tools for lumpy disease diagnosis. The user's individual requirements, such as the desired level of accuracy or the available processing resources, may, however, affect the algorithm that is selected. The study also emphasizes how crucial it is to keep developing and improving these algorithms to increase their precision and usefulness in clinical situations. By utilizing this approach, the model can focus on the specific areas of interest within the image and provide more precise and accurate results.

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# An Automated Tool for Crosscutting Concern Identification using NLP

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## ABSTRACT

Developers are trained to identify and differentiate aspects early in the software development life cycle. This enables them to establish sufficient traceability and functionality in later stages of development. Aspects refer to behaviors that are typically interwoven and dispersed throughout software requirements. While certain aspects could be more obvious, such as such specifics of typical crosscutting behavior, others might be less obvious and challenging to recognize. Therefore, this paper proposes a tool to accurately detect crosscutting concerns and identify candidate aspects from customer requirements in a fully automated manner.

**KEYWORDS:** *Aspect oriented requirement engineering, Crosscutting concern, Requirement engineering, NLP*

## INTRODUCTION

Aspect Oriented Requirements Engineering (AORE) [6] is another range of research under Requirement Engineering space. AORE concentrates on tending to cross cutting concerns by giving intends to recognizable proof modularization, piece and investigation of their effect on different other requirements in the documentation. Searching crosscutting concerns includes large number of detail documents. For example, interview records are normally erroneous, loaded with distinguishable logical inconsistencies and missing essential data. There are sure concerns that can't be recognized and modularized by the current procedure. Cross cutting concerns can exhibit functional or non-functional requirements. They impact on different concerns. They are dispersed among different requirements and trapped inside prerequisite.

Their trademark differs. Few are evident and few are unobtrusive. In this way they tend to be unrecognized. Once recognized the crosscutting concerns are exemplified in parts known as "viewpoints".

Different methodologies have been created, for example, Theme/Doc Approach [2], Early Aspects Identification Method [3] and Crosscutting Concern Identification utilizing UML [4]. Not all are supported by tool which requires client mediation. Subsequently, a completely robotized tool is required. Lamentably, the accessible methodologies are not ready to create mechanized tool for crosscutting concern Identification. In this way, another model or approach is detailed to conquer the lacking. The focus of this research is to outline and actualize a robotized tool for crosscutting concern recognizable proof in light of the described approach which is adapted from the proposed solution by Busyairah Said, Ali and Zarinah Mohd. Kasirun [1].

## BACKGROUND

Cross-cutting concerns are programme aspects that have an impact on several concerns in the development of aspect-oriented programming. These concerns are responsible for bringing code duplication and noteworthy conditions in both its outline and usage [5] [7].

Medical Records can be best example of crosscutting concern as the sequencing of records while logging the history or client database is major concern. The whole system is connected to concerns and hence they are interacting with more part of system and so it is vital that they do not depend on nor they influence any other part of system. Hence, they are responsible for the development of aspects. Such cross-cutting concerns don't cleanly fit into procedural or object-oriented programming (OOP). Cross-cutting concerns are responsible for framework interdependencies within a module. As a result, the code relevant to the cross-cutting issue must be dispersed or replicated throughout many related areas, resulting in a loss of modularity.

In order to maintain standardisation, aspect-oriented programming aims to include cross-cutting concerns into aspects. This enables the reuse and clear segmentation of code for cross-cutting concerns.

Ideally, a requirement specification could report all crosscutting affects in addition to all different semantic relationships amongst necessities. Even though each requirements statement does address simplest one state of affairs and is identifiable, not all semiotics connection between requirements is recognized and explicitly listed in maximum instances[25] [26].

The precept reason for this is the matter that there typically isn't always sufficient time in a software program mission to convert a sub-best specification right into a top-excellent one characterized with the aid of complete traceability. But, if few of the connections among requirements (collectively with crosscutting affects) are obscure, builders run the threat of forgetting approximately them. At exceptional they find those influences in later improvement phases and are capable of react consequently[17,18].

In some scenarios a few impacts stay hidden till even the software program has been delivered and are then

identified by customers in a roundabout manner due to the reality that a few requirements aren't truly fulfilled through the software. This will result in increase in costs an end outcome of the specification deficiencies. It may also lead to decrease[23] [24] in good faith on developers and effects the critical system components.

Moreover, aspects can either be a non-functional or functional requirement so that we can ensure the integrity of the program or device. Overlooking those queries advances deficient program with negative correctness. Whole credentials of crosscutting requirements and crosscutting affects enable easier requirements evolution. For example, if we have an ambiguity between the crosscutting concerns of any requirement than it is preferable to identify them at earlier stage of software development, to reduce the chances of bug occurrence at later stages.

## LITERATURE SURVEY

During the most recent couple of years, a few research endeavors have been committed to creating AORE models that can help in extricating, recognizing, and displaying perspectives in the early period of requirement analysis. Although the need of recognizing requirements level crosscutting concerns has been expressed, as it were hardly any endeavors have been made so far as how to efficiently distinguish them. All the current techniques work in a semi-mechanized manner to recognize crosscutting concerns at the prerequisites level. In the accompanying we discuss about quickly these endeavors.

Busyairah Said. Ali and Zarinah Mohd. Kasirun [1] proposed a model to identify the crosscutting concerns that satisfies all the crosscutting behaviors. We found this proposed model to the best due to its complete automated nature and as it deletes the requirement of human intervention to achieve desired results. However, this approach focuses on only on single word verb as a dominating verb or candidate aspect. It does not give any information for pairing two verbs for identification of candidate aspect. Theme/Doc method [2] on the other hand is a potential method to identify relationship among concerns. But unlike others it cannot deal with complex problem and large number of requirements. On the brighter part we discovered Early Aspects Identification strategy [3] utilizing Corpus – based Natural Language

Processing (NLP) as a decent approach since it is material for prerequisites record regardless of the structure. The last strategy, Identification of Crosscutting Concern with UML [4] is a straightforward strategy and pertinent to little scale necessities. Shockingly it can just perceive non-utilitarian crosscutting concerns. In brief every one of the strategies clarified above requires human mediation to create the final model except for the proposed model by Busyairah and Kasirun [1]. In view of the investigations on all the current strategies for crosscutting concern identification, we found that each technique has its own particular favorable circumstances and weaknesses. Our exploration receives and incorporates certain procedures from the current ways to develop a completely automated crosscutting concern identification approach[21] [22].

## METHODOLOGY

The foremost aim of the methodology is to satisfy all the crosscutting behaviors so that we can identify the concern. Consequently, a concrete technique to research the concerns needs to be advanced. In this file we will display a model to resolve this hassle. The model is as depicted in figure below. The method is inspired from the Theme/doc [2][14-16] technique and EA-Miner [3] [11-13]. Unlike conventional actions in requirements Engineering (RE) that's generally collaborative and iterative in nature, this approach includes non-collaborative processes due to the absolutely automatic nature. Additionally, execution on the approaches in this technique is based totally on the sequence formulated in the model. Every procedure within the model calls for output of the preceding system as an input for execution. Figure 1 shows workflow of proposed work.

