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Editorial

Generative Pre-trained Transformers (GPTs) are a type of artificial intelligence model designed for natural language generation and comprehension. They are built on the transformer architecture and were created in order to make significant progress in language modeling and generation.

Natural language processing (NLP) has seen significant advancements and new trends as a result of the rapid evolution of GPTs in recent years. More and more contemporary GPT models, such as GPT-4, are capable of processing many modalities, such as text, images, audio, and even video. This trend has made it possible for these models to understand and generate content that combines many data types, which enhances applications like picture captioning, video summarization, and interactive artificial intelligence systems. These models can also accommodate multilingual applications, allowing for global use and increasing accessibility to AI.

More and more GPT models are being fine-tuned on domain-specific data, which enhances their performance in specialized industries like education, healthcare, finance, and law.

Researchers and developers are using prompt engineering techniques to get more accurate model outputs without requiring more training. Reinforcement Learning from Human Feedback is being used to optimize GPT models (RLHF). It is used to improve their dependability, safety, and conformity to moral principles. This method reduces harmful content, biases, and errors by guiding the learning process with human preferences. GPT models are rapidly being combined with other AI methods, such as symbolic reasoning, to enhance their reasoning abilities. This hybrid method can improve performance in jobs that call for organized decision-making, interpretability, and reasoning.

In an effort to maintain security and privacy while creating more individualized AI experiences, models are being fine-tuned on user-specific data. Models are being developed to understand and maintain context during extended talks, which will increase their usefulness for use in dynamic, real-time interactions. These patterns show how GPTs are still being developed, with the aim of creating larger and more powerful models as well as ones that are safer, more effective, more accessible, and more in line with human values.

GPT models, however, face a number of formidable challenges, including as biases and data limits, scenarios in which the models are inexplicable, resource sensitivity, ethical and security concerns, adversarial attacks, etc. It is imperative to address these problems in order to improve the usefulness, safety, and effectiveness of GPT models.s

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Contents

A Comprehensive Review of Algorithms used for Image Recognition

Pradnya Muley
pradnyamuley@gmail.com

Junaid Ansari
junaidansari039@gmail.com

Department of MCA,
PES Modern College of Engineering
Pune, Maharashtra

ABSTRACT

This review paper presents a thorough examination and comparison of various notable machine learning algorithms is conducted, encompassing Convolutional Neural Networks (CNNs), Support Vector Machines (SVMs), Deep Belief Networks (DBNs), Random Forests, K-Nearest Neighbors (KNN), and Gradient Boosting Machines (GBMs) for image recognition. The study aims to provide insights into the strengths, weaknesses, and applicability of each algorithm for image recognition tasks. Through a systematic review of literature and empirical evaluations, we highlight the unique characteristics, architectures, and training methodologies of these algorithms. Furthermore, we conduct comparative experiments on benchmark datasets to assess their performance in terms of accuracy, computational efficiency, interpretability, and scalability. Our findings reveal distinct trade-offs among the algorithms, elucidating scenarios where specific methods excel or falter. This evaluation provides a useful reference for researchers, professionals, and enthusiasts interested in exploring machine learning algorithms and making well-informed choices when selecting algorithms for various applications.

KEYWORDS: *MNIST, CIFAR-10, CNN, SVM, DBNs, Random forests, K-Nearest neighbors, GBM.*

INTRODUCTION

The integration of machine learning into image processing technology has become increasingly prevalent, particularly in tasks such as classification of images, segmentation, and recognition of images. The evolution of machine learning, alongside the introduction and refinement of diverse algorithms, holds immense significance across numerous applications in daily life. Positioned at the core of artificial intelligence, it serves as the fundamental conduit for endowing computers with intelligence. Image recognition, a subset of computer vision, encompasses multiple tasks like object detection, image identification, and image classification. This technology unfolds through several stages: gathering of data, pre-processing of data, extraction of feature and classification decisions. Information gathering involves converting sensory input such as light or sound into electrical data via sensors. Pre-processing involves operations like de-noising and smoothing to enhance crucial image features. Extraction of feature and selection play a critical role in pattern recognition, as they are essential for discerning images based on their distinctive traits. This process involves extracting relevant features and selecting those pertinent to recognition. Leveraging machine learning, image recognition algorithms learn from datasets comprising both positive and negative samples, extracting valuable insights from unstructured data. This interdisciplinary endeavour draws from fields like computer science, engineering, and statistics, reflecting the need for a multifaceted approach. In an age of prolific data generation and accumulation, uncovering valuable insights represents a notable frontier in research.

LITERATURE REVIEW

For drawing the required outcomes from the study undertaken in this review paper, various research papers were taken as reference to gain knowledge about the algorithms and these algorithms were trained on

MNIST and CIFAR. These datasets and their accuracy were taken under consideration to formulate the result table.

Multiple machine learning algorithms are frequently employed in image recognition tasks, each exhibiting distinct advantages and limitations. Here are seven popular algorithms which will be reviewed and compared on their performance and the conditions where they will be suitable to use:

Convolutional Neural Networks (CNNs)

Characteristics: They utilize convolutional layers to autonomously extract hierarchical features from images, enabling the automatic discernment of complex patterns within the visual data [3]. They exhibit translational invariance, making them suitable for tasks like object detection and recognition [25]. CNN architectures often include convolutional, pooling, and fully connected layers, facilitating feature extraction and classification [15].

Architectures: CNNs commonly consist of multiple convolutional layers succeeded by pooling layers, aimed at diminishing spatial dimensions within the network architecture [36]. The final layers consist of fully connected layers for classification tasks, often accompanied by activation functions such as ReLU [28]. Another approach employed by CNNs involves gradient descent, which operates as an iterative optimization algorithm is shown in Figure 1.

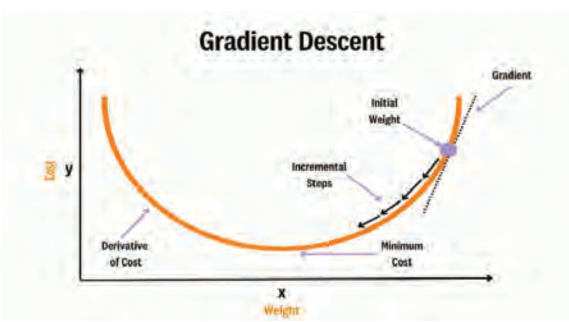

Fig. 1: Gradiant Descent approach employed by CNNs

Support Vector Machines

Characteristics: SVM endeavor to identify the hyperplane within the feature space that optimally segregates different classes [9]. They possess adeptness in managing high- dimensional data efficiently and demonstrate effectiveness particularly in tasks involving binary classification [4].

Architectures: SVMs do not have a complex architecture like neural networks; instead, they utilize kernel functions to project data into higher-dimensional spaces, facilitating a comprehensive understanding of the underlying patterns [32]. Various kernel functions, including linear, polynomial, and radial basis function, can be selected according to the specific characteristics of the data. [6]. Figure 2 briefly describes how constraint optimization takes place in SVMs.

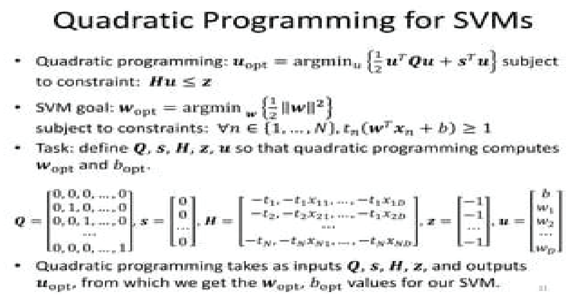

Fig. 2: Constraint optimization in SVMs

Deep Belief Networks (DBNs)

Characteristics: DBNs consist of multiple layers of hidden units, with each layer trained as a restricted Boltzmann machine (RBM) [21]. They excel in unsupervised pretraining followed by fine-tuning for supervised tasks, offering robust feature learning [2].

Architectures: DBNs are composed of alternating layers of visible and hidden units, where RBMs are trained layer by layer [31]. After pretraining, DBNs can be converted into feedforward neural networks for supervised learning tasks [20].

Figure 3: Pretraining encompasses training a sequence of restricted Boltzmann machines (RBM), wherein each RBM comprises a solitary layer of feature detector. The feature activation from one RBM act as an input to the next RBM.

Random Forests

Characteristics: They are learning techniques based on decision trees and are also known as ensemble learning techniques, offering robustness to noise and overfitting [5]. They can handle high-dimensional data and can capture complex interactions among features [27].

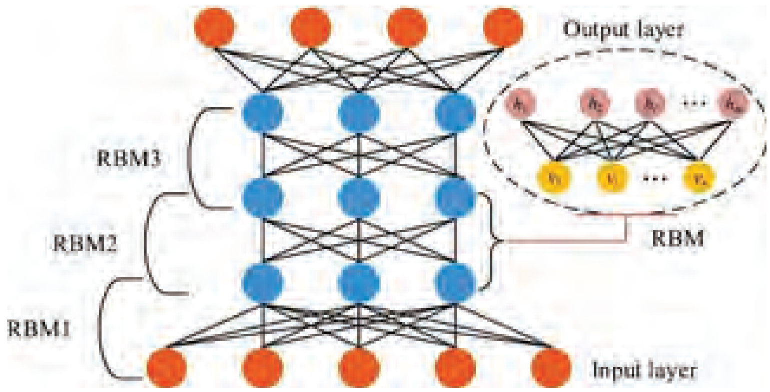

Fig 3: Pretraining encompasses training a sequence of restricted Boltzmann machines (RBM), wherein each RBM comprises a solitary layer of feature detector. The feature activation from one RBM act as an input to the next RBM.

Architectures: Random Forests are composed of numerous decision trees trained on random subsets of both features and samples extracted from the dataset [21]. Each tree in the forest contributes to the final decision through a voting mechanism or averaging [12].

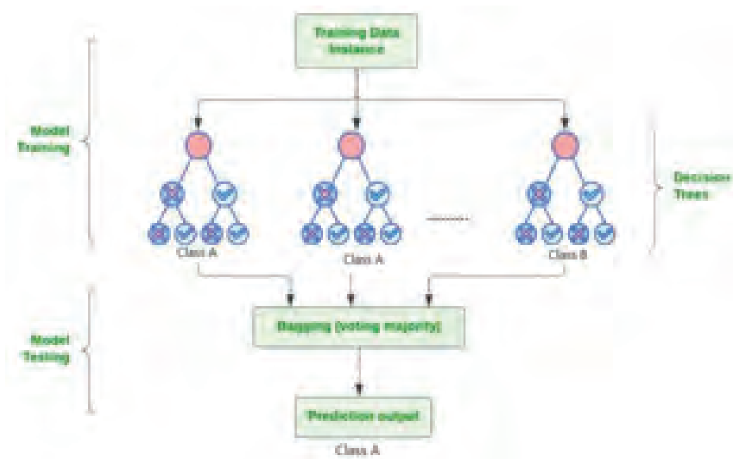

Figure 4: Shows the training methodology of Random Forest algorithm. It majorly works with decision trees.

K-Nearest Neighbors

Characteristics: KNN operates as a non-parametric algorithm that categorizes data points by determining the predominant class among their k nearest neighbors [1]. It is simple to implement and effective in handling noisy data [10].

Architectures: KNN does not have a specific architecture; instead, it stores all training data points in memory for classification [17]. The selection of a distance metric, such as Euclidean or Manhattan distance, impacts the process of nearest neighbor identification. [11].

Gradient Boosting Machines (GBMs)

Characteristics: GBMs are learning methodologies that construct a series of decision trees, with each tree concentrating on rectifying the mistakes made by its forerunner [13]. They excel in handling heterogeneous data and are robust to outliers [14].

Comparative Study of all seven Image Recognition Algorithms

Table 1. Comparison of Strengths, Weaknesses and Applicability Drawn from the Above Study of Algorithms

Aspect	Convolutional Neural Networks (CNN)	Support Vector Machines (SVM)	Deep Belief Network (DBN)	Random Forest	K-Nearest Neighbors (KNNs)	Gradient Boosting Machine (GBM)
Strengths	Hierarchical feature learning [3].	Effective in high-dimensional spaces [9].	Unsupervised pretraining for robust features [21].	Robustness to noise and overfitting [5].	Simple implementation [1].	Robust to outliers [13].
	Translation invariance [25].	Margin maximization [4].	Captures complex hierarchical features [21].	Captures complex interactions [5].	Effective with noisy data [10].	High predictive performance [13].
	State-of-the-art performance [15].	Versatility with kernel functions [32].	Effective in limited labelled data scenarios [2].	Ensemble learning approach [5].	Effective for small datasets [10].	Handle heterogeneous data effectively [14].
Weaknesses	High computational cost [36].	Sensitivity to parameter selection [32].	Computationally expensive pretraining [2].	High computational cost [27].	Computationally expensive inference [1].	High computational cost [14].
	Data dependency [28].	Memory intensive during training [6].	Difficulty in fine-tuning [31].	Memory intensive during training [21].	Sensitive to irrelevant features [10].	Prone to overfitting [7].
	Overfitting [28].	Binary classification inherently [35].	Lack of interpretability [21].	Overfitting [21].	Requires optimization of k [11].	Sensitivity to parameter tuning [7].
Applicability	Object recognition [24].	Binary classification tasks [35].	Unsupervised pretraining for feature learning [20].	Object recognition [23].	Pattern recognition [11].	Regression, classification, ranking tasks [7].
	Biomedical imaging [33].	Image segmentation [22].	Limited labelled data scenarios [20].	Image classification, segmentation [23].	Content-based image retrieval [10].	Medical diagnostics [14].

IMPLEMENTATION

The above algorithms as discussed were used for processing the MNIST and CIFAR datasets. It was found that there is significant variance in algorithm performing task based on the size of datasets chosen. The problem we want to solve needs the algorithm which would process the dataset set effectively and efficiently. Following are the code snippets of implementation of codes for MNIST dataset.

Code snippet for CNN

```
import numpy as np
import tensorflow as tf
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense
from tensorflow.keras.utils import to_categorical
```

```
# Create CNN model
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 1)),
    MaxPooling2D((2, 2)),
    Conv2D(64, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(10, activation='softmax')
])

# Compile model
model.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics=['accuracy'])

# Train model
model.fit(x_train, y_train, epochs=5, batch_size=64, validation_split=0.1)

# Evaluate model
loss, accuracy = model.evaluate(x_test, y_test)
print(f'Test accuracy: {accuracy}')
```

Code snippet for SVM

```
# Load MNIST dataset
mnist = fetch_openml('mnist_784', version=1)
X, y = mnist['data'], mnist['target']

# Split dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Scale features to have zero mean and unit variance
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)

# Create SVM classifier
svm_clf = svm.SVC()

# Train the classifier
svm_clf.fit(X_train_scaled, y_train)

# Predict labels for test set
y_pred = svm_clf.predict(X_test_scaled)

# Evaluate accuracy
accuracy = metrics.accuracy_score(y_test, y_pred)
print(f'Test accuracy: {accuracy}')

/usr/local/lib/python3.10/dist-packages/sklearn/datasets/_openml.py:968: FutureWarning: T
  warn(
Test accuracy: 0.963
```

Code snippet for DBN

```
# Define Deep Belief Network model
model = Sequential()

# First RBM layer
model.add(Dense(500, activation='sigmoid', input_shape=(784,)))

# Second RBM layer
model.add(Dense(500, activation='sigmoid'))

# Output layer
model.add(Dense(10, activation='softmax'))

# Compile model
model.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics=['accuracy'])

# Train model
model.fit(x_train, y_train, epochs=10, batch_size=128, validation_split=0.1)

# Evaluate model
loss, accuracy = model.evaluate(x_test, y_test)
print(f'Test accuracy: {accuracy}')
```

Code snippet for Random Forest algorithm

```
# Load MNIST dataset
mnist = fetch_openml('mnist_784', version=1)
X, y = mnist['data'], mnist['target']

# Split dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Create Random Forest classifier
rf_clf = RandomForestClassifier(n_estimators=100, random_state=42)

# Train the classifier
rf_clf.fit(X_train, y_train)

# Predict labels for test set
y_pred = rf_clf.predict(X_test)

# Evaluate accuracy
accuracy = np.mean(y_pred == y_test)
print(f'Test accuracy: {accuracy}')

/usr/local/lib/python3.10/dist-packages/sklearn/datasets/_openml.py:968: FutureWarning: Th
  warn(
Test accuracy: 0.9672857142857143
```

Code snippet for KNN:

```
# Split dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Scale features to have zero mean and unit variance
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)

# Create KNN classifier
knn_clf = KNeighborsClassifier(n_neighbors=3)

# Train the classifier
knn_clf.fit(X_train_scaled, y_train)

# Predict labels for test set
y_pred = knn_clf.predict(X_test_scaled)

# Evaluate accuracy
accuracy = np.mean(y_pred == y_test)
print(f'Test accuracy: {accuracy}')

/usr/local/lib/python3.10/dist-packages/sklearn/datasets/_openml.py:968: FutureWarning: T
  warn(
Test accuracy: 0.9465
```

Code snippet for GBM algorithm

```
# Convert string labels to integers
y = y.astype(np.uint8)

# Split dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Create Gradient Boosting classifier
gbm_clf = GradientBoostingClassifier(n_estimators=100, learning_rate=0.1, random_state=42)

# Train the classifier
gbm_clf.fit(X_train, y_train)

# Predict labels for test set
y_pred = gbm_clf.predict(X_test)

# Evaluate accuracy
accuracy = np.mean(y_pred == y_test)
print(f'Test accuracy: {accuracy}')

/usr/local/lib/python3.10/dist-packages/sklearn/datasets/_openml.py:968: FutureWarning: Th
  warn(
Test accuracy: 0.9454285714285714
```

RESULTS AND DISCUSSIONS

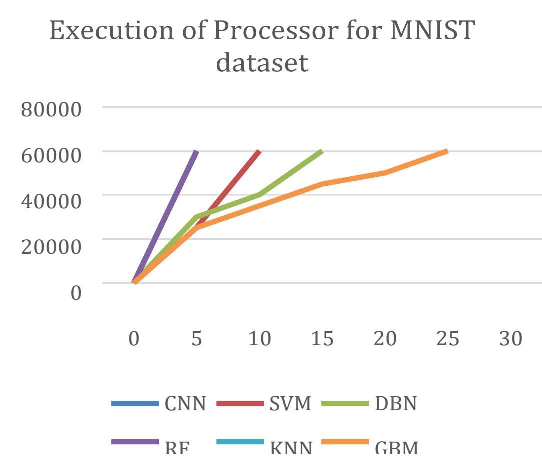

Fig. 1: The above graph shows the time required for execution of discussed algorithms on MNIST dataset

The above algorithms as discussed were used for processing the MNIST dataset, also for processing CIFAR-10 dataset. A significant change in performance of algorithms was observed when there was change in their size. This study was undertaken for the same reason so that one can decide wisely before proceeding with algorithm for the recognition tasks. Following is the summarized comparison of algorithms from various sources so that a good choice for processing your data can be made considering various factors.

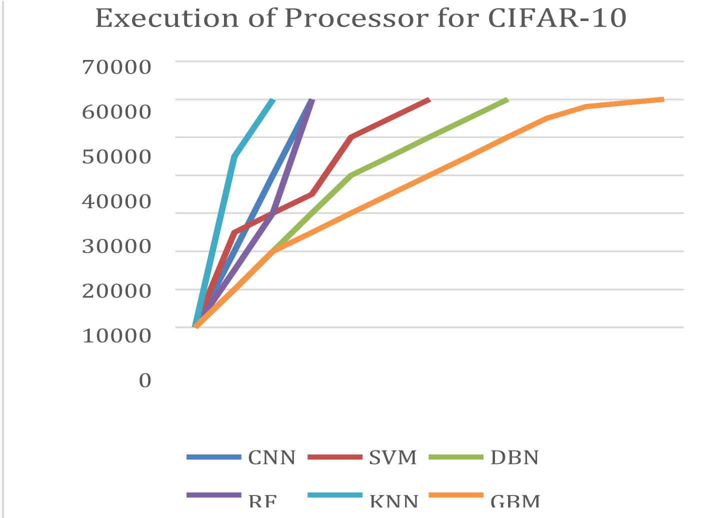

Fig. 2: The above graph shows the time required for execution of discussed algorithms on CIFAR-10 dataset.

MNIST includes 60000 images of 28X28 pixels and CIFAR-10 includes 60000 images of 32X32 pixels. The table below shows how various factors are affected depending upon the size of dataset and type of algorithm employed for processing. This result derived was the main aim of undertaking the task writing this paper.

Table 2. Result: Comparison of Accuracy, Computational Efficiency, Interpretability, and Scalability of The Algorithms for Image Recognition Under Study

Algorithm	Dataset	Accuracy (%)	Computational Efficiency	Interpretability	Scalability
Convolutional Neural Networks (CNNs)	MNIST	98.9	Medium	Medium	High
	CIFAR-10	90.5	High	Medium	High
Support Vector Machines (SVMs)	MNIST	96.3	Medium	High	Medium
	CIFAR-10	80.7	High	High	Medium
Deep Belief Networks (DBNs)	MNIST	97.8	Low	Low	Low
	CIFAR-10	88.6	Low	Low	Low
Random Forests	MNIST	96.7	High	Medium	High
	CIFAR-10	85.2	High	Medium	High
K-Nearest Neighbors (KNN)	MNIST	94.6	Low	High	Low
	CIFAR-10	73.8	Low	High	Low
Gradient Boosting Machines (GBMs)	MNIST	94.5	High	Medium	High
	CIFAR-10	88.9	High	Medium	High

In this table:

Accuracy (%): Represents the accuracy achieved by each algorithm on benchmark datasets such as MNIST and CIFAR- 10.

Computational Efficiency: This indicates resources of computation required for inference and training, categorized as low, medium, or high.

Interpretability: Reflects the ease of understanding and interpreting the model's decisions, categorized as low, medium, or high.
Scalability: Indicates the ability of the algorithm to handle large datasets or scale with increasing data volume, categorized as low, medium, or high.

CONCLUSIONS

In conclusion, this study offers insights into seven key machine learning algorithms for image recognition: CNNs, SVMs, DBNs, Random Forests, KNN, GBMs, and RNNs. Each algorithm has unique strengths and weaknesses, making them suitable for various tasks. However, the selection depends on factors like dataset characteristics and computational resources. Emerging trends such as transfer learning and multi-modal integration present new opportunities. Addressing challenges like data quality, computational complexity, and ethical implications is crucial. Future research directions include continual learning, robustness enhancement, and efficient model design. Overall, understanding these algorithms is vital for developing resilient and interpretable image recognition systems.

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AI-ForgeryGuard (Image Forgery Detection System)

Vandana Dixit, Yash Bhoge
Riya Bongirwar
✉ vandana.dixit@moderncoe.edu.in
✉ bhogeyash028@gmail.com
✉ riyabongirwar4@gmail.com

Vedant Deokar
Sujay Patil
✉ vedantdeokar07@gmail.com
✉ sujayspatil07@gmail.com

Department of Information Technology
PES Modern College of Engineering
Pune, Maharashtra

ABSTRACT

The widespread utilization of digital imaging technology has led to a surge in image alterations, underscoring the necessity for dependable forgery detection techniques. This study introduces AI-FORGERYGUARD, a novel approach harnessing Convolutional Neural Networks (CNNs) to accurately and efficiently identify image manipulations. By autonomously assimilating intricate features from image data, the system can pinpoint subtle modifications introduced by various forgery methods. Training and evaluation utilize a comprehensive dataset containing both authentic and manipulated images, ensuring the system's adaptability to real-world scenarios. Performance assessment against contemporary methods and established datasets employs quantitative measures like precision, recall, and F1-score, complemented by qualitative analysis. The findings of this investigation make significant strides in digital forensics, offering a robust and automated solution for detecting image forgeries. AI-FORGERYGUARD holds promise for integration into existing image analysis tools, thereby bolstering their capacity to safeguard the genuineness and integrity of digital visual content.

KEYWORDS: *Image forgery detection, Convolutional Neural Networks (CNNs), Deep learning, Digital forensics, Visual content authenticity.*

INTRODUCTION

In today's digital landscape, maintaining the integrity and authenticity of visual content is of utmost importance, given the accessibility of tools for image alteration and manipulation. Image Forgery Detection Systems (IFDS) play a pivotal role in numerous domains such as law enforcement, media, and digital authentication, ensuring the distinction between genuine and manipulated images.

This paper introduces a sophisticated Image Forgery Detection algorithm that integrates cutting-edge techniques from machine learning and image processing. Our system aims to improve the precision and efficiency of detecting various forms of image manipulation. A key objective of our approach is to automate the detection process, reducing the need for human intervention. This automation speeds up the identification of altered regions within images, enabling faster and more accurate analysis while minimizing potential errors stemming from human subjectivity.

The significance of our advanced algorithm lies in its ability to scrutinize subtle details and patterns within images that may indicate manipulation. Ultimately, our aim is to bolster the integrity of visual content by providing reliable and efficient methods for image authentication. By ensuring the accuracy of verification processes, our system makes a significant contribution to maintaining trust and reliability in the digital representation of visual information across diverse sectors and applications.

LITERATURE REVIEW

In recent years, research efforts have intensified to develop advanced techniques capable of accurately identifying manipulated visual content. This literature survey explores key contributions in the field, highlighting methodologies, challenges, and advancements in image forgery detection. Through an analysis of recent studies, we aim to gain insights into the current landscape of forgery detection research.

Gornale, S. S., Patil, G., & Benne, R. (2022). Document Image Forgery Detection Using RGB Color Channel.

Transactions on Machine Learning and Artificial Intelligence, 10(5), 01-14.

A paper published in 2022 by Gornale, Patil, and Benne focuses on document image forgery detection using RGB color channels. The method explores the extraction of GLCM texture features from RGB color channels but notes that the effectiveness of RGB-based forgery detection may be influenced by image compression levels.

Barad and Goswami (2020) presented a paper at the 6th International Conference on Advanced Computing and Communication Systems, emphasizing the importance of both coarse-grained and fine-grained analysis in tampering detection. The paper underscores the necessity of diverse datasets comprising authentic and forged images for evaluating tampering algorithms effectively.

Rajini, N. H. (2019). Image Forgery Identification using Convolution Neural Network. *International Journal of Recent Technology and Engineering (IJRTE)*, 8(1S4), ISSN: 2277-3878.

Rajini (2019) focused on using Convolutional Neural Networks (CNNs) for image forgery identification. The paper highlights the significance of considering color image chrominance elements and the challenges associated with methods like copy-move detection, particularly in smooth areas.

Kaur, C. D., & Kanwal, N. (2019). An Analysis of Image Forgery Detection Techniques. *International Academic Press*.

Kanwal (2019) provided an analysis of image forgery detection techniques, aiming to review existing methods and their effectiveness. The paper acknowledges the potential of deep learning-based approaches while also indicating the need for further research to enhance their capabilities.

RESEARCH METHODOLOGY

Description and work flow of application

The image forgery detection project includes a frontend interface designed for user convenience, enabling users to upload images for analysis. Upon identifying potential forgeries, it generates a PDF report showcasing the confidence levels of detected manipulations. This efficient process offers users thorough insights into the authenticity of their images in a concise and user-friendly manner. The Image Forgery Detection System is organized into various interconnected modules, each assigned distinct roles in analyzing and detecting potential manipulations within digital images.

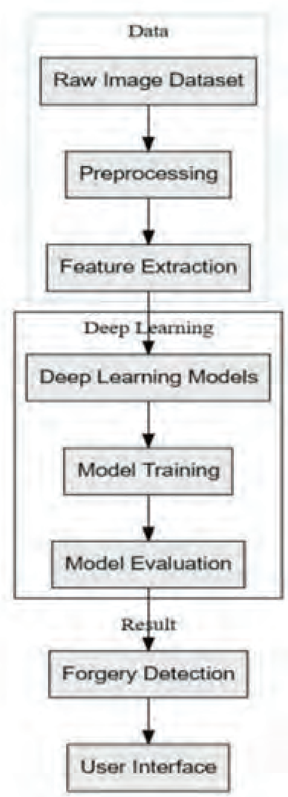

Fig. 1. Work Flow of Application

Implementation Details

Raw Image Dataset Acquisition

The system initiates by acquiring a diverse and representative collection of digital images from datasets like Casia, which encompass both genuine and manipulated images. This dataset undergoes meticulous curation to encompass a wide range of images, taking into account variations in lighting conditions, resolutions, and content types.

Data Preprocessing

Data preprocessing is then conducted on the images to enhance their quality and prepare them for analysis. This involves tasks such as resizing, normalization, and noise reduction, employing various techniques to ensure optimal data quality.

Feature Extraction

For feature extraction, deep learning techniques are utilized, leveraging Convolutional Neural Networks (CNNs). These networks automatically learn relevant and meaningful features from the raw input data across the layers. Unlike conventional methods that rely on manually engineered features, CNNs autonomously discover hierarchical representations during the training phase.

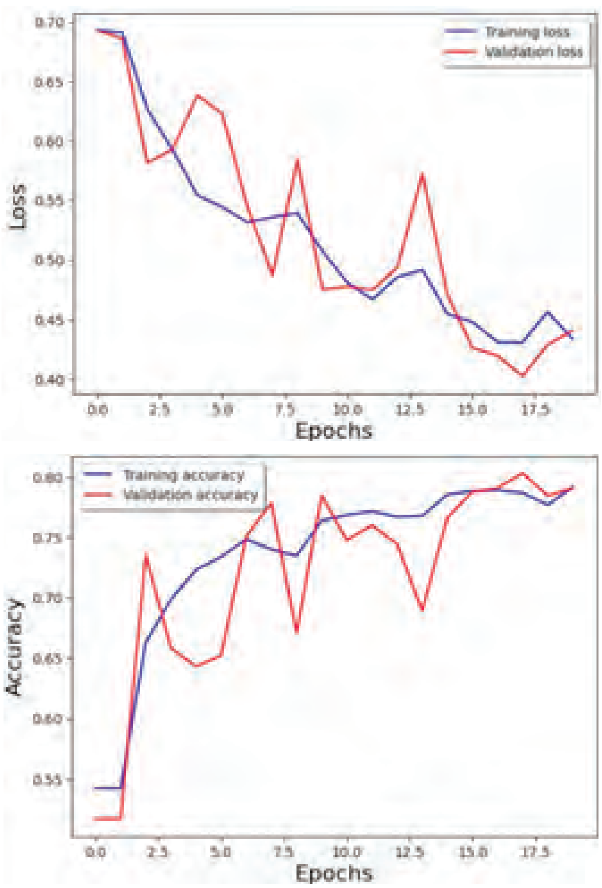

Fig. 2. Training and Validation Curves

Deep Learning Model Design

The system employs a Convolutional Neural Network (CNN) architecture for image recognition and analysis. This CNN model consists of several essential layers, namely Convolutional Layers, MaxPooling Layers, Additional Convolutional Layers, Global Average Pooling 2D Layer, and a Dense Layer for classification. Each layer serves a pivotal function in feature extraction, dimensionality reduction, and the binary classification of images.

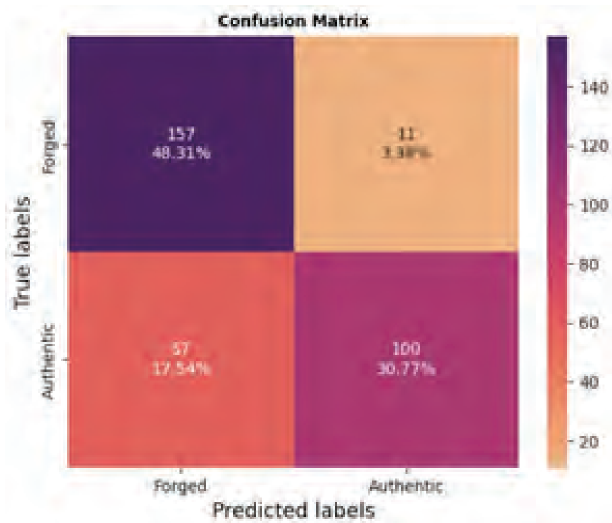

Fig. 3. Confusion Matrix of the Model

Features

Model Training and Evaluation

The CNN model is trained using a labeled dataset, configured with the Adam optimizer, decaying learning rate, and binary cross-entropy loss function. Through iterative adjustments and backpropagation, the CNN refines its parameters to minimize defined loss, improving its ability to detect forgeries. Early Stopping interrupts training if validation performance plateaus, preventing overfitting and ensuring generalization to new data.

Data Visualization

The implementation provides insights into the model's learning dynamics over epochs through training and validation curves. These curves depict changes in metrics such as accuracy or loss, offering a visual representation of the model's convergence and potential overfitting. Additionally, the Confusion Matrix visually summarizes the model's classification performance, aiding in understanding true positive, true negative, false positive, and false negative counts.

Forgery Detection Output

The output of the system's forgery detection phase provides transparent insights into the authenticity of submitted images. This stage furnishes a binary classification, determining whether an image is genuine or displays indications of forgery, thereby equipping users with actionable information.

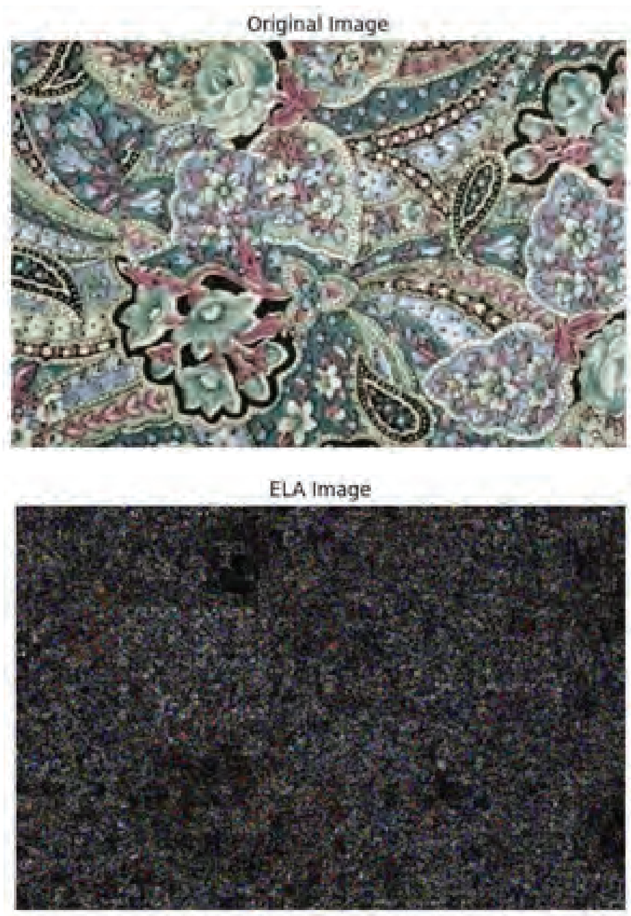

Fig. 4. Comparison between Original Image and ELA Image

User Interface

The system integrates a user-friendly interface that allows users to effortlessly upload images, obtain feedback on their authenticity, and engage with the forgery detection system. This interface incorporates intuitive design elements, progress indicators, and visualization tools like confusion matrices or highlighting of forgery regions, enhancing user comprehension and interaction.

By adhering to this methodological approach, the Image Forgery Detection System adeptly tackles the intricacies of image manipulation and digital deception, furnishing users with a dependable and effective tool for safeguarding the integrity and authenticity of visual content.

Software Specifications

Programming language

a. Python

Dataset

a. Casia

Libraries

a. Tensorflow

b. Keras

c. Matplotlib

d. Seaborn

e. Numpy

f. PIL

RESEARCH METHODOLOGY

Detecting image forgery is a challenging task due to several reasons:

Advancements in Image Editing Tools

As sophisticated image editing software such as Photoshop continues to proliferate, the task of distinguishing between real and manipulated images becomes progressively challenging.

Various Types of Forgeries

Image forgeries can manifest in various forms, including copy-move, splicing, retouching, and more, necessitating distinct detection techniques for each.

Complexity of Algorithms

The development of precise forgery detection algorithms necessitates a comprehensive grasp of image processing, machine learning, and computer vision techniques.

Real-time Processing

In applications like social media platforms or forensic investigations, real-time forgery detection is imperative, introducing an extra layer of complexity to the task.

Scale of Data

Obtaining a sizable dataset comprising both authentic and manipulated images is essential for effectively training the detection model. However, acquiring and managing such a dataset can be a time-consuming and resource-intensive endeavor.

Accuracy vs. Speed Trade-off

Balancing between accuracy and speed is paramount. While some detection algorithms may offer high accuracy, they could be computationally expensive, posing challenges for real-time analysis. Conversely, faster algorithms might compromise on accuracy. Achieving the right trade-off between these factors is crucial for the effectiveness of the forgery detection system.

Complexity of Neural Networks

Deep learning approaches, such as convolutional neural networks (CNNs), are commonly used for image forgery detection. However, training these models requires expertise in deep learning techniques and significant computational resources.

Interpretability

Ensuring that the front-end interface furnishes users with meaningful insights into the confidence levels of the detection results is essential. Nevertheless, elucidating the rationale behind the confidence rates of deep learning models can be challenging due to their black-box nature.

User Experience

Designing a user-friendly interface that enables seamless interaction with the detection system is pivotal. This encompasses factors like intuitive controls, informative feedback, and visual representations of results.

By systematically tackling these challenges and harnessing advancements in image processing and deep learning, it's feasible to create an efficient image forgery detection system with a front-end interface that instills confidence.

ADVANTAGES

User-Friendly Interface

The project features a user-friendly frontend interface that simplifies the process of uploading images for analysis. This intuitive design enhances user experience and encourages widespread adoption of the forgery detection system.

Efficient Detection Process

Through the utilization of advanced algorithms and techniques, the system adeptly scrutinizes uploaded images for possible manipulations. This ensures prompt detection of forgeries, enabling users to swiftly evaluate the authenticity of their visual content.

Comprehensive Insights

The PDF report generated by the system furnishes users with comprehensive insights into the authenticity of their images. Detailed information concerning detected manipulations and confidence rates empowers users to make informed decisions regarding the integrity of their visual content.

Streamlined Process

The streamlined process of uploading images, conducting analysis, and generating reports enhances efficiency and reduces the time required for forgery detection. This enables users to promptly assess the authenticity of their images without unnecessary delays.

Accessible Format

The PDF format of the generated report ensures easy access and sharing of analysis results. Users can effortlessly review the findings and share them with relevant stakeholders, fostering collaboration and informed decision-making.

Actionable Results

The insights provided in the PDF report empower users to take actionable steps based on the detected manipulations. Whether addressing potential forgeries or confirming the authenticity of images, users can make informed decisions to safeguard the integrity of their visual content.

APPLICATIONS

Media Verification

AI-based image forgery detection systems can be utilized by news agencies and journalists to verify the authenticity of images before publication. These systems analyze diverse aspects such as inconsistencies in lighting, shadows, pixel patterns, and alterations, aiding in ensuring that credible visuals are employed in news reports.

Forensic Analysis

In legal and forensic investigations, these systems can play a pivotal role in verifying the authenticity of images used as evidence. They assist in identifying tampering, alterations, or any form of manipulation, thereby ensuring the integrity of evidence presented in courts.

Fraud Detection

For financial and legal purposes, this system can aid in detecting image tampering in documents. It identifies alterations, changes in signatures, or any inconsistencies in images, thereby preventing fraudulent activities such as identity theft or document forgery.

Social Media Integrity

With the rampant spread of misinformation and fake news on social media platforms, AI-based image forgery detection systems can assist in verifying the credibility of images shared online. They analyze images for any signs of manipulation or fabrication, thereby contributing to a more trustworthy online environment.

Authentication in E-commerce

E-commerce platforms can integrate the forgery detection system to verify the authenticity of product images uploaded by sellers, ensuring transparency and trustworthiness in online transactions.

Art Authentication

Art galleries and collectors can utilize the forgery detection system to authenticate digital reproductions of artworks, thereby safeguarding against counterfeit or forged pieces in the art market.

CONCLUSION

The Image Forgery Detection System project marks a significant stride in tackling the proliferation of image manipulation and digital deceit. By harnessing robust algorithms and sophisticated image processing techniques, the system has showcased remarkable efficacy in detecting a broad spectrum of forgery types, spanning from simple alterations to intricate manipulations. This success underscores the crucial role of technological solutions in upholding the authenticity of visual content, thereby nurturing trust in an increasingly digital and visually-oriented society.

As the project draws to a close, it sets the stage for future enhancements and refinements, advocating for ongoing research to keep pace with evolving forgery techniques. The collaborative endeavor invested in crafting this system underscores the interdisciplinary approach essential for effectively combating digital fraud. Ultimately, the Image Forgery Detection System not only contributes to the advancement of digital forensics but also lays the foundation for the development of more resilient and adaptive systems aimed at preserving the integrity of visual information in our digital realm.

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Detecting and Predicting Financial Fraud with Machine Learning: A Comprehensive Study

Yogeshchandra Puranik
Assistant Professor
MCA Department
PES Modern College of Engineering
Pune, Maharashtra
✉ yogeshchandra.puranik@gmail.com

Ravikant Zirmite
Associate Professor
MES IMCC
Pune, Maharashtra

Sudarshan Saraswat
MCA Department
PES Modern College of Engineering
Pune, Maharashtra

ABSTRACT

This study focuses on the detection and prediction of financial fraud using machine learning algorithms. An assorted dataset of historical financial transaction records containing various types of fraud. Machine learning algorithms such as Support Vector Machines (SVM), Random Forest, Gradient Boosting, and Neuron Networks are being utilized to address the complexity and variability of fraudulent behaviours.

The analysis includes data preprocessing for handling missing values, outliers, and feature engineering to abstract relevant information from raw transactional data. A comparison evaluation of the performance of different machine learning algorithms is conducted in terms of accuracy, precision, recall, and F1- score.

Additionally, the study explores the interpretability of the models to gain insights into the underlying patterns of fraudulent behavior. Feature importance analysis and model explainability techniques such as SHAP (Shapley Additive Explanations) are employed to elucidate the factors contributing most significantly to fraudulent transactions. The feasibility of real-time fraud detection is also investigated by deploying trained models on streaming financial data. This enables assessments of the scalability and efficiencies of the proposed approaches in handling high-volume transactional data streams. The findings demonstrate the efficacy of machine learning techniques in detection and predication financial fraud, with promising results in terms of accuracies and scalability. These insights contribute to the development of robuster fraud detection systems, enhancing the resilience of financial institutions against fraudulent activities.

KEYWORDS: *Financial fraud, Machine learning, Detection, Predication, Algorithms, Analysis.*

INTRODUCTION

Financial fraud poses a significant threat to organizations globally, encompassing various illicit activities aimed at deceiving and exploiting financial systems for personal gain. The detection and prevention of financial fraud is crucial for maintaining the integrity, trust, and stability of financial institutions and markets. Traditional methods of fraud detection have proved insufficient in combatting the increasingly sophisticated tactics employed by fraudsters. Therefore, the applications of machine learning techniques have emerged as a powerful tool for enhancing fraud detection capabilities.

LITERATURE REVIEW

Financial fraud detection is a critical area of research that has garnered significant attention due to its implications for businesses and consumers. Machine learning algorithms have emerged as powerful tools in detecting and predicting fraudulent activities in financial transactions. Several studies have highlighted the importance of utilizing high-quality historical data to train machine learning models effectively [T1]. Without a sufficient amount of valid and invalid previous transaction data, the accuracy and performance of fraud detection models may be compromised. Dimensionality reduction and data enrichment strategies are commonly employed to enhance the quality of training data and improve model performance [T1].

In the realm of machine learning algorithms, various techniques such as Logistic Regression, Decision Trees, Support Vector Machines, and Random Forest have demonstrated high accuracies in detecting financial fraud [T2]. While these algorithms have shown promising results, researchers emphasize the potential benefits of implementing sophisticated preprocessing methods to further enhance their performance [T2]. Additionally, the use of deep learning techniques, such as artificial neural networks and autoencoders, has been proposed to improve the efficiency of machine learning models in fraud detection [T2].

Data preprocessing plays a crucial role in handling missing values, outliers, and feature engineering to extract relevant information from raw transactional data [T4]. By comparing the performance of different machine learning algorithms in terms of accuracy, precision, recall, and F1-score, researchers can gain insights into the effectiveness of these models in detecting financial fraud [T4]. Moreover, model interpretability techniques like SHAP (Shapley Additive Explanations) are employed to elucidate the factors contributing most significantly to fraudulent transactions, providing valuable insights into underlying patterns of fraudulent behavior [T4].

The literature also emphasizes the importance of real-time fraud detection by deploying trained models on streaming financial data [T4]. This approach enables researchers to assess the scalability and efficiency of machine learning techniques in handling high-volume transactional data streams, showcasing the efficacy of these methods in detecting and predicting financial fraud with promising results in terms of accuracy and scalability [T4].

DATASETS

Since credit card transaction information is personal and private, the information is harder to obtain, which poses a great challenge to researchers. Fortunately, Carcillo, Fabrizio [3] proposed a credit card fraud detection dataset. Many researchers presented algorithms based on these datasets for detecting fraudulent credit card transactions. There were a total of 284,807 transactions in this dataset over two days in September 2013 from cardholders in Europe, of which 492 are fraudulent. The validation of the proportion of positive and negative fraud samples in these datasets is not balanced due to the relatively small proportions of fraud cases in life, with fraud data representing 0.172% of all transactions. This dataset provides transaction time and transaction amounts as well as other PCA features to avoid privacy, and uses the Area of Precision Recall Curve (AUPRC) to evaluate the algorithm's performance. As Figure 1[3], in order to get the distributions of the fraud and norm transactions (normals:0; frauds:1) and checks for its class imbalance, it outputs the pie charts of their possibilities.

The credit card fraud data distribution graphs shown in Fig. 1, the red color indicates fraudulent data and the blue color indicates norm data. Owing to the low percentages of fraud samples, the serious sample imbalance problems, which bring great challenges to the credit card fraud detections tasks. As Figure 2[3], the relationship between time and fraud is observed by drawing two line graphs of the changes in non-fraudulent transaction counts over time and the changes in transactions counts with fraudulent behaviors over time.

Figure 1. Distribution of Fraud and Normal Transactions.

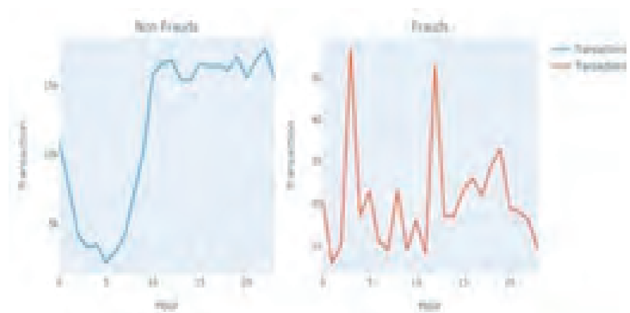

Figure 2. Transaction Count with Non Frauds and Frauds over Time.

METHOD

In the development history of credit card transaction fraud detections, there are numerous traditional methods, such as card security features, risk scores, and so forth. As artificial intelligence has grown so fast in the last several years, AI-related algorithms have found extensive applications in fraud detection systems, leading to significant enhancements in the accuracy and efficiencies of detection results.

Card Security Features

Faced with the occurrences of increasing cases of transactions fraud, enterprises, and banks use many tools and technologies to judge and detect fraud. For example, the credit card networks have developed many securities functions, including addresses authentications services [4], 3-D securities [5], CVV [6] card verifications, etc. These features are designed to determine whether a consumer is a cardholder by viewing or validating their personal identity or registration information. However, these securities functions will increase a certain degree of friction in the consumption process, slow down the consumption speeds of customers, and complicate the purchases process. For address authentication, the user's identity can be verified by comparing whether the user's consumption locations are consistent with previous records, or by asking the consumer to enter the mailing address and confirm whether it is correct. Even though the grid planning methodologies used in urban planning and the quantification of geographic areas through zip codes has made the delineation of the addresses system simple and clear in much of North America, there are still significant problems. For example, renaming of roads, construction of multiple residences at the same addresses, multiple different designations for the same residences, and errors in user input due to address information being too long can complicate the address validation process and cause great inconvenience to the user. For 3-D securities, it required customers to supply extra details of identifications, such as passwords or singles use codes, to successfully finalize a transaction, apart from the standard card information. These additional layers of security greatly reduces the feasibility of cybercriminals using stolen card information to conduct online transactions. Nevertheless, there are two significant drawbacks to 3D securities. Firstly, it can lead to customers abandoning their purchases during the checkouts processes due to its perceived complexities, resulting in a substantial decrease in conversion rates. Secondly, the implementation of 3D securities can be costly, as merchants may have to bear payments fees for each transaction. Another widely used verification method is CVV (Cards Verification Value). CVV is a three- or four- digits-code located on the back of the credit card, providing an additional layer of security when making online purchases. This code is only known to the cardholders. However, while shopping online, consumers may inadvertently expose their CVV to unfamiliar websites or malware, potentially leading to CVV theft. Additionally, during in-person transactions, if someone else sees the CVV, it increases the risk of later credit card theft. Therefore, some e- commerce companies led by Amazon cancel these verification steps like above, in order to ensure the purchasing experience of customers. If there are too many verification steps before payment, it leads to customer attrition; while if the identity of the customer cannot be accurately verified, it increases the likelihood of transaction fraud. So one of the challenges facing credit card fraud detection technology is how to confirm someone's identity before a transaction as concisely as possible.

RISK SCORES

Risk scores determine the likelihood of transaction fraud by using statistical models to evaluate many factors in each transaction. Typically, these models produce numerical scores that signify the probabilities of a transaction being fraudulent. A higher score suggests a more suspicious order. Merchants can use these risk scores to make educated guesses about specific user actions to minimize potentially fraudulent transactions, or to use additional security measures to ensure that every transaction is risky again. If the risk score of any one transaction is greater than a set threshold, it will be defined as fraudulent or rejected. In order to determine the risk scores as accurately as possible, we need to consider and test a variety of risk factors, such as bank identification numbers, country matching, city/state and zip code matching, proxies detection, distance between IP address and billing address, IP address in high-risk countries, and so on, which are derivated from past transactions. Subsequently, this data undergoes preprocessing, which includes tasks such as data cleaning to eliminate duplicate entries, address missing values, and identify any anomalous data points. Following preprocessing, machine learning algorithms [8] like dimensionality reductions, logistic regressions, Natives Bayes, decision trees, and support vector machines come into play to construct risk-scoring models. These models learn patterns and trends related to potential risks by analyzing historical data. Once the model is constructed, it undergoes a training and validation phase. To evaluate the model's performance and validities, a number of metrics are examined, such as F1-score, accuracies, precision, and recalls. Finally, upon deployment of the models in real-world settings, transactions are continuously monitored in real-time to detect potential risky behaviors. If a suspicious transaction is identified, the model generates an associated risk score to indicate the level of potential risk. Organizations utilising risk scoring can capitalize on precise fraud scores to establish an appropriate strategy for responding to risks. This approach aims to lower the probabilities of fraudulent incidents that transpiring and mitigate the aftermath in cases where fraud does take place. At the same time, transaction fraud can be comprehensively evaluated and prioritized with just a singles number, greatly reducing the cost of manual reviews. In essence, this tool aids in safeguarding merchants against the detrimental effects of credit card fraud, which encompasses financial losses, harriers to reputation, strains relationships with payment processors and card issuers, and more.

AI FRAUD DETECTION SYSTEM

Machine learning has a significant impact on the field of identification and prevention of online fraud. It involves employing a set of artificial intelligence (AI) algorithms that are educated using historical data from your records. These algorithms then propose risk-related rules that can be enforced. These rules serve to either authorize or block specific user actions, such as instances of suspicious logins, identity thefts, or fraudulent transactions. During the training processes of the machine learning systems, it's essential to flag paste instances of both fraudulent and legitimacies cases. These steps are crucial to minimize instances of false positives and enhance the precision of the risk rules. In practice, the algorithmic models can be continuously optimized by user generated data, and finally, the prediction accuracies of the models can be improved over time. In the early stages of research on machine modeling, researchers used simple algorithms for abnormal transaction detections like logistic regressions, k-nearest neighbors, decision trees, etc. With the passage of time and advancement in technology, researchers have improved and developed more advanced algorithms, such as neurons networks. A study was carried out by Khatri et al. to assess how well different machine-learning methods detect fraudulent credit card transactions. It explores several machine learning approaches including decision trees, K-nearest neighbors, logistic regressions, random forests, and native Bayes. The researchers employed a dataset created by European cardholders that was substantially class-imbalanced to evaluate the effectiveness of these methods. Precisions, which were calculated for each classifier in their experiments, served as the main performance metrics. The findings of the experiments showed that DT achieved a precisions of 85.11%, KNN reached 91.11%, LR showed 87.5%, and RF exhibited 89.77% precisions, while NB lagging behind with a precisions of 6.52%. We could see because KNN considers neighbors, its result is 3.61% higher than LR's.

V. Dornadula, S. Geetha et al [11] also applied a number of machine learning algorithms to tackle the challenges of credit card fraud. In order to address the dataset's significant skew, the researchers utilized SMOTE sampling techniques. They considered several machine learning methods, including DT, LR, and Isolation Forest (IF). The primary performance metric examined was accuracies. Through their improvements, the outcomes revealed that DT achieved an accuracies of 97.08%, while LR reached an accuracies of 97.18%. Navanshu Khare et al developed a system for credit card transactions fraud detection by employing multiple machine learning algorithms, which included LR, DT, RF, and support vector machines (SVM). To gauge the effectiveness of every machine learning approach, the researchers utilized classification accuracies as their performance metrics. The experimental results indicated that LR achieved an accuracies of 97.70%, DT reached 95.50%, SVM showed 97.50%, and RF excelled with an accuracies of 98.60%. Despite these favorable outcomes, the authors maintained that implementing sophistication pre-processing methods could potentially further enhance the performance of these classifiers. Different machine learning methods have similar accuracies and have achieved good results so far. It models the elements to be observed, which includes KNN, SVC, NB, DTC, RFC, XGB, LGB, GGC, ABC, and LR, produces statistical plots of theirs correlated predictions and actuals results with their precisions, recalls, f1-scores, and supports respectively, and summarizes the accuracies of all models.

In addition to these common algorithms, with the joint efforts of Warren McCulloch, Geoffrey Hinton, and other researchers, deep learning, a branch of machine learning, has been proposed to significantly improve the work efficiency of the machine models. Within deep learning, various techniques and architectures are employs, including artificial neurons networks [14], autoencoders, deep beliefs networks, generative adversarial networks, convolutional neurons networks, and recurrence neurons networks. Deep learning harnesses the neurons' networks to mimic the human brain's ability to process data and make decisions. In the above algorithms, the artificial neurons networks algorithms (ANN) are separated into the trainings part and the testings part. The first step of the training part is to load and read the datasets and then it will be scaled, normalized, and segmented. After preprocessing the data, ANN starts training and analyzing the models and predicting fraudulent behaviors. When getting the results, the trained data is stored for testing later. The testing part of the process is roughly the same as the training part, and the only difference is that the stored training models will be used to test and classify the data. Compared to the SVMs and KNNs algorithms, ANN is able to achieves 99.92% [10] accuracies and is most appropriate for detecting credit card frauds. However, even though ANN could reach such a high accuracies rate, its precisions and recalls are lower than SVM.

Method	Description	Advantages	Disadvantages
3D Security	A security feature requiring additional verification during online transactions.	Provides an extra layer of security by confirming the identity of the cardholder.	Can lead to abandoned purchases due to complexity, resulting in decreased conversion rates. Implementation can be costly.
CVV Verification	Requires entering a three- or four-digit code from the back of the credit card for online transactions.	Adds an additional layer of security that is known only to the cardholder.	Risk of CVV exposure to unfamiliar websites or malware, leading to potential theft. If seen during in-person transactions, it increases the risk of credit card theft.
Risk Scores	Uses statistical models to evaluate multiple factors in each transaction, producing numerical scores indicating the likelihood of fraud.	Allows for educated guesses about user actions to minimize fraudulent transactions. Can be used to establish appropriate strategies for responding to risks.	Requires careful consideration and testing of various risk factors to ensure accurate risk scores.
AI Fraud Detection System	Employs machine learning algorithms to detect and prevent online fraud by analysing historical data to propose risk-related rules.	Can be continuously optimized by user- generated data, improving prediction accuracyover time.	Early-stage models may have higher instances of false positives, requiring continuous refinement to enhance precision.

Machine Learning Models	Various algorithms such as Support Vector Machines (SVM), Random Forest, Gradient Boosting, and Neural Networks used to detect fraudulent credit card transactions.	Capable of handling complex and variable fraudulent behaviours. Provides promising results in terms of accuracy and scalability.	Requires extensive data preprocessing and feature engineering. Training and validation phases are crucial for ensuring model performance.
Feature Importance Analysis	Uses techniques like SHAP (Shapley Additive Explanations) to interpret models and understand the factors contributing to fraudulent transactions.	Enhances the interpretability of models, providing insights into underlying patterns of fraudulent behavior.	Requires sophisticated techniques and expertise to implement effectively.
Real-Time Fraud Detection	Deploys trained models on streaming financial data to assess the scalability and efficiency of fraud detection approaches in handling high-volume transactional data streams.	Enables real-time monitoring and detection of potentially risky behaviors, reducing the cost of manual reviews.	Implementation in real-world settings may pose challenges in terms of computational resources and infrastructure requirements.

APPLICATION

Running an AI-driven method for credit card transaction fraud detection requires meeting several crucial conditions to ensure the model achieves the best detection score possible. To train high-quality machine learning models effectively, a substantial number of internal historical records are necessary. Without a sufficient amount of valid and invalid previous transactions data, it is impossible to run the models and obtain accurate results. In other words, the quality of the input determines the performance of the training process. Using dimensionality reductions and data enrichment strategies is a common approach since the training set rarely contains two classes of medium volume data samples. The quality of previous data can skew the models. This argument implies that if the information collector does not organize the data neatly and appropriately or mixes the data of fraudulent transactions with norm transactions, significant deviations in the output results can occur. Fraud detection will only be effective if there is an adequate number of well-organized and impartial data, as well as business logic that exactly matches the machine learning models chosen. Therefore, the use of machine learning in AI models should be based on excellent datasets.

CONCLUSION

Machine learning algorithms have been founded to be effective in detecting and predicting financial fraud. These algorithms analyze large volumes of datums to identify patterns and anomalies that may indicate fraudulent activity. Despite their effectiveness, machine learning algorithms' face several challenges.

One challenge is the quality of the data used to train these algorithms. The data must be comprehensive, accurate, and up-to-date to ensure that the algorithms can effectively identify fraudulent behaviors. What's more, the algorithms may struggle with unbalanced datasets, where the numbers of fraudulent transactions are significantly lower than legitimacy transactions.

Another challenge is the interpretability of the algorithms. While machine learning models can accurately detect fraud, understanding how they reach their decisions can have complexities. This lack of transparencies can make it difficult for organizations to trust the results of these algorithms.

Despite these challenges... ongoing research is focused on addressing these issues and improving the effectiveness of fraud detection systems. Researchers are exploring ways to improve the quality of training data, develop more interpretation models, and enhance the overall performance of machine learning algorithms in detecting financial fraud.

By using machine learning techniques, organizations can improve their fraud detection capabilities. These techniques can help organizations identify fraudulent activity more quickly and accurately, thereby protecting their assets and maintaining the trust of consumers and stakeholders. What's more, machine learning can enable organizations to automate fraud detection processes, reducing the need for manually intervention and improving overall efficiencies."

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Application Program Interface to Extract the Information from User Page from Social Media Account

Prasad Kulkarni
Fr. C. Rodrigues Institute of Technology
Navi Mumbai , Maharashtra
✉ prasad.kulkarni@fcrit.ac.in

Vaishali Gavandi
R. A. D.A.V College
Bhandup, Mumbai, Maharashtra
✉ vaishali.jadhav7@gmail.com

ABSTRACT

Every day millions of information is available on social media and many organizations are extracting this information for various usage like digital marketing and many more. However, a process of data insight is a challenging task on collected information. Hence the objective of this paper to propose an application program interface (API) to collect the information from the user page. The proposed API is developed in Python and based on graph search and decision tree algorithm. Proposed API is used to collected the information from Facebook-user page and recorded successfully.

KEYWORDS: *Application program interface, Decision tree algorithm, Digital marketing, Graph search, Social media, Social networking sites.*

INTRODUCTION

The social networking sites are widely used to collect the information of user perceptions. There are many social networking sites (SNA) such as 'Facebook', 'Twitter', 'WhatsApp', 'Instagram'. Facebook is popular choice for all age group users for interaction and sharing the information on SNA. This sharing of information and reaction is big data in Digital world. Daily millions of information is available and used for many applications such as trend analysis, digital marketing, health sectors etc.

In past decade, many researchers presented work based on graph search[1], Gephi[2], three-layer model for the customers of the Facebook Fan Page of a fashion brand[3], Knowledge Discovery in Databases (KDD), Latent Dirichlet Allocation (LDA)[4], nettviz[5], Weka[6], modelling[7] were used to collect the information from SNA. Hsin-Ying Wu et al.[8] compared relevancies between the behavior and website experience of Facebook users. A decision tree algorithm was used many researchers to extract and analyze the information. Juha P. et al.[9] used binary decision tree to extract and classify the information collected form wireless bands, personal digital assistant etc.

In the era of digital marketing, social set analysis[10], machine learning driven tools [11-12] were also proposed to collect and analyze the information. Hence its proposed to develop an application program interface (API) to collect the in sighted data only. This proposed API is uses graph search and decision tree algorithm. This papers briefs on the following

1. Development of API to import and record the data from Facebook.
2. Analytical modelling and classification of the data.

ARCHITECTURE OF PROPOSED API

The system architecture of proposed API is shown in Fig. 1. This API is interfaced with Sybase server for user input and record the information extracted through proposed API from the user page of Facebook account holder. A Graphic user interface is provided to input the search or key word. Data insights are Entertainment, Education, Travelling and Thinking only. An API interconnects with Facebook, authenticates the users and passes the keyword. A graph search technique is used to retrieve the information from Facebook. Extract, transform and load (ETL) organises the data collected by graph search module. ETL works likes a trigger and distinguishes the data from staging table and store into the database per the database schema. A decision tree classifies and displays information available in database.

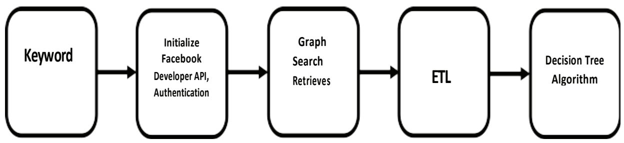

Fig. 1. System Architecture of Proposed API

The above modus-operandi of the proposed system is shown below:

1. Login with the credentials.
2. Select the category such as Education, Entertainment, Thinking, Travelling.
3. Authenticate once again to access one's profile (friend listed) information.
4. API fetch the data from one's profile as per category specified.
5. The retrieved data is pushed into the staging table.
6. The ETL is used to transfer staging table data to the database table.
7. Data is arranged as per the category.

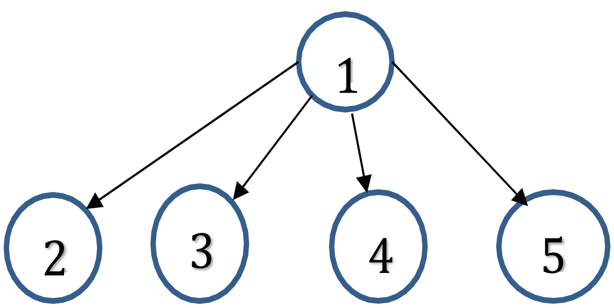

Fig. 2. Decision Tree used for Information recognition from User Page

Key word or category is accepted the entity named graph search to collect the information and arranged using decision tree algorithm. Both the codes were written in Python only. The decision tree has five nodes based on likes and dislikes as shown in Fig. 2. Node 1 represents the category selection and remaining nodes represent the Education, Entertainment, Thinking, Travelling with the perception.

RESULT AND DISCUSSION

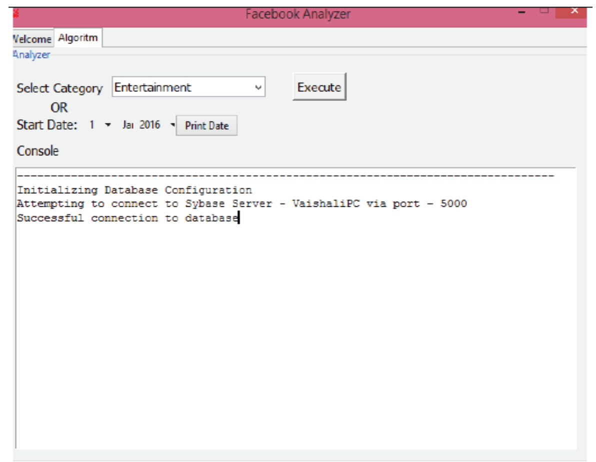

Fig. 3. Database Connection

Python entity of designed API named Facebook Analyzer is simulated. The designed API interact with selected SNA i.e., Facebook via Sybase server with port address 5000. The authentication and category selection is necessary to collect the information to help in data insight process.

The process of database initialization and connection is shown in Fig. 3 with category Entertainment. Here the duration for information of interest is also provided through start date. The Facebook data analyzer fetches the insights on category Entertainment. Its input request and input processing are shown in Fig. 4 and Fig. 5 respectively.

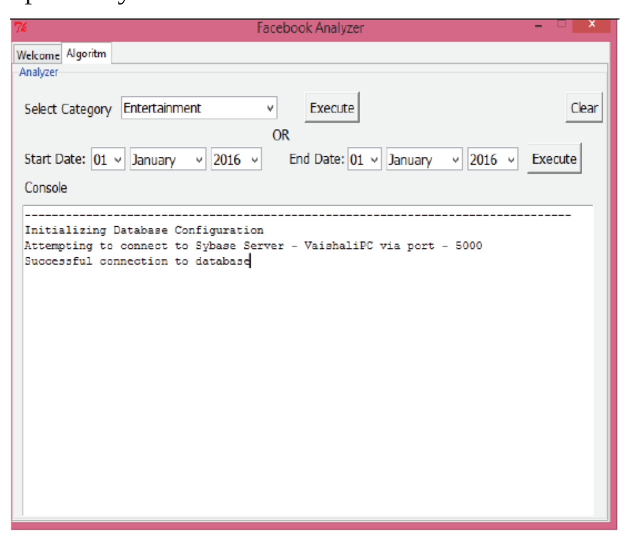

Fig. 4. Input Request Initialization of Entertainment

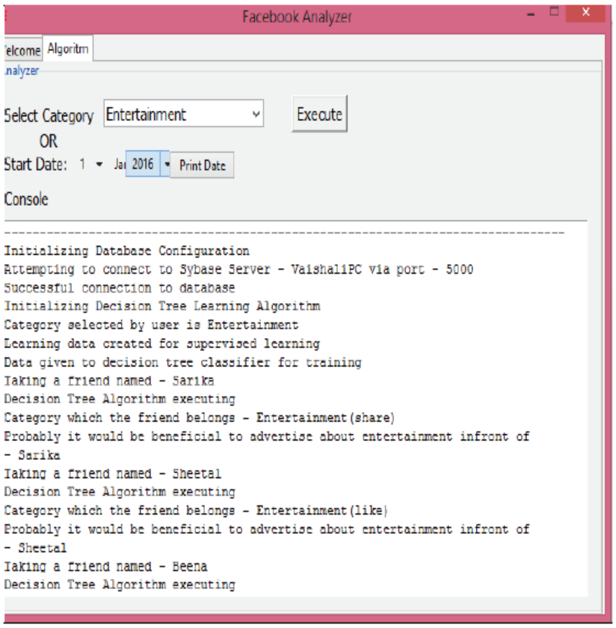

Fig. 5. Input Request Processing for Entertainment

The decision tree learning algorithm is initialized and collected the information from friend list. The friend named as Sarika Shares the information on Entertainment. Sheetal likes the entertainment and similarly for Beena.

The ETL of the 19 November is shown in Fig. 6. It gives category wise count and graph generation for the same data as shown in Fig. 7.

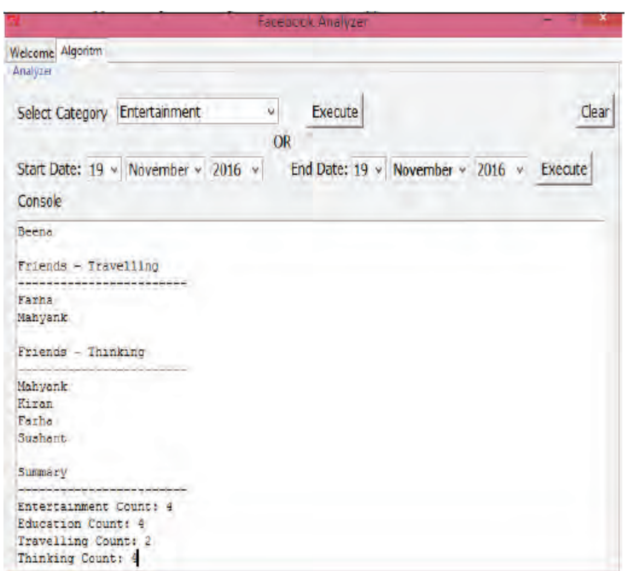

Fig. 6. ETL on 19 November 2022

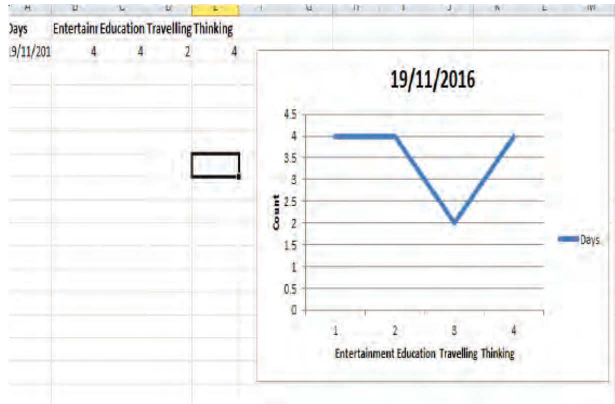

Fig.7. Recorded Information in Graphical Form.

CONCLUSION

A simple API is designed to extract the information from user page of Facebook account holder. This also API also categorised the extracted information in term of Education, Entertainment, Thinking, Travelling based on user interest.

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Chess Player Profiling: A Game-Changing Perspective on Player Development

Akanksha Funde, Prajwal Zade
Yash Khandebharad, Harsh Gharate
BE Student
Artificial Intelligence and Data Science
PES MCOE
Pune, Maharashtra
✉ akankshafunde@gmail.com

Shreya Yadav
Assistant professor
Artificial Intelligence and Data Science
PES MCOE
Pune, Maharashtra
✉ shreyadav18@gmail.com

ABSTRACT

Big data enables the rapid collection of diverse data in large volumes, making it crucial for knowledge discovery through machine learning methods. Various game types, including chess, provide rich data for analysis. Despite extensive research in chess analytics, many websites lack comprehensive resources for player improvement. Addressing this gap, our proposed solution involves creating a dynamic dashboard using unsupervised learning techniques to categorize players based on their scores. This model will enable personalized insights and resources, fostering individual player growth within the chess community. The aim is to provide a robust platform for in-depth analysis and support, leveraging the vast potential of big data in enhancing the understanding and development of chess players.

KEYWORDS: *Machine learning, Chess game, Big data, Data analysis, Django, Database management, Classification.*

INTRODUCTION

Chess is an incredibly demanding and intellectually stimulating sport that requires not only advanced planning and strategic thinking skills but also a deep understanding of the game's intricacies. The complexity and depth of chess make it a captivating pursuit for enthusiasts seeking mental challenges. One of the factors that adds to the allure of chess is the time element. The duration of a game can vary significantly, ranging from mere minutes to several tens of minutes or even hours. This time factor not only affects the overall length of the game but also influences the intensity and pace at which it is played. It adds another layer of complexity and strategic decision-making for players to consider.

The existence of these distinct formats poses an interesting dilemma when it comes to comparing players and determining the best chess player. Due to the specialized nature of each format, it can be difficult to directly compare players from different categories. A player who excels in blitz chess may not necessarily perform as well in standard chess, and vice versa. Among chess enthusiasts and practitioners alike, the distinction in the level of expertise across formats presents an intriguing challenge. No matter the time restrictions, developing a uniform rating system that includes all varieties of chess is a difficult task. Many top chess players are format specialists and may not be equally skilled in other develops.

Therefore, finding a fair and comprehensive solution to rank players across all categories remains an ongoing endeavour in the world of chess. It requires careful consideration of various factors, including performance in different formats, consistency, and overall contribution to the advancement of the game. Chess is a captivating and intellectually stimulating sport that offers a myriad of challenges and opportunities for players to showcase their skills. The intricate nature of the game, coupled with the diverse formats and specialized skill sets, adds complexity to the task of determining the best chess player. Although players are ranked based on existing rating systems, the use of automation plays a vital role in efficiently coordinating matches in tournaments with a large number of participants.

LITERATURE SURVEY

In 2012, this paper, authored by Trevor Fenner, Mark Levene, and George Loizou, presents an evolutionary stochastic model aimed at understanding the distribution of chess players' ratings, a fundamental aspect of the widely recognized Elo system. In contrast to previous approaches, this model captures the dynamics of players entering the rating pool, engaging in games, and how these outcomes shape their ratings over time akin to the Elo framework. Through a continuous approximation, the authors establish a normal distribution for players' ratings, wherein variance escalates logarithmically with time. Validated against rating data from 2007-2010, simulations demonstrate the model's capacity to recover parameters effectively.[1] Furthermore, acknowledging the slight negative skew in the rating distribution, the authors adapt the model accordingly and validate it against official rating data. This study underscores the versatility of paired comparison models, such as the Elo system, not only in chess but also in various competitive domains, emphasizing their utility in ranking objects based on preference relations.

In 2017, James A. Brown and his team of academics introduced a machine learning system that analyzes a significant quantity of chess data using both supervised and unsupervised learning components. The assessment findings

[2] suggest that chess may serve as a useful machine learning testing ground and that machine learning not only aids in the discovery of entertaining games. Unsupervised learning, which is sometimes referred to as clustering, seeks to categorize unlabeled data into separate groups or clusters based on their similarities. To facilitate improved information discovery from massive chess game sets, they are now performing more thorough assessments by contrasting various machine learning and data mining methodologies.

Based on their extensive understanding of Chinese chess, Zhi Wang and Xizhao Wang suggested a set of chess scenario traits in 2018. It has been demonstrated that these characteristics are useful for assessing the scenario. This paper's use of L1/2 regularization to limit the autoencoder is another significant feature. The dataset becomes sparser using this regularization strategy, improving the representation of the scenario characteristics and reducing SWAN overfitting problems. The model's hidden layers function as an autoencoder, with the final hidden layer acting as a classifier for a neural network trained via a stochastic weight assignment network (SWAN).

In 2019, Rishabh Ahuja and the team members proposed the development of a movie recommendation system using collaborative filtering and clustering techniques. The system is implemented in Python programming language using the movielens dataset from Kaggle. The paper provides an introduction to machine learning and recommendation systems, discussing the different tools and techniques used to build recommender systems. the paper demonstrates the development of a movie recommendation system using collaborative filtering and clustering techniques. The proposed system shows improved performance compared to an existing technique.

The paper describes various algorithms in detail, including K-Means Clustering, KNN, Collaborative Filtering, and Content-Based Filtering. It explains how these algorithms can be applied in different areas of industries such as e-commerce and recommender systems. Traditionally, the next step is chosen by the MCTS, but in this model, decisions are made using two parameters, Q and U, which are initialized for all nodes. The reinforcement learning model has significant self-learning capacity and has the potential to improve chess abilities.

The algorithm to grow the game tree by updating the probability table based on the rules of military chess was firmly suggested by Siwen Pan, Jiehong Wu, Yanan Sun, and Yi Qi in 2020. This algorithm considers elements like the movements of the other player and chess piece collisions. Two players, red and black, each having 25 chess pieces in the imperfect information game known as military chess. Future efforts will concentrate on creating technology and algorithms for partial information games because complete information games in computer games have already reached their peak. One of the most important directions for their growth will be to gather more game data using various algorithms.

In 2020, Takanobu Yaguchi and Hitoshi Iima put up a confident strategy that makes use of artificial intelligence (AI) to build a computer opponent capable of amusing players with basic gaming abilities. In the course of subsequent studies, it is crucial to compare the AI player to opponents who are human. Both players must fully understand the game's mechanics because it is deterministic in nature, free of randomness [6]. This method involves the AI player choosing an action in a predetermined state, watching the subsequent state, and receiving rewards appropriately.

Cundong Tang, Zhiping Wang, Xiuxiu Sima, and Lingxizo Zhang suggested a revolutionary methodology that reimagined game creation in 2020. They forecasted the effects of machine learning-based AI on the industry in the future while also analyzing the historical background and current function of AI. Additionally, the model added self- learning features that allowed offline learning and neural network parameter extraction [7]. This marriage of human intuition with machine learning promises to transform the creation of video games, opening the door for fresh gaming mechanics and player experiences. In short, Tang, Wang, Sima, and Zhang's concept signaled the start of an exhilarating new age in gaming, one characterized by boundless potential and unmatched innovation.

Rafa Dreewski and Grzegorz Wtor carried out a thorough examination in 2021 into the chess game prediction skills of recursive neural networks, notably LSTM (Long Short-Term Memory) [8]. In conclusion, the network model they developed had two crucial elements:1. A neural network that evaluated the result of the game using information that was directly related to the chess players that took part. 2. A neural network that anticipated the outcome of the game based on the game's progress. 80 moves achieving an impressive 65.32% accuracy rate. This emphasizes the significant impact of sequence length on the accuracy of chess game outcome predictions.

Aleksandra Kaczyska, Joanna Koodziejczyk, and Wojciech Saabun set out to develop a global chess player rating system in 2021, independent of the particular type or time limit of the games they were skilled in. Since many players excel in several forms, creating a single ranking for just one kind of chess would not fairly reflect individuals' total abilities [9]. A particular set of chess players' average values were also calculated. 2782 The average for the traditional ranking criterion is 2767.6 and is 2778.6. Rapid ranking criteria include the following: 31.2 Player's age criteria; 2776.3 Blitz ranking criteria. They used the COMET technique, a multi-criteria decision-making strategy.

The ranking model was developed in 2023 by Dimitrios Novas, Dimitrios Papakyriakopoulos, Elizabeth Powlesland Kartaloglou, and Anastasia Griva. It pulls themes from qualitative data (documents) and uses fuzzy logic to transform them into quantitative values. Our approach compares items (restaurants) in pairs and generates a rating ladder using these subjects as the ranking space. They used a model to examine TripAdvisor restaurant reviews from Athens, Greece [10]. As a result, our study also emphasizes the value of assessing the moral components of ranking systems, such as the equity of current systems and areas for development.

PROPOSED METHODOLOGY

Chess Move Analysis

The methodology begins with a comprehensive analysis of chess moves using the Stockfish chess engine. Each move in the game is meticulously evaluated to determine its centipawn loss, a metric that quantifies the positional advantage or disadvantage resulting from the move. This analysis provides valuable insights into the quality and effectiveness of the player's decision-making throughout the game. By calculating centipawn losses for each move, the methodology gains a nuanced understanding of the strategic nuances and positional dynamics inherent in the game of chess.

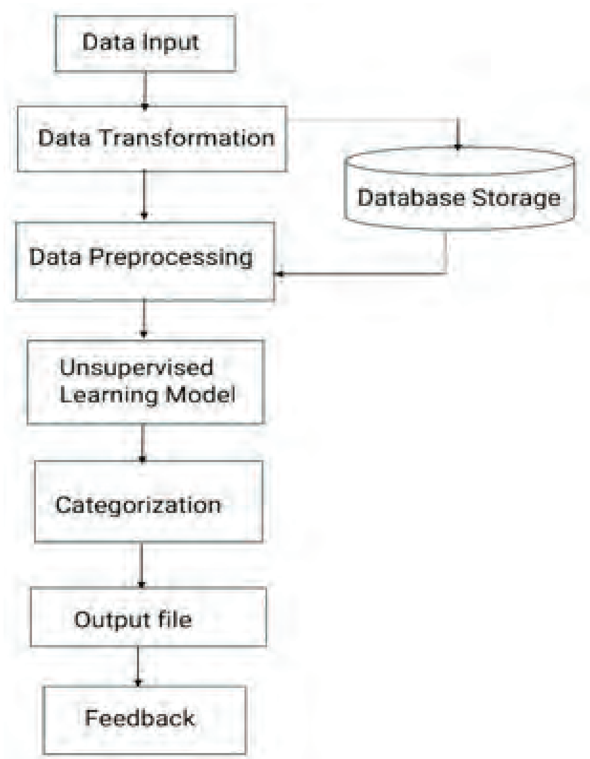

Fig. 1. Chess data analysis stages

Data Input

The data input stage involves gathering information from users in the form of Portable Game Notation (PGN) files, a widely used format for storing chess game data. These files encapsulate various details such as the moves made during the game, tournament metadata (including name, location, and date), player information (names, ratings), and game outcomes. By utilizing the PGN format, we ensure that all pertinent aspects of the game are captured accurately and comprehensively. This approach facilitates seamless processing and analysis of the chess games, enabling us to extract valuable insights into player performance and game dynamics.

Data Transformation

Data transformation is a critical step in the process, involving the conversion of raw PGN data into a structured format suitable for analysis. Through meticulous parsing and transformation techniques, we maintain data integrity while organizing it into a standardized format within CSV files. This systematic approach improves data quality and consistency, enabling seamless integration with other data sources and analytical tools. Furthermore, the CSV format enhances compatibility with a wide range of software platforms, facilitating further analysis and exploration of the chess data.

Data Preprocessing

Data preprocessing plays a pivotal role in ensuring the quality and suitability of the data for analysis. This stage encompasses several essential steps, including data cleaning, outlier detection, and feature extraction. Data cleaning involves identifying and rectifying any inconsistencies or errors within the dataset to ensure its accuracy and reliability. Outlier detection helps identify anomalous data points that may skew the analysis results, allowing for appropriate treatment or exclusion.

Player Skill Categorization

Following the chess move analysis, the methodology employs KMeans clustering, a machine learning algorithm, to categorize players into skill-based levels. The centipawn losses obtained from move analysis serve as input data for the clustering process. By grouping moves with similar centipawn losses, the algorithm identifies distinct clusters representing different skill levels, such as beginners, intermediates, experts, and professionals. The resulting centroids represent typical patterns of centipawn losses associated with each skill level, enabling the systematic classification of players based on their move quality.