Case Study: Course Management System

R1: Student should get a notification when they receive a new message

R2: System should allow teachers to send messages to student through an email

R3: System should give unique ids to students and teachers

R4: System should provide login to registered students

R5: System should allow teachers to upload assignments for students

R6: System should allow teachers to create a new course

R7: System should allow students to check their marks anytime

R8: System should provide a graph chart of student progress

### Step 1: Pre-processing

Structure Requirements

Step one identifies all the requirements set via the shareholders by assigning unique number to each requirement. This is needed to perceive and manage every requirement separately inside the later levels. From example R1-R8 are the series assigned to requirements to course management system.

Remove Redundancy

Sometimes extremely good shareholders generally point out the identical necessities more than once so one can put off the copied requirement, the unnecessary necessities are removed on this challenge.

### Step 2: POS Analysis

This assignment is to fetch out verbs from each necessities. The count of their incidence could be determined to reveal its distribution in the course of the report. Higher stage of distribution shows the electricity of the verb as candidate aspect. Like verbs might be used to cast the connection with the necessities and inter dependency among distinctive verbs [8-10].

From example: Verbs highlighted in italics are identified using POS tagger.

### Step 3: Semantic Analysis

This step uses semantic tagger to research the background of the word in which the infinitive is used. This statistics is used to pick out participles used to provide an explanation for comparable necessities. For example: verbs such as *stable* and *secure* each have the same meaning which means strong. So it's miles the assignment of semantic tagger to perceive them.

### Step 4: Filter Verbs Identified

After the semantic assessment is completed, the verb which has the same meaning in the context is removed. For instance the word 'guard' and 'secure' has the same meaning within the same context allow us to remove

one of them. From example there are two verbs provide and give with similar meaning hence we discard give.

**Step 5: Mapping requirements against verbs**

To slim down the scope of identification of crosscutting concern, we map the requirements using a matrix to identify the necessities N1...Nn prompted with the aid of manner of corresponding participles P1...Pn. The matrix can turn out to be quite massive if there are various necessities and masses of participles. This may be mitigated by using the usage of imposing condition inside the subsequent level.

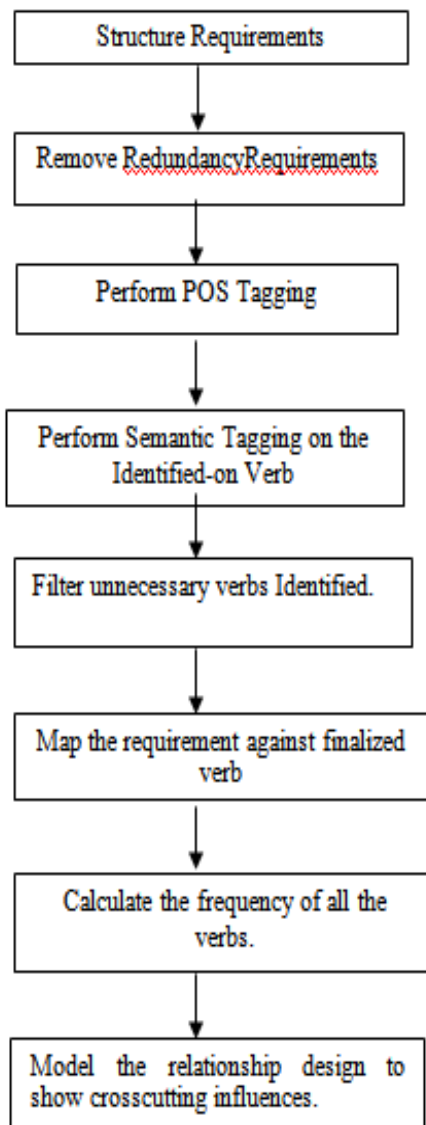


Fig. 1: Workflow of proposed work

**Step 6: Refine the matrix**

Based totally on the connection view, the necessities shared by manner of multiple verb and the distributed participles are diagnosed.

Table I. Matrix for Requirement Against Verbs

Requirement	R1	R2	R3	R4	R5	R6	R7	R8
Verbs								
Get	✓							
Receive	✓							
Allow		✓			✓	✓	✓	
Send		✓						
Provide				✓				✓

Table 2. Matrix for Requirement Against Verbs

Requirement	R1	R2	R3	R4	R5	R6	R7	R8
Verbs								
Get	✓							
Receive	✓							
Allow		✓			✓	✓	✓	
Send		✓						
Provide				✓				✓

**Step 7: Frequency count of Verb**

Based on the results of above steps frequency for individual verb is calculated. These verbs are tabulated in a descending order of their frequency.

Table 3. Frequency of verbs

Verbs	Frequency
11Get	1
Receive	1
Allow	4
Send	1
Provide	2
Create	1
Upload	1
Check	1

The Major change in the methodology from that of stated in previous researches is, here we identify the frequency of verb-pair rather than singleton verb. Each verb is matched for a pair in the document and there occurrence is checked in all other requirements.

### Step 8: Identifying Candidate Aspect

Verb-pair having the highest frequency of occurrence are taken as a candidate aspect. These are further modeled to show crosscutting influences.

From the above table it is found that the verb allow has maximum 4 frequency hence it became the candidate aspect or key.

### CONCLUSION

In conclusion, this paper proposes a tool that can help developers accurately detect crosscutting concerns and identify candidate aspects from customer requirements in an automated manner. By enabling early identification of aspects in software development, developers can establish better traceability and functionality in later stages of development. The proposed tool can help developers to identify both obvious and subtle aspects, thus improving the overall quality of software development.

### FUTURE WORK

The future scope of this conclusion could be seen as the potential impact of the proposed tool on software development. The use of automated tools to identify crosscutting concerns can greatly reduce the effort and time needed for manual inspection, thus improving the efficiency and accuracy of software development. This can lead to a reduction in development costs, better adherence to customer requirements, and increased customer satisfaction.

The proposed tool could also potentially lead to the development of more sophisticated software development tools and techniques that incorporate automated aspect identification. This could further improve the quality and reliability of software, as well as reduce the likelihood of bugs and errors.

Moreover, this conclusion could be used to motivate further research into the field of automated aspect identification and the development of more advanced tools and techniques for identifying crosscutting concerns in software development. As software continues to grow in complexity, there will likely be an increasing need for automated tools to help developers manage and identify crosscutting concerns.

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# Net-Banking Chatbot using Python

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## ABSTRACT

Chatbots are software systems designed to mimic human interactions and assist in resolving problems or managing various situations. The capability to ask questions is crucial in fostering both human and machine intelligence. So, we are doing research on the net banking chatbot To aid bank users in conducting transactions, there is a need for an effective question generation method. Traditional question generation approaches used in other chatbots struggle to generate a substantial amount of high-quality question-answer pairs from unstructured text. This is primarily due to the inherent challenge of mapping a single answer and input passage to multiple questions. In this study, we introduce answer-clue-style-aware question generation (ACS-QG) as a solution. ACS-QG aims to emulate human questioning by generating a wide range of top-notch question-answer pairs from unlabeled text corpora, enabling scalability and diversity. Natural language processing allows a bot to converse in the most natural way possible, making the development and operation of the chatbot the most comfortable option for bank customers to get their questions answered.

**KEYWORDS:** *Artificial intelligence; Chatbot; Chatbot architecture; Net banking; NLU (natural language understanding); NLP (natural language processing); Python*

## INTRODUCTION

**B**anks are very important in every country's development and success. Almost everyone needs banks for their everyday needs, especially those who are new to banking. They struggle to understand the different policies and documents required to complete their banking tasks and benefit from various services. Nowadays, banks have their own websites, mobile apps, and online banking services, but these can be overwhelming for many users, especially those who are not familiar with technology or have trouble finding the right information. There are different banks with different policies, and people have difficulty navigating through their websites and interfaces. It

would be helpful to automatically generate questions and answers from text passages that don't have labels. This can be used to improve machine reading comprehension systems, enhance search engines, train chatbots, create educational exercises, and make frequently asked questions (FAQs) for websites. Many question-answering tasks, including machine understanding of literature and chatbots, necessitate a large number of labelled samples for supervised training, which is both time-consuming and expensive to get. Automatic question-answer generating enables these systems to receive scalable training data and to transfer a pre-trained model to other domains without manually labelled training examples.

In this case, artificial intelligence applications are useful. Some of the most well-known uses of artificial intelligence to date include natural language processing, machine learning, robots, and e-service agents, sometimes known as chatbots [2]. Computer programs known as chatbots interact with humans by utilizing Natural Language Processing (NLP). Conversation development plays a pivotal role in the functionality of any Chatbot. Despite notable advancements in natural language processing (NLP) and artificial intelligence (AI), creating a robust chatbot model remains a challenging undertaking. It can be applied to many different activities [3].

## LITERATURE SURVEY

A Chatbot is a piece of artificial intelligence (AI) [[2], [4]] software for computers that can imitate a conversation through textual or audio means. Chatbots are powered by artificial intelligence, which evaluates a customer's data and blends the response with it. Bots powered by AI can take over a range of tasks since they are far more powerful and can perform multiple tasks at once. Natural language processing allows a bot to communicate as naturally as feasible. The ideal user-chatbot connection is a well-balanced mix of modern technology and human intervention.

The primary objective of the referenced paper [5] is to enhance the software utilized in the bank chatbot system. The research conducted in this paper focuses on developing a bot that facilitates efficient and prompt execution of tasks, leveraging the capabilities of chatbot systems controlled by the software. Python language and the chatterbot library are employed in this study to achieve this goal, ensuring accurate responses within the existing management system.

As outlined in research paper [6], a concept is proposed for a Web-based Dental Information Management System tailored for a private dental clinic, emphasizing the advantages of Information Systems over traditional approaches. Using Chatbot technology, the solution intends to automate operations such as dental record storage, billing, report generating, and smart appointment scheduling. The V-Model methodology is used in this project, and it contains a project management plan. The research reveals a favorable cost/benefit

analysis, with the ability to increase efficiency and handle more patients. Future upgrades should include the integration of decision-support systems for tooth disease identification and dental treatment suggestions.

According to the findings presented in research paper [7], their approach outperforms state-of-the-art neural question generation models in terms of generating high-quality and scalable questions. By training models on a smaller dataset, they were able to generate a total of 2.8 million quality-assured questions and responses from one million words sourced from Wikipedia.

In the study described in paper [8], the Stanford CoreNLP Natural Language Processing Toolkit is introduced. This toolkit serves as a versatile pipeline for essential natural language analysis and has gained popularity in both the research NLP community and among users in commercial and government sectors seeking open source NLP solutions.

IBM Watson Assistant [9], utilizing conversational AI, demonstrates an understanding of queries, searches for optimal solutions, and accomplishes desired user actions through deep learning, machine learning, and natural language processing (NLP) models. In addition, Watson employs intent categorization and identification of entities to better comprehend consumers within perspective and move them to a human agent when necessary.

The paper [10] presents that chatbots are usually used in return systems for a variety of sensible objectives such as customer service or gathering of information. The majority of central chatbots arrange a customer's commitment with a specified set of conversations. The chatbot organizes the client's input and provides an answer based on what the customer has recently sent. It could be a greeting, a topic of conversation, or even an image.

The significance of paper [11] emphasizes the fact about data innovation and correspondence have advanced, AI has grown increasingly challenging. Artificial intelligence frameworks replicate human behaviours such as making decisions in real time, performing repetitive tasks, reacting to users quickly, and answering queries. There are numerous electronic groups for e-business, pleasure, virtual assistance,

and other purposes. Everything in this generation is becoming increasingly connected to the internet. It's an excellent method to manage and benefit from everything just outside your front door. A competent marketing strategy is crucial in a competitive sector like credit card insurance. Despite the fact that credit cards have difficult and complex elements, consumers are progressively using them. As part of their package, most credit cards contain a supplemental insurance coverage. Consumers are typically unaware of these freebies, and the perks and advantages may be difficult to understand.

The paper [12] represents about how various chatbot applications improve customer experience by facilitating smooth interactions between services and people. Simultaneously, chatbots provide businesses with numerous options to increase client loyalty while also ensuring operational efficiency by reducing the excess cost of customer service. For successful implementation, chatbot systems must be capable of doing both duties. Human engagement is also necessary here; regardless of the approach or platform, human assistance is critical in training, optimising, and configuring the chatbot system.

The important aspect of paper [13] is how various platforms uses chatbots and the way in which the use of chatbot in the market is growing. According to research, chatbots are now utilized to address a wide range of commercial tasks in a variety of industries, including E-Commerce, Insurance, Banking, Healthcare, Finance, Legal, Telecom, Logistics, Retail, Auto, Leisure, Travel, Sports, Entertainment, Media, and many more. The software sector is mostly focused on chatbots. Several chatbots are created on startups and employed by enterprises to boost customer service and keep them hanging by a kind discussion. As a result, the time has come to consider chatbots as a new communication tool. Nowadays, many businesses use chatbots to swiftly and efficiently respond to frequently asked inquiries from their clients.

The significance of paper [14] is that it evaluates about the implementation and working of different chatbots created using different algorithms, also the current scenario is discussed. Current chat bots are developed in a variety of ways, including rule-based, where rules are programmed in code, AI-based, and pattern-based,

which can only deal with specified patterns to acquire answers. There are frameworks for developing chat bots, but they all use rule-based or pattern-based methods. It is nearly tough to write rules and/or patterns for massive volumes of data. NLP and ML are the backbones of AI bots. They are based on the human propensity to learn information in a more efficient manner. When preordained or static rules or patterns are unsuccessful, Natural Language Processing (NLP) might be used.

The paper [15] proposes a novel approach on the methodologies and techniques used in the creation of a chatbot. Chatbots are built using AIML and LSA. Chatbots are created using Artificial Intelligence Markup Language (AIML) and Latent Semantic Analysis (LSA) which are used to define broad pattern-based queries. This pattern can also be utilized in the chatbot to produce various replies to the same query. LSA is a Python Latent Semantic Analysis technology used to detect similarities between words as vector representation. As a result, AIML's unanswered inquiries will be interpreted as a response by LSA. Chatbot by means of neural network and deep-learning gives tremendously good consequences in carrying a human verbal conversation.