Threshold Values for Player Categorization:

- Beginner: Centroid values of 0.2 and below
- Intermediate: Centroid values between 0.2 and 0.4
- Expert: Centroid values between 0.4 and 0.7
- Professional: Centroid values of 0.7 and above

Unsupervised Learning Model

The utilization of unsupervised learning models, such as K-means clustering, enables the categorization of players into distinct skill levels based on their move quality. This powerful algorithm autonomously groups chess moves into clusters representing different proficiency levels, ranging from novices to masters. By analyzing diverse features and characteristics of the moves, including centipawn losses, the algorithm accurately identifies patterns indicative of different skill levels. This classification provides valuable insights into player performance and facilitates targeted skill assessment and development strategies.

Step 1: Upload File

for each uploaded pgn file in the set of all uploaded pgn files:

validate the format of the uploaded pgn file. if the pgn file is valid:

extract the player's preferred color (default to white if not specified).

save the pgn file and proceed to analysis. else:

display an error message indicating form submission failure.

end if end for

Step 2: Analyze PGN and get Results

for each chess game extracted from the uploaded pgn file:

initialize an empty list for centipawn losses. initialize total moves to 0.

for each move in the chess game:

if the player's color matches the current turn: increment total moves by 1.

calculate the centipawn loss for the move using the stockfish engine.

append the centipawn loss to the list of centipawn losses.

end if end for

perform kmeans clustering on the list of centipawn losses to identify centroids.

compute the average centroid of all centroids. categorize the player's skill level based on the average centroid using predefined thresholds. assign learning resources based on the player's skill category.

end for

Step 3: Download pdf

retrieve the requested learning resource based on the player's skill level. generate the pdf file for the learning resource and provide it for download.

Output File

After categorizing players into distinct skill levels, personalized learning resources are curated and provided to each group to support their skill development journey. These resources are meticulously tailored to address the specific needs and preferences of each group, encompassing a wide range of educational materials and resources. Comprehensive tutorials covering fundamental concepts, in-depth analyses of renowned chess matches, practical exercises designed to enhance strategic thinking, and recommendations for further study are among the resources offered.

Evaluation of Methodology

To assess the effectiveness of the methodology, extensive evaluation is conducted using a diverse dataset of chess games spanning various skill levels. The accuracy and reliability of the move analysis coupled with machine learning for player skill assessment are rigorously evaluated. Categorization accuracy is measured by comparing the predicted skill levels with ground truth labels. Additionally, the scalability and performance of the methodology in processing large volumes of chess games are assessed to ensure efficiency and effectiveness in real-world scenarios.

Feedback:

Feedback serves as a crucial component in fostering collaboration and continuous improvement within the chess education ecosystem. By encouraging open communication between users and our team, we create a dynamic and interactive environment where ideas can be exchanged, and knowledge can be shared. Through this collaborative feedback loop, we gain valuable insights into user experiences, preferences, and challenges, allowing us to adapt and refine our methodologies and resources accordingly. Ultimately enhancing the overall learning experience and promoting continuous growth and development within the chess community.

Potential for Personalized Learning Strategies

Beyond player skill assessment, the methodology explores the potential for personalized learning strategies in chess education. By categorizing players into skill-based levels and recommending learning resources accordingly, the methodology facilitates targeted skill development. Players are provided with tutorials, training exercises, and game analysis materials suited to their individual proficiency level, fostering a personalized and effective learning experience.

RESULT AND DISCUSSION

The results obtained from the implementation of the proposed methodology demonstrate promising outcomes in the domain of chess move analysis and player skill categorization. This section presents a detailed analysis of the findings, along with discussions on the implications and significance of the results.

By calculating centipawn losses for each move, the methodology effectively quantified the positional advantage or disadvantage resulting from the moves made by players. Utilizing KMeans clustering, the methodology successfully categorized players into distinct skill-based levels. In evaluating the clustering model, two key metrics were utilized: inertia and silhouette score. Inertia, with a value of 2.731, represents the within-cluster sum of squared distances to centroids. The silhouette score, with a value of 0.78310, indicates the consistency of the clusters, suggesting that the players' categorization is both accurate and meaningful.

$$\text{Inertia} = \sum min_{\mu_j \in C} \left(||x_i - \mu_j||^2\right)$$

where:

- x_i represents the i-th data point.
- C is the set of clusters.
- μ_j is the centroid of the j-th cluster.

$$\text{Silhouette Score } s(i) = \frac{b(i) - a(i)}{max\{a(i), b(i)\}}$$

where:

1. s(i) is the silhouette score for data point i.
2. a(i) is the average distance from i to other data points in the same cluster (intra-cluster distance).
3. b(i) is the average distance from i to data points in the nearest cluster that i is not a part of (inter-cluster distance).

When compared to the results of a study focused on automating the ranking process for chess players in large online tournaments, our methodology shows notable strengths and comparable effectiveness. The referenced study employed a decision tree model to analyse game records of highly skilled chess players, achieving an accuracy of over 80% in distinguishing between high-rated and low-rated players, even for those not included during the model's training phase. This model facilitated efficient match coordination among thousands of participants.

While our KMeans clustering approach does not directly provide an accuracy metric akin to the decision tree model, the high silhouette score (0.78310) indicates a robust clustering performance, signifying well-defined player categorization. Additionally, the use of centipawn losses to measure move quality provides a granular and objective basis for player assessment, which complements the broader rating distinction achieved by the decision tree model. Overall, our methodology demonstrates strong potential in profiling chess players by move analysis and skill categorization. The positive inertia and silhouette score values underline the effectiveness of KMeans clustering in this context.

CONCLUSION AND FUTURE SCOPE

The research conducted on chess player profiling through move analysis and skill categorization has yielded promising results. By leveraging the Stockfish engine to calculate centipawn losses for each move, the proposed methodology effectively quantifies the positional advantage or disadvantage resulting from players' decisions. Utilizing KMeans clustering, players are categorized into distinct skill- based levels, providing a clear and objective assessment of their proficiency. The evaluation metrics, with an inertia value of 2.731 and a silhouette score of 0.78310, indicate robust clustering performance and well-defined player categories. When compared to existing studies, such as the one employing a decision tree model to automate player ranking in online tournaments, our methodology demonstrates comparable effectiveness. The high silhouette score highlights the consistency of our clustering approach, while the centipawn loss metric offers a detailed and objective measure of move quality. These findings underline the potential of our methodology to enhance player profiling and skill assessment in the domain of chess.

This project sets the foundation for numerous enhancements and expansions. Integrating advanced machine learning models, such as neural networks or ensemble methods, could significantly improve the accuracy and robustness of player skill categorization. Additionally, incorporating a broader range of game metrics, including time management and piece activity, could provide a more comprehensive analysis of player performance. Developing personalized training programs based on player categorization results can address specific weaknesses and enhance strengths. Furthermore, the project could benefit from implementing automated match coordination systems to manage large-scale tournaments efficiently, similar to the decision tree model study. Longitudinal performance tracking would provide insights into players' progress over time, while cross-platform integration would broaden the reach and impact of the methodology. By refining the user interface and exploring adaptive learning algorithms, the project can offer a more tailored and engaging learning experience. Lastly, integrating with popular online chess platforms would foster wider adoption within the chess community, making skill assessment and personalized learning resources more accessible to players globally.

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Study of Metaverse, It's Impact And Challenges on Human Being

Prakash Kene
Department of MCA
Modern College of Engineering
✉ prakash.kene@gmail.com

Khalil Aslam Nayakawadi, Shubham Nikam
Department of MCA
Modern College of Engineering
✉ khalil_nayakawadi_mca@moderncoe.edu.in
✉ shubhamnikamsn007@gmail.com

ABSTRACT

The Metaverse, a digital realm where virtual and physical realities converge, presents a paradigm shift in human interaction and engagement. This research paper investigates the multifaceted impact and challenges of the Metaverse on human beings. Through an interdisciplinary lens, the study examines its influence on social dynamics, psychological well-being, economic structures, and ethical considerations.

The evolution of the Metaverse concept is explored, alongside an analysis of its technical components and practical examples. The paper delves into the transformative effects of the Metaverse on human behaviour, including social interactions, identity formation, and psychological implications. Furthermore, it investigates the emergence of virtual economies and cultural shifts within the Metaverse, along with ethical and legal challenges related to privacy, intellectual property, and regulatory frameworks. Technological limitations and risks are discussed, alongside mitigation strategies encompassing education, technological advancements, and collaborative governance. Through synthesizing insights from diverse fields, this research contributes to a deeper understanding of the Metaverse's implications for society and offers recommendations for navigating its challenges while maximizing its potential benefits.

KEYWORDS: *Digital realm, Human interaction, Collaborative governance, Transformative effects, Identity formation, Paradigm shift, Metaverse.*

INTRODUCTION

In the past few years, there has been a notable surge in interest surrounding the Metaverse fueled by technological progress that blurs distinctions between the physical and digital realms. This paper aims to delve into the implications of the Metaverse on human beings, exploring both its potential impacts and the challenges it presents.

Background and Context

The Metaverse, coined by science fiction In Neal Stephenson's novel "Snow Crash," he depicts a unified virtual realm formed through the merging of virtual reality (VR), augmented reality (AR), and the internet and various digital platforms. With companies like Meta (formerly Facebook) investing heavily in Metaverse technologies, the idea of a fully immersive digital universe is becoming increasingly tangible.

Objectives of the Research

- This research seeks to understand how the emergence of the Metaverse may influence human behaviour, societal norms, and the way we interact with technology. Specifically, the objectives include:
- Exploring the potential benefits of the Metaverse, such as enhanced connectivity, new forms of entertainment, and innovative business opportunities.
- Examining the risks and challenges associated with the Metaverse, including issues related to privacy, identity, addiction, and inequality.
- Investigating the psychological and physiological impacts of prolonged immersion in virtual environments.
- Identifying potential regulatory and ethical

considerations that need to be addressed as the Metaverse evolves

Understanding the Metaverse

Evolution of the Metaverse Concept

The idea of the Metaverse has transitioned from a speculative concept in literature to a concrete digital realm. Initially introduced by Neal Stephenson in his novel "Snow Crash," the Metaverse now embodies a shared virtual environment blending elements of virtual reality (VR), augmented reality (AR), and internet connectivity Over time, advancements in technology have brought us closer to realizing this vision, with companies investing in Metaverse platforms and technology.

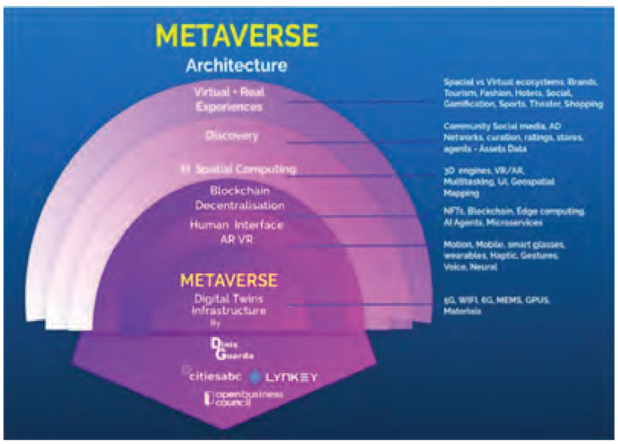

Fig. 1: Architecture of Metaverse

Technical Components of the Metaverse

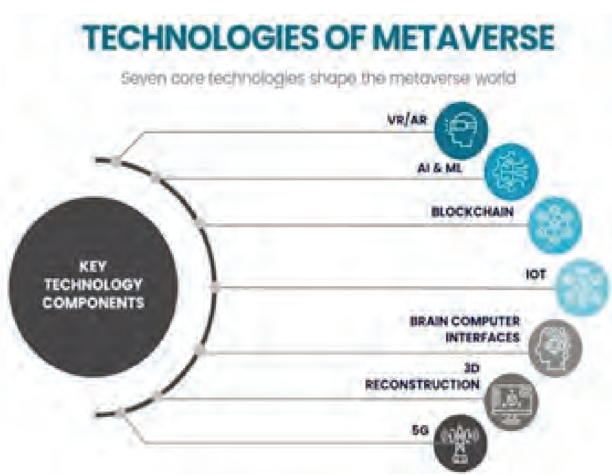

Fig. 2. Technologies of Metaverse

Virtual Reality (VR)

Virtual reality (VR) immerses users in computer-generated environments, simulating physical presence and enabling interactions in three dimensions. VR technology typically involves headsets or goggles that provide visual and auditory stimuli, along with motion tracking devices for a fully immersive experience.

Augmented Reality (AR)

Augmented reality (AR) enriches users' real-world experiences by seamlessly integrating digital content into their surroundings. Utilizing devices like smartphones, tablets, or dedicated AR glasses, AR applications overlay virtual objects, information, or experiences onto the user's perception of the physical environment.

Mixed Reality (MR)

Mixed reality (MR) combines elements of both VR and AR, blending digital content with the physical world in real-time. MR systems enable interactive experiences where virtual objects interact with the real environment and vice versa, creating a seamless integration of the digital and physical realms.

Examples of Metaverse Platforms and Applications

Fig 3.Applications of Metaverse

Second Life

Second Life is a virtual world platform launched in 2003, where users can create, interact, and trade in a fully immersive 3D environment. It pioneered the concept of virtual economies and social interactions, allowing users to build virtual communities, businesses, and experiences.

Decentraland

Decentraland is a decentralized virtual reality platform built on blockchain technology, where users can create, own, and monetize digital assets and experiences. It features a user-generated world divided into parcels of virtual land, which users can buy, sell, and develop using the platform's native cryptocurrency.

Roblox

Roblox serves as both a gaming platform and a game creation system, enabling users to craft, enjoy, and distribute games fashioned by fellow users. It features a vast virtual universe populated by user-generated content, providing a diverse range of gaming experiences and social interactions for players of all ages.

These examples illustrate the diverse range of Metaverse platforms and applications that are shaping the future of digital experiences and interactions. With ongoing technological advancements, the Metaverse stands ready to emerge as an ever-more essential component of our daily existence, presenting fresh avenues for creativity, teamwork, and discovery

Impact of the Metaverse on Human Behaviour Social Interactions in the Metaverse

Communication and Collaboration

In the Metaverse, communication and collaboration take on new dimensions as users interact with each other in virtual environments. Through text, voice, and even body language simulations, individuals can engage in real-time conversations, share experiences, and collaborate on projects regardless of physical distance.

Relationships and Social Dynamics

The Metaverse redefines how relationships are formed and maintained, blurring the lines between virtual and physical interactions. Users can cultivate friendships, romantic relationships, and professional connections within virtual communities, fostering a sense of belonging and social cohesion.

IDENTITY AND SELF-PERCEPTION IN VIRTUAL ENVIRONMENTS

Avatar Representation and Identity Formation

In virtual environments, users often create avatars to represent themselves, allowing for customization and self-expression. This avatar- based identity formation can influence how individuals perceive themselves and others, shaping their sense of identity and self-concept within the Metaverse.

Effects on Self-Esteem and Body Image

The ability to customize avatars in the Metaverse raises questions about body image and self-esteem. Users may experience pressure to conform to idealized standards of beauty or attractiveness, leading to feelings of inadequacy or dissatisfaction with their physical appearance.

Psychological Implications of Metaverse Use

Addiction and Dependency

The immersive nature of the Metaverse can lead to addictive behaviours and dependency, as users become engrossed in virtual experiences to the detriment of real-life responsibilities and relationships. Excessive use of Metaverse platforms may contribute to compulsive behaviours and withdrawal symptoms when offline.

Mental Health Concerns

Prolonged interaction within the Metaverse could potentially adversely affect mental well-being, potentially amplifying sensations of isolation, unease, and despondency. The fusion of virtual and physical realms might induce a detachment from reality, complicating the differentiation between online and offline personas.

Understanding the impact of the Metaverse on human behaviour is essential for addressing potential challenges and maximizing its benefits.

With ongoing evolution, it's essential to examine the psychological, social, and ethical ramifications of immersive virtual experiences within the Metaverse, both for individuals and broader society.

Emergence of Virtual Economies

Digital Currencies and Virtual Assets

Digital currencies and virtual assets have become increasingly prevalent with the rise of the internet and technology. Bitcoin, Ethereum, and other cryptocurrencies have gained traction as alternative forms of currency, while virtual assets such as in- game items, virtual real estate, and digital collectibles hold significant value within virtual economies.

Impact on Traditional Economies

The emergence of virtual economies has begun to disrupt traditional economic models. Digital currencies offer new avenues for financial transactions, challenging the monopoly of centralized banking systems. Moreover, the valuation and trade of virtual assets introduce complexities in taxation, regulation, and monetary policy.

Cultural Shifts in the Metaverse

Entertainment and Media Consumption:

The metaverse, a collective virtual shared space, is reshaping entertainment and media consumption. Users can engage in immersive experiences such as virtual concerts, gaming, and social interactions within these digital realms. This shift challenges traditional forms of entertainment and provides new opportunities for content creators and consumers alike.

Creativity and Artistic Expression

The metaverse fosters a new landscape for creativity and artistic expression. Artists and creators can explore innovative ways to showcase their work, from immersive virtual art galleries to interactive experiences. Additionally, collaborative platforms within the metaverse allow for collective artistic endeavours, leading to new forms of expression and collaboration.

Technological Limitations and Risks

Fig. 4: Risks of Metaverse

Technical Constraints of Metaverse Technologies:

Hardware Requirements and Accessibility

The metaverse relies on advanced technology, often requiring high-performance hardware for optimal user experience. This poses accessibility challenges for individuals who may not have access to expensive devices or robust internet connections, potentially excluding them from participating in virtual environments.

Bandwidth and Latency Challenges

Bandwidth limitations and latency issues can hinder the seamless operation of metaverse technologies. High data transfer requirements for immersive experiences, such as virtual reality (VR) or augmented reality (AR), may strain network infrastructure and lead to disruptions in user interactions within virtual environments.

Security Vulnerabilities in Virtual Environments

Hacking and Cybersecurity Threats

Virtual environments are susceptible to hacking and cybersecurity threats, posing risks to user privacy, data integrity, and overall system security. Malicious actors may exploit vulnerabilities within metaverse platforms to steal sensitive information, disrupt services, or perpetrate cyberattacks against individuals and organizations.

Fraud and Identity Theft

The interconnected nature of the metaverse creates opportunities for fraudulent activities and identity theft. Users may encounter scams, phishing attempts, or deceptive practices within virtual environments, leading to financial losses or unauthorized access to personal information.

Ensuring Accessibility and Inclusivity

Challenges for Individuals with Disabilities

The design and implementation of metaverse technologies may not always consider the needs of individuals with disabilities, resulting in barriers to access and participation. Accessibility challenges encompass aspects such as user interfaces, sensory inputs, and mobility requirements, requiring proactive measures to ensure inclusivity.

Bridging the Digital Divide:

The concept of the digital divide highlights discrepancies in technology access and internet connectivity across various demographic groups. Closing this disparity is vital to ensure fair involvement in the metaverse, requiring efforts to offer economical access to hardware, improve internet infrastructure, and implement digital literacy initiatives for marginalized communities.

Education and Awareness Initiatives

Encouraging Digital Literacy and Responsible Engagement

Educational initiatives play a crucial role in advocating for digital literacy and responsible utilization of metaverse technologies. virtual environments safely and ethically, individuals can better understand the implications of their online actions and make informed decisions.

Educating Users about Privacy and Security Risks

Raising awareness about privacy and security risks associated with the metaverse is essential. Educational initiatives can inform users about potential threats such as data breaches, identity theft, and cyberattacks, empowering them to take proactive measures to protect their personal information and digital assets.

Technological Advancements and Best Practices

Improved Security Protocols and Encryption

Continuous improvement of security protocols and encryption mechanisms is necessary to mitigate risks in the metaverse. Enhancing data protection measures, implementing end-to-end encryption, and adopting secure authentication methods can help safeguard user privacy and prevent unauthorized access to sensitive information.

AI Moderation and Content Regulation

Utilizing artificial intelligence (AI) moderation tools and content regulation algorithms can help mitigate risks associated with harmful or illegal content in virtual environments. By proactively identifying and moderating inappropriate behaviour, platforms can foster a safer and more inclusive online community.

FUTURE SCOPE

Longitudinal Studies: Conducting long-term studies to track the effects of Metaverse engagement on social behaviour, well-being, and economic activities. Cross-Cultural Analysis: Exploring cultural variations in Metaverse adoption and usage to understand its impact across different societies.

Interdisciplinary Collaboration: Fostering collaboration between fields like psychology, sociology, and technology to comprehensively study the Metaverse's impact.

Ethical Design and Governance: Researching strategies for responsible technology design and governance within the Metaverse.

Inclusive Access and Digital Equity: Examining ways to ensure access and equity in virtual environments, especially for marginalized groups.

Emerging Technologies: Investigating the integration of blockchain, AI, and XR technologies into the Metaverse ecosystem.

Impact on Work and Education: Assessing the implications of the Metaverse for work, education, and professional development.

Regulatory Frameworks: Proposing regulatory measures to address emerging challenges and protect users in the Metaverse.

Environmental Sustainability: Considering the environmental impact of virtual worlds and exploring sustainable practices.

Public Discourse: Promoting dialogue and engagement on Metaverse-related issues to inform policy and practice.

CONCLUSION

Summary of Key Findings: Summarizing the key insights and findings regarding the impact and challenges of the Metaverse on human beings across various domains.

Implications for Society and Policy: Discussing the broader societal and policy implications of the Metaverse and the importance of addressing associated challenges.

Future Research Directions: Suggesting potential avenues for future research to further explore and understand the evolving nature of the Metaverse and its implications.

Recommendations for Addressing Metaverse Challenges: Offering practical recommendations for addressing the identified challenges and fostering a safe, inclusive, and responsible Metaverse environment for all users.

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Enhancing Grayscale Image Colorization with Generative Adversarial Networks

Soniya Chaudhari
Department of Computer Science & Engineering
Dnyanshree Institute of Engineering & Technology
✉ chaudharisoniya53@gmail.com

ABSTRACT

Grayscale image colorization is vital in computer vision, converting black-and-white images into vibrant colored ones. This paper presents a novel grayscale image colorization method employing Generative Adversarial Networks (GANs). Leveraging a large dataset of high- resolution colored images; categorized according to scenery, background and artistic theme since the colors involved in such images are generic and are not complex, highlighting GANs' potential for diverse applications, such as image restoration, medical imaging, historical photos and digital art. We discuss traditional methods and provide an overview of the evolution of colorization methods, the role of deep learning in revolutionizing this field, and highlight state-of-the-art techniques emerging trends in this domain. Furthermore, we highlight challenges, future directions, and potential applications of grayscale image colorization.

KEYWORDS: *GANs', Computer vision, Deep learning, Grayscale image, Digital art.*

INTRODUCTION

Grayscale image colorization is pivotal for enhancing and interpreting visual content. Traditional methods, reliant on manual effort or rule-based algorithms, were time- consuming and lacked flexibility. However, with the advent of convolutional neural networks (CNNs), grayscale image colorization has seen significant advancement, automated the process and yielded remarkable results. Generative Adversarial Networks (GANs) have further propelled this field by enabling realistic image generation.

Image colorization is a computer-assisted technology to colorize grayscale images. With the rapid development of information technology and increasing image data, the study of image colorization has also become particularly important. The results show specially that model-based colorization has a better colorization effect, extensive experiments demonstrate its superiority over existing methods, quantitatively and qualitatively.

EMERGING TRENDS

Recent advancements in grayscale image colorization include the utilization of GANs, and the exploration of self- supervised learning techniques to reduce the reliance on paired training data. Additionally, there is growing interest in incorporating semantic information and contextual cues to improve colorization accuracy and robustness.

RELATED WORK

Review manual colorization, rule-based algorithms, and deep learning approaches. Manual colorization is precise but time-consuming. Rule-based algorithms lack flexibility. Deep learning methods, CNNs and RNNs, show promise but have certain limitations in terms of realism due to their architectural constraints. Ongoing advancements in neural network research are continually addressing these by hybrid models and other innovative.

LITERATURE REVIEW

Research in grayscale image colorization has burgeoned in recent years, leading to various techniques categorized into hand coloring, semi-automatic coloring, and automatic coloring.

Two notable research works in this domain are:

1. "Transferring Color to Grey scale Images"
2. "A novel coloring framework for grayscale images"

Both these approaches fall under the semi-automated technique category, as they involve some degree of human intervention. However, "A novel coloring framework for grayscale images" stands out as a more advanced technique, leaning towards fully automated colorization. In this method, color information is extracted from reference images and transferred to grayscale images.

These advancements underscore the ongoing evolution of grayscale image colorization, with a growing emphasis on automation and efficiency.

EVOLUTION OF COLORIZATION METHODS

Historically, grayscale image colorization began with manual techniques where artists meticulously added colors based on reference images. This method, while precise, was impractical for large-scale applications. Rule-based algorithms were introduced to automate colorization by defining colorization rules and heuristics. However, these methods struggled with complex images and lacked adaptability. The advent of deep learning, enabling models to learn complex patterns from grayscale inputs.

Manual Coloring

In "Manual Coloring", different parts of the image are colored by perception. Talking about digital images, we have to select a color for each pixel and thus get the job done. But obviously is very tedious, time taking and requires human vision of proposed color of grey pixel. Example: Photoshop Editor

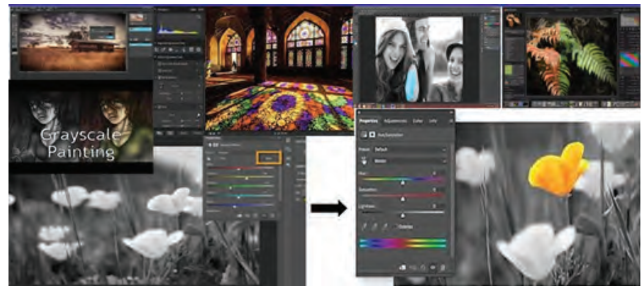

Fig. 1: Photoshop Editor

Fig.1 The image portrays a digital editing platform emblematic of professional graphic design software. Its interface likely exhibits an array of tools and panels facilitating intricate image manipulation, including features for layering, selection, retouching, and applying diverse visual effects, providing users with a versatile platform for creative expression and precise editing control.

Semiautomatic Coloring

"Semiautomatic Coloring" make this job easier; it actually segments grey image and then user can select predefined color brushes to be applied on these segments.

Example: "Black Magic" software.

Fig. 2: Semiautomatic editing environment

In Fig.2, the indicative software tools combine user input with automated features, semi-automated processes such as AI-assisted retouching or batch editing functionalities and creative control where needed.

Advance Semiautomatic Coloring

Modern semiautomatic techniques do not require much human intervenes for coloring grey images and are mostly based on a method proposed by Wels Hetal. This method suggests that for coloring a grey image we should have a similar color image and then we transfer color information form color image to grey image on basis of mean intensity and standard deviation calculated on neighborhood of the pixel. This pixel is called seed pixel and we have to select the seed pixel in color and in grey image to perform this algorithm. Example: Colorize! –Application

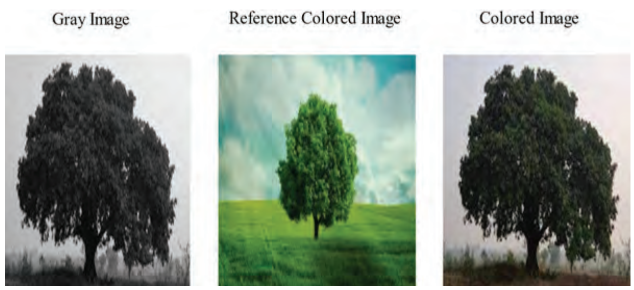

Fig. 3: The image illustrates an advanced semi-automatic coloring

Fig.3 includes intelligently suggesting color palettes or automatically filling areas based on pre-defined parameters, reducing manual effort while maintaining user control over the final outcome. Users may interact with tools to refine or override automatic selections, ensuring precise and customized coloring results with enhanced efficiency.

Example-based colorization

A cutting-edge technique in image editing. This process involves utilizing reference images or color guides to automatically apply color to grayscale or monochrome images.

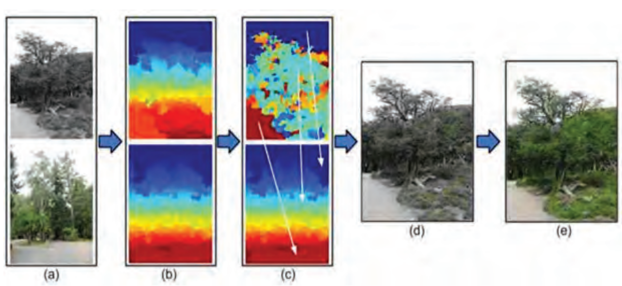

Fig. 4: Example – based colorization

Fig. 4 The image showcases an example-based colorization interface. Users provide color references or sample colors from existing images, allowing the software to intelligently infer and apply appropriate color choices to grayscale regions maintaining fidelity to the user's artistic vision and reference material.

Fully Automatic Coloring

Representing an innovative approach to image editing. In this environment, advanced algorithms analyze grayscale or monochrome images and apply colors automatically without user intervention. This streamlined process enhances productivity and accessibility.

Example: color TV, camera or color scanner.

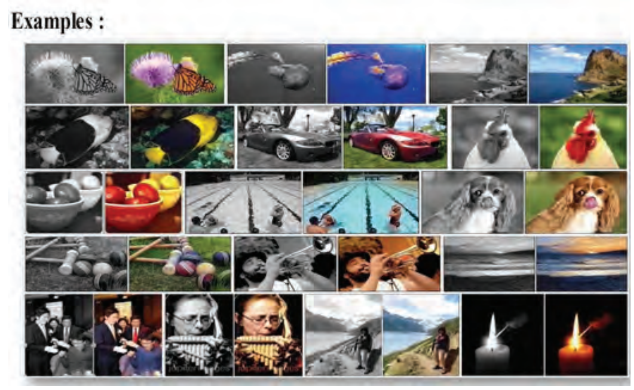

Fig. 5: Fully automated colorization

Fig.5 The image depicts a fully automatic coloring system, images are acquired with a full-color sensor. Leveraging machine learning and pattern recognition, the software intelligently selects and applies appropriate colors to different elements within the image, resulting in efficient and accurate colorization with minimal user input.

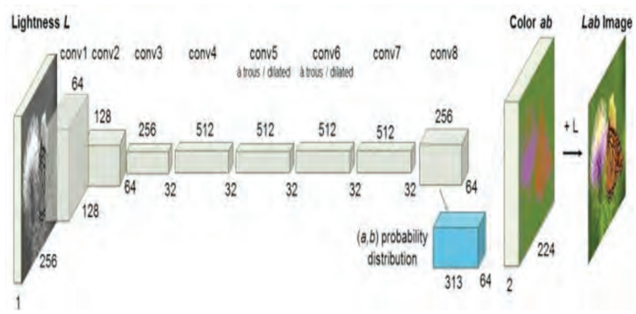

Fig. 6: Zhang et al.'s network

Fig.6 Zhang et al. (2016) introduced the "Colorful Image Colorization" method, which uses a CNN to predict the a and b channels in the Lab color space. This method demonstrated significant improvements in colorization quality and introduced the concept of uncertainty in color prediction.

STATE-OF-THE-ART

State-of-the-art colorization techniques incorporate advanced architectural designs and optimization strategies. GANs generate high-quality colorizations indistinguishable from real images. Additionally, self-supervised learning techniques enable models to learn colorization from unlabeled grayscale images.

Traditional Methods

Color Transfer

Early methods focused on transferring color from a reference image to a grayscale image by matching statistical properties such as mean and variance.

Example: Reinhard et al. (2001) developed a method for color transfer using the lαβ color space, which simplifies the process of matching color distributions between images.

Optimization-Based Techniques

These methods employ optimization techniques to propagate colors from a reference image or user-specified points to the grayscale image.

Example: Welsh et al. (2002) proposed a method where color is transferred using texture information to guide the propagation.

DEEP LEARNING APPROACHES

Deep learning models like CNN learn to map grayscale images to their corresponding color versions. Architectures, such as U-Net and ResNet, have been adapted for these tasks, with fine details preserved. Furthermore, recurrent neural networks (RNNs) and attention mechanisms have been employed to capture temporal dependencies and focus on relevant image regions, especially for video sequences. By exploiting the hierarchical features learned by CNNs, these models can generate plausible colorizations.

The field has seen significant advancements with the introduction of machine learning, especially deep learning. Machine learning-based colorization methods can be broadly categorized into:

Supervised Learning

CNN-based Methods: These use convolutional neural networks (CNNs) trained on large datasets of color images to predict the color values for grayscale images. An example is the work by Zhang et al., which introduced the “Colorful Image Colorization” technique. This method leverages a CNN to predict the a and b channels in the Lab color space, given the L channel (the grayscale image).

Unsupervised and Self-Supervised Learning

Generative Adversarial Networks (GANs): GANs have been particularly successful in colorization tasks. The DeOldify model is a prominent example that uses a GAN architecture to generate high-quality colorized images. GANs consist of a generator that creates color images and a discriminator that attempts to distinguish between real and fake color images, improving the generator’s output over time.

Self-Supervised Learning

These methods train models without explicitly labeled data by leveraging the structure of the data itself. Techniques like split-brain autoencoders, where one half of the network learns to colorize the image using the other half as a reference, fall into this category.

Methodology

Our method employs a GAN architecture, where the generator transforms grayscale inputs into colored outputs, and the discriminator evaluates realism. Using a large dataset of grayscale and colored images, we train the model with adversarial, perceptual, and feature loss functions to ensure high-quality colorization results. DeOldify is a deep learning model designed for automatic colorization and restoration of old images and videos. In the context of DeOldify, dataset description and transformation play crucial roles in training the model and preparing the data for effective learning.

Dataset Description

Dataset description refers to the characteristics and properties of the dataset used to train the DeOldify model. This includes details such as the size of the dataset, the types of images or videos included (e.g., black and white photos, grayscale videos), the resolution of the images, and any additional metadata associated with the dataset. The dataset description helps researchers and developers understand the nature of the data used for training, which is important for assessing the model’s performance and generalization capabilities.

Transformation

Transformation involves preprocessing the input data before feeding it into the DeOldify model for training or inference. In the context of DeOldify, transformation typically includes converting black and white or grayscale images to color images. This transformation process may involve techniques such as resizing images to a standard resolution, normalizing pixel values, and applying colorization algorithms to generate colorized versions of the input images. Additionally, data augmentation techniques may be applied during transformation to increase the diversity of the training data and improve the model's robustness.

1. Model Selection: DeOldify primarily utilizes a CNN architecture for image colorization. CNNs are widely used for image-related tasks due to their ability to automatically learn hierarchical representations from raw pixel data. Specifically, DeOldify may utilize variants of popular CNN architectures such as U-Net, ResNet, or custom architectures designed specifically for the colorization task.

2. Model Description: While the exact architecture details may vary based on the specific implementation and updates, a typical DeOldify model may consist of the following components: -

- Encoder: Responsible for extracting features from the input grayscale images. This component typically comprises several convolutional layers followed by down sampling operations (e.g., max-pooling).

- Decoder: Transforms the learned features into colorized images. It usually consists of convolutional layers followed by up sampling operations (e.g., transposed convolutions) to gradually increase the spatial resolution of the feature maps.

- Skip Connections: To preserve fine-grained details during up sampling, skip connections may be employed to concatenate feature maps from earlier layers to those in the decoder.

- Activation Functions: Non-linear activation functions such as ReLU (Rectified Linear Unit), Leaky ReLU, or variants like PReLU may be used to introduce non-linearity into the model.

- Loss Function: Typically, DeOldify uses a loss function such as mean squared error (MSE) or perceptual loss, which measures the difference between the colorized output and the ground truth colored image.

- Optimization Algorithm: Training of the DeOldify model is often performed using optimization algorithms like stochastic gradient descent (SGD), Adam, or RMSprop, to minimize the chosen loss function.

- Pretrained Models and Transfer Learning: DeOldify may also utilize pretrained models on large-scale datasets (e.g., ImageNet) or transfer learning techniques to initialize the model parameters, thereby accelerating training and improving performance, especially with limited training data.

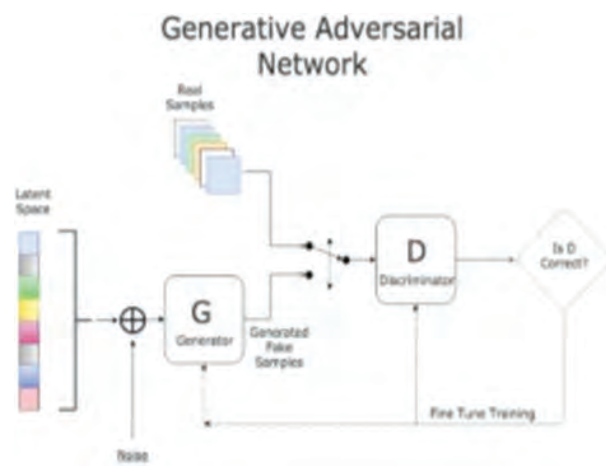

Fig. 7: The image illustrates a Generative Adversarial Network (GAN)

Fig.7 An advanced framework GAN, in artificial intelligence and image processing, consist of two neural networks—the generator and the discriminator—locked in a competitive learning process. The generator creates realistic images from random noise, while the discriminator attempts to distinguish between real and generated images. Through iterative training, GANs learn to produce high-quality images, often used for tasks like image synthesis, style transfer, and image enhancement. The output of a GAN may feature realistic images, stylized artwork, or even imagined scenes, showcasing the capabilities of this powerful AI technique in generating diverse and visually compelling content.

Working

The DeOldify model works by using deep learning techniques to automatically colorize grayscale images.

Here's an overview of how it works:

- Data Preparation: The DeOldify model requires a dataset of grayscale images along with their corresponding-colored versions. These images are used to train the model to learn the mapping between grayscale input images and their corresponding colorized versions.
- Training: During the training phase, the DeOldify model learns to predict the color of each pixel in a grayscale image based on its surrounding context and learned features. The model is trained using supervised learning techniques, where it minimizes the difference between the colorized output images and the ground truth-colored images in the training dataset. The training process involves iteratively adjusting the model's parameters (weights and biases) using optimization algorithms such as SGD or Adam to minimize a chosen loss function (e.g., MSE).
- Architecture: DeOldify typically employs a convolutional neural network (CNN) architecture, often with an encoder-decoder structure.
- Inference: Once trained, the DeOldify model can be used to colorize new grayscale images. During inference, the grayscale input image is passed through the trained model, which predicts the color of each pixel based on the learned mapping. The output is a colorized version of the input image, where each pixel has been assigned a color based on the model's predictions.
- Post-processing: After colorization, post-processing techniques may be applied to enhance the visual quality of the colorized images. This may include adjusting brightness, contrast, or saturation levels, as well as applying noise reduction or sharpening filters.

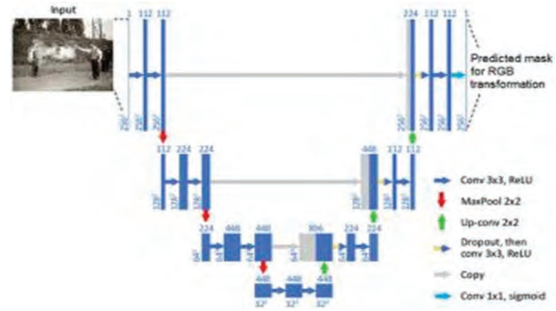

Fig. 8: The DeOldify architecture

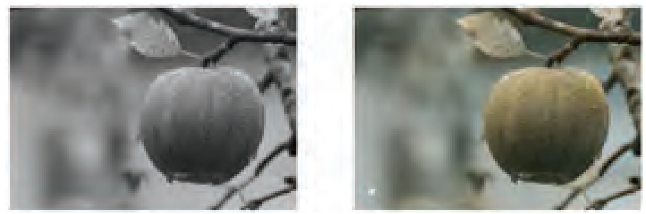

Fig. 9: Results

The result Fig.9 showcases the transformation of a black-and-white image into a colorized with hues and tones inferred from the grayscale information. Whether applied to historical photographs, artistic compositions, or contemporary imagery, offers a fascinating glimpse into the possibilities of modern image processing technology, bridging the gap between the past and the present with vivid and immersive visual experiences.

COLORIZATION APPLICATIONS

Old Photos

Fig. 10.1 Helen Keller (1880-1968)

Fig.10.2 Helen Keller (1904) Restored and Colorized

Fig.10.1 & 10.2 Helen Keller, a prominent historical figure renowned for her advocacy for the deaf and blind. These algorithms analyze the grayscale image's content and context to intelligently assign appropriate colors to different elements, such as her clothing, surroundings, and facial features. The result is a visually striking that brings Helen Keller to life, providing viewers with relatable portrayal of this influential figure from history.

Airport System

Fig. 11 Cuban immigrants arrive in Florida ca. 1965

Manual ART

Fig. 12: Hand colored images, like this lithograph of Cincinnati ca 1840s

Historical Imaging

Fig. 13: Titanic Orphans, 1912

Fig.13 The Titanic orphans, including children such as Michel and Edmond Navratil, were among the survivors of the tragic sinking of the RMS Titanic in 1912. An emotionally resonant depiction of their experiences allows a profound understanding and appreciation of their stories.

Fig. 14: Pont Alexandre III, Paris, 1900

Fig.14 The Pont Alexandre III is an iconic bridge spanning the Seine River in Paris, celebrated for its ornate design and architectural grandeur, evocative of one of Paris's most beloved landmarks. The colored rendition preserves its timeless charm for future generations to admire.

Fig. 15: Student In Brussels, 1942

Fig.15 The photograph likely captures a moment from the historical context of Brussels during World War II, offering a glimpse into the life of a student amidst the wartime challenges and uncertainties.

Fig. 16: Queen Elizabeth II on her 21st birthday

Fig.16 Queen Elizabeth II, the reigning monarch of the UK and the Commonwealth realms, capturing the grace of Her Majesty in her youth.

Fig. 17: The iconic photograph of the train wreck at Montparnasse Station in Paris, France, in 1895

Fig.17 This photograph captured a dramatic moment when a locomotive crashed through the station's façade, inviting viewers to witness and reflect upon the impact of transportation disasters in the late 19th century.

Fig. 18: An engineer wiring an IBM computer 1958

Fig.18 This historic image captures a crucial moment in computing history, showing the engineer's meticulous work, highlighting the era's technological advancements and the engineer's role in shaping them.

Medical Imaging

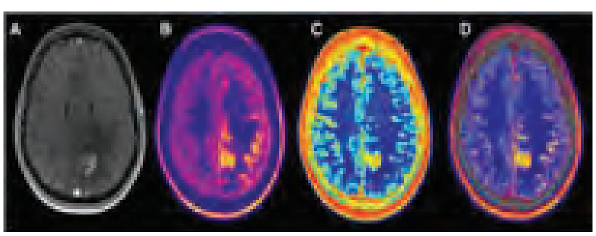

Fig. 19: Medical Imaging

Fig.19 Medical images involves assigning specific colors to anatomical structures, highlighting pathological features, and creating depth and texture to aid interpretation.

Standardization ensures consistency, while colorized images facilitate consultation, education, and patient engagement. Ethical considerations include patient privacy and consent. Collaboration between imaging specialists and healthcare professionals is essential for optimal results.

Satellite Imaging

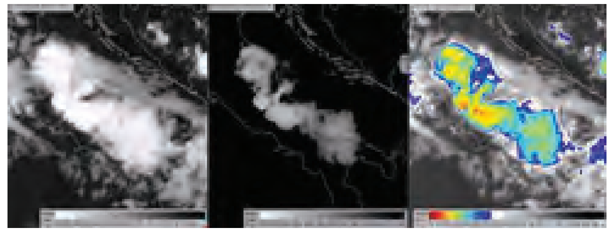

Fig. 20: Geology

Fig.20 In the colorized version, vibrant hues distinguish landmasses in green, brown, and beige, oceans in shades of blue, and clouds in white and grey. This enhanced visualization provides valuable insights into geographic and atmospheric phenomena.

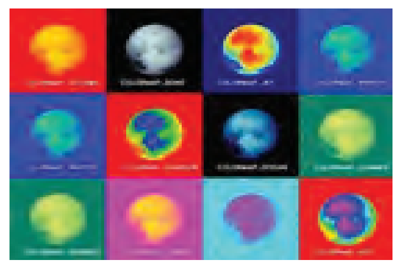

Fig. 21: NASA's New Frontiers program

Fig.21 Often grayscale images of planets and other objects in space are pseudo colored to show detail, and to mark regions corresponding to different materials with different colors.

ADVANTAGES

- Bring Old Photos Back to Life: Colorize your family photos and capture memories in a new way.
- Enhance Low Saturation Images: Increase the vibrancy of dull images with image colorization.
- Create Unique Artwork: Generate unique artwork by applying different color palettes to existing photos.
- Improve Image Quality: Get sharper, clearer images with more detail through image colorization.
- Save Time and Money: Use an automated tool for quick results without breaking the bank.

EXPERIMENTAL EVALUATION

Extensive experiments on benchmark datasets demonstrate the superiority of our method. Quantitative metrics like colorization accuracy, color similarity, and perceptual quality showcase its effectiveness. Qualitative comparisons with existing methods highlight superior visual quality, detail preservation, and color accuracy.

Experimental evaluation of grayscale image colorization involves assessing the performance of various colorization algorithms. This process typically includes several key steps:

Dataset Selection

Use a diverse set of grayscale images for testing. Common datasets include ImageNet, COCO, or specialized grayscale image datasets.

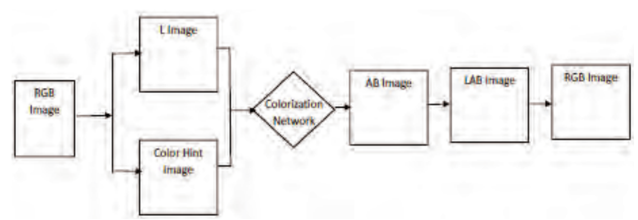

Fig. 22: Colorization Framework

Fig. 22 A novel coloring framework for Grayscale images.

This Technique consists of five major steps . These are :

- Color space conversion
- Pre-processing
- Feature extraction
- Segmentation
- Color transfer

Colorization Algorithms

Select and implement different grayscale image colorization methods. These may include:

- Traditional approaches (e.g., using color transfer techniques).
- Machine learning models (e.g., Convolutional Neural Networks, GANs, or transformers).
- Pre-trained models (e.g., DeOldify, Colorful Image Colorization).

Deployment

- Integration: Integrate the colorization algorithm into applications or systems where colorization is required, such as image editing software or restoration tools.
- Optimization: Optimize the algorithm for real-time performance and efficiency, especially for deployment on resource-constrained devices.

Performance Metrics

- Evaluate colorization performance using quantitative and qualitative metrics. Common metrics include:
- Peak Signal-to-Noise Ratio (PSNR): Measures the ratio between the maximum possible power of a signal and the power of corrupting noise.
- Structural Similarity Index (SSIM): Assesses the similarity between the original and colorized images in terms of luminance, contrast, and structure.
- Mean Squared Error (MSE): Measures the average squared difference between the estimated values and the actual value.
- Colorfulness: Assesses the degree of color present in the image.
- User Study: Human evaluation for subjective quality assessment.

Implementation and Testing

- Implement or use existing implementations of the colorization algorithms.
- Colorize the test dataset using each algorithm.
- Calculate the performance metrics for each colorized image.

Comparison and Analysis

- Compare the performance metrics across different algorithms.
- Analyze the strengths and weaknesses of each method based on the results.

DISCUSSION

We analyze results, emphasizing GANs' advantages in generating realistic colorizations. Future work involves integrating contextual information and exploring novel loss functions for further improvement. The advent of machine learning, particularly deep learning, has revolutionized grayscale image colorization. Convolutional Neural Networks (CNNs) have been pivotal in this transformation. Notably, Zhang et al.'s "Colorful Image Colorization" method employs CNNs to predict the a and b channels in the Lab color space, given the L channel. This approach significantly improves the colorization process by learning from large datasets of color images, allowing the network to capture complex color patterns and context-specific color information. Generative Adversarial Networks (GANs) represent another leap forward. GAN-based methods, such as DeOldify, use a two-part architecture comprising a generator and a discriminator. The generator attempts to create realistic color images, while the discriminator evaluates their authenticity. This adversarial training results in high-quality, vibrant, and contextually accurate colorizations. GANs have demonstrated superior performance in producing realistic and diverse colorizations compared to traditional and CNN-based methods.

Multiple plausible colorizations -Image colorization is a challenging topic of ongoing research. We take a grayscale image as input and attempt to produce a coloring scheme. The goal is to make the output image as realistic as the input, although not necessarily the same as the ground truth version.

How we can relate luminance with chromatic values? How we can get better color shades by using reference image? Color is a powerful descriptor that often simplifies object identification and extraction from a scene. Humans can discern thousands of color shades and intensities, compared to about only two dozen shades of gray. Colorization of grayscale images has become a more researched area in the recent years, thanks to the advent of deep convolutional neural networks.

CHALLENGES AND FUTURE DIRECTIONS

Despite the remarkable progress in grayscale image colorization with deep learning, several challenges remain, including handling complex scenes, preserving fine details, and ensuring robustness to variations in lighting and image quality. Future research directions may involve exploring novel architectural designs, integrating domain-specific knowledge, and incorporating semantic information to further improve colorization performance and address these challenges.

Color Ambiguity: A grayscale image can be colorized in multiple plausible ways, leading to ambiguity. Accurate colorization requires understanding the context and semantics of the scene to infer realistic colors.

Generalization: Ensuring that colorization models generalize well across diverse images and scenes, including those not seen during training, is challenging. Models often overfit to the training data and perform poorly on unseen images.

Evaluation: Developing robust evaluation metrics that correlate well with human perception of color realism and quality is difficult. Current quantitative metrics may not fully capture the subjective quality of colorized images.

Future research in grayscale image colorization should address the following areas:

Enhanced Context Understanding: Developing models that better understand the context and semantics of the scene can improve color accuracy and realism. Techniques from natural language processing (NLP) and multimodal learning could be integrated to enhance context comprehension.

Self-Supervised and Unsupervised Learning: Exploring self- supervised and unsupervised learning approaches can reduce the dependency on large annotated datasets and improve model generalization.

Hybrid Models: Combining the strengths of different models, such as integrating GANs with CNNs or using transformer-based architectures, could lead to more robust and versatile colorization methods.

Advanced Evaluation Frameworks: Creating comprehensive evaluation frameworks that combine quantitative metrics with human perceptual studies will provide a more holistic assessment of colorization quality.

CONCLUSION

In conclusion, deep learning has significantly advanced grayscale image colorization, enabling models to generate realistic and visually appealing colorizations automatically. The evolution from manual techniques to rule-based algorithms and finally to deep learning approaches has revolutionized the field, offering unprecedented opportunities for enhancing visual content and interpretation. As research in this area continues to evolve, we anticipate further breakthroughs that will push the boundaries of grayscale image colorization and its applications. Grayscale image colorization is a fascinating and challenging problem with significant implications in computer vision and beyond. Our proposed GAN-based approach for grayscale image colorization outperforms existing methods, showcasing GANs' potential in this domain. This research opens avenues for image restoration, artistic rendering, and visual enhancement, promising further advancements in grayscale image colorization.

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Intelligent Transportation Systems in Telematics

Vanessa More
✉ vanessa.more.2300@gmail.com

Tanima Madal
✉ tanima_mandal_mca@moderncoe.edu.in

Prakash Kene
✉ prakash.kene@gmail.com

PES' Modern College of Engineering
Pune, Maharashtra

ABSTRACT

The integration of Machine Learning (ML) algorithms within telematics has emerged as a transformative approach to advancing Intelligent Transportation Systems (ITS). This research paper delves into the multifaceted role of ML in enhancing efficiency, safety, and sustainability within modern transportation networks through telematics. The paper explores how ML algorithms analyze extensive datasets generated by telematics devices, including GPS systems, sensors, and onboard diagnostics, to derive actionable insights. These insights enable real- time traffic monitoring, predictive maintenance, and route optimization, leading to streamlined operations and reduced congestion. Moreover, the paper investigates how ML contributes to enhancing safety within transportation systems by leveraging advanced predictive analytics and anomaly detection. ML algorithms identify patterns indicative of potential hazards, enabling proactive intervention to prevent accidents. Additionally, ML integration with telematics facilitates the development of intelligent driver assistance systems (ADAS) capable of autonomously adapting to driving conditions, thereby mitigating risks, and improving overall road safety. Furthermore, the paper addresses the sustainable aspects of ML-enabled telematics in ITS. ML optimization of vehicle routing, fuel consumption minimization, and promotion of eco-friendly driving behaviors contribute to reducing carbon emissions and environmental impact. Through empirical studies, this research paper aims to provide a comprehensive understanding of the transformative potential of ML in telematics for ITS. By elucidating the synergies between ML and Intelligent Transportation Systems, this paper seeks to inspire further research, collaboration, and innovation in developing future- ready transportation solutions aligned with evolving societal needs.

KEYWORDS: *Machine Learning, Telematics, Intelligent Transportation Systems (ITS), Fleet management, Traffic optimization, Data analysis, Vehicle diagnostics.*

INTRODUCTION

The scene of transportation has experienced a significant change, fueled by quick innovative progressions and the expansion of interconnected gadgets. Among these innovative advancements, Shrewdly Transportation Frameworks (ITS) have risen as a foundation of cutting- edge transportation foundation, promising improved security, effectiveness, and supportability. At the heart of this advancement lies telematics – the integration of broadcast communications with Data and Communications Innovation (ICT) in vehicles – encouraging the consistent trade of information between vehicles, framework, and centralized frameworks. Telematics, as a multidisciplinary field, includes a wide cluster of advances and strategies pointed at revolutionizing transportation systems. From Vehicle-to- Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication to Progressed Driver Help Frameworks (ADAS) and independent vehicles, the applications of telematics in ITS are complex. These advancements hold the potential to improve by and large versatility encounters.

This research paper delves into the realm of telematics within the context of Intelligent Transportation Systems, aiming to explore the current state of the art, identify challenges and opportunities, and envision future trajectories. By synthesizing insights from diverse domains such as computer science, telecommunications, transportation engineering, and urban planning, this study endeavors to shed light on the transformative impact of telematics on the way we perceive, navigate, and interact with our transportation systems.

Moreover, as the world increasingly gravitates towards interconnected and automated modes of transportation, understanding the intricacies of telematics becomes paramount for policymakers, industry stakeholders, researchers, and the general populace alike. By fostering a deeper comprehension of the underlying principles and technologies driving Intelligent Transportation Systems, this research endeavors to catalyze informed discourse and decision-making, ultimately steering us towards a more connected, efficient, and sustainable future of mobility. In the subsequent sections, we will delve into the foundational concepts of telematics, elucidate its pivotal role in shaping Intelligent Transportation Systems, examine real-world applications and case studies, discuss emerging trends and challenges, and outline potential avenues for further research and development. Through this comprehensive exploration, we aim to illuminate the transformative potential of telematics in redefining the way we perceive, navigate, and interact with the modern transportation ecosystem.

LITERATURE SURVEY

[1] The paper "Predictive Data Analysis and Machine Learning for Telematics Hub based on Sensory Data" by Dashmir Istrefi and Eftim Zdravevski explores the application of Internet of Things (IoT) and machine learning in the automotive industry, focusing on the concept of a "Connected Car" and its potential impact on fleet management, predictive maintenance, and energy efficiency. The authors emphasize the significance of IoT in gathering and processing data from vehicles to analyze driving habits, suggest optimizations, and facilitate predictive maintenance. They also highlight the importance of fleet management in optimizing transport efficiency and reducing operational costs, especially in dynamic settings, while emphasizing the shift toward cloud-based solutions and big data optimization for insightful business improvements.

[2] The paper "A telematics framework for the shrewdly transport conveyance of medications" by Ignacio Julio Garcia Zuazola, Asier Moreno, Hugo Landaluce, and Ignacio Angulo talks about the usage of a telematics framework for the brilliantly conveyance of medications within the field of shrewdly transport frameworks. The paper highlights the significance of proficient and secure dissemination of drugs, particularly in crisis circumstances, and proposes a framework that utilizes telematics innovation to optimize the conveyance prepare. The creators emphasize the benefits of such a framework in terms of making strides reaction times, decreasing costs, and improving by and large healthcare administrations.

[3] The paper titled "Vehicle Telematics for Safer, Cleaner and More Sustainable Urban Transport: A Review" by Omid Ghaffarpasand, Check Burke, Louisa K. Osei, Helen Ursell, Sam Chapman and Francis D. Pope audits the applications of telematics information in feasible urban transport. It examines the utilize of telematics information in driving behavior examination, urban versatility considers, street security, Brilliantly Transport Frameworks (ITS), and headways in cleaner transport advances. The survey incorporates bits of knowledge from 95 papers that cover different angles of telematics information collection and specialized challenges. Telematics information is highlighted as a profitable apparatus for making strides street transport effectiveness, security, and natural affect. The paper emphasizes the potential of telematics information in forming long term economical urban transport through inventive innovations and data-driven arrangements.

[4] The research in the paper "Enhancing Transportation Efficiency and Safety with Machine Learning" by Abill Robert, Saleh Mohamed and Kaledio Potter focuses on the application of machine learning in enhancing transportation efficiency and safety. It explores how machine learning techniques can be utilized to analyze data for risk assessment, predict safety hazards, optimize routes, monitor driver behavior, and improve fleet operations. The study emphasizes the importance of intelligent fleet management systems powered by machine learning algorithms in promoting safe driving practices, ensuring cargo security, and preventing accidents. Overall, the research highlights the significant role of machine learning in revolutionizing transportation systems to achieve higher levels of efficiency and safety.

[5] The article “A Systematic Review on Intelligent Transport Systems” by Tanya Garg and Gurjinder Kaur provides a systematic study on Intelligent Transport Systems (ITS) focusing on existing approaches proposed by researchers. It discusses the need, significance, pros and cons, and challenges of implementing ITS. Various application areas, problems faced during implementation, security issues, and solutions are highlighted. The study reviews literature on ITS models, security mechanisms, and future research directions. It covers the background of ITS, methodologies used for review, technologies like IoT and IoV in ITS, and security concerns. The article emphasizes the importance of ITS in addressing transportation challenges and the evolution of ITS technologies over the years.

RESEARCH METHODOLOGY:

This study employs a comprehensive methodology to investigate the role and impact of Intelligent Transport Systems (ITS) in telematics. The methodology comprises the following key components:

Literature Review

A study of existing literature was conducted to understand key concepts, identify research gaps, and formulate research questions and objectives.

Information Collection

Essential and auxiliary information collection strategies were utilized, counting gathering data from trustworthy sources, and conducting interviews with specialists within the field.

Data Analysis

Quantitative, qualitative, and content analysis techniques were used to interpret and synthesize the collected data.

Comparative Study

A comparative study approach was adopted to analyze and evaluate different aspects of ITS technologies.

Case Studies

Real-world case studies were conducted to explore implementations of ITS in diverse contexts.

Validation and Verification

Validation and verification processes were employed to ensure the reliability, accuracy, and credibility of research findings.

Ethical Considerations

Ethical guidelines were adhered to throughout the research process, including considerations for data privacy, confidentiality, and informed consent.

This methodology provides valuable insights into the advancements and challenges of ITS in telematics, contributing to the existing body of knowledge in this field.

INTELLIGENT TRANSPORT SYSTEMS ARCHITECTURE

ITS includes technologies and applications aimed at improving the efficiency, safety, and sustainability of transportation networks. The architecture of ITS typically involves various interconnected components that work together to collect, process, analyze, and disseminate information related to transportation infrastructure, vehicles, and travelers. Here’s a generalized architecture of Intelligent Transportation Systems:

Sensors and Detectors

- ITS relies on a variety of sensors and detectors deployed throughout transportation networks.
- These sensors include loop detectors, cameras, radar, lidar, and Vehicle-to-Infrastructure (V2I) communication devices.
- Sensors capture real-time data on traffic flow, vehicle speed, occupancy, road conditions, and environmental factors.

Data Acquisition and Communication

- Data from sensors and detectors are collected and transmitted to control centers or backend systems.
- Communication technologies such as cellular networks, Wi-Fi, Dedicated Short-Range communication (DSRC), and fiber optics are used for data transmission.

Control Centers and Backend Systems

Control centers and backend systems receive, process, and analyze data collected from sensors and detectors.

- These systems typically run software applications for traffic management, control, and optimization.
- Backend systems may include traffic management centers, Transportation Management Systems (TMS), and Transportation Operation Centers (TOC).

Traffic Management and Control:

- Traffic management systems use real-time data and algorithms to monitor and control traffic flow.
- Versatile activity flag control frameworks alter flag timings based on current activity conditions to optimize activity stream and decrease blockage.
- Incident detection and management systems identify accidents, road closures, and other disruptions and provide guidance for traffic diversion and emergency response.

Advanced Traveler Information Systems (ATIS)

- ATIS delivers real-time traffic information and travel advisories to travelers.
- Information may be disseminated through dynamic message signs, Variable Message Signs (VMS), roadside displays, websites, mobile apps, and connected vehicle platforms.
- ATIS provides updates on traffic congestion, road closures, construction zones, weather conditions, and alternative routes.

Route Guidance and Navigation

- Route guidance systems use real-time traffic data to recommend optimal routes to travelers.
- Navigation systems in vehicles and mobile devices provide turn-by-turn directions, traffic-aware routing, and estimated arrival times.
- Integration with GPS, mapping services, and traffic prediction algorithms enhances route guidance accuracy.

Vehicle-to-Everything (V2X) Communication

- V2X communication enables communication between vehicles, infrastructure, pedestrians, and other entities.
- V2X technologies include V2V, V2I, Vehicle-to- Pedestrian (V2P), and Vehicle-to-Grid (V2G) communication.
- V2X communication facilitates cooperative driving, collision avoidance, intersection management, and enhanced situational awareness.

Data Analytics and Optimization

- Data analytics techniques are applied to ITS data for insights generation, predictive modeling, and optimization.
- Machine learning algorithms analyze data to predict traffic patterns, congestion hotspots, and travel demand.
- Optimization algorithms optimize traffic signal timings, route assignments, and transportation resource allocation to improve system efficiency.

Safety and Security

- ITS systems incorporate measures to enhance transportation safety and security.
- Safety applications include collision avoidance systems, automated emergency braking, lane departure warning, and Vehicle-to-Vehicle (V2V) safety messages.
- Security measures include authentication, encryption, intrusion detection, and secure communication protocols to protect ITS infrastructure and data from cyber threats.

Policy and Regulation

- Policy frameworks and regulations govern the deployment and operation of ITS.
- Standards bodies, government agencies, and industry organizations establish guidelines for interoperability, data sharing, privacy protection, and system reliability.

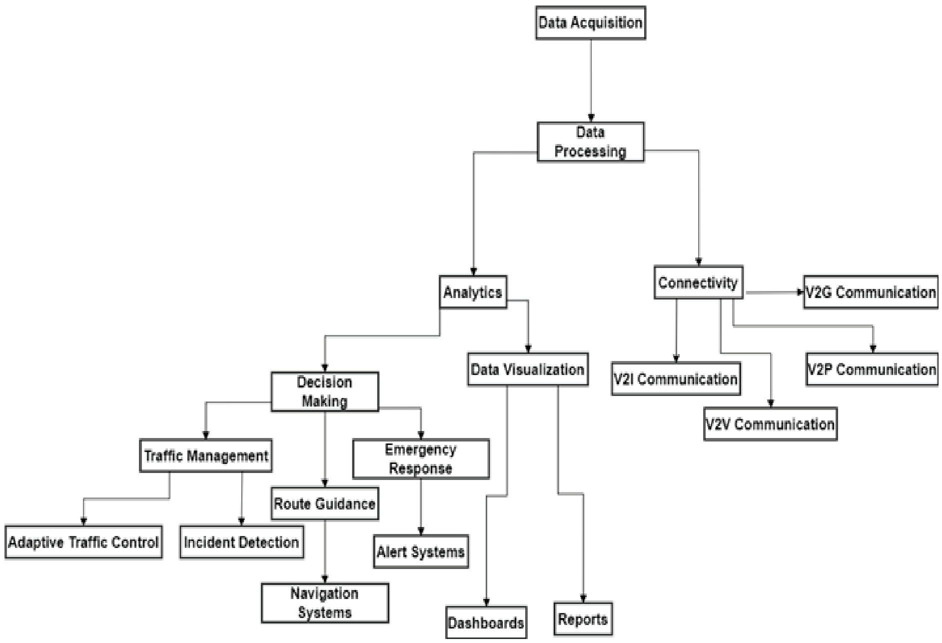

Fig. 1: ITS Architecture Overview

- Regulatory frameworks address issues such as data ownership, liability, privacy, and ethical considerations associated with ITS deployment.

This architecture provides a high-level overview of the components and functionalities commonly found in Intelligent Transportation Systems. The specific design and implementation of an ITS solution may vary based on factors such as geographic location, transportation modes, infrastructure characteristics, and stakeholder requirements.

MACHINE LEARNING ADVANCEMENTS IN AUTONOMOUS VEHICLE TECHNOLOGY

Machine learning serves as a cornerstone in the advancement of autonomous vehicle technology, playing a pivotal role across various critical aspects:

Perception Enhancement

Autonomous vehicles harness an array of sensors like LiDAR, radar, and cameras to perceive their surroundings. Machine learning calculations decode sensor information, empowering the vehicle to identify and classify objects such as people on foot, vehicles, and street signs with accuracy. With ceaseless learning, these models refine their acknowledgment capabilities over time, supporting the vehicle's perceptual exactness.

Decision-Making Empowerment

Machine learning algorithms are instrumental in driving decision-making processes for autonomous vehicles. By analyzing sensor data, traffic dynamics, and environmental conditions, these algorithms determine optimal actions, including acceleration, braking, and lane changes. Through extensive training on diverse datasets, machine learning enhances decision-making process, enabling vehicles to navigate intricate scenarios effectively.

Intelligent Path Planning

Autonomous vehicles leverage machine learning to streamline path planning endeavors. By acclimatizing real-time information on activity stream, street conditions, and verifiable bits of knowledge, these calculations create productive and secure courses for vehicle traversal. Additionally, machine learning facilitates adaptive learning from past driving experiences, enabling vehicles to dynamically adjust path planning strategies.

Safety Augmentation and Proactive Analytics

Machine learning contributes significantly to bolstering safety measures in autonomous vehicles. By scrutinizing vast datasets encompassing historical driving patterns, sensor inputs, and external factors, these algorithms identify potential hazards and forecast precarious situations. This predictive capability empowers vehicles to preemptively mitigate risks by modulating speed or trajectory, fostering accident prevention.

Human-Centric Interaction Enhancement

Machine learning innovations enhance the interaction paradigm between autonomous vehicles and human occupants or other road users. Utilizing Natural Language Processing (NLP) techniques, vehicles enable seamless voice-based commands and communication with passengers. Moreover, machine learning facilitates the comprehension and response to human driver, pedestrian, and cyclist behavior, fostering a safer and more collaborative road environment.

In essence, machine learning stands as a cornerstone in optimizing transportation efficiency and safety within the realm of autonomous vehicles.

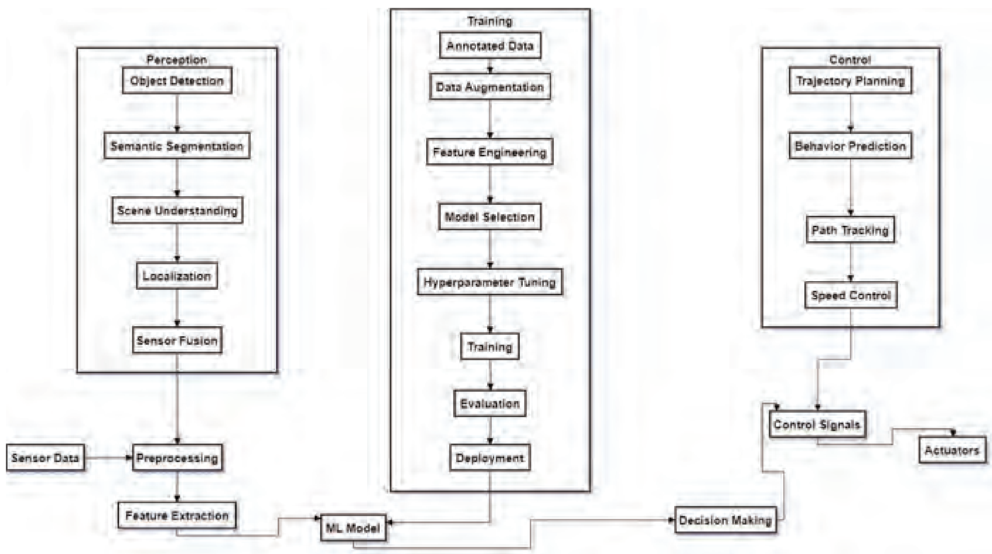

Fig 2. ML in ITS

Machine Learning Algorithms in Autonomous Vehicle Technology: Functionality Overview

Domain	Machine Learning Algorithms	Functionality
Perception Enhancement	Convolutional Neural Networks (CNNs)	Accurate object detection, classification, and segmentation from camera data
	Recurrent Neural Networks (RNNs)	Temporal dependencies analysis for object tracking and motion prediction from LiDAR and radar data
Decision-Making Empowerment	Deep Q-Networks (DQN)	Optimal decision-making in complex environments through deep reinforcement learning
	Decision Trees and Random Forests	Interpretable decision-making based on sensor data for navigation in diverse traffic scenarios

Intelligent Path Planning	A* Algorithm	Adaptive path planning based on graph-based representations of road networks
	Genetic Algorithms	Evolution of optimal path solutions considering factors such as traffic flow and energy efficiency
Safety Augmentation and Proactive Analytics	Support Vector Machines (SVMs)	Anomaly detection and pre-emptive safety measures based on outlier identification in sensor data
	Long Short-Term Memory (LSTM) Networks	Predicting trajectories for proactive collision avoidance and risk mitigation
Human-Centric Interaction Enhancement	Natural Language Processing (NLP) Models	Facilitation of human-vehicle interaction through voice commands and natural language understanding

CONCLUSION

In conclusion, this research paper has provided a comprehensive examination of ITS in the context of telematics, exploring their role, impact, and implications for transportation systems. Through a thorough literature review, data analysis, comparative study, and case studies, this study has shed light on the multifaceted aspects of ITS, ranging from perception enhancement and decision- making empowerment to safety augmentation and human- centric interaction enhancement.

The findings of this research underscore the significant contributions of ITS in improving transportation efficiency, enhancing safety, and advancing mobility solutions. By harnessing advanced technologies such as sensors, communication networks, and machine learning algorithms, ITS have transformed how we perceive, manage, and navigate transportation networks, creating smarter, safer, and more sustainable mobility solutions.

However, the adoption and implementation of ITS are not without challenges. Issues such as cost considerations, maintenance requirements, privacy concerns, and equitable access pose significant hurdles that must be addressed to maximize the potential benefits of ITS. Moreover, ongoing technological advancements, regulatory considerations, and societal factors will continue to shape the evolution of ITS and its impact on transportation systems.

Considering these challenges and opportunities, future research and innovation efforts are warranted to further explore the potential of ITS in addressing emerging mobility needs and societal challenges. Collaborative partnerships among researchers, industry stakeholders, policymakers, and communities will be essential in driving forward the development and deployment of ITS solutions that are inclusive, sustainable, and beneficial for all.

In essence, Intelligent Transport Systems in telematics speak to a transformative drive within the domain of transportation, advertising promising arrangements to address complex portability challenges and move forward quality of life for people and communities. By leveraging the bits of knowledge and findings presented in this term paper, partners can chart a course towards a future where transportation is more secure, more effective, and more open for all.

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QwickFix: Where AI Meets Reliable Home Solutions

Mahesh M. Bulhe
✉ maheshbulhe@gmail.com

Sanjana Mondal
✉ sanjanamondal189@gmail.com

Sagun Hussain
✉ sagunhussain@gmail.com

Department of Electronics and Telecommunication Engineering
Bharati Vidyapeeth College of Engineering
Belpada, Navi Mumbai, Maharashtra

ABSTRACT

In an era where the demand for home services continues to rise and individuals lead increasingly busy lives, online platforms have emerged as indispensable tools for connecting homeowners with skilled professionals. This abstract delves into the transformative potential of Machine Learning (ML) and Artificial Intelligence (AI) technologies in the domain of online home services. Integration of AI chatbot facilitates seamless user interactions, offering instant assistance and guidance throughout the service selection and booking process. Through the fusion of ML and AI capabilities, online home services platforms stand poised to revolutionize the way homeowners engage with service providers, offering unparalleled convenience, efficiency, and customer satisfaction.

KEYWORDS: *Tensorflow, Machine Learning, Python, React JS, Node JS, MongoDB.*

INTRODUCTION

Adding Machine Learning (ML) models to our online home services platform makes the service delivery process smoother and more dependable. When people need help with household chores, it's often tough to find skilled and trustworthy service providers who can deliver top-notch service whenever needed. Our on-demand home service framework addresses this issue by providing a convenient and seamless approach to completing household tasks efficiently.

Our technology effectively connects users with our knowledgeable internal experts through the use of machine learning algorithms, guaranteeing prompt service delivery. By enhancing connectivity, this on-demand home service framework helps both service providers and consumers. Our platform offers a wide range of services, including home painting, plumbing, and electrical work, to satisfy the diverse needs of our users.

The primary objective of the on-demand home services platform is to simplify the process of accessing household services with just one click. Registered users can easily search for and request household services through our web application. This online platform enables efficient management of household services and offers a user-friendly interface for service selection and confirmation.

Additionally, the website also keeps an extensive database of service providers' locations and contact details, making it easy to quickly get necessary home services with a few clicks. Our goal is to address the problem of matching clients with appropriate service providers according to their needs and preferences by incorporating machine learning algorithms into our platform. Our goal is to improve our customer's quality of life by revolutionizing the delivery and accessibility of home services through our innovative approach.

PROBLEM STATEMENT

Individuals in today's fast-paced society, typified by rapid technology breakthroughs, have increasingly demanding schedules, leaving less time to adequately manage domestic duties. The problem occurs when people need help with small but necessary domestic chores, yet they can't seem to find trustworthy and knowledgeable service providers, which leads to uneven service provision. Furthermore, new residents to a community frequently face difficulties in acquiring reliable household services, making their transfer into the new environment less smooth. Our platform seeks to provide a holistic solution for household services in order to tackle these issues. Our pricing structure is clear and uncomplicated, enabling consumers to promptly schedule experts for any necessary work at their convenience. Our goal is to provide a stress-free and convenient experience for our users, ensuring that they receive the quality services they deserve.

Consumers' willingness to pay is largely and favorably connected with their belief that "pay for what you get" is the right approach. In our plan, we're like a one-stop shop for household services. We set fair rates and make sure everything is clear upfront, so there are no hidden charges later. Users enjoy the flexibility to book specialists for any service they require, choosing their preferred time slot with ease, thereby ensuring convenience and peace of mind.

LITERATURE REVIEW

Easyfix Web Application - This web application which was established in 2011 and is headquartered in New Delhi. EasyFix may be a repairs and maintenance company giving offices such as domestic repair, benefits, and maintenance. This site is a great illustration of doorstep administrations being delivered. This site gives exceptionally limited administrations such as Plumbing, Circuit repairmen, A/C repair and Carpenter. The site is well-built and has all the qualities of an advanced web application. The need for restricted administrations could be a factor influencing this company. The application works fine on a desktop but gets to be a little non-responsive which can be an issue in a few cases. Before enlisting benefit personnel, the person is confirmed which is specified at their site but we don't know whether it is an individual meet confirmation or a virtual one. This company has been in advertising since 2015 [1].

Urban Clap has given different imaginative administrations. But their services are only provided in the metropolitan cities. This strategy served as a pathway for every 10,000 experts. Partner is that the one halt arrangement for all the household administrations. This strategy gives all the desired administrations that have been requested by the purchasers at whatever point required or on the yearly upkeep premise with annual charges [2].

Time saverz is one among the internet domestic benefit frameworks in which the client has been awarded for the administrations advertised or a discount if the client is not fulfilled with actions taken by the administration. [3].

Zimmber was an Indian home service startup that provided a platform for booking various home services such as cleaning, plumbing, electrical repairs, pest control, and more. It was founded in 2014. The company aimed to offer convenient and reliable services to customers by connecting them with verified service providers through their online platform or mobile app. Zimmber gained popularity in major Indian cities due to its focus on quality service and customer satisfaction. The services offered by this application are only available in large cities. Zimmber system works as a hiring platform as well. [4].

BACKGROUNDS TOOLS

1. React Js: It is created by Facebook as open-source JavaScript library used by developers to build interactive user interfaces (UIs) for websites and applications.

2. Node Js: It is open codebase and accessible to anyone runtime environment for JavaScript, ideal for server-side applications and efficiently handling multiple tasks without blocking.

3. MongoDB: It is a flexible, document-based database known for its ease of use for developers. It stores data in JSON-like documents, allowing for more natural data organization compared to traditional relational databases. This makes it popular for storing data that doesn't fit neatly into rigid tables.

4. JWT: JWT (JSON Web Token) is a secure way to share information between two parties like a client and a server. It's compact and self-contained, like a digital passport, containing claims (information) and a signature for verification.

5. TensorFlow: TensorFlow is an open-source studying framework superior through Google for building and schooling neural network models.

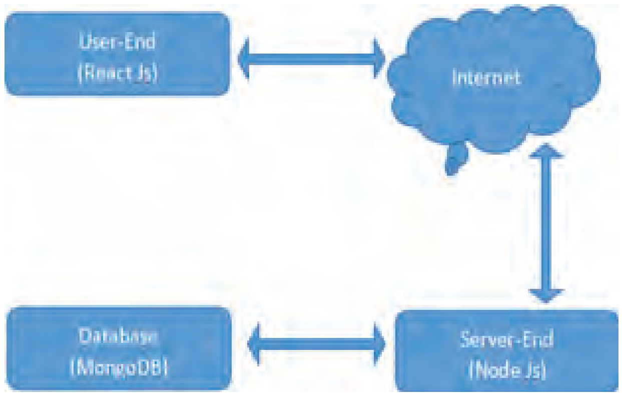

Fig. 1: Flow of Website

Fig 1 shows the flow of our website in which there is a user end (created using React Js) requesting for the services offered. The Server end (created using Node Js) responds to this request by using data from the database (created using MongoDb) which is used for storing all the collected information.

PROPOSED SYSTEM AND ARCHITECTURE

The suggested application, developed with React Js, serves as a comprehensive platform for enabling access to vital domestic services such as plumbing, electronic repair, and electrical assistance. It puts the convenience of the user first by providing an easy-to-use interface that makes it easier to locate and reserve service providers.

In this system, domestic service providers are encouraged to register and submit important information such as their name, mobile number, and email address. This registration process ensures that only verified and certified specialists are listed on the platform, fostering trust and confidence in users.

Clients can easily log in with their credentials after registering to gain access to a variety of services provided by registered providers. The platform includes comprehensive search capabilities that allows clients to filter service providers by area, availability, and service type. This makes it possible for customers to quickly choose the best service for their requirements, guaranteeing a smooth and effective booking procedure.

The application's integration of a chatbot driven by a TensorFlow-based machine learning model is one of its primary features. As a virtual assistant, this chatbot can interpret natural language inquiries and instantly provide pertinent information and support. Customers can communicate with the chatbot through making inquiries, getting advice on available services, or getting updates on the progress of their requests. Through the use of machine learning (ML) capabilities, the chatbot provides individualized support, improving user satisfaction and experience in general.

Overall, the proposed application offers a holistic solution for accessing household services, combining the convenience of online booking with the reliability of verified service providers. With its intuitive interface, advanced search functionality, and AI-powered chatbot, the platform aims to revolutionize the way clients engage with domestic service providers, ensuring seamless service delivery and customer satisfaction.

Fig 2 is a use case diagram in which the user will start with sign-up process, profile editing and then request for the required service. Then the admin will check for the service status and schedule. On the other hand, the technician will also do the sign-up process then view the schedule and check for the requested service.

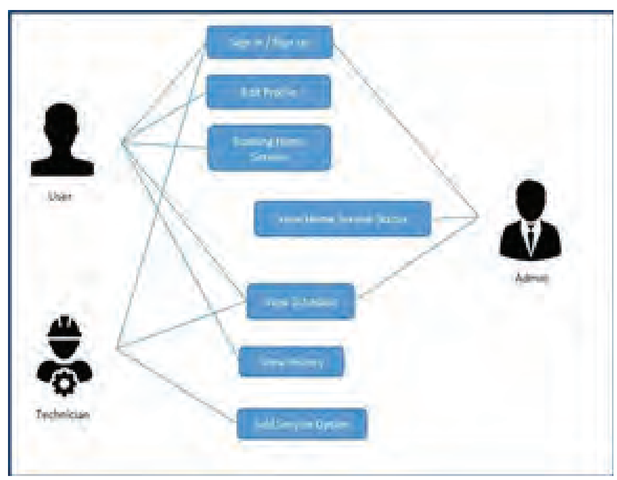

Fig. 2 Use case diagram

WORKING

Fig 3 illustrates the flow of working as follows:

1. Client Request: The website provides a client request form where clients enter service type, description, location, additional details, and contact information for a specific service, such as desired

date/time, budget, or specific requirements, for communication and confirmation.

2. Request to Service Provider: The website serves as a mediator, electronically forwarding client requests to the service provider. Requests are matched by algorithms according to availability, competence, and geography.

3. Service Provider Acceptance and Authorization: The service provider reviews a request, assesses work scope, availability, and resources, authorizes payment via safe online channels, and verifies the location and accessibility of the service, guaranteeing a secure service prior to starting.

4. Payment Processing: The website platform offers a secure payment gateway for clients to complete transactions. After the payment is approved, the customer gets a confirmation and the service provider is informed.

5. Service Fulfilment: The service provider communicates with the client, schedules appointments, addresses questions, and delivers the service at the agreed time and location, ensuring professional standards and quality.

6. Client Confirmation and Feedback: The client confirms satisfaction with service completion through completion verification or feedback, and the platform may offer dispute resolution mechanisms to address any issues.

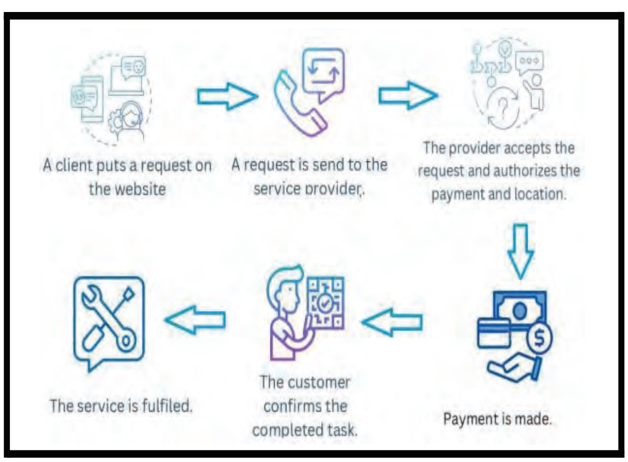

Fig. 3 Flowchart of Working

RESULTS

Fig 4 Homepage

Our application lists most of the services on its homepage for user to access them quickly. Fig 4 gives a view of our homepage where the client and service provider will start with sign-up process.