The research conducted in paper [16] provides insights into Computer-Supported Collaborative Learning (CSCL) and the evolution of chatbots throughout the decades. The study encompasses various academic disciplines, including teaching innovation, instructional psychology, sociology, brain science, and social psychology. Benton and Radziwill (2017) define a chatbot as an online platform that enables human interaction, where computer software comes to life through natural language input. It is often described as a computer program leveraging artificial intelligence to simulate human communication. Schlarl (2004) characterizes a chatbot as software that facilitates textual communication using natural language, often fooling users into believing they are interacting with an actual person. This highlights the importance of a comprehensive knowledge base that encompasses a wide array of rules possessed by a chatbot. Chatbots are expected to become an effective means for organizations to engage with individual users and swiftly address their concerns (Moore, 2017). Furthermore, the surge



in interest in chatbots has spurred advancements in messaging services and artificial intelligence (Guzman & Pathania, 2016). Chatbots are now found in task-specific applications, serving various purposes such as educational, conversational, or value-driven interactions.

The purpose of paper [17] is that it focuses on the technologies which are used widely nowadays and also the interactive nature of chatbot is being discussed and implemented. The development of Artificial intelligence (AI), big data, and the internet of things (iot), amongst other technologies, have resulted in major technical advancements during the last decade. These technologies have numerous uses. One such application is chatbot or chatterbot. This technique uses both to combine AI and Natural Language Processing (NLP). AI and Natural Language Processing (NLP) are the critical elements of this technology. Chatterbot is python library which makes the working of chatbot possible and is responsible for making the chatbot responsive.

The relevance of paper [18] is about the study published by WHO and carried out for NCMH, at least 6.5% of India's population suffers from a serious mental disorder, and there are currently 450 million people worldwide who experience mental health issues, making mental disorders one of the main causes of illness and disability worldwide. The fact is that there is a severe lack of mental health professionals including psychologists, psychiatrists, and doctors, despite the fact that there are effective measures and treatments in place. We will develop a chatbot dubbed "Buddy" that is inspired by kindness and acts. Buddy is a mobile chatbot program powered by artificial intelligence for initiating constructive interactions.

The research work proposed in [19] gives brief about how growing a chatbot gives us access to all the solutions we need and provides the right information when and where we need it. This helps a bank perform better and increase its customer base. It removes the human element from corporations and could provide assistance around the clock to increase the bank's wealth. We want to provide a chatbot alliance for customers that can be reached anywhere and whenever they need it. Net banking chatbots are designed to the point where every

user may ask any question in their own language and receive an immediate response. The suggested method will be incredibly user-friendly and efficient enough that anyone can use it. The ability of chat bots to respond quickly will also save users' time. The proposed system aims to be an intelligent interrogation platform that not only replicates but also learns autonomously to enhance its own capabilities. By doing so, it not only improves the quality of customer service but also reduces individual workload, resulting in increased satisfaction among customers and overall productivity.

The research in paper [20] describes the dataset, design, and methodology utilized for creating such conversation larva using FAQs from multidomain websites. This study compares seven categorization techniques that are used to determine the category of input for speech larvae. With the exception that the client would be communicating with a larva rather of a real person, the proposed approach would make it easier to recreate the customer service experience and still help with answering and resolving queries. By offering solutions for help desks, phone respondent systems, and client care centres, it will improve quality of life.

## METHODOLOGY

The system that is suggested is a Banking bot, an artificial intelligence built for banking operations that understands and replies to people's enquiries. The primary goal of this study is to examine a banking bot employing artificially intelligent algorithms that can analyze and understand user questions and respond accordingly. We must visit the bank or call customer service for any banking-related questions. It requires an enormous amount of time and effort, and the bank employees are also quite busy answering our questions. On the other hand, we don't get complete information from the customer care executives. It would be preferable if we could directly post our questions online or speak with bank representatives and receive a quick response. To address this issue, we proposed an online banking bot that allows users to communicate with the bot directly.

In the aforementioned figure, we explain the process flow of the working of every component and tool involved in responding of the chatbot. Initially, the user asks the



query from the chatbot which is taken by the corpus of the chatterbot library that divides the query in segments using bag of words tool. NLP then takes the query and acts an interface in the conversation of the bot and the human. Now the chat window that is the interface responds to the query. The interface is developed using Html, CSS and JavaScript. The application database responds along with NLP and reverts back to the user.

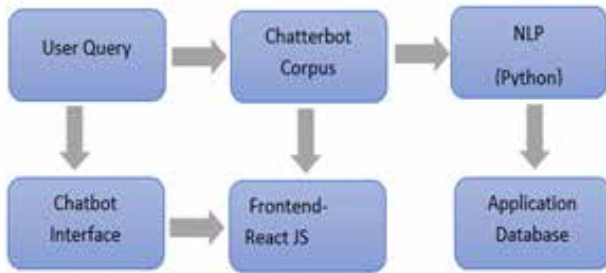


Fig. 1: Process flow of the chatbot

**Problem Formulation**

The primary challenge encountered in this research pertains to the bank’s users. If a user decides to discontinue using the service, their data needs to be detached, thereby allowing for effective data management. Additionally, when adding a new user, it is important to ensure the appropriate organization is associated with their account. The paper outlines functionalities such as user account setup, deposit/withdrawal transactions, and access to account details. The presentation also introduces an identification system for organizing these activities effectively.

The chatbot’s software is quite easy to operate, according to the system’s ease of use. It helps reduce the number of staff that software needs at each branch in order to run freely.

The ability for users to create global chats makes banking chatbot software outstanding. They are able to communicate with their bot from anywhere in the world and conduct business there.

**IMPLEMENTATION**

By implementing a chatbot, we gain access to a versatile solution that provides timely and accurate information, thereby enhancing the performance of a bank and attracting a larger customer base. It eliminates the need

for human intervention within the organization, offering 24/7 availability to further expand the bank’s reach and provide genuine customer support. Our chatbots are designed to accommodate users in their preferred language, ensuring effortless communication and prompt responses. The proposed system is highly effective and user-friendly, accessible to individuals with varying levels of expertise. Users will benefit from time-saving interactions as chatbots can provide rapid responses. The suggested methodology emphasizes intelligent questioning, allowing the system to continuously improve and exceed customer expectations, resulting in heightened customer satisfaction and business growth for the bank. Consequently, customers will be delighted with the bank’s services, leading to an expanded and content customer base.

**Tools for Implementation**

Preconditions often face challenges such as ambiguity, lack of refinement, and incompatibility. To address these issues, a meticulous survey was conducted to provide effective solutions. It has been observed that when these problems are identified and resolved early in the developmental stages, the overall cost and complexity are significantly reduced compared to addressing them at later stages. Demanding scrutiny plays a crucial role in mitigating these issues. In our chatbot development, we will utilize Python as the programming language[22] [23] .

**Pre-processing**

To enable the chatbot to understand various natural languages, we employ the NLTK (Natural Language Toolkit) library for Natural Language Processing. This allows the chatbot to effectively process user input, which is primarily in the English language. By incorporating Natural Language Processing tools, we ensure that the chatbot can comprehend and respond appropriately to English statements from users.