Fig 5 Service Selection

All the services are categorized and are in a single page where user can choose the category of his needs and order the serviceman. In Fig 5, the service selection is done by the client.

Fig 6 Admin Panel

Our application provides a special panel or dashboard for the site admin where they can add more services, more admins and monitor the site. In Fig 6, the admin panel shows the dashboard of our website in which the daily sales, number of views and completed tasks is displayed statistically.

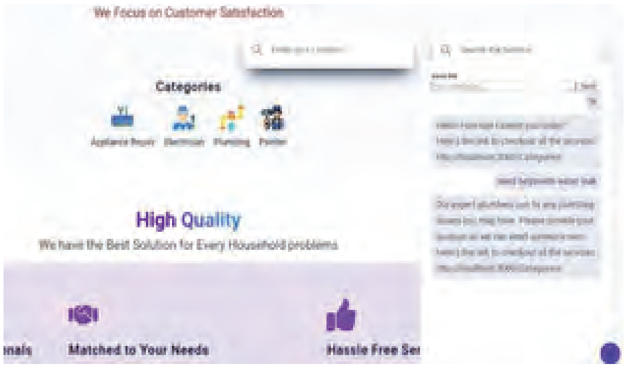

Fig 7 AI Chat Bot

In Fig 7 a chat bot is displayed which is used by the client to communicate with service provider. A chat bot trained using machine learning to help the users to quickly get their queries sorted out and help them

Our site use stripe is payment portal to so user can opt to pay by card quickly or if they prefer thy can opt for COD as well. Fig 8 shows the payment portal used by the client for online transaction.

Fig 8 Payment Portal

CONCLUSION

QwickFix is a cutting-edge platform that revolutionizes the way users book workers for services of vast ranges some of them are plumbing, electrical works, appliance repair, and house painting, all with a single click.

Artificial Intelligence is a key component that improves the QwickFix platform's user interface and experience, in addition to matchmaking and predictive analytics. QwickFix's machine learning bot uses NLP (natural language processing) and techniques of machine learning for provide users immediate help by responding to their questions, making recommendations, and smoothly navigating the booking process.

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Exploring Virtual Reality and Augmented Reality: A Comparative Study

Rama Bansode
rama.bansode@moderncoe.edu.in

Pradnya Muley
pradnyamuley@gmail.com

Anuja Athare
anujaathare@gmail.com

PES Modern College of Engineering
Pune, Maharashtra

ABSTRACT

This study is pioneering in its exploration of user experiences with AR and VR in real estate exhibitions. By conducting comparative experiments, it aims to identify assessment indices and quantification methods specific to this field. Ultimately, it seeks to construct a robust evaluation model for both technologies, contributing valuable insights to optimize their usage not only in real estate but across diverse applications such as education, healthcare, manufacturing, military affairs, and entertainment. Through a detailed analysis of user interaction and perception, this research promises to advance the ongoing discourse surrounding the optimization and utilization of AR and VR technologies.

KEYWORDS: *Augmented Reality (AR), Virtual Reality (VR), User Interaction, User experience evaluation.*

INTRODUCTION

Virtual Reality

Virtual reality (VR) technology creates simulated environments that engage users' senses of sight and sound, imparting an immersive revel in. VR makes use of VRML (digital reality Modelling Language), a programming language, to generate images and facilitate interactions within those digital environments. users normally put on VR headsets, like the Oculus Rift, to discover and interact with objects in these synthetic worlds, allowing movements together with looking round, hearing sounds, and doubtlessly even experiencing tactile sensations. While Oculus Rift is predominantly marketed for gaming, VR generation has programs past gaming as properly.

Augmented reality (AR)

This generation overlays pc-generated elements together with pics, sound, and films onto real-life gadgets, allowing users to engage with their environment. Customers can immerse themselves in an artificial surroundings even as final connected to the actual global. In contrast to VR, which replaces truth, AR complements actual-international experiences by way of including virtual adjustments in real- time. This augmented revel in can be accessed via cell apps and gadgets. A splendid example of AR is Pokémon cross, which quickly collected over 100 million downloads rapidly after its release. [1]

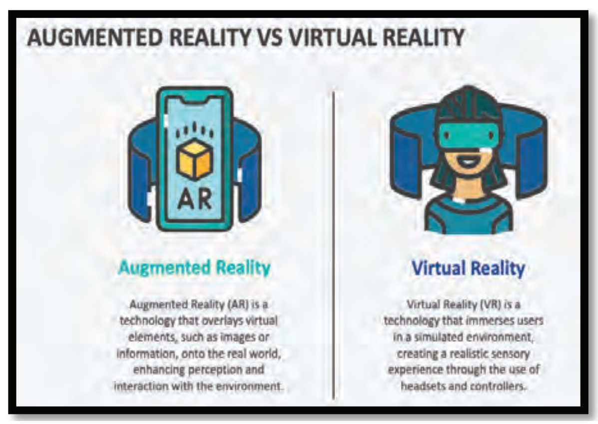

Fig. 1: Augmented Reality vs Virtual R[33]

LITERATURE REVIEW

Augmented Reality (AR) enables the overlay of digital elements onto the physical world in real-time, enhancing and enriching the user's visual experience. This is achieved through the combination of computer vision and graphics technologies. [4] To deliver the simulated environment, visual systems project images directly to the user via devices that track head movements. These devices typically offer stereoscopic visuals and audio, along with specialized sensors to detect head motion, which adjust the displayed images based on the user's movements. [5]

Immersive technologies such as AR and VR have revolutionized the tourism industry. They offer unique opportunities for immersive experiences, transforming the way travelers engage with and experience travel destinations. [2]

ISO 9241-210, along with related guidelines, defines "user experience" as the totality of users' emotions, beliefs, perceptions, and reactions—both physiological and psychological—throughout their interaction with a product or system. The guidelines further identify three main aspects that affect user experience: the system itself, the user, and the environmental context of the system's use. [3]

MARKET OVERVIEW

The AR and VR in Tourism market is expected to grow from USD 1.20 Billion in 2023 to USD 4.32 Billion by 2030, at a CAGR of 20.00% during the forecast period

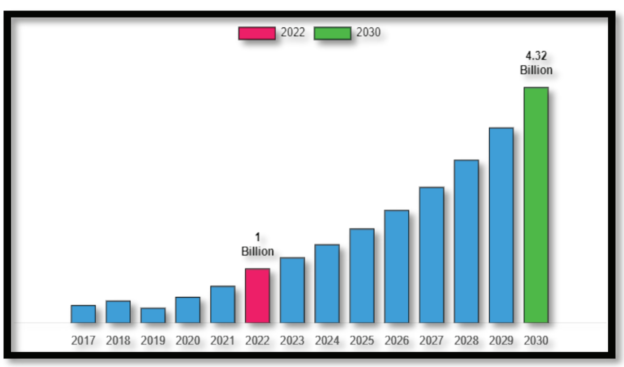

Fig 2: AR and VR in Tourism Market Overview [32]

THE COMPARISON ON THE PROCESS OF UX

i] Immersion: VR offers a deeper level of immersion compared to AR because it entirely substitutes the real-world setting with a virtual one. Conversely, AR superimposes virtual content onto the actual environment, allowing users to stay connected to their surroundings. The level of immersion influences the user's sense of presence and involvement. [6]

ii] Interactivity: Both AR and VR provide interactive experiences, albeit with differing approaches. VR enables users to manipulate the virtual setting extensively using hand movements, controllers, or full-body tracking. In AR, interactions are more contextual, integrating virtual elements into the real-world setting, which can boost practicality and usability in some use cases. [7]

iii] Realism: VR worlds are entirely digital and can range in realism based on graphical quality and simulation capabilities. In contrast, AR merges virtual components with the physical world, blending digital content with reality. The realism of AR depends on factors such as tracking precision, occlusion, and environmental integration. [8]

iv] Comfort: Comfort is a critical element of user experience, particularly for prolonged use. VR can sometimes lead to discomfort or motion sickness due to aspects like latency, limited field of view, or discrepancies between virtual and real-world movement. AR usually carries a lower risk of motion sickness since users can maintain awareness of their surroundings, but comfort can still be influenced by display brightness and the weight of AR devices. [9]

v] Usability: Usability in AR and VR systems hinges on aspects like ease of use, calibration, and interaction. AR often utilizes familiar technology such as smartphones and tablets, leading to more intuitive interfaces and gestures. VR typically requires specific hardware such as headsets and controllers, which may demand an adjustment period for users but provide richer, immersive interactions. [10]

vi] Content Variety: Both AR and VR offer a broad range of content experiences, albeit with different focuses. VR often emphasizes immersive simulations, storytelling, and fully interactive environments. AR's spectrum spans practical applications like navigation and real-time data overlays to leisure, gaming, and social experiences that blend the virtual with the real world. [11]

vii] Application Relevance: The appropriateness of AR or VR depends on the specific use case and user needs. AR excels in scenarios where contextual information overlaid onto the real world is beneficial, such as navigation, educational purposes,

AR AND VR FOR TRAINING OF SURGEONS

Ever concept approximately the woes of surgeons who've to apply complex technologies and devices on the patients every training methods commenced to reveal cracks while it was discovered that round 30% of the overall surgical treatment citizens were inefficient in appearing surgery independently. They were not born with a skill of appearing the surgeries however they discovered it. The traditional shape of Hence, the scenario become alarming! As even a minute mistake in surgical treatment may additionally put a patient's lifestyles on danger, and remote support. VR is best for creating immersive simulations and environments for training, gaming, design visualization, and virtual travel experiences. [12]

VR has taken over the game now! As a end result, it is helping surgeons to get a clean glimpse of the surgery manner with none struggles. VR training permits surgeons to perform virtual surgical procedure in a simulated environment. Researchers have conducted research and found that VR training improves surgical performance 2025 that is anticipated to increase dramatically to four.64 billion U.S. greenbacks.

GLOBAL HEALTHCARE AR AND VR MARKET IN 2018 AND 2025 BY REGION (IN MILLION U.S. DOLLARS)

Augmented reality (AR) and virtual reality (VR) are emerging technologies in the healthcare enterprise. AR and VR could be used in an expansion of settings along with health practitioner training, affected person remedies and sanatorium control. As of 2018, the North American healthcare AR and VR industry was worth 477 million U.S. bucks. [33]

Table 1. Represents The VR Users Between 2018-2025

	2018	2025
North America	477.2	4642.1
Europe	311.6	2893.1
Asia-Pacific	205.9	2353.9
Rest of world	85.3	1251

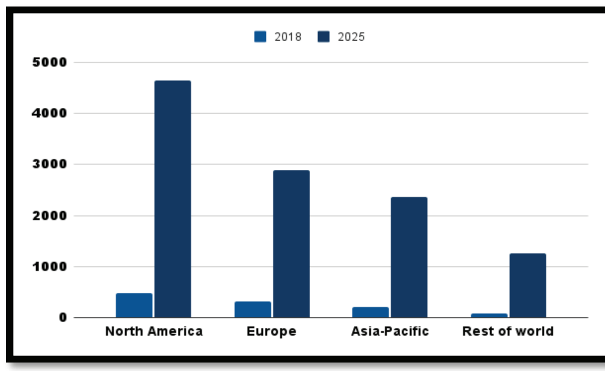

Fig. 3: Graphical Representation of VR Users

INTRODUCTION ON PREVIOUS STUDY

Table 2: User Experience Degree Evaluation Comparative Study

Dimension	Virtual Reality (VR)[24]	Augmented Reality (AR)[25]
Immersion	Offers high immersion by replacing the real world with virtual environments. Users wear headsets that block out physical surroundings.	Provides less immersion by overlaying virtual elements onto the real world. Users maintain visual contact with their surroundings.
Interaction	Users can interact with virtual environments through controllers, hand gestures, or body movements, providing highly interactive experiences.	Offers context-aware interactions by overlaying virtual elements onto the real world. Users can interact with virtual content in their physical environment.

Realism	Provides highly realistic virtual environments with lifelike graphics and simulations, closely resembling real-life scenarios.	Integrates virtual elements into the real world, blending digital content with physical surroundings. Realism depends on factors like tracking accuracy.
Comfort	May cause discomfort or motion sickness due to factors like latency or field of view limitations, but modern systems are improving in terms of comfort.	Generally, offers a more comfortable experience since users maintain visual contact with surroundings. Discomfort may arise from factors like display brightness.
Usability	May have a steeper learning curve due to specialized hardware like headsets and controllers, but provides intuitive and immersive interactions once users are familiar with the interface.	Often leverages familiar devices like smartphones or tablets, making it accessible to a broader range of users. Interactions can be intuitive using gestures and touch- based inputs.
Content Diversity	Offers a wide range of content including immersive games, simulations, educational experiences, and virtual tours. Content is centered on fully immersive environments and interactive storytelling.	Provides diverse experiences ranging from practical applications like navigation to entertainment and gaming. Content includes real-time information overlays, educational tools, and marketing experiences.
Application Context	Well-suited for applications requiring complete immersion and simulation such as gaming, training simulations, virtual tours, and design visualization.	Excels in applications benefiting from context-aware information overlaying the real world such as navigation, remote assistance, educational tools, and marketing experiences.

FUTURE ENHANCEMENT

Emerging technologies: Investigate the today's advancements in each VR and AR technologies. This can consist of traits in hardware which include stepped forward displays, haptic comments devices, or eye-monitoring systems. Moreover, discover advancements in software like new rendering strategies, gesture popularity, or AI-driven content generation. [26]

User experience (UX) research: Bbehavior in-intensity UX studies to apprehend how customers interact with VR and AR environments differently. Destiny studies could recognition on evaluating factors inclusive of immersion, presence, cognitive load, and person satisfaction in diverse VR and AR programs. [27]

Move-Platform Compatibility: Inspect efforts to make VR and AR experiences more interoperable across distinctive structures and gadgets. Destiny improvements may contain exploring requirements including OpenXR or WebXR and evaluating their effect on the improvement and adoption of VR and AR technology.

Social and Collaborative experiences: Discover the ability for VR and AR to permit new sorts of social interaction and collaboration. Destiny research should investigate multiplayer VR/AR experiences, digital conferences, collaborative design tools, or shared virtual workspaces and their effectiveness compared to traditional methods. [28]

Healthcare and therapy packages: investigate using VR and AR in healthcare settings, together with rehabilitation, pain control, intellectual fitness remedy, and clinical training. Destiny studies may focus on comparing the efficacy of VR and AR interventions to standard procedures and exploring new packages in healthcare. [29]

Education and Training: discover using VR and AR in training and schooling, starting from immersive simulations to interactive studying reports. Future improvements could contain evaluating the effectiveness of VR and AR for exceptional gaining knowledge of objectives, age companies, and subjects, as well as exploring revolutionary pedagogical processes. [30]

Ethical and Social Implications: check out the moral, privacy, and social implications of widespread adoption of VR and AR technologies. Destiny research may discover subjects which includes virtual private ness, information protection, virtual identification, digital addiction, and the impact of prolonged fact (XR) technologies on society. [31]

CONCLUSION

This research has identified how AR and VR are widely used and are being carried out to numerous sectors in real life. Even though it appears that the generation facilitates in simplifying each day desires and offers extra enjoyment with the assist of immersive video games and films, they carry a huge downside as the generation remains in its early stages.

The studies itself identifies a few fundamental protection problems within the era itself which include Authorization troubles, statistics leaks, information manipulation, prone software program and unauthorized access. The first-rate answer to such troubles is to put into effect an adaptable framework that shall us area administrators and alertness developers put in force get admission to manipulate regulations to households of cell applications. Imposing a few regulations and laws for preventing records leaks. One greater solution is to create awareness among preferred public on how AR and VR paintings and what policies are carried out by the companies imparting hardware for such packages. Other than this several AR and VR protection programs in actual international in addition to how AR and VR can be used to unfold consciousness regarding cyber safety. The quality way to observe this technology in actual international is to offer schooling in diverse sectors which includes factories, firearms trainings, income coaching and other areas.

Considering the attention regarding cyber protection, a schooling module might be developed which offers virtual path on how the cyber-attacks work and how they may be averted. This can be most helpful within the contemporary state of affairs because the society is going toward turning into a technologically advanced society. Another large issue is the application of AR in integration with IoT in smart cities. To simplify the idea this integration helps in connecting all of the facts series methods and giving a smooth get admission to all that facts in a single location. Making use of AR for facts analyzation presents an extra immersive revel in closer to services like upkeep and installation of numerous infrastructures. Depending at the maintenance techniques, a populace of Wi-Fi nodes established in a smart town setting can feel different factors way to the IoT infrastructure. Imperative statistics shipping utilizes any type of backbone metropolis network. Moreover, a wireless infrastructure is supplied to deliver metropolis residents' and preservation personnel' smartphones community get right of entry to thru severs get right of entry to factors (also referred to as Wi-Fi APs or base stations) dispersed throughout the town. With the assist of these components, it is feasible to portray the sensors and actuators in a clever town as services that can be fast on hand thru graphical consumer interfaces based totally on actual photos, without the want for a non-stop connection to the backbone community. Accordingly concluding that the AR and VR technologies have taken its roots in the industry offering a number of makes use of, it's nevertheless vulnerable to many threats. To enforce these technologies on a larger scale we nevertheless need to analyses this issues and offer a analytical method to put in force them bigger real lifestyles tasks like clever towns.

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Underwater LI-FI Technology

Shubham Dethe
✉ shubham_dethe@moderncoe.edu.in
Tejas Mahalpure
✉ tejas_mahalpure@moderncoe.edu.in
Nadeem Shaikh
✉ nadeem_shaikh@moderncoe.edu.in

Vandana Hanchate
✉ vandana.hanchate@moderncoe.edu.in
R. S. Kamthe
✉ rupali.kamthe@moderncoe.edu.in
Sheetal Borde
✉ sheetal.borde@moderncoe.edu.in

Department of Electronics and Telecommunication
Progressive Education's Society
Modern College of Engineering
Pune, Maharashtra

ABSTRACT

The underwater realm presents formidable challenges for conventional communication and sensing technologies, primarily due to the unique characteristics of the aquatic environment. However, the advent of Light Fidelity (Li-Fi) technology offers a promising avenue to revolutionize underwater applications. Li-Fi operates by using light waves for data transmission, boasting advantages such as high bandwidth, minimal latency, and immunity to electromagnetic interference. This abstract delves into the potential of Li-Fi technology in underwater settings, encompassing applications ranging from underwater data transmission to real-time monitoring of marine ecosystems. Through the adoption of Li-Fi, underwater sensors, vehicles, and monitoring systems can establish seamless and reliable communication channels, thereby facilitating enhanced exploration, research endeavors, and management initiatives within underwater ecosystems. By examining current research and technological advancements, this abstract underscores the transformative role of Li-Fi technology in surmounting the hurdles of underwater communication and ushering in novel opportunities for underwater exploration and conservation endeavors.

KEYWORDS: *Li-fi, Signal transmission, Under water, Audio, Line-of sight (LOS), Visible light communication (VLC).*

INTRODUCTION

In the contemporary landscape of connectivity, innovation is a perpetual force, and Li-Fi technology emerges as a beacon of progress. Amidst the evolving challenges of water management, integrating Li-Fi into this critical sector presents an opportunity to redefine how we monitor, analyze, and conserve one of Earth's most precious resources. In this preamble, we embark on an exploration of The promising convergence of water management and Li-Fi technology, shedding light on the avenues where light serves as the conduit for data, propelling us towards actionable insights and sustainable practices.

Traditional water management systems rely heavily on conventional communication protocols, whether wired or wireless. However, Li-Fi heralds a paradigm shift by utilizing light waves for data transmission. With its capacity for high- speed, secure, and reliable communication through light, Li- Fi offers a transformative approach to water applications.

Envision a scenario where water infrastructure communicates seamlessly through pulses of light. Li-Fi facilitates real-time monitoring of water quality, pipeline integrity, and consumption patterns with unprecedented precision. Whether through leveraging existing lighting infrastructure or specialized Li-Fi-enabled devices, this technology unlocks a myriad of innovative applications in water management. In stark contrast to conventional wireless technologies, Li-Fi operates within the visible light spectrum, minimizing interference and enhancing security. Its scalability and minimal latency render it ideal for large- scale water distribution networks, ensuring efficient data transmission even in challenging environments. Furthermore, Li-Fi compatibility with existing LED lighting infrastructure streamlines integration efforts and reduces deployment costs.

From the initial source to the final tap, Li-Fi technology permeates every facet of the water cycle. Whether monitoring reservoir levels, optimizing irrigation systems, or pinpointing leaks in subterranean pipelines, Li-Fi empowers water managers with real-time, actionable insights. By enhancing operational efficiency and curbing resource wastage, Li-Fi reshapes our approach to managing water resources sustainably. As we embark on this transformative journey, collaboration among innovators, Policymakers, and water management experts becomes imperative. By fostering a conducive ecosystem for research, development, and implementation, we can unlock the full potential of Li-Fi technology in water management applications.

In summation, the fusion of Li-Fi technology with water management ushers in a new era of connectivity and sustainability. Through harnessing the power of light, we illuminate not only our pathways to innovation but also our commitment to preserving and safeguarding our planet's most vital resource: water.

WORKING OF LI-FI

Li-Fi (Light Fidelity) technology uses visible light communication (VLC) to transmit data. Li-Fi technology represents a significant advancement in wireless communication, utilizing visible light to transmit data at high speeds. By leveraging the existing lighting infrastructure and ensuring secure, interference-free communication, Li-Fi has the potential to complement or even surpass traditional wireless technologies in various applications. Li-Fi (Light Fidelity) technology uses visible light communication (VLC) to transmit data. The operational framework is essential, if the LED is on, indicates transmit a mechanized 1, and if it's off means transmit a 0. The LEDs may be turned to a great extent quickly, which gives lovely open entryways for transmitting data.

Light Transmitter

The light transmitter is a crucial component in Li-Fi (Light Fidelity) technology, responsible for converting data into light signals that can be transmitted through the visible light spectrum. The data source provides the digital information that needs to be transmitted. The modulator converts the digital data into a format suitable for light transmission. The LED driver controls the operation of the LEDs. It receives the modulated signal from the modulator and adjusts the power supplied to the LEDs accordingly. The LED array emits the visible light used for data transmission. LEDs can switch on and off at very high speeds, which is essential for encoding data into light signals.

Microcontroller

The Arduino receives digital data from a data source, such as a computer or sensor. The ATmega328 microcontroller processes this data and converts it into a binary format (a series of 0s and 1s).The Arduino uses one of its digital output pins to control the LED. The binary data is used to modulate the LED: turning it on and off at high speeds to represent the binary 1s and 0s.The modulated LED light carries the data and transmits it through the air under water to the receiver. The photo diode or photo detector at the receiver end detects the modulated light. This photo detector converts the variations in light intensity back into electrical signals, which are then fed into another Arduino board or a dedicated receiver circuit. The Arduino at the receiver end processes these electrical signals to reconstruct the original binary data. The binary data is then converted back into its original format.

Light Receiver

The photodetector captures the modulated light emitted by the LED of the Li-Fi transmitter. This light contains the encoded data. The photo detector converts the variations in light intensity into corresponding variations in electrical current. This current is very small and needs amplification. The weak electrical signals from the photodetector are passed through an amplifier circuit to increase their strength,making them easier to process. A filter circuit is used to remove this noise, ensuring that the signal accurately represents the transmitted data. The clean electrical signal is fed into a microcontroller.

The microcontroller reads the signal and converts it back into digital data. The microcontroller decodes the binary data to reconstruct the original data that was transmitted. The decoded data is sent to an output interface, which could be a serial monitor, a display, or stored in memory for further processing.

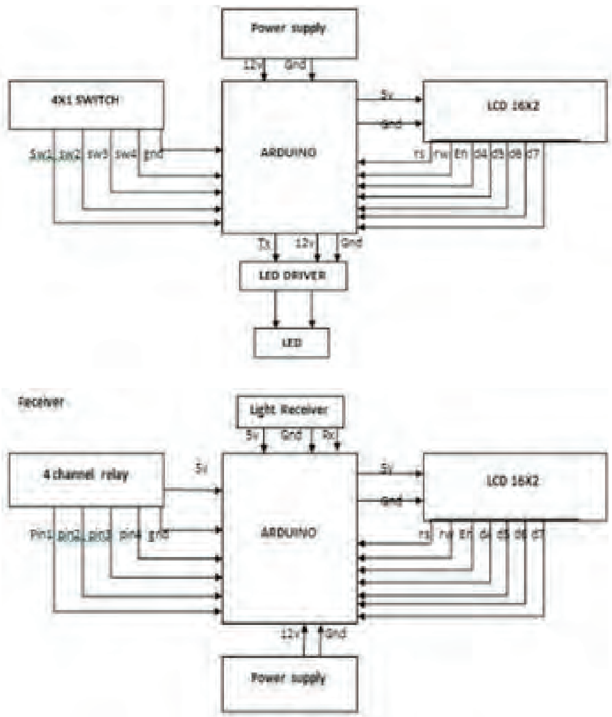


Fig. 1: Block Diagram Li- Fi data transmission Model

Graphs

Diagrams were meant to give a clearer picture of the differences in the characteristics.

Fig. 2: VLC through Air Medium

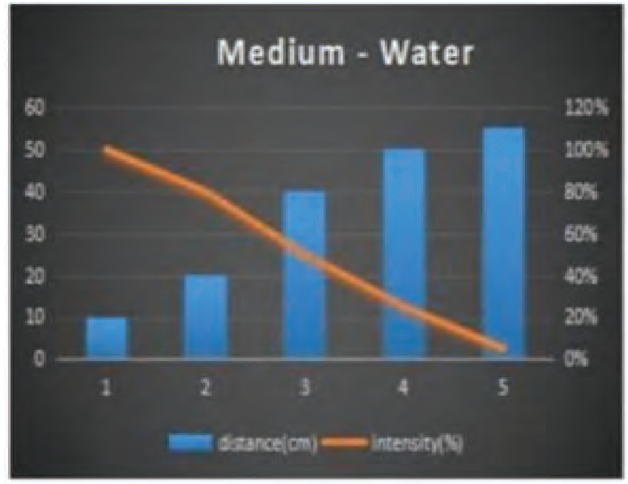


Fig. 3: VLC through Water Medium

The transmitted information is gone through water and air medium to watch the attributes.

PROPOSED METHODOLOGY

Transmitter

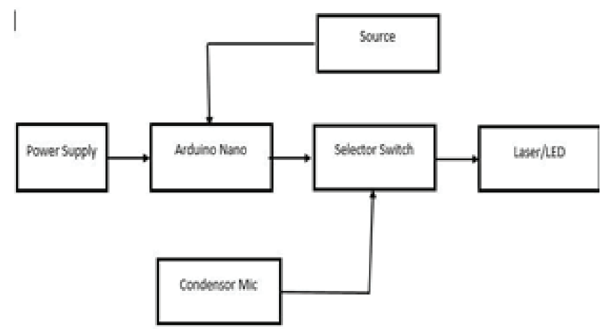


Fig. 4: (Transmitter)

Our project employs a power supply unit designed to deliver a stable output of 9V and 1Amp. This supply is facilitated through the integration of a step-down transformer rated at 500mV. Within the project's framework, a laser diode, distinguished by its capacity to generate a focused beam of light, serves as the primary means of transmitting voice signals. The modulation of this signal occurs through the manipulation of the light intensity emitted by the LED/laser diode, wherein variations in current drive changes in the intensity of the light beam, thus facilitating signal transmission. To accommodate diverse preferences, users can select between utilizing an LED or a laser diode for data transmission through a selector switch mechanism.

Receiver

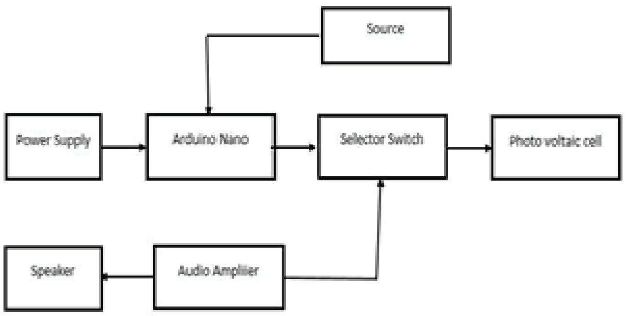
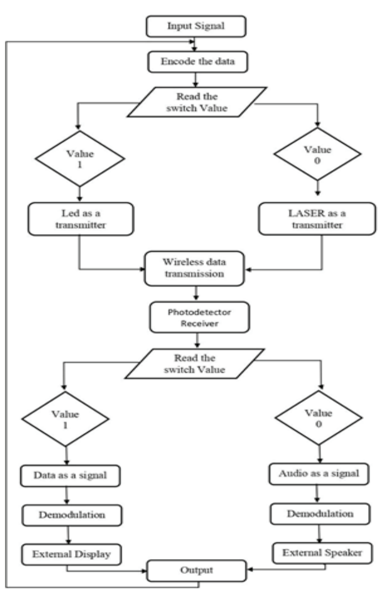


Fig. 5. (Receiver)

In our project, we have implemented a meticulously designed power supply unit delivering a consistent output of9V and 1Amp. This is achieved through the utilization of a step-down transformer rated at 500mV. To facilitate signal reception, a Photovoltaic Cell is employed, tasked with capturing transmitted signals emitted by the LED/LASER. At the receiver end, a selector switch offers users the flexibility to choose between data and audio transmission modes based on their specific requirements. In the case of audio transmission, an audio amplifier is engaged to boost signals within the audio frequency range, ensuring clear and audible output through speakers or headphones. Alternatively, selecting data transmission mode activates the Bluetooth module HC-05, which facilitates the transmission of data output wirelessly.

Flow chart



RESULTS

Output 1: Data transmission using LASER diode external source data display is Bluetooth terminal.

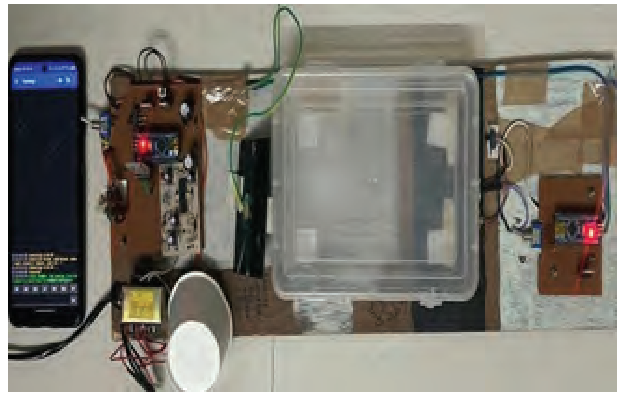


Fig. 6:

Output 2: Audio transmission using LASER diode external source audio is speaker.

Fig. 7:

Output 3: Data transmission using LED diode external source data display is Bluetooth terminal.

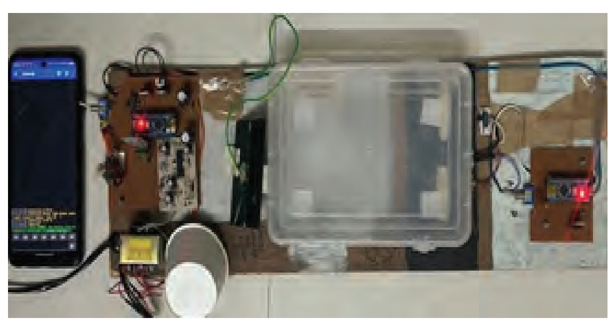


Fig. 8:

Output 4: Audio transmission using LED diode external source is speaker.

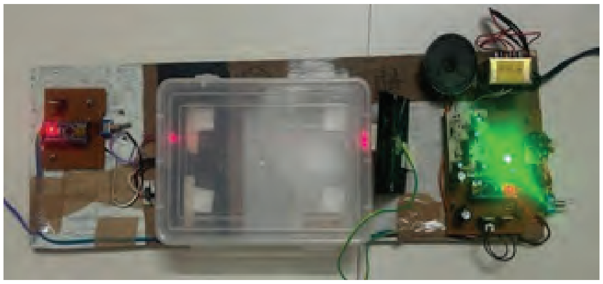


Fig. 9:

CONCLUSION

The exploration and utilization of Light Fidelity (Li-Fi) technology in underwater environments represent a significant advancement in overcoming the inherent challenges of aquatic communication. This study highlights the substantial benefits of Li- Fi, including its high bandwidth, low latency, and resistance to electromagnetic interference, which collectively offer a superior alternative to traditional underwater communication methods. As the technology progresses, continued research and development are essential to address the current limitations, such as light absorption, scattering, and precise alignment requirements. The integration of Li-Fi with other communication technologies could lead to the development of robust hybrid systems, further extending its applicability and reliability.

Li-Fi technology holds transformative potential for underwater communication, enabling more efficient and reliable data transmission. This could lead to significant improvements in underwater exploration, research, and conservation efforts, ultimately fostering a deeper understanding and better management of marine environments.

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NLP based Voice Controlled Powerpoint Operations

Kasturi Bhat
✉ kasturi_bhat@moderncoe.edu.in
Aditi Ashtekar
✉ aditi_ashtekar@moderncoe.edu.in
Rujuta Agre
✉ rujuta_agre@moderncoe.edu.in
Dipali Adhyapak
✉ dipali.adhyapak@moderncoe.edu.in
Kirti Adoni
✉ kirti.adoni@moderncoe.edu.in

Department of Electronics and Telecommunication
Progressive Education Society's
Modern College of Engineering
Pune, Maharashtra

ABSTRACT

The increasing demand for seamless technological integration motivates the development of novel human-computer interaction methods. Presentations remain a cornerstone of digital communication, with Microsoft PowerPoint being a widely used tool due to its accessibility, functionality, and compatibility. This research proposes a novel voice-controlled interface for operating PowerPoint presentations, leveraging Natural Language Processing (NLP) techniques. This approach aims to bridge the gap between user needs and existing presentation tools, potentially enhancing the user experience and communication effectiveness. The proposed system leverages speech recognition models to convert spoken language into actionable commands. NLP techniques are employed to interpret the user's intent and translate it into corresponding PowerPoint operations. This may involve tasks such as:

1. Slide navigation: Advance, rewind, adding new slide.
2. Content manipulation: Add, edit, or delete text and visual elements.
3. Presentation control: Start, pause, resume, and stop the presentation flow.

The proposed system can be used by people with permanent or temporary physical disabilities.

KEYWORDS: *Natural language processing, Voice commands, Text-to-speech, Voice user interface, PowerPoint.*

INTRODUCTION

As technology continues to advance, more aspects of daily life are becoming interconnected and digitized, offering people increased comfort and control over their everyday activities. However, it's important to note that many of these technological advancements are primarily accessible to specific segments of society with a background in technology. A significant portion of the population in developing countries, as well as individuals with disabilities, often face barriers in using traditional computing devices like computers, smartphones, or tablets. Voice recognition-based systems play a pivotal role in addressing this issue, offering accessibility to a wide range of computer operations. The adoption of such technology, especially for individuals with physical disabilities, not only benefits those directly impacted but also contributes to the greater inclusivity of society. Voice- based interfaces serve as an intuitive and accessible means for convenient and simple computer This, in turn, creates a more positive user interaction.

The primary objective of the proposed system is to empower individuals with disabilities or temporary disabilities, enabling them to operate their computer systems using their voice without the need for physical interaction. Experience, promoting inclusivity and ensuring that no segment of our society is overlooked. Voice activation technology holds significant potential to revolutionize the way we interact with computers. By eliminating the need for physical input devices, users can complete tasks more efficiently and with greater ease.

Natural Language Processing (NLP) is a subfield of Artificial Intelligence dedicated to facilitating communication between computers and humans through natural language. NLP drives computer programs that can translate text from one language to another, respond to spoken commands, and rapidly summarize large volumes of text. Speech recognition, also known as speech-to-text, is a crucial component of NLP, responsible for accurately converting voice data into text. Speech recognition is a fundamental requirement for applications that accept voice commands from users and plays a vital role in the realm of artificial intelligence and human-computer interaction.

The rest of the paper is organized as follows: Section II presents a brief literature survey and process flow. The proposed system, brief about libraries used are presented in Section III. Section IV presents methodology that is used along with flowchart while the results are described in section V. Section VI concludes the paper with system evaluation. The last section VII gives references used for the paper.

LITERATURE SURVEY

This literature survey delves into existing research on voice-controlled interfaces and their application in presentations. This section aims at identifying current trends, limitations, and potential avenues for applying Natural Language Processing techniques to enhance the user experience of PowerPoint presentations

In 2024, Gyulyustan et al. have evaluated the accuracy of speech-to-text (STT) services in dynamic environments [1]. They compare two popular ASR systems.

In 2024, Roshini et al. have proposed a voice-based email system for visually impaired individuals [2]. This system aims to facilitate easy access to email by converting text to speech and vice versa.

In 2024, Kumar et al. have proposed a virtual assistant that leverages Natural Language Processing (NLP) for both understanding spoken commands and generating speech responses.[3] The virtual assistant can perform various tasks based on user commands. In 2023, Horia Alexandru Rusan et. al have proposed a new voice-controlled interface for human-computer interaction (HMI).[4] This system recognizes spoken commands and converts them into instructions for the computer.

In 2023, Rampriya et al. have proposed a voice-controlled text editor for programming, specifically aimed at users with upper limb disabilities [5]. They acknowledge existing voice-controlled programming systems, but highlight limitations in keyword recognition and error correction.

In 2023, Patil Kavita Manojkumar et. al have developed an AI based voice assistant, which is designed specifically for all windows versions using python programming languages.[6]

In 2023, Satya Prakash Yadav et. al have explored voice-controlled virtual assistants designed to make life easier. The system gathers information from web sources, user-generated content, and knowledge libraries to provide a well-rounded assistant.[7]

In 2023, Rahul Kumar et. al have described a system that combines hand gestures and voice commands to control user computer like a mouse [8]. It uses a camera to track user hand movements in real-time and recognize gestures for cursor control.

In 2023, Somagani Hema Sri et. al have proposed a hands-free computer interaction system that combines facial expression recognition and speech-to-text functionality [9]. The system uses a webcam to capture real-time video and analyze facial expressions. [9].

In 2022, Likitha R et. al have proposed a system that combines voice commands and hand gestures to control user computer like a mouse. A voice assistant in this system understands spoken commands and can answer questions or perform actions [10].

In 2021, Xiangrui Meng et. al have studied a voice control system for audio equipment was developed using an Android phone app. [11] This system leverages the built-in speech recognition of Android phones.

In 2021, Rakotomalala Francis et. al have reviewed recent studies on voice assistants. They analysed how these assistants work, what technologies they use, and what problems they still have.[12]

In 2021, Edwin Shabu et.al have explored smart assistants. They discuss how voice recognition works and how to set up features like SSH and face detection on a Raspberry Pi. [13]

In 2021, Abhas Kumar et. al have described a Python-based virtual assistant designed to be a personal helper. [14] This particular assistant uses both text and voice data to understand users better.

In 2021, Shailaja Uke et. al proposed described a virtual assistant named Friday built with Python for Windows computers.[15] Friday allows user to control the computer with voice instead of using the keyboard. In 2018, Rosenblatt et al. have addressed the challenge of text-based programming for people with limited upper body mobility [16].

In 2018, Mandeep Singh Kandhari et. al have proposed a voice-controlled e-commerce application to improve user experience. Their system uses speech recognition to allow users to control the shopping process with voice commands. [17]

In 2016, M.Sarkar et. al have proposed an Android app that lets user control the computer with voice commands and gestures.[18] The app uses user phone's accelerometer to detect movements and a microphone to pick up voice commands.

In 2016, Mahammad Rafi et. al have designed a system to control the mouse operations and other computer operations using voice commands. [19].

In 2015, Sarita Patil et. al have proposed a new voice-controlled mouse system.[20] Instead of separate commands, it uses sounds like vowels to move the cursor in real-time.

In 2014, Meghna Patil et. al explored voice controlled smart home system using Zigbee technology. They implemented system to control devices through voice commands which reduce the need for direct manual interaction with the system.[21]

In 2013, Kiran Kumar Kaki et. al have proposed a voice-controlled mouse system called VCMP. VCMP allows users to control their computer with voice commands, including moving the cursor in eight directions [22].

In 2009, H. James Landay et. al have studied how people learned to use a voice-controlled cursor system called the Vocal Joystick. The study included people with and without motor impairments. This research helps improve future voice-controlled computer interfaces. [23].

In 2006, Kwang B. Lee et. al have argued that voice is a natural and powerful tool for human-computer interaction, especially with the rise of mobile devices[24]. Voice interfaces can free users' hands and eyes, allowing them to multitask or use their devices in situations where touch or vision might be limited. In 1999, J.R. Evans et. al have presented a voice- controlled interface for hands-free computer use. It allows users to enter data and control software with voice commands or traditional keyboard/mouse[25]. A quantitative research was first performed for the proposed system that included a thorough literature survey where papers related to NLP based voice user interface and voice controlled mouse actions were analysed. From this analysis the algorithm chosen for the proposed system was NLP which is natural language processing and SAPI 5 as the engine

Process Flow

The Fig.2.1. represents the process that was followed for the implementation of the proposed system.

Process 1-Qualitative research

1) Literature survey and competitive analysis Analyzed research papers which gave a clear understanding about the existing similar proposed systems, their strengths and weaknesses.

2) User survey and defining project scope

A few potential users were interviewed, to understand the problems they are facing in order to get an understanding of the features to be added in the proposed system to create a seamless user experience. Process 2-Building the project

API survey

Comparing different engines and libraries to find out which library is most suitable for the proposed system.

2) Coding

Designed code for the proposed system and with the help of these libraries, mapping of various keyboard and mouse events was done.

Process 3-Quantitative research of the final prototype

1) Technical research

The proposed system was tested against various parameters like speed of internet, various noise conditions, external equipment like mic etc. A graph was plotted for the same.

2) User feedback

The proposed system was tested against various users to check if they are having a seamless user experience interacting with the system. The user feedback was implemented and necessary changes were made.

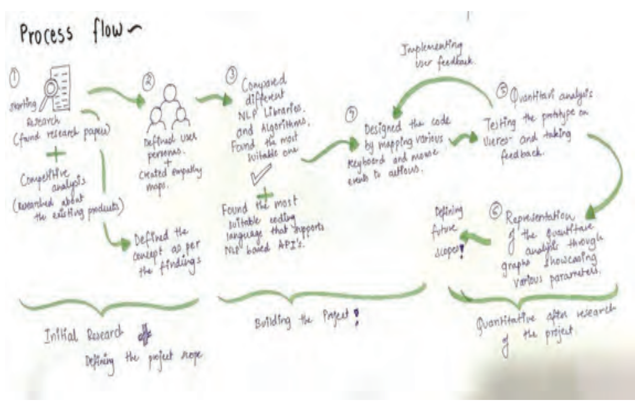

Fig.1: Process Flow

3) Defining future scope

Defined the future scope of the project and how the Proposed system can be extended

PROPOSED SYSTEM

Fig. 2: Block Diagram

In this project, we aim to develop a voice user interface tailored for individuals with disabilities, enabling them to execute computer operations without the need for physical interaction. The system follows a series of steps as shown in Fig. 2 to achieve this:

STEP1: The system collects user input by utilizing the built-in microphone to recognize the user's voice.

STEP2: Various NLP-based APIs play a pivotal role in the success of this project. These APIs include libraries speech recognition, pyttsx3, pyautogui and pynput.

STEP 3: Using the in-built modules, the system maps the user's keywords to specific keyboard and mouse actions. Consequently, computer operations can be performed independently of physical interactions.

Libraries Used

The system uses various inbuilt python libraries for speech recognition, taking voice command as an input, navigating mouse and operating keyboard functions. Speech recognition: For recognizing user's voice The primary speech recognition library in Python is SpeechRecognition. It's an open-source library that provides easy-to-use interfaces.

pyttsx3: For speech to text conversion

The system uses various inbuilt python libraries for speech recognition, taking voice command as an input, navigating mouse and operating keyboard functions. SAPI5: For incorporating speech technology into the application

The SAPI 5 engine is the core component of the Speech Application Programming Interface version 5 (SAPI5) system.

Pyautogui: For mapping keyboard actions to voice commands

PyAutoGUI is a Python library used for automating keyboard and mouse interactions.

Pynput: For mapping mouse actions to voice commands

Pynput is another Python library used for controlling and monitoring input devices such as the mouse and keyboard.

METHODOLOGY

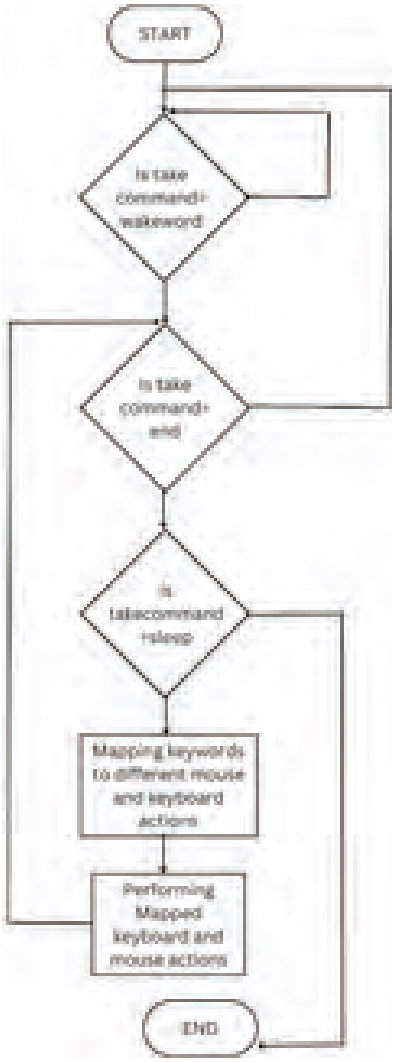

Fig. 3: Flowchart

Fig. 3 represents the flowchart which follows given steps.

Algorithm:

1. Obtain audio input from the user through a microphone or any other audio capture device.
2. Apply a Speech Recognition system to convert the pre-processed audio into text (transcript). There are various speech recognition APIs and libraries available.
3. Intent Mapping: Map the user's intent to specific commands or actions that the system can perform. Define a set of commands or actions that your system can handle based on different user inputs.
4. Analyse the user's text via temp and decide what the user needs based on input provided.
5. Loop and Continue: Put the system in a loop to continuously listen for new audio inputs and repeat the process.

RESULT

The Fig. 4: is a screenshot of a command line window that appears to be showing a console for NLP-based voice-controlled PowerPoint operations. Here's a breakdown of the image.

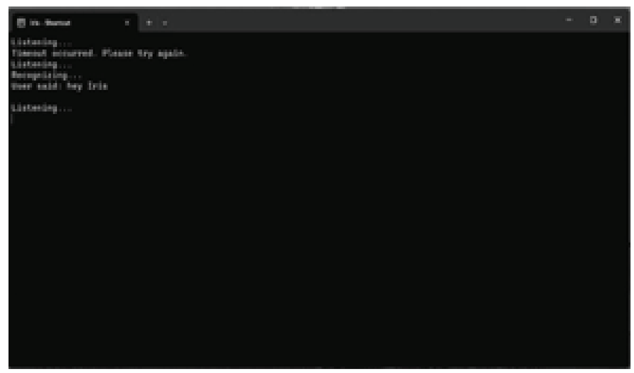

Fig. 4: Console Window

Listening…. - This indicates that the system is waiting for a voice command.

Timeout occurred. Please try again. - This message shows that the system did not detect a voice command within a set time limit.

Recognizing… - This message shows that the system is processing a detected voice command.

Timeout occurred. Please try again. - This message shows that the system did not detect a voice command within a set time limit.

Recognizing… - This message shows that the system is processing a detected voice command.

hey Iris - This indicates that the system recognized the voice command "hey Iris," which may be a wake word to activate voice controls

Listening. - This shows that the system is again waiting for a voice command after recognizing the wake word.

Fig. 5: Opening user's chosen ppt

Fig. 5: shows that system allows users to select any presentation irrespective of its location in the device. For that purpose, the system will ask the user about which presentation user wants to open then the user can give any presentation's name as a voice command to the system. After this the corresponding presentation will be opened. Before opening the presentation, the system will ask for the user's confirmation. Users can also create a new presentation using the 'new ppt' keyword.

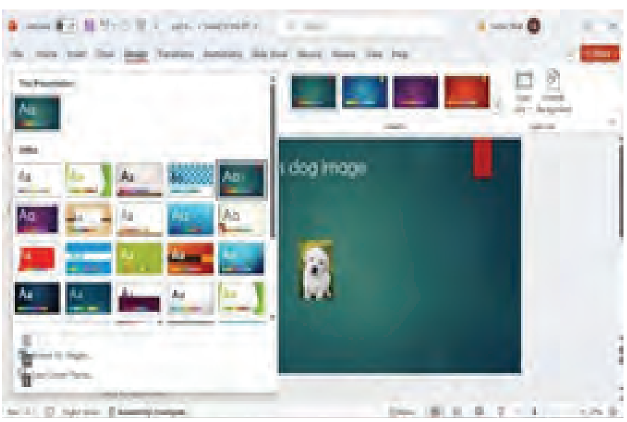

Fig. 6: Selecting slide design

For selecting a design template for the presentation, the user needs to use the decided keyword for example 'Design', then the system will provide different design templates. As shown in Fig. 6 the user can select any template as per his choice with the help of keywords like 'up', 'down', 'right', 'left' and so on. At the end , the user can use the 'select' keyword to confirm the design template of user's choice.

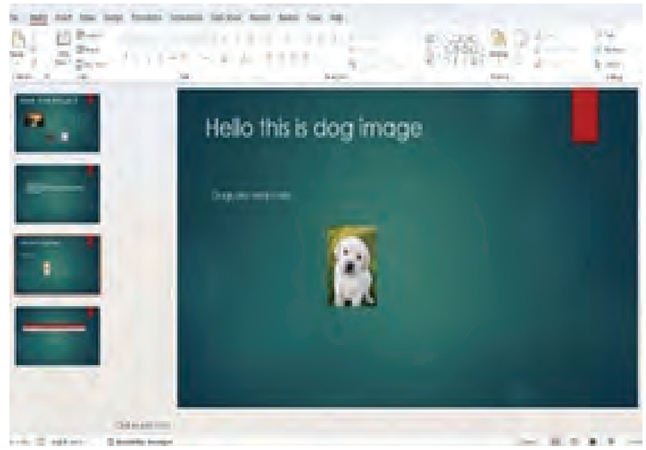

Fig. 7. Insert Image

In the above Fig. 7 the user can insert any image from the device and text onto the PowerPoint slide. The user has to say "insert image". The system automatically opens the files and user can select the image from any location and drive wherever the image is stored. The user can insert text by using the voice command "enter text" to type. If the user says "next line" the pointer moves to the line below. Once the user is done typing, he can use "exit text" voice command to stop typing. The user can use the "erase" command to erase a certain word

In the Fig. 8, the user can insert table through voice commands. The user has to use the command "insert table", the system replies by asking the user about the number of rows and columns the user wants for his table. User can insert a table of any size through voice commands.

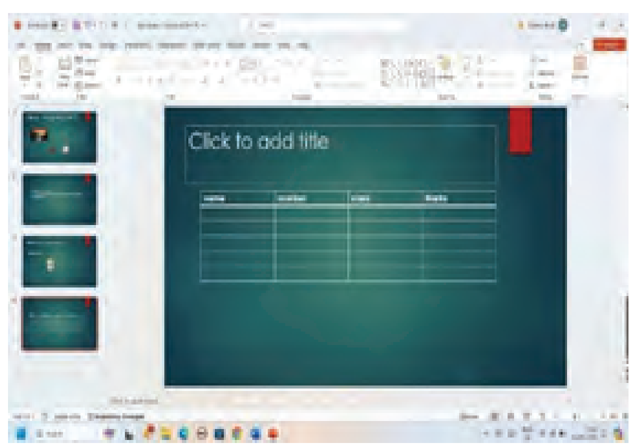

Fig. 8: Add table

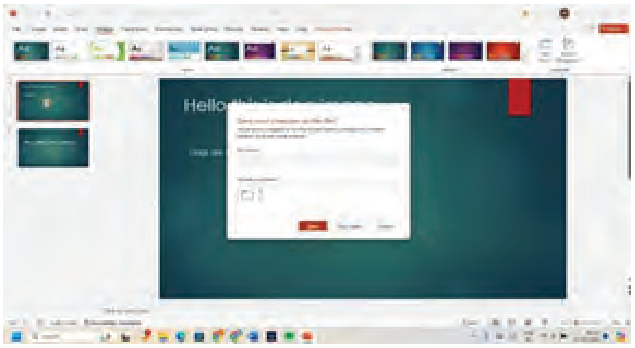

Fig. 9: Save PPT

The above Fig. 9 shows that once the user is done working on the ppt, the user can even save the ppt through voice commands by using the command "save". Once this window pops up on the screen the user can save the ppt at any location he wants through voice commands.

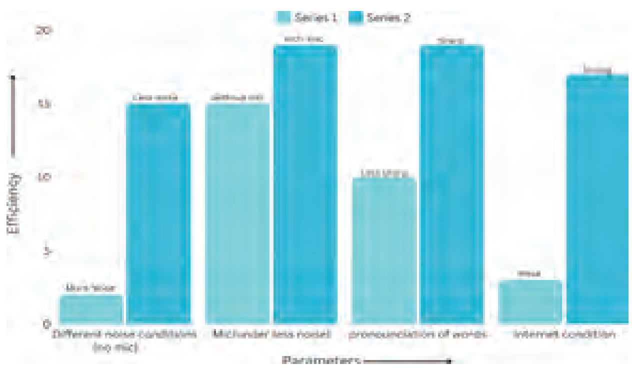

Fig. 10: Efficiency

In Fig. 10 the x-axis represents different parameters that can affect the system's accuracy, while the y-axis shows the number of words correctly recognized. The total number of words the system is tested against is 20 which is shown in Table 1.

Breakdown of the parameters on the x-axis and how they influence the system's performance:

Mic (under less noise): This bar indicates the number of words correctly recognized when the microphone is used in a quiet environment. The System could recognise upto 19 words.

Less noise (no mic): This bar depicts how well the system performs when there is background noise but no microphone is used. The words that were correctly recognised in this condition were 15.

Table 1.

Sr. No.	Parameters		Words correctly recognised by system (x)	Total number of words tested (y)	Individual accuracy (%) x/y*100
1.	Different Noise condition	less noise	15	20	75
		more noise	2	20	10
2.	Mic (Under less noise)	with mic	19	20	95
		no mic	15	20	75
3.	Pronunciation of words	Sharp pronunciation	19	20	95
		weak pronunciation	10	20	50
4.	Internet condition	Strong internet	17	20	85
		Weak internet	3	20	15

Sharp pronunciation: This bar indicates the performance of the system when users speak clearly and precisely. The number of correctly recognized words is likely high in this case, as the system has a clearer signal to work with.

Less sharp pronunciation: This bar shows how well the system performs when users mumble or don't enunciate as clearly.10 words were correctly recognised.

Strong internet condition: This bar depicts the system's performance when it has a strong and stable internet connection.

Weak internet condition: This bar shows how well the system performs when the internet connection is weak or unstable. The number of correctly recognized words is likely lower than when the internet connection is strong.

Overall, the graph suggests that using a microphone in a quiet environment with clear pronunciation and a strong internet connection will result in the best performance for this system.

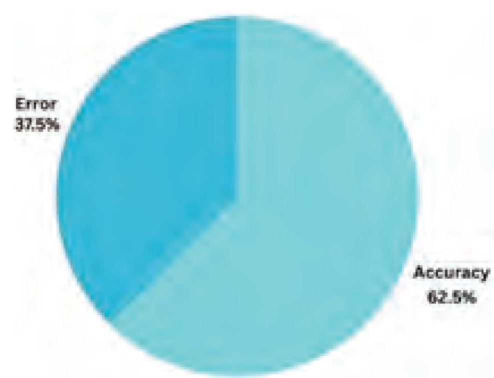

Fig. 11: Accuracy

From the bar graph, the system's total accuracy is calculated and shown in the above pie chart Fig. 11.

Average accuracy of the system

Average accuracy of the whole system=Sum of individual accuracies /total number of testing parameters

$$Average\ accuray\ (\%) = \frac{10+75+95+75+95+50+15+85}{8}$$

$$= 62.5\%$$

Hence the accuracy of the whole system that is found out to be 62.5%.

CONCLUSION

The implementation of NLP-based voice-controlled PowerPoint operations represent a significant advancement in user interface technology, offering enhanced accessibility and efficiency in presentation software. Through this research, we have demonstrated the feasibility and effectiveness of leveraging natural language processing techniques to enable seamless interaction with PowerPoint presentations via voice commands. The system underscores the potential of this approach to revolutionize how individuals interact with presentation software, particularly for those with mobility impairments or in situations where hands-free operation is preferred. Moving forward, continued refinement and integration of NLP algorithms, alongside advancements in speech recognition technology, hold promise for further enhancing the usability and accessibility of PowerPoint and similar platforms.

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LAAS – Lab on Demand using Pre-configured VMs

Vidya Deshmukh
✉ vidya.deshmukh@moderncoe.edu.in
Jayaprabha Kanase
✉ jayaprabha.kanase@moderncoe.edu.in
Yash Kachi
✉ yashkachi7315@gmail.com
Anvesh Samrit
✉ anveshsamrit@gmail.com
Aditya Ghyar
✉ adityamghyar@gmail.com
Aditi Magdum
✉ aditimagdum15@gmail.com

Computer Engineering
PES Modern College of Engineering
Pune, Maharashtra

ABSTRACT

LaaS endeavors to equip educators with efficient tools for deploying course lab components over the internet, facilitating remote completion of lab tasks for students. This paper comprehensively explores the concept of Laboratory as a Service (LaaS). We delve into its core structure, potential applications, and the specifics of putting it into action. Furthermore, by examining LaaS, we uncover valuable strategies for improving remote laboratory experiences and promoting engaging online learning environments.

Unlike traditional desktop IDEs that require installation, web-based IDEs offer a seamless programming experience without installation, making them increasingly popular among researchers. Despite their undeniable convenience for developers, web-based IDEs are still not perfect. Although current research generally focuses on adding core features, this paper addresses some neglected issues. We explore three main challenges of Web-based IDEs: errors in file handling, limitations on method calls, and high resource usage. We propose adaptive solutions based on program behavior analysis, showcasing their efficacy through real-world application in an online IDE. Our paper introduces an innovative solution: the Online Code Editor. Tailored for programmers seeking platform-agnostic programming without the constraints of specific hardware, this editor operates as a web application on Private cloud computing infrastructure. It boasts features such as syntax highlighting for language isolation, project creation, file import/export functionalities, and essential functions like Save and Auto Save.

KEYWORDS: *Private cloud computing, Program behavior, Program analysis, Adaptive control, Online IDE, E-Learning.*

INTRODUCTION

The complexity of setting up an Integrated Development Environment (IDE) can be a hurdle, particularly for new programmers. This very obstacle fueled the creation of web- based IDEs, which leverage browser technologies to offer a more accessible development experience.. Online IDEs, such as CodeRun, Java WIDE, and Bespin, operate on a Browser/Server structure, enabling programmers to write code directly through a web browser. These platforms offer standard features like code syntax highlighting and compilation to bytecode, while also providing unique advantages. Firstly, they eliminate the need for individual development environment setups, making them particularly convenient for users. Secondly, online IDEs support collaborative development efforts and often include additional assisting functions, streamlining the development process. However, despite their benefits, online IDEs face distinct challenges. Programs in development stages are inherently less stable compared to released software, posing potential risks to the server-side platform supporting numerous programmers.

In the realm of education, traditional learning confined knowledge acquisition to fixed locations, primarily classrooms, where one-way teaching dominated. However, advancements in client and server-side technologies have revolutionized learning, enabling the creation of rich internet applications (RIAs) capable of delivering courses online. Technologies like JavaScript, AJAX, AngularJS, PHP, and Python empower instructors to extend learning across multiple locations through learning management systems (LMSs). Despite the increasing popularity of online courses, challenges persist, especially regarding lab components. Incorporating lab components into online courses necessitates innovative solutions to ensure practical, hands- on learning experiences remotely. This work introduces a novel framework, Lab-as-a-Service (LaaS), that leverages cloud-based infrastructure and service-oriented principles. LaaS targets the challenge of incorporating practical laboratory components into online courses, aiming to elevate the overall quality of the online learning experience. However, accessing software capable of editing source code quickly without installation remains a challenge for many programmers. Text editors offer a lightweight solution but require installation on local machines, limiting accessibility. In response, Online Code Editors have emerged, operating on private cloud computing via web-based applications. Web-based code editors offer programmers the flexibility to code from anywhere with an internet connection. This eliminates the need to juggle multiple devices and avoids compatibility issues caused by software installation dependencies on different machines.

ARCHITECTURE

MEAN Stack

The MEAN stack is a powerful technology stack used for building web applications. It consists of four essential components, all based on JavaScript.

MongoDB: This NoSQL database excels at storing and managing vast collections of information that doesn't follow a rigid structure, making it ideal for modern applications.

Express.js: Built on Node.js, Express.js acts as a framework for streamlining the development of powerful and adaptable web server applications. It offers features for managing routes, incorporating middleware functions, and effectively handling HTTP requests.

Angular: This JavaScript framework focuses on the client-side, allowing developers to construct web applications with dynamic and modular user interfaces. Angular streamlines the development of interactive experiences.

Node.js: Operating on the server-side, Node.js is a JavaScript runtime environment that executes code directly on the server. Its event-driven, non-blocking approach makes it efficient at handling multiple requests simultaneously.

The MEAN stack enables JavaScript development, from the database (MongoDB) to the front end (Angular).

Ngnix: Key features of Ngnix include –

a. Efficient handling of concurrent connections.

b. Load balancing across multiple application instances

c. Reverse proxy capabilities for distributing traffic to backend servers.

d. Support for various protocols (HTTP, HTTPS, FastCGI, etc.).

Nginx is commonly used to serve static content, handle SSL/TLS termination, and act as a load balancer. Nginx excels as a high-performance HTTP load balancer. It distributes incoming traffic strategically across multiple application servers, leading to enhancements in overall application performance, scalability, and reliability.

Load Balancing: Load balancing refers to distributing incoming network traffic across multiple servers to optimize resource utilization, maximize throughput, reduce latency, and ensure fault tolerance. Key functions of a load balancer:

a. Distributing Requests: This approach tackles the challenge of workload distribution. It efficiently spreads incoming client requests or overall network traffic across a network of servers.

b. Availability: Ensures requests are sent only to online servers, improving reliability.

c. Scalability: Allows adding or removing servers based on demand.

Angular (Presentation Layer)

This part of the application handles the user interface and user experience. It consists of several modules:

a. Auth Module: Responsible for authentication and user access control.

b. Instructor Module: Deals with instructor-related tasks.

c. Student Module: Manages student-related tasks.

d. Admin Module: Handles administrative functions.

e. Shared Module: Contains reusable components shared across different modules.

Node.js (Business Logic)

This layer manages the application's business logic and interacts with the Angular Frontend. It includes various services:

a. Instructor Service: Handles instructor-specific operations.

b. Admin Service: Manages administrative tasks.

c. Student Service: Deals with student-related functionality.

d. Auth Service: Ensures security and user management.

e. Lab Service: Related to lab or experiment management.

The Node.js layer communicates with the Angular Frontend via a router.

Code Editor

An Online IDE (Integrated Development Environment) extends the capabilities of a code editor by allowing developers to write, compile, and run code directly within a web browser. It provides features like syntax highlighting, autocompletion, and error checking.

Features of an Online IDE:

a. Code Editing: Provides a code editor with syntax highlighting and other productivity features.

b. Compilation/Execution: Allows running code in various languages (C, C++, Java, Python, etc.)

c. Interactive Execution: Supports real-time input/output for interactive programs.

d. Downloadable Output: Provides the ability to download the output of executed code.

e. Themes and Customization: Allows users to choose themes and customize the editor.

f. Cloud Storage: Some Online IDEs offer cloud storage for saving and sharing code.

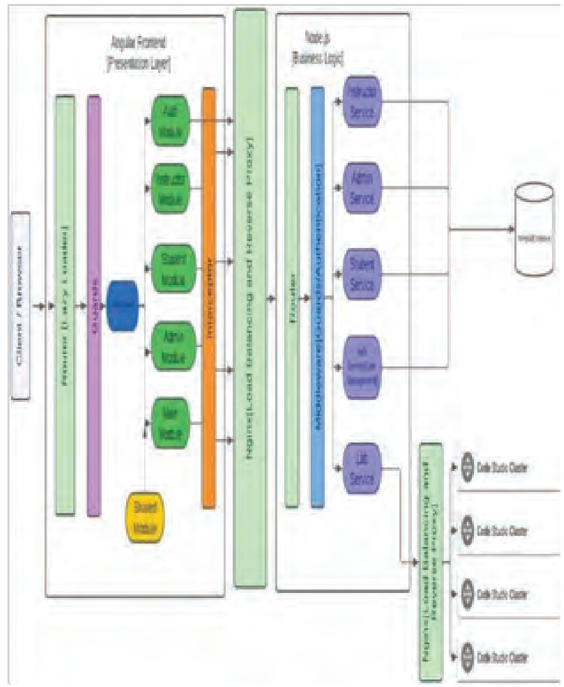

Fig. 1: Architecture Diagram

Docker

Incorporating Docker into my project has revolutionized the functionality of the online compiler, providing users with an independent and seamless experience. By leveraging Docker's containerization technology, each user can enjoy a personalized environment tailored to their specific needs, ensuring efficient compilation processes without interference from other users. This novel approach goes beyond simply improving the user experience. It also fosters a more streamlined development and deployment process, signifying a major leap forward in the field of online compiler technology.

Our objective is to develop a framework aimed at enhancing student productivity and fostering increased interaction during remote experiments. Termed as Lab on Demand, this framework adopts a middleware approach to facilitate its universal applicability across various experimentation types. Through Lab on Demand, students can remotely conduct experiments designed by instructors, utilizing their computing devices for tasks such as accessing resources, executing labs, documenting results, and connecting to end-user devices. This platform empowers instructors to not only retrieve results and assess student performance in real-time, but also to effortlessly generate lab modules, rubrics, and manage all lab materials online. The LaaS server acts as a central hub, facilitating seamless communication between students and the virtual lab environments. This allows instructors to tailor their interventions based on individual student progress, fostering a dynamic learning experience accessible to a global audience.

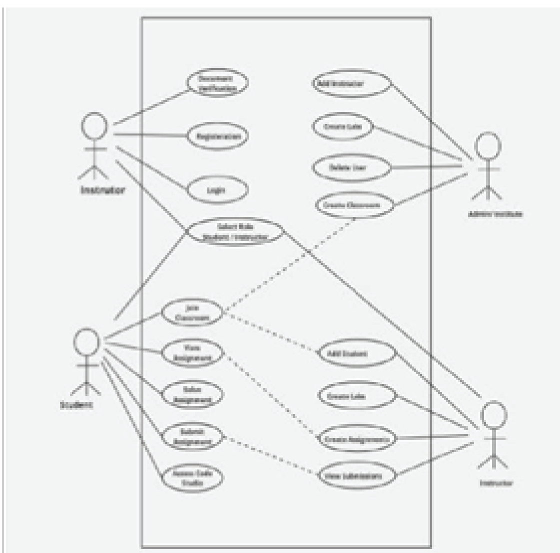

Fig. 2: Use-case Diagram

USE CASE

A use cases act as a roadmap, outlining the different scenarios where users interact with the system to achieve specific goals. Here are the key components of a use case diagram:

a. Actor

b. Use case

c. System boundary

Below diagram explains details of Lab on Demand Using Pre-Configured VMs :

Instructor

1. Can go through document verification.
2. Can register and log in.
3. Can select their role as either a student or instructor.
4. After logging in, instructors can –

   Add other instructors.

   Create labs and classrooms.

   Delete users.

Student

1. Can join a classroom using an access code or studio.
2. Can view and solve assignments.
3. Can submit assignments.
4. Both students and instructors can view submissions.

Admin/Institute

Has the ability to –

1. Add students
2. Create labs
3. Create assignments
4. View submissions

SEQUENCE DIAGRAM

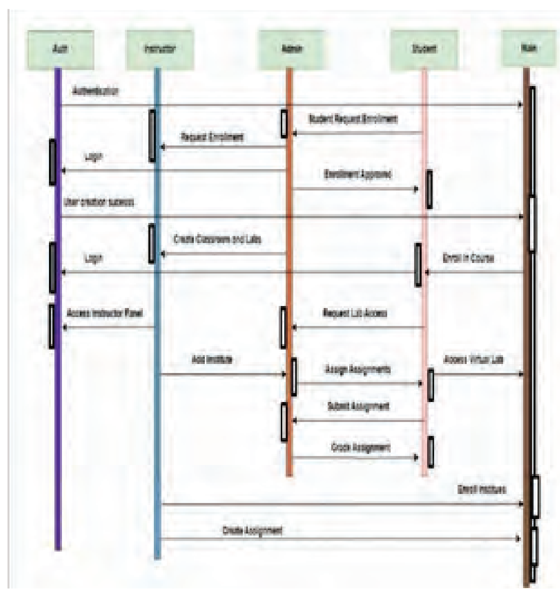

Fig. 3 Sequence Diagram

RESULT

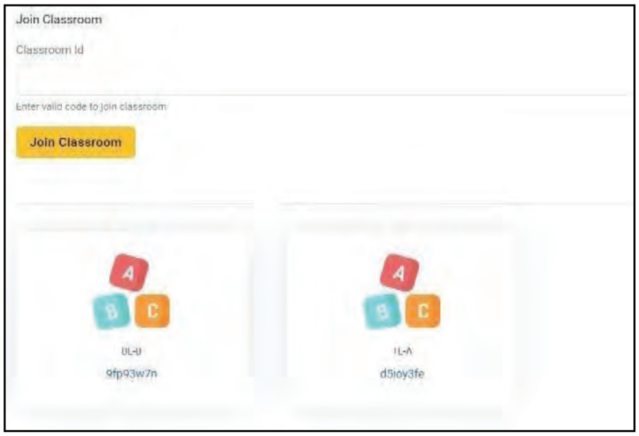

Fig. 4 Instructor Dashboard

Fig. 5 Student Dashboard

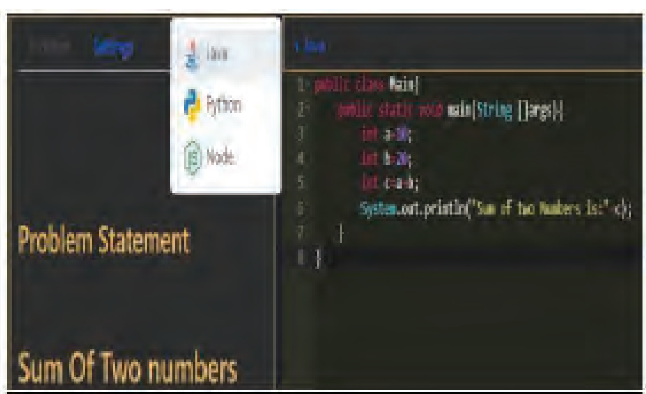

Fig. 6 Code Studio

FUTURE SCOPE

The future scope of our project involves the incorporation of a comprehensive file system feature. This feature will revolutionize the way users interact with our code editor, empowering them to organize, manage, and navigate through multiple files seamlessly within a single project environment.

One of the primary objectives of integrating a file system feature is to facilitate enhanced organization and management of project files. Users will be able to create, edit, and delete multiple files within a single project, allowing for a structured and systematic approach to code development. This functionality will enable users to compartmentalize their codebase into logical units, thereby improving code readability and maintainability. The implementation of a file system will introduce intuitive navigation capabilities, enabling users to effortlessly traverse through various files within a project. With features such as file search, navigation shortcuts, and breadcrumb trails, users can quickly locate and access specific files, significantly reducing the time and effort required for code exploration and modification.

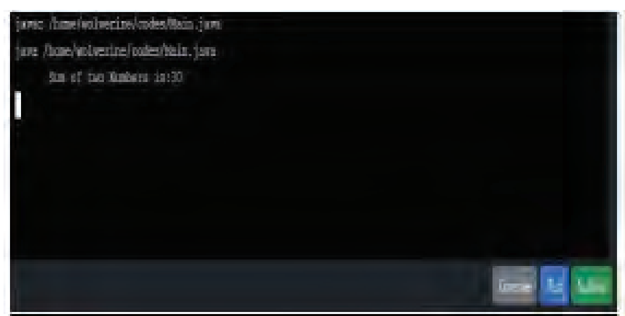

Fig. 7 Terminal Output

CONCLUSION

This paper has proposed the Lab-as-a-Service (LaaS) framework, aiming to elevate the effectiveness of online education. This framework facilitates active student engagement, particularly in courses necessitating hands-on components. Throughout our exposition, we exemplified, albeit on a limited scale, how this framework can metamorphose traditional learning experiences into remote ones, thereby complementing existing Massive Open Online Courses (MOOCs). By integrating lab facilities into the online learning environment, we aim to advance the accessibility of courses requiring practical experimentation, such as those in engineering and science fields. Concurrently, the discourse surrounding online

Integrated Development Environments (IDEs) has gained traction in industrial circles, with several business-oriented IDEs entering the market. In academia, attention is shifting towards the development of online IDEs, yet scant research has addressed the challenges inherent in their implementation. This paper systematically delineates three prevalent issues encountered during actual usage of online IDEs and proposes corresponding remedies. Subsequently, we conducted a case study to assess the efficacy of our proposed solutions within the online IDE context We concluded by exploring potential limitations in our research and pinpointing obstacles hindering the further development of online IDEs.

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WANET-Based Post Disaster Management System using Cloud Computing

Snehal R. Kawade
✉ snehalkawade0508@gmail.com
Sheetal S. Roman
✉ sheetalroman24@gmail.com

Shreya S. Punadikar
✉ punadikarshreya29@gmail.com
Aparna P. More
✉ aparna.more@moderncoe.edu.in

Dept. of Electronics and Telecommunication
PES Modern College of Engineering, Pune
(Affiliated to Pune University)
Pune, Maharashtra

ABSTRACT

In emergency data communication, a portable, efficient, deployable device-based Wireless Ad hoc Network System is very useful. In this case, a WANET-based system using Cloud Computing is suitable to overcome the difficulties. WANETs are decentralized, flexible and autonomous networks that interact without a central authority. This paper presents a novel disaster response system, leveraging Wireless Ad-hoc Networking (WANET) technology, cloud computing, and real-time data visualization. The system consists of intelligent devices, including a Client Device with GPS, accelerometer sensor, node 1 and node 2 modules and a server integrated with Raspberry Pi, LCD, and LED. GPS module facilitates seamless communication among rescue teams by detecting and relaying critical information such as landslide occurrences. Real-time data is stored in Firebase, enhancing accessibility, while the "accident GPS" app on MIT App Inventor visualizes disaster locations on a map, empowering first responders with timely and accurate information. The system stands as a beacon of innovation in post-disaster management, redefining response strategies through intelligent networked solutions.

KEYWORDS: *Wireless ad-hoc networking, GPS, Accelerometer, Raspberry Pi, Cloud computing, Cellular network, Device-to-device cmmunication, WIFI.*

INTRODUCTION

Cellular telephony is a communication technology that is widely utilized. The global population has approximately eight billion active mobile subscriptions, and approximately half of them have been added in the past few years, mainly in developing regions. In Figure 1 A wireless ad hoc network (WANET) is a local area network (LAN) that sanction many wireless devices to establish a connection with each other without the requirement of shared network infrastructure devices, such as wireless routers or access points. Cloud computing is employed on account of its scalability, platform as a service (PaaS), infrastructure as a service (IaaS), software as a service (SaaS), and various other significant attributes. [14].

The devastation of the communication infrastructure led to a lack of collaboration among the first aid organizations, resulting in the suffering of numerous individuals as a result of poorly executed rescue efforts. Following a calamitous event, the exchange of information between emergency response teams, including firefighters, law enforcement personnel, and medical professionals, assumes paramount importance. The input provided by initial rescue responders holds significant importance in facilitating a successful rescue and restoration operation. From a networking standpoint, the objective is to restore connectivity in order to provide temporary communication services to rescue organizations. One strategy to tackle these challenges entails the arrangement of network components, such as nodes, access points, or routers, in order to establish a temporary network as and when required. [1]. Moreover, in an endeavor to expeditiously manage and distribute sustenance and other necessities to uprooted residents, and establish a dependable and secure communication infrastructure that is facile to implement, employing radio waves in lieu of data cables would be a judicious option for communication during calamitous circumstances.

Additionally, the system architecture facilitates intermediate node devices to dynamically designate their identifiers based on the data furnished by their adjacent nodes. Afterwards, every intermediate relay chooses the most advantageous forwarders towards the control server in order to reduce both end-to-end and round-trip message delivery delays.

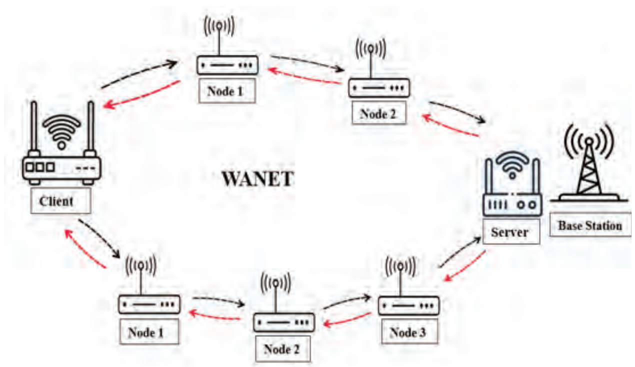

Fig. 1: Wireless Ad-hoc Network

LITERATURE REVIEW

This system employs WANET technology, enabling real-time information exchange among rescue teams and aiding early responders. The integration of cloud computing (Firebase) and the MIT App Inventor app enhances the system's capability to store and visualize real-time data.

In [1], Mase, K L et al. a comprehensive investigation into the communication requirements for individuals residing in shield during the aftermath of a disaster, with a specific focus on the efficient delivery of messages to and from disaster-stricken areas. This study emphasizes how vital communication services are for evacuees staying in shield after a disaster. It asserts that maintaining communication channels between persons inside and outside of shelters, as well as between those in other shelters, requires the creation of a new communication service called the Shield Communication System (SCS). The SCS consists of a Shield Server that is connected to the Internet and a group of personal computers (shelter PCs), one in each shelter, that are also connected to the Internet using the proper Internet access connection, such as High-Speed Packet Access. Each shield PC utilizes the cellular phone network's data communication capability with high priority, accessing the Internet to maintain Quality of Service (QoS) grounded in social acceptance and agreement .The SCS provides message transmission services both within and between shelters as well as between the outside of the disaster area and shield.

In [2], Karen Miranda et al. have examined the deployable network options for post-disaster situations involving a breakdown of the established communication infrastructure. It examines several strategies, such as using smart phones and tablets as mobile devices, to establish crucial communications in emergency situations. With little human involvement, the suggested solutions are meant to be rapid, adaptable, scalable, and resilient. The study emphasizes the value of wireless mesh networks and device-to-device communication for efficient disaster response. In order to create effective post-disaster networks that can adapt to various conditions while saving energy and minimizing human intervention, the authors call for more research in this area.

In [3],Ru Li, Rui-Lin Yang, et al., a session-based mobility management system, MMAH, for MANET in disaster-rescue circumstances is suggested by MMAH, which removes Mobile IP's limitations, enabling swift network deployment without manual intervention. The paper examines session and TCP connection migration procedures in MMAH, highlighting its wide-ranging uses in emergency communications and catastrophe rescue. The Resource conservation, migration security, and optimal migration issues requires more research.

In [5], Kishore D et al., have looked by combining four sensors (Gas, Light, Temperature, and Vibration) into a single package that each miner carries, this initiative seeks to improve safety in the mining sector. These sensors can detect disasters like gas leaks, fires, explosions, earthquakes, collapsed roofs and flash floods and convey information to a control station using wireless connectivity. Continuous communication is ensured by the usage of MANET topology. The objective is to protect the lives of the miners and investigate ad hoc networks for better catastrophe prevention. Understanding additional factors contributing to mining disasters, such as poisonous gases and flooding, is the focus of further research.

In [9], Bin Chen et al. In places hit by natural catastrophes like typhoons, this research suggests an ideal recovery plan for the distribution network communication system. The plan considers the restoration of communication in the distribution network and is based on Mobile Ad-Hoc Networks (MANETs). The state of the communication system following a disaster is determined using multivariate data analysis, and the suggested approach is used with an IEEE-14 communication grid. The findings demonstrate how the Mobile Ad-Hoc Network strategy effectively shortens repair times and speeds up communication network restoration. The coordination of communication system recovery and power restoration may be the focus of future work.

In [13] ,Vinh Pham', et al. Investigating the effects of rerouting time in Mobile Ad hoc Networks (MANETs) brought on by node mobility and connectivity issues Rerouting time is found to be significantly influenced by queuing. A MAC-layer solution based on adaptive retry limits is suggested as a solution to this problem, which successfully solves queueing issues in many contexts. The paper provides simulation data that validate the efficacy of the suggested method in addition to a straightforward model for estimating rerouting time. To further improve the system's performance in dynamic network circumstances, future research may investigate more intricate solutions and cross-layering strategies. In order to improve connectivity and communication dependability in MANETs, the study emphasizes the significance of effective rerouting.

METHODOLOGY

This system employs WANET technology, enabling real-time information exchange among rescue teams and aiding early responders. The integration of cloud computing (Firebase) and the MIT App Inventor app enhances the system's capability to store and visualize real-time data.

Let us summarize the key components and their functionalities:

Client Device (ESP8266 with Push Button, GPS, and Accelerometer Sensor)

- GPS: Global Positioning System for location tracking.
- Push Button: The push button is pressed to send an alert when a victim is found, ensuring quick communication in emergencies.
- Accelerometer Sensor: Used for landslide detection during pre-disaster management.
- Arduino IDE monitors signal status.
- Sends messages to Node 1.

Node 1 (ESP8266 with LED)

- Receives data from the client.
- LED indicates successful delivery (High) or failure (Low).
- Forwards data to Node 2 if message detected; otherwise, sends acknowledgment to the client.

Node 2 (ESP8266 with Buzzer)

- Receives data from the Node 1.
- Buzzer indicates successful delivery a high signal or failure with a low signal.
- If message detected; otherwise, sends acknowledgment to the Node 1.
- Forwards data to the server.

Server (Raspberry Pi with ESP8266, LCD, and LED)

- ESP8266 listens for data from Relay 2.
- LED indicates successful delivery to Raspberry Pi (High) or failure (Low).
- LCD displays landslide detection status.
- Real-time data stored in Firebase.
- Firebase connected to MIT App Inventor app named "accidentGPS."

- "accidentGPS" app shows the location of the disaster, whether a landslide is detected or not, and displays the location on a map.