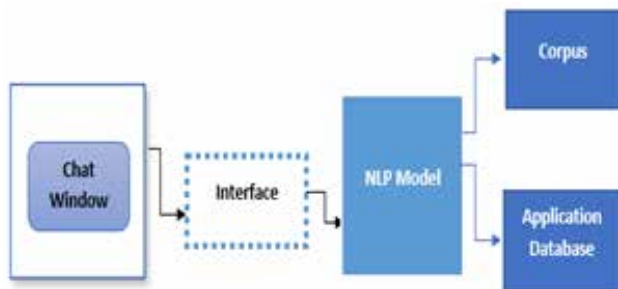
- Chatterbot library
- Scikit-learn library
- Tfidfvectorizer
- Nltk toolkit which involves:
- Stop words
- Word\_toknlktokenizer

- Lancaster stemmer
- nltk.corpus
- datetime

**System Architecture**

A basic chatbot architecture should consist of the following:

- A chat window/ session/ or front end application interface for the user.
- The deep learning model for Natural Language Processing [NLP].
- The corpus or training data for training the NLP model Application Database for carrying out actions to be performed by the chatbot.



**Fig. 2: Net banking chatbot system architecture**

The aforementioned figure explains the internal structure of the chatbot and the working is explained as mentioned below:

**Corpus or Training Data:** The term corpus refers to data that can be used to train an NLP model to recognize human language either written or spoken and respond in the same medium. A corpus is often large amounts of data with numerous human interactions[21] [24] .

**Chatbot window:** We created a feature that allows the user to engage with the bot via text. Unless broken or quit, the function keeps the chat window open. Emily is the name of our text bot.

**Evaluate or test the chatbot:** There could be several ways to work and engage with different types of processes.

**Data pre-processing Upper- or lower-case text handling:** Translate all information from an input corpus or user inputs to upper or lower case. This eliminates word deformation and wrong interpretation when written in

lower or upper case[25] [26] .

**Tokenization:** Convert a sentence i.e., a collection of words into single words.

**Stemming:** It is the technique of identifying similarities between words that share the same base words. This will assist us in reducing the bag of words by linking related words with their root words.

**Software Specification**

- **Frontend and Backend:** The front end is designed using HTML & CSS framework along with JavaScript. The interface of the chatbot is designed which is compatible to all kinds of devices when opened on a browser.
- **Machine learning:** Machine learning is a fundamental subfield of artificial intelligence which enables computers to go into a self-learning mode without being manually programmed. When these computer programs are subjected to new data, they are able to learn, grow, alter, and develop on their own.
- **NLP:** Natural-language processing (NLP) is a discipline of software engineering and artificial intelligence that studies the communication amongst computers and human languages, about how to program computers to process huge volumes of natural language data effectively.

**CONCLUSION**

This research paper introduces a specialized computer program known as a chatbot, designed specifically to engage with customers of a bank. The chatbot possesses the ability to comprehend and respond to written messages from customers. Python, a programming language, along with various libraries, was employed to develop the functioning chatbot. While the chatbot can provide answers to questions regarding the bank and customer accounts, it relies on pre-programmed responses. To enhance its intelligence and broaden its question-answering capabilities, the chatbot can be integrated with external information sources such as Wikipedia, the Weather Prediction Department, Sports, News, and Government. By doing so, the chatbot becomes capable of conversing with users on diverse topics.

## FUTURE SCOPE

The future advancement of chatbots entails enabling them to understand and respond to human language or adhere to specific rules, thereby making them even more helpful. With the integration of machine learning technology, chatbots will possess the ability to retain information from previous conversations, leveraging that knowledge to address new queries. A key challenge lies in ensuring the chatbot can effectively interact with a wide range of users and comprehend their conversations. The suggested system would be a first step towards having an in-house intelligent question-handling technology that, in stages afterwards, may not only relate but also self-improve, so boosting not only the norm of customer service but also decreasing human load, better efficiency, and, ultimately, maximizing the number of satisfied customers.

The future scope of this conclusion could be seen as the potential impact of the proposed tool on software development. The use of automated tools to identify crosscutting concerns can greatly reduce the effort and time needed for manual inspection, thus improving the efficiency and accuracy of software development. This can lead to a reduction in development costs, better adherence to customer requirements, and increased customer satisfaction.

The proposed tool could also potentially lead to the development of more sophisticated software development tools and techniques that incorporate automated aspect identification. This could further improve the quality and reliability of software, as well as reduce the likelihood of bugs and errors.

Moreover, this conclusion could be used to motivate further research into the field of automated aspect identification and the development of more advanced tools and techniques for identifying crosscutting concerns in software development. As software continues to grow in complexity, there will likely be an increasing need for automated tools to help developers manage and identify crosscutting concerns.

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# Optimization of Mechanical Properties of In-Situ Aluminum Matrix Composites by Hybrid Process

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## ABSTRACT

The potential material which caters that requirement of various engineering sectors is aluminium matrix composites (AMMCs). Liquid metallurgy processing technique to obtain the AMMCs possesses the quality of environmental favoring, effectiveness from view of economy, and can be combined with other processing techniques. It superbly scatters the reinforcement particles in the molten alloy. Agglomeration of reinforcement particles in the composites are not much after the use of ultrasonic processing as it breaks the big and the medium kind of clusters into small clusters of reinforcement particles. The governing factors for the selection of material and fabrication process are shape and size of the component, cost, ease of fabrication, distribution and wettability between the reinforcement phase and matrix alloy.

In the present study, the investigation of the ultrasonication effect in various aluminium matrix composites have been carried out. The composites were fabricated by employing different conditions like in one case we added 1 wt. % CeO<sub>2</sub> powder in molten alloy and in another case 1.5 wt. % CeO<sub>2</sub> powder in molten alloy. We also prepared composites by going one step ahead after addition of 1 wt. % CeO<sub>2</sub> or 1.5 wt. % CeO<sub>2</sub> powder by introducing the ultrasonication process. Hardness comparisons and tensile strength comparisons between the samples casted at above stated conditions were done. The sample ultrasonically treated was found to have higher hardness than the samples not been ultrasonically treated. Regarding porosity, observation of porosity was high in those samples which had not given ultrasonic treatment. Al<sub>2</sub>O<sub>3</sub> particles were observed by XRD analysis but not with EDAX analysis. The 0.2 % proof stress, UTS and elongation were on increase with increase in reinforcement content and with introduction of ultrasonic treatment.

**KEYWORDS:** *Component, Formatting, Style, Styling.*

## INTRODUCTION

Aluminium matrix composites (AMCs) have generated tremendous interest for researchers since twenties. The major fields where they are finding important roles are like making electronic appliances, sports related equipment, automotive and armours industries. They give an outstanding form of mechanical properties regarding the chemical composition of the Aluminium matrix. . It has become the present need of the hour to design the existing systems in such a way as to experience further volume and mass savings [1]. AMCs can offer economically

viable answers for broad variety of economic and commercial applications due to selective reinforcing methods and near net shape forming methods [3]. It was observed that due to incorrect and inadequate casting methods several defects like clustering of the particles, porosities, oxide inclusions and interfacial reactions were recorded [10, 13]. The clustering of tiny particles is not difficult to form inside the matrix and is often considered as responsible for lowering the entire system free energy [14]. There are several processes for producing in-situ composites, for example, DIMOX (Directed melt oxidation process), XD, reactive gas infiltration, DMI (Directed melt infiltration), high



temperature self-propagating synthesis (SHS), and liquid-solid, or solid-gas-liquid reactions [4,5].