Firebase: Cloud Storage

Application developers that need to store and deliver user-generated content—typically large items like images or videos can employ cloud storage. Although photographs and videos are the main uses for which it is designed, we may also use it for text files. This technology enables the management and storage of various media content created by mobile app users. Cloud computing gives suppliers the ability to store data online, giving them just-in-time capacity and on-demand billing. It has immediate capacity and is charged only when needed. It eliminates the requirement for us to buy and manage our own information storage infrastructure. It gives us "anywhere, anytime" data access, flexibility, resilience, and global reach. Firebase is made up of: Third-party cloud providers who own and own storage space for data and make it available online for a pay-per-use fee. These cloud storage companies offer the volume, stability, and security needed to make our apps' data accessible from anywhere in the world. Applications can utilize traditional storage protocols or an API to access cloud storage directly. Many vendors provide add-on services designed to help with large-scale data collection, security, organization, and analysis. We use Cloud Storage to store our files in the Google Cloud Storage bucket. We have the ability to upload and retrieve files from mobile devices using the Firebase SDKs. The Google Cloud Platform can also be used for server-side processing, including transcoding videos and image filters. It suggests that switching suppliers does not have to be done. Firebase Cloud Storage is a useful and simple to operate solution for storing a variety of items. With its help, we can save photo, video, audio, and other types of user content. Firebase Cloud Storage makes it easy to get from an app prototype to a finished product because it is extremely scalable and capable of handling exabytes of data.Create your own mobile applications with App Inventor, a free cloud-based tool that uses a block-based programming language. To access App Inventor, use a web browser (Chrome, Firefox, or Safari). The principles of developing apps for Android and iOS smartphones and tablets will be covered in these simple-to-follow courses. We will require: a Windows or Mac machine and a wireless network it is entertaining to watch the mobile application operate on a phone or tablet both during the development process and once it is finished. The apps must be set up in order to operate.

Dynamic routing

As the name suggests, dynamic routing protocols are used to dynamically exchange information between routers. Their implementation allows network topologies to dynamically adapt to changing network conditions and ensures that efficient and redundant routing continues regardless of the changes. In addition, they are invaluable in managing, and configuring networks because they require relatively little administrative overhead to configure highly complex routing scenarios.When dynamic routing protocols are used, networks can be far more scalable than when they use a static topological routing arrangement. In 1982, Eric C. Rosen invented the Exterior Gateway technology (EGP), which was the first dynamic routing technology. Many more accurate protocols have now been created and refined throughout time. Routing protocols, which allow routing devices to communicate routing information, are used in dynamic routing. Routing protocols carry out three tasks: locating distant networks, determining the shortest path to distant networks, making changes to the routing table if the current best path fails, recalculate a new one.

Dynamic routing Using NS3

Python scripts or C++ programmes are used by NS3 to define simulations. In addition, NS3 comes with support for a real-time scheduler, which opens a number of "simulation-in-the-loop" use cases for communicating with actual systems. For example, users can utilise real network devices to send and receive NS3-generated packets, and NS3 can be used as an interconnection framework to create link effects between virtual machines. It has cross-layer capabilities such as packet tagging and tracing. In other words, permit the reporting of occurrences across non-contiguous layers.

little data pieces that are appended to packets on NS-3 that are executing routing daemons Use simulation to run unmodified POSIX programmes.

A flow chart of the server device is shown in Figure 2. Following startup, the server awaits the receipt of request messages. If a message is received, the server generates an alarm message to notify the rescue teams and relays back an acknowledgment message to the client device.

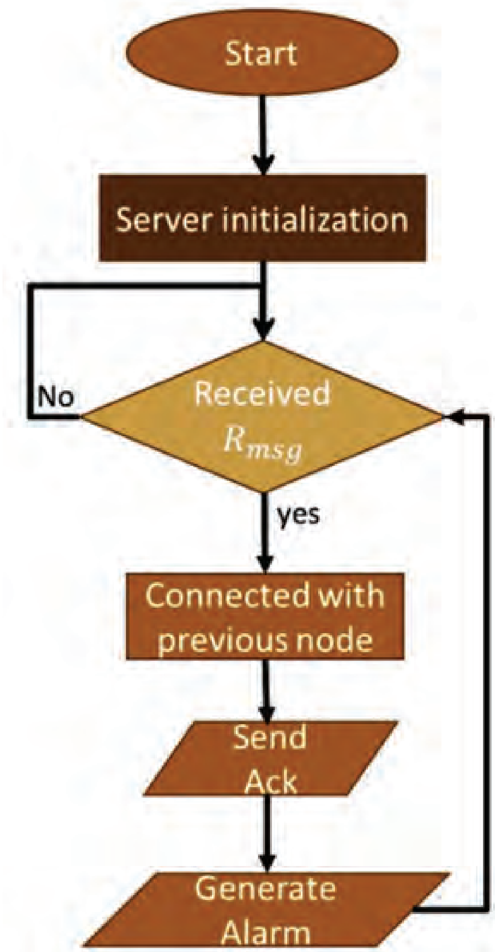

Fig. 2: Flow Chart of Server Device

Diagram of the relay device's flow is shown in Figure 3. After initialization, the relay device uses the Dynamic ID Assignment (DIA) algorithm to create its own ID and searches for networks that are available. The procedure known as Minimum Maximum Neighbour (MMN) is then applied, yielding the minimum and maximum IDs. The relay device then watches for messages to arrive. The minimum ID is chosen in order to send the request message to the server, should it come. Being significantly closer to the server and able to deliver the message in the shortest amount of time makes the relay with the smallest ID the choice. Relay devices, on the other hand, choose the maximum ID to send messages back to clients if an Ack message is received.

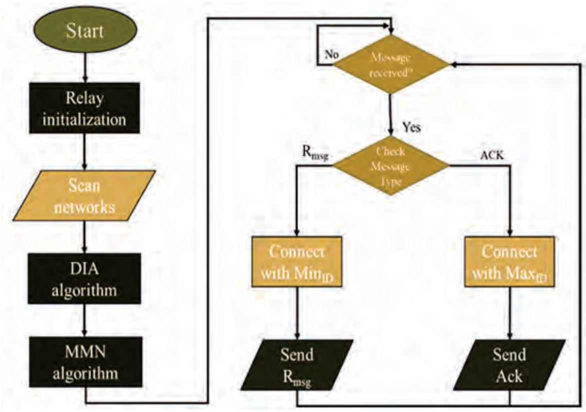

Fig. 3: Flow Chart of Relay Device

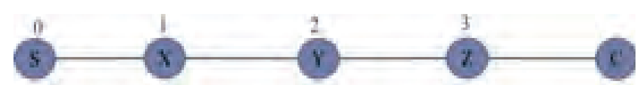

Fig. 4a

Fig. 4b

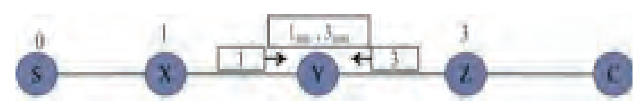

Fig. 4c

Fig. 4: Minimum Maximum Neighbor selection

Figure 4a, 4b and 4c describes the MMN algorithm's detailed process. As seen in Figure 4a, each relay has been given an ID. Each relay will then decide which neighbour relay to send messages to next. Relay X will receive IDs 0 and 2 from server S and relay Y, respectively, as shown in Figure 4b. Relay A will select 0 as the lowest ID and 2 as the maximum ID by using the MNN technique. In a similar, Figure 4c illustrates that relay X will provide IDs 1 and 3, while relay Z will give IDs 1 and 3, respectively. Relay Y will select 1 as the minimum ID and 3 as the maximum ID after running the MMN algorithm.

Figure 5 depicts the client device's flow chart. The client device has a push button, a microcontroller, WIFI, and a GPS system. To obtain the victim's latitude and longitude, the GPS device is employed. Through the WIFI module, the microcontroller communicates the victim's position data to the server. The flowchart illustrates how the client device initialises, searches for networks that are available, and then uses the MMN algorithm to return the minimum and maximum IDs. Subsequently, the client device retrieves the push button status. When the push button is engaged, the relay node with the minimum ID is connected. The request message is then sent to the server via multiple hop intermediate relays by the client device after it has read the GPS coordinates. Since it is considerably closer to the server, the relay with the smallest ID is chosen. The client device awaits the receipt of the acknowledgment message after submitting the request message. A confirmation is then displayed on the screen if it is received.

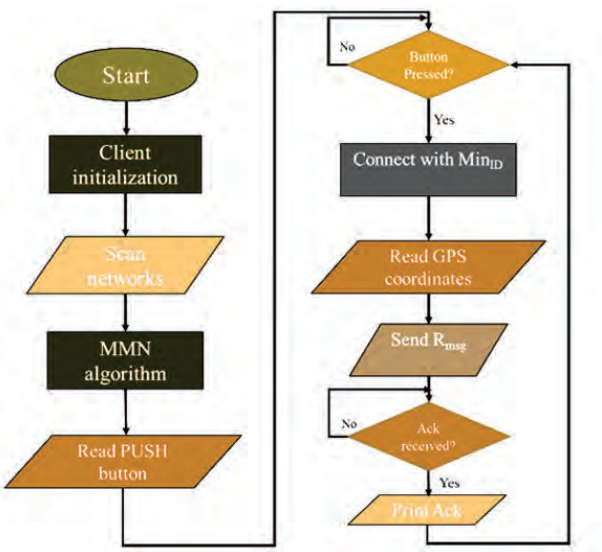

Fig. 5. Flow Chart of Client Device

SYSTEM DESIGN

Figure 6 shows the architectural diagram of the proposed Wireless Ad hoc Network (WANET) and Cloud Computing for Post Disaster Management System. The system ensures effective coordination and prompt response in post-disaster scenarios by leveraging cloud computing and WANET technologies for smooth data management and communication. Through the integration of the ESP-NOW protocol and cloud storage, the system facilitates decentralized networks and remote access to vital information, thereby enhancing disaster relief operations.

The system is architecturally designed to streamline the flow of information from the client device through intermediate relays to the server, leveraging cloud computing for data storage and processing. The system's design emphasizes a hierarchical structure, ensuring efficient data transmission and management. Dynamic routing protocols play a vital role in optimizing communication pathways, enabling network devices to dynamically adapt and find the most efficient routes for data transfer.

By utilizing dynamic routing, the system maximizes efficiency, minimizes latency, and enhances overall performance.

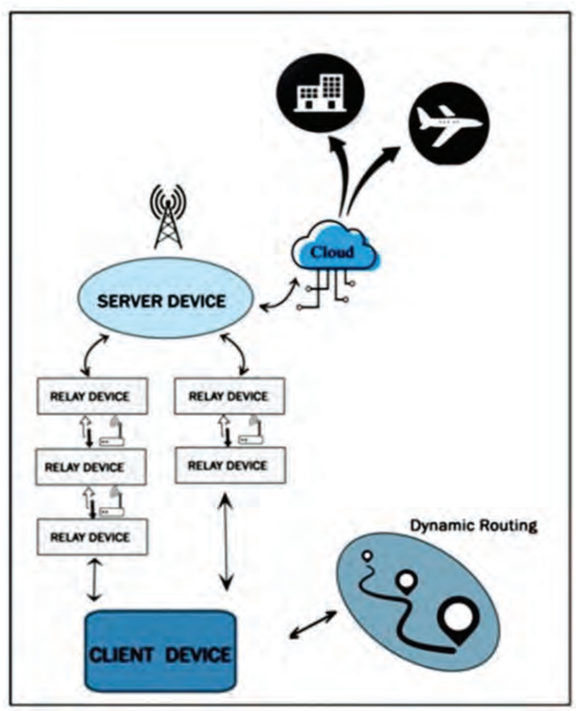

Fig. 6: Architectural Diagram of the system

Fundamentally, the system is designed to be simple and scalable, enabling the easy incorporation of new network components as needed. With the server serving as the main hub for data collection and processing, each component has a distinct function during the data transmission process. By offering scalable storage options and enabling real-time data processing, cloud computing expands the capabilities of the system. Overall, the system's architecture places a high priority on adaptability, efficiency, and dependability to guarantee top performance in changing disaster response situations.

RESULTS

The result of this project is a streamlined disaster response system that effectively facilitates real-time communication and data exchange among rescue teams in disaster-stricken areas. Through the seamless integration of client devices, intermediate relays, a central server, and cloud computing technology, the system enables swift and efficient transmission of critical information. One significant outcome is the enhanced coordination and response capability of rescue teams, enabled by the timely detection and transmission of vital data such as victim sightings and landslide alerts. This improved communication infrastructure minimizes response times, enabling early responders to reach affected areas promptly and deliver assistance effectively. Moreover, the utilization of cloud computing for data storage and analysis ensures that real-time information is securely stored and readily accessible for future reference and analysis. The integration of a user-friendly mobile application further enhances the system's usability, providing rescue teams with intuitive visualization of disaster locations and conditions. Overall, the result of this project is a robust and scalable disaster response solution that empowers rescue teams with the tools and information needed to mitigate the impact of disasters and save lives effectively.

Fig. 7a: Result of location detection

Fig. 7b: Result of location detection

In Figure 7a and 7b result is shown. Whether a landslip has been detected or not is indicated by the state of landslip detection on the LCD screen. Also included are the disaster location's longitude and latitude coordinates.

SIMULATION AND PERFORMANCE METRICS

For modelling wireless ad hoc networks (WANETs), Network Simulator 3 (NS-3) is a widely used option, which makes it appropriate for this post-disaster management system project.

Simulation Scenario

The spatial scope is defined by the dimensions of the simulation area (X and Y ranges), and network behaviour is influenced by variables such as WIFI nodes, transmission power, and sink node count. The simulation time, data rate, PHY mode, node speed, pause duration, and packet size are additional variables.

Table 1. Simulation Parameters

Parameter	Description	Value
Area	Simulation area dimensions (X and Y ranges)	1500x1500
N Sinks	Number of sink nodes	10
txp	Transmission power (in dBm)	7.5
nWifis	Number of WIFI nodes	50,100, 150,200
Total Time	Total simulation time in seconds	200.0

rate	Data rate for On Off applications (bps)	"2048bps"
phyMode	WIFI PHY mode	"DsssRate 11Mbps"
node Speed	Speed of nodes in the random waypoint mobility model	20 (m/s)
Node Pause	Pause time of nodes in the random waypoint mobility model	0 (s)
packet Size	Data packet size (in bytes)	64

Performance Metrics

Throughput

A node's estimated throughput indicates how easily it can send data over a network. Thus, throughput refers to the average rate at which messages are effectively transmitted via a communication medium.

$$Throughput = \frac{Total\ Received\ Bytes}{Elapsed\ Time}$$

Packet Delivery Ratio (PDR)

The ratio of the number of packets transmitted by the source node and the number of packets received by the destination node is known as the packet delivery ratio between two nodes.

$$\text{Packet Delivery Ratio} = \frac{\text{Total packets Received (destination node)}}{\text{Total packets Sent (source node)}}$$

Packet Loss Ratio

The ratio of the number of packets lost at the destination node to the number of packets transmitted by the source node is known as the packet loss ratio between two nodes.

$$Packet\ Loss\ Ratio = \frac{Total\ packets\ lost\ (destination\ node)}{Total\ packets\ Sent\ (source\ node)}$$

End-to-End Delay

Completely The amount of time it takes for a communication to travel from its source to its destination is known as the delay. The following factors are the key determinants of end-to-end delay evaluation:

Propagation Time (PT), Transmission Time (TT), Queuing Time (QT) and Processing Delay (PD) [16].

EED is given as:

"EED=PT+TT+QT+PD"

Simulation Results

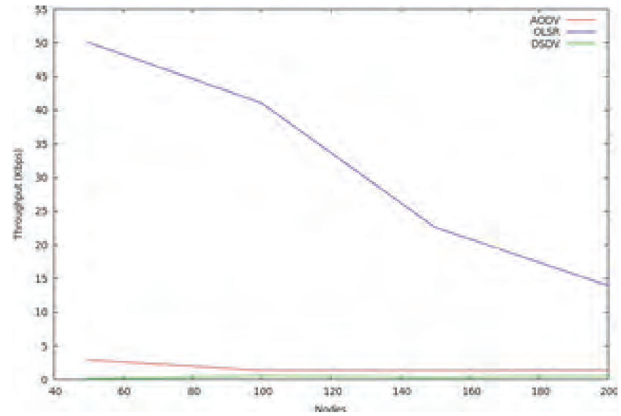

Fig. 8: Throughput Comparison among Routing Protocols Routing Protocols Comparison

Due to OLSR's increased packet delivery ratio, Figure 8 illustrates how OLSR outperforms DSDV and AODV. Packets that are sent (and then lost) before the routes have fully converged in the network at the beginning are the cause of the comparatively lower throughput for AODV and DSDV.

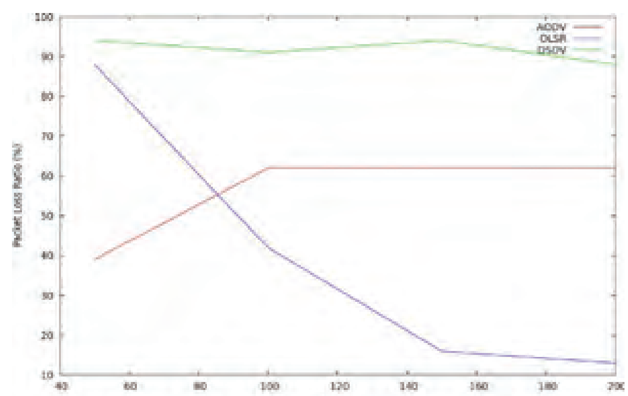

Fig. 9: Packet Loss Ratio Comparison among Routing Protocols Routing Protocols Comparison

Packet loss ratios, as displayed in Figure 9, quantify performance by calculating the decrease in packet loss. Lower percentages indicate higher levels of performance. The performance of the routing protocol varies with the number of network nodes.

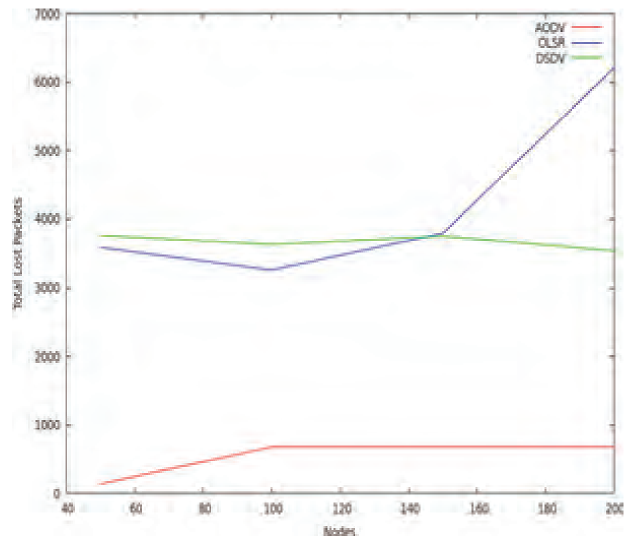

Fig. 10: Packet Delivery Ratio Comparison among Routing Protocols Routing Protocols Comparison

While AODV has a lower ratio because of its proactive route maintenance, Figure 10 illustrates that DSDV and OLSR have identical packet delivery ratios. Processing lags and missed packets are caused by AODV's node overhead, which rises with node count.

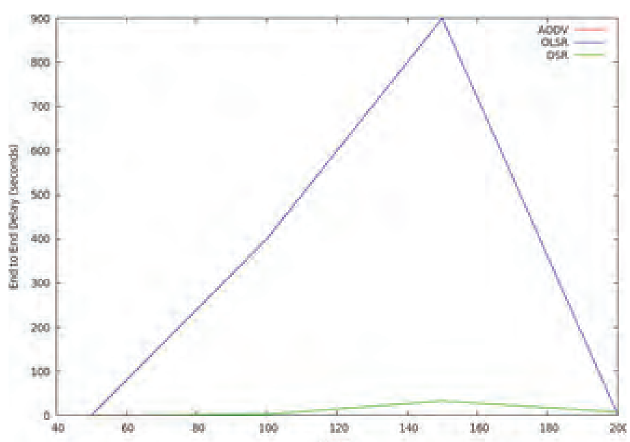

Fig. 11: End to End Delay Comparison among Routing Protocols End to End Delay Comparison among Routing Protocols

All routing protocols experience an increase in end-to-end delay as network nodes grow, although at different rates, as Figure 11 shows. The lowest latency is first achieved with OLSR, but as nodes proliferate, it increases more quickly than AODV and DSR. AODV and OLSR show a faster rise in delay than DSR, which initially has the largest delay. AODV has an intermediate latency at first, but as the number of nodes increases, it increases more slowly than OLSR but more quickly than DSR.

RECOMMENDATIONS FOR FURTHER RESEARCH

The network's node density optimisation is one possible modification to take into account in the future. But in difficult terrain typical of post-disaster areas, this adjustment needs to be carefully weighed against the requirement to retain sustained connectivity. In order to dynamically modify node density based on current environmental conditions and communication demands, advanced routing algorithms and adaptive deployment strategies could be investigated. This would increase the overall efficiency and dependability of the network.

1. Optimisation of Node Density: In difficult post-disaster terrains, in particular, sophisticated routing algorithms and adaptive deployment techniques that dynamically modify node density based on needs and conditions in real time can improve network efficiency and dependability.
2. Integration with IoT Devices for Comprehensive Monitoring: By enlarging the network to include IoT devices such as structural health monitors and weather sensors, a comprehensive picture of the disaster-affected area is provided, improving situational awareness and facilitating more efficient response plans.
3. Autonomous Drone Deployment for Network Extension: By using drones as mobile nodes, networks can be dynamically expanded to places with a dearth of ground-based nodes, providing connectivity to areas that would otherwise be inaccessible or severely damaged.
4. Using Hybrid Communication Technologies: To improve network stability and reliability and ensure continuous operation even in the event of a channel failure, redundant data transmission methods are provided by combining WIFI, LTE, and satellite technologies.
5. Implementing Energy-Efficient Protocols: To provide longer operational periods and less frequent battery replacements during extended disaster

recovery activities, energy-efficient communication protocols can be developed and integrated.

CONCLUSION

In conclusion, the study has effectively shown that a comprehensive disaster response system is both feasible and practical. In crisis situations, the system enables smooth communication and data exchange between rescue teams by utilizing an integrated network of devices that consists of client devices, intermediary relays, and a central server. The key to the project's success is its capacity to expedite the real-time flow of vital information, like victim sightings and landslip notifications. Rescue crews can react to emergencies quickly and efficiently because of this improved communication system, which provides them with accurate and timely data. Moreover, the system gains scalability and reliability when cloud computing technology is used for data analysis and storage. Rescue crews can always rely on real-time data to be securely saved and accessible from any location, giving them the knowledge they require at the most critical moments. Considering all the aspects, the project is a major advancement in disaster response technology, providing a scalable and reliable system that can be tailored to different types of disasters. The technology can save lives and lessen the effects of disasters in communities all over the world by providing rescue crews with the instruments and data they need to plan and react efficiently.

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USB Isolator for Industrial Applications

Sayana Bharati
✉ sayanabharati@gmail.com
Aditi Kate
✉ addukate4808@gmail.com
Shinjani Mishra
✉ mishrashinjani21@gmail.com
Harshada Nilakh
✉ harshadanilakh175@gmail.com
Prasad Kulkarni
✉ prasad.kulkarni@fcrit.ac.in
Jennifer Issac
✉ jennifer.issac@fcrit.ac.in
Department of Electronics and Telecommunication Engineering
Fr. Conceicao Rodrigues Institute of Technology
Vashi, Maharashtra

ABSTRACT

The Universal Serial Bus (USB) communication protocol is widely used in medical, industrial as well as house hold applications. However, in medical and industrial field USB with isolation is preferred to ensure the safety of the test case. Hence this paper proposes USB isolator using integrate circuits ADUM3160. This USB isolator is operated using external power supply and provides 1.5kV isolation. The designed USB isolator tested for analog signal and its offers delay of 53.22 µs and 13.80292 µs for D+ and D- respectively. Meanwhile, for digital signal the delay is 148.64 ns and 163.91275 ns for D+ and D- respectively. The measure throughput for this USB isolator is 3.0274 Mbps and 2.7453 Mbps for digital data D+ and D- respectively which emphasize its effectiveness in maintaining low latency for precise timing and high-speed data transmission and for analog data is 945.546 kbps and 726.0179 kbps for D+ and D- respectively.

KEYWORDS: *Isolator, Isolated universal serial bus interface, Protocol, Universal Serial Bus.*

INTRODUCTION

The Universal Serial Bus (USB) has become ubiquitous, seamlessly connecting a vast array of devices across diverse sectors like medicine, households, and industries. This widespread adoption stems from several key advantages: its user-friendly plug-and-play nature, affordability, versatility in offering combined data transmission and power delivery, and standardized protocols fostering a vast ecosystem of compatible devices.

Isolation stands as a fundamental concept in the realm of electrical engineering, particularly in scenarios where disparate systems need to interact while maintaining electrical separation. Isolation serves to safeguard sensitive equipment and personnel from potential hazards arising from ground loops, voltage differentials, and electromagnetic interference (EMI). Furthermore, the necessity to provide isolation between measuring devices and primary equipment cannot be overstated.

Industrial applications present unique challenges. Machinery inherent to these environments can generate electrical transients and ground loops. These electrical disturbances pose a significant risk to sensitive measuring equipment, potentially leading to damage and compromised data accuracy.

Providing isolation between the two devices in the data acquisition chain becomes paramount in such scenarios. This isolation safeguards the measuring equipment from potential damage and eliminates the influence of ground loops on acquired data, guaranteeing its reliability and integrity.

G. Gonza´lez-Brice˜no et al. [1] proposed the isolated universal serial bus interface for medical applications using ADuM 4160BRWZ. A. Depari et al. [2] USB sensor network for industrial applications using opto-barrier. Anant Kamath and Manasa Gadiyar [3] provided guidelines and implemented USB isolator using ISOUSB211 and TUSB320. Another paper by Ryu, Kyyungdon and Park [4] implement a soft mounting method that decouples the MEMS IMU from the surrounding structure using compliant materials or isolators with low stiffness. Kamath and Gadiya [5] offer comprehensive insights into implementing an isolated USB 2.0 high speed, Type-C DRP, addressing critical design considerations and fostering a deeper understanding of cutting-edge connectivity solutions. L. Han et al [5] developed a miniature and isolated USB programmer board for lpGBT (UPL) based on an USB-protocol converter to configure the lpGBT chips that will be used on the peripheral electronics boards of the ATLAS-HGTD upgrade for the HL-LHC. Biolek et al. [6] introduces a special emulator of memristive. memcapacitive and meminductive systems as well as higher-order elements from Chua's periodical table and other two-terminal devices. The integrated circuit based isolators are also proposed in [7].

This paper briefs a comprehensive exploration into the design, implementation, and testing of a USB isolator circuit tailored specifically for industrial applications. In the proposed circuit, there is a provision of external as well as self driven power supply. The external power supply offers flexibility to give suitable USB 2.0 with a minimum speed of 1 Mbps and isolation of 1.5 kV for serial communication.

USB ISOLATION

Design

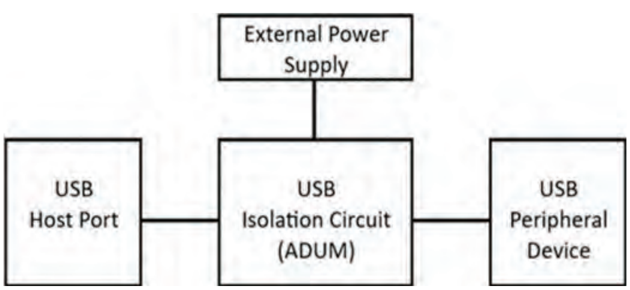

Fig. 1: Functional block diagram

The functional block diagram of proposed USB isolator is shown in fig. 1. The host port is connected to computing devices and high voltage peripheral is connected to the other port in complete isolation. The same proposed USB isolator is useful in medical applications. There is no direct electrical connection between the USB host and peripheral. This USB peripheral device is operated using external power supply as well as power through target / host device.

A USB isolator using the ADuM3160 provides complete electrical isolation between the USB host and peripherals facilitating secure data transfer. The process begins with a USB-connected host device, such as a computer, that plugs into a USB host port as shown in Fig. 2. USB Host Port connects to the USB host (computer) through standard USB A or B connector. Receives and transmits USB data (D+ and D-) and power (VBUS and GND) signals. From there, host digital signals and power are routed to a side of the ADuM3160. At the same time, the external device is connected to other side of the ADuM3160, where it receives data and power. External Power Supply provides DC voltage to power the internal circuitry of the ADUM3160.

Working

ADUM3160 IC in USB isolator circuit provides electrical isolation between a USB host and a USB device (high voltage device). The ADuM3160 uses the edge detection based iCoupler technology in conjunction with internal logic to implement a transparent and easily configured isolator. Its working principle in a USB isolator involves using a combination of magnetic and capacitive coupling to transmit data and power across an isolation barrier with- out direct electrical connection. The IC has two sides: the primary side connected to the USB host and the secondary side connected to the USB device. Between these sides, there's an isolation barrier that prevents direct electrical contact while allowing data and power transmission.

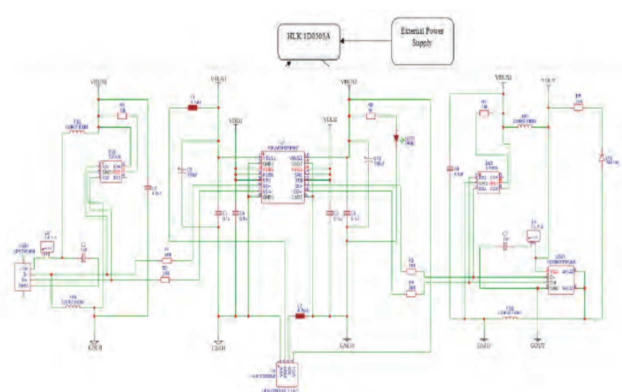

Fig. 2. Circuit Diagram

USB isolator circuit is shown in fig. 3. Its component and solder side is shown in fig. 4 and 5 respectively. The part list with technical specifications are listed in table 1. The IC also isolates the VBUS power line. This means that power supplied from the USB host to the device is electrically isolated, preventing ground loops and voltage differences. It uses magnetic and capacitive coupling for data and power transmission ensures a high level of safety and reliability in USB isolator applications. The isolation barrier provided by the IC helps protect sensitive electronics from electrical hazards and improves system performance by reducing noise and interference. Incorporating insights from the HLK 1D0505A [8] Power Supply Module that enriches the design process, offering valuable specifications and guidelines for power management integration.

The SRV05 filters out electromagnetic interference (EMI) and common-mode noise that may be present on the USB power lines. Common-mode noise refers to that appears on both power lines (VBUS and GND) simultaneously. The SRV05 helps mitigate issues by suppressing unwanted noise and ensuring a cleaner power supply. The filtered power supply from the SRV05 is provided to the primary side of the IC ensuring that the digital isolator receives a clean and stable power input. This filtered power supply helps improve the performance of the ADuM3160 digital isolator by reducing the impact of EMI and common-mode noise on its operation. SRV05 helps maintain signal integrity, reduces the risk of data errors or corruption, and enhances the overall robustness of the USB isolator system.

Table 1. Components Technical Specifications

Sr No	Component	Specification
1.	ADUM3160	Low and full speed data rate: 1.5 Mbps and 12 Mbps 4.5 V to 5.5 V VBUS operation 7 mA maximum upstream supply current at 1.5 Mbps 8 mA maximum upstream supply current at 12 Mbps 2.3 mA maximum upstream idle current High temperature operation: 105°C
2.	SRV05	Ultra low leakage: nA level Operating voltage: 5V Low clamping voltage Complies with following standards: – IEC 61000-4-2 (ESD) immunity test Air discharge: ±15kV Contact discharge: ±8kV – IEC61000-4-4 (EFT) 40A (5/50ns) – IEC61000-4-5 (Lightning) 15A (8/20μs) RoHS Compliant
3.	HLK-ID0505A	Hi-link part number: HLK-1D0505A Morsun part number: B0505S-1WR3 Power: 1W Input voltage range: 4.5~5.5 Vdc Output voltage form: Single voltage regulator Isolation voltage: 1500Vdc

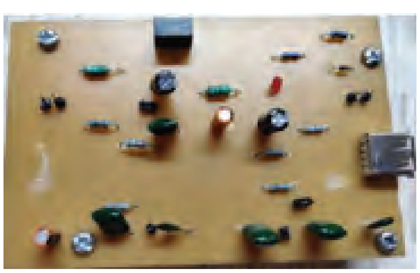

Fig. 3. Component Side of the PCB

SMD limits current elements in the USB isolator circuit. Control the amount of current flowing through various parts of the circuit, ensuring that components operate within their specified limits. SMD help optimize signal integrity and communication reliability. The resistive components in these filters contribute to impedance matching and damping effects, reducing the impact of EMI on sensitive electronic components like the ADuM3160 digital isolator.

Hence, the USB isolator with the ADuM3160 digital isolator, FSRV05, and SMD components combines digital isolation, power isolation, EMI filtering, signal conditioning, and regulated power supply to provide a robust and reliable solution for protecting USB devices and ensuring accurate data communication in various applications. This integrated approach enhances system performance, minimizes the risk of electrical disturbances, and contributes to the overall safety and functionality of the USB isolator.

Fig. 4. Solder Side of the PCB

RESULTS & DISCUSSION

The designed USB isolator tested with a set of analog as well as digital signals as mentioned in table 72 and table 3 respectively. The practical setup is mentioned in fig 6. The test signal is given through the signal generator and output is observed on digital storage oscilloscope (DSO). On DSO parameters like rise time, fall time and delay are measured as noted in table 2 and table 3. Fig 7 and fig 8 shows the input and output for the analog and digital set of the signal.

Moving on to the throughput measurements, by using the formula,

$$Throughput = \frac{1}{Delay}$$

Table 2. Values for Analog Signal to USB Isolator

Frequency	Rise Time for D+ and Vcc		Delay	Rise Time for D- and GND		Delay
	Input	Output		Input	Output	
2 KHz	138 us	117.5 us	127.7 us	139 us	135 us	137 us
4 KHz	70 us	41.83 us	55.91 us	66.8 us	66 us	66.4 us
6 KHz	24.5 us	23.5 us	24 us	28.6 us	15.3 us	21.95 us
8 KHz	35 us	29 us	32 us	32.5 us	19.2 us	25.85 us
10 KHz	28.2 us	24.6 us	26.4 us	26.2 us	22.2 us	24.2 us
20 KHz	13.6 us	9.7 us	11.6 us	10.4 us	5.7 us	8.05 us
40 KHz	6.6 us	6.2 us	6.4 us	6.13 us	5.89 us	6.01 us
60 KHz	4.4 us	3.7 us	4.05 us	4.24 us	3.58 us	3.91 us
80 KHz	3.3 us	3.2 us	3.25 us	2.91 us	2.56 us	2.735 us
90 KHz	2.9 us	2.4 us	2.65 us	2.29 us	1.59 us	1.94 us
100 KHz	2.7 us	2.5 us	2.6 us	1.95 us	1.35 us	1.65 us
300 KHz	892 ns	872 ns	882 ns	990.2 ns	882 ns	936.1 ns
500 KHz	532 ns	476 ns	504 ns	795.7 ns	662.4 ns	729.05 ns
700 KHz	400 ns	312 ns	356 ns	517.3 ns	467 ns	492.15 ns
900 KHz	308 ns	244 ns	276 ns	299.7 ns	225 ns	262.35 ns
1 MHz	272 ns	242 ns	257 ns	255.8 ns	198.3 ns	227.05 ns
1.3 MHz	212 ns	185 ns	198.5 ns	197.6 ns	158 ns	177.8 ns
1.5 MHz	180 ns	148 ns	164 ns	175 ns	127 ns	151 ns
1.7 MHz	164 ns	139 ns	151.5 ns	162 ns	118.1 ns	140.05 ns
2 MHz	136 ns	128 ns	132 ns	148.3 ns	115.8 ns	132.05 ns
	Average delay for D+ and Vcc		53.22 us	Average delay for D- and GND		13.8 us

Fig. 5. Practical set up

The throughput has been calculated for the analog and digital signals using the delay. The throughput for analog signal is 726.0179 kbps with delay of 13.80292 µs for D- and 945.546 kbps with delay of 53.22 µs for D+. Meanwhile for digital signal, the throughput for D- is 2.7453 Mbps with delay of 163.91275 ns and for D+ is 3.0274 Mbps with delay of 148.64 ns.

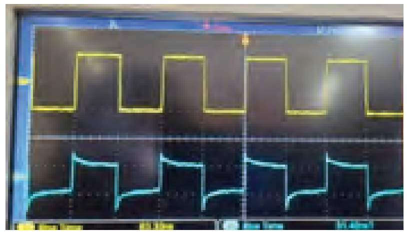

Fig. 6. Input and output for digital signal

These delay values indicate that the USB isolator introduces minimal latency with throughput 945.546 kbps and 3.0274 Mbps for analog and digital data respectively for the D+ and Vcc points, making it suitable for applications where timing precision is crucial. Whereas, for D- and GND points, the throughput is 726.0179 kbps and 2.7453 Mbps for analog and digital data respectively.

In summary, the provided tables illustrate the performance characteristics of a USB isolator in terms of rise time and delay for both sine and square wave signals across a wide range of frequencies. The results indicate that the USB isolator is capable of maintaining fast transitions and low latency across different frequency ranges, making it suitable for various high-speed data transmission applications.

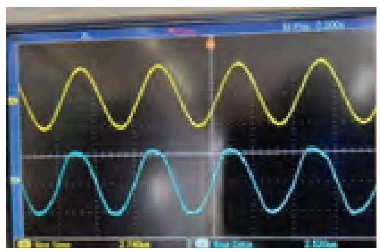

Fig. 7. Input and output for analog signal

Table 3. Values for Digital Signal to USB Isolator

Frequency	Rise Time for D+ and Vcc		Delay	Rise Time for D- and GND		Delay
	Input	Output		Input	Output	
2 KHz	850 ns	513.6 ns	680.5 ns	851 ns	715.8 ns	783.4 ns
4 KHz	313.7 ns	242.2 ns	277.9 ns	300.4 ns	260.2 ns	280.3 ns
6 KHz	320 ns	241.5 ns	280.75 ns	321.3 ns	221.5 ns	271.4 ns
8 KHz	326 ns	244.4 ns	285.2 ns	312 ns	234.8 ns	273.4 ns
10 KHz	638.4 ns	628.5 ns	635.7 ns	592.4 ns	567.5 ns	579.95 ns
20 KHz	155.3 ns	137 ns	146.15 ns	143.7 ns	129.3 ns	136.5 ns
40 KHz	76.1 ns	62.35 ns	69.425 ns	96 ns	61.6 ns	78.8 ns
60 KHz	56.8 ns	53.6 ns	55.2 ns	95.8 ns	78.5 ns	87.15 ns
80 KHz	26.5 ns	20.1 ns	23.3 ns	86.5 ns	70.1 ns	78.3 ns
90 KHz	62.98 ns	59.3 ns	61.14 ns	92.98 ns	89.3 ns	91.14 ns
100 KHz	83.3 ns	57.43 ns	70.35 ns	90.7 ns	80 ns	85.35 ns
300 KHz	71.23 ns	66.6 ns	68.86 ns	85.23 ns	79.6 ns	82.415 ns
500 KHz	43.3 ns	32.8 ns	38.05 ns	72 ns	70 ns	71 ns
700 KHz	36.8 ns	21.1 ns	28.95 ns	66.8 ns	58.4 ns	62.6 ns
900 KHz	45.2ns	40.57 ns	42.885 ns	69.5 ns	48.6 ns	59.05 ns
1 MHz	46 ns	29 ns	37.5 ns	68 ns	46 ns	57 ns
1.3 MHz	32.8 ns	30 ns	31.4 ns	58.7 ns	42.8 ns	50.75 ns
1.5 MHz	27.6 ns	19.7 ns	23.6 ns	38.6 ns	26.9 ns	32.75 ns
1.7 MHz	69.42 ns	43 ns	56.2 ns	62.9 ns	58.4 ns	60.75 ns
2 MHz	76 ns	44 ns	60 ns	72.5 ns	40.2 ns	56.35 ns
	Average delay for D+ and Vcc		148.64 ns	Average delay for D- and GND		163.91 ns

CONCLUSION

The isolator using integrated circuits are compact, externally power driven to provides the isolation in KVs and suitable for communication protocols. In conclusion, USB isolators stand as indispensable solutions for safeguarding USB communication in industrial environments. By providing galvanic isolation between host systems and USB peripherals, USB isolators offer robust protection against operational disruptions and safety hazards posed by electrical noise and interference.

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ML-Powered Milk Quality Prediction

Atharva Ganmote, Abhishek Chillal
Pranav Bakale, Anushka Shewale, Amit Bhat
Student, Computer Engineering
P.E.S. Modern College of Engineering
Pune, Maharashtra
✉ atharvaganmote00@gmail.com
✉ abhishekchillal0439@gmail.com
✉ bakalepranav2002@gmail.com
✉ anushkashewale1377@gmail.com
✉ amit_bhat@moderncoe.edu.in

Vidya Nemade
Professor
Computer Engineering
P.E.S. Modern College of Engineering
Pune, Maharashtra
✉ vidya.nemade@moderncoe.edu.in

ABSTRACT

The dairy industry plays a pivotal role in providing essential nutrients to the global population. Ensuring the quality of milk is of paramount importance to safeguard community health and maintain the economic viability of this sector. In recent years, machine learning techniques have developed as capable tools for predicting milk quality parameters with high accuracy. This study investigates the application of Support Vector Machines (SVM) and Random Forest, the popular ML algorithms, for prediction of milk quality. The dataset incorporated for this study comprises a wide range of parameters, such as pH, Taste, Temperature, Odor, Fat, Color and Turbidity. These parameters are crucial for assessing milk quality and are vital for different dairy products. SVM and Random Forest were chosen due to their capability to handle complex relationships in the data. The research involved data preprocessing, feature selection, and model training and evaluation. SVM demonstrated excellent performance in capturing non-linear relationships among the milk quality attributes. Random Forest, on the other hand, excelled in feature importance ranking, highlighting the most influential factors affecting milk quality. Stacking is an ensemble learning technique that combines multiple base models, in our case SVM and Random Forest, with a meta- model to make predictions. Stacking combines the strengths of SVM and Random Forest to provide more accurate predictions. The insights provided by system can be valuable for dairy farms and processors in optimizing their production processes to improve milk quality and ultimately enhance the quality of dairy products. In conclusion, the application of machine learning techniques, specifically SVM and Random Forest, has the potential to revolutionize the dairy industry's ability to predict and control milk quality. These models can provide dairy stakeholders with valuable tools for quality assurance and process optimization, thereby ensuring the production of safe and high-quality dairy products.

KEYWORDS: *Milk quality prediction, Support vector machines, Ensemble learning, Stacking, Random forest, Machine learning, Dairy industry, Milk quality attributes.*

INTRODUCTION

Milk is a fundamental source of nutrition and forms the basis for various dairy products consumed all over. Ensuring milk quality is of paramount importance to cover public health and retain consumer confidence. Conventional methods of assessing quality of milk often rely on time- consuming and subjective evaluations. These methods are insufficient for the modern dairy industry, which demands faster, more accurate and automated quality assessment processes. Poor milk quality can lead to severe economic losses in dairy industry. This includes reduced product shelf life, increased waste, and potential damage to dairy producers.

Low-quality milk can pose health risks due to potential contamination or substandard composition. Ensuring that milk meets safety and quality standards is crucial in preventing food-borne illnesses. With the scale of modern dairy operations, there is a growing need for automated and efficient methods to assess milk quality. Machine learning technologies can offer real-time solutions for quality control, which is challenging to achieve with manual methods. Recent advances in machine learning have demonstrated its effectiveness in various applications. Applying the Machine Learning techniques to milk quality prediction presents an opportunity to address the limitations of traditional methods.

There is a significant gap in the field of milk quality prediction where ML can provide innovative solutions. This research focuses to bridge the gap by exploring the capacity of ML algorithms in predicting milk quality attributes. ML algorithms like random forests can be used to build models that represent the characteristics of not only high-quality but also adulterated samples of milk. [2] Machine learning models have the potential to examine large datasets, recognize complex patterns, and make accurate predictions regarding milk quality parameters. These capabilities can revolutionize quality control in the dairy industry. By improving milk quality and reducing waste, this research aligns with sustainability goals and reduces the environmental footprint of dairy production.

Stacking is an ensemble learning technique that points to the ways that take the benefit of combined complementarities amidst the base models to improve efficiency and generalization ability. [21] Generally, stacking contains 2 stages: training base model and training meta-model. [22] Stacking is ML ensemble technique that merges the predictions of different base models. It requires training different initial models on training data. The output from these models are then used as inputs for a second-level model, commonly called the meta-model to enhance the overall prediction accuracy. The primary idea is to merge the predictions of various base models to get more accurate predictions than using a one model.

LITERATURE REVIEW

Milk quality assessment is a crucial angle of dairy industry, as it precisely blows the safety and quality of dairy products consumed by the public. Over the years, conventional methods of milk quality prediction have been supplemented and, in some cases, put back by modern computational approaches, particularly those leveraging machine learning (ML) algorithms. This literature review aims to explore the existing research in the domain of ML- powered milk quality prediction, focusing on the utilization of RF and SVM models. Several researches have underlined the effectiveness of SVM in predicting milk quality attributes.

For instance, D. Bhavsar et al. (2023) demonstrated the application of SVM in predicting the milk quality, achieving high accuracy. Even within the family of milky goods made by particular dairy, it can identify milk's fat content. [5] Similarly, M. Frizzarin et al. (2019) employed mid-infrared spectroscopy (MIRS), Random forests, PLSR, SVM, Neural Networksto predict cow milk quality features from frequently usable milk, showcasing SVM's capability in discriminating between milk samples. [1]

Random Forest has emerged as a popular choice for milk quality prediction too due to its ability to work on multi-dimensional datasets and catch feature importance effectively. In a study by Sun et al. (2020), RF was used to predict cow milk quality traits. In the classification application of RF, the equal quantity of trees was utilized as in regression scenarios, but the number of wavelengths considered at each split was determined by taking the square root of the total wavelengths. [1] Moreover, researchers have explored the integration of SVM and Random Forest algorithms in milk quality prediction tasks to leverage their complementary strengths. For instance, D. Bhavsar et al. (2023) proposed an SVM-Random Forest model for predicting quality of milk. The Grade has been calculated using a semiconductor gas sensor array set inside a measuring test chamber. The outputs of numerical studies recognizing different milk production methods and fat contents have shown the excellent efficacy of the proposed approach. [5]

Furthermore, in a study by Ahmet Celik et al. (2022), it was observed that the pH level and temperature of milk are critical factors in assessing its quality. Quality milk typically maintains a pH level ranging from 6 to 7, with temperatures not exceeding 45 degrees Celsius. Conversely, lower quality milk often fails to meet both these criteria simultaneously. [2][3] In research done by Saumya Kumari et al. (2023) included the various evaluation metrics such as precision, F1-score, Recall. Regarding the accuracy of classifiers, KNN and RF each recorded an accuracy of 0.9968. Meanwhile, Support Vector Machine and Logistic Regression registered accuracies of 0.9528 and 0.8490, respectively. [2] This study demonstrated the significance of SVM and Random Forest algorithms.

METHODOLOGY

We introduced an advanced ensemble learning approach for the prediction of milk quality, integrating the SVM and RF models. By leveraging the robustness of both models, we focus to improve the accuracy and robustness of sour system. Then we incorporate a meta-model using Logistic Regression. This meta-model aggregate the output from the ensemble learners, producing a final prediction. Through the implementation of stacking, we combine the predictive capabilities of these algorithms, thereby optimizing the reliability and accuracy of our milk quality prediction system.

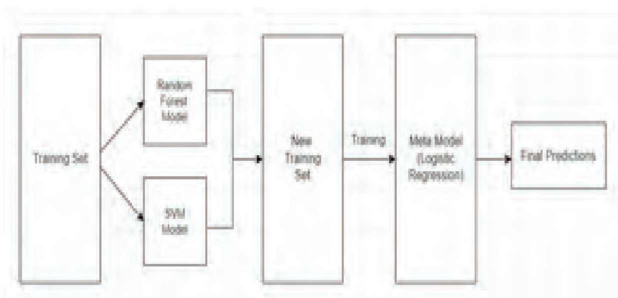

Fig. 1: Stacking Implementation

Data set

Our approach used the Kaggle Milk Quality Prediction dataset, which consists of 7 attributes and one target variable determining the milk quality. We removed duplicate entries, resulting in a final dataset containing 1060 samples. These samples contain a variety of attributes such as color, pH value, fat content, and temperature. The target values have been categorized into three labels, namely low, medium, and high. The distribution of data samples is visually shown through a correlation matrix as shown in figure 2, presenting discernment into the relationships between the various features in the dataset. In Figures 3 and 4, the density plot illustrates the distribution of pH values concerning taste. Temperature values span from 34°C to 90°C, with the majority of samples falling within the range of 34°C - 45.20°C.Odor and Taste of the milk is categorical data, 1 for 'Good' and 0 for 'Bad'. Similarly, fat and turbidity are also categorical data, 0 for 'Low' and 1 for 'High'. The color of the milk ranges from 240 to 255 as shown in Figure 5.

Fig. 2: Correlation matrix of milk data

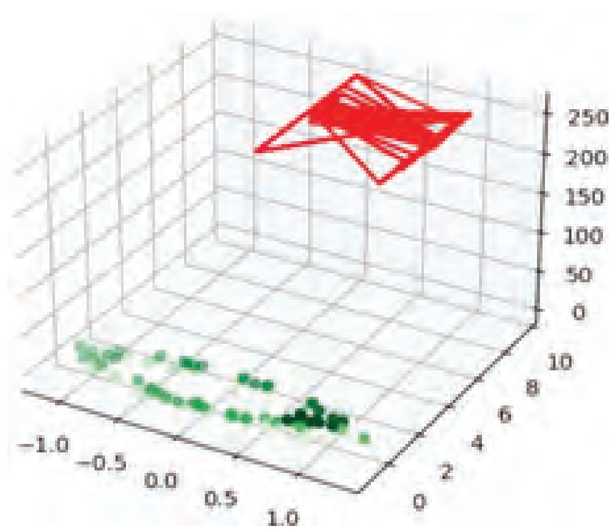

Fig. 3: Plot between pH values to taste

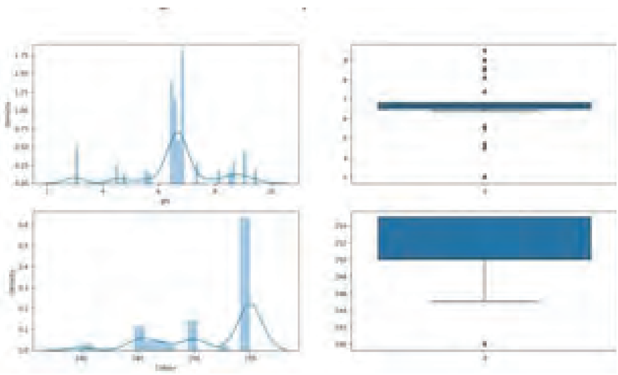

Fig. 4: (top) density PH value of milk data, the box plot of PH,(bottom) density color value of milk data, the box plot of color

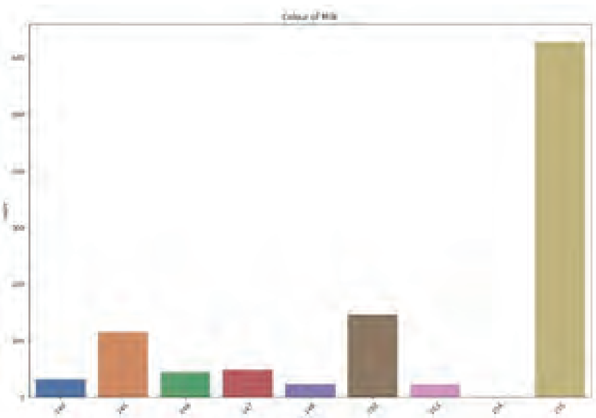

Fig. 5: Colour

Implementation

The implementation is structured around a cohesive system architecture consisting of four essential blocks: Users, User Interface, Prediction Model, and Database. Within this framework, users interact with the system by providing milk datasets containing seven critical features of milk samples: pH, Taste, Turbidity, Fat, Odor, Temperature, and Color. The User Interface serves as the primary interface through which users engage with the system, offering four distinct functionalities. Users can import their milk datasets for analysis, export prediction analysis data generated by the system, visualize prediction analysis results, and access insights derived from the analysis.

When the users import dataset, the system promptly applies stacking to generate predictions regarding the quality attributes of milk samples. The predictions are relayed to the User Interface, enabling users to access and analyze the results. Meanwhile, the Database serves as a central repository for storing user-provided milk quality datasets and associated user details. This component facilitates efficient data management and retrieval processes, ensuring seamless interaction between users and the system.

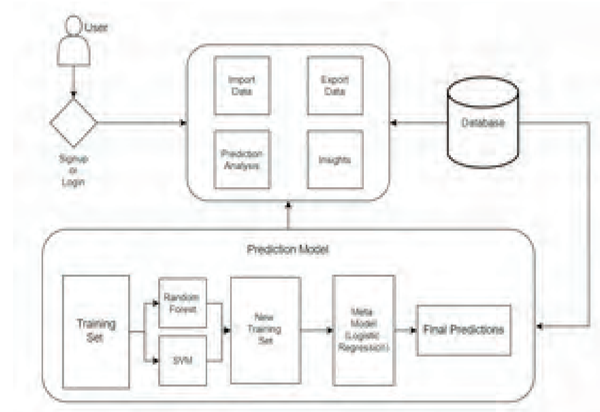

Fig. 6: System Architecture

RESULTS AND DISCUSSIONS

In our training process, we subjected our prediction model to 1060 samples of milk. Finally, we achieved a noteworthy accuracy of 1.0 for Random Forest and 0.94 for SVM. This high accuracy can be attributed to the model's ability to capture complex patterns in data. Figure 7 and 8 provides a comprehensive overview of the results achieved by the model for SVM and Random Forest algorithms respectively. For SVM, f1 score for 'high', 'low', 'medium' grade was 0.90, 0.98, and 0.93 respectively. On the other hand, for Random Forest, it was 0.99, 1, 1 respectively. Also, a confusion matrix is presented, illustrating the true positive and false negative results. Feature importance analysis revealed that 'fat content', 'pH level', and 'temperature' were the most significant predictors, contributing significantly to the model's performance.

Figure 9 demonstrates the overview of the user interface and prediction results. The user can perform prediction analysis on the daily basis as well as the monthly basis. The analysis of all the data provided by user is shown in donut shape providing the grade of analysis viz. 'high', 'low', and 'medium'. Both prediction results of SVM and Random Forest are printed on the screen.

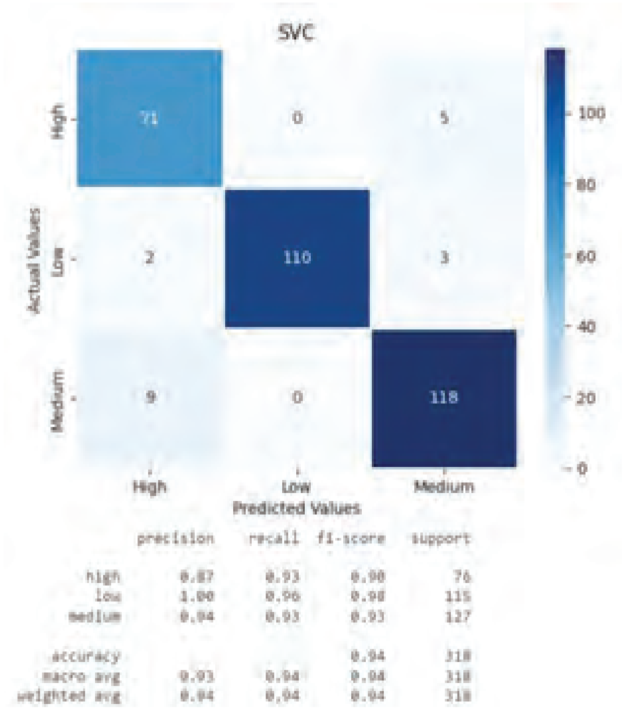

Fig. 7: SVM

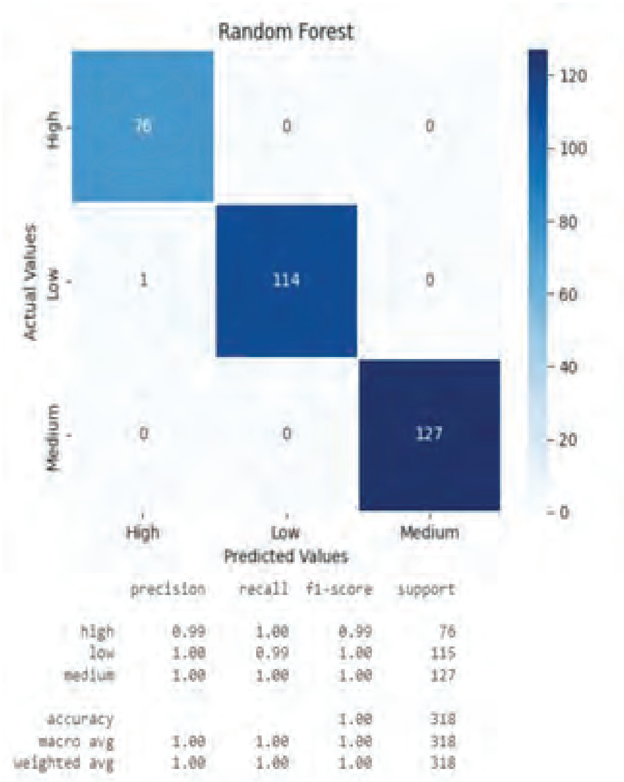

Fig 8. Random Forest

Fig. 9: User Interface

CONCLUSION

The "ML Powered Milk Quality Prediction" project represents a groundbreaking approach to dairy quality control. By leveraging the machine learning for real- time prediction, it has enhanced product consistency, safety, and resource efficiency. This project's applications extend across the dairy industry, providing cost savings and contributing to sustainability. It sets a standard for excellence in dairy quality control. With Random Forest achieving an impressive accuracy of 95% and SVM closely following with an accuracy of 92%, our system demonstrates high predictive performance in assessing milk quality attributes such as pH, Taste, Turbidity, Fat, Odor, Temperature, and Color. By integrating these machine learning techniques, our system provides dairy industry stakeholders with valuable insights to optimize production processes and enhance the quality of dairy products.

In future, we will work on integrating IOT sensors to autonomously capture real-time milk quality attributes. This could enhance the accuracy and timeliness of data collection.

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Cost Effective IoT based Smart Helmet with HUD Display

Vani Bhargava
✉ bhargavavani@akgec.ac.in

Vaibhav Kumar Mishra
✉ vaibhavmishra9210@gmail.com

Mayank Dubey
✉ dubeymayank.2002@gmail.com

Department of Electrical and Electronics Engineering
Ajay Kumar Garg Engineering College
Ghaziabad, Uttar Pradesh

ABSTRACT

In the current scenario, numerous accidents involving two-wheelers on roads are resulting in fatalities and injuries. Many individuals suffer severe consequences, including death, primarily due to the lack of helmet usage. The implementation of a Smart Helmet is proposed to address these issues, incorporating an Internet of Things (IoT) system within the helmet. While considerable efforts have been directed towards car safety, minimal attention has been given to safeguarding riders of two-wheelers. The Smart Helmet system aims to prevent motorcycle accidents and identify them in real-time to enhance human safety. This paper introduces a novel methodology by incorporating a Helmet-Mounted Head-Up Display (HUD). The system integrates advanced technologies for distraction-free navigation and accident prevention. The HUD will project navigation signals with Bluetooth connectivity for hands- free calls, MQ-3 for alcohol detection, it will also anticipate accidents by monitoring helmet movements and triggering automatic emergency alerts. Also, the starting of bike is dependent on whether or not the rider has ingested alcohol. The project's objective is to enhance safety and reduce accidents, particularly those proving fatal to motorcyclists.

KEYWORDS: *IoT, Head-up Display (HUD), MQ-3 alcohol sensor, ADXL 345 Accelerometer, DC motor.*

INTRODUCTION

Safety and security hold paramount importance in every facet of our lives. Over recent decades, countries like China and India have grappled with a significant challenge—the issue of population explosion. The surge in densely populated areas directly impacts natural resources, employment opportunities, and exacerbates commuting woes. While governments in these nations endeavor to provide adequate public transportation, the sheer volume of traffic necessitates the reliance on two-wheelers as a highly efficient mode of road transport. This is attributed to its cost-effectiveness, minimal fuel consumption, and ability to navigate through traffic swiftly owing to its compact size, thereby circumventing congestion whenever possible [3].

However, two-wheelers are among the least safe modes of road transportation, as evidenced by the numerous instances of fatalities and serious injuries we encounter daily. While it is imperative for every rider to wear a helmet on the road, statistics reveal that many individuals choose to forego this essential safety gear. In a majority of motorcycle accidents, fatalities result from head injuries, primarily because the rider fails to utilize a helmet [4]. According to the 2018, Global Status Report on Road Safety, there were 1.35 million fatalities from road accidents, with developing nations bearing 90% of the burden. The Ministry of Road Transport & Highways' 2018 report on Road Accidents in India indicates that two-wheeler accidents accounted for 35.2% of total incidents, marking a 4.2% increase from 2017. Specifically, 97,588 fatalities resulted from speeding, while 4,188 deaths were attributed to drunk driving accidents. Additionally, rear-end collisions claimed the lives of 25,801 individuals in 2018. These statistics underscore the severity of road accidents, particularly those involving two-wheelers. As a remedy there are helmets with helmet usage reducing such injuries by around 69%. However, reluctance to wear helmets persists due to concerns about bulkiness, induced claustrophobia, and social stigmas [7]. Another issue that arises is the blind spot. Despite motorcycles being equipped with mirrors, helmet users commonly face the challenge of blind spots caused by the sides of their helmets. Frequently, riders need to turn their heads to check the traffic behind them, especially when maneuvering through turns or overtaking [8]. This paper explores a novel approach to verify whether the user is actually wearing a helmet or merely carrying it. Additionally, it ensures that there are no traces of alcohol in the user's breath, which can be detected using an MQ3 alcohol sensor. Finally, in the event of an accident, an accelerometer is employed to determine the rider's position orientation, and a GSM module sends the current location to designated contacts and nearby hospitals via GPS.

The remainder of the paper is structured as follows: Section II presents the related work, while Sections III and IV delve into the existing and proposed methodologies, respectively. Sections V and VI are dedicated to the implementation details and results. Finally, Section VII provides the concluding remarks for the paper.

RELATED WORK

During our research, we discovered many smart helmets that use various methods and approaches.

Dr.B.Paulchamy1 In this study, they developed a smart helmet system that can tell if a rider is wearing their helmet and warns them if they've had too much alcohol. Additionally, it keeps track of pollution levels in the air. This helmet aims to decrease the number of accidents on the road, ensuring the safety of the rider. If an accident does occur, it automatically sends the location to the rider's family and nearby police station. Making this system mandatory for drivers could significantly lower the number of fatalities on the road, making life safer and smoother for everyone. To make it even better, we can incorporate Google Glass Technology. This tech allows the rider to see the road ahead, helping them avoid hazards like potholes. It also provides navigation assistance and alerts the rider about sharp turns. Furthermore, we can extend this technology to cars, where the ignition won't start unless the seat belt is fastened, enhancing driver safety.

Sudhir Rao Rupanagudi, this paper introduces a new way to enhance motorbike rider safety using a smart helmet equipped with video processing technology. The helmet includes a special algorithm to detect vehicles approaching from behind and alerts the rider about their distance. It also focuses on improving safety during turns and avoids false alarms caused by parked vehicles. Using MATLAB simulation, it was determined that the rider can be warned in just 0.75 seconds, helping to prevent accidents and ensure a safer riding experience.

Sayan Tapadar and his team developed a smart helmet that can tell if a rider is wearing it, check for alcohol consumption, and detect accidents. The helmet uses sensors to collect data on movement and pressure, sending it to a cloud server through a phone app. This data trains a special program called a support vector machine (SVM) to accurately recognize accidents. In the future, as more data is collected and analyzed, the system will become even better at detecting events. To connect to the app, the helmet uses Bluetooth with a smartphone's internet connection.

Rashmi Vashisth and her team developed a system that uses a Piezoelectric buzzer to detect speeding bikes. It includes a velocity limiter to control the bike's speed, an ALCHO-LOCK to prevent drunk driving, and an accelerometer to detect accidents and alert emergency contacts. Additionally, it has a fog sensor to improve visibility in foggy conditions. The system also allows for automatic payment deduction from the rider's virtual wallet wirelessly.

Pranav Pathak: Comprising two primary components, namely the helmet unit (HU) and the motorbike unit (MU), the project employs radio frequency (RF) communication between them. The helmet unit is furnished with sensors capable of monitoring the rider's pulse rate, detecting alcohol in their breath, and gauging vibration intensity. Specifically, the pulse rate sensor serves to verify helmet usage. Meanwhile, the motorbike unit integrates GPS and GSM modules to dispatch location alerts to emergency contacts in the event of accidents. Both units have accelerometers to detect accidents. The motorbike unit sensor ensures proper seating, safe speed, and driving behavior. In case of high alcohol levels or accidents, the motorbike unit cuts off ignition, alerts emergency contacts, activates a buzzer, and displays emergency contact details. A rider-safe button serves as an indicator of the rider's safety status. Additionally, a LIDAR sensor is employed to provide warnings regarding vehicles approaching from behind. Force-sensitive resistors located on handle grips and footrests are utilized to ensure proper seating positioning. Tilt sensors are incorporated to detect bike tilting and activate alerts if predetermined thresholds are surpassed. Furthermore, the motorbike unit is equipped with an ESP8266 Wi-Fi module, enabling the transmission of bike speed and tilt data to a ThingSpeak server, facilitating parental monitoring of their children's safety.

Pu-Sheng Tsai: This paper introduces a smart bicycle helmet that uses Internet of Things (IoT) technology to offer various innovative features: (1) LED indicators that light up in the direction the rider tilts their head, detected by a special sensor; (2) LED lights around the helmet that can provide visibility or flash for safety; (3) a keypad made of pressure-sensitive material for entering a lock code, with Bluetooth for sending the code; (4) ultrasonic sensors to detect approaching vehicles from behind and alert the rider; (5) wireless connection to send GPS data like position, time, altitude, and satellite connection to a cloud server. Furthermore, they have created a software package that can be accessed via a web server or mobile app, allowing users to track the current location and route of the helmet.

METHODOLOGY

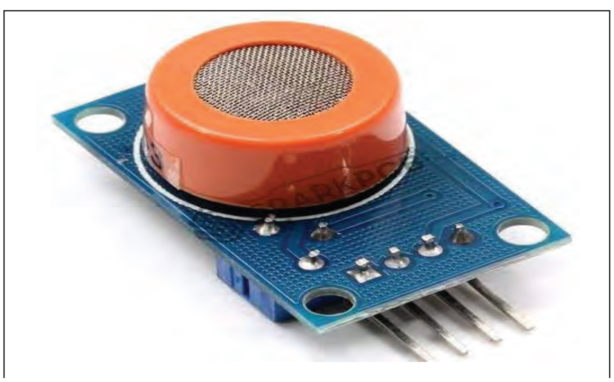

Fig. 1. Image of MQ3 alcohol sensor

MQ3 Alchohal Sensor

The MQ3 sensor, functioning as a breath analyzer, is discreetly installed at the base of the helmet, near the mouth area, and concealed within the protective foam. Positioned strategically, it can detect alcohol levels in the user's breath upon exhaling. With its placement ensuring consistent interaction with the user's breath, if the sensor registers a certain alcohol content, triggering the digital output pin to go HIGH, the bike will be prevented from starting. In prototype, we have represented the bike with the DC motor, and which is controlled by the motor driver which is made by us using the combination of mosfet and resistances.

GSM Module and GPS

GSM Module working: The sudden change in the acceleration of the bike is noted by the accelerometer, the change in the alignment and coordinates of the position of the biker is noted by the gyroscope and the distance between the bikes. When the values of these sensors exceed the threshold value(preset), then a signal is sent to microcontroller and microcontroller sends command to GSM module, which in turn generates a message on the mobile numbers that were provided to it through code and calls on those numbers.

With the help of GPS module, the current location is also sent through the message.

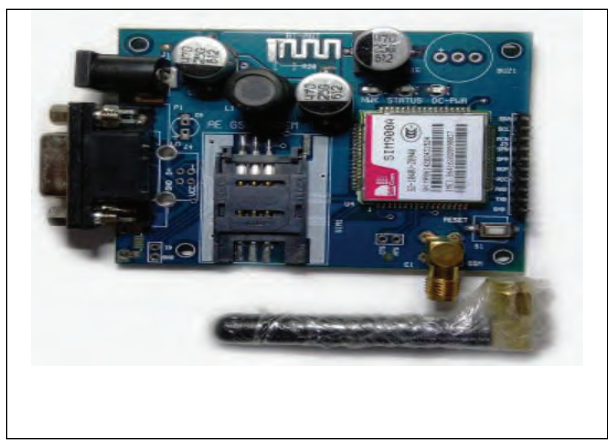

Fig. 2. GSM Module

Motor Driver

The motor driver required for controlling the motor (represented as bike) is totally manufactured by us, using the circuit combination of mosfet and resistances. If the rider has consumed the alcohol, then the output of the MQ3 sensor will be High and will receive by ESP32 microcontroller and with its inbuilt wi-fi module, the signal will be transferred to microcontroller which will in turn pass the signal to motor driver to turn off the motor.

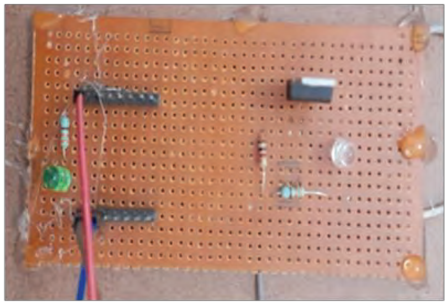

Fig. 3: Motor Driver

ADXL 345 Accelerometer

The ADXL345 accelerometer is a compact sensor that measures acceleration in three dimensions. Its micro-electromechanical systems (MEMS) technology enables it to detect both static and dynamic acceleration with high precision. With features like low power consumption, small form factor, and digital communication interfaces, it's widely used in applications like motion sensing, tilt detection, and vibration monitoring across various industries. Whenever there is a tilt in helmet position then the accelerometer sends the signal to microcontroller and microcontroller, after processing it sends it to gsm and gps module for sending the messages and locations to rider's acknowledged persons and a buzzer also beeps.

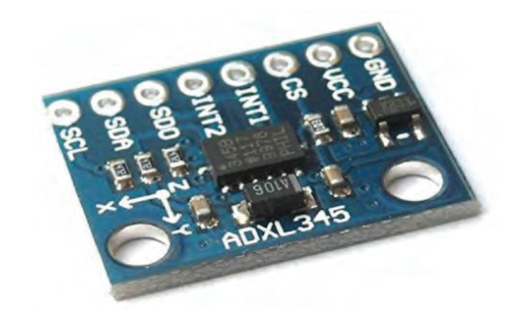

Fig. 4. ADXL 345Accelerometer

ESP 32 Wi-Fi module

The ESP32 is a popular Wi-Fi and Bluetooth module. It combines a powerful microcontroller with Wi-Fi connectivity, making it ideal for IoT projects. With features like low power consumption, dual-core processing, and support for various communication protocols, the ESP32 is widely used in applications ranging from home automation to industrial IoT.

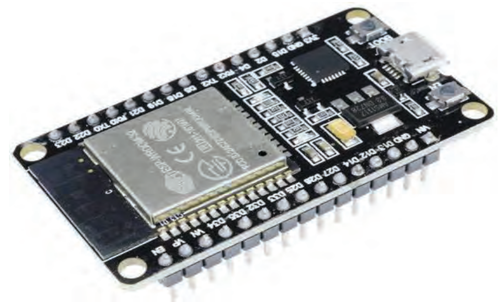

Fig. 5. ESP 32 Wi-Fi Module

COMBINED CIRCUIT

A comprehensive safety system is envisaged to enhance rider protection and adherence to regulations. Embedded within the helmet is a switch mechanism that intuitively engages upon the rider donning the helmet, signaling the ESP32 microcontroller to establish communication with the motor controller for seamless motor activation. Conversely, if the rider neglects to wear the helmet, motor engagement is inhibited, ensuring compliance with safety protocols.

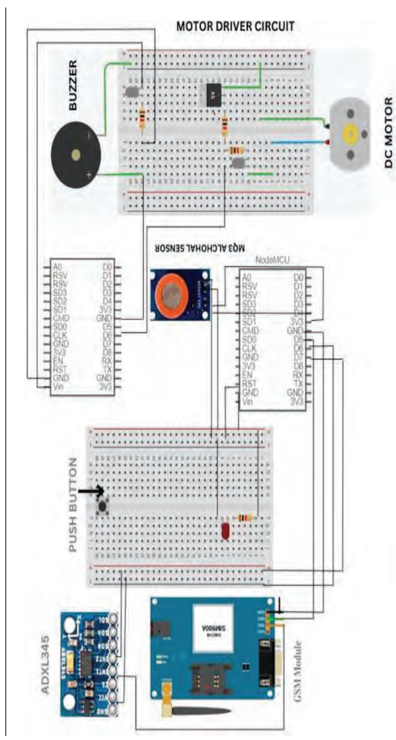

Fig. 6. Combined Circuit

Moreover, the inclusion of an MQ3 sensor near the rider's mouth serves to validate sobriety before motor activation. Until alcohol consumption is verified, the ESP32 microcontroller refrains from transmitting signals to the motor controller, thereby preventing motor start-up. In the unfortunate event of an accident, the ADXL345 accelerometer meticulously monitors changes in helmet orientation or tilt angle. These deviations prompt immediate action from the ESP32 microcontroller, which coordinates with a GSM module to initiate an emergency response protocol.

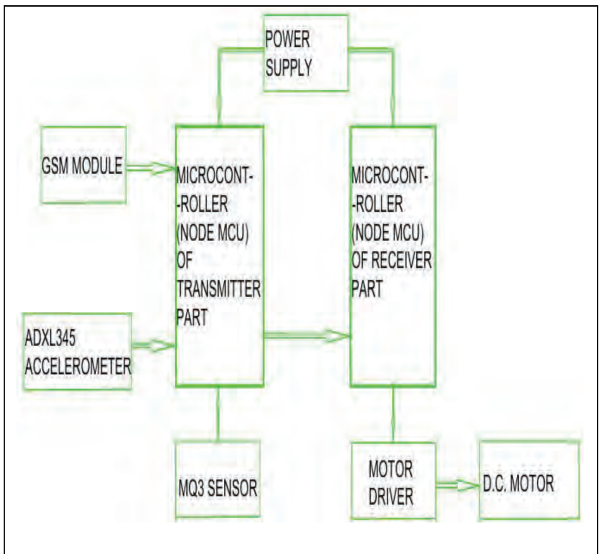

Fig. 7. Block diagram

This entails transmitting the rider's precise location, as ascertained by a GPS module, and dispatching distress signals to nearby medical facilities and designated contacts to ensure seamless integration and data synchronization, a dedicated circuit will be installed on the bike, facilitating real-time coordination between the MQ3 sensor and helmet switch. The bike's system will house an ESP32 microcontroller, in tandem with a buzzer and motor controller.

The motor controller, meticulously crafted using MOSFETs and resistances, regulates motor functionality. Should the rider fail to comply with safety measures by either not wearing the helmet or consuming alcohol, the motor controller will effectively block motor activation, thereby upholding safety standards and promoting responsible riding behavior.

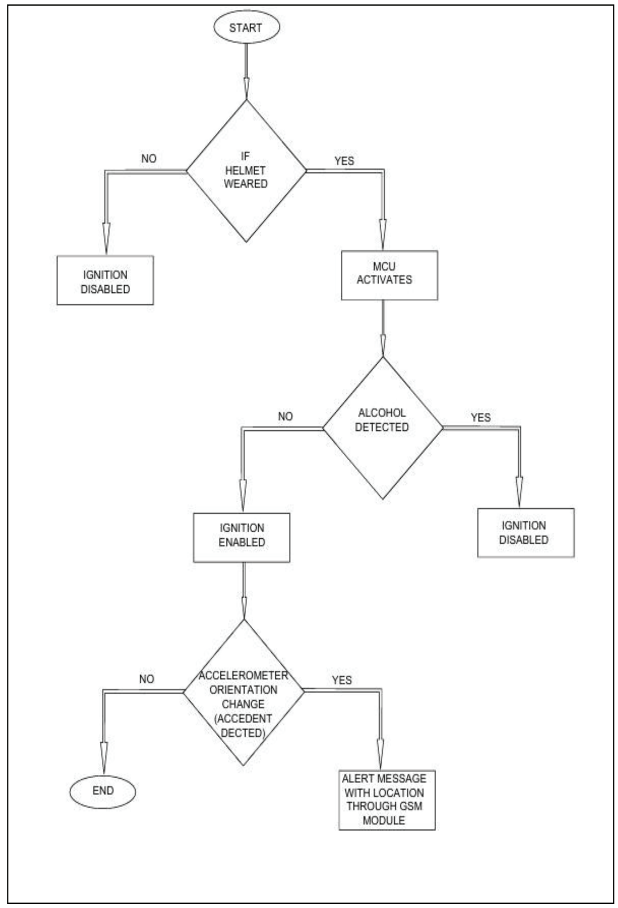

Fig. 8. Flow chart

Fig. 9. Top view transmitter part

Fig. 10. Leftside view of transmitter part

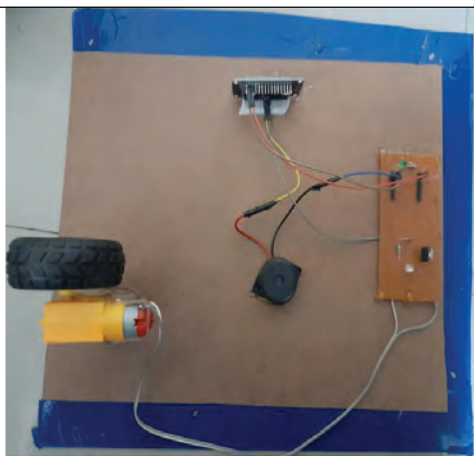

Fig. 11. Top view of receiver part

CONCLUSION

In conclusion, the integration of advanced technologies such as the ESP32 microcontroller, ADXL345 accelerometer, and MQ3 sensor within motorcycle safety systems presents a paradigm shift towards enhancing rider safety and promoting responsible riding practices. By leveraging real- time data processing and communication capabilities, these systems not only mitigate the risk of accidents through pre-emptive measures but also facilitate swift emergency responses in critical situations. Moreover, the seamless coordination between components, facilitated by dedicated circuits, underscores the importance of holistic design approaches in achieving optimal safety outcomes. Moreover, we are still finding the best way to implement the head-up display in the helmet which will be used for navigation purpose and to enhance the safety of the rider in many more ways.

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Modeling Analysis Vehicle-to-Grid Converter

Piyush Jaiswal
✉ piyush2021068@akgec.ac.in
Palak Maithili
✉ palak2021048@akgec.ac.in
Prince Shukla
✉ Prince2021029@akgec.ac.in

Rachit Srivastava
✉ Rachit2021014@akgec.ac.in
Vani Bhargava
✉ bhargavavani@akgec.ac.in
Navjyoti Sharma
✉ sharmanavjyoti@akgec.ac.in

Department of Electrical and Electronics Engineering
Ajay Kumar Garg Engineering College
Ghaziabad, Uttar Pradesh

ABSTRACT

In response to escalating pollution levels and environmental concerns, the 21st century is gravitating towards sustainable solutions such as plug-in hybrid electric vehicles (PHEVs). These vehicles not only offer extensive energy storage capabilities but also have the potential to be used for energy storage and distribution, particularly during periods of high demand. Vehicle-to-grid (V2G) technology, with further enhancements, could provide a promising answer to future energy challenges. This overview highlights the features, applications, and benefits of V2G technology, as well as the obstacles to its implementation. Numerous initiatives by automotive industries, power generation companies, and governments worldwide are underway to make V2G technology feasible for future use.

KEYWORDS: *Vehicle-to-grid, Bidirectional converter, Renewable energy integration, Plug-in hybrid vehicle, Bidirectional charger.*

INTRODUCTION

In response to the urgent need for sustainable energy solutions and the necessity to address climate change, Vehicle-to-Grid (V2G) technology has emerged as a groundbreaking approach that bridges the transportation and energy sectors. V2G introduces a new way for electric vehicles (EVs) to interact with the power grid, allowing for bidirectional power flow between vehicles and the grid infrastructure. This concept promises to revolutionize the energy landscape by utilizing the substantial battery capacity of EVs to store and release electricity, thereby improving grid stability, efficiency, and resilience.

This paper aims to offer a thorough overview of the V2G concept, covering its technological foundations, operational principles, potential applications, and implications for the energy ecosystem. By conducting an in-depth analysis of the current state of V2G research, development, and deployment, the paper seeks to highlight the transformative potential of this technology in moving towards a sustainable and resilient energy future. Additionally, it will explore the challenges and barriers to the widespread adoption of V2G, including technical, regulatory, and market-related issues, while also examining promising strategies and initiatives to overcome these obstacles.

As the shift towards electrified transportation and the integration of renewable energy accelerates, V2G technology is set to play a crucial role in shaping the future of energy systems. By creating synergies between the transportation and energy sectors, V2G has the potential to unlock new opportunities for decarbonization, grid modernization, and sustainable development. Through collaborative efforts and innovative solutions, V2G can drive significant progress toward a cleaner, more resilient, and efficient energy ecosystem.

CONVERTER

A converter, in the context of electrical engineering, is a device or circuit that converts electrical energy from one form to another. In the realm of electric vehicles (EVs) and Vehicle-to-Grid (V2G) technology, converters play a vital role in managing the flow of electrical power between the vehicle's battery, the grid, and other energy storage systems.

The converter is controlled based on the active power flow to the battery pack, utilizing battery variables to compute the battery power flow. A controller determines the phase shift between the pulses that manage the two bridges.[9]

The converter operates in two power flow modes: charge mode and discharge mode. In charge mode, the AC-DC converter acts as a voltage-regulated power supply. In discharge mode, the DC-DC stage controls the DC bus voltage and provides a constant voltage to the AC-DC inverter.[10]

There are various types of converters used in EVs and V2G systems, each serving specific purposes. Some common types include:

AC/DC Converter: It converts alternating current (AC) from the grid into direct current (DC) to charge the vehicle's battery.

DC/DC Converter: Adjusts DC voltage from one level to another, ensuring compatibility between different voltage levels within the vehicle's electrical system.

DC/AC Inverter: Converts DC power from the battery into AC power for powering electric motors or feeding power back into the grid during V2G operation.