Various researches have been carried out to investigate the effects of kind of reinforcement and volume fraction on the microstructure and mechanical properties of numerous Al alloys. Ultrasonic oscillations are widely used in the treatment of molten metal, such as degasification, processing and purification. Further, ultrasonic vibration was used in the manufacture of composites reinforced with metal particles from the ultrasonic vibration to enhance the wettability between the matrix and reinforcements. However, in the contemporarily literatures there is very less published work particularly emphasized on  $\text{Al}_2\text{O}_3$  particulates reinforced and ultasonicated Al matrix composites or less amount of progress has been reported on the manufacturing of in-situ  $\text{Al}_2\text{O}_3/\text{Al}$  composites by using ultrasonic vibration of high intensity [23]. The intent of the present research is therefore, to examine the comparative effects of the addition of different amount of cerium oxide like, 1 and 1.5 wt. %  $\text{CeO}_2$  under condition of water quenching, also under condition of ultrasonication and water quenching and  $\text{Al}_2\text{O}_3$  particulate reinforcements on the microstructure and mechanical properties of AA6061 untempered alloy. Also our research focuses to explore an approach to fabricate in-situ  $\text{Al}_2\text{O}_3/\text{Al}$  composites at a low synthesizing temperature. In addition, high intensity ultrasound vibration was introduced in the fabrication of in-situ  $\text{Al}_2\text{O}_3/\text{Al}$  composites, and the effect of ultrasound vibration on the microstructure of the composites was also investigated.

## LITERATURE REVIEW

Zhiwei Liu et al. [8] reported that pure aluminum; pure titanium and graphite powder is used to make aluminum matrix composite material. The molar ratio of Ti and graphite powder was 1.0, which was milled for 6 hours and then pre - heated for 5 hours at 300 °C. The pure aluminum was melted at 850 °C and 10% by weight Ti - C powder, which is wrapped in a sheet of aluminum, was added to the melt. After the complete melting of Al - 10 wt. % ( Ti- C ), the ‘ ultrasonic agitation was performed for 5 minutes for uniform distribution of the particles formed in situ , and so as to degas the melt. The frequency and power of the ultrasonic generator was

20kHz and 1.5 kW, respectively. Compare this example with a contrast sample is formed by the conventional technique of iron mechanical agitation. There were no oxide inclusions and clusters of particles in situ due to the ultrasonic vibration, and the porosity is decreased significantly due to outgassing ultrasound. The reaction between the ‘Al with Ti and C formed in situ TiC and  $\text{Al}_3\text{Ti}$  particles whose dimensions are respectively less than 10  $\mu\text{m}$  and 1  $\mu\text{m}$  , respectively, and a homogeneous microstructure obtained .

X. Jian et al [17] reported that aluminum alloy A356 was used to study the effect of ultrasound on solidification of this alloy. First, the thermodynamic simulations were performed for the solid fraction with respect to the temperature curve. Based on this, it took three different experimental conditions, it was before processing continues in a range from 634 to 574°C and 574 °C then ultrasonic system was not working. The power and frequency of the ultrasonic generator was 1.5 kW and 20 KHz, respectively . Lead zirconate titanate piezoelectric crystals were used for the transducer and titanium alloy Ti - 6Al - 4V has been used to make acoustic radiator. The second condition is intermittent transformation in a range of 614 to 574°C in various dwell times of 5, 10 and 20 if the temperature ranges were 5°C. The third condition was isothermal for the application of ultrasonic vibrations and the treatment time varies from 5, 10, 20 s. In the process of flashing the dendrite microstructure was globular and free compared to continuous treatment. Particle size is smaller in the process in continuous processing intermittent because of the speed of faster cooling. Particle size reduction was obtained in the ultrasonic treatment in isothermal mushy zone with little time treated without ultrasound. Globular structure observed for different isothermal processing temperature between 614 to 574°C and time. The mechanism responsible for grain refinement was heterogeneous nucleation induced cavitation.

Hanbing Xu et al [18] reported that aluminum alloy A356 was used to study the effect of the vacuum and ultrasonic vibration of aluminum alloy. Up to 800 gm of aluminum alloy, which was held in a graphite crucible was melted in an electric furnace. For the ultrasonic vibration, the power and frequency of the ultrasonic generator was 1.5KW and 20 KHz respectively and the radiator was made of a titanium alloy. Ultrasonic

degassing is carried out at 700 °C under 60 % humidity and between 700 °C and 740 °C outgassing rate was fast. For vacuum degassing of the residual pressure ranged from 0.1 Torr to 760 Torr and the time of degassing is from 1 to 45 min. For this experiment, the process parameters are the temperature of 720 °C , 60 % humidity and the holding pressure was 100 Torr and 10 Torr , but the humidity was about 50% when the residual pressure was reduced to 0.1 Torr to 1 Torr. Ultrasonic vibrations in combination with vacuum degassing was carried out for two different pressures remaining 100 Torr and 1 Torr . For this experiment, the process parameters were the 720 °C temperature and 50 % humidity. It was performed to verify the degree of porosity reduced pressure (RPT) in which 120 g of molten metal is taken in and heats cup thin wall iron and solidification was allowed to 50 mm Hg of pressure. After solidification, the sample was cut from the means for determining the degree of porosity was measured by the method of measuring the apparent density. The increase in the volume of flow of the melt decreases the ultrasonic degassing and outgassing rate of ultrasound was much higher than the vacuum degasser. Vacuum degassing, in reducing the content of hydrogen in the holding pressure to decrease and also the effect of outgassing fusion was more efficient when ultrasonic degassing vacuum degassing combined with the mass.

Chong Lin et al [19] reported that (DRC) of Al-Si alloy - Rheo Die casted been used to study the microstructure and mechanical properties compared to samples obtained by conventional pressure casting process. The alloy was melted at a temperature between 820-850 °C in an electric furnace, where the degassing of the melt was carried out for 10 minutes with argon gas. After degassing, the melt was allowed to cool to temperatures between 750 and 780 °C. The liquid metal is poured into a metal cup on 600 gm is preheated to a temperature between 530 to 550°C and ultrasonic treatment was done for 1.5 min at different temperature ranges were 685 to 665°C , 645°C and 62 °C for 665-645 . The power and frequency of the ultrasonic generator of 1.6 kW and 20 KHz, respectively. Tensile specimen were made by pouring slurry into the firing chamber of the cold chamber die casting, where the pressure and the injection speed was 4 m / s and 80 MPa . Refined phases were obtained by the method of casting RHEO - along

with the ultrasonic treatment in the temperature range from 665 to 645°C. Tensile strength, elongation and hardness of the samples DRC, which were heat-treated T6 process, increased by 34.9%, 40.4% and 17.5 % , respectively, from the conventional die casting process due to the refinement phase of elimination and porosity led to improved mechanical properties of the samples DRC.