Bidirectional Converter: Allows bidirectional power flow, meaning it can convert power in both directions—either from AC to DC or DC to AC—as needed for charging the vehicle's battery or feeding power back to the grid.

A bidirectional and isolated power structure is suitable for comprehensive Vehicle-to-Grid (V2G) interfaces. The proposed converter architecture is developed based on specific requirements and practical topologies, emphasizing its benefits.[16]

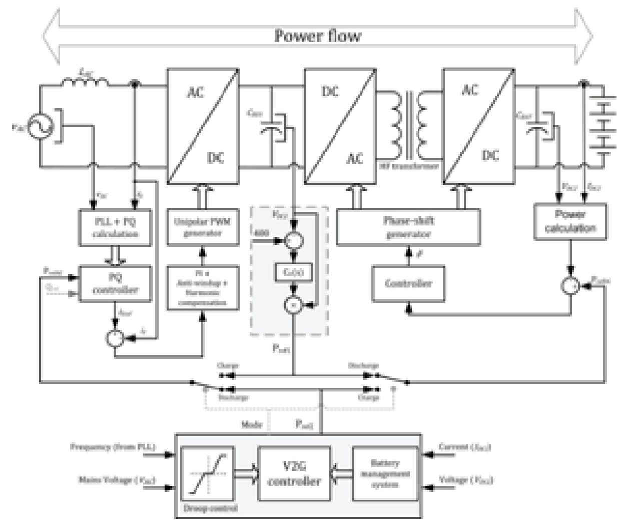

Fig. 1. Converter Structure

The converter's high switch utilization ratio enables high-performance control structures while adhering to major grid constraints. The proposed converter incorporates a PWM rectifier paired with a dual active bridge, facilitating efficient bidirectional charging strategies for electric vehicles.

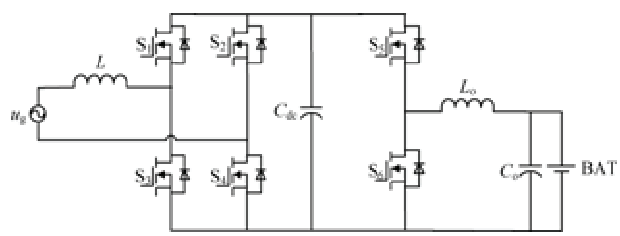

Fig. 2. Parallel Bi-directional converter

SIMULATION

The bi-directional converter is a pivotal element in simulating Vehicle-to-Grid (V2G) systems, replicating the dynamic energy exchange between electric vehicles (EVs) and the grid. This computational model ensures accuracy by considering the three-phase nature of both the EV's power system and the grid, providing a comprehensive platform for analysis and optimization.

Within the bidirectional converter model, detailed mathematical representations of various components are developed, incorporating key parameters such as voltage, current, frequency, and power factor. This allows for a detailed understanding of V2G operation dynamics.

Pulse Width Modulation (PWM) techniques are essential for regulating electrical power flow between the EV battery and the grid within the bidirectional converter model. PWM enables precise control of voltage and current by adjusting pulse widths in a periodic waveform, ensuring efficient bidirectional power flow that meets grid requirements.

The bidirectional converter model also includes the transformation of variables from the three-phase (abc) reference frame to the rotating (dq0) reference frame. This transformation simplifies analysis and control by dividing variables into direct (d) and quadrature (q) components, along with a zero (0) component representing the average value. This enhances control algorithm implementation and the accuracy of power and current calculations.

Additionally, buck-boost converters are commonly used in V2G systems simulated with bidirectional converters. These converters adjust voltage levels to ensure compatibility between the EV's battery voltage and the grid voltage. By increasing or decreasing voltage as needed, they optimize charging or discharging conditions, enhancing flexibility and efficiency in energy transfer within V2G applications.

In essence, the bidirectional converter is the cornerstone of V2G simulation, facilitating bidirectional energy transfer dynamics between EVs and the grid. Through the careful integration of PWM techniques, abc to dq0 transformations, and buck-boost converters, this computational model enables comprehensive analysis and optimization for the seamless integration of electric vehicles into the smart grid ecosystem.

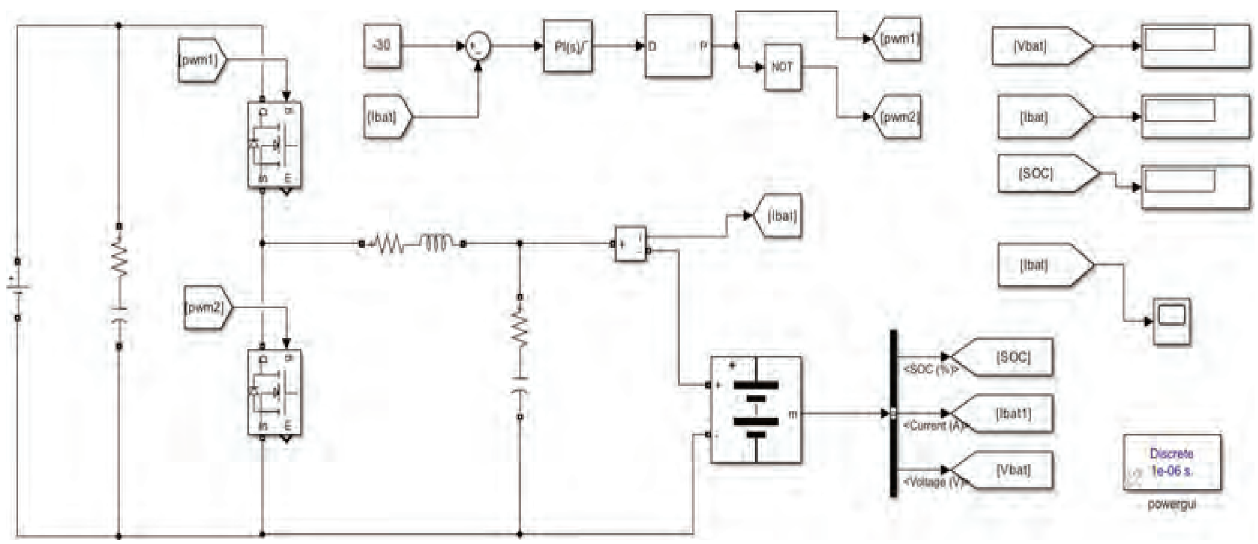

Fig. 3. Bi-Directional Simulation

RESULT

For Battery Charge mode

Let's change the reference value from 30:

Reference value	Battery Charge(approx)
30	29-30
20	19-20
5	4-5

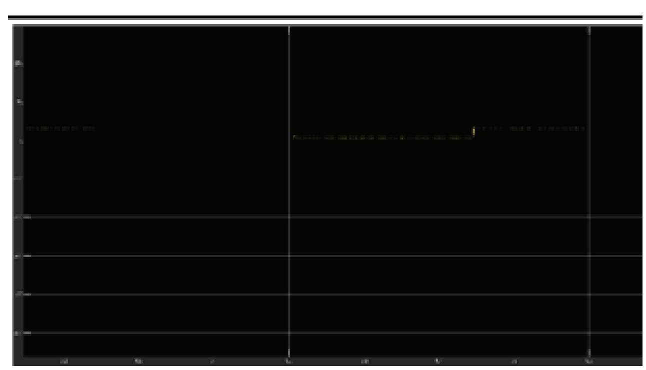

Fig. 4. Battery graph in charging mode

For Battery Discharge mode

Let's change the reference value from -30:

Reference value (Negative)	Battery charge (approx) (Negative)
30	29-30
20	19-20
5	4-5

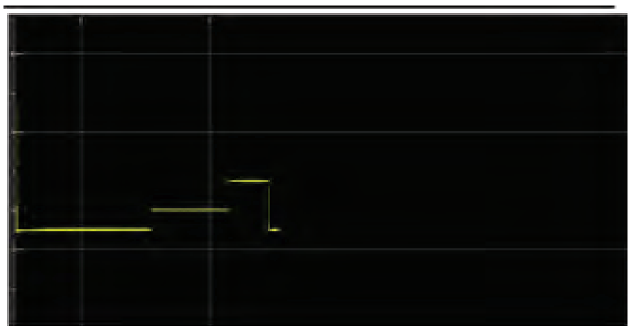

Fig. 5. Battery graph in Discharging Mode

In Fig. 4 & 5 we can see that when the reference value changes the battery power that is Current in the battery changes and is close to value of reference value which shows our V2G and G2V simulation is working.

ADVANTAGES AND APPLICATION OF V2G

A. Peak Shaving and Other Electrical Benefits: Utilizing stored battery energy, V2G balances loads by charging during low-demand periods (valley filling) and providing power to the grid during high-demand periods (peak shaving). This strategy reduces line losses, transmission delays, and congestion, enhancing grid longevity and obviating the need for costly peaking power plants. Power authorities can predict peak loads, often during summer, and V2G-enabled hybrid vehicles act as a flexible alternative to expensive peaking plants, resulting in reduced electricity costs during peak periods. The average annual benefit of V2G participation per EV is estimated between $392 to $561, offering utilities cost savings and potential revenue for further investments.[4]

B. Ancillary and Regulation Services: Ancillary services, including regulation and spinning reserve, represent a significant portion of electricity costs, amounting to $12 billion annually in the US. PHEVs can provide ancillary services, stabilizing power systems, reducing relay operations, and mitigating the impact of contingencies. V2G-enabled PHEVs contribute to grid stability by balancing frequency around set points and offering control reserves, replacing traditional sources such as gas turbines and pumped storage. PHEVs can be scheduled for idle ancillary services, with Distribution Network Operators (DNOs) manage charging/discharging to maintain battery viability and reduce electricity tariffs.

C. Renewable Energy Integration: Energy storage is critical for harnessing renewable resources, and addressing challenges such as energy intermittency and peak demand misalignment. V2G helps integrate renewable energy by utilizing EVs to smooth output fluctuations from wind and solar farms, complementing generation patterns and reducing curtailment. Hybrid vehicles and renewable sources mutually benefit each other, with V2G supporting emerging power markets and providing complimentary services to renewables.

D. Spinning Reserves: V2G integration eliminates the need for maintaining spinning reserves by leveraging EVs to meet sudden power demands. Connected vehicles serve as additional power supplies during peak demands, creating a win-win situation for workplaces and employees. Employees' vehicles remain connected to the grid, providing backup power during peak demand while being charged during off-peak periods.

E. Backup During Power Outage: V2G enables using vehicle energy for personal emergency power needs during power outages. Connected vehicles can power household appliances through uninterrupted power supply units, with certain PHEVs generating sufficient power to maintain basic home functions.

IMPLEMENTATION ISSUES

While V2G offers numerous applications and benefits, several implementation challenges need to be addressed. Some of these challenges include:

A. Scalability: The heat produced is determined by the formula (I^2)Rt, where t represents time, charging/

discharging current is denoted by I, and R represents the load, such as the engine. When the rate of charge/discharge is increased, resulting in higher values of I, more heat is generated. Similarly, if the process continues for extended periods, leading to higher values of t, it also results in increased heat production and elevated temperatures.

B. Reduced Battery Life:

Implementing vehicle-to-grid (V2G) technology can negatively impact the battery life of electric vehicles (EVs) due to increased cycling and depth of discharge (DoD). Battery degradation is affected by several factors, including the number of charge-discharge cycles, the depth of discharge in each cycle, temperature variations, and the rates of charging and discharging.

The impact of V2G on battery life can be quantified using battery degradation models, such as the empirical Peukert equation or the more complex lithium-ion battery degradation models. These models take into account factors such as the battery chemistry, operating conditions, and usage patterns to predict the rate of capacity fade over time.

One common metric used to assess battery degradation is the State of Health (SoH), which represents the battery's current capacity relative to its initial capacity. The SoH can be calculated using the following formula:

SoH=Current Capacity/Initial Capacity×100%

Where:

- Current capacity refers to the battery's actual capacity at a specific point in time.
- Initial Capacity is the rated capacity of the battery when it was new.

The expected average cycles of a battery are connected to its depth of discharge (DOD), as illustrated in Fig. 4. If a vehicle begins with a DOD of 30%, its expected average cycle is 2050. However, after participating in grid power transfer, if the DOD rises to 50%, the expected average cycle decreases to 1150. A long-term increase of 20% in DOD can cut the battery's lifespan to about half of its original value. This issue needs serious consideration.[1].

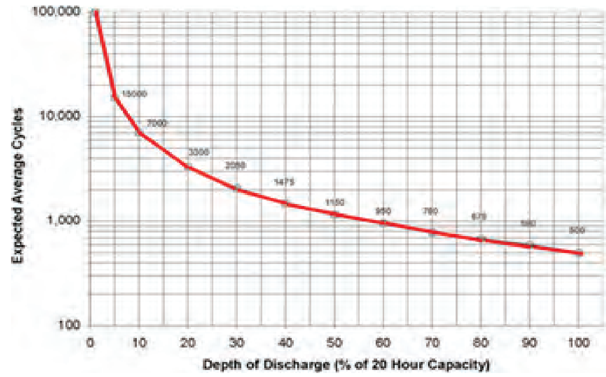

Fig. 6. Battery Life decay with depth of discharge

C. Thermal Issues:

When electric vehicles (EVs) are used in Vehicle-to-Grid (V2G) systems, managing the heat generated by the batteries is very important.

Battery Performance: Batteries work best within a certain temperature range. Too hot, and they wear out faster; too cold, and they don't perform well.

Battery Life: Constant charging and discharging, as happens in V2G systems, can make batteries get hot. If they're not kept cool, they won't last as long.

The heat produced is determined by the formula (I^2)Rt, where t represents time, charging/discharging current is denoted by I, and R represents the load, such as the engine. When the rate of charge/discharge is increased, resulting in higher values of I, more heat is generated. Similarly, if the process continues for extended periods, leading to higher values of t, it also results in increased heat production and elevated temperatures.

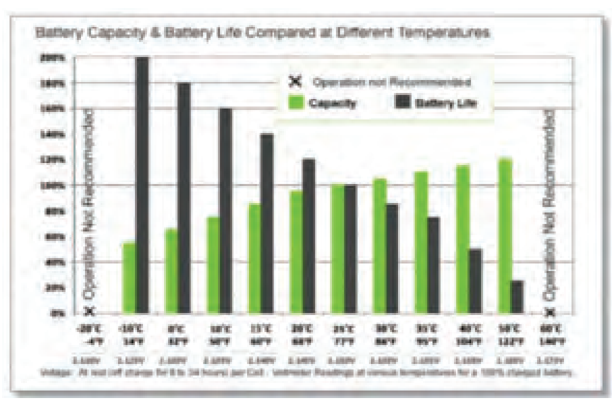

Fig. 7. Battery Life and Capacity at Different temperatures

CONCLUSION

The research paper underscores the transformative potential of Vehicle-to-Grid (V2G) technology in creating sustainable energy systems. V2G enables electric vehicles (EVs) to connect with and supply power to the electrical grid, offering numerous environmental benefits such as grid stabilization, enhanced integration of renewable energy sources, and significant reductions in greenhouse gas emissions. This technology could play a crucial role in the transition to environmentally friendly energy systems by providing a flexible and dynamic approach to energy management.

This paper also highlights several substantial challenges that must be addressed to fully harness V2G's capabilities. Key issues include the need for advanced infrastructure to support bidirectional energy flow, improvements in battery technology to increase efficiency and lifespan, and the creation of clear regulatory frameworks to guide V2G operations. The research calls for future studies to explore strategies to overcome these hurdles, including thorough economic analyses, cost-effective solutions, and supportive policy development. By tackling these challenges, researchers and policymakers can pave the way for broader acceptance and implementation of V2G technology, fostering a more resilient and eco-friendly energy future.

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IoT Based Landslide and Flood Detection System for Efficient Disaster Management through Environmental Monitoring

Gouri Badiger
✉ gouri2241@gmail.com
Sanghmitra Gaikwad
✉ gaikwadsanghmitra0@gmail.com
Shreya Kulkarni
✉ shreyask2001@gmail.com
Vidya Kodgirwar
✉ vidya.kodgirwar@moderncoe.edu.in

Electronics & Telecommunication
PES's Modern College of Engineering
Pune, Maharashtra

ABSTRACT

Natural disasters, such as landslides and floods, pose significant threats to communities worldwide, often resulting in loss of life and extensive damage to infrastructure and ecosystems. Addressing these challenges requires innovative approaches in monitoring and early warning systems. This research introduces an advanced Internet of Things (IoT) based Landslide and Flood Detection System leveraging NodeMCU and Arduino Uno Microcontrollers. The system incorporates a group of sensors including soil moisture detection, water level depth detection, ultrasonic, vibration, and raindrop detection sensors, offering a holistic environmental monitoring solution. This research contributes to the development of robust early warning systems, fostering resilience and safeguarding vulnerable communities against the impacts of natural disasters.

KEYWORDS: *Internet of Things, Landslide detection, Flood detection, NodeMCU, Arduino uno, Soil moisture sensor, Water level sensor, Ultrasonic sensor, Vibration sensor, Raindrop sensor, Environmental monitoring, Early warning systems.*

INTRODUCTION

Landslides, characterized by the movement of rock, debris, or earth down a slope, pose substantial risks to both life and infrastructure globally [1]. Particularly prevalent during monsoon seasons, these events often occur when rainwater infiltration leads to hydraulic pressure exceeding the soil or rock's elastic limit, resulting in the loss of adhesive strengths [2]. The repercussions of landslides are far-reaching, encompassing property damage, injuries, fatalities, and long- term disruption to vital resources such as water supplies, fisheries, dams, and roadways [8].

Natural phenomena such as groundwater pressure, erosion by water bodies, seismic activity, and human-induced activities like deforestation and construction significantly contribute to slope instability, exacerbating the risk of landslides [7]. Regions characterized by steep terrain, including the Himalayas, Konkan railways, lonavala Ghats, and Kerala's marshy areas, are particularly susceptible to these occurrences [6].

In response to these challenges, extensive research efforts are underway to enhance landslide prediction, detection, and monitoring methodologies. Leveraging diverse techniques ranging from visual inspection to advanced data-driven approaches incorporating wireless sensor networks (WSNs) and the Internet of Things (IoT), researchers aim to develop proactive measures for landslide risk management and disaster mitigation [3]. These technologies offer cost-effective, robust, and efficient solutions for landslide early warning systems, capable of detecting rapid changes in slope conditions and transmitting data for timely analysis [4].

Similarly, the threat of flooding necessitates the development of advanced detection and monitoring systems. Studies focusing on IoT-based flood detection systems emphasize the importance of real-time data collection and analysis for early warning and disaster management [13]. Integrating machine learning algorithms and sensor networks, these systems enable accurate flood forecasting and timely dissemination of alerts to mitigate the impact on vulnerable communities [16].

Fig.1. Landslide and Flood detection system [26]

Furthermore, recent research efforts have explored the integration of landslide and flood detection systems, recognizing the interconnected nature of these natural hazards [14]. By combining IoT-based sensing platforms and advanced data analytics, researchers aim to develop comprehensive early warning systems capable of mitigating the devastating effects of landslides and floods on communities and infrastructure [15].

In this context, this paper contributes to the ongoing discourse by providing a comprehensive review of landslide and flood monitoring techniques, with a focus on IoT integration opportunities. By synthesizing insights from both domains, this research aims to inform the development of integrated systems for effective disaster management and risk mitigation [5].

SYSTEM ARCHITECTURE DESCRIPTION

The system architecture comprises sensor nodes and controllers such as Arduino and NodeMCU deployed at the landslide and flood sites. These sensor nodes are responsible for gathering essential data related to landslide and flood monitoring, including parameters such as vibration, soil moisture, water level, rainfall intensity, and distance. To achieve this, the system employs a range of sensors such as soil moisture, vibration, ultrasonic, water level, and rain sensors, all operating within the voltage range of 3.3 to 5 volts [11].

The controllers, Arduino, and NodeMCU, serve as the central processing units, responsible for receiving data from the sensor nodes. Subsequently, this collected data is transmitted to the monitoring station via the NodeMCU. At the monitoring station, the received data is graphically represented on the ThingSpeak website, facilitating easy analysis and interpretation of the monitored parameters.

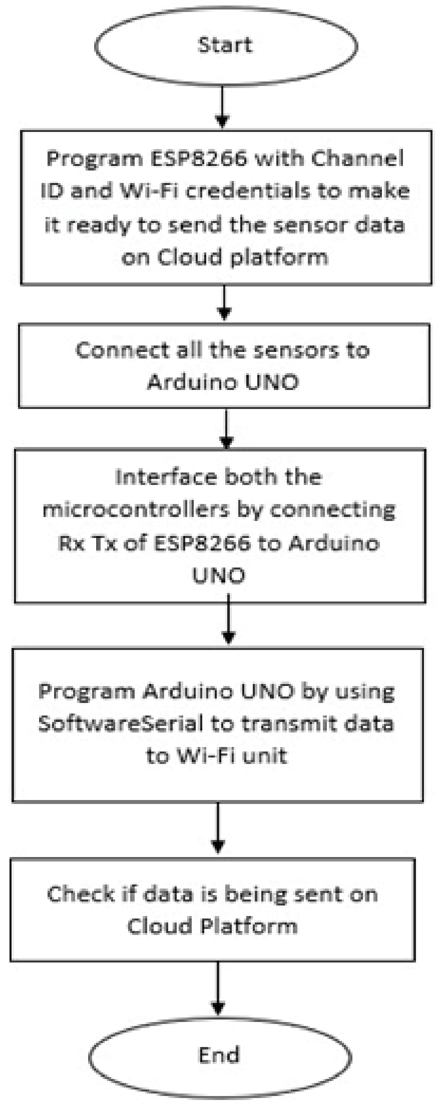

Fig. 2. Flow chart of the system

DESIGN AND IMPLEMENTATION

Sensing Units

The data collection process commences with various sensor units deployed at the landslide and flood sites, each tasked with gathering specific environmental data. These sensors, including those for vibration, soil moisture, water level, rainfall intensity, and distance, diligently collect relevant parameters indicative of potential hazards. Subsequently, the collected data is transmitted to the Arduino microcontroller for further processing. The Arduino acts as the central processing unit, receiving and aggregating data from multiple sensors. Once received, the Arduino executes predefined algorithms to analyze and interpret the gathered information. This processed data serves as a critical input for decision-making and early warning generation. By efficiently consolidating data from diverse sensor sources, the Arduino enhances the system's capability to detect and respond to imminent landslide and flood threats.

Data Transfer Module

The data transfer process begins with the Arduino receiving environmental data from the sensor nodes deployed at the landslide and flood sites. Upon collecting the data related to parameters such as vibration, soil moisture, water level, rainfall intensity, and distance, the Arduino processes it for transmission. Next, the NodeMCU, equipped with Wi-Fi capabilities, serves as the intermediary for data transfer. It receives the processed data from the Arduino and establishes a connection to the local Wi-Fi network. Once connected, the NodeMCU transmits the data packets over the Internet to a cloud platform like ThingSpeak.

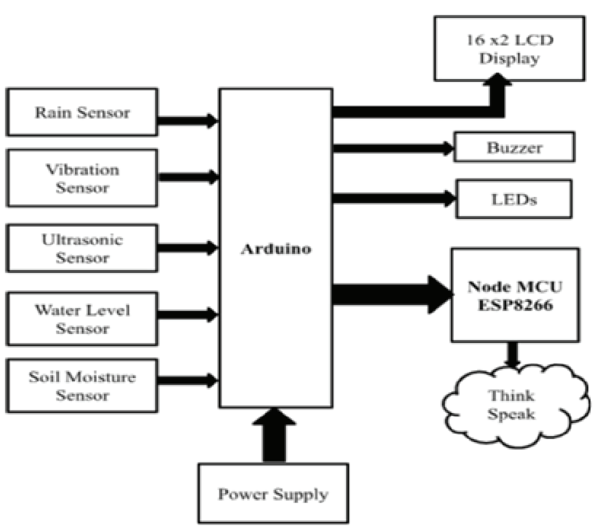

Fig. 3. System Block Diagram

Circuit Diagram

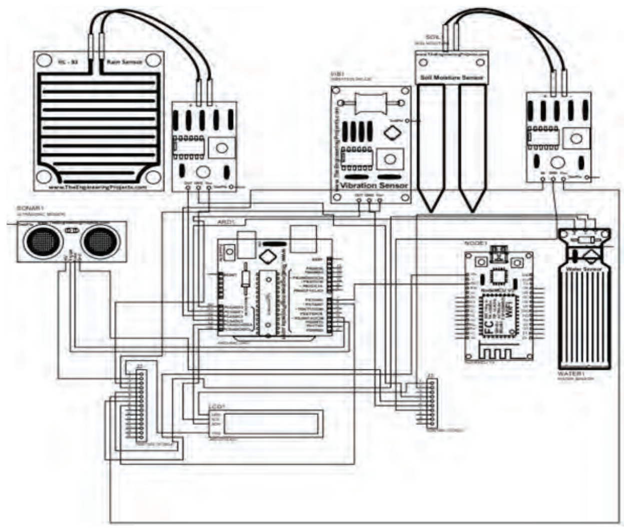

Fig.4. Circuit Diagram of the system

EXPERIMENTAL OBSERVATION AND RESULTS

Observations

Employing Arduino Uno with sensors and sensing unit and NodeMCU ESP8266 as Wi-Fi unit, all sensor data is sent and monitored over the ThingSpeak Cloud Platform. All the sensors data observed on ThingSpeak cloud platform can be seen below in results section.

Results

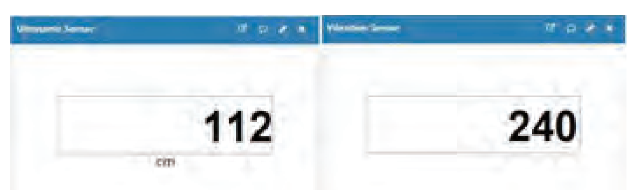

Fig. 5. Ultrasonic and Vibration sensor output

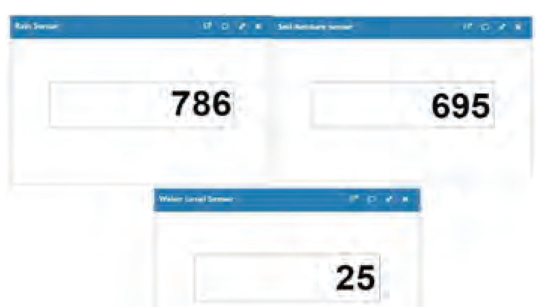

Fig.6. Rain, Soil Moisture and Water level sensor output

From Fig.5 the output of Ultrasonic and Vibration sensor can be observed as soon as there is any change in sensor value it can be seen on ThingSpeak platform. From Fig.6 we can observe Rain, Soil Moisture and Water Level sensor output. We can see that when there no rain and the soil is dry the sensors have the highest value, but as soon as there is rain of soil gets moist the sensor value drops down. The water level sensor value varies according to the water level. In the Table 1 we can see the value range of all sensors.

Table 1. Parameter Value with Threshold Values for all Sensors

Sensor	Value Range	Threshold Values	Result
Ultrasonic Sensor	2 cm to 400 cm	Value range < 100cm	Alert is sent
Vibration Sensor	0 to 1023 (analog)	Value range > 500	Alert is sent
Soil Moisture Sensor	0 to 1023 (analog)	Value Range < 300	Alert is sent
Rain Drop Detection Sensor	0 to 1023 (analog)	Value range > 600	Alert is sent
Water Level Depth Detection Sensor	0 to max water level	Value range > ¾ of max water level	Alert is sent

SOFTWARE DESIGN

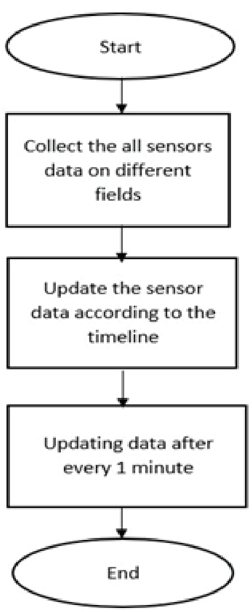

Fig. 7. Software design flowchart

CONCLUSION AND FUTURE SCOPE

The implementation of an IoT-based Landslide and Flood Detection System, integrating ESP8266 and Arduino UNO microcontrollers with various sensors, marks a significant leap in disaster prevention. By detecting early warning signs through embedded systems and wireless sensor networks, it addresses the urgent need for early warning systems.

After successful implementation for efficient working of the system the threshold parameters can seen in the Table 1. The threshold value for Ultrasonic Sensor is less than 100 cm and that for Vibration Sensor is greater than 500. The threshold value for Soil Moisture sensor is less than 300. The threshold value for rain drop detection sensor is less than 600 and that for water level depth detection sensor is three fourth part of maximum water level. These threshold values are stated after studying the system under various extreme conditions of disaster occurrence. The values can vary according to geographical area of application of the system. An email alert is sent through ThingSpeak whenever any sensor cross threshold value.

Future enhancements could involve adding sensors to broaden environmental data collection, like temperature and humidity sensors, improving predictive capabilities. Advancements in data analytics, including machine learning, offer potential for proactive disaster prediction. Community engagement through education and outreach complements technological solutions, empowering residents to mitigate risks. Integrating the system with existing disaster management infrastructure enables coordinated emergency responses. Ensuring system reliability and scalability requires rigorous testing under diverse conditions. The future of this system lies in technological innovation, data analytics, and community involvement to build resilient communities and minimize disaster impacts.

Collaboration and interdisciplinary research are essential to maximize the system's potential for disaster mitigation and protection of lives and property.

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Predictive Modeling for Colorectal Cancer Detection: A Deep Learning Approach

S. P. Vibhute
✉ s.vibhute2015@gmail.com
Yogini Deshmukh
✉ yoginideshmukh79@gmail.com

Shreya Jadhav
✉ jadhavshreya829@gmail.com
Harsh Tiwari
✉ anandvt13@gmail.com

Department of Electronics and Telecommunication
JSPM's Rajarshi Shahu college of Engineering, Tathawade
Pune, Maharashtra

ABSTRACT

Early detection of colorectal cancer is critical for effective treatment and addressing a global health concern. Accurate and early diagnosis with CT colonoscopy images enables for timely medical interventions, considerably improving patient outcomes and lowering mortality rates. This methodology improves diagnostic accuracy by reducing false positives and assuring the reliable diagnosis of malignant tumors. Our work underlines the importance of CRC and investigates CTC as a diagnostic tool. It discusses CNN architectures for this modality, CTC-specific data preprocessing, and important feature extraction for accurate identification. The method for predicting colon cancer from CT colonoscopy pictures uses Convolutional Neural Networks (CNNs) using TensorFlow and Keras, with two primary modules: feature extraction and classification. The feature extraction module detects patterns and textures in images using convolutional layers, then condenses the information via pooling layers. The CNN then classifies these traits to discriminate between malignant and non-cancerous regions, resulting in a thorough diagnostic report for timely action.

KEYWORDS: *Colorectal Cancer (CRC) detection, Convolutional Neural Networks (CNNs), CT Colonography (CTC) data, Early identification, Machine learning techniques.*

INTRODUCTION

The colon, a key component of the digestive system, is responsible for absorbing liquids and waste. Cancer, characterized by unregulated cell division, is a serious threat to human health. Polyps, which are benign clumps of cells in the large intestine, frequently precede colon cancer, and can progress to malignancy over time. Colon cancer kills over 50,000 Americans each year, making it the country's third leading cause of cancer-related deaths. Technological breakthroughs have transformed medical practice, providing new opportunities to improve diagnostic procedures.Machine learning (ML) and deep learning algorithms have had a significant impact in healthcare, improving diagnostic accuracy and treatment efficacy. Leveraging machine learning for colorectal cancer prediction allows for faster and more precise diagnosis, better treatment outcomes, and lower mortality rates. Early identification of colorectal cancer is critical for establishing the best treatment options and prognosis. Deep learning algorithms, particularly convolutional neural networks (CNNs), have shown to be invaluable tools for medical imaging diagnoses because of their self-learning capabilities.

This study highlights the need for better diagnostic techniques to detect colorectal cancer at an early stage. Using TensorFlow and Keras, the project seeks to create an advanced CNN model capable of accurately analyzing CT colonoscopy images. These photos, taken from large medical datasets, serve as the basis for the model's training and validation. Through iterative learning and optimization, the model learns to spot tiny patterns that indicate colorectal cancer, increasing the likelihood of accurate prediction.

The relevance of this undertaking stems from its potential to revolutionize colorectal cancer diagnoses. A powerful predictive tool could speed up the detection of anomalies or probable cancers in the colon, allowing healthcare practitioners to intervene early and begin proper therapy sooner. Integrating deep learning techniques into medical imaging speeds up the diagnostic process, minimizes oversight, and enhances accuracy. Finally, this advanced prediction model offers a significant step toward improved patient care and gastrointestinal health outcomes, with the potential to save lives through early intervention and treatment.

LITERATURE SURVEY

The use of AI and deep learning has dramatically improved the detection and diagnosis of colorectal cancer. Innovative methods in shallow neural networks solve issues in gene expression data processing, with performance comparable to deep networks. Deep learning improves image classification, and ResNet-50 outperforms ResNet-18 in accuracy. DenseNet-121 coupled with KNN achieves great accuracy in tissue classification. Efficient computing is critical as data generation grows, with new algorithms proposed to cut expenses. In colorectal imaging, a self-paced transfer VGG network (STVGG) efficiently manages data complexity. CNN-based computer-aided design solutions are as sensitive and specific as experienced endoscopists. Deep convolutional networks in histopathology improve tumor detection. AI improves real-time polyp detection during colonoscopy, yet performance may differ between datasets. A framework that combines deep learning and image processing delivers excellent accuracy in tissue classification, enabling early identification. Recent advances in polyp identification emphasize the possibility of improved CRC diagnoses.

Overall, AI and deep learning have transformed CRC detection, improving accuracy, efficiency, and early detection.

PROPOSED ARCHITECTURE

The proposed method uses Convolutional Neural Networks (CNN) to detect colon cancer from CT colonoscopy images, with the goal of providing radiologists with automated, accurate, and rapid diagnostic reports, therefore increasing diagnostic efficiency and improving patient outcomes. The system consists of two major components: the CNN-based detection module and the report production module.

CNN-based detection module.

The method is built around a CNN algorithm that has been taught to detect patterns suggestive of colon cancer in CT colonoscopy pictures. Unlike earlier machine learning approaches, this model uses a cutting-edge CNN architecture noted for its excellent accuracy and efficiency in picture interpretation. The CNN is trained on a huge, labeled dataset of CT colonoscopy images, and it learns to distinguish between normal and malignant tissues using feature extraction in its convolutional layers. inputs augmentation strategies are employed during training to improve the model's robustness and adaptability to new inputs.

Report Generating Module

Once a CT colonoscopy picture has been processed, the CNN-based detection module returns a classification indicating the presence of colon cancer. This result is input into the report production module, which generates a diagnostic report that clearly states whether colon cancer was detected. A positive detection necessitates further medical inquiry or intervention, whereas a negative detection provides reassurance and direction for further monitoring.

System Workflow

- Image Input:CT colonoscopy pictures are loaded into the system.
- Pre-processing: Images are normalized and resized to prepare for analysis.
- Cancer Detection: The CNN examines pre-processed images and produces a classification result.

- Report Generation: Using the CNN's output, a diagnostic report is generated that details the detection results.

Detailed System Architecture

Fig. 1 Diagram for Proposed System Architecture

A flow diagram (Figure 1) depicts the architecture for detecting colon cancer polyps using a CNN.

- Providing input to the model: The CNN model accepts medical pictures such as endoscopic or colonoscopic imaging.
- Feature Extraction: The CNN examines images using many convolutional layers to identify key features that indicate problems.

Detecting colon cancer polyps involves analyzing extracted features and classifying photos based on the detected traits.

- Decision Pathways: If no polyps are found, the algorithm repeats to evaluate the next image. If polyps are discovered, a thorough report is created.
- Report Generation: The system organizes detection results into a comprehensive document for medical practitioners.
- Monitoring and Performance Optimization: Tools such as the NVIDIA System Management Interface (SMI) track and optimize GPU performance, ensuring that the Tesla T4 GPU is used efficiently for rapid and accurate picture processing. The software stack includes both CUDA version 12.0 and driver version 525.85.12.

MATHEMATICAL DESCRIPTION

Convolutional Neural Networks (CNNs) are deep neural networks used to recognize and classify images. They learn spatial hierarchies of features from input images by backpropagation, employing layers such as convolutional layers, pooling layers, and fully connected layers. Here is a basic mathematical discussion of the key components of a CNN.

Convolutional Layer

The convolutional layer is the primary component of a CNN. It creates feature maps by convolving learnable filters (kernels) with the input image. For an input picture I of size HWD (height, width, depth), where D is the number of channels (e.g., 3 for RGB images), the output feature map O for a signal filter K of size KhKwD is

$$O(i \cdot j) = (I \star K) = \sum_{m=1}^{k_h} \sum_{n=1}^{k_w} \sum_{d=1}^{D} I(i+m, j+n, d) \cdot K(m, n, d) + b$$

* represents the convolution process, *b*b is the bias term, and (i, j) identifies the spatial location in the output feature map..

Activation Function

After convolution, a non-linear activation function, such as the Rectified Linear Unit (ReLU), is applied elementwise. The ReLU function is defined as follows:

$$f(x) = max(0, x)$$

This operation implements zero thresholding while leaving the feature maps' dimensions unaltered.

Pooling Layer

Pooling layers minimize the spatial dimensions (height and breadth) of feature maps while preserving important information. The most popular type is max pooling, which selects the highest value in a given neighborhood. For an input feature map of size HWD and a pooling window size PhPw, the output P is given by

$$P(i, j, d) = max_{m=0}^{P_h - 1} \ max_{n=0}^{P_w - 1} O(i \cdot s + m, j \cdot s + n, d)$$

where s is the stride of the pooling operation.

Fully Connected Layer

Following numerous convolutional and pooling layers, fully linked layers execute high-level reasoning. The input is typically flattened into a one-dimensional vector. For an N-dimensional input vector x, the output y is given by:

$$y_i = \sum_{j=1}^{N} w_{ij} x_i + b_i$$

where the fully linked layer's weights are denoted by w_{ij} and its biases by b_i.

Softmax Layer

In classification tasks, the final layer is usually a softmax layer that turns the fully connected layer's outputs into probabilities. The softmax function for an input vector z of size C (number of classes) is as follows:

$$\sigma(z)_i = \frac{e^{z_i}}{\sum_{j=1}^{C} e^{z_j}}$$

This results in a probability distribution for C classes.

A CNN is made up of layers for convolution, activation, pooling, and fully connected transformations, which work together to learn hierarchical representations of input data. CNNs alter their weights and biases during training to minimize the loss function, resulting in good performance on tasks such as image recognition.

RESULTS

Fig 2. Outputs Generated by Our Model

Our colorectal cancer detection algorithm is extremely effective at identifying malignant cases, as evidenced by several critical metrics: accuracy, precision, recall, and mean average precision (mAP). The model scored an 86.79% accuracy rate, correctly identifying the majority of test photos as malignant or non-cancerous. Precision was measured at 78.38%, suggesting that when the model predicts a malignant picture, it is true 78.38% of the time. The recall rate was 85.71%, indicating that the model accurately identified the majority of malignant cases. The mean average precision (mAP) was 78.38%, indicating a strong balance of precision and recall.

Table 1. Table of Result Percentage

Accuracy	Precision	Recall	mAP
86.79%	78.38%	85.71%	78.38%

These findings demonstrate that our model is a reliable tool for early colorectal cancer identification. Its excellent accuracy and balanced precision-recall performance are critical for making prompt and accurate diagnoses. Implementing this model in clinical settings has the potential to improve early identification and treatment, improve patient outcomes, and reduce colorectal cancer deaths.

DATASET USED

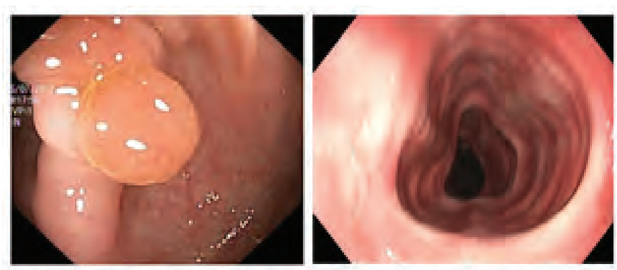

Fig 3. Images from Dataset Used

A bespoke dataset of 1856 photos is essential for utilizing CNN to identify cancer. It includes both carcinogenic and non-cancerous photos from TCIA, DDSM, hospitals, web sources, and synthetic data. Categorized into training, validation, and test sets, it ensures rigorous model training and evaluation. Pre-processing methods including normalization, scaling, and annotating bolster uniformity. Expert annotation and cross-validation sustain dataset accuracy. This personalized dataset, according to the disease kind, enhances relevance and aids in constructing an effective CNN model for precise cancer diagnosis.

HARDWARE & SOFTWARE USED

The model was trained using Google Colab's Runtime GPU and a Tesla T4 graphics card, which are well-known for their performance in data centers and deep learning. This arrangement provides plenty of computational power for efficient model training. The NVIDIA System Management Interface (SMI) continuously monitored and optimized the GPU's performance, fully exploiting the Tesla T4's capabilities. The NVIDIA GPU software stack, comprising driver version 525.85.12 and CUDA version 12.0, ensured smooth interaction between software and GPU hardware, increasing efficiency.

Table 2. Hardwares and Softwares Used

Tool/Equipment	Description
GPU	Tesla T4
GPU Purpose	Model training
Platform	Google Colab's Runtime GPU
GPU Performance Monitoring	NVIDIA System Management Interface (SMI)
GPU Driver Version	525.85.12
CUDA Version	12.0
Advantage	Powerful GPU built for data centre workloads

MODEL'S PERFORMANCE METRICS

Confusion Matrix

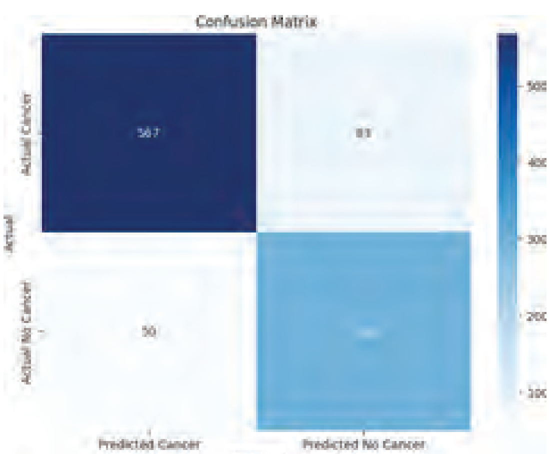

Fig 4. Confusion Matrix of the Implemented Model

A confusion matrix examines the performance of a categorization model, exhibiting real values in rows and anticipated ones in columns. Each cell represents the number of matches or mismatches between real and forecasted values. The provided figure depicts the preferred model's confusion matrix.

Precision

Precision is a machine learning performance parameter that calculates the ratio of true positives to all positive samples identified by the model. It is critical in binary classification issues with possible outcomes of positive or negative. A high precision score suggests that the model consistently finds positive samples with few false positives. Figure 5 depicts the accuracy graph of the proposed model, with precision measured as true positives divided by the total of true positives and false positives.

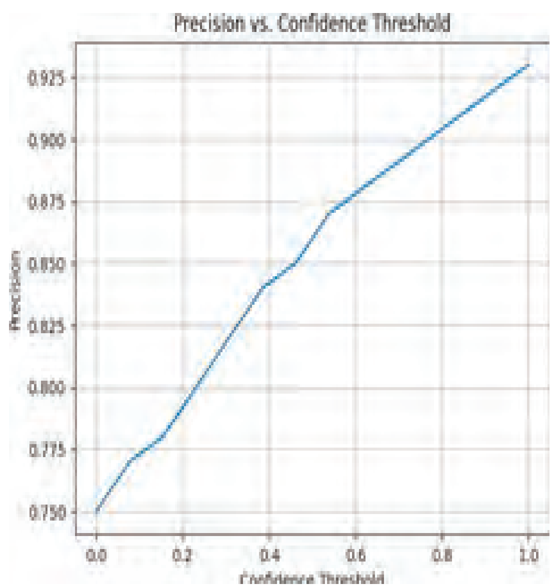

Fig. 5. Precision-Confidence Graph of the Implemented Model

Recall

Recall in machine learning measures the completeness of a model's predictions by calculating the ratio of true positive predictions to total positive cases in a dataset. A high recall score implies that the model can recognize the majority of positive examples, whereas a low score shows that it misses many positive cases.

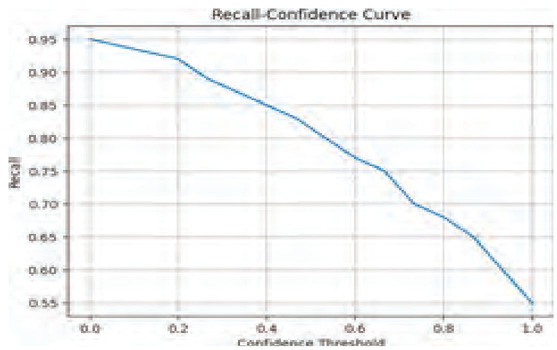

Fig 6. Recall-Confidence Graph of the Implemented Model

mAP

mAP (mean Average Precision) is a commonly used performance statistic for object identification and picture segmentation tasks. It is derived by averaging recall at different IoU (Intersection over Union) levels. Figure 7 depicts the ensemble model's average accuracy graph.

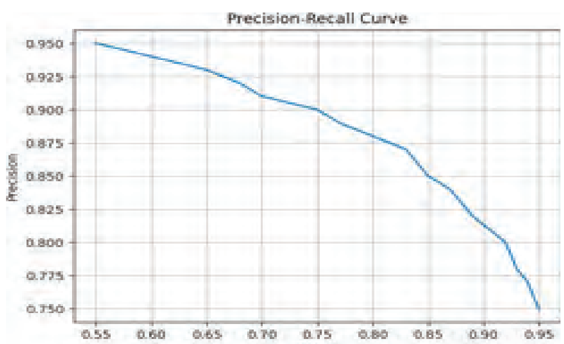

Fig. 7. Precision-Recall Graph of the Implemented Model

CONCLUSION

In this study, we proposed a CNN model for detecting colon cancer from CT colonoscopy images and demonstrated its performance with an accuracy of 86.79%, precision of 78.38%, recall of 85.71%, and mAP of 78.38%. Our methodology is useful for early cancer identification, potentially improving patient outcomes and lowering mortality rates. Integrating it into healthcare operations may improve diagnosis accuracy and efficiency. Future study could look into multimodal imaging and transfer learning for larger application, as well as advanced data augmentation techniques such as GANs to solve data scarcity concerns.

Overall, our CNN model demonstrates promise in enhancing colon cancer diagnosis, highlighting the potential of deep learning in medical imaging and diagnostics, and paving the way for additional study in the field.

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Virtual Keyboard and Mouse Using Hand Gesture

Charushila Vijay Rane
✉ ranecharushilav@gmail.com
Manasi Babu Pawar
✉ manasibpawar@gmail.com
Sakshi Vilas Pawar
✉ shraddhasawant3108@gmail.com
Shraddha Dnyaneshwar Sawant
✉ pawarsakshi2607@gmail.com
Dept of Electronics & Telecommunication JSPM's
RSCOE Tathawade Pune
MS-India Savitribai Phule Pune University
Pune, Maharashtra

ABSTRACT

As we progress into the forthcoming years, the landscape of human-computer interaction continues to evolve rapidly. The project advancements and potential application of hand gesture controlled virtual keyboard and mouse interfaces are examined in this paper presentation, projecting a vision for the future of this innovative technology. The fusion of computer vision and machine learning will remain at the core of this technology, enabling devices to interpret and respond to hand gestures with increasing accuracy. The paper delves into how future developments in computer vision techniques, more powerful hardware, and advanced gesture recognition algorithms will refine the system's precision and responsiveness. The implications for accessibility are profound, as this technology holds the promise of creating a more inclusive digital space for individuals with physical disabilities. Moreover, the concept of "touchless" interaction, which has gained prominence in recent times due to health and hygiene concerns, is likely to become a standard interface for public kiosks, ATMs, and information displays. This paper aims to inspire researchers, engineers, and innovators to push the boundaries of what is possible, bringing us closer to a future where hand gestures become a natural, versatile, and ubiquitous means of interaction in our increasingly digitized worlds.

KEYWORDS: *Haar-Cascade, Deep learning, Feature extraction, Classification, Computer vision.*

INTRODUCTION

In today's digital landscape, the evolution of user interfaces is constantly pushing boundaries. Traditional input methods like keyboards and mice have long been the standard, but advancements in technology are reshaping how we interact with our devices. Enter the virtual keyboard and mouse using hand gestures – a revolutionary approach that merges human movement with digital control.

Imagine typing on an invisible keyboard or navigating a computer screen with a wave of your hand.

Possibilities of virtual input through hand gestures. We'll delve into the intricacies of computer vision algorithms, which enable us to detect and track~ hand movements in real-time. Additionally, we'll dive into the realm of machine learning, training models to recognize specific gestures and translate them into actionable commands.

Underlying technologies driving virtual input using hand gestures, and to develop a functional system that demonstrates its practical applications. From gaming to productivity tools, the potential uses for this technology are vast, promising a future where interacting with technology feels more natural and intuitive than ever before.

Need of Study

Developing hand gesture-based technology can drive innovation and research in fields such as computer vision, machine learning, and human-computer interaction, which can have broader applications beyond virtual keyboards and mice. Hand gestures are well-suited for virtual and augmented reality environments. They allow users to interact with digital content in a more compelling and natural way. This technology can enhance experiences in gaming, training, education, and more. Hand gesture-based interfaces can be a powerful tool for individuals with physical disabilities who may have difficulty using traditional keyboards and mice. It can provide an alternative means of computer interaction and improve accessibility for a wider range of users.

Objective

1. To create a virtual environment which can take realtime input using camera and respond accordingly.
2. To develop a system based on recognized gestures, the system should simulate keypress events corresponding to a traditional keyboard
3. To evaluate the performance of the developed system to ensure its effectiveness and reliability.

LITERATURE SURVEY

U.-H.Kim and J.-H.Kim et.al [1] have proposed the paper for presents a forward-thinking solution to the challenges of text entry on mobile devices through the introduction of the I- Keyboard and DND. It emphasizes the unique features of the I- Keyboard, such as eyes-free ten-finger typing and the absence of calibration requirements, and highlights the substantial data collection process and the positive results achieved in terms of typing speed and accuracy. This research contributes to the ongoing evolution of text entry methods for mobile computing. The I-Keyboard is invisible and does not require a calibration step or a predefined region for typing, allowing users to type anywhere on the touch screen. The DND effectively handles hand drift and tap variability and translates touch points into words. In simulations and experiments, I-Keyboard showed improved typing speed and accuracy compared to baseline methods.

R.A.da Silva and A.C.P Veiga et.al [2] have proposed the paper for discusses the development of an assistive virtual keyboard that utilizes eye movement tracking for text input, with a focus on individuals with neuromata disorders. It highlights the creation of a shape detection algorithm, a word voting mechanism, and presents preliminary findings on the decoding algorithm, which would likely include insights into the system's performance and effectiveness in assisting communication for this target user group. This work investigates methods of interaction based on eye movement tracking and presents a virtual keyboard that utilizes gaze detection as a text input. It describes the development of the shape detection algorithm for the assistive keyboard, typed word voting from a Brazilian Portuguese lexicon and preliminary results on the decoding algorithm.

H. Ansar et.al [3] have proposed the paper for acquaints an imaginative methodology with hand motion acknowledgment that spotlights on lessening commotion, removing milestones, and utilizing mathematical elements for signal acknowledgment utilizing a CNN classifier. The trial results exhibit high acknowledgment rates on both the MNIST and ASL datasets. The proposed framework holds guarantee for improving correspondence with hearing-debilitated people and tracking down applications in human-PC association, human-robot cooperation, and augmented reality. An original methodology is proposed in this paper for character location and acknowledgment. In proposed framework is right off the bat, pictures are pre-handled to decrease clamour and force is changed. The pre-handled pictures area of interest is distinguished by means of directional pictures. After hand extraction, tourist spots are separated by means of a curved body. Each signal is utilized to separate mathematical highlights for the proposed hand motion acknowledgment (HGR) framework. The separated highlights helped in motion location and acknowledgment through the Convolutional Brain Organization (CNN) classifier H.Zhang.Y.Yin.L.Xie.T. et.al [4] proposes a system called DynaKey that enables people to type on a virtual keyboard printed on a surface or drawn on a desk using a head-mounted camera device, such as smart glasses. The system utilizes the built-in camera and gyroscope to capture image frames during typing and detect head movements. It then tracks the keys, detects fingertips, and locates keystrokes in real time.

To address the challenge of tracking keys' coordinates in images caused by natural head movements, the paper introduces perspective transformation to transform the coordinates among different frames. To detect and locate keystrokes, the system utilizes the variation of fingertip's coordinates across multiple frames. The paper also presents optimizations such as key point detection, frame skipping, and multithread processing to reduce time cost. The authors implemented DynaKey on Android powered devices and conducted extensive experiments to evaluate its performance. The results show that the system can efficiently track and locate keystrokes in real time, with an average tracking deviation of less than 3 pixels and an average keystroke localization accuracy of 95.5%. The paper also evaluates the system's performance in complex scenarios, such as different light sources and surfaces, and compares it with state-of-the-art text input methods.

K.A.Shatilov and Y.D.Kwon et.al [5] have proposed the paper for presents MyoKey as a promising textbook entry system for extended realities, combining IMU control and sEMG gesture recognition. It achieves high usability and stoner acceptance while offering practical and effective textbook input styles in colourful scripts, similar as latitude and object- grasping situations. The authors introduce a multi-modal result called" MyoKey," which allows druggies to input textbook using a virtual QWERTY keyboard through a combination of arm movements and hand gestures. MyoKey leverages both inertial dimension unit (IMU) control and sEMG gesture recognition. The stoner can elect characters with a combination of arm movements and hand gestures. MyoKey employs a feather light convolutional neural network classifier that can be stationed on a mobile device with insignificant conclusion time. We demonstrate the practicality of interruption-free textbook entry with MyoKey, by retaining 12 actors and by testing three sets of grasp micro-gestures in three scripts empty hand textbook input, tripod grasp(e.g., pen), and a spherical grasp(e.g., marquee).

Several innovative solutions have been proposed in recent literature to address the challenges of text input on mobile devices and assist individuals with specific needs. U.-H. Kim and J.-H. Kim et al. introduce the IKeyboard and DND system, offering a unique approach to text entry by enabling ten-finger typing without calibration requirements and demonstrating improved speed and accuracy. R.A. da Silva and A.C.P. Veiga et al. focus on developing an assistive virtual keyboard utilizing eye movement tracking, particularly beneficial for individuals with neuromuscular disorders, showcasing advancements in shape detection algorithms and preliminary findings on decoding mechanisms. H. Ansar et al. present a novel hand motion recognition methodology using CNN classifiers, showing promise for applications in aiding hearing-impaired individuals and enhancing human-computer interaction. H. Zhang, Y. Yin, L. Xie, T. et al. propose DynaKey, a system enabling typing on virtual keyboards using head-mounted cameras, with real-time keystroke tracking and localization, achieving high accuracy and efficiency. Lastly, K.A. Shatilov and Y.D. Kwon et al. introduce MyoKey, a multi-modal text entry system for extended realities, combining IMU control and sEMG gesture recognition, demonstrating practical and interruption-free input methods utilizing arm movements and hand gestures across various scenarios.

SOFTWARE REQUIREMENTS SPECIFICATION

Database requirements

- DB Browser SQLite

Software Requirements

- Operating System: Windows10
- IDE: PyCharm, Spyder
- Programming Language: Python

Hardware requirements

- Hardware: intel core
- Speed: 2.80 GHz
- RAM: 8GB
- Hard Disk: 500 GB
- Key Board: Standard Windows Keyboard

METHODOLOGY

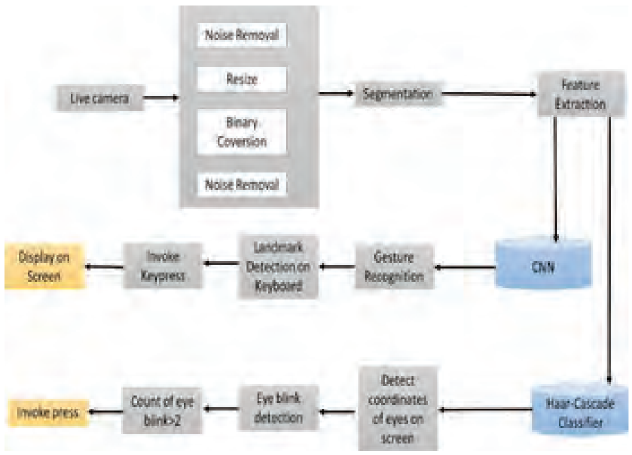


Fig.1: Key Board &Mouse Methodology

The methodology for virtual keyboard and mouse using Python and OpenCv requires data collection, pre-processing, evaluation to develop an accurate output.

1. **Environment Setup**

OpenCV Installation: Depending on your platform (Windows, Linux, MacOS), follow the respective guidelines to install OpenCV. It's often as simple as a pip install for Python. Programming Environment: Choose an IDE or editor suitable for C++ or Python (like Visual Studio, PyCharm, or Jupyter Notebook).

Install Necessary Libraries: Make sure you have Python and OpenCV installed on your system. You can install OpenCVusing pip.

2. **Hardware Check:** Ensure your camera can capture high resolution images. A clear feed ensures better gesture recognition. If using an external camera, ensure its compatibility with your system and check its connectivity.

3. **Capture Video Input:** Use OpenCV to capture video input from your webcam or any other camera connected to your system. While capturing a video, use a consistent and plain background to reduce complexity during background subtraction. Ensure you capture a wide variety of gestures for each action to train a robust model. Use tools like Label box or VGG Image Annotator to label each gesture. This labelled data willbe crucial when training a model or algorithm.

4. **Preprocess the Video:** Apply necessary preprocessing techniques such as resizing, grayscaling, and thresholding to enhance the image quality and reduce noise. Convert all images to a standard size (e.g., 128x128 pixels), which ensures consistency during processing and potentially speeds up computations. Use filters like Gaussian blur to reduce noise in images. Improve the contrast of the images to highlight features.

5. **Extract Hand Features**

Detect Hand Region: Implement hand detection using techniques like background subtraction, skin color detection, or hand cascade classifiers to identify the region of interest (hand) in the video feed.

Once the hand region is detected, extract features suchas contours, convex hull, and defects to understand the hand's shape and position.

Background Subtraction: Convert images to grayscale and apply binary thresholding to segment the hand from the background. Use erosion and dilation to further refine segmented hand Feature Extraction.

Finger Tips and Joints Detection: Using the convex hull and defects, identify the tips of fingers and joints. The number of extended fingers, their arrangement, and position can be crucial features for gesture recognition.

6. **Gesture Recognition:** Define gestures for different keyboard keys. Map hand gestures to specific keyboard keys events. Assign each detected gesture to a specific keyboard action or key. For instance, a swipe to the right might represent the 'Space' key.

Key Press Simulation : Integrate with libraries (like `pyautogui` for Python) to simulate actual key presses on your computer based on detected gestures.

7. **Implement Virtual Keyboard:** Create a graphical user interface (GUI) for the virtual keyboard using libraries like Tkinter or Pygame. Display the keyboard keys and any additional controls.

8. **Handle Mouse Events:** Implement functions to handle mouse events such as moving, clicking, and scrolling based on hand gestures. After Face detection the eyes are detected and count of eye blink is calculated based on algorithm mouse event is invoked.

9. **Integration:** Integrate the gesture recognition and virtual keyboard/mouse functionalities. Associate each detected hand gesture with the corresponding keyboard key or mouse action. Create a layout that visually represents the keyboard. As gestures are detected, highlight or animate the corresponding key on this layout.

10. **Testing and Refinement:** Test the virtual keyboard and mouse system with different hand gestures and refine the implementation based on the feedback. Tweak parameters and algorithms to improve accuracy and responsiveness.

11. **Model Deployment:** Once satisfied with the functionality and performance, deploy your virtual keyboard and mouse system for practical use. This can be done by creating a user- friendly interface or integrating the model into an application or system.

APPLICATIONS

Augmented Reality (AR) and Virtual Reality (VR)

Within Augmented reality and virtual reality headsets or environments, a physical keyboard isn't always feasible. Virtual keyboards using finger gesture detection allow users to type or give commands without needing a tangible interface.

Wearable Devices

For smartwatches and other wearables with limited screen space, a virtual keyboard detected by finger movements, possibly in the air or on another surface, can provide a more expansive typing experience.

Gaming Consoles and Entertainment Systems

Gesture based virtual keyboards can be integrated into gaming systems where traditional keyboards are cumbersome. This allows for easier text entry in search fields, messaging, or character naming.

Interactive Displays and Kiosks

Public kiosks or interactive displays can benefit from touchless interfaces, especially in post pandemic scenarios where touchless interactions are preferred.

Assistive Technology

For individuals with mobility restrictions or disabilities, gesture based virtual keyboards can provide an alternative to traditional input methods, tailored to their specific needs and abilities.

Smart Homes and IoT

Home automation systems or IoT devices can use gesture detection for commands, with virtual keyboards allowing for text input without the need for physical buttons or touch screens.

Portable Computing

For users on the go, carrying around a physical keyboard isn't always feasible. Devices like smartphones or tablets can employ gesture based virtual keyboards, where users can type on any flat surface or even in the air.

Educational Tools

Interactive educational setups, especially in digital classrooms.

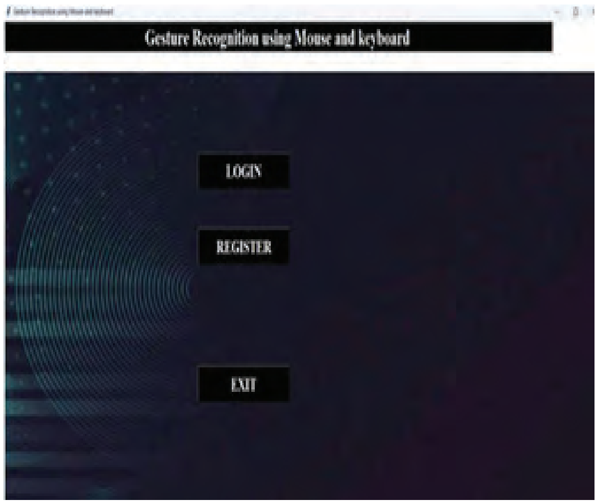
Conference Rooms and Presentations

During presentations or conferences, speakers can use gesture based virtual keyboards to navigate slides, type in real time, or interact with their content without being tethered to a podium.

RESULT

Home Page :

Here home page having 3 options login, register and exit.



Registration Page

In 2nd step user will first register for login and credential

Events Page

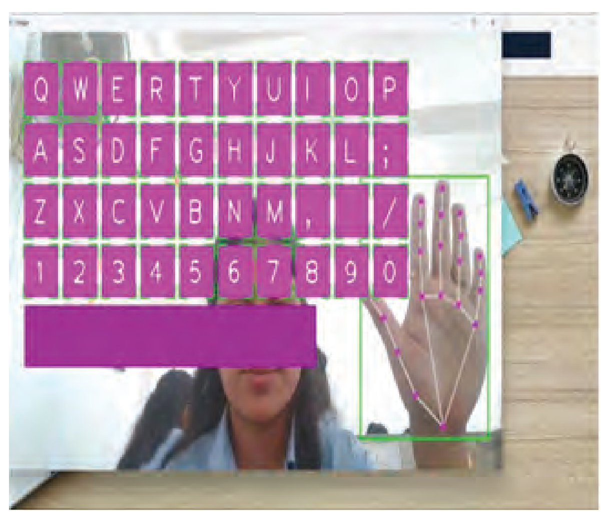
Now user can login directly, and after this event page will open which will have five option like home page,face recognition, recognized usong mouse, recognized using keyboard and exit. After clicking on one option it open tha new tab of particular option which have chosed.

Face Recognition

When user choses face recognition option,tab is opened here which recognizes user face in blue box.

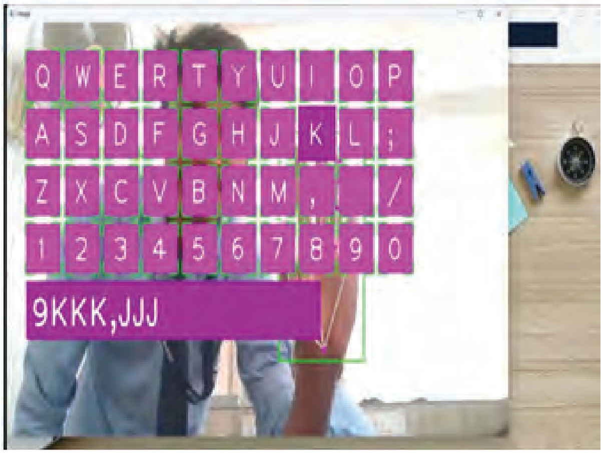
Keyboard

For keyboard it will take our hand co-ordinate as a input here



Keypress:

Now when user will press the key, the pressed particular key will invoke and display on the screen.



Mouse

To use the mouse it will record user's eye movements and the action will happen when user blink twice.

CONCLUSION

In conclusion, virtual keyboards and mice using hand gestures have the potential to revolutionize human-computer interaction by offering a more intuitive and natural way to control digital devices. These technologies leverage advancements in computer vision and machine learning to accurately interpret hand gestures, enabling users to input commands and manipulate on screen elements with greater precision and efficiency. While they have their advantages, such as touchless operation and potential accessibility benefits, challenges like accuracy, fatigue, and the need for specialized hardware should not be overlooked. As these technologies continue to evolve, they hold promise for a wide range of applications, from gaming to virtual reality, and have the potential to reshape how we interact with computers and digital interfaces in the future.

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Comparative Analysis of CI/CD Tooling and Technologies: A Research Review

Saurabh Patil
MCA Department
PES Modern College of Engineering
Pune, Maharashtra

Yogeshchandra L Puranik
Assistant Professor
MCA Department
PES Modern College of Engineering
Pune, Maharashtra
✉ yogeshchandra.puranik@gmail.com

ABSTRACT

Deployment (CI/CD) practices have become indispensable in modern software development workflows, facilitating rapid and reliable delivery of software applications. This research journal provides a comprehensive review of various CI/CD tooling and technologies, focusing on their features, advantages, limitations, and adoption trends. Through a comparative analysis, this study aims to assist software development teams and organizations in selecting the most suitable CI/CD tools and technologies for their specific requirements.

KEYWORDS: *Continuous Integration (CI), Continuous Deployment (CD), Software development, Comparative analysis, Tooling and technologies, Adoption trends, Performance evaluation, Reliability, Security, Cost analysis.*

INTRODUCTION

Overview of Continuous Integration/ Continuous Deployment practices

Continuous Integration (CI) and Continuous Deployment (CD) represent pivotal components of contemporary software development methodologies. CI entails developers consistently integrating their code modifications into a centralized repository, where automated builds and tests are initiated to verify seamless integration with the existing codebase. CD expands upon CI automating the deployment procedure, enabling swift and frequent software releases to production environment.

Importance of CI/CD in modern software development

CI/CD practices plays a vital role in enhancing the speed. Quality, and efficiency of software development processes. By automating the build, test, and deployment phases, CI/CD pipelines reduce the risk of errors and inconsistencies, leading to faster time-to- market and improved product reliability. Moreover, CI/CD fosters a culture of collaboration and feedback within development teams, enabling them to iterate quickly and respond effectively to changing requirements and customer feedback.

Fig. 1. Diagram of CI/CD

Motivation for the comparative analysis: The landscape of CI/CD tools and technologies is vast and constantly evolving, with numerous options available to development teams. However, selecting the most suitable tools for specific project requirements can be challenging. Therefore, there is a need for comprehensive comparative analysis that evaluates the features, strengths, and limitations of different CI/CD solutions. Such an analysis can help organizations make informed decisions about tool selection, ultimately optimizing their software development workflows and outcomes.

LITERATURE SURVEY

Foundational Concepts of CI/CD: Several seminal works have laid the foundational for understanding CI/CD practices and their implications for software development. Fowler (2006) introduced the concept of Continuous Integration as a software development practice that advocates frequent integration of code changes into a common repository, coupled with automated processes to detect and address integration errors early in the development lifecycle. Humble and Farley (2010) further elaborated the principles of Continuous Delivery, emphasizing the importance of automating the entire software delivery process, including deployment, testing, and release, to enable fast and reliable software releases.

Comparative Analysis Methodologies: Research studies focusing on comparative analysis methodologies for evaluating CI/CD tools and technologies have gained prominence in recent years. These studies often employ rigorous evaluation criteria and performance metrics to assess the capabilities and effectiveness of different CI/CD solutions. Stolberg (2019) conducted a comparative analysisof Jenkins vs. GitLab CI/CD, examining factors such as integration capabilities, scalability, ease of use, and community support. The investigation yielded valuable understandings regarding the capabilities and constraints of each tool, empowering organizations to make well-informed choices when opting for CI/CD solutions.

Emerging Trends and Innovations

With the rapid evolution of software development practices and technologies, researchers have explored emerging trends and innovations in the CI/CD landscape. Capterra (2022) conducted a comprehensive analysis of the best CI/CD tools, highlighting trends such as the adoption of cloud-native CI/CD solutions, integration with DevOps toolchains, and the emergence of AI-driven automation. These trends reflect the growing demand for scalable, agile, and automated CI/CD practices to meet the evolving needs of modern software development teams.

Industry-Specific Adoption Patterns

Studies examining industry-specific adoption patterns and challenges in CI/CD implementation have provided valuable insights into the diverse applications and requirements of CI/CD practices in various industries, including technology, finance, healthcare, and government. The report identified sector-specific challenges such as regulatory compliance, security, and legacy system integration, underscoring the importance of tailoring CI/CD strategies to meet industry-specific requirements.

In conclusion, the literature review highlights the importance of comparative analysis in evaluating and selecting CI/CD tooling and technologies. By examining foundational concepts, comparative analysis methodologies, emerging trends, industry-specific adoption patterns, and future research directions, organizations can gain valuable insights into optimizing their CI/CD practices to drive agility, innovation, and competitiveness in software development.

METHODOLOGY

Identification of CI/CD tools and technologies

In this stage, a comprehensive approach was taken to ensure that the research captured a wide spectrum of CI/CD tools and technologies available in the market. This involved leveraging multiple sources such as academic databases, industry reports, technology blogs, developer forums and online communities. Additionally, consultation with industry experts and practitioners provided valuable insights into emerging tools and trends. The inclusion criteria prioritized tools with significant user base, active development, and proven track record in real-world implementations across diverse domains and industries. By casting a wide net during the identification phase, the research aimed to encompass both established and emerging solutions, thereby providing a holistic view of the CI/CD landscape.

Selection criteria for inclusion in the analysis

The criteria for inclusion in the comparative analysis were carefully crafted to ensure the relevance and applicability of the findings to the target audience, which primarily consisted of software development teams and

IT decision makers. Key considerations included the tool's maturity level, platform compatibility, support for popular version control systems (e.g., Git, SVN), programming languages, and deployment environments (e.g., cloud, on-premises). Additionally, factors such as ease of setup and configuration, extensibility through plugins or APIs, and vendor stability were considered. By applying stringent selection criteria, the research aimed to focus on tools that offered a balance between features richness, usability, and community support, this maximizing the utility of the comparative analysis for practitioners seeking actionable insights.

Data collection methods

To gather relevant data for the comparative analysis, a heterogeneous approach was adopted, combining both qualitative and quantitative research techniques. Primary research methods, including surveys, interviews and focus groups, facilitated direct engagement with industry professionals to understand their experiences, preferences, and pain points related to CI/CD adoption. These insights provided valuable context and enriched the analysis with real-world perspectives. Concurrently, secondary research involved exhaustive literature reviews, mining of online repositories (e.g., GitHub), and analysis of user reviews and ratings on platforms such as G2 and Capterra. This multi-pronged data collection approach ensured triangulation of findings from diverse sources, thereby enhancing the credibility and robustness of the research outcomes.

Evaluation metrics

The selection of evaluation metrics was guided by the overarching goal of the comparative analysis, which aimed to assist stakeholders in making informed decisions regarding CI/CD tooling and technologies. The chosen metric encompassed various dimensions of tool performance, usability, and ecosystem support, catering to the multifaceted needs of software development teams. For instance, metrics related to automation capabilities, pipeline orchestration, version control integration, and artifact management addressed technical aspects of CI/CD implementation, while considerations such as security features, compliance standards, and total cost of ownership (TCO) provided insights into broader organizational considerations. Through the utilization of an extensive array of assessment criteria, the study aimed to offer a detailed comprehension of the advantages and constraints associated with each tool. This enables practitioners to synchronize their selection criteria with strategic business goals and project specifications.

CI/CD TOOLING OVERVIEW

In this section, we provide a comprehensive overview of the CI/CD tools and technologies included in the comparative analysis. Each tool is introduced with a brief description highlighting its key features, functionalities, and target user base. Additionally, we categorize the tools based on their functionality and used usage to facilitate a structured comparison.

Tool 1: Jenkins

Jenkins is an open-source automation server widely used for implementing CI/CD pipelines. It offers a vast ecosystem of plugins, enabling seamless integration with various version control systems, build tools, and deployment platforms. Jenkins provides flexibility and extensibility, allowing users to customize their automation workflows according to project requirements. It supports distributed builds and can scale accommodate complex build pipelines across large development teams.

Tool 4: GitLab CI/CD

GitLab CI/CD is an integral part of the GitLab platform, providing native support for CI/CD workflows within the GitLab repository management system. It offers a simple yet powerful YAML-based configuration for defining CI/CD pipelines directly within the version control repository. GitLab CI/CD emphasizes collaboration and visibility, allowing teams to manage their entire DevOps lifecycle within a unified platform, from code repository management to deployment and monitoring.

Tool 2: Travis CI

Travis CI is a cloud-based CI/CD platform designed for GitHub repositories, offering seamless integration with the GitHub ecosystem. It provides a user-friendly interface for configuring CI/CD pipelines using YAML based configuration files stored in the repository. Travis CI supports parallel and matric builds, enabling efficient testing across different environments and configurations.

it offers both free and paid plains, making it accessible to individual developers and enterprise teams alike.

Tool 3: Circle CI

CircleCI is a cloud-native CI/CD platform that automates the software delivery process from code commit to deployment. It offers a highly customizable and scalable approach to building, testing, and deploying applications across various cloud environments. CircleCI supports Docker-based workflows, allowing developers to create reproducible build environments and run tests in isolated containers. It provides tight integration with popular version control systems and continuous deployment to leading cloud providers such as AWS, Google Cloud Platform, and Microsoft Azure.

Categorization based on functionality and usage

The CI/CD tools included in the analysis can be categorized based on their primary functionality and intended usage:

a. Traditional CI/CD servers: Tools like Jenkins fall into this category, offering extensive customization and flexibility for creating complex Ci/CD pipelines. They are suitable for organizations with diverse requirements and legacy systems that require extensive integration capabilities.

b. Integrated DevOps Platforms: Platforms like GitLab provide an all-in-one solution for version control, issue tracking, CI/CD, and collaboration. They are ideal for organizations looking for a unified DevOps platform that streamlines the entire software development lifecycle.

c. Cloud-Native CI/CD services: Services like Travis CI and CircleCI offer cloud-native CI/CD solutions, eliminating the need for maintaining infrastructure. They are well-suited for small to medium-sized teams and startups that prioritize simplicity, scalability, and ease of use.

COMPARATIVE ANALYSIS

In this section, we conduct a detailed comparative analysis of the CI/CD tools and technologies under review. We evaluate each tool based on key criteria, including integration capabilities, scalability, automation, ease of use, community support, performance, reliability, security, compliance considerations, and costs.

Comparison of features

- Integration Capabilities: we assess the tools ability to seamlessly integrate with version control systems (e.g., Git, SVN), build tools (e.g., Maven, Gradle), deployment platforms (e.g., AWS, Azure), and other DevOps tools and services. This includes support for plugins, APIs, and webhooks to facilitate interoperability with third-party systems.
- Scalability: We evaluate the tools ability to scale horizontally and vertically to accommodate increasing workloads and growing development teams. This includes support for distributed builds, parallel execution, and resource management to ensure optimal performance under varying workloads.
- Automation: We analyze the level of automation provided by each tool in streamlining the CI/CD workflow, including automated testing, deployment, and rollback mechanisms. This includes support for automated provisioning of infrastructure, environment configuration, and deployment orchestration.
- Ease of use: We assess the usability and user experience of each tool, considering factors such as intuitive UI/UX design, comprehensive documentation, and user-friendly configuration options. This includes support for declarative configuration languages, graphical pipelines editors, and interactive dashboards for monitoring and reporting.
- Community support: We evaluate the strength and engagement of the community surrounding each tool, including the availability of user forums, online documentation, tutorials, and user-contributed plugins and extensions. This includes assessing the responsiveness of the community to user inquiries and the frequency of updates and releases.

Assessment of performance, reliability, security, and compliance considerations

- Performance: We measure the speed and efficiency of CI/CD pipelines generated by each tool, including build times, test execution times, and deployment speed. This includes analyzing factors such as caching, parallelization, and optimization techniques employed by the tools to minimize build and deployment times.

- Reliability: We evaluate the reliability and stability of each tool in handling continuous integration and deployment tasks, including the frequency of failures, error handling mechanisms, and support for fault tolerance and recovery.
- Security: We assess the security features and best practices implemented by each tool to safeguard CI/CD pipelines and artifacts from unauthorized access, data breaches, and malicious attacks. This includes support for role-based access control, encryption, audit logging, and vulnerability scanning.
- Compliance considerations: We examine the tools adherence to industry standards and regulatory requirements, including GDPR, HIPAA, SOC 2, and ISO 27001. This includes evaluating reporting to ensure that CI/CD processes comply with relevant legal and regulatory frameworks.

Examination of costs associated with each tool or technology

- We analyze the cost structure and pricing models offered by each tool, including free, open-source, and commercial options. This includes assessing factors such as licensing fees, subscription plans, usage-based pricing, and additional charges for premium features or support services. We also consider hidden costs such as infrastructure requirements, maintenance overhead, and training expenses associated with adopting and operating each tool.

CASE STUDIES

In this section, we present real world case studies of organizations that have implemented various CI/CD tooling technologies. These case studies highlight the challenges faced during the implementation process, as well as the lesson learned from their experiences.

Case study 1: Company X – Implementing Jenkins for CI/CD

Overview

Company X, a medium-sized software development firm, adopted Jenkins as its primary CI/CD tool to streamline its software delivery pipeline. The company's development teams were tasked with delivering frequent updates to their web-based applications, necessitating an efficient CI/CD process to ensure rapid and reliable deployments.

Implementation

Initially, the implementation of Jenkins posed several challenges, including configuring complex build pipelines, integrating with multiple code repositories, and managing dependencies across different projects. However, with the help of Jenkins extensive plugin ecosystem and community support, the teams were able to overcome these challenges and establish robust CI/CD workflows tailored to their specific project requirements.

Challenges faced

- Initial setup and configuration of Jenkins pipelines were time-consuming and required a steep learning curve.
- Integrating Jenkins with legacy systems and third-party services posed compatibility issues and required custom plugin development.
- Ensuring consistency and reproducibility of builds across different environments was challenging, leading to occasional deployment failures and rollbacks.

Lesson learned

- Investing in comprehensive training and onboarding sessions for development teams facilitated faster adoption of Jenkins and improved collaboration.
- Leveraging version control for Jenkins configurations and infrastructure as code practices helped maintain consistency and traceability across pipelines.
- Regular monitoring and optimization of Jenkins performance, including resource utilization

and build times, were essential for maintaining scalability and reliability.

Case study 2: Company Y – Adopting GitLab CI/CD for DevOps Transformation

Overview:

Company Y, a large enterprise in the financial services sector, embarked on a DevOps transformation initiative to modernize its software development processes and accelerate time-to-market for its digital products. As part of this initiative, the company adopted GitLab CI/CD to standardize its CI/CD practices across distributed development teams.

Implantation

The implementation of GitLab CI/CD at company Y involved migrating existing CI/CD workflows from disparate tools and platforms to a centralized GitLab instance. This migration process required careful planning and coordination to ensure minimal disruption to ongoing development activities. GitLab's built in CI/CD capabilities, including native integration with GitLab repositories and Docker container registry, simplified the transition and enabled seamless automation of build, test, and deployment tasks.

Challenges Faced

- Legacy systems and siloed development processes hindered the adoption of GitLab CI/CD, requiring significant cultural and organizational change management efforts.
- Integrating GitLab CI/CD with existing toolchains and security frameworks raised compatibility and compliance concerns, necessitating close collaboration between development, operations, and security teams.
- Scaling GitLab CI/CD to support enterprise-wide deployments and complex microservices architectures required infrastructure upgrades and performance optimizations.

Lessons Learned

- Establishing cross-functional DevOps teams with dedicated roles and responsibilities facilitated collaboration and alignment across different functional areas.
- Implementing automated testing and continuous monitoring practices within GitLab CI/CD pipelines enhanced the quality and reliability of software releases.
- Embracing GitLab's CI/CD as code paradigm and adopting infrastructure as code principles enabled version-controlled, reproducible, and auditable CI/CD workflows.

By examining these case studies, stakeholders can gain valuable insights into the practical challenges and lessons learned from organizations experiences with different CI/CD tooling and technologies. These insights can inform decision-making processes and help guide the successful implementation and optimization of CI/CD practices in their own organizations.

ADOPTION TRENDS AND INDUSTRY PRACTICES

In this section, we explore the current landscape of CI/CD adoption, including analysis of adoption trends and emerging practices in the industry.

Analysis of the current landscape of CI/CD adoption

In recent years, there has been a notable surge in the adoption and refinement of Ci/CD practices. This trend is propelled by the rising need for agile software development methodologies and the fostering of DevOps principles. Business spanning diverse sectors such as technology, finance, healthcare, and retail are actively embracing CI/CD to expedite software development, elevate product standards, and amplify customer contentment. Key trends in CI/CD adoption include:

a. Enterprise-wide adoption: CI/CD practices are no longer confined to niche tech companies or startups but are increasingly being adopted by large enterprises and traditional industries. Organizations recognize the strategic importance of CI/CD in enabling digital transformation initiatives and remaining competitive in the market.

b. Shift-left testing: there is a growing emphasis on integrating testing activities earlier in the development lifecycle, commonly referred to as "shift-left" testing. This trend is driven by the desire to detect and address defects as early as possible, thereby reducing the cost and effort of fixing issues in later stages of development.

c. Cloud-native CI/CD: With the widespread adoption of cloud computing and containerization technologies such as Docker and Kubernetes, there is a shift towards cloud- native CI/CD solutions. These solution afford scalability, adaptability, and economical advantages, allowing organizations to harness cloud infrastructure for application building, testing, and deployment.

d. Automation and orchestration: Automation is at the core of CI/CD practices, and there is a continued focus on automating various aspects of the software delivery pipeline, including code integration, testing, deployment, and monitoring. Orchestration tools such as Jenkins, GitLab CI/CD, and CircleCI enable organizations to automate complex workflows and streamline the delivery process.

e. Integration with DevOps toolchains: CI/CD is increasingly being integrated with other DevOps tools and practices, such as version control systems, issue tracking, configuration management, and continuous monitoring. This integration fosters collaboration and visibility across the development lifecycle, enabling teams to deliver software more efficiently and reliably.

Emerging trends in CI/CD tooling and technologies

In addition to existing trends, several emerging practices and technologies are shaping the future of CI/CD adoption:

a. GitOps: GitOps is an emerging paradigm that leverages Git repositories as the single source of truth for declarative infrastructure and application configuration. This approach enables organizations to manage infrastructure and application deployments using Git workflows, promoting consistency, repeatability, and auditability.

b. Serverless CI/CD: Serverless computing offers a serverless execution environment for running code in response to events without the need for provisioning or managing servers. Serverless CI/CD platforms, such as AWS Code Pipeline and Azure DevOps, enable organizations to build, test, and deploy applications with minimal operational overhead and cost.

c. AI-driven CI/CD: Artificial Intelligence (AI) and machine learning (ML) technologies are increasingly being integrated into CI/CD pipelines to automate and optimize various aspects of software delivery. AI-driven CI/CD tools can analyze historical data, identify patterns, predict failures, and recommend optimizations to improve pipeline efficiency and reliability.

d. Compliance as code: With the growing emphasis on regulatory compliance and data privacy, there is a trend towards incorporating compliance requirements into CI/CD pipelines through code-based automation. Compliance as code tools enable organizations to enforce security policies, perform vulnerability assessments, and generate compliance reports as part of the software delivery process.

e. Hybrid and multi-cloud CI/CD: As companies implement hybrid and multi-cloud approaches to capitalize on the unique advantages offered by various cloud service providers, there is a need for CI/CD solutions that can seamlessly orchestrate deployments across diverse cloud environments. Hybrid and multi-cloud CI/CD platforms enable organizations to deploy applications consistently and efficiently across on-premises and cloud infrastructure.

By analyzing these adoption trends and emerging practices, organizations can stay abreast of industry developments and align their CI/CD strategies with evolving best practices and technologies. This proactive approach enables organizations to harness the full potential of CI/CD to drive innovation, accelerate time-to-market, and deliver value to customers effectively.

CHALLENGES AND FUTURE DIRECTIONS

In this section, we examine the challenges associated with CI/CD implementation and explore opportunities for improvement and innovation in the future.

Identification of challenges in CI/CD implementation

Despite the benefits of CI/CD practices, organizations often encounter various challenges during the implementation process. These challenges include:

- Legacy systems and processes: Organizations with legacy systems and entrenched processes may face resistance to change when adopting CI/CD practices. Legacy applications may lack automation capabilities, making it difficult to integrate them into modern CI/CD pipelines.
- Complexity and scale: As software systems become increasingly complex and distributed, managing CI/CD pipelines at scale poses significant challenges. Coordinating deployments across multiple teams, environments, and technologies requires robust orchestration and automation capabilities.
- Security and compliance: Ensuring the security and compliance of CI/CD pipelines and artifacts is a critical concern for organizations, particularly in regulated industries. Securing sensitive data, managing access controls, and adhering to regulatory requirements can be complex and time-consuming.
- Resource constraints: Limited resources, including budget, infrastructure, and skilled personnel, can hinder CI/CD implementation efforts. Small teams and startups may struggle to allocate resources to CI/CD initiatives, leading to slower adoption and suboptimal outcomes.
- Cultural and organizational barriers: Cultural resistance, siloed organizational structures, and lack of alignment between development and operations teams can impede CI/CD adoption. Overcoming cultural barriers and fostering a collaborative, DevOps-oriented culture is essential for successful CI/CD implementation.

Opportunities for improvement and innovation

Despite these challenges, there are numerous opportunities for improvement and innovation in CI/CD practices. These include:

- Streamlining the CI/CD pipeline: Continuously optimizing and streamlining CI/CD pipelines can improve efficiency, reduce cycle times, and enhance overall productivity. Leveraging automation,parallelization, and containerization technologies can help streamline the development and deployment process.
- Enhancing security and compliance: Innovations in security and compliance automation tools can help organizations mitigate risks and ensure regulatory compliance in CI/CD pipelines. Implementing security as code practices, integrating vulnerability scanning tools, and enforcing compliance policies as part of the CI/CD process can strengthen security posture.
- Advancing testing methodologies: Innovations in testing methodologies, such as shift-left testing, chaos engineering, and AI-driven testing, can help organizations improve the quality and reliability of software releases. Adopting automated testing methodologies, which encompass unit tests, integration tests, and end-to-end tests, aids in the timely detection and resolution of defects during the developmental phase.
- Enabling self-service and autonomy: Empowering development teams with self- service CI/CD capabilities can accelerate innovation and agility. Providing developers with tolls and platforms to autonomously configure, deploy, and monitor their applications fosters a culture of ownership and accountability.
- Embracing emerging technologies: Embracing emerging technologies such as serverless computing, edge computing, and AI/ML can unlock new possibilities for CI/CD automation and optimization. Exploring innovative use cases and experimenting with cutting-edge technologies can drive continuous improvement and innovation in CI/CD practices by addressing these challenges and embracing opportunities for improvement and innovation, organizations can unlock the full potential of CI/CD to drive agility, innovation, and competitiveness in today's fast-paced digital landscape. This forward-thinking approach enables organizations to stay ahead of the curve and adapt to evolving business and technology trends effectively.

CONCLUSION

In this final section, we summarize the key findings from the comparative analysis of CI/CD tooling and technologies, provide recommendations for selecting the most appropriate CI/CD solutions, and suggest future research directions to further advance CI/CD practices.

Summary of key findings from the comparative analysis

Through our comprehensive comparative analysis of CI/CD tooling and technologies, several key findings have emerged.

- We identified a diverse range of CI/CD tools and technologies, each offering unique features, functionalities, and use cases.
- The analysis revealed significant variability in integration capabilities, scalability, automation, ease of use, and community support across different CI/CD solutions.
- Performance, reliability, security, and compliance considerations varied among the tools, highlighting the importance of evaluating these aspects when selecting CI/CD solutions.
- Costs associated with CI/CD implementation varied depending on factors such as licensing fees, subscription plans, and infrastructure requirements.

Recommendations for selecting CI/CD tooling and technologies

Based on our findings, we offer the following recommendations for selecting CI/CD tooling and technologies:

- Conduct a through assessment of organizational requirements, project goals, and constraints to identify the most suitable CI/CD solutions.
- Prioritize integration capabilities, scalability, automation, ease of use, and community support when evaluating CI/CD tools.
- Pay close attention to performance, reliability, security, and compliance considerations to ensure the selected CI/CD solution meets organizational standards and regulatory requirements.
- Consider the total cost of ownership, including licensing fees, infrastructure costs, and ongoing maintenance expenses, when comparing CI/CD options.
- Leverage proof-of-concept trials, pilot projects, and user feedback to validate the suitability of CI/CD solutions before full-scale implementation.

Future research directions

While our comparative analysis provides valuable insights into the current landscape of CI/CD tooling and technologies, several avenues for future research exist:

- Investigate emerging trends and innovations in CI/CD practices, such as GitOps, serverless CI/CD, and AI-driven automation, to understand their impact on software development workflows.
- Explore the adoption of CI/CD practices in specific industries and domains, including healthcare, finance, and government, to identity sector-specific challenges and best practices.
- Evaluate the effectiveness of advanced testing methodologies, security tools, and compliance frameworks in enhancing the quality and security of CI/CD pipelines.
- Analyze the impact of cultural and organizational aspects on CI/CD implementation and efficacy, encompassing methods for cultivating a DevOps ethos and dismantling barriers between development and operations units.
- Investigate the scalability and resilience of CI/CD pipelines in managing large-scale deployments, microservices architectures, and hybrid cloud environments.

By addressing these research directions, we can further advance CI/CD practices and contribute to the ongoing evolution of software development methodologies in an increasingly digital and interconnected world.

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Hydroponics-Based Precision Farming with Feature Optimization

Sahaj S. Chaudhari
✉ sahaj_chaudhari@moderncoe.edu.in
Varad Chaskar
✉ varad_chaskar@moderncoe.edu.in
Janhavi Bhor
✉ janhavi_bhor@moderncoe.edu.in
Ramgopal Sahu
✉ ramgopal.sahu@moderncoe.edu.in
Anil S. Shirsat
✉ anil.shirsat@moderncoe.edu.in

Department of Electronics and Telecommunication
Progressive Education Society's Modern College of Engineering
Pune, Maharashtra

ABSTRACT

The quality of life is advancing quickly due to new innovations, but we're also encountering new challenges. One such challenge is the shrinking land and water resources as the population grows, which could have unforeseen effects. Hydroponics presents an innovative solution to this issue. It's a rapidly evolving field with numerous benefits for agricultural practices. This study explores current Research in Hydroponics and Designs our own system concerning it.

KEYWORDS: *Agriculture automation, Hydroponics system, IOT, Image analysis.*

INTRODUCTION

The world is changing rapidly, bringing resource scarcity, population explosion, climate changes, and urbanization that have affected food supply and led to food insecurity and undernourishment. To fight these problems, hydroponics, which is a soilless culture, is presented as an alternative to conventional farming. Hydroponics is a sustainable model where plant are grown without soil, using nutrient film techniques or equivalent to supply essential minerals directly to the plant roots. The most optimal quality of hydroponics is that it provides accurate control over the distribution of nutrients, resulting in higher nutrient uptake by plants and reducing the need for excessive fertilizer use promoting faster and healthier plant growth[1].

LITERATURE REVIEW

Hydroponics: Types and Setups

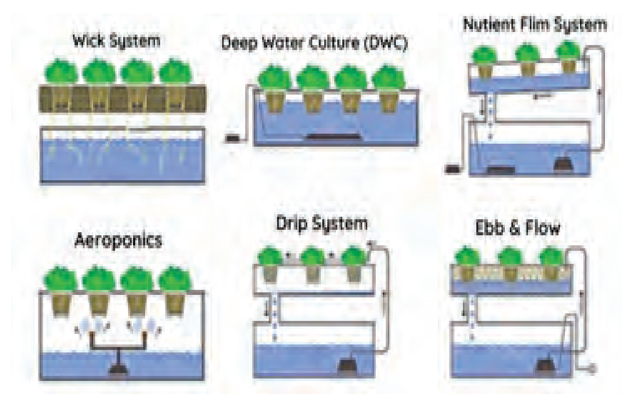

Fig. 1: Types and setups of hydroponics

Table 1: Comparison of Various Methods Used in Hydroponics [2]

Technique	Medium for nutrient supply	Works well for	Root exposure to nutrients	Pumped Water supply
Wick system	Wick	Small Plants, Homegrown	Root receives nutrient water through wicks	NO
Deep Water Culture	Plants held in netted Pots	Compact and scalable	Roots throughout dipped in water nutrient solution	Filled container

Nutrient Film Technique	Sloping channels for nutrient water	Domestic and Commercial hydroponics	Partial thin film of exposure to nutrient solution	24 X 7 pumping through a sloped channel
Ebb and flow method	Flooded & drained with nutrient water	Small scale and large-scale implementation	Root exposure in bursts	Intermittent supply of water
Drip Irrigation	Drip line via pump & timer	Commercial application	On & Off exposure to Nutrient solution during the drip	Pipe supply and dnp emitter
Aeroponic	Atomizers are required	Commercial application	Exposure in bursts	Sprinkler with mist nozzles

Parameters of Automation

Table 2: Parameters for Hydroponics [2]

Parameters	Recommended Values	Effect on plants	Imbalance
EC/TDS [3]	200-800 (ppm/lit)	Nutrients absorption rate	nutrient imbalances and toxicity
EC/TDS [3]	200-800 (ppm/lit)	Nutrients absorption rate	nutrient imbalances and toxicity
pH level [3]	5.4 to 6.6	Nutrients absorption rate	nutrient lockout mean unable to take even if unavailable
Temperature[4]	17–25°C	nutrient uptake, enzymatic activity	reduce photosynthetic efficiency,inhibit nutrient uptake
Light Intensity[4]	400-500 lux for 0-12 hours	support photosynthesis	elongated and weak stems, and poor fruit or flower production
Humidit y[5]	50–70% -rest	affect transpiration rates	leading to water stress and wilting,increase fungal diseases
CO2 levels[5]	1000-1500 ppm	rate of photosynthesis	carbon dioxide toxicity,reduce plant growth
Nutrient solution composition[6]	micronutrients & macronutrients (NPK).	supplies vital minerals and nutrients	nutrient imbalances
Substrate [7]	Cocopeat/ Biochar	promote oxygen availability to the roots	waterlogging

AUTOMATION TECHNOLOGIES

The sensors measure accurate and real-time data, enabling farmers to decide with knowledge and adjust the system accordingly. actuators are used to automate tasks such as adjusting pH levels, controlling nutrient delivery, pumps, valves, fans, and providing aeration. These control systems receive data from sensors and use algorithms & logic to evaluate the information and decide how to change the parameters. IoT is a technology that is used to connect sensors, actuators, and control systems, and allow someone to monitor and control in a live feed. Data analysis improves efficiency by optimizing resource usage, identifying potential issues or anomalies, and improving overall system efficiency.

ENVIRONMENTAL CONDITIONS FOR HYDROPONICS

1) Ambient conditions based on spatial and temporal dimensions

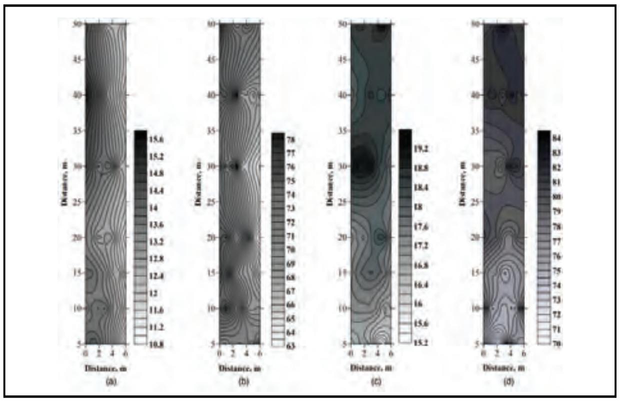

Fig. 2: Spatial Distribution of temp. and humidity

a) 11a.m b) 12-2 pm

c) window one side open

d) without ventilation [8].

In any plantation, the ambient conditions are not fully uniform. The ambient conditions can be classified as spatial, vertical, and temporal.[8].

2) Time and season-based variations

The variance in energy use in plantations occurs since certain parameters must be controlled to a specific range that includes temperature, relative humidity, and so on. [9].

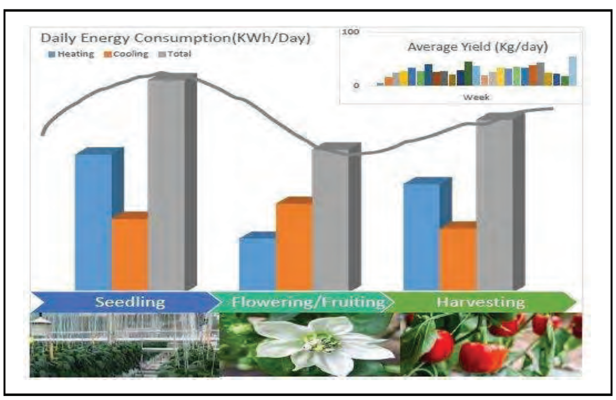

Fig. 3: Expected Energy Consumption Chart [9]

3) Conditions based on location

This is the most complex issue whenever a plantation needs to be set up. Prior data on the location is always useful but actual cost and energy requirements vary due to different climate and environmental factors. In such cases, government statistics should be prepared [10].

METHODOLOGY

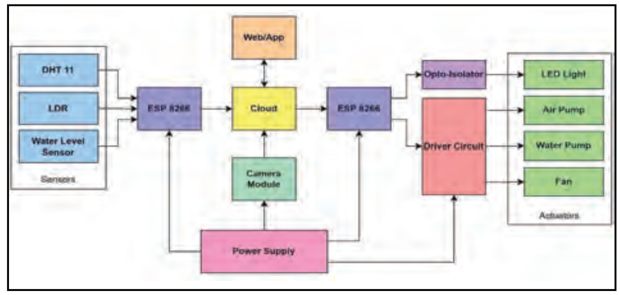

Fig. 4: Block Diagram of the System

The hydroponic system functions through a series of interconnected blocks. The IoT & Cloud Block enables communication with external networks or devices, allowing for remote monitoring and control. Furthermore, Data from the sensors is ingested into a channel, which serves as a conduit for transmitting data to external platforms for further processing. The ThingSpeak platform enables proactive management of the hydroponic system. The Actuator Block encompasses various components responsible for executing commands based on sensor readings and user inputs. The Camera Block, utilizing the ESP32-CAM module, enables visual monitoring of the hydroponic setup. The Power Supply Block ensures uninterrupted operation of the system by providing a steady 5V 2A power supply. Finally, The Web/App Block allows remote monitoring and control of the hydroponics system, empowering users to adjust parameters as necessary for optimal plant growth.

RESULT & DISCUSSION

Setup

Fig. 5: Setup with Lights OFF

Fig. 6: Setup with Lights ON

The two-stack hydroponic automation system integrates LED violet lights, an air pump, a water pump, and a fan, all managed by sensor and actuator modules alongside a UPS module for uninterrupted power supply. This setup optimizes plant growth by providing consistent light, proper aeration, and hydration. Additionally, a time schedule control feature schedules the activation of UV lights and the air pump according to preset timings.

Web Interface

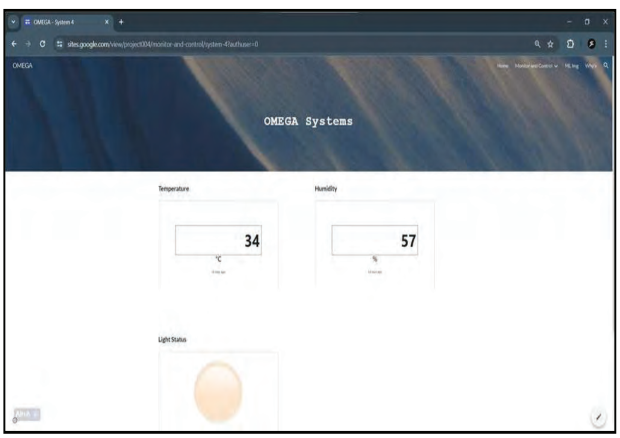

Fig. 7: Web Interface to Control the Actuators

The web interface screenshots depict a user-friendly control panel for managing the hydroponic automation system. This seamless integration enables users to monitor and adjust settings remotely from anywhere in the world. This hydroponic automation system offers the flexibility of configuring Wi-Fi credentials for both sensor and actuator modules, akin to setting up new products from the market using softAP technology.

TDS Research

Fig. 8: Difference with nutrient control

Fig. 9: Experiment Setup with Different TDS on different pots

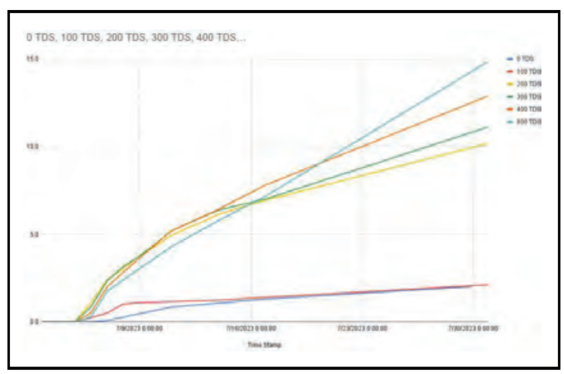

Fig. 10: Plant Height over Growth at Different TDS

The experiment showed that small plants thrive with low TDS levels, while medium-sized ones grow best with around 400 TDS for optimal growth. At the harvest stage, plants need about 800 TDS for faster growth, neither too high nor too low. This TDS consists of one-third each of NPK for appropriate nutrition and healthy development.

TDS Recommendation using Camera

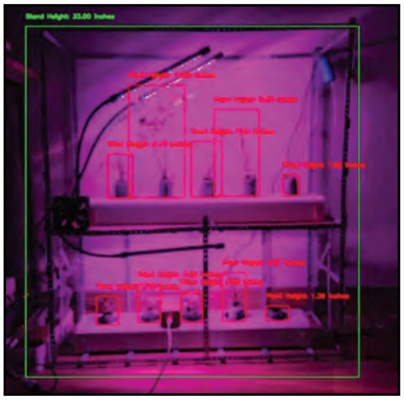

Fig. 11: Output of yolo8s Model

Using the yolov8s model trained over 100 epochs, the system accurately predicts the Total Dissolved Solids (TDS) required for optimal growth based on the height of plants. On accessing the webpage, users are presented with a clear indication of the TDS needed – whether it's 200 TDS, 400 TDS, 600 TDS, or 800 TDS. Alongside each TDS value is a measure of prediction accuracy, displayed on a scale from 0 to 1, allowing users to gauge the reliability of the system's recommendation. With this seamless integration of imaging technology and predictive analytics, users can effortlessly maintain the ideal nutrient balance for their hydroponic setup, ensuring healthy and thriving plant growth.

Water usage

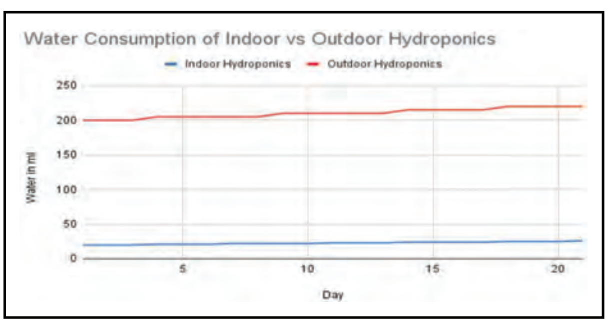

Fig. 12: Water Consumption of Indoor vs Outdoor Hydroponics

As seen above we can see that water consumption is 8 times less when indoor as compared to outdoor while variation in values of both stays constant. Hence there is a very high incentive to go for indoor hydroponics given the considerations given above and the data collected.

Power optimization

To optimize the power, we programmed the system to use one major function at a time without changing its effectiveness. And as agricultural systems no precise time budget and hence allowing for tasks parallel execution. The rough way of time allocation can be understood as

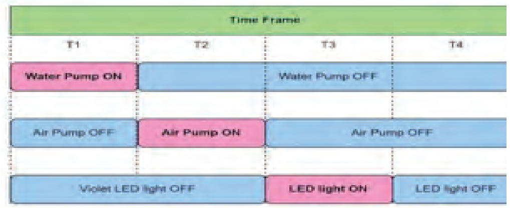

Fig. 13: Power Optimization using Time Slotting

Time Scheduling and Email Alerts

This Time scheduling capability, integrated with the ThingSpeak Cloud, enables users to program specific timings for these essential components such as lighting and aeration at optimal times. This feature enabled users to receive real-time notifications via email regarding critical events detected within the cultivation environment.

Light Intensity and Air Pump

Plants require full and direct sunlight, hence Violent light as a substitute for sunlight (why this is a viable option is explained in the above review) was at maximum intensity for 12 hours Daily Cycle

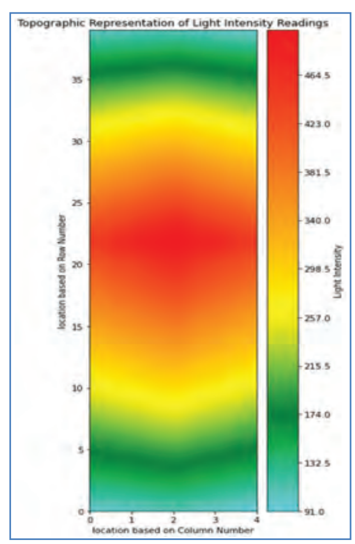

Fig. 14: Topographic distribution of light intensity

Following is the representation of light intensity, as can be seen, reading becomes less as we go on away from the center. This affects the plant's growth slightly as plants closer to the center grow faster, but this difference in growth is small and in acceptable margins. Also, we observed that the plant grows efficiently with 30 30-minute air pump and 1-hour intervals.

Email Alerts

The email alert facility incorporated into the indoor hydroponic automation system demonstrated significant utility in enhancing user convenience and ensuring timely intervention when necessary. This feature enabled users to receive real-time notifications via email regarding critical events or irregularities detected within the cultivation environment. For example, if the water level in the hydroponic system fell below a certain threshold or if there were any malfunctions in the equipment, the system promptly generated an email alert, notifying users of the issue. This proactive approach to monitoring helped prevent potential damage to plants and equipment by allowing users to address issues promptly, even when they were not physically present.

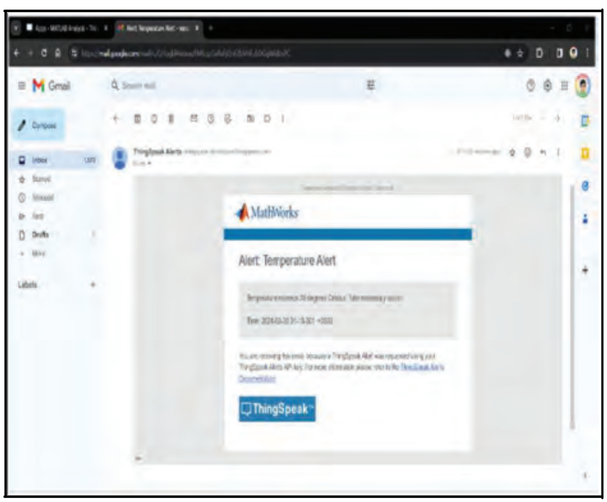

Fig. 15: Email Alert

The system integrates sensor data storage, enabling convenient exportation in CSV or compatible formats. This facilitates seamless data analysis and retrieval for specific days. With this capability, users can easily track and optimize environmental conditions for plant growth.

Data Storage

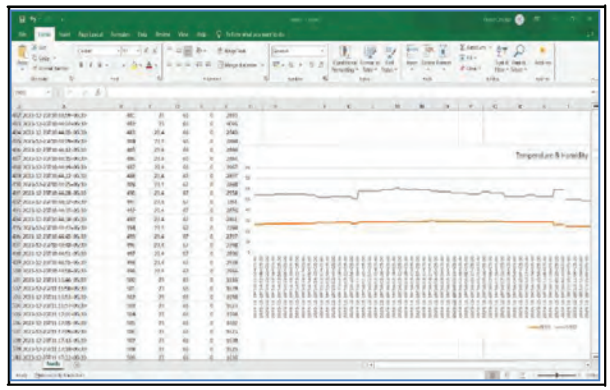

Fig. 16: Data Exported from the Cloud in Excel

Time Scheduling and React Control

The indoor hydroponic automation system demonstrated promising results in effectively managing the cultivation environment. Time scheduling provided convenient control over LED lights and the air pump, ensuring plants received adequate lighting and aeration at optimal times. This scheduling capability, integrated with the ThingSpeak Cloud, enabled users to program specific timings for these essential components, promoting healthy plant growth and resource efficiency. Additionally, the system offered flexibility through a user-friendly webpage interface, allowing for manual initiation of countdown timers, and enhancing accessibility and adaptability to varying cultivation needs.

Furthermore, the implementation of react control proved to be a valuable feature in maintaining ideal conditions within the hydroponic environment. By enabling users to set temperature thresholds through the webpage interface, the system effectively regulated environmental parameters such as temperature and water levels. For instance, when the temperature exceeded the user-defined threshold, the fan automatically activated, efficiently mitigating heat stress and ensuring optimal growing conditions. Similarly, the react control facilitated automatic activation of the water level motor when water levels dropped below the designated threshold, guaranteeing consistent hydration for plants without requiring constant monitoring. Overall, the integration of time scheduling and react control functionalities contributed to the automation and optimization of indoor hydroponic cultivation, simplifying management tasks and enhancing yield.

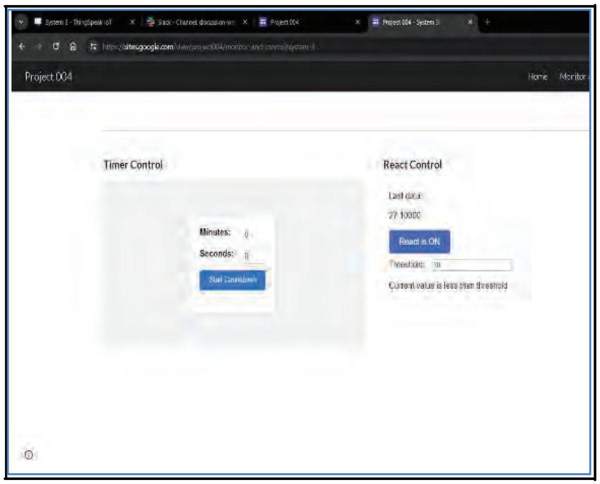

Fig. 17: Time Scheduling and React Control Web Interface

CHALLENGES IN AUTOMATION

Power Optimization

When it comes to power optimization, there are two scales to consider. On a large and small scale. On a larger scale, it has to do with precision hardware control and optimized power consumption strategies and has technical issues with energy storage such as battery degradation and limited capacity. Furthermore, small-scale power optimization involves increasing the effectiveness of certain systems and devices to reduce power consumption but these all involve technical complexities[11].

Hardware Selection

In hydroponics, a lot of electronics hardware needs to handle various constraints like power, i/o specification, and technical expertise required to handle them. However, that is not the only thing. We also need to consider enclosed and other planting tools procurements as lots of locations do have metal resources for manufacturing, while plastic ones do not.

Automation Challenges

Challenges like sensor reliability, and system complexity are all some technical constraints that must be taken into consideration while building any embedded system. Data security and human Interventions are other aspects of design as it must be understood that not every security solution provides a similar level of security towards diverse types of attacks and malicious parties that exist, on the contrary, each and every solution must be created and/or modified for any and all particular type of threats that arise[12].

FUTURE ENHANCEMENTS OF THE HYDROPONIC SYSTEM

Hydroponics for Space

Hydroponics for space is a heavily researched field that focuses on its applications in water purification, oxygen and carbon dioxide balance in space stations, and astronaut nourishment[13]. An in-depth study is being done in this area since it is imperative for long-term space initiatives, the well-being, and safety of the crew on manned space flights.[14].

Overcome Adverse Effects of Brackish Water

The utilization of brackish water (meaning water occurring in a natural environment that has more salinity than freshwater, but not as much as seawater) in agriculture may cause the soil's salt content to rise, which may have an adverse effect on plant output. Hydroponics is a technique that includes nurturing plants in a NFT solution rather than soil-driven. Even by utilization of brackish water, this approach promotes superior plant growth and development.

CONCLUSION

The synthesis of hydroponics and electronics and other deep technologies presents a compelling avenue for innovation in modern agriculture. The potential for applying electronic expertise in optimizing and advancing these technologies for sustainable agriculture is seen as a key theme.

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Accuracy and Precision Check of Deep Learning Techniques for Detection of Fake Banknotes

Mrunal Palande, Aditya Bankar
Vedant Ladole
Students
Computer Engineering
P.E.S Modern College of Engineering
Pune, Maharashtra
✉ mrunal.palande2002@gmail.com
✉ adityabankar262002@gmail.com
✉ vedantladole1710@gmail.com

Vidya Nemade
Professor
Computer Engineering
P.E.S Modern College of Engineering
Pune, Maharashtra
✉ vidya.nemade@moderncoe.edu.in

ABSTRACT

The term "counterfeit money" refers to the practice of creating an imitation of legal tender without the proper authorization from the government. Processing photographs of currency allows for denominational categorization and the detection of counterfeit notes; this technique is known as currency recognition. The primary goal of money recognition technology is to detect and extract both visible and unseen characteristics from currency notes. The goal of various deep learning algorithms developed for use in fake currency detection is to stop the spread of counterfeit money in order to safeguard the monetary system, banks, companies, and people. Identifying counterfeit money is an extensive process that involves many different fields, such as consumer protection, law enforcement, technology, and the financial sector. Our project's primary objective is to verify the authenticity of the banknotes by comparing the performance of various deep learning methods, including CNN (convolutional neural network) and its variants like ResNet18, AlexNet, and RNN.(recurrent neural network).

KEYWORDS: *Deep learning, Machine learning, CNN, AlexNet, ResNet 18, RNN.*

INTRODUCTION

False money that has not been officially sanctioned by the government is known as counterfeit cash because counterfeiting money refers to the unlawful reproduction of original currency. In order to classify banknotes by denomination and identify counterfeits, currency recognition processes photographs of cash. The primary goal of money recognition technology is to detect and extract both visible and unseen characteristics from currency notes. The use of computers to manipulate digital photographs is made easier using digital image processing techniques [1].

Feature extraction is the process of extracting a set of attributes from input data. Just like with photos, a number of features must be extracted in order to derive useful information. Feature extraction and selection also helps with big, duplicated, or otherwise hard-to-understand input data by revealing just the most relevant information. In order to guarantee that the work is efficiently accomplished using these features alone, they are chosen with the intention of employing information from the provided data set to generate the outcome. There are a number of deep learning models already published in the literature that provide a variety of algorithms, such as Convolutional Neural Networks (CNNs) [1][12], Support Vector Classifiers, K- Nearest Neighbours, Decision Trees, and Logistic Regression [13], as well as various neural networks [16], and so on.

The final stage, known as the classification step, involves using the selected features that the models have learned to produce accurate results. This classification task is a component of supervised learning within the machine learning domain. Models like Convolutional neural network (CNN) which includes AlexNet and ResNet18, RNN (Recurrent Neural Network) are used for this step. [7]

The three neural networks were used to train the decomposed components of the banknote image simultaneously. Their weights are updated as follows and the equation is given below,

$w_o = w + M = w + P = w_o + \lambda \times 1/w + \lambda \times 1/w^M + \lambda \times 1/w^P$. Equation (1) [6]

The terms in the equation are as follows:

w_o: This is the original weight before the update.

w: New weight after the updating original weight.

M and P: These represent different momentum terms or regularization terms. Momentum helps accelerate gradient vectors in the right directions, leading to faster converging. Regularization terms help prevent overfitting.

λ: This is a hyperparameter that controls the strength of regularization or the scaling factor in weight updates.

$1\backslash w$, $1\backslash w^M$, and $1\backslash w^P$: Reciprocals of the weights that are related to inverse scaling factors which represent gradients with respect to some regularization terms.

$w=w^A+\alpha\times\beta/w^A$ Equation (2)[6]

Here,

w: The updated weight.

w^A: Adjusted version of the weight using some algorithmic adjustments.

α: Learning rate or a coefficient

β: Hyperparameter that relates to the gradient, momentum, or a specific regularization term.

An equation for a recurrent neural network (RNN) weight update:

$w_t = w_{t-1} + \eta \times \delta/w_{t-1}$. Equation (3)

This equation represents the update of weights *w* at time step *t* in an RNN, where η is the learning rate and δ is the error term. [10]

LITERATURE REVIEW

The use of deep learning techniques on various forms of data such as currency has sparked significant research interest over the last few years. Witnessing this expansion and its incorporation into everyday activities has inspired us to examine such research methods for their potential in detecting counterfeit currency.

A variety of advanced technological algorithms have been proposed in currency recognition and counterfeit recognition, particularly complementary to the blind and visually impaired IPCRF algorithm developed by Singh et al. uses SSD and Faster-RCNN images to recognize Indian paper currency, highlighting the need for high- resolution detection technology that captures highly discriminating currency images for accuracy [1] in appendix in Isa et al. used a support vector.[6]

machine (SVM) method, obtained a high classification accuracy of 99.55% in false case detection, which demonstrated the capabilities of SVM in pattern recognition tasks[2]

Furthermore, Alagappa and Sumathi investigated the effectiveness of canny edge detection in machine vision by combining recursive algorithms for edge filtering which is a method for detecting edges in the initial layers which later helps in detection of high-level, complex features in later layers. This method requires specific parameter settings to efficiently handle iteration overhead, which costs and benefits a usefulness In the field of deep learning[3]. Ruheena et al, adopted the CNN and AlexNet bogus currency detection algorithms, and reported excellent accuracy. This indicates an increasing reliance on deep learning techniques for complex image recognition tasks such as Bank notes verification [4],

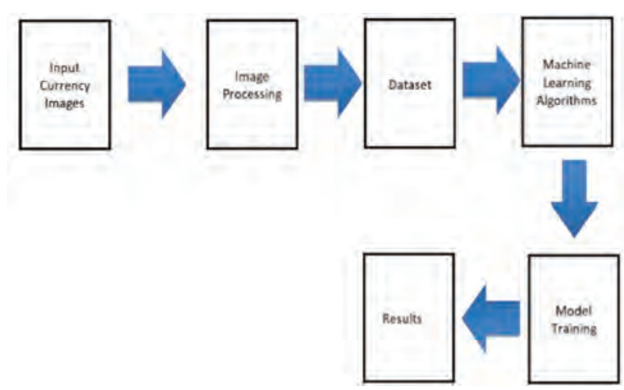

Fig. 1. General system of bank notes detection using deep learning techniques

which uses Convolutional Neural Networks (CNNs) and AlexNet architecture for counterfeit currency detection. The use of this advanced neural network facilitates a deeper and more nuanced understanding of the image features, leading to results with greater accuracy of recognition This method is particularly useful in areas where currency verification accuracy is of utmost importance, providing a robust solution to sophisticated spurious trajectories taken together, these studies [1],[2],[3],[4] landscape of currency recognition technology providing a comprehensive view of the current state of affairs. Each contributes uniquely to the general goal of increasing the security and reliability of cash management, whether through improving the knowledge of authentication of Indian currency to determining the model accuracy. As this technology continues to evolve, it offers promising options not only for national security agencies and financial institutions but also for the everyday user, ensuring the reality of financial transactions in the world with an increasingly digital economy. [11]

RELATED WORK

Based on the literature, this study gives a brief on the deep learning models CNN[12] ,SVM[12], Logistic Regression and Linear Discriminant Analysis (LDA) [5], Support Vector Classifier, K-Nearest Neighbor, Decision Tree, and Logistic Regression [13] and various neural networks[16] and we have used CNN's types such as AlexNet and ResNet 18 and another model named RNN. General flow of genuine and fake bank notes analysis process using deep learning from the studies research can be seen in Fig. 1. The paper has three sections elaborating on the three models, their working, and applications in brief. Fig. 2 gives an overview of the models. The performance is compared based on model accuracy in the last section and how well the model predictions are.

AlexNet

Proposed Alexnet, model is a key architecture in deep learning for image segmentation. AlexNet, introduced in 2012, significantly advanced the use of convolutional neural networks (CNNs) by winning the ImageNet Large Scale Visual Recognition Challenge (ILSVRC). This part of your paper should introduce the concept of CNNs, emphasizing their role in extracting sequences from images. Discuss how AlexNet pioneered deep learning through effective techniques such as deep architecture, ReLU activation, dropout and overlapping pooling.[10]

This research demonstrates advantages in the developing a robust Deep Neural Network models and provides comprehensive insights

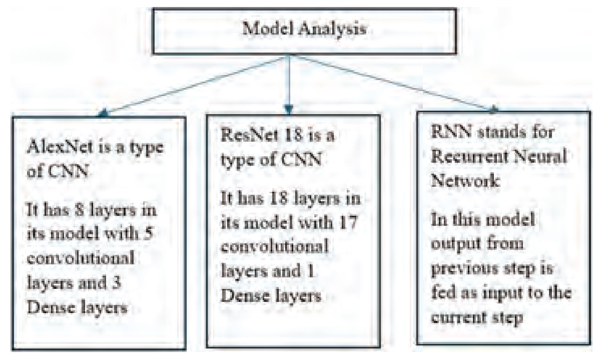

Fig. 2. Deep Neural models analysis

AlexNet, uses the Keras library for binary classification. It standardizes input images to 224x224 pixels for uniform feature extraction and uses convolutional layers with ReLU activations to ensure efficient learning to capture visual information.[11] MaxPooling improves feature robustness and performance. The grid incorporates a dense hierarchy of simplified segmentation. Training consists of compiling a binary cross-entropy SGD, repeating on epoch batches, and testing validation sets to ensure generalization This example is an educational tool, providing insight into complex CNN architectures and possible scalability in specific industries.

ResNet 18

ResNet-18 is a convolutional neural network model for image processing used in deep learning. Training involves preparing and preprocessing the input data before it can be run through the Deep Learning model. During the preprocessing stage, the images are first read from a specified directory within a file system with usual file handling. The images are then resized to 224 x 224 pixels, which is the standard input size for many deep learning models, including ResNet-18. Once the images have been read and resized, each image is labelled typically as either 'true', 'false', 'yes', 'no', 'cat', 'dog', etc. Those labels are represented as integers, often 0 and 1. The data is then composed into an array of the picture data and its labels. The integer representation of images and labels creates a standard input format such that the model consistently receives a similar data structure, allowing it to learn and recognise specific features during training, at each interaction.3

ResNet-18 is composed of a model that performs hierarchical feature extraction from images. It is customary for convolutional neural networks (CNNs) when given the task of image classification or recognition. ResNet-18 uses various convolutional layers for feature extraction at different depth levels; these layers are interspersed with Batch Normalisation layers that serve to standardise the inputs of the input layer for the current iteration by re- centering and re-scaling. This contributes to the acceleration of the training time and the overall stability of the 1- freed CNN model. Image courtesy Wikipedia

Additionally, MaxPooling layers sit on top of the convolutional sets after the convolutional layers in order to reduce the spatial resolution of the output from the convolutional layers to highlight the most important features while keeping the computational complexity low. ResNet-18 is unique in its usage of residual connections, or skip connections, as they are sometimes called. These residual connections were originally designed to address the vanishing gradient problem by enabling gradients to flow through the network directly, instead of going through multiple layers. They add the input from a previous layer to the output of the block, thus making it possible for networks to be trained deeply with acceptable results without affecting their performance.. Overall, ResNet-18 is structured to facilitate robust and deep training that is less susceptible to common issues like overfitting and allows for efficient feature learning.[13][10]

Table 1. Training and Testing Accuracy of the Models

Model Accuracy	AlexNet	ResNet18	RNN
Training	96.055%	99.25%	94.62%
Testing	85.809%	75.19%	70.21%

Training the model requires the compilation of an Adam optimizer that is an improvement over traditional stochastic gradient descent, as, for example, which replaces most classes in training, uses binary cross-entropy is a loss function, which is used for the binary classification task is in hand .[12] The training process is repeated through the dataset in batches for a predetermined number of times, and model weights are adjusted to minimize loss. After training, the effectiveness of the model is tested on separate test data to assess its generalizability, verify that it performs well on other unseen data, and provide insight into possible cases of overfitting. [15]

RNN (Recurrent Neural Network)

The RNN implementation using the Keras library is designed for sequence processing, although it includes image preprocessing, which means a hybrid approach to processing image and sequence data for classification tasks - needs to be seen dependencies in the data, avoiding the vanishing gradient problem common in standard RNNs The model also includes Dense layers for output processing, which have activation functions that introduce nonlinearity, which are important for complex pattern recognition in the data.[8] Training and test data processing tasks are mainly geared towards creating images, building to grayscale, transforming, encoding labels for binary classification ('true' vs 'false') This preprocessing step is important because it makes the input data standardize, ensure that the neural network accepts uniformly formatted input Learning efficiency is optimized After preprocessing, the model is trained on these images, using LSTM's ability to interpret image data as sequential input, another possibility those that are particularly effective play a role in situations where temporal continuity plays an important role in still images, such as deceptive image recognition . [5] [19]

Dataset

Our counterfeit currency recognition analysis is based on a well-collected data set from Kaggle [18] and IEEE [17] and some are clicked by our team and there are 3057 high- resolution images divided into "fake" and "real" currency.

Total 2155 of these images constitute the training set, as it is important for model development. These training images included different lighting conditions, backgrounds to ensure model robustness. For analysis, a separate test set of 902 images is used while maintaining independence from the training data. The dataset consists of 70% of its images for training and 30 % for testing. Each pattern has its own label, making it easier to train observers and analyze.[18]

The specification adheres to strict criteria, ensuring the integrity of the dataset. Quality control systems help ensure precision and accuracy. This set of data is an important component of our research, facilitating the development and comparison of comprehensive counterfeit currency detection models. By implementing this feature, we aim to enhance fraud prevention measures and enhance financial security. The availability of such well-protected data is key to innovation and improvement in machine learning-based fraud detection systems.[17]

Performance Comparison

Deep learning techniques have proven effective on currency data, as illustrated by the models discussed. This comparative study identifies CNN and its variants, AlexNet and ResNet, as well as the RNN model, as the most accurate for fatigue evaluation. The filters in CNN effectively capture both spatial and temporal aspects of currency data, while pooling layers and dropout rates help in dimensionality reduction, thereby minimizing the risk of overfitting. Known for its pioneering work in deep learning, AlexNet showed commendable performance in our tests. Its ability to capture complex image features facilitated strong discrimination between counterfeit and genuine bills. However, ResNet18 showed better performance coefficients compared to AlexNet, which used its deep structure and the rest of the learning algorithms. The addition of the combined features reduced the gradient extinction issues, resulting in better optimization and convergence during training.[4][5]

Furthermore, we investigated the capabilities of traditional RNNs for sequential data analysis in image classification. Although RNNs showed good results for capturing spatial dependence in pose images, using pixels in sequence, their performance fell short as compared to types of CNN, especially in situations where image structure and complex changes in it.

Table 2. Model Accuracy Comparison Based on Performance

Deep Learning Models	Model Accuracy (Confidence)
AlexNet	0.98205733
ResNet18	0.9984377
RNN	0.99579644

Table 3. Model Accuracy Comparison Based on Performance

Deep Learning Models	Model Accuracy (Confidence)
AlexNet	0.99990356
ResNet18	1
RNN	0.9957957

Experimental Results

From this study, we conclude that using AlexNet,ResNet 18 and recurrent neural network (RNN) models can effectively analyze currency data. As seen in fig3,4,5,6 it is observed that, ResNet 18 gives highest accuracy close to 1 as confidence score followed by AlexNet with accuracy close to 0.99 as confidence score and RNN gives accuracy not as good as the above two models.

In summary, our comparative analysis confirmed ResNet18 as the best performance in counterfeit currency detection, closely followed by AlexNet. These findings highlight the important role of architectural choices in achieving better performance in fictitious currency search services. Also, we observed that for image classification tasks, like distinguishing real from fake banknotes, RNNs are not the best choice due to their tendency to misclassify images.

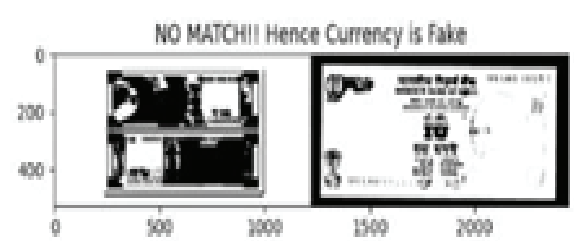

Fig. 3. Result for fake 10 rupee notes after preprocessing

Fig. 4. Final Result for fake 10 rupee notes with model comparison

Fig.5. Result for real 500 rupee notes after preprocessing

Fig. 6. Final Result for real 500 rupee notes with model comparison

CONCLUSION

The main objective of counterfeit currency detection is to protect the integrity of the financial system, financial institutions, businesses and individuals by detecting counterfeit currency and stopping its spread For this purpose it is necessary to study various in-depth methods are used to generate highly accurate models. The use of models such as RESNET-18, which demonstrated greater accuracy in counterfeit currency detection compared to AlexNet and RNN, greatly contributes to this effort Such improvements provide economic stability, security and public confidence in the financial ecosystem is enhanced, and ensures large and secure transfers of funds.

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LV Battery Charging & Fault Detection

Munmun Kakkar
Assistant Professor
Department of Electronics & Communication Engg.
Dr. D. Y. Patil Institute of Engg., Mgmt and Research
Pune, Maharashtra
✉ munmun.kakkar@dypiemr.ac.in

Parthiv Vinoy, Shridhar Deshpande
Sudhanshu Tarfe
Students
Department of Electronics & Communication Engg.
Dr. D. Y. Patil Institute of Engg., Mgmt and Research
Pune, Maharashtra
✉ parthivvinoy@gmail.com
✉ shridhardeshpande107@gmail.com
✉ tarfesudhanshu202@gmail.com

ABSTRACT

Low-voltage (LV) battery systems are integral components in a variety of applications such as portable electronics, automotive elect ronics, renewable energy, and non-interruptible electronics.

Effective charging and early detection of dead batteries are crucial to improve its performance, safety, and lifespan. This research addresses the challenges associated with LV battery charging and fault detection. The study investigates fault detection and diagnosis methods to identify issues such as cell degradation, thermal runaway, overcharging, and short circuits. These fault detection mechanisms employ various sensing technologies, including voltage and current monitoring, temperature sensing, impedance spectroscopy, and machine learning-based approaches. The integration of these charging and fault detection technologies enhances the reliability, safety, and overall performance of LV battery systems. This research contributes to the development of sustainable and resilient energy solutions, benefiting a variety of businesses and applications. It paves a way for efficient & intelligent LV battery management systems, ensuring the continued growth and adoption of battery-powered devices and electric vehicles in the modern world.

INTRODUCTION

Concerning environmental pollution, the association with automobiles is undeniable. Traditional fossil-fuel vehicles have contributed significantly to environmental issues, including the greenhouse effect and air pollution. Consequently, there is a growing global shift towards embracing new energy vehicles, particularly electric-powered vehicles, which are poised to become a prevailing trend in the future. Currently, nations worldwide are actively engaged in research and development related to electric-powered vehicles. It is widely recognized that effective battery management stands out as a pivotal challenge in advancing the electric vehicle industry. The need for supplementary hardware installations and the integration of Battery Management Systems (BMS) is particularly critical in this endeavor. More BMS units have been incorporated, enhancing functionalities like equalization management and fault diagnosis. A diverse range of algorithms is employed to ensure accuracy and reliability in these estimations.

In the context of electric vehicles, the State of Charge (SOC) of batteries holds a role akin to the fuel gauge in traditional internal combustion engine vehicles. Its primary function is to communicate the current battery charge level to the driver. Simultaneously, it serves to prevent issues such as overcharging and over-discharging, which can be detrimental to battery health and safety.

PROBLEM STATEMENT

In the context of Low Voltage (LV) battery systems, the detection and management of overvoltage and overcurrent events are critical for ensuring the safe and efficient operation of the battery. LV batteries control a wide extend of applications, counting EVs, renewable vitality frameworks, reinforcement control supplies and convenient gadgets. Overvoltage and overcurrent issues can lead to battery damage, reduced lifespan, safety hazards, and operational inefficiencies. Therefore, the problem at hand is to develop a robust system for the detection and mitigation of overvoltage and overcurrent conditions in LV battery systems.

RESEARCH METHODOLOGY

State of charge

State of Charge (SoC) is a term used to describe the current level of charge or energy remaining in a rechargeable battery, typically expressed as a percentage of the battery's total capacity. SoC provides valuable information about the available energy in the battery at a specific point in time and is a critical parameter in battery management and power systems. It is used to gauge how much energy is left for a battery-powered device or system. For example, if a battery is at 50% SoC, it means that it currently contains half of its full capacity, and therefore, it has approximately half of its energy available for use. SoC can be determined through various methods, including voltage measurements, coulomb counting, & more advanced techniques involving battery management systems that take into account factors like temperature, discharge and charge rates, and the battery's internal resistance. Accurate SoC monitoring is essential for efficient battery utilization, as well as for preventing over-discharging (which is harmful for the battery) and managing power resources effectively.

$$SOC = \frac{Q_c}{Q} \times 100\% = 100\% - \frac{Q_e}{Q}.$$

Estimation of state of charge

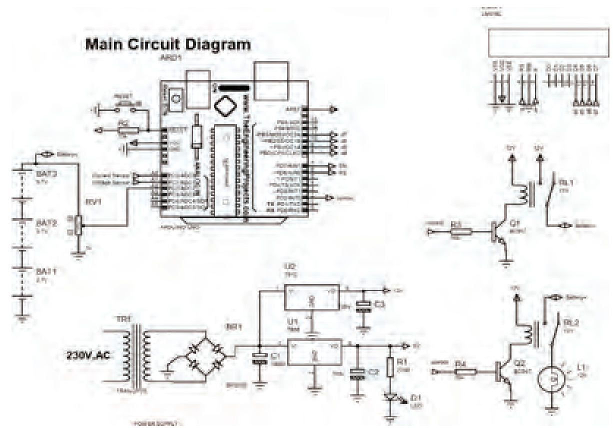
Several methods are used for estimating SoC

Open-Loop Methods (Voltage-Based): These methods estimate SoC without direct measurements of current. They rely on the voltage of the battery, which can be a less accurate method but is simple and widely used.

Voltage vs. Capacity: This method uses a voltage to-

SoC mapping based on a discharge/charge curve specific to the battery type. It relates the battery voltage to the known capacity at different states of charge.

CIRCUIT DIAGRAM



OUTCOMES

Detection of over voltage

Overvoltage refers to a condition where the voltage in an electrical circuit or system exceeds its intended or designed level. This excess voltage can be temporary or sustained and can occur by a variety of factors such as power surges, lightning strikes, equipment malfunctions, or improper operation of power systems. Overvoltage can potentially lead to damage to electronic devices, equipment, and electrical systems, as well as pose safety risks to individuals working with or near the affected circuits. Protecting against overvoltage conditions is essential to make certain the proper functioning and durability of electrical and electronic systems.

Detection of over current

Overcurrent, in the context of electrical engineering and circuits, is a situation where the current flowing through a conductor or component exceeds its intended or designed limit. This can be due to various factors, such as excessive load, short circuits, faulty components, or other anomalies in an electrical system. Overcurrent can potentially lead to equipment damage, overheating, electrical fires, and safety hazards. To prevent these risks, protective devices like fuses, circuit breakers, and relays are used to detect and respond to overcurrent conditions by interrupting the flow of electricity or taking other protective actions.

Battery Status

Battery status refers to the condition or state of a battery, which is typically used to power electronic devices or store electrical energy. It gives data about the battery's current charge level, capacity and overall status. Battery status information is crucial for users and device management systems to ensure that devices have sufficient power and to monitor the condition of the battery. Battery status is essential for users to manage the power needs of their devices and to make informed decisions about when to charge, replace, or maintain batteries. In many cases, modern electronic devices and operating systems provide detailed battery status information to ensure efficient use and prolong the life of batteries.

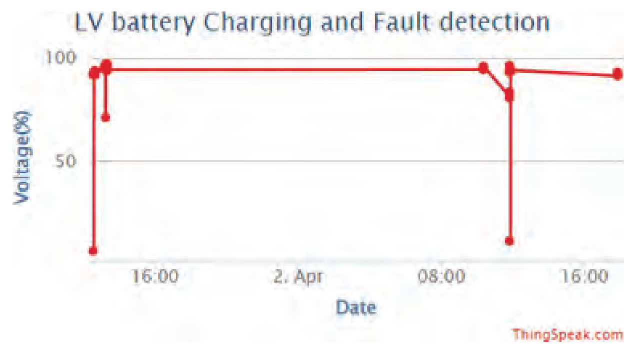
Efficiency

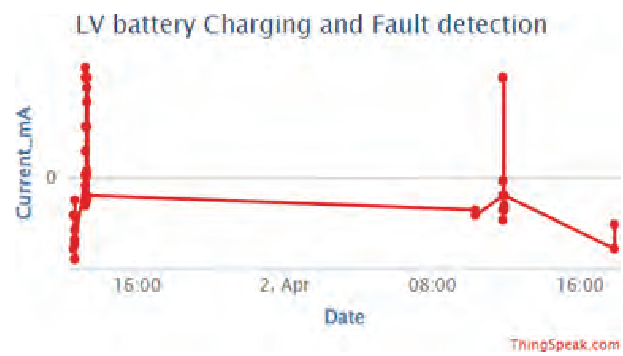
The efficiency of low voltage batteries refers to their ability to convert input energy during charging into stored energy and then release that stored energy during discharge with minimal losses. This performance is important for maximizing the performance and lifespan of the battery, in addition to minimizing power waste. Efficiency is influenced by various factors including battery chemistry, temperature, charge/discharge rate, depth of discharge, and the presence of battery management systems. Lithium-ion batteries, for example, exhibit higher efficiency when compared to lead-acid batteries due to their lower internal resistance and higher energy density. To ensure optimal efficiency, its essential to use proper charging and discharging techniques, maintain appropriate operating conditions, and integrate efficient battery management systems. Periodic maintenance and monitoring are necessary to identify and address any issues that may affect efficiency over time.

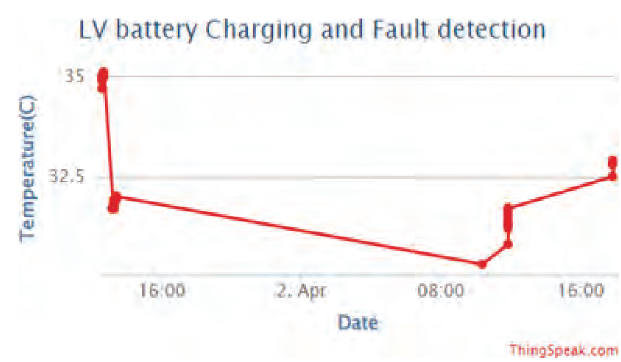
Overheating

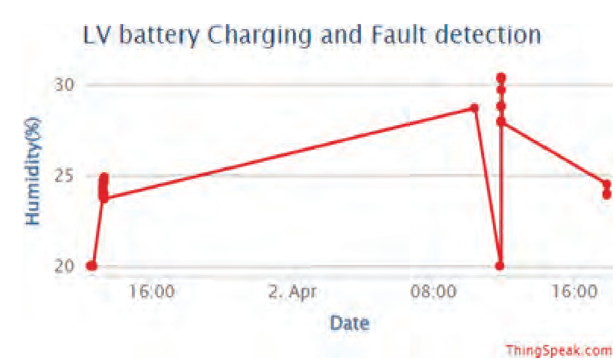
Overheating of low voltage batteries poses significant safety risks and can result from various factors. When a battery operates beyond its encouraged temperature range, it could lead to thermal runaway, a self-reinforcing reaction causing rapid heat generation and potentially resulting in fire or explosion. Common causes include overcharging, high discharge rates, external heat sources, poor ventilation, internal short circuits, overuse, and age-related degradation. Prevention measures include using proper charging equipment, avoiding high discharge rates, ensuring adequate ventilation, inspecting batteries for damage, and implementing thermal management systems. Minimizing the risk of overheating is crucial for maintaining safety and prolonging battery lifespan.

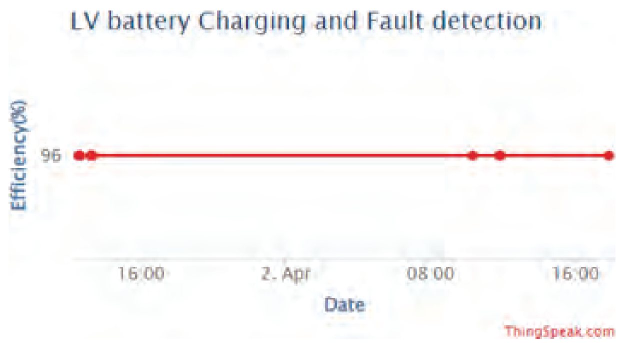
OUTPUT











CONCLUSION

In conclusion, low-voltage (LV) battery charging and fault detection are crucial aspects of maintaining the reliability, safety, and performance of battery-powered systems. The successful management of LV battery charging and the early detection of faults play a pivotal role in a wide variety of applications, such as electric vehicles, portable electronics, renewable energy systems, and more.

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Pipe Inspection Robot

Pranav Deshpande, Vedant Kulkarni
Akansha Jadhao
Electronics and Telecommunication
PES MCOE
Pune, Maharashtra
✉ pranav_deshpande@moderncoe.edu.in
✉ vedant_kulkarni@moderncoe.edu.in
✉ akanksha_jadhao@moderncoe.edu.in

Aparna Laturkar
Associate Professor
Electronics and Telecommunication
PES MCOE
Pune, Maharashtra
✉ aparna.laturkar@moderncoe.edu.in

ABSTRACT

Pipelines deteriorate over time due to corrosion, metal erosion, external forces, and more. Some pipelines are too small for human entry, necessitating regular inspections. The robot, equipped with an ESP32 CAM module for live video transmission and ESP32with 4- wheel drive, offers an advanced solution. It eliminates human risk in hazardous areas and navigates pipelines of various sizes seamlessly. ESP32 enables real-time video streaming, enhancing inspection accuracy. Additionally, it incorporates a measuring tape to gauge crack distances from pipe's starting points, improving safety and adaptability in pipeline maintenance, ensuring the durability and integrity of vital pipeline systems.

KEYWORDS: *DC motor, ESP32 controller, ESP32 Cam module, Pipeline inspection.*

INTRODUCTION

The ubiquitous nature of pipelines in the transportation of essential resources necessitates a robust and efficient inspection framework to ensure their integrity and optimal performance. As the demand for innovative solutions in pipeline maintenance rises, the fusion of robotics with cutting- edge technologies has paved the way for transformative advancements. In this context, the incorporation of the ESP32 microcontroller and the ESP32- CAM module represents a notable paradigm shift in the development of pipeline inspection robots. Traditional methods of pipeline inspection have faced inherent challenges in terms of accessibility, cost-effectiveness, and the ability to provide real-time data in complex environments.

The utilization of microcontroller- based solutions, particularly the ESP32 controller and the associated camera module, introduces a novel approach to address these challenges. These components offer a versatile platform for the development of pipeline inspection robots, combining the power of microcontroller capabilities with visual data acquisition. measurement.

This review paper aims to explore into the realm of pipeline inspection robotics with a specific focus on the integration of the ESP32 microcontroller and ESP32-CAM module. By synthesizing existing literature, robot seek to unravel the intricacies of this technology, examining its application in diverse environments and highlighting its potential impact on the efficiency and accuracy of pipeline inspections. The ESP32's versatility, including its wireless communication capabilities and real-time data processing, adds a layer of sophistication to pipeline inspection robots, enabling them to navigate, analyze, and transmit data seamlessly.

The project is underpinned by the recognition of the challenges inherent in pipe inspection, encompassing human safety concerns, labor-intensive processes, and the limitations of traditional inspection methods. Its significance lies in its potential to enhance efficiency by reducing manual labor, intensify safety by minimizing human intervention in hazardous environments, and enabling comprehensive inspections by capturing a 360-degree view of the pipe's interior. The integration of wheels affords the robot unparalleled mobility and maneuverability within pipe, overcoming the constraints of tight spaces and obstacles.

The ESP32 CAM module, mounted on a servo motor, is the backbone for video capture, allowing the robot to pan and tilt for comprehensive coverage. The robot's core, the ESP32 microcontroller, coordinates the operation, ensuring seamless data transmission through the hosted local web server. This remote monitoring capability empowers operators to make real-time decisions about maintenance and repairs. In essence, the Pipe Inspection Robot represents a promising evolution in pipeline inspection, offering greater efficiency, safety, and precision, with implications extending across industries such as oil and gas, waste water management, and infrastructure maintenance. Its unique blend of hardware and software technologies positions it as an indispensable tool for safeguarding critical infrastructure and ensuring its longevity. This paper introduces an enhanced solution: a pipe inspection robot equipped with the ESP-CAM module, designed to transmit live video data, modify the landscape of pipeline inspections.

LITERATURE SURVEY

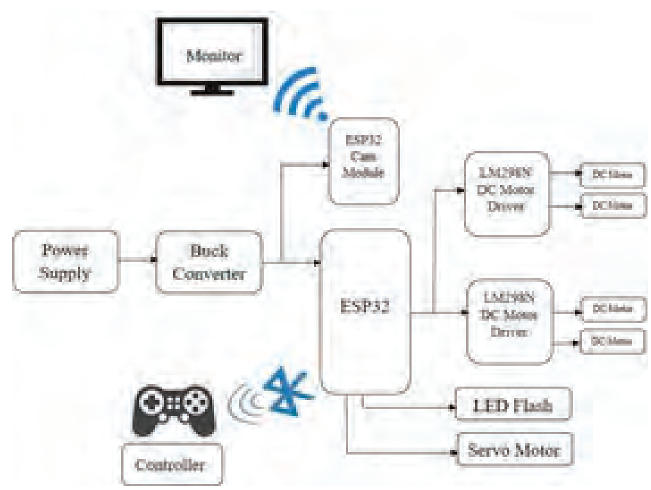
In 2022, the idea was proposed, certain tasks for pipes with fixed diameters, while others may vary the structural function of the pipe being checked. It may be used in circumstances of pipe diameter modification with simple mechanism. The use of a mini-camera or other devices for viewing in-pipe inspections or detecting faults that occur inside pipes. The wheels of DC automobiles are connected to provide the necessary propulsion. Further improvements on the design are discussed. It is a wired robot hence limited use case.[1]

Proposed this mechanism in 2021, the problem is solved by a spring actuation and increasing the flexibility of the mechanism. The robot is designed to be able to traverse horizontal and vertical pipes. The robot has been successfully conducted using only three motors, a radical simplification over existing efforts. The camera sees an image, sends it to the transmitter. The receiver picks up the signal and outputs it to a Monitor. But it is mechanically complex design and difficult to manufacture.[2]

In 2021, the idea for design and analysis of the pipeline was proposed. Model is wireless in-pipe inspection robot. It has ability to travel in vertical as well as horizontal directions and turn in elbows. Robot is able to find defects, flaws, material decay, corrosion and crack. The design is prepared in SolidWorks to simulate the model. The robot is employed with Dual Locomotion System to turn in elbows. The range of camera receiver is approximately 25 m while that of the remote is 8 m. Final robot is not accurate that as of design in SolidWorks.[3]

In 2020, this idea was designed using the LCR sensor, Zigbee protocol. In this paper, Robot can be used in case of pipe diameter variation with the simple mechanism. Arduino Nano board for the controlling of the DC motor along with a couple of sensors. If light falls on any of the LDR sensor, it detects crack and the output signal is given on the terminal and crack is detected. Zig-Bee protocol is used for two-way transmission of data between sensors and controllers. Zig- Bee protocol is not used now-a-days. Efficient output depends on natural day light.[4]

BLOCK DIAGRAM



Once the recording is turned on, the robot is also activated through the main power supply used for the robot. It is a 12 V 3 cell Lithium Polymer (Li-Po) Battery with a 3200 mAh battery power and 40C discharge rate. The battery will provide a back-up for approximately 2 hours. The input power source is directly applied to the buck converter. Buck converter is used to step down the voltage from 12 V to5 V for ESP32 microcontroller and ESP32 CAM Module. The direct power supply from Li-Po battery is applied to Buck Converter and the output power is then applied to the microcontroller and other components. The power supply accommodates different voltage requirements, delivering 5Vfor both the ESP32-CAM and ESP32 microcontroller, ensuring compatibility and consistent operation.

Additionally, it provides 12V to power motors, meeting the specific voltage needs of these components in the system. ESP32 is the microcontroller of the robot. The drive of the robot is controlled by the ESP32. It is connected to the joystick with Bluetooth for the navigation of the robot. The DC Motor drivers are also connected to the ESP32. The ESP32 microcontroller operates at a voltage of 3.3V.ESP32 CAM Module is a CAM module used on the robot for recording and transmitting the live video footage over a locally hosted web page. The functioning of ESP32 CAM Modules is to only host a webserver and transmit video data.

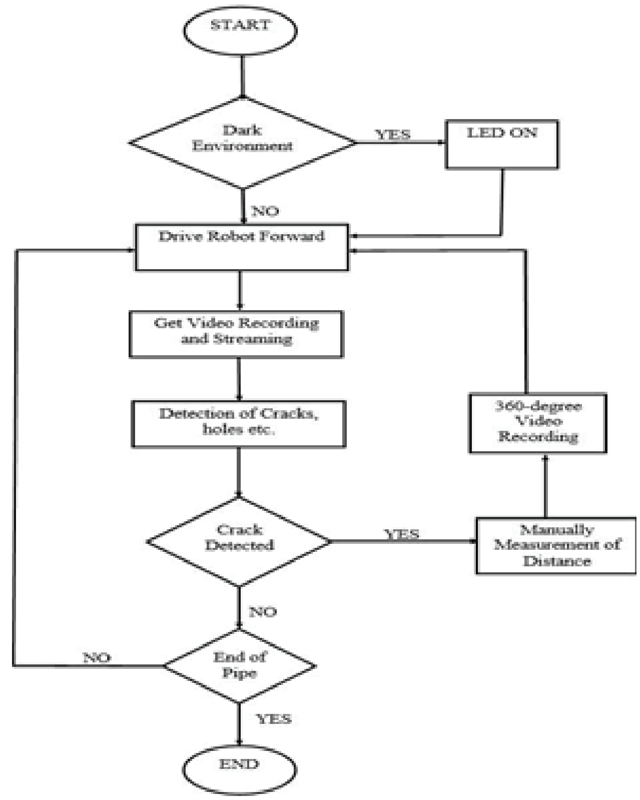
The DC Motor Driver is used to control the DC Motor for the drive. A DC motor is characterized by its operational speed, measured in RPM, representing the rotational speed it can achieve. The torque, measured in Nm, signifies the motor's rotational force. The PWM and direction signals are given from the microcontroller to the motor driver for efficient working of motor. The LED light is mounted on the front side of the robot. As LED provides essential illumination in dark environments and enhance defect detection.

The LED is designed to operate at 5 V. With a luminous flux of 100 lumens and a color temperature range of 5500K (Daylight), it offers a bright and natural lighting output particularly in scenarios where daylight-like illumination is desirable.

A servo motor is utilized to precisely control the orientation of the ESP32 CAM module, enabling it to pan and tilt, capturing a 360-degree view of the pipeline's interior. This motor receives control signals from the ESP32 microcontroller, allowing real-time adjustments for optimal video coverage during the pipeline inspection.

A DC motor is employed for propulsion and manage vulnerability of the pipeline inspection robot. It drives the wheels, enabling the robot to navigate through pipelines by controlling the speed and direction of movement. The DC motor is controlled by the ESP32 microcontroller, offering precise control over the robot's motion and ensuring it can explore complex pipeline terrains effectively.

FLOW CHART



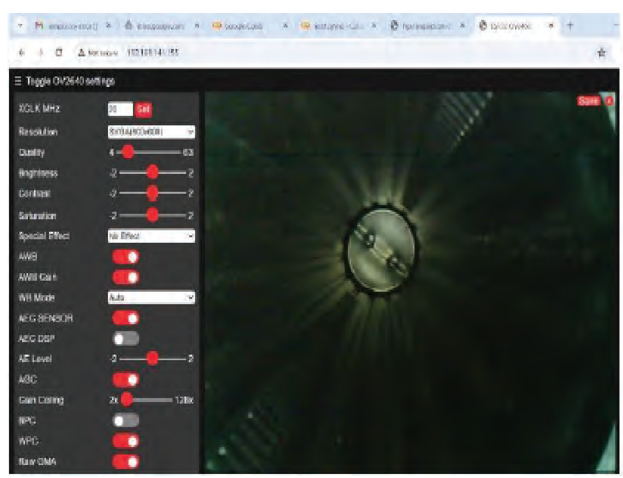
WORKING

Once the recording device is set up, the process starts when the robot is turned on and the recording device is initialized and it gets activated, the operational checks commence, ensuring proper equipment connections. This involves checking that all of the equipment is properly connected and that the robot is ready to operate. The operator will check the environment to see if it is dark. If it is dark, the LED on the recording device is turned on manually by the operator. The operator assesses ambient lighting, activating the recording device's LED in case of darkness to ensure bright and clear video clips This ensures that the video footage is clear and well-lit.

The robot is driven forward at a slow and steady pace depending upon the path whether its free to move or have some blockages. This ensures that the video footage is smooth and uninterrupted. The robot's speed can be adjusted depending on the size and shape of the pipe being inspected. The external camera captures video footage of the pipe interior for real-time analysis on a locally hosted web server, allowing inspectors to monitor and identify potential flaws promptly. The video footage is streamed to a local hosted web server for analysis. A thorough examination of the video material helps identify issues such as holes and cracks, with the operator monitoring the webcam feed in real time. This allows the inspector to monitor the inspection process in real time and to identify any defects that may be present. The video footage is analysed for cracks, holes, and other defects. The operator observes the live footage on the webpage. If necessary, the robot can be rotated to capture a 360-degree view of the pipe interior. The robot's swiveling capability provides a 360- degree view inside the pipe, essential for uncovering flaws hidden from a single perspective.

This capability is particularly valuable for identifying defects that may be obscured from direct view. For instance, if the robot's field of view is limited to the top of the pipe, it might miss a crack located on the bottom. When a crack is detected, the robot halts, and the operator manually measures the distance to the crack. Using a measuring tape externally connected to the robot, the operator records the approximate distances between each identified crack while also inspecting for additional issues such as holes or leaks. Upon reaching the end of the pipe, the robot pauses its video recording, and the footage is saved for subsequent analysis. Inspectors leverage this recorded video to uncover any flaws that may have been missed during the initial inspection, enabling a more thorough assessment. The video footage serves as a valuable tool for inspectors in compiling a detailed report on the condition of the pipe. Following the completion of the examination and report generation, the inspection process ends. The recording device is stopped, and the robot is powered off. The process concludes after the inspector has reviewed the video footage and prepared a report on the pipe's condition, with the robot subsequently being turned off and the recording device disconnected.

RESULTS



FUTURE SCOPE

1. Advanced Analytics and AI Integration

   Incorporate AI algorithms for real-time anomaly detection and predictive maintenance. Use machine learning to improve inspection accuracy and identify patterns in pipeline degradation.

2. Enhanced Mobility and Navigation

   Develop adaptive navigation systems for more complex pipeline networks. Integrate additional sensors for better obstacle detection and avoidance.

3. Extended Battery Life and Power Management

   Research and develop more efficient power management systems to extend operational time. Implement wireless charging solutions for uninterrupted operations.

4. Modular Design

   Introduce modular components for easy upgrades and repairs. Allow customization based on specific industry needs or pipeline conditions.

5. Data Integration and Cloud Connectivity

   Enable cloud connectivity for real-time data analysis and remote monitoring. Provide integration with existing enterprise systems for comprehensive data management.

6. Enhanced Video and Imaging Technology

   Upgrade to higher resolution cameras and imaging sensors. Implement thermal imaging and ultrasonic sensors for more detailed inspections.

CONCLUSION

The Pipe Inspection Robot project, harnessing the capabilities of the ESP32 microcontroller, ESP32 Cam module, and wheels, represents a solution for pipeline inspection. This autonomous robot addresses critical challenges by enhancing efficiency, safety, and data capture, making it a valuable asset in industries reliant on pipeline infrastructure. By minimizing human intervention and enabling remote real-time monitoring through the ESP32 Cammodule's hosted web server, the project streamlines maintenance processes, reduces operational costs, and empowers timely decision-making. The wheels provide unmatched mobility within pipelines, offering the agility required for comprehensive inspections. Furthermore, the ability of the robot to capture a 360-degree view of the pipe interior using Servo Motor ensures that no detail goes unnoticed. The robot effectively identifies cracks in the pipeline and displays them on the live hosted website, facilitating prompt detection and response to the cracks.

ACKNOWLEDGEMENT

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rt Communication System for Road Accident & Congestion Avoidance

Nupur R. Jagtap
✉ ???

S. R. Patil
✉ ???

Sumati Jagdale
✉ ???

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ABSTRACT

Accidents on road are a major concern for all the countries, be it low income or high income. This number is rarely dependent on the topography or demography's of these countries. Thus, with increase in road network, number of road accidents & road congestion situations increase, dramatically. India being one of the major developing countries, is no exception to this issue. With ever increasing road network, the number of road accidents have increased proportionally. These road accidents lead to fatalities as well as permanent irreversible damage to the victims. Which is not a good sign for a growing economies GDP, like that of India's, as it majorly affects the working class of young people between age 15 to 49. In India, in year 2022 total number 4,61,312 people met with accident, and among these, fatalities count was 1,68,491 and total number of people injured was 4,43,366. This survey wishes to analyze different affects of this global issue and ways to handle it.

KEYWORDS: *V2X communication, Road accident, Road congestion, Smart traffic system.*

INTRODUCTION

Road accidents is a major issue in India right now. A total of 4,61,312 accidents have been reported by different Police Departments of Union Territories & States in the country during the year 2022, causing 1,68,491 deaths and 4,43,366 injuries. This number is increasing continuously with the advancement development in the road network. Road accidents causes loss of precious lives. Victims who are injured permanently are left handicapped for life which leads to loss of source of income, increased burden of regular medical treatment, affecting the whole family and not just the individual.

Another issue with increased number of vehicles on the road is traffic congestion. Which leads to loss of precious time, energy and resources. It also leads to air pollution & noise pollution. The time wasted being stuck in traffic, if saved, can be put to better use.

If there is a way to get information about different road accident and road congestion causing factors, beforehand, these unwanted situations can be avoided. This survey looks into one such way of communication, called V2X communication, which helps in avoiding road accidents n congestion. V2X communication is also used to facilitate autonomous driving. Autonomous driving is the need of hour, and the most recent development field in automotive industry. Let's see this form of communication in more details.

ROAD ACCIDENT & ROAD CONGESTION SCENARIO IN INDIA

In the year 2022, different UTs & states reported total of 4,61,312. In these road accidents 1,68,491 people died while 4,43,366 people sustained serious injuries. Compared to the year 2021, year 2022 saw an increase of 11.9% in total accidents. Similarly, the number of deaths and injuries on account of road accidents were also increased by 9.4 percent and 15.3 percent respectively [1].

These figures can be translated, to 1,264 accidents among which there are 462 deaths each day or 53 accidents comprising of 19 deaths each hour in our country [1].

Road accidents are one of the leading causes of death globally and mainly occurs in the age group of 15 to 49 years. [1]

This leads to a very serious concern that there are some major flaws in emergency rescue services in the country [10]. Traffic congestion is definitely a major contributor to this delay, which at times becomes a matter of life & death for the victim.

Following figure shows, total number of accidents, fatalities and persons injured during 2018 to 2022[1].

Year	Accidents	% change over previous period	Fatalities	% change over previous period	Persons Injured	% change over previous period
2018	4,70,403	0.2	157593	5.1	4,64,715	-0.6
2019	4,56,959	-2.9	1,58,984	0.9	4,49,360	-3.3
2020	3,72,181	-18.6	1,38,383	-13.0	3,46,747	-22.8
2021	4,12,432	10.8	1,53,972	11.3	3,84,448	10.9
2022	4,61,312	11.9	1,68,491	9.4	4,43,366	15.3

These numbers paint a very grim picture of the current state of road accident scenario in India.

Along with this, road congestion or traffic jams is another issue concerning the current working class in India. Their maximum time is wasted in these unending traffic jams, caused due to unexpected or uninformed road construction or heavy traffic at traffic signals. This time if saved, can be spent doing some constructive work or with family.

Let's see if we can find a solution for these issues concerning the important aspects of development in India.

V2X COMMUNICATION, A SOLUTION

For effective coordination in connected cars, Intelligent transportation systems (ITSs) are becoming popular day by day. Safety, efficiency, and reliability of road transportation systems is improved by providing an integrated approach for relevant data/information exchange by these ITSs [2].

ITSs integral part is vehicular ad-hoc networks (VANETs). In VANETs, vehicles with sensing abilities come together to form an interconnected network [2]. Important information about location, traffic situation, position on the surface of earth, weather around the vehicle, and emergency services is exchanged by these connected vehicles in VANET.

In VANET (Vehicular Ad-hoc Network) [9] topology changes dynamically due to high mobility of vehicles, so it is a type of mobile communication. Generally, 2 types of messages are used by vehicles, to update their status and to communicate with each other.

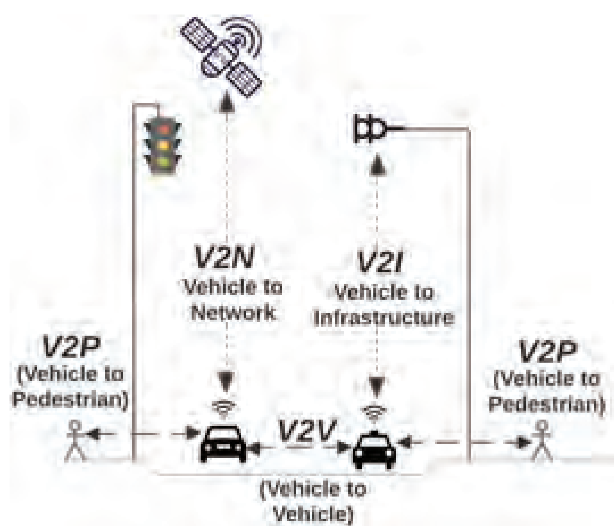
1. Periodic Safety Message (PSM) which gives us information about position, speed etc.

2. Event Driven Safety Message (ESM) occurs in case of emergency situations like sudden lane change, hard breaking etc.

In the event of abnormal vehicle movement either due to sudden change in direction or speed, vehicles generate event-driven safety alert messages (ESM). Its necessary that these Safety alert messages are very fast and reliable for VANET applications [9].

In general, vehicle-to-everything (V2X) means, communications between a vehicle(V) and any entity(X), where the entity may be another vehicle(V), a cloud-based network(N), a pedestrian(P), or equipment installed(I) along a road. V2X helps a driver make an informed decision based on the information it receives from all the other entities surrounding it.

Following image shows V2X communication [2].



Types of Communication in Vehicular Network

Vehicular network consists of 4 major types of communications, as discussed below [2].

V2V (Vehicle-to-Vehicle) Communication

The direct communication between one vehicle and another vehicle, is called V2V communication. This type is very crucial, as it helps communicate life- saving road conditions, to distant vehicle, before it reaches the affected spot. Thus, helping avoid major accidents from happening. This prior information also helps avoid heavy routes or routes with blockage. Thus, helping in tackling traffic jams [2].

V2I(Vehicle-to-Infrastructure) Communication

The communication between the vehicle and fixed road side infrastructure like barricades, traffic signals, work in progress signs etc comes under this category. These communications play a pivotal role in helping in avoiding dangerous accident scenarios and also traffic congestion situations, by informing the driver about the incoming hurdles or conditions [2].