Songli Zhang et al [24] reported that aluminum alloy A356 was used to study the effect of high-intensity ultrasonic field on the microstructure and mechanical properties compared to samples that are manufactured without ultrasonic treatment. After the merger of 500 g of aluminum alloy at 760°C , ultrasonic treatment was done for 10 minutes at different power with 0.6 kW , 0.8 kW, 1.0 kW to 1.2 kW, respectively , but the frequency same ultrasonic generator was maintained 20KHz . After ultrasonic treatment, the molten metal is degassed and then poured in the mould of 14 mm diameter. Thanks to sonication , mechanical properties are improved due to the rupture of a long dendrite silicon phase into small pieces and maximum improvement are obtained when the ultrasonic power was 1.2 kW , in which the phase of Si was uniform and  $\alpha$  - Al is approximately in the shape of a sphere. Due to the effect of acoustic flow, cavitation effect and the mechanical effect , yield strength , tensile strength and elongation were 1.93, 1.55 and 1.10 times for the untreated was ultrasonic high energy .

Shulin Lu et al [21] reported that Rheo – Pressguss A 356 aluminum alloy was used to examine the effect of indirect sonication. This alloy was melted at 720 to 730°C in an electric resistance furnace which was degassed for 10 minutes using an argon gas, and the melt was allowed to cool to a temperature of 640-650°C. Then, 450 g of metal was poured into a beaker that was preheated to 570°C. The average particle diameter and  $\alpha_1$   $\alpha_2$  - Al -Al decreases as the mechanical properties and dense due to increased compression pressure by 25 to 100 MPa to increase. Al  $\alpha_2$  - grain Al - al Fine and large were observed and the main grain  $\alpha$  - Al dendritic and were not evenly distributed in the league. Due to the T6 heat treatment RCS had better mechanical properties than the samples of conventional SC samples. This improvement is due to primary  $\alpha$  - Al phase refinement and uniform distribution of silicon particles.

Eskin studied the effects of UST in the liquidities pool of constantly cast aluminium ingots on inoculation potential of uncontrollable solid inclusions and modifying additions in the melt [24]. He concluded that without using UST, only intrinsically active particles and modifiers participate in the process of nucleation, but with UST, even particles with large wetting angles (unwanted solid inclusions) were energized and affect the nucleation, resulting in much finer grains.

Meek et al. [28] have studied the degassing of molten aluminum alloy A356 with high intensity ultrasound. Experimental results indicate that a hydrogen concentration in an equilibrium state can be obtained within a few minutes of ultrasonic vibration, irrespective of the initial hydrogen concentration in the melt. The dynamics of the evolution of hydrogen as a function of the temperature of the processing time in the molten state, and the initial concentration of hydrogen were investigated.

Zhang et al. [15] studied the effects of high-energy ultrasonic field on the microstructure and mechanical properties of A356 alloy. Their results indicated that the long dendritic silicon phases were broken into pieces and a considerable improvement in the mechanical properties were achieved by UST.

Zhang et al. [24] have used a combination of UST and electromagnetic treatment to modify the microstructure of the alloy A356. They have shown that the combined effects of ultrasonic cavitation, acoustic and electromagnetic steam agitation caused considerable refinement and periodization of primary aluminum dendrites and aging in size and morphology of the eutectic Si.

## EXPERIMENTAL METHODOLOGY

### Material Selection

The material of interest for this investigation is AA6061 alloy reinforced with various percentages of reinforcing material, i.e. CeO<sub>2</sub>.

**Table 1. The chemical composition of AA6061 alloy**

Alloy	Al	Cu	Mg	Mn	Si	Fe	Zn	Other
Wt. %	97.65	0.32	0.99	0.05	0.54	0.20	0.008	0.212

### Processing Parameters

#### Intensity of ultrasonic vibration

The ultrasonic intensity (I) is given by [33]

$$I = \frac{1}{2} \rho C (2\pi f A)^2 \quad (1)$$

Where,  $\rho$  is density of liquid in g/cm<sup>3</sup>, C is speed of sound (4.3×10<sup>3</sup> m/s [33] in molten Al), f is Ultrasonic frequency (20 kHz), A is ultrasound's amplitude. All variables except amplitude of ultrasound remain constant. It makes the intensity directly related to amplitude of ultrasound.

#### Processing temperature and times

The temperature of 830oC is set to melt the alloy. The processing temperatures above the liquids temperature are selected and processing time is 240s.

### Experimental Setup

Ultrasonic system, a unit of high power ultrasound probe (Model VCX 1500 Sonics and Materials, USA). There is an air-cooled converter piezoelectric crystals formed from lead zirconate titanate (PZT), an acoustic radiator and a probe formed from a titanium alloy Ti-6Al-4V. The amplitude of the ultrasound probe can be adjusted from 0% to 100% (60 μm), which is the maximum amplitude of the unit. Ultrasonic treatment time and the melt temperature is accurately controlled throughout the process. Before treatment with ultrasound zirconia coating was applied on the probe and baked at 250°C for 5 minutes in an oven in order to prevent the reaction between the probe metal and the liquid metal at high temperature. After ultrasonic treatment, it was discovered that the zirconia coating provides sufficient protection to probe damage.

#### Experimental procedure for preparation of composites

The raw materials were AA6061 aluminium alloy ingots (97.652%Al) and cerium carbonate (Ce<sub>2</sub>(CO<sub>3</sub>)<sub>3</sub>.nH<sub>2</sub>O). Preheated powder of cerium carbonate was to dehydrate in electric drying oven at 250°C for 3 hours. During the heating process the cerium carbonate decompose to generate cerium oxide. Then the dried cerium oxide powder was cooled. After that the aluminium alloy ingots in a decided amount were melted in a graphite

crucible in an electric furnace and held at 830°C. Specific amount of dehydrated reactant powder was mixed by mechanical stirring. Immediately in-situ reaction will occur. And leads to reinforcement of particles of  $Al_2O_3$  in the matrix. The designed weight fraction of dehydrated reactant powder ( $CeO_2$ ) was 1wt% and 1.5 wt.% respectively. Followed by the reaction, high-intensity ultrasonic vibration was introduced into the melt with a niobium radiator for 4 minutes to embed the in-situ formed particles and degas the melt. While holding at the temperature at 830°C for 10 minutes, the molten metal alloy degassing and deslagging was carried out. Then the molten metal alloy was cast into a cylindrical mild steel mould whose inside surface is coated with zirconia paste to prevent reaction between mild steel and molten metal alloy. After that it was water quenched.

Scanning Electron Microscope and incidental Electronic Dispersive X-ray spectroscopy (EDX) were used to analyze the raw material morphology, reinforcement phases and elementary composition and amounts in particles. The X-Ray Diffraction was employed to analyze the kinds of reinforcement phases. The size distribution was analyzed by using ImageJ software.

**RESULTS AND DISCUSSION**

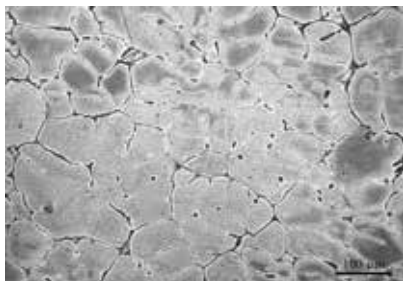


Fig. 1. Microstructure of 1.5 wt. % water quenched sample

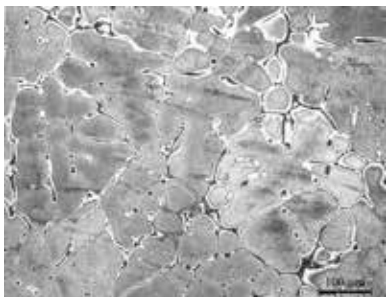


Fig. 2. Microstructure of 1 wt.% water quenched sample

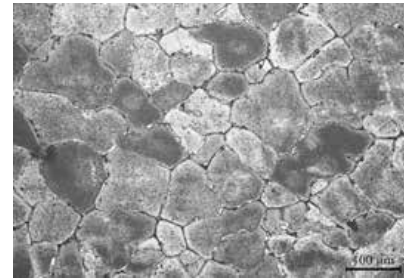


Fig. 3. Microstructure of 1.5 wt.% ultrasonication and water quenched sample

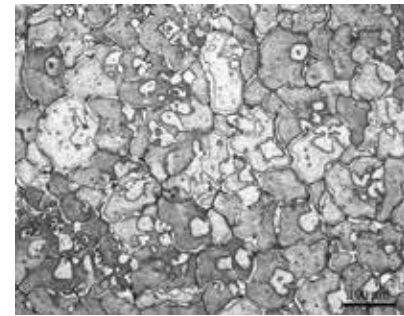


Fig. 4. Microstructure of 1 wt.% ultrasonication and water quenched sample

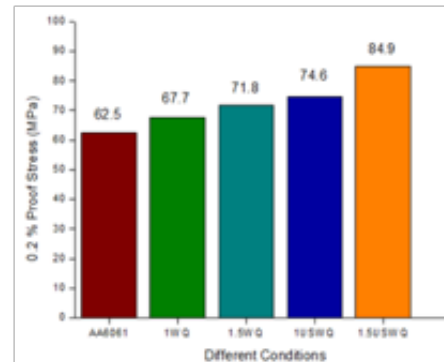


Fig. 5. Comparison of 0.2% proof stress

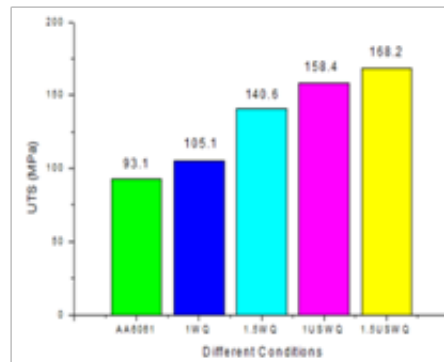


Fig. 6. Comparison of UTS



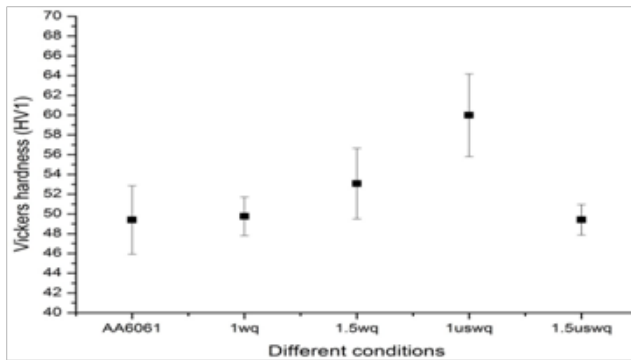


Fig. 7. Comparison of hardness

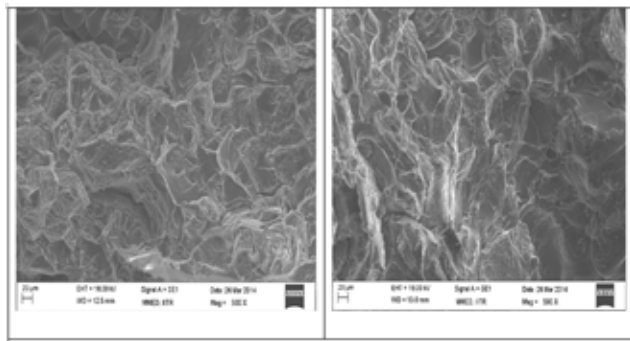


Fig. 8. SEM fractograph of 1 wt. % and 1.5 wt. % water quenched samples

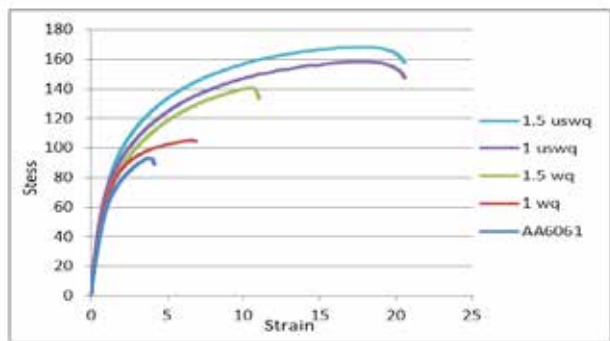


Fig. 9. Stress-Strain for AA6061 alloy composites reinforced with 0%, 1% and 1.5% CeO<sub>2</sub> reinforcing particles

The 1 wt. % CeO<sub>2</sub> reinforcing particles for making composite which is ultrasonically treated is having mixed mode type of tensile fracture showing few facets and more amount of dimples. By this we can definitely predict a good improvement in ductility after the introduction of ultrasonication process. For the composite formed from mixing of 1.5 wt. % cerium oxide powder and molten alloy, the SEM

fracture surface (Figure 8) is also showing the cleavage morphology formed due to faceted structure. Here we can experience clearly that it is a brittle mode of fracture.

## CONCLUSION

AA6061/Al<sub>2</sub>O<sub>3</sub> AMCs were synthesized by the in-situ reaction of cerium oxide powder and molten aluminium alloy. The in-situ reaction resulted in the formation of Al<sub>2</sub>O<sub>3</sub> particles. No other intermetallic compounds in substantial amount were detected as could be seen in the XRD analysis of various fabricated composites. The XRD results show the weaker peaks of Al<sub>2</sub>O<sub>3</sub> particles which indicates that the Al<sub>2</sub>O<sub>3</sub> particles are formed in less amount in the composites. With the increase in reinforcement (Al<sub>2</sub>O<sub>3</sub>) percentage, the ductility of composites also gets increased. The tensile elongation of the composite (1.5 wt. % CeO<sub>2</sub>, ultrasonication and water quenched) is about 15 % higher than the value of tensile elongation of the AA6061 alloy. As the in-situ formation of reinforcement particles take place, clustering of those particles is a major problem in fabricating composites. Also the porosity plays a significant role in decreasing the mechanical properties. But the results of ultrasonic treatment are telling that ultrasonic stirring has effectively eliminated the clusters in large amount. Also ultrasonic degassing which has taken place has decreased the porosity level to a considerable level. Porosity has been seen in those samples which are not ultrasonically treated due to non-presence of ultrasonic degassing effect and consequently it decreases the mechanical properties to some extent. It has also been observed that mixing the cerium oxide powder into the molten alloy is not so easy in practical. Ductility increases with increase in reinforcement up to 1.5 wt. % CeO<sub>2</sub> addition. Proof stress, UTS, and strain to failure show the tendency to increase with increase in reinforcement and introduction of ultrasonication. The mechanical properties of the AMCs improved when the content of Al<sub>2</sub>O<sub>3</sub> particles was increased.

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