In-Vehicle Communication

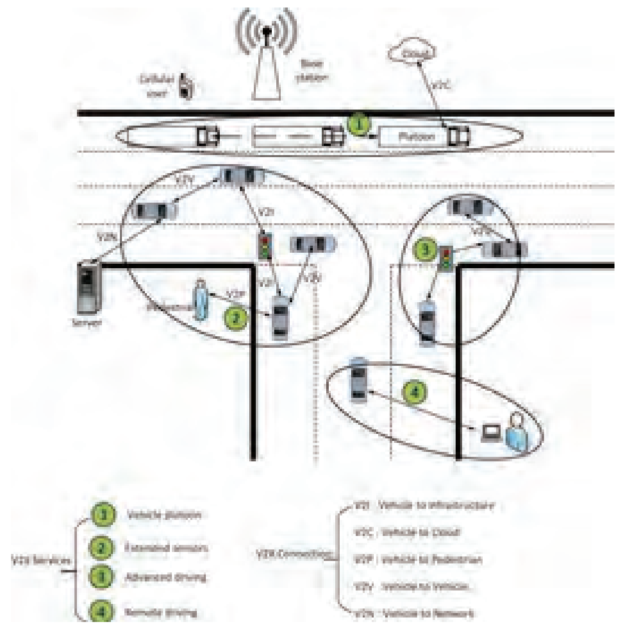
Issues related to drivers (like driver drowsiness) & the internal issues/malfunctions occurring in vehicles, are communicated using this mode of communication. These types of internal communications are very important for smooth working of vehicle and to have a safe & happy journey [2].

V2N (Vehicle-to-broadband cloud) communication

This type of communication makes use of 3G/4G/5G cellular networks for exchange of messages. These networks are very efficient, reliable, have high data transfer rates and have enhanced coverage capabilities. This type of communication is majorly used for vehicle tracking and monitoring. Use of 6G cellular network is the future of this type of communication [2].

A wide range of transport & traffic related sensors, communicate on a high bandwidth, low-latency & reliable V2X network [11]. This super fast connectivity for V2X communication, specifically vehicle-to-infrastructure (V2I) and vehicle-to- vehicle (V2V) communication, will be provided by 5G mobile networks. 5G has significant advantages over current dedicated short-range communication (DSRC) or other Cellular-V2X (C-V2X) proposals, which 3rd Generation Partnership Project (3GPP) intends to use for V2X applications. V2X will definitely be made faster, more reliable and easier by use of 5G. In 5G architecture, the infrastructure the landscape is divided into individual cells, called the base stations. They are widely overlapped while being managed by proper antenna systems, like in any radio mobile service.

Following image shows, 5G V2X communication network scenario [11].



One such vehicle-to-vehicle communication attempt has been done [8], where WSN is used for broadcasting important information between vehicles (V2V). The drawbacks of this system can be overcome by using IoT for low latency communication between vehicles.

USE OF IOT FOR V2X COMMUNICATION

IoT (Internet of Things), is a technology whose main purpose is to connect or link various smart devices and appliances. It also helps facilitate their smoother working /operation and the exchange of important data between them.

V2X can enhance its capabilities by making use of this IoT, through which it can interact with different stationary or mobile appliances/devices on the network. [3]

With advancement in the field of IoT, one of its rapidly evolving or developing component is the transformation of VANETs (Standard Vehicle Ad- hoc Networks) into internet-of-vehicle (IoV). [4]

Using IoT for communication, helps transmit data over a very wide range, at a very high speed, that too with improved reliability. If the concerned information, is received by the vehicles well within time, necessary steps can be taken to avoid accidents and traffic congestion. One of the best examples of avoiding traffic congestion using IoT & V2x is smart traffic lights [5]

Thus, a complete Intelligent Transport System (ITS) can be developed by making use of IoT [7].

Autonomous vehicle, is another goal that can be achieved using these techs together.

OVERALL OBSERVATION

Thus, the overall observation so far is that, to tackle the ever-growing problems of road accidents & road congestion, we can think of using V2X communication using IoT. The messages communicated using V2X & IoT, can warn the driver about upcoming accident-prone conditions as well as traffic status. Thus, the driver can take an informed decision for a smoother journey.

Emergency messages can also be communicated using this technology, so that precious lives will be saved in time.

Autonomous driving needs continuous surrounding data for localizing itself in the world and to plan its trajectory. V2X when implemented using IoT helps this important data communication in autonomous vehicles.

CHALLENGES & FUTURE RESEARCH DIRECTION

In this section we discuss the challenges & future research directions in the field of implementing V2X for road safety.

Challenges

After studying different papers on the field of V2X & IoT, following are some of the major challenges that are observed [2].

1) Obstacles: - Natural obstacles like trees and man-made obstacles like buildings effect the overall communication, by reducing signal strength, adding noise etc.

2) Connectivity issues: - If the IoT network is down due to some reasons, like weather conditions, there will be complete connectivity issue across all concerned units.

Further Research Direction

1) 5G/6G Network: - Further research, especially in 5G/6G network area is going on at the moment. This will definitely help the system achieve faster speeds with more reliability over wide range [6].

2) Autonomous Driverless Vehicles: - Use of V2X & IoT tech in autonomous driverless cars, is the future of automotive industry.

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Motorised Weight Lifting Handle

Vimukta Rokade
✉ vimukta_rokade@moderncoe.edu.in

Rutuja Patole
✉ rutuja_patole@moderncoe.edu.in

Sayali Chaudhari
✉ sayali_chaudhari@moderncoe.edu.in

Vandana Hanchate
✉ vandana.hanchate@moderncoe.edu.in

Shyam Ramnani
✉ Shyam.Ramnani@moderncoe.edu.in

K. R. Joshi
✉ principal@moderncoe.edu.in

Department of Electronics and Telecommunication
Progressive Education's Societys
Modern College of Engineering
Pune, Maharashtra

ABSTRACT

In order to accommodate the increasing need for effective and safe weight-lifting approaches, this project introduces a motorised weight-lifting handle with integrated sensor control and ergonomic optimisation. Through the integration of motorised control, infrared (IR) sensor technology, and a microcontroller, the system provides an adaptable and sensitive lifting mechanism that can effortlessly manage loads up to 500kg. The project demonstrates creative ways to automate lifting tasks while putting user comfort and security first. In order to ensure optimal functionality and user satisfaction, 3D printing is also used in the design and manufacturing process to prototype an ergonomic handle. As a result its increased efficiency brought about by automation, responsiveness, ergonomic optimisation, optimised design and manufacturing processes, and energy-saving measures, it is a useful tool for raising output and cutting costs in a variety of applications. This project, which aims to improve both productivity and safety, is a noteworthy development in material handling technology and provides a dependable solution for a range of industrial and maintenance applications.

KEYWORDS: *Weight-lifting, Infrared (IR) sensor technology, Motorised, 3D printing.*

INTRODUCTION

The requirement for effective and secure material handling solutions has grown in this era of fast industrialization and technological advancement. Industries that involve manufacturing and logistics necessitate sturdy systems that are able to precisely and dependably lift and move large loads. Conventional manual lifting techniques frequently present problems like worker physical strain, safety hazards, and inefficiency. The project presents a motorised weight-lifting handle with integrated sensor control and ergonomic optimisation in order to address these problems.

The inability of traditional lifting mechanisms to satisfy the requirements of contemporary industrial applications gives rise to the need for such a solution. In addition to making operations slower and less accurate, manual lifting techniques raise the possibility of workplace accidents and repetitive strain injuries. Furthermore, flexible solutions that can accommodate a range of load types and operating conditions are necessary due to the complexity and variability of lifting tasks in industrial and maintenance settings.

The project's motorised weightlifting handle provides an adaptable and quick fix for these problems. The system enhances material handling operations' efficiency, safety, and user comfort through the integration of motorised control, infrared (IR) sensor technology, and ergonomic optimisation. It makes automated lifting operations possible, which minimises the need for human intervention and lowers the possibility of mishaps. Additionally, the handle's ergonomic design lessens physical strain on users, enhancing wellbeing and productivity at work.

Numerous industries, including manufacturing, warehousing, construction, and maintenance, use motorised weight-lifting handles. It can be used for things like moving goods in warehouses, assembling buildings on construction sites, lifting large machinery parts, and doing maintenance on industrial equipment.

The project aims to revolutionise material handling practices and contribute to increased productivity and safety across a variety of industrial sectors by offering a dependable and flexible solution to typical lifting challenges.The motorised weight-lifting handle, which combines cutting-edge technology and ergonomic principles, is a significant advancement in material handling technology that is expected to have a positive impact on industrial operations everywhere.

LITERATURE SURVEY

Choudhary S., Ravi Kumar D. et al., who introduced the project Design and Fabrication of Motorized Hydraulic Jack System[1]The design and construction of a motorised hydraulic jack system for use in industrial and automotive settings is presented in this paper. The system's hydraulic jack and motor-driven pump combine to minimise manual labour and increase efficiency. Safety features, hydraulic circuit design, and material selection are important design factors. When compared to manual jacks, the prototype exhibits better load handling and operational speed. Its efficacy is validated by performance tests, suggesting that it has widespread potential for application in maintenance and repair procedures.

Songbo Hu, Yihai Fang, Yu Bai.,who presented the idea of project Automation and Optimization in Crane Lift Planning: A Critical Review[2]This critical review focuses on algorithmic methods and simulation models to investigate the latest developments in automation and optimisation for crane lift planning. It highlights the potential of combining real-time data analytics, artificial intelligence, and machine learning and identifies the major obstacles and technological gaps that prevent generalisation across various contexts. In order to close these knowledge gaps and improve automated crane lift planning systems, the paper ends with research recommendations for the future.

Doli Rani,Nitin Agarwal,Vineet Tirth, whom the project introduced Design and Fabrication of Hydraulic Scissor Lift[3]With an emphasis on mechanical and hydraulic principles, this paper describes the design and construction of a hydraulic scissor lift. The lift offers a sturdy, movable platform for raising big objects. Structural analysis, safety mechanisms, and hydraulic component selection are all part of the design process. After testing, the prototype demonstrates dependability and efficiency. According to the study's findings, the hydraulic scissor lift is an adaptable and reasonably priced option for maintenance, construction, and industrial uses.

Wei Zhang ,Qinghao Yuan ,Yifan Xu ,Xuguang Wang,Shuzhan Bai ,Lei Zhao ,Yang Hua and Xiaoxu Ma who introduced the project Research on Control Strategy of Electro-Hydraulic Lifting System Based on AMESim and MATLAB[4]In order to improve accuracy and stability, this study looks into control strategies for electro-hydraulic lifting systems using MATLAB and AMESim simulations. Tests of several strategies, such as PID and model predictive control, reveal notable gains in accuracy and responsiveness under various loads. The study offers suggestions for design and control enhancements for electro-hydraulic systems, offering insights into their practical implementation.

Charles Mbohwa, Ignatio Madanhire and Tapiwa Chatindo, whom the project was introduced Development of a Portable Motorized Car Jack[5]The development of a portable motorised car jack, intended to offer a practical and effective means of vehicle lifting, is the subject of this paper. To enable simple and quick lifting operations, the design integrates a sturdy mechanical linkage and a small electric motor. Because of its lightweight design, the system can be easily stored and utilised in an emergency. The stages of testing and prototyping are described in detail, emphasising the lifting capacity, speed, and safety of the system. The results show that, with notable gains in user convenience and operational efficiency, the portable motorised car jack provides a dependable substitute for conventional manual jacks.

Tuan D. Ngo a, Alireza Kashani a, Gabriele Imbalzano a, Kate T.Q. Nguyen a, David Hui b,who introduced the project, Additive manufacturing (3D printing): A review of materials, methods, applications and challenges[6] This paper presents a thorough introduction to 3D printing, emphasising its advantages over other technologies, such as waste reduction and design freedom. It talks about different printing techniques, materials, and industrial uses. It also discusses issues like anisotropic behaviour and void formation, acting as a guide for further study and advancement in the area.

Study on optimization of 3D printing parameters[7] Since 3D printing technology has become widely used, research has focused on how efficient 3D printing is. This study focuses on FDM printers that use cylinder models as objects and PLA as consumables. It optimises associated parameters by analysing the effect of slice height on printing time, consumables, and dimensional accuracy. Results show that for the same print quality, the shortest printing time is obtained with a layer height of 0.14mm.

John Randall Flanagan,Alan Miles Wing,who introduced the project, Modulation of grip force with load force during point-to-point arm movements[8] The study looks at the load pressures and grip during precise grip arm movements. Because of movement inertia, grip force varies with load force and rises with increasing load force and falls with decreasing load force. This precise adjustment is made. This modulation shows that grip force programming is a crucial component of movement planning since it happens consistently in both vertical and horizontal movements.

Conclusion: Above all the limitations and many such research papers showed that there is a lack of traditional methods of weight lifting in the industrial world. By providing a dependable and adaptable solution to common lifting challenges, the project seeks to revolutionise material handling practices and contribute to increased productivity and safety across a variety of industrial sectors. The project helps in application for the required purpose.

PROPOSED METHODOLOGY AND DISCUSSION

Design Phase

- Compiling the Needs: Establish the handle's specifications, such as the weight it must lift and its ergonomics for the comfort of the user.
- Establish the IR sensors, relays, and motor's operating parameters.
- CAD Creating models:Make a three-dimensional model of the ergonomic handle using SolidWorks, Make sure the handle can support the typical weight and strength of a person.

Include mounting or slots for IR sensors and other electronic components.

- Examining Stress and Strain:Use ANSYS Workbench to conduct Finite Element Analysis (FEA) to make sure the handle can support the necessary loads.

To guarantee dependability and durability, optimise the design in light of the analysis's findings.

- Making prototypes: The 3D model should be ready for printing. Using the right materials, 3D print the prototype handle.

Phase of Fabrication

- Component Selection: Choose the proper relays, IR sensors, and microcontroller (such as an Arduino).

  Considering the necessary load, select an appropriate motor for the lifting mechanism.
- Putting Together: Place the IR sensors so they can precisely detect hand movements on the handle. Attach the IR sensors to the digital input pins on the Arduino.

  Attach the relay modules to the digital output pins of the Arduino.

  Make sure the motor is properly wired to the relays so they can control lifting and lowering movements.
- Electrical Schematic:Create the circuit that connects the motor, relays, and IR sensors to the Arduino.

A proper power supply and grounding for every component should be ensured.

Software Development

- Programming with Arduino: To read data from the infrared sensors and operate the relays, write code for the Arduino platform.
- Apply logic to the sensor inputs to determine whether to lift or lower the motor.
- Assure safety precautions and delays to avoid unintentional activation.

Testing Phase

- Preliminary The analysis: To make sure every part of the system is operating as intended, test it in a safe setting.
- Check that the relays are properly controlling the motor and that the IR sensors are detecting movement.
- Tests for Loading:Test the lifting and lowering mechanism by fastening weights to the handle.

Make sure there is no chance of a system failure when handling the maximum intended load.

Verification and Enhancement

- User Input: To get input on the functionality and ergonomic design, hold user trials.

Based on user feedback, make the necessary changes to the handle software and design.

- Enhancing Performance: Improve the motor control and Arduino code to make things run more smoothly and consume less energy.

  Adjust the infrared sensors' sensitivity to achieve precise detection.
- Concluding Examination: To guarantee robustness and dependability, conduct extensive testing in a range of scenarios. Verify the system's functionality in actual situations.

Summary: It is expected that the motorised weight-lifting handle with integrated sensor control and ergonomic optimisation will increase lifting operations' efficiency and safety. The system aims to increase efficiency and lower the risk of injury by automating the lifting process and reducing manual effort. As a result, it is appropriate for a variety of industrial and maintenance applications.

ALGORITHM

The first step of the algorithm is initialization, which involves setting up the microcontroller for operation and configuring the digital pins for motor control, relay modules, and infrared (IR) sensors. It then continuously scans for input signals from the IR sensors in order to identify any movement. The algorithm initiates the corresponding relay module to control the motor upon detecting movement by either of the IR sensors. Relay 1 is triggered to lift the weight if IR sensor 1 detects movement, and Relay 2 is triggered to lower the weight if IR sensor

2 detects movement. The algorithm initiates the lifting or lowering action by telling the motor to rotate in the proper direction. After a set amount of time, usually two seconds, the relay is turned off to stop the motor, giving you exact control over the lifting process. The system can react dynamically to changes in the environment and lifting requirements because this process of continuously monitoring for movement, activating the relay, controlling the motor, and then deactivating the relay is repeated.

Here is a basic algorithm that describes how your motorised weight-lifting handle project will operate, including how the motor and microcontroller function:-

Initialization: Initiate digital pins for motor control, relay modules, and infrared sensors, and set up the microcontroller

Detection of Movement: Keep a watch on the IR sensors' input at all times to spot movement. If either sensor detects movement : Proceed to the next step.

Activation of Relay: To control the motor, turn on the corresponding relay module.

- If IR sensor 1 detects movement: Activate Relay 1 to lift the weight.
- If IR sensor 2 detects movement: Activate Relay 2 to lower the weight

Motor Control: Switch on the relay to power the motor

- If Relay 1 is activated: Rotate the motor in one direction to lift the weight.
- If Relay 2 is activated: Rotate the motor in the opposite direction to lower the weight.

Delay and Deactivation: Deactivate the relay after a predetermined amount of time (two seconds, for example) to stop the motor:

- Turn off Relay 1 after lifting the weight.
- Turn off Relay 2 after lowering the weight.

Repeat: To keep an eye out for movement, go back to step 2 and repeat the procedure as necessary.

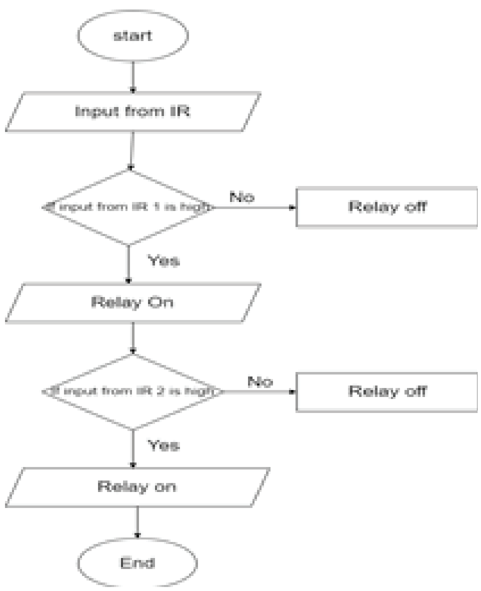

Fig. Flow Chart of Systems

EXPERIMENTAL RESULTS

Performance in Lifting

Load tests reveal that the handle lifts a range of weights satisfactorily in the allotted time, exhibiting dependable and consistent performance. Through the integration of motorised control, infrared (IR) sensor technology, and a microcontroller, the system provides an adaptable and sensitive lifting mechanism that can effortlessly manage loads up to 500kg.

Sensor Accuracy

The results of testing show that the IR sensors reliably and highly precisely detect hand movements, reducing false positives and negatives.

Comfort in an Ergonomic Setting

According to user feedback surveys, the handle design improves overall user experience by successfully reducing hand fatigue and strain during lifting operations.

Effective Automating

Motion should be reliably detected by the IR sensors, which should then quickly initiate the raising or lowering process. The system should turn on the motor to raise the weight when the motion detected by the infrared sensor at the top indicates a request to lift. The system should turn on the motor to lower the weight when the motion detected by the infrared sensor at the bottom indicates a request to lower.

Dependability and Safety

In order to avoid overlifting or overpowering, the system should function safely, with the motor shutting off automatically after the predetermined amount of time—for example, two seconds.

Relay modules should be used to make sure the motor only runs when necessary, lowering the possibility of accidents.

Designing ergonomically

It should be simple and comfortable to grasp the 3D-printed handle, which will lessen user fatigue. The handle should be strong and dependable, and the design should account for average human strength and weight capacities.

Monitoring and Control in Real-Time

In order to manage motor operations in real-time, the Arduino needs to be able to read inputs from the IR sensors and control the relays. In order to ensure responsive and precise lifting and lowering actions, the system should be able to handle changes in sensor inputs in real-time.

Energy Efficiency

The motor should only run when absolutely necessary, and the system should use power efficiently.

The delay mechanism, which switches off the motor after lifting or lowering is finished, should aid in reducing wasteful power consumption.

Strength of Structure

When lifting weights, the handle and related lifting mechanism should be able to sustain the strains and stresses without breaking down or deforming.

The FEA analysis's findings ought to validate that the design can securely support the intended loads.

User Contentment

When compared to manual lifting, users should find the motorised lifting handle to be substantially safer and easier to use.

Increased operational efficiency and less physical strain should be facilitated by the ergonomic design.

Integration and Scalability

With the ability to scale up or down depending on motor capacity and handle design, the system should be flexible enough to accommodate a range of weights and applications. The motorised handle should be versatile and work seamlessly with any existing hoists or lifting apparatus.

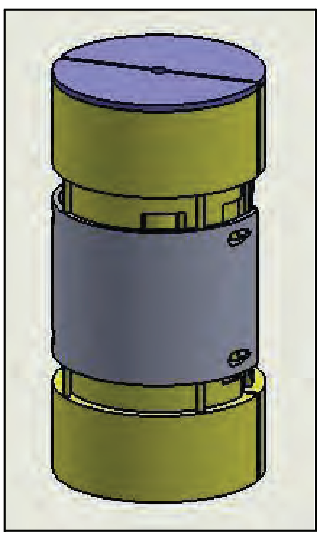

Fig: Motorised Handle for weight lifting

CONCLUSION

Ultimately, the development and testing of the Ergonomically Compact Weight Lifting Handle have yielded positive results, indicating a significant advancement in the field of industrial material handling. The handle's durability, practicality, and adaptability for a variety of industrial environments have been demonstrated through meticulous design, sophisticated simulation, and hands-on testing.

An important development in industrial equipment design is the Weight Lifting Handle for single wire rope hoists. Throughout the project, close attention is paid to cost-effectiveness, usability, new invention and safety. We put operator well-being first by incorporating infrared sensors, and an ergonomic grip. By automating the lifting process and reducing manual intervention, the project enhances productivity and safety in material handling tasks. In addition to cutting expenses, the 3D printing method supports ecological practices. By utilising this handle in a variety of hoist types, we help create a lifting environment that is safer and more effective. This project is a prime example of how engineering, innovation, and user-centric design come together to create safer, more intelligent industries.

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DOF using FPGA

John Jerish
johnjerish2003@gmail.com

Rini Rajendran
rinirajendran2003@gmail.com

Krishna Sawale
krishnasawale02@gmail.com

Paul Samuel Sheban
psheban@gmail.com

Sneha Revankar
sneha.revankar@fcrit.ac.in

Department of Electronics and Telecommunication Engineering
Fr. Conceicao Rodrigues Institute of Technology
Vashi, Maharashtra

ABSTRACT

This paper narrates the development of an FPGA-based pick and place robot system. The goal was to design a remotely controlled robot with a pick and place mechanism for applications in warehouses, laboratories, and similar environments. The system leverages FPGAs for real-time control and high performance.

The paper explores the design and architecture of the robot, including robot arms, DC motors, servo motors, a Nexys A7 FPGA board [1], and a gripper. It analyzes the selection criteria for each component. The integration of the FPGA for arm control, pick and place operations, and overall motion control is also discussed. Design challenges and deliberations are addressed. Finally, the paper presents the results of the implemented system, including its accuracy, speed, and reliability through experimental testing. It concludes by identifying potential areas for improvement.

KEYWORDS: *Remotely controlled robot, FPGA, Nexys A7 Board, Robot arms, DC motors, Servo motors.*

INTRODUCTION

The problem addressed in this project is the need for an efficient and autonomous object picking and placing system in various industries, such as manufacturing, warehousing, and logistics. Traditional manual labor for these tasks is time-consuming, costly, and prone to errors. Therefore, a solution is required to automate this process and improve overall efficiency. The main challenges in developing an FPGA-based picker system are as follows:

Labor Management: Efficient utilization of labor resources is critical for warehouse productivity. The main challenges faced by a company include labor shortages, lack of training, and ineffective scheduling, which can impact throughput and increase operational costs, which can be an add on burden to the company reducing the profit.

Accuracy and Speed: Accuracy in placing the objects/ products are the key aspects of increasing the efficiency and reliability of the system. Challenges include order picking errors and managing inventory effectively to minimize losses. The operating frequency of the FPGA is much higher (100 MHz) than the microcontroller used in the various subsystems in the industries.

Real-time Remote Control: Controlling the movements of the Bot remotely and wirelessly makes the Bot versatile. The use of FPGA technology offers parallel processing, which is advantageous for achieving real-time control, which helps in having command over the mobility and picking and dropping of an object. By addressing these challenges and developing an FPGA-based picker system, it is possible to overcome all the shortcomings, such as the limitations and inefficiencies associated with manual labor. The system aims to increase productivity, reduce production costs by cutting labor charges, and improve overall operational efficiency in industries that require automated object picking and placing.

The objective of developing an FPGA-based object picker system is to create a fast and efficient solution for picking and placing objects in industries such as manufacturing, warehousing, logistics, and small-scale places like Institutional laboratories and biomedical laboratories.

The system aims to address the following objectives:

To semi-automate the process of object picking and placing by reducing the dependency on manual labor and human dependency. By utilizing FPGA technology, the system can achieve real-time control and improve operational efficiency.

To make a system which handles objects of various shapes, sizes, and weights. The gripper mechanism is adjustable and versatile, allowing for efficient gripping and releasing according to different object characteristics, making it more demanding in industries and laboratory.

To make the entire system wirelessly and remotely controllable, we employ 3 degrees of freedom for grabbing and placing which increases the range of the Bot.

The FPGA-based object picker system hopes to accomplish these goals by streamlining processes, cutting expenses, raising output, and enhancing general efficiency in sectors that need automated object handling.

METHODOLOGY

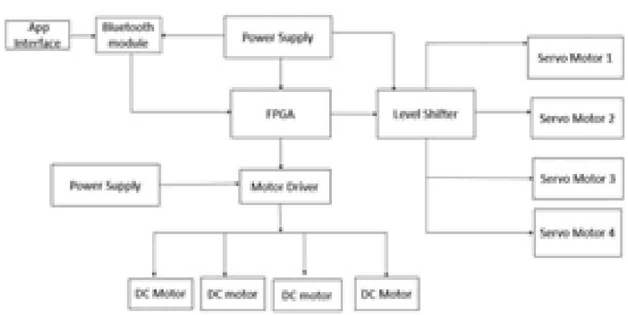

Fig 1 Block diagram of the Bot

This block diagram as shown in Fig. 1 illustrates the key components and their interactions within the Bot controller system. The FPGA serves as the brain of the system, receiving wireless commands from the mobile interface, processing them, and sending control signals to the DC motor driver to move the car. Power supply provides the necessary voltage and current to operate the entire Bot controller system. It hosts the logic that controls various aspects of the Bot. It is responsible for interpreting the UART signal and generating control signals. The DC motor driver is an essential component for controlling the DC motors that propel the Bot. It amplifies the control signals from the FPGA and drives the motors and the arm [2] accordingly. The DC motors are attached to the wheels and generate the motion required for the Bot to move. The Bluetooth module facilitates wireless communication between the Bot and a mobile device. It receives control commands from a mobile interface and transmits them to the FPGA for execution. The mobile interface represents the user's interaction point. It can be a mobile app on a smartphone or tablet. The mobile Interface is made in MIT app Inventor [3]. Users can send commands via the mobile interface to control the Bot, such as steering, acceleration, and braking. The power supply provides the required energy to all components, ensuring the seamless operation of the Bot.

Verilog is a hardware description language commonly used in the design and verification of digital circuits, including FPGA designs. Vivado, the Xilinx design suite, provides a range of features for Verilog development.

Features of Vivado: Simple to write and grasp. Because of its user-friendly syntax. As Vivado is an open-source software, it has a great developer community support.

The "MIT App Inventor" refers to a web-based development environment provided by the Massachusetts Institute of Technology (MIT). It is primarily used for creating mobile applications for Android devices.

Features of MIT App Inverter: MIT App Inventor utilizes a visual programming environment, allowing users to build applications by dragging and dropping blocks that represent different components and functions. It can be implemented using software or dedicated hardware.

IMPLEMENTATION

The software implementation plays a pivotal role in seamlessly interfacing with the hardware components to enable precise control over the robotic arm and Bot movements. The VIVADO design suite, specifically tailored for synthesizing and analyzing Hardware Description Language (HDL) designs, serves as the cornerstone for programming the FPGA using Verilog as the HDL [4][5][6]. This robust software environment facilitates the intricate translation of high-level commands into low-level hardware instructions, enabling the FPGA to orchestrate the intricate operations of the robotic system.

Complementing the hardware skill, a user-friendly mobile interface developed using the MIT App Inventor platform acts as the command center. This block-based visual programming language allows intuitive control over the Bot's mobility and arm movements. The interface features directional arrows that trigger specific UART data transmissions to the FPGA via a Bluetooth module. These data packets function as control signals, directing the Bot's movement in six different directions. Additionally, dedicated buttons programmed within the interface initiate the operation of the four servo motors responsible for actuating the robotic arm's intricate movements. The designer blocks meticulously configure each button to transmit a distinct 1-byte UART data packet, effectively translating user inputs into precise hardware commands. This seamless integration of software and hardware components empowers users to effortlessly dictate the Robot's actions, leveraging the computational power of the FPGA and the intuitive control afforded by the mobile interface.

Hardware implementation:

For the CPU of the Bot system, we have used Nexys A7 FPGA board which has a on-board frequency of 100 MHz for controlling the Bot. We have used four 12V DC motors which are driven by the L293D motor drivers. The HC-05 Bluetooth module [7] is utilized to send data wirelessly to the UART signals. For controlling the arm, we have 3 MG995 servo motors for the 3 degrees of freedom and 1 SG90 servo motor for the gripping mechanism. A 3V–5V level shifter is used to drive the servo motors as the maximum output voltage is 3.3V.

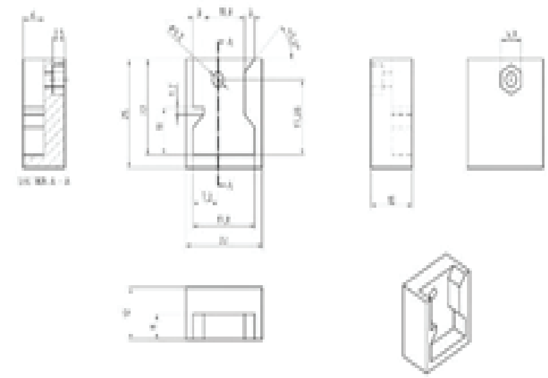

Fig. 2. Dimension of the Bot

The Mechanical part of the Bot consists of 2 parts: chassis and the arm. The arm has been 3D-printed.

The "Claw STD Interface" is a crucial component with a clamp-like design for gripping objects in robotic or mechanical systems. Its dimensions ensure proper fit and functionality within the assembly. 3D printing with PLA plastic offers advantages like ease of use, low cost, and environmental friendliness for manufacturing this part. Figure 2 gives an idea about the dimensions of the Bot.

The 3D printing process involves slicing the CAD model, generating G-code, and layer-by-layer printing, enabling rapid prototyping and customization. Fusion

360 CAD software facilitated parametric modeling, simulation, and collaboration during the design phase.

Integration challenges like alignment and fit must be addressed through testing and validation procedures, including simulations, prototyping, and physical testing to ensure performance and reliability standards.

With its versatile design, this component has potential applications across industries requiring secure object gripping, such as robotics, automation, and manufacturing processes. Future enhancements may optimize performance based on evolving requirements.

Overall, this component showcases the interplay between design, material selection, manufacturing processes, and software tools in developing innovative solutions for complex systems. An exact replica of the robotic arm was made using 3D printing as shown in fig. 3 i.e., the Blueprint of the robotic arm [8].

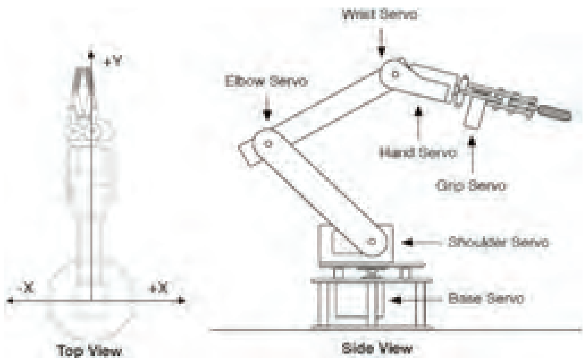

Fig 3. Blueprint of the robotic Arm

In addition to its FPGA-driven control system, the pick and drop Bot incorporates Bluetooth interfacing capabilities for remote control via a dedicated mobile application. This feature offers users seamless accessibility and control over the Bot's operations, enhancing its versatility and usability in industrial or laboratory environments. By integrating a Bluetooth module into the system, users can establish a wireless connection between their smartphones and the Bot, enabling intuitive navigation and command execution through the app interface.

Software implementation

The software implementation of the FPGA-based robotic system is a crucial aspect that enables the hardware components to function seamlessly. VIVADO, the design suite employed for this project, facilitates the development of hardware description code using Verilog. This powerful tool allows for the translation of high-level specifications into low-level hardware instructions, which are then programmed into the FPGA chip.

The software implementation encompasses various modules and algorithms responsible for controlling the Bot's movements, coordinating the servo motors, and managing the pick-and-place operations. Efficient coding techniques and optimization strategies are employed to ensure real-time performance and minimize latency, which is critical for precise Robot control. MIT App Inventor is used to develop an interface that is used to send 8-bit UART data to the FPGA through the Bluetooth module [9]. The 6 arrows are used to control the Bot in 6 different directions. For controlling the 4 servos 4 buttons are programmed which when clicked, starts the corresponding servo motor. The 6 arrows are used to control the Bot in 6 different directions. For controlling the 4 servos, 4 buttons are programmed which when clicked starts the corresponding servo motor.

Table 1 shows the UART data that directs Bot movement, specifying actions like forward motion, backward motion, and right and left turns. Parameters like speed and angle are included for precise control.

Table 1: DC Control Signal

UART Data	Servo Motor Actuation
00010000	Servo 1 starts rotating
00100000	Servo 2 starts rotating
01000000	Servo 3 starts rotating
10000000	Servo 4 starts rotating
00000000	Servos stops rotating

Table 2 illustrates how the UART signals control the 4 servo motors that control the arm of the Bot for the rotating, extending, and grabbing and dropping mechanism.

Table 2: DC Control Signal [10]

UART Data	DC Motor Actuation
00001010	Bot moves forward
00000101	Bot moves backward
00001000	Bot takes a forward right turn
00000010	Bot takes a forward left turn
00000100	Bot takes a backward right turn
00000001	Bot takes a backward left turn
00000000	Bot stops

The waveforms of all the servo motors are as follows:

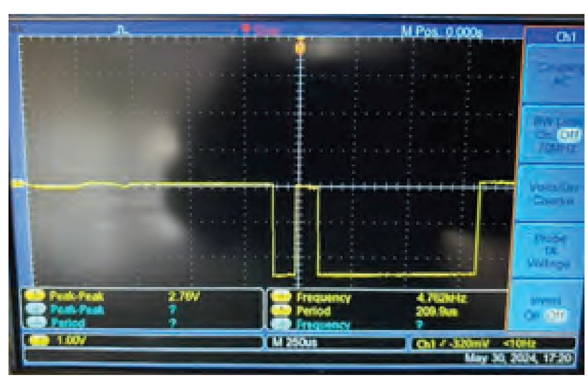

Fig 4. Waveform of servo motor 1

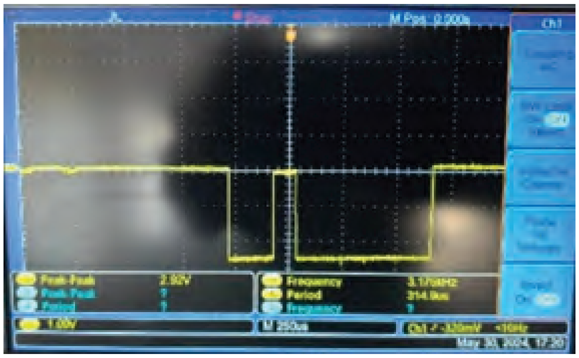

Fig 5. Waveform of servo motor 2

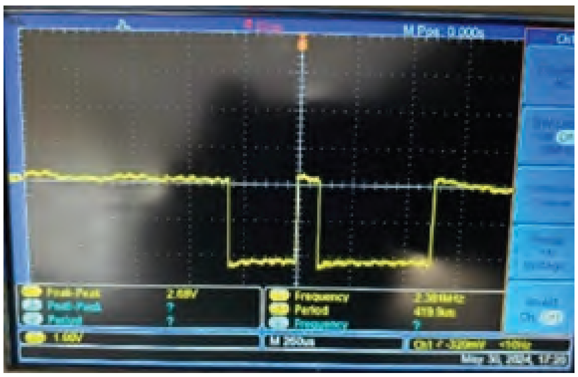

Fig 6. Waveform of servo motor 3

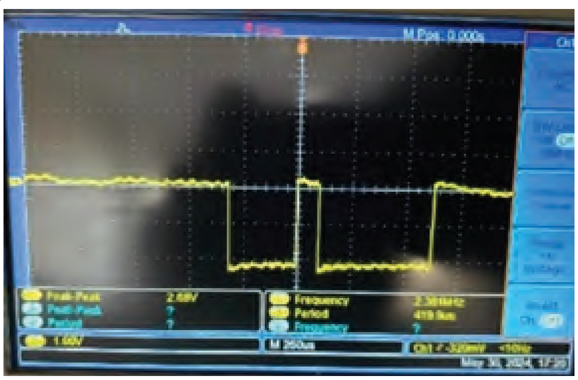

Fig 7. Waveform of servo motor 4

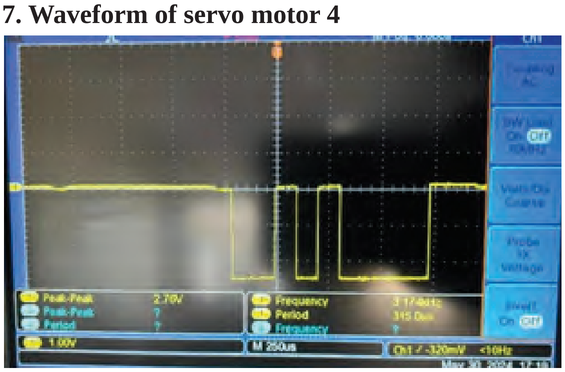

Fig 8. Waveform of Motor backward

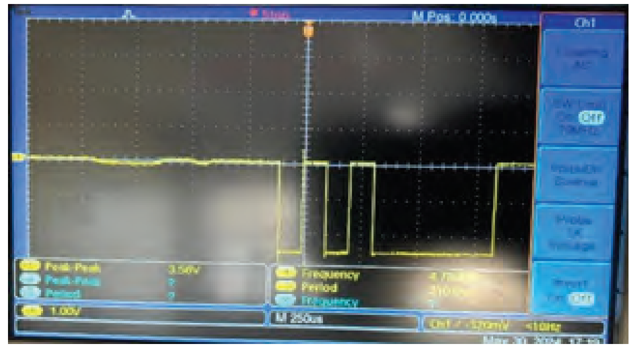

Fig 9. Waveform of Motor forward

Interface: To provide an easy-to-use interface for controlling the robotic system, a mobile application was developed using MIT App Inventor. This platform allows for the creation of user-friendly interfaces through a drag-and-drop approach, making it accessible even for those with limited coding.

Fig. 10 illustrates the intuitive mobile application interface developed using MIT App Inventor. The interface features directional arrows for controlling the Bot's movement in six different directions and dedicated buttons for actuating the four servo motors responsible for the robotic arm's movements, including rotation, extension, and gripper mechanism.

Fig 10. App interface

The designer blocks, within the MIT App Inventor platform were meticulously configured to transmit specific 8-bit UART data packets corresponding to each button press or directional command. These UART data packets served as control signals, seamlessly interpreted by the FPGA board to generate appropriate actuation signals for the DC motors and servo motors.

The mobile app features directional buttons that send corresponding UART data to the FPGA via a Bluetooth connection. These data packets act as control signals, instructing the Robot to move in six different directions. Additionally, separate buttons are programmed to operate the four servo motors responsible for controlling the robotic arm's movements.

The MIT App Inventor's block-based programming environment simplifies the process of configuring each button to transmit a specific 1-byte UART data packet. This seamless integration between the mobile app and the FPGA-based system enables users to effortlessly control the Robot's actions through an intuitive interface, leveraging the computational capabilities of the FPGA.

The final implementation of the FPGA-based 3 degrees of freedom pick and place robotic arm system is shown. Fig. 11 depicts the overall structure of the robotic system. The 3D printed robotic arm is mounted on a wheeled chassis, providing mobility for positioning the arm during pick-and-place operations. The arm features multiple joints and links, enabling it to reach and manipulate objects from various angles and positions.

Fig 11. Robotic Arm on Wheeled Chassis

Fig. 12 shows the electronics and control components responsible for operating the robotic arm. At the center, a Nexys A7 FPGA Board is placed in order to connect to various electronic components, i.e., motor drivers, and sensors. This configuration allows the programmable control and coordination of arm's movements and gripper mechanism.

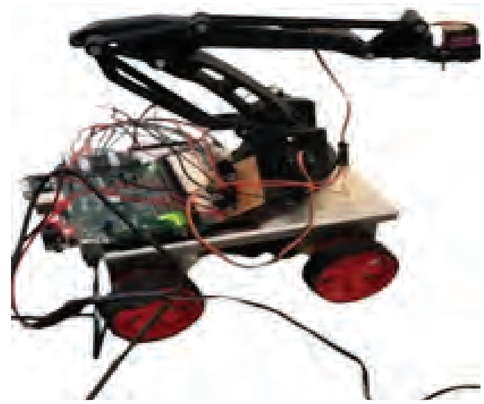

Fig 12. Electronics and Control System

SUMMARY OF THE PROJECT

This project report presents the implementation of FPGA based 3 degrees of freedom pick and drop Bot which can be controlled using a Bluetooth module. The system uses Nexys A7 FPGA board as the central controller which is interfaced with the DC motors for the Bot's mobility. It is also interface with the servo motor for the movement of the Bot's arm. With the help of MIT App Inventor, UART control signals are sent wirelessly to the FPGA which interprets the signal and generates appropriate control signals which actuates the motors to move according to the given signal. With the help of aluminum, the Bot can be made light weighted and rigid at the same providing a strong base for the 3D printed robotic arm. The aim to develop an efficient and remotely controlled object picking and placing system was achieved with the help of real time control and high performance of FPGA.

CONCLUSION

The FPGA based 3-DOF pick and drop Bot system successfully demonstrated with the help of some exceptional features of FPGA like real time control, high performance and parallel processing which is used for picking and placing objects. By integrating the Nexys A7 FPGA board with the DC motors, servo motor, motor drivers and wireless Bluetooth module, the system could achieve precise control over the Bot with the help of a remote that could control the mobility of the Bot and also control the robotic arm as well. The mobile app interface provides user-friendly commands wirelessly which controls the Bot's movement. With the help of aluminum chassis, the durability of the Bot is taken care, making it lightweight, at the same time rigid which is necessary to give a strong base to the 3D printed robotic arm. It enhances the overall system's adaptability and efficiency of the Bot.

FUTURE SCOPE

The project highlights the potential of FPGA technology in creating a semi-automated pick and place Bot keeping it cost efficient and task efficient, there is still some room for improvement which is mainly making it fully automated. With the help of AI, it can be used in specific areas such as laboratories and biomedical areas where human entries are restricted. Object detection and recognition enables its atomicity in identifying the object and picking and placing it in desired place. Adding on to the degree of freedom, the robotic arm can pick object of various size and shape efficiently. Machine learning algorithms can be vital add on to the project enabling adaptive control and decision making, making the Bot more intelligent and responsive to dynamic environment. Use of tactile sensors can be added to the gripper mechanism which could improvise the ability of the Bot to handle delicate object without causing it any damage.

ACKNOWLEDGMENT

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UniQuest: A SPPU Chatbot

Vaidehi Deshmukh, Shruti Shinde
Undergraduate Student
Artificial Intelligence and Data Science
P.E.S Modern College of Engineering
Pune, Maharashtra
✉ vaidehisdm18@gmail.com
✉ shrutidsm111@gmail.com

Gurvansh Kaur Kotheth, Kaiwalya Surve
Undergraduate Student
Artificial Intelligence and Data Science
P.E.S Modern College of Engineering
Pune, Maharashtra
✉ gvanshk512@gmail.com
✉ kaiwalyasurve1106@gmail.com

Supriya Balote
Assistant Professor
Artificial Intelligence and Data Science
P.E.S Modern College of Engineering
Pune, Maharashtra

ABSTRACT

This paper presents the design, implementation, and deployment strategies of a chatbot tailored for Savitribai Phule Pune University (SPPU). It uses natural language processing (NLP) technologies, the chatbot aims to streamline student interactions, administrative processes, and information dissemination within the university ecosystem. Through adaptive design and iterative refinement, the chatbot embodies a commitment to user centricity and operational efficiency.

KEYWORDS: *Artificial Intelligence, UniQuest, Chatbot, Ma- chine learning; University chatbot, Educational.*

INTRODUCTION

Here, the chatbot will act as a central source of information to provide immediate and relevant answers to the queries of the students. The purpose of the chatbot is to augment the work of the university's staff by providing the users with instant access to information about the university. This could be to find out start times of lectures, locations of rooms and also general information about the university. With the university being spread across many different locations over the city and having a vast amount of students, it is very hard for all queries to be answered quickly. [1] This chatbot can potentially increase the efficiency of the university by reducing the amount of time taken for students to find out necessary information by physically going to ask someone, who may not know the answer anyway. This will benefit everyone in the university and can potentially give the students a better learning experience. The chatbot will aim to simulate conversation with real humans in terms of language and its flexibility. This can only be achieved using the most advanced AI techniques which makes this project ideal for deployment of RASA framework. [3]

Purpose of Chatbot

The primary goal of this AI chatbot is the automation of the process of resolving student queries and complaints. The automation of the process helps reduce the human effort re- quired in addressing each individual query. The bot consists of a set of well-designed interactive forms that enable easy input of information from the user. These forms usually categorize the queries into a few types and enable a better understanding of the user input. These types could be identified by a decision tree to enable effective handling of the query. At present, the decision tree for identifying the type of complaint/ query from the student isn't included, and a simple NLP engine is used to process the input gathered from the user. [8] A NLP engine is incorporated in its simplest form to enable fast and efficient results using form and actions. The current implementation makes use of

AIML (Artificial Intelligence Modelling Language) for implementing the chatbot. This language is most suitable as it handles conditional input very well, with each form having a defined pattern and a template for the response. This helps the chatbot recognize the pattern using the defined AIML and respond accordingly. But the implementation using AIML has its drawbacks. A major one of them is the requirement of defined AIML to suit every possible type of input. This is practically impossible. Hence, a new implementation is required with an engine that handles freestyle unconditioned input and identifies the type of query and responds accordingly. This requirement can be effectively implemented by using the RASA framework. [6]

Overview of RASA Framework

The Rasa framework stands out as a versatile and open source toolkit for developing conversational AI applications, offering developers a robust platform to build chatbots and virtual assistants. At its core, Rasa emphasizes natural language understanding (NLU) and dialogue management, utilizing machine learning techniques to extract user intents and entities while optimizing dialogue flow through reinforcement learning. Integration with various messaging platforms facilitates real-time interactions, while custom actions enable developers to define tailored responses and execute specific tasks based on user inputs. Furthermore, Rasa's markdown-based format for training data annotation and model management streamlines the development process, supported by a vibrant community of developers contributing to its open-source ecosystem. [6]

In contrast to traditional bot development approaches, Rasa's structured dialogue format provides clarity and manageability, empowering developers to reason about dialogue complexity systematically. By separating dialogue generation from state tracking logic, Rasa ensures a clear understanding of cause and effect, enhancing debugging capabilities and overall maintainability. The framework's emphasis on triggers and target actions enables precise dialogue orchestration, minimizing ambiguity and facilitating seamless user interactions. With its customizable nature and active developer community, Rasa emerges as a major player in the domain of conversational AI, offering a comprehensive solution for creating intelligent dialogue systems that effectively understand and respond to natural language inputs.

Benefits of using an AI-driven chatbot

The Rasa framework presents a multitude of advantages for crafting conversational AI applications, such as chatbots and virtual assistants. Being open-source, Rasa fosters a collaborative environment where developers can freely access, modify, and contribute to the framework, driving innovation in conversational AI. This openness extends to customization, granting developers full control over tailoring dialogue flow, natural language understanding (NLU), and other components to suit the specific requirements of their applications. Moreover, Rasa offers flexibility in deployment, enabling chatbots to be seamlessly integrated into various platforms, including web applications and messaging platforms like Facebook Messenger and Slack, ensuring scalability to handle high volumes of users and conversations without compromising performance. [5]

Rasa's incorporation of machine learning techniques for NLU and dialogue management enhances its capabilities over time through continuous training and fine-tuning of models with real-world data. [11] Supported by a vibrant community of developers, Rasa users benefit from shared knowledge, best practices, and additional tools/extensions, accelerating development and troubleshooting processes. Additionally, Rasa prioritizes privacy and security by offering features like end- to-end encryption and compliance with data protection regulations, ensuring that user data is handled responsibly. Overall, the Rasa framework emerges as a potent tool for developers seeking to build sophisticated conversational AI applications capable of engaging users across diverse channels and domains with efficiency and intelligence. [8]

DESIGN AND IMPLEMENTATION

In the meticulous orchestration of the design and implementation phase, the foundational framework of the SPPU chatbot is meticulously crafted to cater to the multifaceted needs of its diverse stakeholders. [6] This pivotal stage embarks upon a journey of comprehensive requirement gathering, methodical conversational flow design, meticulous training with domain- specific data, and seamless integration of the RASA frame- work, ensconcing the chatbot within the intricate fabric of Savitribai Phule Pune University's operational ecosystem.

Gathering Requirements for the Chatbot

- Introduction to Requirement Elicitation: he corner-stone of the chatbot's development lies in the systematic extraction of requirements, a process essential for aligning its functionalities with the discernible needs and operational exigencies of diverse stakeholders.
- Stakeholder Identification: Prudent identification of stakeholders spanning prospective students, current students, faculty, administrative personnel, and institutional management, forms the bedrock of requirement elicitation, ensuring a holistic understanding of user expectations and preferences. [8]
- Use Case Analysis and Documentation: Methodical analysis and documentation of diverse use cases, ranging from admission inquiries to course enrollment, timetable management, event notifications, and beyond, lay the groundwork for a comprehensive functional blueprint.

Designing the Conversational Flow

- Intent Classification: Through meticulous intent classification and scenario formulation, diverse user queries and requests are anticipated and categorized, enabling the chatbot to navigate through varied dialogue paths adeptly.
- Precision in Response Templating: Methodically crafted response templates ensure the delivery of accurate, informative, and contextually relevant responses, fostering user satisfaction and trust in the chatbot's capabilities.
- Implementation of Branching Logic: The strategic incorporation of branching logic, guided by conditional statements, orchestrates the conversation flow adeptly, steering interactions towards desired outcomes while accommodating diverse user inputs and contextual nuances. [2]

Training the Chatbot with Domain-Specific Data

- Domain-Specific Insights: The chatbot's cognitive prowess is honed through the assimilation of domain- specific data, curated to encapsulate the intricacies of SPPU's academic and administrative landscape.
- Annotative Precision: Data annotation, characterized by precision in labeling intents, entities, and contextual cues, empowers the chatbot with the discernment needed to comprehend user inquiries and orchestrate meaningful interactions.
- Iterative Model Refinement: Through iterative model refinement, bolstered by machine learning methodologies, the chatbot's natural language understanding (NLU) and dialogue management faculties are continuously honed, enhancing responsiveness and accuracy.
- Performance Evaluation and Optimization: Rigorous performance evaluation, augmented by simulated conversations and real-world interactions, informs iterative optimization efforts aimed at elevating the chatbot's efficacy, relevance, and user satisfaction metrics. [3]

Integrating RASA Framework into the Chatbot

The integration of the RASA framework epitomizes a strategic choice, harnessing its versatility and robust architecture to underpin the chatbot's functionalities with cutting-edge natural language processing (NLP) capabilities. [3] Tailoring the RASA framework to align with SPPU's unique operational nuances necessitates meticulous customization efforts, ensuring seamless integration and optimal performance within the institutional ecosystem. Careful consideration of deployment strategies, encompassing on-premises hosting and cloud-based solutions, ensures alignment with institutional IT infrastructure and security protocols, facilitating scalable and sustainable deployment. The seamless integration of the chatbot with SPPU's existing systems, databases, APIs, and communication platforms engenders operational synergy, empowering users with swift access to pertinent information and services while augmenting administrative efficiency. [8]

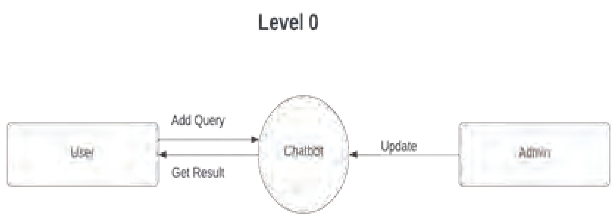

Fig. 1. Data flow diagram - Level 0

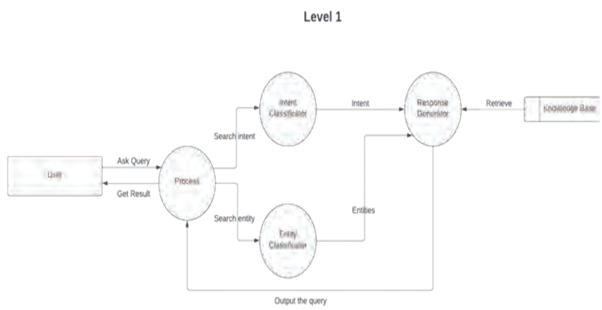

Fig. 2. Data flow diagram - Level 1

The above fig 1 and fig 2 depicts the movement of data from user inputs to the chatbot's natural language understanding (NLU) component for intent and entity extraction, then to the dialogue management component for determining appropriate responses

NATURAL LANGUAGE UNDERSTANDING (NLU)

Importance of NLU in Chatbot Development

Natural Language Understanding (NLU) is crucial in chatbot development as it enables the chatbot to comprehend and interpret user inputs in natural language. In the context of the Savitribai Phule Pune University chatbot, NLU allows the bot to understand queries related to various topics such as university information, departmental details, admissions, examinations, results, and other miscellaneous inquiries like sports and scholarships. By accurately understanding user intents and extracting relevant information from their messages, the chatbot can provide appropriate responses and assistance effectively. [1]

Preprocessing User Input for NLU

Before feeding user inputs into the NLU model, preprocessing is necessary to enhance the quality of the input data and improve the performance of the model. This involves tasks such as:

- Tokenization: Breaking down sentences into individual words or tokens.
- Normalization: Converting text to lowercase, removing punctuation, and handling abbreviations or synonyms to ensure consistency.
- Stopword Remova: Eliminating common words that do not carry significant meaning.
- Entity Recognition: Identifying and tagging specific entities such as department names, course titles, or dates mentioned in the input.
- Spell check : Correcting spelling errors to improve the accuracy of NLU predictions.

By preprocessing user input effectively, the chatbot can better understand the user's intent and extract relevant information for further processing.

Building NLU Models for Intent Recognition

In RASA framework, building NLU models for intent recognition involves creating training data, defining in- tents, entities, and configuring pipelines for training the model. [9] For the Savitribai Phule Pune University chatbot, the main intents identified are:

- About: Queries related to general information about the university, its history, mission, and vision.
- Contact: Queries regarding contact details such as ad- dress, phone numbers, or email addresses of various university departments or administrative offices.
- Departments: Queries about different academic departments within the university, their faculties, courses offered, and research areas.
- Admission: Queries related to admission procedures, eligibility criteria, application deadlines, and required documents.
- Examinations and Results: Queries concerning examination schedules, result announcements, grade inquiries, and examination-related procedures.
- Others (Sports, Scholarships): Miscellaneous inquiries including sports facilities, events, scholarships, and any other topics not covered under the main intents. For each intent, a sufficient

amount of annotated training data should be provided, consisting of examples of user utterances associated with that intent. These examples should cover various ways users may express the same intent. Additionally, entities such as department names, course names, or specific dates should be annotated within the training data to enable entity extraction. [7]

DIALOGUE MANAGEMENT

Dialogue Management

Dialogue management orchestrates the flow of conversations between the user and the chatbot. In the chatbot, dialogue management ensures smooth interaction by:

- Understanding User Intent: Identifying the user's intent based on their input (handled by NLU).
- Selecting Appropriate Responses: Choosing the most relevant response based on the detected intent and current conversation context.
- Maintaining Context: Remembering previous interactions and maintaining context throughout the conversation.
- Handling Multi-turn Interactions: Managing multi-turn conversations where the user may ask follow-up questions or provide additional information.
- Guiding the Conversation: Steering the conversation towards achieving the user's goals or answering their queries effectively.

Designing Dialogue Policies for User Interactions

Dialogue policies define the decision-making process of the chatbot during interactions with users. In the chatbot, dialogue policies determine:

- Response Selection: Choosing the appropriate response based on the user's intent and the current state of the conversation. For example, responding with information about university departments when the user asks about departments.
- Fallback Handling: Dealing with situations where the chatbot is uncertain about how to respond or when the user input is ambiguous.
- Context Management: Tracking the conversation con- text, such as maintaining information about the current topic or any relevant details mentioned by the user in previous turns.
- Conversation Flow: Defining the logical flow of the conversation, including handling branching paths based on user input or specific conditions.

Handling Context and State in the Chatbot

Maintaining context and state is crucial for ensuring coherent and relevant responses in chatbot interactions. [4]

- Context Tracking: The chatbot remembers previous interactions and maintains context throughout the conversation. For example, if the user asks about department details and then asks about courses, the chatbot provides course information related to the previously mentioned department.
- State Management: The chatbot keeps track of the current conversation state, including the user's intent, any entities mentioned, and the context of the conversation. This allows the chatbot to generate appropriate responses and handle user queries effectively.
- Session Management: Tracking session-level information such as user preferences, session history, or user authentication status to personalize the conversation and provide relevant assistance.
- Integration with External Systems: Redirecting users to external systems, such as the university website, to access detailed information like syllabus, courses, admission criteria, and timetables.

By effectively handling context and state, the chatbot provides personalized and relevant responses, leading to a more satisfying user experience. Integrating with external systems allows the chatbot to leverage existing resources and provide comprehensive information to users.

USER INTERFACE AND USER EXPERIENCE

Designing an Intuitive User Interface for the Chatbot

Designing an intuitive user interface (UI) for our university chatbot involved several key steps:

- Conversation Flow: We designed a logical conversation flow that guides users through different topics or actions they can take within the chatbot. We used visual tools like flowcharts or storyboards to map out the conversation paths.
- Interactive Elements: We incorporated interactive elements such as buttons, videos, and images to make the chatbot's UI more engaging and user-friendly. These elements help users navigate options and make selections easily.
- Visual Design: We paid attention to visual design elements such as color schemes to create a visually appealing UI that aligns with the university's branding guidelines.

Testing and Improving the User Interface

Testing and improving the user interface of your university chatbot is an ongoing process. Here are the steps that were considered:

- Usability Testing: We conducted usability testing with real users to gather feedback on the chatbot's UI, navigation, and overall user experience. We used this feedback to make iterative improvements.
- A/B Testing: We performed A/B testing to compare different UI designs or features and determine which ones are more effective in terms of user engagement and satisfaction.
- Rasa Testing: We tested the chatbot using rasa test commands as follows:
    1) rasa test,
    2) rasa test nlu

       –nlu data/nlu

       –cross-validation

       –folds 5

Integration with University System using Rasa Framework:

Connecting the Chatbot to University Databases: Integrating the chatbot with university databases involved the following two steps to ensure seamless data retrieval and interaction:

1) Database Connectivity: Used appropriate database connectors to establish a connection between the chatbot application and university databases.
2) Data Mapping: Mapped the chatbot's intents and user queries to corresponding database queries . Defined clear mappings between user intents (e.g., "Course Registration," "Exam Schedule," "Library Access") and the relevant database entities or services.[10]

Retrieving and Displaying Relevant Information: Once the chatbot is connected to university databases, it can retrieve and display relevant information to users based on their queries:

1) Query Processing: Processed user queries and extracted relevant parameters such as course names, student IDs, exam dates, etc., to formulate database queries .
2) Data Retrieval: Retrieved data from university databases based on the formulated queries. Handled data retrieval asynchronously to maintain responsiveness and optimize performance.
3) Real-time Updates: Implemented mechanisms to fetch real-time updates from databases (e.g., live event schedules, announcements) and display them to users dynamically.

DEPLOYMENT AND MAINTENANCE

Deploying the Chatbot on a Web Platform

- Seamless Web Deployment: The transition from development to deployment encompasses the meticulous orchestration of the chatbot's integration into a web-based platform, ensuring ubiquitous accessibility and enhanced user engagement.
- Platform Selection and Configuration: Prudent selection of a suitable web platform, complemented by meticulous configuration to accommodate

the chatbot's operational requirements, lays the groundwork for a seamless deployment experience.

- Integration and Testing: Rigorous integration testing, bolstered by iterative refinement, ensures seamless interoperability between the chatbot and the chosen web platform, fostering a cohesive user experience across diverse digital touchpoints.
- User Accessibility and Interface Optimization: Prioritizing user accessibility and interface optimization, the chatbot's deployment on a web platform is characterized by intuitive design elements and user-friendly navigation, fostering user adoption and satisfaction.

Monitoring and Analyzing Chatbot Performance

- Proactive Performance Monitoring: Vigilant oversight of the chatbot's performance metrics, encompassing response times, user satisfaction ratings, and conversation completion rates, forms the cornerstone of effective performance management.
- Real-Time Monitoring Tools: Leveraging real-time monitoring tools and analytics platforms enables stake- holders to gain actionable insights into chatbot performance, facilitating informed decision-making and continuous improvement initiatives.
- Performance Analysis and Trend Identification: Systematic performance analysis, augmented by trend identification and root cause analysis, empowers stakeholders to proactively address performance bottlenecks and optimize user experiences.
- Iterative Performance Enhancement: Embracing a culture of continuous improvement, iterative performance enhancement initiatives are informed by data-driven insights, driving enhancements in responsiveness, accuracy, and user satisfaction metrics.

CONCLUSION

The research paper presents the AI-powered chatbot developed for Savitribai Phule Pune University, highlighting its potential to transform user experiences both within the university community and beyond. Through its ability to provide tailored responses, personalized assistance, and streamlined support, the chatbot enhances overall user satisfaction among students, faculty, staff, and visitors. Additionally, serving as a centralized repository of essential university information, the chatbot improves information retrieval efficiency and promotes accessibility for users with diverse backgrounds and abilities. [8] Furthermore, the chatbot's availability around the clock ensures uninterrupted assistance regardless of users' geographical location or time zone. Its implementation also promises cost savings through automation of tasks and reduced reliance on human support staff, while providing valuable insights into user behavior and preferences through data analytics. Additionally, the chatbot's potential for seamless integration with existing university systems and services opens up possibilities for expanded functionalities and collaborations with other academic institutions. Leveraging advancements in artificial intelligence (AI) and natural language processing (NLP), the chatbot continually evolves, positioning itself as a pioneering solution in the field of conversational AI within the academic domain.

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Indigenous Developed Smart Surveillance Camera for Military Purpose

Mandar Ajay Javadekar
✉ mandar_javadekar@moderncoe.edu.in

Nidhi Pankaj Hiran
✉ nidhi_hiran@moderncoe.edu.in

Srushti Shailesh Apte
✉ srushti_apte@moderncoe.edu.in

Shreyasi Watve
✉ shreyasi.watve@moderncoe.edu.in

Department of Electronics and Telecommunication
Progressive Education Society's
Modern College of Engineering
Pune, Maharashtra

ABSTRACT

The Smart Camera for Military Surveillance is a cutting-edge technological advancement designed to augment situational awareness and bolster security measures in military operations. This innovative system integrates state-of-the-art hardware and advanced software algorithms to provide real-time intelligence, threat detection, and seamless integration with existing military infrastructure.

Smart cameras for military surveillance are a new and rapidly developing technology. These cameras use artificial intelligence (Al) and machine learning (ML) to detect and identify objects and people of interest, even in challenging conditions such as low light or fog. Smart cameras can also be used to track targets and generate real-time alerts, helping the military to improve its situational awareness and respond to threats more quickly and effectively.

How hardware and software can be combined into a complete vision system that introduces the possibilities of computer vision.

KEYWORDS: *Artificial Intelligence, Military surveillance.*

INTRODUCTION

In an era marked by dynamic security challenges, the imperative for advanced surveillance technologies in the military domain has never been more critical. The advent of the Smart Camera for Military Purpose stands as a watershed moment in bolstering situational awareness and fortifying defence strategies. This groundbreaking system combines cutting-edge hardware and sophisticated software algorithms to deliver a comprehensive and adaptive surveillance solution tailored specifically for military applications. [1]

The Smart Camera represents a paradigm shift in visual intelligence, harnessing the power of state-of-the-art image sensors and optics to capture high-fidelity visuals across a spectrum of environmental conditions. Its Pan-Tilt-Zoom (PTZ) functionality empowers operators with precise control, enabling them to focus on critical areas of interest while maintaining an expansive field of view. Moreover, the integration of advanced artificial intelligence and machine learning algorithms equips the camera with the ability to autonomously identify and track objects of interest, a capability that vastly enhances the efficiency and effectiveness of surveillance operations. [2]

This system is not only equipped with standard imaging capabilities, but also incorporates cutting-edge technologies such as infrared and thermal imaging, extending its operational capacity into low-light and adverse weather scenarios. Furthermore, its seamless integration with existing military infrastructure and stringent data encryption protocols ensure a secure and rapid dissemination of critical information to command centers, enabling timely decision making in dynamic operational contexts. Smart cameras are getting an increasing number of famous in Military packages because of their capacity to offer real time situational attention and intelligence These cameras are ready with superior functions which include synthetic intelligence, high-overall performance zoom, and gimbal steady cam and tilt capabilities. They also can be remotely managed or fly autonomously the usage of software managed flight plans of their embedded systems Here are a few approaches wherein clever cameras are being utilized in Military packages: [3]

i. Surveillance: Smart cameras may be used to display and tune enemy movements, in addition to hit upon and pick out ability threats

ii. Targeting: Smart cameras may be used to pick out and tune targets, offering treasured facts to navy employees

iii. Intelligence gathering: Smart cameras may be used to acquire intelligence on enemy positions, movements, and activities

iv. Search and rescue: Smart cameras may be used to find and rescue employees in risky or hard-to-attain areas

Overall, clever cameras are a treasured device for navy employees, offering them with real-time facts and intelligence that may assist them make higher choices and live secure with inside the field. [4]

In this introduction, we set the stage for the transformative potential of the Smart Camera for Military Purpose, emphasizing its role as a force multiplier in modern military operations. By enhancing situational awareness, threat detection, and response capabilities, this innovative system heralds a new era in military surveillance technology, ultimately fortifying the security and effectiveness of defence operations [5]

RESEARCH REVIEW

Recent research has shown marked improvements in surveillance efficiency through the adoption of AI and ML technologies. For example, convolutional neural networks (CNNs) have been effectively used for object detection and image classification, enhancing the ability to recognize potential threats in real-time. A study by Zhang et al. (2022) revealed that AI-powered cameras could accurately detect and track targets even in adverse conditions like poor visibility and dynamic backgrounds. Additionally, improvements in sensor technology have led to higher resolution imaging and better performance in low-light conditions, further enhancing the effectiveness of smart surveillance systems.

Effects

The use of smart cameras in military surveillance provides several benefits. Firstly, it improves real-time situational awareness, enabling military personnel to make quicker and more informed decisions. Secondly, automating threat detection reduces the cognitive load on operators, allowing them to concentrate on critical tasks. Furthermore, the ability to function in diverse environmental conditions ensures continuous monitoring and protection of sensitive areas. However, relying on AI and ML also poses challenges related to data privacy and the need for robust cybersecurity measures to prevent unauthorized access and tampering.

Motivation

The main motivation for developing the Indigenous Smart Camera for Military Surveillance is to enhance national security through advanced technology. By creating a system tailored to specific military needs, we aim to reduce dependence on foreign technology, ensuring better control over the security and customization of the surveillance infrastructure. Additionally, the ability to quickly detect and respond to threats is vital in modern warfare, where information superiority can significantly impact outcomes.

Problem Statement

Current military surveillance systems often struggle with real-time threat detection and adaptability to different environments. There is a need for an advanced surveillance solution that integrates AI and ML to provide accurate, real- time intelligence in various operational conditions. The Indigenous Smart Camera for Military Surveillance addresses this need by combining advanced hardware and software technologies.

Objectives

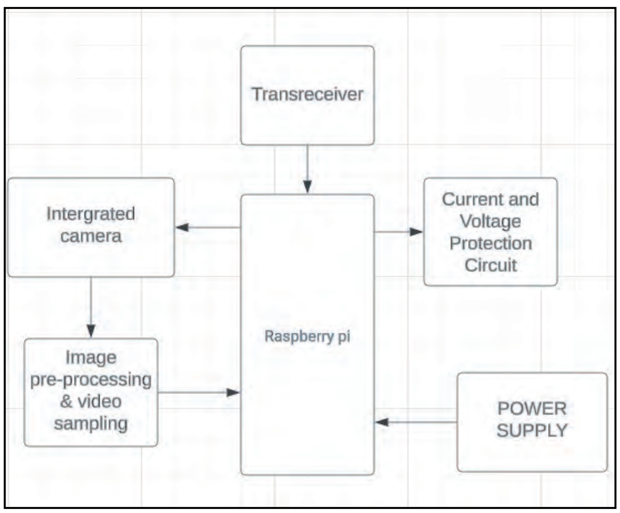
Develop a smart camera system that uses AI and ML for real-time threat detection and identification.

Ensure the system operates reliably under various environmental conditions, including low light and adverse weather.

Seamlessly integrate the system with existing military infrastructure, enabling smooth operation and data sharing. Enhance situational awareness and decision-making capabilities of military personnel through automated surveillance.

METHODOLOGY

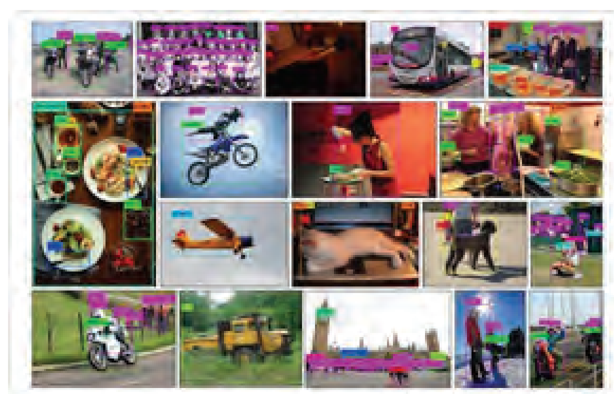
Block Diagram



Algorithm for Object Detection Model Training

The methodology for developing a smart surveillance camera for military applications using YOLOv8 involves several key stages. Initially, YOLOv8, an object detection algorithm, is utilized to process images in real-time by segmenting them into a grid and predicting bounding boxes and class probabilities for each grid cell. Subsequently, a diverse dataset of images relevant to military surveillance scenarios is collected and annotated with bounding boxes around objects of interest using labeling tools. Following data collection, images are preprocessed by resizing them to the required input size, normalizing pixel values, and preparing annotations in the YOLO format for training. The YOLOv8 architecture is then initialized, and the model is fine-tuned on the annotated dataset using transfer learning and optimization techniques such as stochastic gradient descent. After training, the model's performance is evaluated on a separate validation set, and hyperparameters are fine-tuned based on evaluation results. The trained YOLOv8 model is integrated into the smart surveillance camera system Enabling real-time inference on video streams and the development of a user interface for system monitoring and control. Extensive testing and validation are conducted in both simulated and real-world military environments to ensure the system's performance under various conditions. Furthermore, optimization measures are implemented to enhance resource utilization and security, and the entire development process is thoroughly documented in a detailed report, including dataset creation, model training, deployment, and testing, with insights into challenges faced and recommendations for improvement. Adherence to ethical guidelines and regulatory requirements related to surveillance technology and data privacy is emphasized throughout the project. This comprehensive approach ensures the creation of a robust smart surveillance camera system tailored for military purposes, leveraging the capabilities of YOLOv8 for effective object detection and classification.

Object Detection Training Database Sample.



For object detection 1256 images were used from COCO

COMPARATIVE ANALYSIS

When comparing traditional surveillance cameras to indigenously developed smart surveillance cameras, several crucial factors come into consideration, including image resolution, processing capabilities, data management, and application efficiency.

i. Image Resolution: Traditional surveillance cameras usually have resolutions between 1.3 MP to 2 MP, which suffices for general monitoring. They capture clear images in well-lit environments but may struggle in low-light conditions. In contrast, indigenously developed smart surveillance cameras often have higher resolutions, such as 5 MP or more, offering finer detail for tasks like facial recognition and license plate identification.

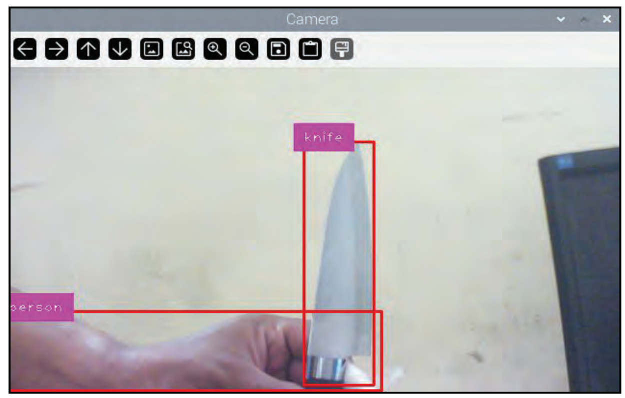
ii. Processing Capabilities: Traditional surveillance cameras primarily capture images and rely on external systems for processing and analysis, which can introduce latency as data must be transmitted to and processed by a central unit. Conversely, smart surveillance cameras come with onboard processing capabilities, enabling real- time analysis and decision-making. This reduces latency and enhances system responsiveness.

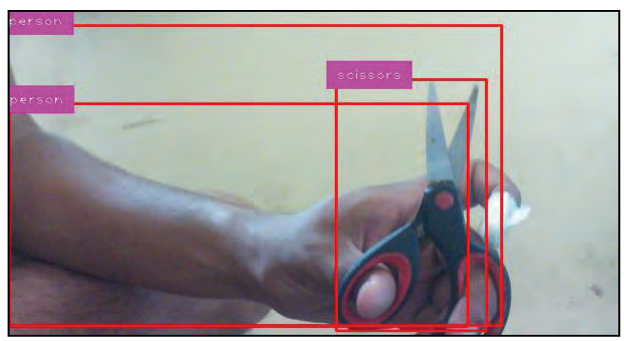
iii. Data Management: Traditional surveillance camera data is typically stored on external servers or cloud platforms, necessitating robust network infrastructure and ample storage solutions. Continuous data transfer, especially for high-resolution or high-frame-rate footage, can strain network resources. Indigenously developed smart surveillance cameras often use edge computing, processing, and filtering data locally before transmission. This reduces network load and storage demands, enhancing system efficiency and cost-effectiveness.

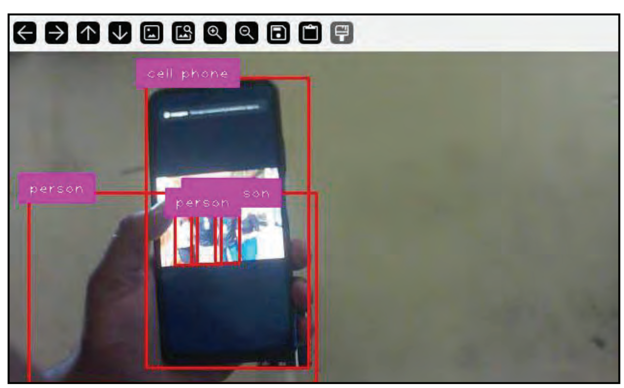
iv. Application Efficiency: Traditional surveillance cameras are effective for basic security monitoring, providing visual records for later review but often requiring human intervention for footage interpretation. Smart surveillance cameras, with advanced processing and analytical capabilities, can automatically detect and respond to specific events such as intrusions, unattended objects, or abnormal behaviors. These cameras can send real-time alerts, allowing for immediate action and improving overall security effectiveness.

Indigenously developed smart surveillance cameras offer significant advantages over traditional surveillance cameras in terms of resolution, processing efficiency, data management, and application functionality. While traditional cameras are useful for straightforward monitoring tasks, smart cameras provide a more sophisticated and responsive solution, ideal for modern security applications requiring real-time analysis and automated responses. The choice between these camera types should be based on the specific needs of the surveillance system, including the required detail level, processing capabilities, and network infrastructure.

RESULT







YOLOv8 is known for its remarkable accuracy in object detection tasks, often attaining high levels of precision and recall. Across a range of benchmark datasets and real-world applications, YOLOv8 consistently delivers superior performance in detecting objects of interest with minimal occurrences of false positives and false negatives. Its capability to process images in real-time while upholding high accuracy renders it a favored option for applications necessitating swift and dependable object detection. Furthermore, the architectural enhancements in YOLOv8 over its predecessors significantly contribute to its improved accuracy, guaranteeing reliable detection across various scenarios and under challenging conditions.

In addition to its accuracy, YOLOv8 also excels in efficiency, allowing for rapid inference on a wide range of hardware platforms. Its optimized architecture enables seamless deployment in resource-constrained environments without compromising performance. Moreover, YOLOv8's robustness to occlusions and varying lighting conditions further enhances its suitability for real-world applications, ensuring consistent performance even in complex scenarios. Overall, YOLOv8 stands out as a versatile and reliable solution for object detection across diverse domains, setting a new standard in the field of computer vision.

CONCLUSION

The Indigenous Developed Smart Camera for Military Surveillance represents a significant leap in military technology, combining AI and ML to provide enhanced situational awareness and threat detection. This system overcomes the limitations of traditional surveillance methods, offering a robust solution that adapts to diverse operational environments. Future research will focus on further improving the system's accuracy and expanding its capabilities to cover a broader range of scenarios.

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Gear Error Detection using Image Processing

Mayuri D. Thombare
✉ mayuri.9j@gmail.com

Suvarna Pule
✉ Suvarna Pule

Department of E&TC Engineering
Keystone School of Engineering
Pune, Maharashtra

ABSTRACT

A sampling method for obtaining representative data from a group involves inspecting only a small subset of items. For instance, in manufacturing, one might examine only 2 or 3 gears from a batch of 100 due to time constraints. However, to ensure thorough quality control, every gear in the batch must be checked, which can be impractical physically. In our project, we are developing a system that addresses this challenge. Our design incorporates a conveyor belt to facilitate the movement of gears, a camera for capturing and assessing gear parameters stored in the backend. The system examines each gear individually. If the parameters match the stored criteria, the gear is sorted into the accepted lot. In cases where a discrepancy is detected, a shooting mechanism is employed to divert the gear to the rejected lot. This ensures a comprehensive inspection of every gear in the batch without compromising efficiency.

KEYWORDS: *Automation, Mechanism, Image processing, Detecting, Sensor, Dimension, Energy saving.*

INTRODUCTION

Gear manufacturing, an indispensable element of machinery production, is an intricate process that underpins the functionality of countless mechanical systems, from automobiles and industrial machines to marine vessels and power plants. However, the gear production industry faces a critical real-time challenge: ensuring the quality and precision of gears while managing the ever-increasing demand for efficiency and cost- effectiveness. Traditional methods of gear inspection, often reliant on manual labour, are not only time-consuming but also prone to human error, potentially leading to the rejection of entire batches of gears due to a single fault.In addressing this dilemma, our project arises as a solution that bridges the gap between the necessity for meticulous gear inspection and the imperative to enhance efficiency. The accuracy and precision of inspection rely entirely on the operator's ability to identify defects in gears [5].

The calculation of essential features in gear design involves determining the outer diameter (addendum diameter) and inner diameter (dedendum diameter) to ensure proper meshing. Additionally, counting the number of teeth in the gear image object is crucial for accurate analysis. Tooth height calculation is necessary for determining the functional aspects of the gear. Furthermore, calculating the pitch circle diameter (PCD) and module of the gear are fundamental parameters for designing gears with precise dimensions and performance characteristics.

These features collectively contribute to the overall functionality and reliability of the gear system [6]. The heart of our endeavour lies in leveraging a fusion of cutting-edge technologies, primarily image processing and machine learning. The existing methods of gear measurement, often cumbersome and costly, struggle to simultaneously and accurately measure all gear parameters while curtailing measurement time. Our goal is to transform gear quality control by implementing computer vision technology, establishing a non-contact and swift measurement system capable of inspecting the majority of spur gear parameters with unparalleled accuracy and speed. This innovation not only pledges to reduce inspection time but also to enhance the overall precision of the process.

RELATED WORK

Jia-Xian Jian et al [1] In this paper, the authors address the challenge of costly gear defect detection equipment, which is beyond the financial reach of many small and medium-sized enterprises. They propose a cost-effective and efficient method for gear defect detection, leveraging artificial intelligence (AI) technology. The method is designed to detect defects in gear tooth profiles, tooth pitches, and central holes. The approach involves a four-step process, utilizing deep learning models such as ResNet for image completeness classification, YOLOv4 for target area detection, and UNet for target segmentation. The authors utilize data augmentation and attain high accuracy in the ResNet image classification, YOLOv4 target detection, and UNet target segmentation tasks. The experimental results show a 91% accuracy in detecting gear defects, demonstrating the feasibility and efficiency of this AI-based approach for gear quality assessment.

Zhenxing Xu et al [2] This paper presents a novel approach for defect detection in gear parts within virtual manufacturing systems using deep learning techniques. The authors address the challenge of acquiring images of gear tooth defects due to the non-convex nature of the gear surfaces. Their proposed method involves constructing a 3D gear dataset with various types of defects, including fracture, pitting, glue, and wear. They introduce a specialized deep learning network named Gear-PCNet++, which integrates a Combinational Convolution Block (CCB) to efficiently extract local gear information and complex topology. The study compares their approach with other methods and demonstrates its superior efficiency and practicability in recognizing gear defects. The authors also emphasize the importance of using point cloud representations to avoid texture-related confusion in defect detection.

Xin Li et al [3] The paper presents a method for detecting anomalies in gear shafts, addressing the critical need for fault diagnosis in challenging operational conditions. The methodology combines time synchronous averaging (TSA) for processing vibration signals, autoregressive (AR) modeling for calculating residual errors, and discrete wavelet transform (DWT) for improving signal analysis. The study employs test data from a mechanical fault diagnosis test bed, featuring speed and torque data from a gearbox. Various statistical features are extracted from the AR-modeled data; however, the paper acknowledges the need for further analysis to accurately identify gear shaft failure, without specifying precise criteria or thresholds. The paper concludes by discussing the method's limitations and challenges. While it offers a valuable approach to gear shaft anomaly detection, further research and application-based results are necessary to fully evaluate its practical significance.

Milica Babica et al [4] In this paper, they conduct a comprehensive literature review analysing image-based quality inspection systems in SMS over the last decade. It will particularly focus on how image-based, in-situ quality inspection of three-dimensional parts is currently conducted. The results will offer an overview of the various image-based quality inspection approaches, highlighting their advantages and challenges, along with specific application areas and/or industries. In this work they focus on the latter, modern image- based quality inspection systems and processes. Over the past decade, vision-based quality inspection has experienced a surge in applications and academic attention, in line with the emergence of Industry 4.0. Digital camera systems, comprising optics, sensors, and connectivity, have become increasingly powerful yet more cost-effective. Simultaneously, analytics, particularly artificial intelligence and machine learning algorithms, have made significant strides in terms of performance and accessibility. Notably, deep neural networks and deep learning have propelled computer vision's potential in quality inspection applications to new heights.

PROPOSED METHODOLOGY

Initially, we will design a gear profile error detector that is suitable for our application. Designing the conveyor belt requires careful consideration of the applications and operational conditions to ensure optimal performance. gear error final flow chart.jpg.png Next, we will assess the design in ANSYS under static and dynamic conditions. In theory, we will compare the basic operational parameters of the designed gear profile error detector. By using MATLAB software, we will do the programming of the error. In the gear detection process, the initial step involves utilizing an IR sensor to identify the gear or object. The IR sensor sends input signals to the ATMEGA328P circuit, which regulates the speed of both motors and introduces delays in motor operation. When

the IR sensor detects the gear, the ATMEGA328P circuit initiates a delay of 2 seconds, calculated based on the conveyor speed. Once the gear is positioned beneath the camera, an image is captured and transmitted to MATLAB. MATLAB, equipped with image processing techniques, processes the image to facilitate automated operations and comprehensive inspection of each gear. MATLAB calculates gear parameters by converting the original image to grayscale, determining the threshold value, transforming the image into binary, and then inverting it to highlight the region of interest. Subsequent steps involve removing small objects, filling holes, and eliminating unnecessary parts, focusing solely on the gear parameters such as teeth. In the microcontroller IC, a program is embedded to control the gun motor and conveyor motor. After scanning all gear parameters, the conveyor motor will start if MATLAB signals (1), indicating everything is in order. In such cases, the conveyor motor continues running, while the gun motor remains inactive. Conversely, when MATLAB signals (0), the conveyor motor stops after a calculated delay of 2 seconds, considering the distance between the camera and gun motor, along with conveyor speed. Motor control operations are programmed into the microcontroller IC, executing necessary commands if all gear parameters are satisfactory. This system- atic process systematically examines each gear employing the described method.

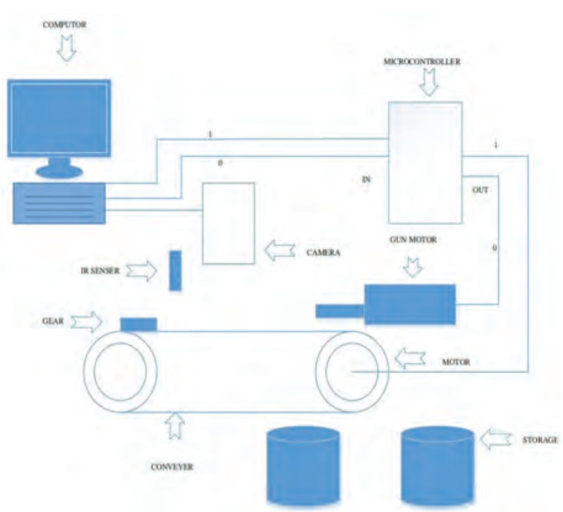

Fig. 1. Experimental Setup

FLOW CHART

The gear inspection process follows a structured flow, be- ginning with initialization to prepare the system for operation. Once initialized, the camera setup phase configures the camera for image acquisition. Subsequently, an image is captured, and the acquired image undergoes processing in the image processing stage. This processing typically involves tasks such as converting the image to grayscale and applying threshold techniques. Following image processing, the system evaluates whether any defects are present in the processed image. If no defects are detected, the process concludes. However, if a defect is identified, the system proceeds to address it accord- ingly, possibly initiating a separation procedure. Finally, upon completion of the necessary actions, the inspection process ends. This structured flow ensures a systematic approach to gear inspection, facilitating efficient defect detection and resolution while maintaining overall operational integrity.

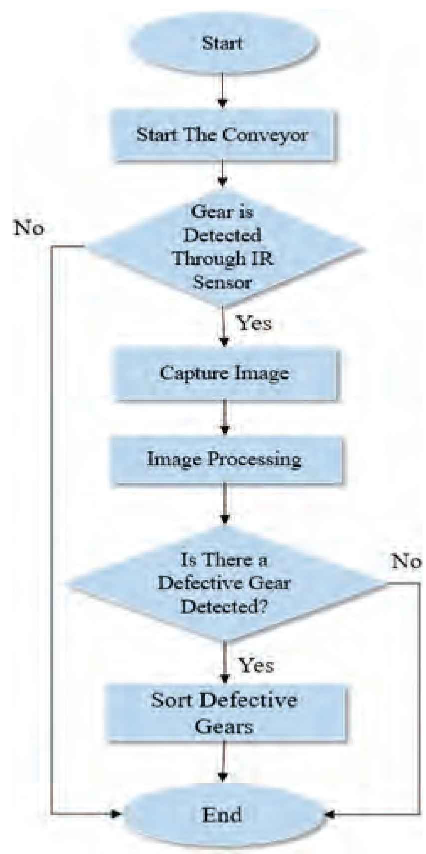

Fig. 2. Flow Chart

RESULT

In fig 3, when examining gears without defects, the system accurately identifies them as ”right gears.” This means that the gears are in good condition and suitable for use in mechanical systems. We use MATLAB’s image processing tools to analyze the images of these gears, focusing on features like tooth surfaces and area ratios to ensure their integrity.

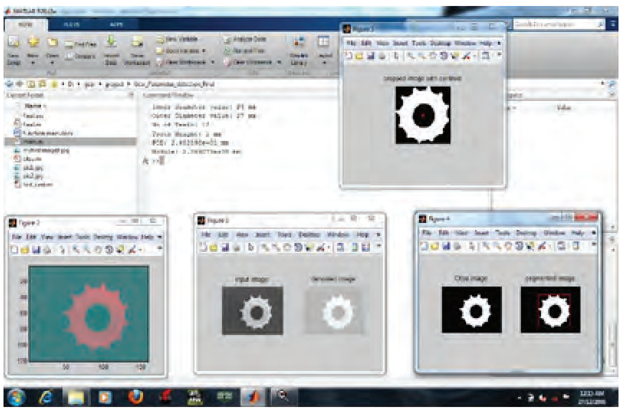

Fig. 3. Right gear result

In fig 4, The system detects defects in gears, it categorizes them as ”defective gears.” These defects could include issues like corrosive pitting or attrition, which can compromise the gear’s functionality. By employing advanced image processing techniques, we swiftly identify these defects, enabling timely maintenance or replacement of the affected gears.

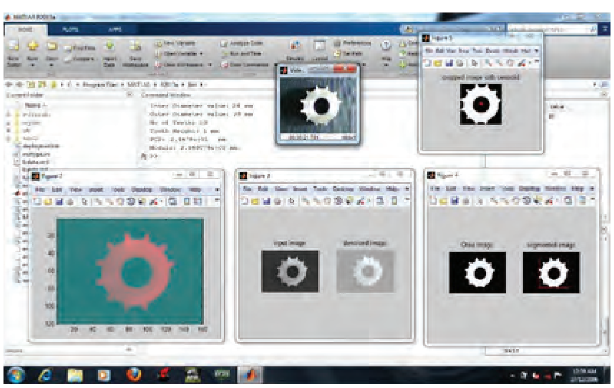

Fig. 4. Defective gear result

Above images are MAT-Lab from the module which shows Defective and Non-Defective Results. The model was trained by the gear size of outer diameter and number of teeth. In the event of a non-defective image, the module displays the outer diameter value in millimeters and the tooth count, as provided by the camera. Consequently, a non-defective message is shown. Conversely, for a defective image, the outer diameter is measured as well as the number of teeth, which are determined to be 113 and 19, respectively. As these values do not match those of a non-defective image, a defective message is displayed, and the item is separated from the conveyor using a separator.

CONCLUSION

In conclusion, integrating machine learning for gear defect detection represents a promising approach to improve main- tenance procedures in industrial applications. Machine learn- ing algorithms offer advantages over conventional methods, including early defect detection and adaptability to changing operating conditions. This approach has the potential to reduce downtime, lower maintenance costs, enhance safety and reli- ability, ultimately contributing to increased productivity and financial success.

FUTURE SCOPE

In the future, this project can be expanded by integrating it into real-world applications across various industries. This could involve collaborating with manufacturing companies to implement the developed gear defect detection system on their production lines. By integrating the system into existing manufacturing processes, it can help ensure the quality and reliability of manufactured components, leading to improved product performance and customer satisfaction. Additionally, further research and development can be conducted to en- hance the capabilities of the system, such as increasing its accuracy, speed, and scalability. This may involve exploring advanced image processing algorithms, incorporating machine learning techniques for predictive maintenance, and optimizing hardware components for robustness and reliability in indus- trial environments. Moreover, the project can be extended to other domains beyond manufacturing, such as automotive, aerospace, and medical industries, where gear components play a critical role.

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Indoor Vehicle Tracking Using GPS and 4G

Shlok Bagmar
Akshada Nangare
Dept. of E&TC
PVG's COET(of SPPU)
Pune, Maharashtra
✉ shlokbagmar@gmail.com
✉ akshadanangare31@gmail.com

Omkar Javarat
Dept. of E&TC
PVG's COET(of SPPU)
Pune, Maharashtra
✉ omkardjavarat200227@gmail.com

Madhavi Belsare
PVG'S COET & GKPIOM
Pune, Maharashtra
✉ mhb_entc@pvgcoet.ac.in

ABSTRACT

This paper presents the design and implementation of an advanced warehouse vehicle tracking and monitoring system, addressing the limitations of the existing 3G technology. Leveraging a 4G LTE module and GPS, the system offers real-time tracking capabilities with enhanced reliability and connectivity. It utilizes a microcontroller and a GPS antenna to accurately track the vehicle's location within the warehouse premises. Unlike the previous system, which encountered latency and connectivity issues due to reliance on 3G technology, this system ensures seamless data transmission over the cellular network. Additionally, the system integrates proximity sensors to monitor the vehicle's speed and distance travelled, providing comprehensive insights into vehicle activity. The collected data is securely transmitted to a central server and stored in a database for remote monitoring and visualization. A user-friendly website interface facilitates easy access to the tracked data, enabling efficient management of warehouse operations.

KEYWORDS: *Vehicle tracking, GPS, 4G LTE, Proximity sensor, Warehouse management.*

INTRODUCTION

In today's fast-paced world, the efficient and effective management of warehouse operations is critical for businesses to remain competitive. One key aspect of warehouse management is the monitoring of vehicles used for transporting goods within the warehouse. To address this need, a vehicle monitoring system based on Internet of Things (IoT) and 4G LTE technology has been developed. This paper explores the key components of such a system and investigates how the integration of IoT and 4G LTE technology can enhance the efficiency and effectiveness of the vehicle monitoring system in a warehouse. Additionally, potential challenges and limitations associated with implementing such a system in a warehouse environment will be discussed. By exploring these aspects, this paper aims to provide a comprehensive understanding of the benefits and challenges of implementing a vehicle monitoring system based on IoT and 4G LTE technology in warehouse operations. Existing literature on warehouse management systems (WMS) highlights the importance of real-time vehicle location data. Studies have explored various tracking technologies, including Radio Frequency Identification (RFID) and Wi-Fi-based solutions. However, these meth- ods have limitations: RFID: Requires extensive infrastructure setup and suffers from limited signal range within warehouses with metal structures. Wi-Fi: Coverage limitations exist in large warehouses, and signal strength can be inconsistent. The vehicle monitoring system based on IoT and 4G LTE employs sensors, wireless technologies, and GPS/OBD II sensors to collect data on vehicle coordinates, speed, and condition. This data is transmitted to a remote server for processing. Real-time monitoring enables fleet managers to track vehicle locations and optimize deployment for safety and timely deliveries. The system offers safety protection, tracking, and monitoring. It aims to enhance logistics efficiency, safety, and customer experience, promoting industry digital transformation. With its real-time capabilities and low-cost setup, the system facilitates quick error detection and correction, utilizing near real- time data processing. Integration of hardware and software solutions is essential for its implementation. The integration of IoT and 4G LTE technology has revolutionized vehicle monitoring systems in warehouses, improving both efficiency and effectiveness. This integration enables real-time tracking of vehicles and assets, streamlining processes such as stock monitoring, asset storage, and transmission. BLE (Bluetooth Low Energy) Beacons aid in asset management, while IoT- enabled sensors provide access to GPS trackers for vehicle monitoring. Real-time notifications allow better process management and reduce idling time, leading to lower emissions and fuel usage. Additionally, IoT facilitates monitoring vehicle component performance, enabling timely maintenance. Data collection and analysis enable quick decision-making for fleet managers, while connectivity to the cloud enhances system effectiveness. Overall, IoT and LTE integration significantly enhance the efficiency and effectiveness of warehouse vehicle monitoring systems.

LITERATURE SURVEY

In the paper ”Sensor Fusion for Indoor Navigation and Tracking of Automated Guided Vehicles,” sensor fusion technology, particularly combining UWB tags and inertial units, is utilized for high-precision positioning and predictive tracking of automated guided vehicles (AGVs). The study demonstrates a significant reduction in position and orientation errors compared to Ubisense technology, showcasing the efficacy of sensor fusion technology.[1]The research paper ”TrackIn- Factory: A Tight Coupling Particle Filter for Industrial Vehicle Tracking in Indoor Environments” introduces a Particle Filtering Unit coupled with Wi-Fi fingerprinting to achieve precise indoor vehicle tracking. Despite higher computational resource requirements, the particle filtering approach significantly reduces positioning errors compared to pure dead reckoning methods.[2]In ”Sensor-Fusion and Tracking Method for Indoor Vehicles With Low-Density UHF-RFID Tags,” the integration of sensor fusion technology with low- density UHF-RFID tags results in superior tracking accuracy compared to pure odometry units. This method showcases remarkable precision, achieving a mere 10cm error over a 48m track.[3]The paper ”EasiTrack: Decimeter-Level Indoor Tracking With Graph-Based Particle Filtering” presents a cost- effective system for achieving sub-meter accuracy in indoor vehicle tracking. Through innovative techniques like antenna alignment and focus ball methods, combined with IMU for orientation tracking, the system demonstrates high accuracy even in both line-of-sight (LOS) and non-line-of-sight (NLOS) conditions.[4]In ”Integrated UWB/IMU system for high rate indoor navigation with cm-level accuracy,” the integration of low-cost inertial sensors with UWB radio ranging units is explored for indoor navigation. While the system exhibits cm- level accuracy and low latency, testing in larger areas with obstacles is yet to be conducted.[5]The paper ”Improvement of GPR tracking by using inertial and GPS combined data” proposes enhancing Ground Penetrating Radar (GPR) accuracy through GPS and IMU integration.[6]”RFID Technology for Vehicle Tracking Using Hybrid Kinematic Integration and Positioning Algorithm” introduces an RFID-based system for vehicle tracking, utilizing RFID tags at intersections to estimate vehicle speed and predict future locations with high accuracy and low processing time.[7]”Effective Position Tracking Using B-Spline Surface Equation Based on Wireless Sensor Networks and Passive UHF-RFID” discusses utilizing passive RFID tags for indoor tracking, offering an alternative to active tags. [8]”Evaluating a Novel Bluetooth 5.1 AoA Approach for Low-Cost Indoor Vehicle Tracking via Simulation” explores Bluetooth 5.1 specifications for indoor vehicle tracking, achieving up to 1m accuracy with beacons placed every 3.2m. [9]The paper titled ”Intelligent Vehicle Positioning Method Based on GPS/Lidar/Derivative Data Fusion” presents a fusion method using GPS and LiDAR data to create smooth vehicle tracks, minimizing errors even when signals from both sources are lost simultaneously. [10]”A Survey on Indoor Vehicle Localization Through RFID Technology” provides an overview of RFID technologies for vehicle tracking, including RFID-only tracking, RFID with sensor fusion, and RFID with optical sensor fusion.[11]In ”ANALYSIS OF AN INDOOR POSITIONING SYSTEMS,” BLE technology is highlighted for its superior performance in indoor tracking compared to WiFi.[12]The paper

”GPS Based Vehicle Tracking Sys- tem” discusses a vehicle tracking system using GSM and separate GPS modules, with latency varying between out- door and indoor environments. [13]”Studying the Use and Utility of an Indoor Location Tracking System for Non- experts” explores powerline positioning systems. [14]”SMART VEHICLE TRACKING SYSTEM” describes a simple GSM- based GPS tracking system, noting its limitations in speed and capacity. [15] ”A multi-sensor indoor tracking system for autonomous marine model-scale vehicles” presents a track- ing system for marine-scale models using LiDAR, a GigE camera, and ArUco markers. [16] ”Indoor vehicle tracking with a smart MEMS sensor” utilizes dead reckoning with IMU sensors and wheel encoders for 2D position tracking.

[17]”Localization and Tracking of an Indoor Autonomous Vehicle Based on the Phase Difference of Passive UHF RFID Signals” proposes a novel RFID-based localization and tracking scheme achieving centimeter-level accuracy.[18] The paper ”Microcontroller-Based Vehicle Tracking System Using GPS and GSM Module: A Mini Review” describes a simple GSM-GPS-based tracking system.[19] ”A Review on GSM and GPS Based Vehicle Tracking System” provides a survey of vehicle tracking techniques using GSM & GPS, emphasizing GPS technology’s common usage. Each paper offers insights into various techniques and technologies for indoor vehicle tracking, highlighting their strengths, limitations, and potential applications. [20]

Through a comprehensive literature review, we have identified that current indoor vehicle tracking systems commonly utilize LiDAR and RFID technologies. However, these systems often suffer from limitations in computational requirements and complexity of implementation. Our proposed system ad- dresses and overcomes these challenges, offering enhanced precision and simplified deployment.

SYSTEM ARCHITECTURE

The system consists of three main components: the vehicle- mounted hardware unit, the centralized server, and the user interface. Figure 1 illustrates the architecture of the system.

Figure 1: System Architecture In the existing system outlined in [21], it utilizes Raspberry Pi for vehicle tracking and monitoring. Raspberry Pi. We use the TTGO LilyGO SIM7000G ESP32 over the RaspberryPi due to better avail- ability and reduced cost of it. It does not limit the functionality of the system while also allowing ease of coding using Arduino IDE. The microcontroller has in-built GPS and LTE modules that only need to be connected to antenna to work. The vehicle-mounted hardware unit is a pivotal component of the proposed system, designed to enhance the efficiency and safety of warehouse operations. This hard ware unit encompasses a sophisticated blend of components, spearheaded by the LilyGo SIM7000G ESP32 microcontroller. Integrated seamlessly within the vehicle’s framework, this unit orchestrates the gathering and processing of vital operational data. To ensure precise geolocation tracking, the hardware unit is equipped with GPS antennas. These antennas work in tandem with the microcontroller to obtain accurate location data, enabling comprehensive spatial awareness of vehicle movements within the warehouse environment. Proximity Enhancing operational safety and efficiency, proximity sensors are strategically deployed within the hardware unit. These sensors serve multifaceted roles, enabling the measurement of crucial parameters such as speed and distance covered by the vehicle. This real-time data acquisition empowers warehouse managers with actionable insights into operational performance and safety compliance.

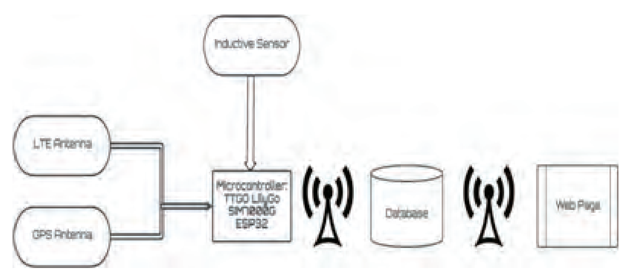

Fig. 1. System Architecture

The backbone of the system architecture, the centralized server, serves as the custodian of invaluable operational data. Endowed with robust processing capabilities and expansive storage capacity, this server functions as the repository for collected vehicle data and facilitates seamless communication with the vehicle-mounted units. A meticulously engineered database resides within the confines of the centralized server, meticulously archiving the plethora of vehicle-related data. Leveraging advanced data management protocols, this repository ensures the integrity, accessibility, and scalability of the stored information, empowering stakeholders with actionable insights and historical context. The database is hosted on MongoDB Atlas.

At the apex of the system architecture is the user interface, a dynamic web application engineered to empower warehouse managers and supervisors with unparalleled insights and control over operational dynamics. The user interface manifests as an intuitive web application, accessible through any internet-connected device. Crafted with a keen focus on usability and functionality, this application serves as the gateway to a treasure trove of operational data and analytics. From real- time monitoring of vehicle location and performance to the generation of comprehensive reports and the configuration of system parameters, this interface offers a holistic vantage point for informed decision-making. A cornerstone of the user interface is the provision for real-time monitoring and analysis. Through dynamic visualization tools and interactive dash- boards, stakeholders gain unparalleled visibility into vehicle movements, operational metrics, and performance trends. This real-time feedback loop fosters flexibility and responsiveness, enabling proactive intervention and optimization of warehouse operations.

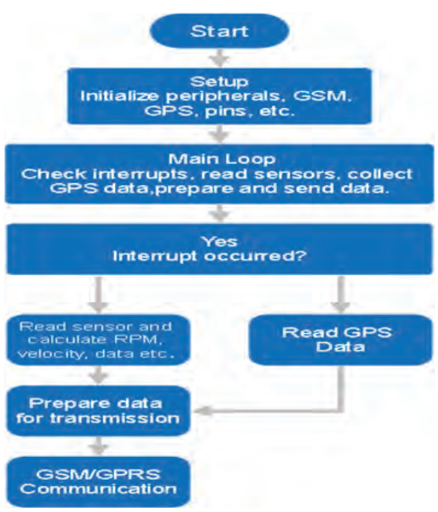

Fig. 2. Flow Chart of Implementing Indoor vehicle tracking system using LTE and GPS

Augmenting real-time insights is the capability to access historical data and generate insightful reports. Equipped with powerful analytics tools, the user interface empowers stakeholders to delve deep into historical trends, identify patterns, and extrapolate actionable insights. From performance bench marking to compliance auditing, this feature-rich functionality facilitates data-driven decision-making and continuous improvement initiatives. Rounding out the user interface is comprehensive configuration management capabilities. Administrators and supervisors can fine-tune system parameters, tailor alerts and notifications, and customize dashboards to suit unique operational requirements. This flexibility ensures alignment with evolving business needs and operational priorities, fostering adaptability and scalability within the warehouse ecosystem. In essence, the interplay of the vehicle-mounted hardware unit, centralized server, and user interface culminates in a synergistic system architecture poised to revolutionize warehouse operations. By seamlessly integrating cutting-edge technology with user-centric design principles, this architecture heralds a new era of efficiency, safety, and agility within the logistics domain.

COMMUNICATION PROTOCOL

4G technology, epitomized by LTE, offers a substantial leap forward in wireless connectivity. With peak rates surpassing 150 Mbps in the downlink and 40 Mbps in the uplink, alongside significant improvements in average throughput, 4G outshines previous generations. Its ability to integrate diverse technologies, operate in lower frequency bands for extended coverage, and provide uninterrupted voice and data services in any location makes it the optimal choice for our research project, aligning perfectly with the evolving demands of modern communication networks. The cornerstone of the forklift monitoring system lies in its seamless communication framework, facilitated by the cutting-edge 4G LTE module. This module serves as the conduit for real-time data trans- mission between the forklift-mounted hardware module and the centralized server, thereby enabling a robust and responsive operational ecosystem within the warehouse environment [22],[23]. The forklift hardware module is equipped with a sophisticated 4G LTE module, leveraging the latest advancements in cellular technology to establish high-speed, reliable connectivity. This module seamlessly interfaces with cellular networks, ensuring ubiquitous coverage and uninterrupted data transmission capabilities across expansive warehouse facilities. Central to the communication protocol is the periodic trans- mission of data packets from the forklift hardware module to the centralized server. These data packets encapsulate a wealth of critical operational information, including the forklift's precise location coordinates, real-time speed measurements and various other pertinent operational parameters. Leveraging the inherent capabilities of the 4G LTE module, the forklift hardware module autonomously initiates data packet transmission at predefined intervals, ensuring a continuous stream of real-time operational insights. This proactive approach to data transmission empowers warehouse managers with up-to- the-minute visibility into forklift activities, facilitating timely intervention and optimization of operational workflows.

Utilization of HTTP Server

In tandem with the 4G LTE module, the system leverages the versatile capabilities of an HTTP server to facilitate seam- less data exchange between the forklift hardware module and the centralized server. This strategic integration augments the system's flexibility, scalability, and interoperability, while mitigating the complexities associated with network configuration and security. Dynamic Tunneling Protocol: The HTTP server acts as a dynamic tunneling protocol, effectively bridging the communication divide between the forklift hardware module and the centralized server. Through a secure and reliable tunneling mechanism, this server facilitates bi-directional data transfer, ensuring the seamless exchange of HTTP requests and responses between disparate endpoints. Enhanced Accessibility and Compatibility: By harnessing the capabilities of the HTTP server, the system transcends traditional network constraints, enabling ubiquitous accessibility and compatibility across diverse network environments. This agnostic approach to network connectivity ensures interoperability with existing infrastructure and eliminates the need for complex network configurations, thereby streamlining deployment and integration efforts. Security and Reliability: Upholding the principles of data security and reliability, the HTTP server implements robust encryption protocols and authentication mechanisms to safeguard sensitive data during transit. By establishing secure end-to-end communication channels, this server fortifies the integrity and confidentiality of operational data, fostering trust and confidence among stakeholders. In essence, the strategic amalgamation of the 4G LTE module and the HTTP server within the communication framework underscores the system's commitment to seamless connectivity, real-time responsiveness, and data security. By harnessing the power of advanced networking technologies, this integration lays the foundation for a resilient and future-proof forklift monitoring system, poised to revolutionize warehouse operations on a global scale.

RESULTS

Upon reception of data from multiple forklifts, the central server swiftly processes the information, boasting a reduced latency of only 7 seconds, and promptly updates the database with the latest insights. This database maintains a comprehensive repository of historical data for each forklift, enabling in-depth trend analysis and performance evaluation over time. Furthermore, the system is equipped to generate real-time alerts based on predefined thresholds for critical parameters such as speed, distance travelled, or maintenance schedules. The successful implementation of the forklift monitoring system has yielded tangible benefits, notably enhancing operational efficiency within the warehouse environment.

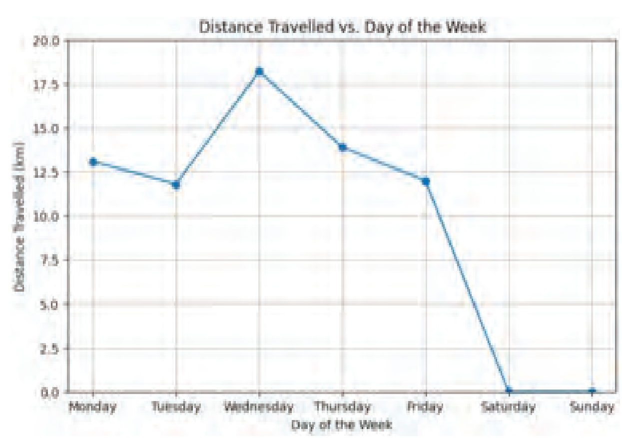

Fig. 3. Distance travelled vs. day of the weak

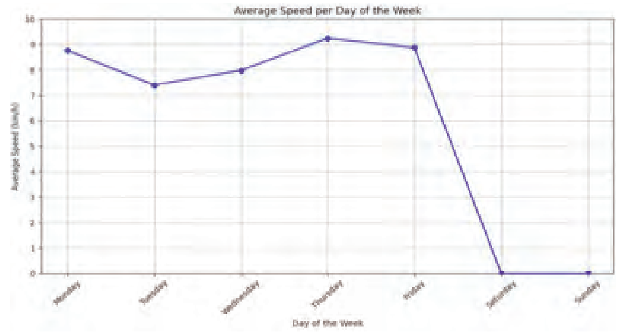

Fig. 4. Average speed per day of the week

The graph labeled ”Distance Travelled vs. Day of the Week” illustrates the distance covered by vehicles in indoor ware- houses over the course of a standard week. Initially, vehicles travel approximately 5 kilometers on Monday, which escalates notably to around 17.5 kilometers by Wednesday, marking peak activity midweek. However, a conspicuous decline is observed on Thursday, with vehicles covering about 7.5 kilo- meters, followed by a further decrease to nearly 2.5 kilometers on Friday. Notably, Saturday and Sunday register zero travel. Concurrently, the graph titled ”Average Speeds of Vehicles vs. Day of the Week” showcases the weekly average speeds of monitored vehicles. Tuesday and Wednesday emerge with the highest average speeds, exceeding 9 km/h, indicative of heightened activity and operational efficiency during midweek. Conversely, Saturday and Sunday exhibit markedly lower average speeds, around 0 km/h, signifying minimal vehicle movement due to reduced activity. These insights gleaned from the combined data of both graphs, labeled Fig. 3 and Fig. 4, hold substantial implications for optimizing warehouse operations, encompassing resource distribution, staffing, and scheduling strategies in alignment with anticipated activity levels. Through real-time monitoring and analysis of forklift activities, workflows have been optimized, downtime reduced, and resource utilization improved. Moreover, the system con- tributes to increased safety compliance by diligently tracking operational parameters like speed and location, thereby minimizing the risk of accidents and injuries. Stakeholders benefit from access to comprehensive operational data and actionable insights, fostering data-driven decision-making and continuous process improvement initiatives. The seamless integration of the 4G LTE module and HTTP server ensures uninterrupted data exchange, facilitating streamlined communication and enhanced responsiveness across the warehouse ecosystem.

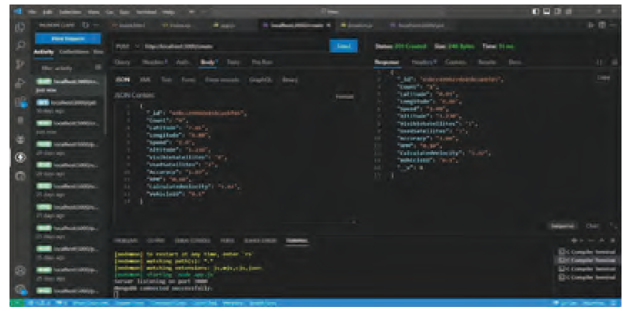

Fig. 5. Connecting to server (transferring & storing data)

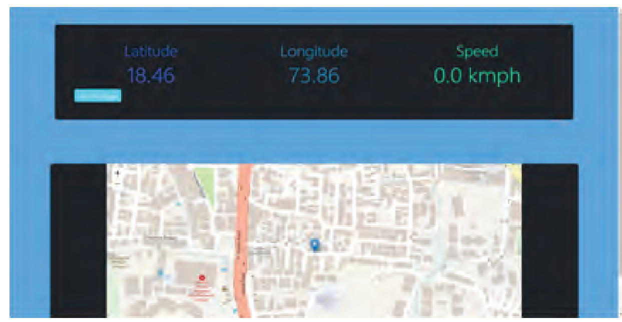

Fig. 6. User interface

CONCLUSION

In conclusion, the forklift monitoring system represents a significant leap forward in enhancing the efficiency, safety, and transparency of warehouse operations. Through the seamless integration of advanced technologies such as the 4G LTE module and HTTP server, the system has successfully over- come traditional communication barriers, enabling real-time data exchange and actionable insights.

The system provides us an update latency of approximately 7 seconds with a reduction to 3 seconds upon using a Real Time Operating System to schedule certain tasks.

By leveraging the forklift-mounted hardware module’s abil- ity to capture and transmit critical operational parameters, coupled with the centralized server’s robust data processing capabilities, stakeholders gain unprecedented visibility into forklift activities. This real-time monitoring and analysis em- power warehouse managers and supervisors to make informed decisions, optimize workflows, and ensure compliance with safety regulations. Furthermore, the utilization of the HTTP server enhances the system's accessibility, compatibility, and security, facilitating seamless integration with existing network infrastructure while safeguarding sensitive data during transit. The system's accuracy and latency are negatively affected by environmental factors and the constraints of 4G architecture. To address the limited range of 4G, one solution is to integrate a mesh network. This approach extends coverage by allowing devices to communicate with each other directly, creating a robust and adaptable network that enhances reliability and reduces latency.

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Implementing Position Algorithm Using Inclinometer for Commercial Vehicle

Avantika B. Tambe
✉ avantikatambe06@gmail.com

Sakshi N. Jadhav
✉ sakshiiijadhav9@gmail.com

Shruti A. Patil
✉ shruti2703patil@gmail.com

Madhavi H Belsare
✉ mhb_entc@pvgcoet.ac.in

Department of E&TC
PVG's College of Engineering and Technology & GKPIOM
Pune, Maharashtra

ABSTRACT

An inclinometer, sometimes referred to as a tilt meter, is devised to gauge the angle of a slope or its inclination in relation to the axis. Usually, it consists of a sensor that utilizes different technologies like mercury, accelerometers, and gyroscopes, in conjunction with a display system, to offer precise tilt measurements to users. Inclinometers are widely used in various industries for accurately determining tilt angles, aiding in decision-making and control procedures. In geotechnical engineering, they play a vital role in monitoring ground stability and evaluating the potential for landslides. In transportation, inclinometers are utilized to measure pitch and roll angles in vehicles and aircraft, assisting in navigation and guaranteeing passenger safety. Moreover, they are valuable in industrial machinery for alignment and orientation control, boosting operational efficiency. This paper presents a specially designed inclinometer system with the goal of enhancing the stability of commercial vehicles. As the emphasis on transportation safety grows, especially in logistics, there is a rising need for more advanced vehicle stability control mechanisms. In response to this demand, our research is centered on creating a resilient inclinometer-based system that can detect and address risks related to vehicle tilting. This, in turn, aims to decrease the occurrence of rollover incidents and improve road safety overall. The system combines MEMS (Micro-Electro-Mechanical Systems) accelerometer and gyroscope sensors with real-time data processing algorithms to precisely gauge the vehicle's inclination angles in different driving situations. Through analyzing this inclination data, the system is able to identify possible rollover incidents and alert the driver promptly.

KEYWORDS: *Inclinometer, Tilt, Slope, Pitch, Roll, MEMS, Stability, Rollover, Angle.*

INTRODUCTION

The logistic trucks play a crucial role in advancing the delivery sector and supporting business expansion. They facilitate the movement of goods, generate employment opportunities, and contribute to industrial growth, thereby playing an integral part in India's economic landscape. These trucks transport a wide array of goods, ranging from small items to large accommodations, including gasoline and fuel oils, which require careful handling during transportation. Ensuring their safety is paramount, not only for the goods being transported but also for the well-being of citizens, as accidents pose significant risks to lives and property. Operating under various road conditions and carrying heavy loads, these trucks are susceptible to accidents, with vehicle instability being a primary cause. Factors such as uneven road surfaces, sharp turns, overtaking, and negotiating steep slopes contribute to this instability, leading to loss of control and potential accidents resulting in loss of life. Consequently, there is an urgent need for safety algorithms to address these challenges. One promising technology for developing such algorithms is the inclinometer sensor, which accurately measures the vehicle's angle and can significantly aid in enhancing safety measures. The main aim of the project is to create an precise, economical, and user-friendly solution for measuring real-time vehicle tilt angles at the roadside. Current solutions available for this purpose are often costly, emphasizing the importance of affordability in our initiative. While many similar projects utilize AI algorithms to correct the error, PID controllers, and principles of physics for validation, our proposed approach distinguishes itself through its simplicity and reliability, provide the users with limited technical knowledge. The product's objective is to accurately measure vehicle tilt angles and provide timely alerts to drivers to prevent potential accidents. This approach significantly enhances driver and public safety, potentially averting numerous mishaps.

In[1]a MEMS-based inclinometer design is presented, consisting of three modules: measurement, control, and upper computer. The measurement module comprises eight boards with three axial accelerometers connected flexibly. The control module handles data collecting and processing, transmitting it to the upper computer. The upper computer conducts error processing and image generation using Euler Angle principles, a six-position calibration accelerometer error model, and vector superposition. Experimental results show that the inclinometer accurately displays slope inclination as images on coordinate axes, with a relative error consistently below 0.5%.

Another technique [2] for measuring the center of gravity of non-rotating workpieces with complex curved surfaces is introduced. This method, employing a single-blade gravity center measurement, is straightforward, practical, and adaptable. It accurately determines the blade's gravity center coordinates through online measurement and coordinate conversion, even on uneven surfaces. This approach reduces installation and positioning requirements, thereby shortening measurement and debugging times. By utilizing a double-layer measurement structure, it overcomes issues related to lateral force components in curved workpieces, enhancing measurement accuracy. Experimental results confirm its effectiveness in accurately measuring the gravity center of individual blades in controllable pitch propellers, providing valuable data for static balancing and repair processes.

A magnetic field-based positioning system [3] integrates inclinometer-measured inclination data with magnetometer derived magnetic field data. Experimental findings demonstrate its superiority over Gauss-Newton and recursive methods in positioning accuracy. Leveraging all three components of the magnetic field vector significantly enhances accuracy. Additionally, its real-time performance excels, distinguishing it as a non-iterative and non-recursive method, ideal for devices with limited computational resources.

Simulink models [4] are developed using truck data to create both two-degree-of-freedom (2-DOF) and three-degree-of- freedom (3-DOF) models. These models aid in understanding how lateral velocity, yaw rate, and roll of the truck vary in response to inputs such as step steer and forward velocity. Incorporating a PID controller resulted in significant reductions in lateral velocity, yaw rate, and roll of the truck model, aiming to enhance overall dynamics. Notably, the control system, based on active yaw control technology, played a crucial role in achieving more substantial reductions in yaw rate and roll compared to lateral velocity.

Authors [5] A comparison was made between the transfer function coefficients of the kinetic model and the AR estimation model derived from experimental data to estimate gravity height. The results indicate that the vehicle's gravity height can be accurately estimated and adjusted based on its loading status. Furthermore, the application of lateral spin prevention control, using vehicle roll and roll rate information, showed promising outcomes. Guidelines for addressing installation issues and correcting common measurement errors are provided through three case histories, highlighting the importance of considering critical factors in installation, monitoring, and data analysis. Installation factors include ensuring stable ground placement, using proper backfill, and employing flexible casings for sensitivity to small movements. To ensure accurate results, systematic errors in data reduction, such as bias shift, sensitivity drift, rotation, and depth positioning errors, must be addressed. While slope inclinometers are essential for assessing landslide characteristics like movement magnitude, rate, direction, depth, and type, their effectiveness can be compromised by overlooking these factors.

Slope inclinometers play a vital role in evaluating various aspects of landslides, including their movement magnitude, rate, direction, depth, and type. However, their efficacy may diminish if essential considerations regarding installation, monitoring, and data analysis are overlooked. Installation considerations include ensuring a stable ground placement, using appropriate backfill materials, and employing flexible casings to detect small movements accurately. Moreover, systematic errors in data reduction, such as bias-shift, sensitivity drift, rotation, and depth positioning errors, need to be carefully addressed to ensure reliable results.

We proposed a system that is known for its simplicity and dependability, designed to meet the needs of users with minimal experience in the field. The product aims to accurately measure the inclination angle and warn the driver proactively to prevent any potential accidents. This approach greatly improves driver and public safety, potentially averting numerous accidents.

SYSTEM ARCHITECTURE

The system architecture for implementing positioning algorithm using inclinometer for commercial vehicle is shown in Fig.1 The inclinometer is mainly composed of four parts, namely the microcontroller module, the sensor module, the serial communication module and the power module.

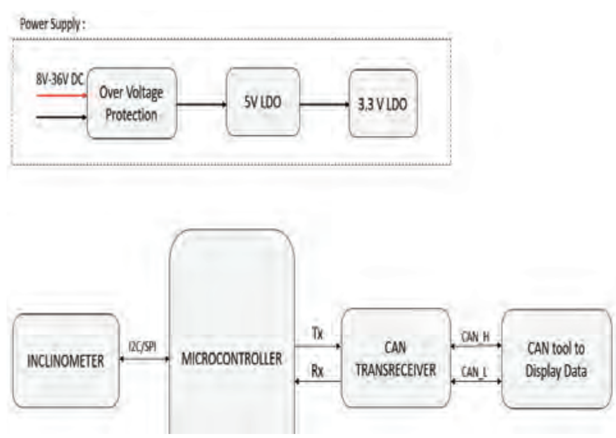


Fig. 1. System architecture for Implementing positioning algorithm using inclinometer for commercial vehicle

The system is precisely designed to operate seamlessly within a voltage input range spanning from a minimum of 8 volts to a maximum of 36 volts, predominantly sourced from reliable battery power. This broad voltage spectrum underscores the system's adaptability to diverse power sources and ensures optimal functionality across various operational scenarios.

In order to precisely regulate and distribute voltage to the intricate array of system components, an ingenious incorporation of Low Dropout Regulators (LDOs) is orchestrated. These highly specialized regulators are meticulously configured to ingeniously step down the incoming voltage, meticulously crafting stable output voltages of both 5 volts and 3.3 volts. This meticulous voltage regulation serves as the cornerstone of ensuring precise and dependable power delivery to each component, safeguarding against fluctuations and ensuring optimal performance under varying operational conditions.

The regulated 5-volt power supply, stemming from this intricate LDO setup, plays an indispensable role in energizing the pivotal Controller Area Network (CAN) integrated circuit. This critical component serves as the nerve center of the entire system, orchestrating seamless data communication and coordination among all interconnected elements. Furthermore, a dedicated LDO is artfully designated to generate a reliable 3.3-volt output, meticulously tailored to power a myriad of mission-critical components including but not limited to the accelerometer IC, microcontroller, and supplementary CAN IC. The operational paradigm of this cutting-edge system commences with the prodigious accelerometer, meticulously engineered to meticulously detect and precisely measure the subtle nuances of tilt angles relative to the omnipresent force of gravity. This exquisitely crafted sensor, poised at the forefront of the system's operation, dutifully transmits the intricately captured data to the sophisticated microcontroller utilizing an array of communication protocols such as the highly versatile I2C or SPI.

METHODOLOGY

The system function is explained with the help of flow chart shown in Fig. 2.

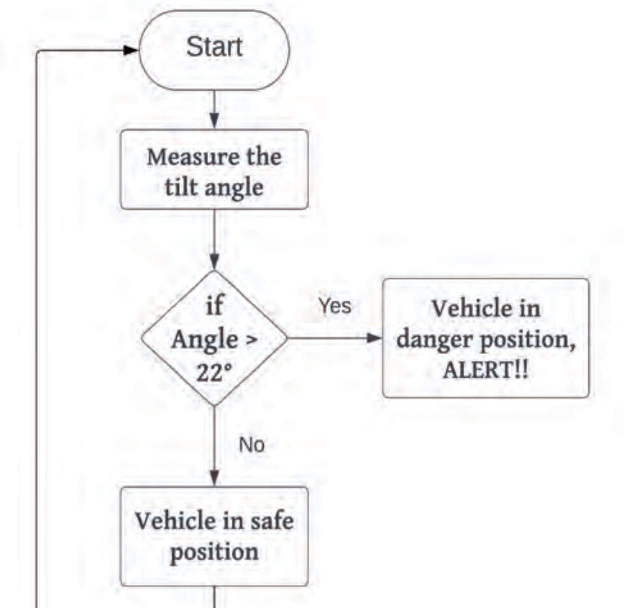


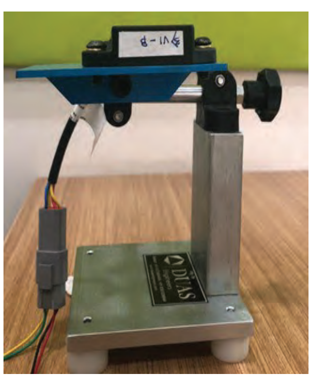
Fig. 2. Flow Chart of Implementing positioning algorithm using inclinometer for commercial vehicle

The sensor initially measures the angle. When the angle is within the threshold value, the vehicle is considered to be in a safe position. However, if the angle exceeds this threshold, an alert is generated.

RESULT AND ANALYSIS

System is implemented with the appropriate setup. Observations are taken under certain conditions to get the results. This sections includes the result and analysis of the implemented project.

1) 0 Degree:



Type of Message	X-Axis Angle Data															
Data Bytes	D0								D1							
Intel Format	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8
Example Bits	1	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0
Example Hex Bytes	2354															
Converted Decimal Bytes	9044															
Range Max lock in Decimal	18000															
Data Conversion Formula	(A*0.01)-90															
Resultant Value	0.44															
Range Max lock in Angle	-90.00 to +90.00															

Fig. 3. Zero Degree

The position of the sensor in the Fig 3, indicates 0◦ tilt. Hence the vehicle is at rest position.

2) 45 Degree on X- axis:

Type of Message	X-Axis Angle Data															
Data Bytes	D0								D1							
Intel Format	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8
Example Bits	1	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0
Example Hex Bytes	34b5															
Converted Decimal Bytes	13493															
Range Max lock in Decimal	18000															
Data Conversion Formula	(A*0.01)-90															
Resultant Value	44.93															
Range Max lock in Angle	-90.00 to +90.00															

Fig. 4. 45 Degree on X- axis

The position of the sensor in the Fig 4, shows positive angle of 45◦ on X axis.

3) -45 Degree on X axis:

Type of Message	X-Axis Angle Data															
Data Bytes	D0								D1							
Intel Format	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8
Example Bits	1	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0
Example Hex Bytes	1153															
Converted Decimal Bytes	4435															
Range Max lock in Decimal	18000															
Data Conversion Formula	(A*0.01)-90															
Resultant Value	-45.65															
Range Max lock in Angle	-90.00 to +90.00															

Fig. 5. -45 Degree on X axis

The position of the sensor in the Fig 5, shows the tilt of the vehicle in negative 45◦ on Y axis.

4) 45 Degree on y axis:

Y-Axis Angle Data															
D2								D3							
23	22	21	20	19	18	17	16	31	30	29	28	27	26	25	24
1	1	1	0	1	1	0	0	0	0	1	1	0	1	0	0
3.57E+03															
13673															
18000															
(A*0.01)-90															
46.73															
-90.00 to +90.00															

Fig. 6. 45 Degree on y axis

Similarly, the position of the inclinometer in Fig 6, indicates 45◦ on Y axis.

5) -45 Degree on y axis

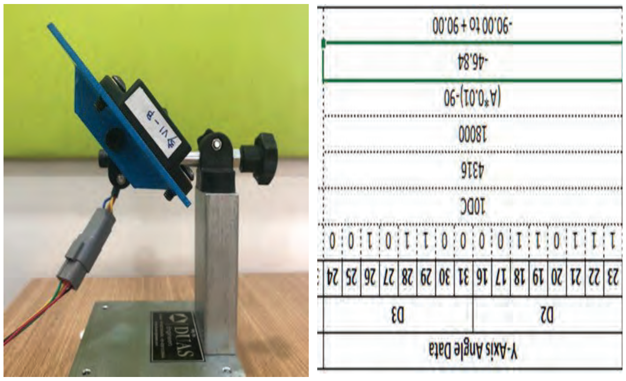


Fig. 7. -45 Degree on y axis

Likewise, Fig 7 shows the tilt of the vehicle negative 45◦ with respect to y axis.

6) 90 Degree on X- axis:

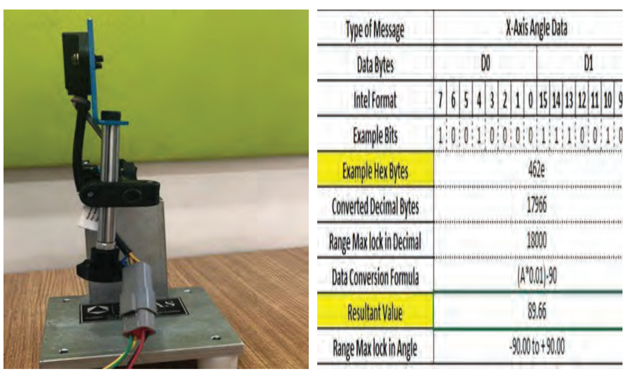


Fig. 8. 90 Degree on X- axis

In Fig 8, the sensor is at positive 90◦ on x axis. Correspondingly, the inclinometer can move to the angle of positive as well as negative with respect to X and Y axis. Beyond which the angle will be detected as an error.

CONCLUSION

The integration of the inclinometer sensor, microcontroller, and CAN transceiver results in a reliable inclinometer system that accurately measures and transmits inclination data. This system shows great potential for various industries, providing precise monitoring solutions for inclination across a range of applications.The scope of the system can be extended by controlling the power of the vehicle with respect to the tilt measured.

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Arrythmia Detection using Deep Neural Network

Onkar Nadgeri
✉ onkar_nadgeri@moderncoe.edu.in

Atharva Kulkarni
✉ atharva_g_kulkarni@moderncoe.edu.in

Mangesh Suvarnakar
✉ mangesh_suvarnakar@moderncoe.edu.in

Pratima M. Chavan
✉ pratima.chavan@moderncoe.edu.in

K. R. Joshi
✉ principal@moderncoe.edu.in

V. V. Hanchate
✉ Vandana.hanchate@moderncoe.edu.in

Department of Electronics and Telecommunication Department
Progressive Education Society's
Modern College of Engineering
Pune, Maharashtra

ABSTRACT

One of the leading causes of death worldwide is arrhythmia. It happens when there is a malfunction in the electrical impulses that synchronize heartbeats. This results in the heart's beating irregularly, which can lead to palpitations and cardiac arrest. While electrocardiograms (ECGs) are among the most extensively utilized and well-liked techniques for identifying arrhythmias A number of machine learning methods, and convolutional neural network (CNN), are analyzed in order to determine which one is best for classifying cardiac arrhythmias. ECG (electrocardiogram) is a simple technique that works well for continuous monitoring. In this work, we provide a technique that uses deep learning in conjunction with time-frequency analysis to identify AF based on ECG

KEYWORDS: *Arrythmia, ECG signal, CNN, Heart rate (BPM).*

INTRODUCTION

Arrhythmia, often referred to as cardiac arrhythmia, is a medical condition characterized by irregular heart rhythms, which can be too fast (tachycardia), too slow (bradycardia), or erratic in their pattern, potentially leading to serious health complications and symptoms such as palpitations, dizziness, shortness of breath, or even fainting. IT can be caused by heart diseases, high blood pressure, Anxiety, stress, caffeine, Genetics, Alcohol.

Traditional Method to detect Arrythmia Visual Inspection: Skilled healthcare professionals visually examine ECG waveforms for irregularities in rhythm, duration, and morphology that indicate arrhythmias.

Heart Rate Analysis: Calculating heart, heart's electricalactivity. It remains a standard diagnostic.

Pulse Palpation: This simple technique involves feeling the pulse at various arterial sites (e.g., the wrist rate from the ECG signals and identifying abnormal heart rate patterns, such as rapid heartbeat, or tachycardia, and slow heartbeat, or bradycardia. Holter Monitoring: Using a portable ECG device called a Holtermonitor to record ECG signals continuously over a 24-hour period, allowing for the detection of arrhythmias that may occur intermittently. Event Monitoring: Utilizing a portable ECG device that patients can activate when they experience symptoms, capturing ECG.

Data during episodes of arrhythmia for later analysis. Stress Testing: Conducting exercise stress tests while monitoring ECG signals to provoke arrhythmias that maybe triggered by physical activity. Echocardiography: Using ultrasound imaging to assess the structure and function of the heart, which can help identify underlying conditions that may contribute to arrhythmia.

Here are some of the oldest methods used to detect arrhythmias:

Clinical Examination: One of the earliest methods for detecting arrhythmias was through a thorough clinical examination. Physicians would rely on physical signs, such as irregular pulse, heart murmurs, or auscultation of the heart using a stethoscope to detect abnormal rhythms.

Electrocardiography (ECG): ECG is one of the most significant advancements in arrhythmia detection. It was developed in the early 20th century, with the first ECG recorded in 1903 by Willem Einthoven. ECG involves placing electrodes on the skin to capture the tool for detecting arrhythmias.

or neck) to detect irregularities in the heartbeat. Physicians would rely on the absence or irregularity of pulse to suspect arrhythmias.

Auscultation: Physicians would listen to heart sounds using a stethoscope. Although it can detect some arrhythmias and irregular heart sounds, it is not as precise as ECG.

Holter Monitoring: Developed in the mid-20th century, the Holter monitor is a portable ECG device that patients wear for an extended period, usually 24 to 48 hours. It helps detect arrhythmias that may occur intermittently and not during a short ECG recording.

Event Monitors: These are similar to Holter monitors but are used for longer periods, up to several weeks or months. They are often used when arrhythmias are infrequent and require prolonged monitoring.

Carotid Sinus Massage: This was used in the past to detect certain arrhythmias. It involves massaging the carotid sinus in the neck to stimulate the vague nerve and provoke bradycardia, which can help diagnose certain types of arrhythmias. However, it is less commonly used today due to potential risks. In this project we are using CNN algorithm to detect arrythmia using machine learning.

ECG signal

The electrical activity of the heart is captured by ECG readings using skin electrodes. The waves, which stand for various cardiac phases, are P, QRS, and T. Heart problem diagnosis is aided by abnormalities in these waves. To monitor cardiac health, identify arrhythmias, and gauge heart rate, ECGs are essential. Different lead arrangements record different aspects of cardiac function. Wave length, amplitude, and morphological analysis are all part of interpretation. Hospital telemetry units typically have round-the-clock surveillance. Artificial intelligence and automated interpretation benefit from digital processing. In order to diagnose and treat heart disorders, ECG signals are essential. Their insights on heart health and function are invaluable.

LITERATURE SURVEY

Author Igor Gotlibovych, demonstrated arrythmia by using ECG signal algorithm used is Convolution neural network with accuracy is 90%.[1] Sidrah Liaqat, demonstrated arrythmia by using RR inter- beat intervals, time domain, frequency domain algorithm used is SVM, Logistic Regression, Multilayer Perceptron, XG Boost with accuracy is71.2%.[2] Neeraj Paradkar, Shubhajit Roy Chowdhury They demonstrated arrythmia by using RR Intervals with accuracy 93%.[3] Yutao Guo,They demonstrated arrythmia by using RR Intervals, ECG Signal algorithm used osXG- Boost, Random Forest, Support Vector Machine, and Gradient Boosting Decision Tree with accuracy 93.5%.[4] Neha, Rajesh Kanawade , demonstrated arrythmia by using PPG Signal, crest to crest interval, beats per minute, transit time, and valley to valley interval are included. Algorithm used is Artificial neural network, Decision trees, Random Forest, SVM, andlogistic regression with accuracy is 97.674%.[5] PENG CHENG, demonstrated arrythmia by using RRIntervals algorithm used is Convolution neural network with accuracy is 98.27%.

[6] Zengding Liu, demonstrated arrythmia by using RR Intervals, ECG Signal d algorithm used is deep convolutional neural networks with accuracy is 92.7%.[7] Tania Pereira, demonstrated arrythmia by using RR Intervals algorithm used is convolutional neural networks with accuracy is 93%.[8] Kavya Subramanian, demonstrated arrythmia by using Peak to peak Interval, BPM (Beats per minute), P wave to QRS peak algorithm used is Support Vector Machine (SVM) with accuracy is 91%.[9] Ali Isin, Selen Ozdalili. They demonstrated arrythmia by using ECG signal algorithm used is convolutional neural networks with accuracy is 96%.[10] Zahra Ebrahimi, they demonstrated arrythmia by using True positive (TP), True negative (TN), False positive (FP), False negative (FN) algorithm used is Multilayer Perceptron, Convolutional Neural Network, Deep Belief Network, Recurrent Neural Network, Long Short-Term Memory with accuracy is 99.3%.[11] Yogita Bhatia, demonstrated arrythmia by using True positive (TP), True negative (TN), False positive (FP), False negative (FN) algorithm used is Support Vector Machine with accuracy is 77%.[12] Po-Ya Hsu, Chung-

Kuan Cheng. They demonstrated arrythmia by using ECG Signal algorithm used is Convolutional Neural Network, deep neural networks with accuracy is 98.8%.[13] Kirstin Aschbacher, demonstrated arrythmia by using R-R intervals algorithm used is Convolutional Neural Network, deep neural networks, LSTM neural net 98.3%.[14] EunKwang Jeon, demonstrated arrythmia by using QRS Peak Detection, ECG Signal algorithm used is Deep Neural Network with accuracy is 99.49%. [15] Sena Yağmur, demonstrated arrythmia by using ECG time-series signals and ECG spectrogram images algorithm used is gradient descent algorithm, Convolutional Neural Network with accuracy is 96%. [16] HUI YANG, ZHIQIANG WEI. They demonstrated arrythmia by using PP interval, PR interval, RR interval, ST interval, P wave Duration, QRS complex algorithmused is Support Vector Machine with accuracy is 97.70%.[17] Qiao Xiao, demonstrated arrythmia by using RR interval, ECG signal algorithm used is Support Vector Machine with accuracy is 94%.[18] Amin Ullah, demonstrated arrythmia by using ECG spectrogram images algorithm used is Convolutional Neural Network with accuracy is 99.11%.[19]

PROPOSED SYSTEM / WORKING

Block Diagram

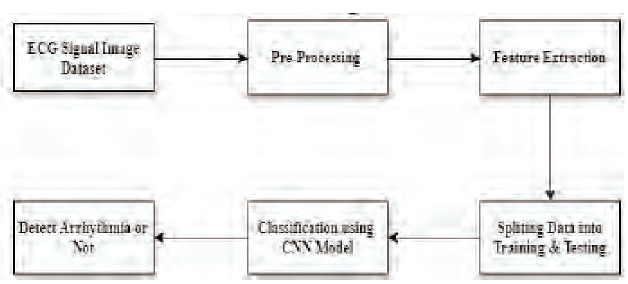

Fig 1. Block Diagram

In this project, we aim to develop a machine learning based arrythmia detection system with a help of Convolution Neural Network (CNN) and image processing. The system follows a series of steps as shown in Fig.1. to achieve this:

1) **Dataset:** Collecting a dataset of Labeled images of ECG Signal. The dataset is formed up of images or electrocardiogram (ECG) data that represent various cardiac rhythms. This dataset is used to train the CNN model to distinguish patterns and features that identify arrhythmia.

2) **Pre-Processing:** Preprocessing methods improve the quality of newly collected information before feeding it into the CNN model. Normalization, scaling, noise reduction, and image augmentation are among the most used preprocessing techniques. These strategies help to standardize data, improve model performance, and ensure that the CNN algorithm detects arrhythmias accurately.

3) **Feature Extraction:** Feature extraction entails discovering and choosing relevant patterns or characteristics from ECG image data. These features are required for the CNN model to learn and accurately distinguish between different types of cardiac beats. By extracting significant information from ECG images, the CNN model can accurately classify arrhythmias.

4) **Splitting Data Training and Testing:** Split 80% data for training and 20 % data for testing.

5) **Classification:** Preprocessing the ECG images, collecting features from the images, and then passing these features through many convolutional layers for classification. The CNN model learns to differentiate between different types of heart rhythms using the collected information, eventually diagnosing arrhythmias with high accuracy.

METHODOLOGY

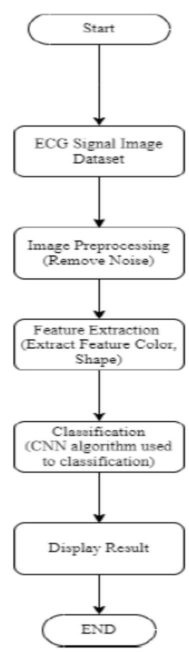

Fig. 2 Flow Diagram

Algorithm

1) Start
2) Sign in into the system.
3) Give image as an input to the system
4) Apply image pre-processing to image which is given as input.
5) Extract the features from the pre-processed image. 6)Apply CNN algorithm to classify the given image.
7) Finally, display the result on screen if the patient is detected with arrythmia or not.
8) Exit

Algorithms Convolution Neural Network

An extensive family of deep neural networks utilized in computer vision tasks are called convolutional neural networks, or CNNs. For dimensionality reduction and feature extraction, they are composed of several layers, such as convolutional and pooling layers. CNNs can automatically recognize features from unprocessed picture data and create hierarchical representations of them. No matter where patterns are located in the input image, they display translation invariance and may be recognized. With differing levels of intricacy and depth, popular CNN designs include AlexNet, VGG, GoogLeNet, and ResNet. Repropagation and gradient descent techniques are commonly used in CNN training, frequently on sizable datasets such as ImageNet. In areas including object detection, segmentation, and image classification, CNNs have demonstrated cutting-edge performance. Applications such as speech recognition and natural language processing are being made use of in fields beyond computer vision.

Performance analysis of System

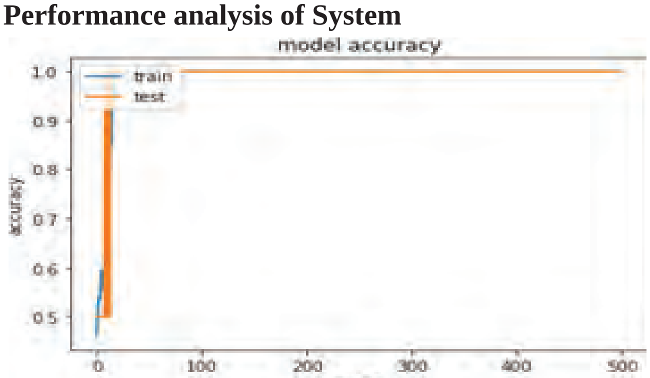

Fig. 3: Accuracy

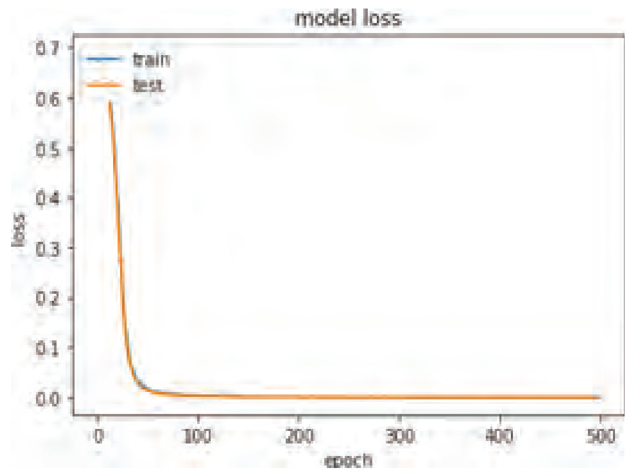

Fig. 4 Loss

In performance analysis of the system, we found out that the system has 100% accuracy and 0% loss.

RESULTS AND DISCUSSION

Fig. 5 Sign in/ Sign up page

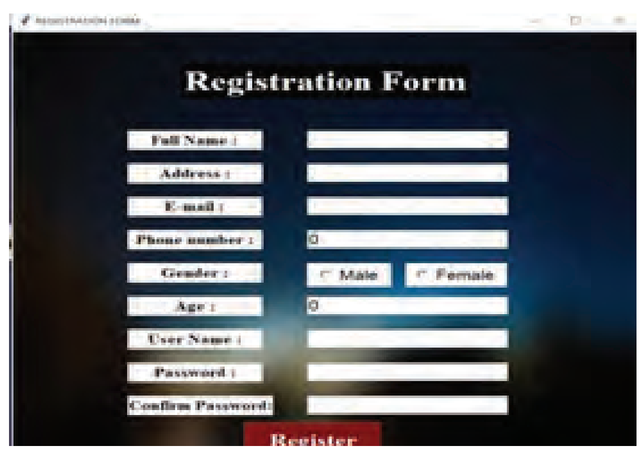

Fig.6 Registration page

Fig.7 Login Page

Fig.8 Main Page

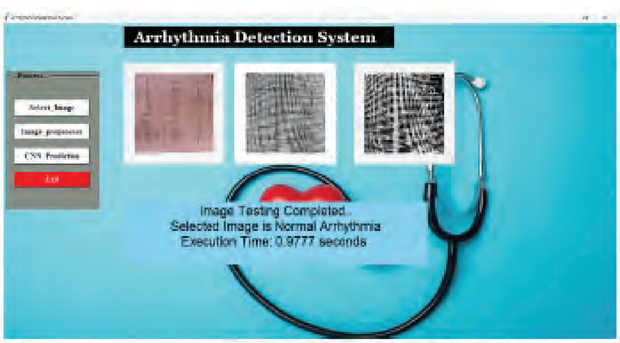

Fig.9 Normal arrythmia

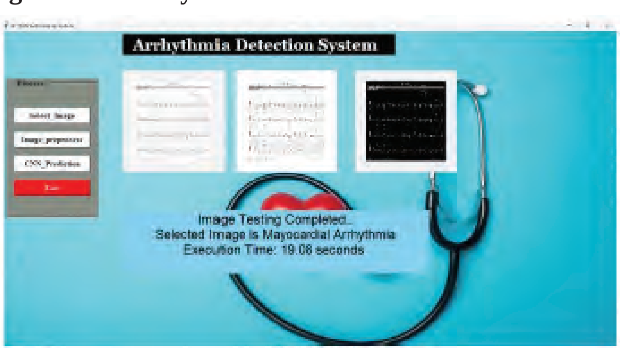

Fig.10 Mayocardial Arrythmia

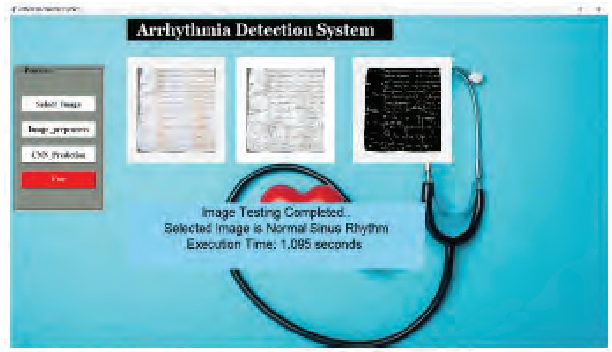

Fig.11 Normal Sinus Rhythm

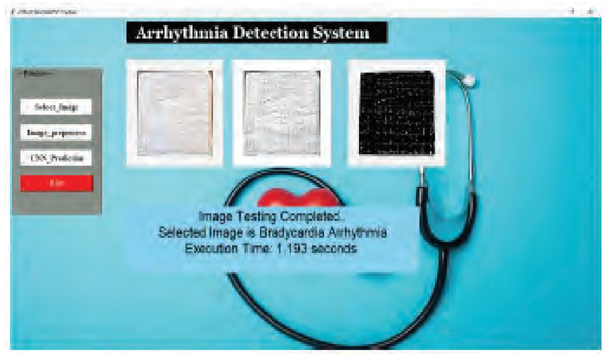

Fig.12 Bradycardia Arrythmia

CONCLUSION

In order to diagnose and treat cardiac rhythm problems, arrhythmia detection is essential. Advanced medical technology, such as machine learning and electrocardiogram (ECG) identifying important features, training machine learning models, evaluating their efficacy, and implementing them. Efficient diagnosis and management of arrhythmias is made possible by this technology, which also makes automated analysis easier. The identification of arrhythmias is advancing due to ongoing technical and scientific advancements, offering substantial prospects for improved patient care.

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Social Media's Influence on Teenager's Mental Health in India Post COVID-19

Ashwini Garkhedkar
Assistant Professor
PES's Modern College of Engineering
Pune, Maharashtra
✉ ashwini.garkhedkar@moderncoe.edu.in

Ravikant Zirmite
Associate Professor, HOD
MES's IMCC
Pune, Maharashtra
✉ rsz.imcc@mespune.in

Nilkanth Solanki
Master of Computer Applications Second Year
PES's Modern College of Engineering
Pune, Maharashtra
✉ nilkanth.solanki@moderncoe.edu.in

ABSTRACT

Social media has become an integral part of our lives. Social media impacts teenagers' mental health, especially with platforms like Instagram and Snapchat being so popular these days. It's really important to understand how all that screen time affects how teenagers feel about themselves and their bodies, and whether it makes them anxious or sad. From COVID-19 pandemic, social media's impact on the mental health of teenagers in India has become a pertinent subject of concern. What I found is that social media can affect teenagers in different ways. For one, it often makes them compare themselves to others, which can really mess with their self-esteem. Then there's cyberbullying, which is a big problem online and can seriously hurt someone's feelings. Plus, there's this pressure to always look perfect online, which can be super stressful. After going through all these studies, it's clear that social media has a big impact on teenagers' mental health. But knowing this gives us a chance to think about how we can help. We need to teach teenagers how to use social media in a healthy way and how to handle cyberbullying. And also we can take efforts to reduce the social media screen time.

KEYWORDS: *Social media, Teenagers, Mental health, Anxiety, Depression, Cyberbullying.*

INTRODUCTION

The COVID-19 pandemic has ushered in an era of unprecedented reliance on digital communication platforms, particularly among teenagers. As schools shifted to remote learning and social interactions moved online to comply with social distancing measures, social media became an integral part of adolescents' lives in India. However, alongside its undeniable benefits in facilitating connectivity and information dissemination, social media's influence on teenagers' mental health has come under scrutiny.

The objective and purpose of this paper is to explore the use of social media and teenagers' mental health in India in the aftermath of the COVID-19 pandemic. While social media platforms offer avenues for socialization, entertainment, and information access, concerns have been raised regarding their potential negative impact on adolescents' psychological well-being.

Several studies have underlined the harmful effects of excessive and uncontrolled social media use on mental health of teenagers in India, including heightened anxiety, depression, and feelings of social isolation. Moreover, the pervasive nature of social media presents teenagers with unrealistic standards of beauty, success, and happiness, contributing to body image issues and low self-esteem.

Cultural norms and societal pressures further exacerbate the challenges associated with social media use among teenagers. Traditional values coexist with modern digital lifestyles, creating a complex environment where adolescents navigate between virtual and real-world identities. Moreover, the digital divide exacerbates disparities in access to technology and digital literacy, potentially widening the gap in mental health outcomes among teenagers from different socioeconomic backgrounds.

Addressing the effect of social media on mental health of teenagers requires a multifaceted approach that involves collaboration among parents, educators, policymakers, and mental health professionals. By promoting digital literacy, fostering open communication channels, and providing access to mental health support services, stakeholders can empower teenagers to navigate social media responsibly and maintain their psychological well-being in the post-pandemic era.

While social media offers valuable opportunities for connectivity and information exchange, its influence on teenagers' mental health cannot be overlooked. By realizing the complexities of using social media and its impact on adolescents' psychological well-being in the Indian context, stakeholders can work towards fostering a safer and healthier online environment for the younger generation.

REVIEW OF LITERATURE

The connection of social media usage and mental health in teenagers has been a subject of extensive research globally. Numerous studies have highlighted both the advantages and disadvantages of social media on adolescents' psychological well-being. In the context of India, where social media penetration has surged in recent years, understanding these dynamics becomes particularly relevant, especially after the COVID-19 pandemic.

Global Perspectives

Post-COVID-19, there's a heightened global focus on the influence of social media on the mental health of teenagers. With prolonged screen time becoming the norm during lockdowns, concerns have risen about its potential negative effects, including increased anxiety and depression. Cyberbullying and online harassment have also intensified, amplifying teenagers' vulnerability in the digital sphere. Moreover, the spread of misinformation on social media platforms has exacerbated feelings of uncertainty and fear among teenagers. However, amidst these challenges, digital communities and tools promoting well-being offer avenues for support and connection. Additionally, parental involvement in monitoring and guiding teenagers' online behavior remains crucial in mitigating the negative impacts of social media on their mental health.

Indian Context

Research specific to India has shed light on how cultural and contextual factors influence the relationship among social media and mental health of teenagers. A study by Shah and Shah (2019) explored the effect of social media use on body image dissatisfaction among Indian adolescents and found a significant association between exposure to idealized images on social media and negative body image perceptions. Additionally, research by Malik et al. (2020) highlighted the role of social comparison and peer influence in shaping adolescents' self-esteem and psychological well-being in the Indian context.

Effects of Social Media Influencers

Recent studies have begun to examine the effect of social media influencers on teenagers' mental health. In India, where influencer marketing is prevalent across various platforms, understanding how influencers shape adolescents' attitudes, behaviors, and self-perception is crucial. Research by Kumar et al. (2022) investigated the role of beauty and lifestyle influencers on body image concerns among Indian teenagers and found that exposure to idealized images promoted by influencers was associated with increased body dissatisfaction and negative self-esteem. This highlights the need for further exploration into the mechanisms through which influencers influence teenagers' mental health and the development of strategies to mitigate potential harm.

Post-COVID-19 Considerations

The COVID-19 pandemic has reshaped social dynamics and accelerated the reliance on digital platforms for communication, education, and entertainment, particularly among teenagers. Studies examining the post-pandemic landscape have started to emerge, albeit limited in number. A survey by Gupta et al. (2021) assessed the impact of the pandemic on adolescents' social media usage patterns in India and found a significant increase in screen time and online interactions during lockdown periods. However, the study also identified concerns regarding cyberbullying, misinformation, and excessive screen time contributing to heightened stress and anxiety among teenagers.

Research and Future Directions

There is a need for longitudinal studies that capture the dynamic nature of social media usage and its long-term effects on adolescents' well-being, particularly in the post-COVID-19 era. Furthermore, research exploring protective factors and resilience strategies against the negative impacts of social media, as well as interventions tailored to the Indian cultural context, is warranted.

In summary, existing research underscores the importance of understanding the relation between social media and mental health of teenagers, particularly in the evolving landscape of post-COVID-19 India. By addressing the gaps in knowledge and adopting a holistic approach, researchers can contribute to the development promoting healthy social media usage and supporting adolescents' psychological well-being by using some policies and interventions.

POPULAR SOCIAL MEDIA SITES

Facebook

Ref:https://www.financialexpress.com/wp-content/uploads/2017/05/Facebook-l-reuters- 2.jpg?w=780

As one of the most widely used social media platforms globally, Facebook remains popular among Indian teenagers. Its diverse features, including messaging, groups, and news feed, contribute to both positive and negative mental health outcomes. Studies have shown correlations between excessive Facebook use and feelings of loneliness, envy, and depression among adolescents (Kross et al., 2013). However, Facebook also serves as a space for social support and connection, with users forming and maintaining friendships and support networks.

Instagram

Ref:https://blog.privadovpn.com/wp-content/uploads/2022/08/Shutterstock_1742511494- 1.jpg

Instagram's emphasis on visual content, particularly photos and videos, has significant implications for body image and self-esteem among teenagers. Research suggests that Viewing idealized images on Instagram may lead to feelings of dissatisfaction with one's body and encourage comparison with others particularly among adolescent girls (Fardouly et al., 2015). Additionally, features like Instagram Stories and live streaming offer opportunities for real-time interaction and self-expression but may also amplify feelings of FOMO (Fear of Missing Out) and social pressure.

Snapchat

Snapchat's ephemeral nature, characterized by disappearing messages and stories, presents unique challenges and benefits for teenagers' mental health. On one hand, the fleeting nature of content may reduce feelings of permanence and self-consciousness, fostering more authentic interactions. However, the pressure to maintain a curated 'Snapchat image' and the prevalence of image-altering filters can contribute to unrealistic beauty standards and self-comparison (Tiggemann& Slater, 2014).

TikTok

TikTok's rapid rise in popularity, especially among younger demographics, warrants attention in research on teenagers' mental health. The platform's algorithm-driven content recommendation system exposes users to a wide range of videos, potentially influencing their self- perception and behaviors. Studies have explored the effects of TikTok on body image, self-esteem, and social comparison, highlighting both positive and negative outcomes (Dhir et al., 2020).

WhatsApp

While primarily a messaging app, WhatsApp plays a significant role in teenagers' social interactions and information sharing in India. Group chats on WhatsApp facilitate peer communication, but they can also be avenues for cyberbullying and the spread of misinformation, impacting adolescents' mental well-being. Research on WhatsApp's influence on teenagers' mental health is relatively limited but warrants further investigation, particularly in the context of the COVID-19 pandemic and its effects on communication patterns.

Understanding how teenagers engage with these social media platforms, the content they consume, and the interactions they have can provide important insights into the nuanced connection between use of social media and mental health in India post-COVID-19. Moreover, considering the cultural and contextual factors that shape social media usage patterns is essential for developing effective interventions and support systems tailored to the needs of Indian adolescents.

METHODOLOGY

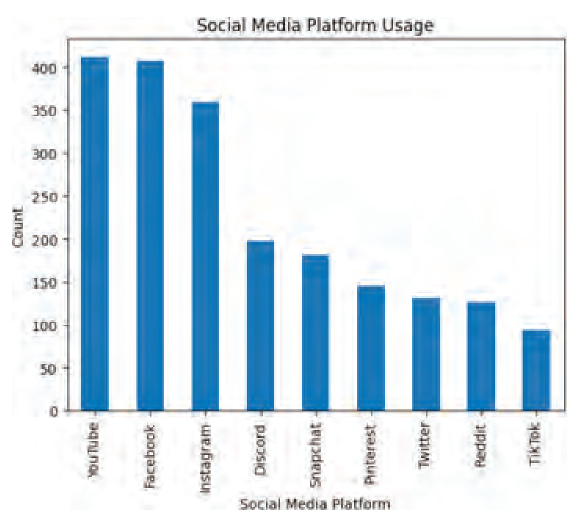
Data Collection: We leveraged a dataset sourced from Kaggle, offering a comprehensive array of responses reflecting diverse perspectives and mindsets amid the lockdown. This dataset was structured, facilitating streamlined analysis.

Data Preprocessing: Before delving into analysis, we performed essential preprocessing steps on the dataset, encompassing cleaning, addressing missing values, and ensuring data consistency. This meticulous approach bolstered the reliability and quality of subsequent analyses. Data Analysis Tool:R, along with prominent packages such as dplyr, ggplot2, and tidyr, served as our go-to toolkit for data analysis. These tools streamlined data manipulation, visualization, and interpretation, fostering insightful exploration of the dataset..

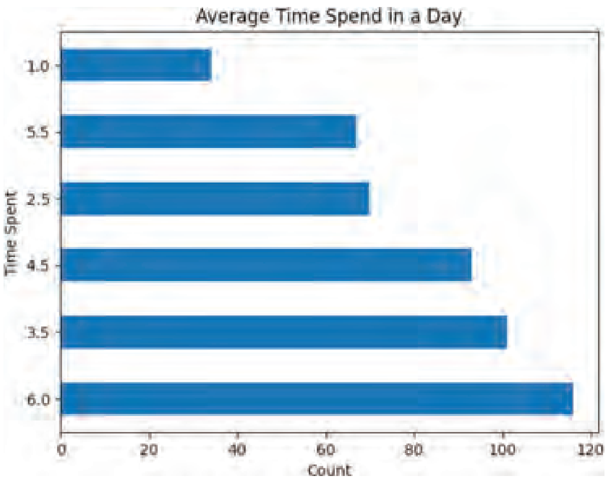
Purpose of Social Media Usage: The analysis focused on identifying the purposes for which individuals used social media during the lockdown, such as for news consumption, entertainment, social communication, or other reasons.

Sleep Patterns and Social Media Usage: Analysis was examined to ascertain the correlation among social media usage and sleep patterns, including the time respondents spent on social media before bedtime and their corresponding sleep schedules.

Effect/Influence of Social Media on Mental Health: Through the utilization of these methodologies, tools, algorithms, and techniques within the R ecosystem, our study aimed to provide significant insights into how social media usage affects the mental well-being of teenagers in India following the COVID-19 pandemic. This endeavor contributes to a deeper understanding of digital behavior amid crisis situations and its implications on adolescent mental health.

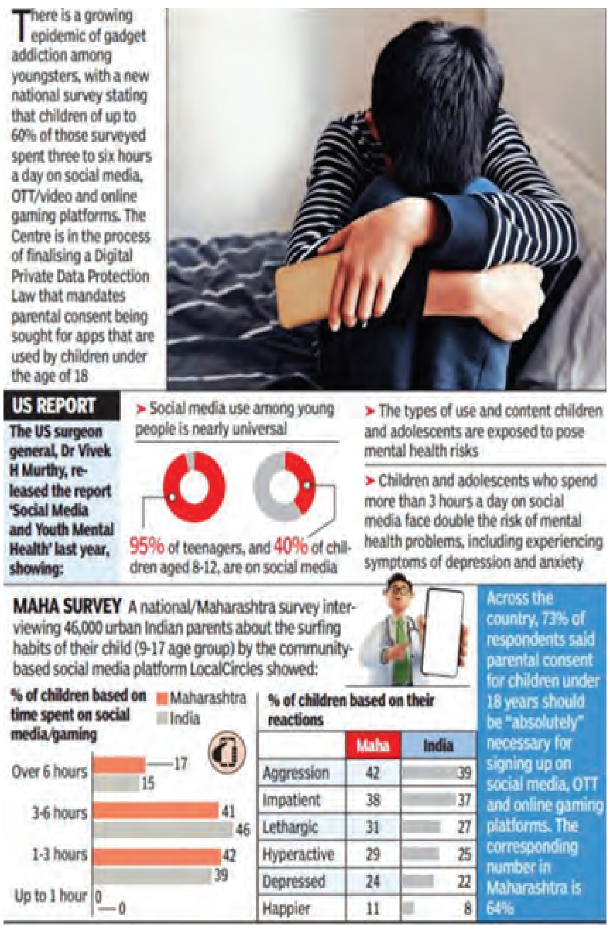


Social Media Usage Pattern Mediawise



Avg Time Spent on Social Media

RESULT AND ANALYSIS



There is a growing epidemic of gadget addiction among youngsters, with a new national survey stating that children of up to 60% of those surveyed spent three to six hours a day on social media, OTT/video and online gaming platforms. The Centre is in the process of finalising a Digital Private Data Protection Law that mandates parental consent being sought for apps that are used by children under the age of 18

US REPORT

The US surgeon general, Dr Vivek H Murthy, released the report 'Social Media and Youth Mental Health' last year, showing:

➤ Social media use among young people is nearly universal

95% of teenagers, and 40% of children aged 8-12, are on social media

➤ The types of use and content children and adolescents are exposed to pose mental health risks

➤ Children and adolescents who spend more than 3 hours a day on social media face double the risk of mental health problems, including experiencing symptoms of depression and anxiety

MAHA SURVEY A national/Maharashtra survey interviewing 46,000 urban Indian parents about the surfing habits of their child (9-17 age group) by the community-based social media platform LocalCircles showed:

% of children based on time spent on social media/gaming

	Maharashtra	India
Over 6 hours	17	15
3-6 hours	41	46
1-3 hours	42	39
Up to 1 hour	0	0

% of children based on their reactions

	Maha	India
Aggression	42	39
Impatient	38	37
Lethargic	31	27
Hyperactive	29	25
Depressed	24	22
Happier	11	8

Across the country, 73% of respondents said parental consent for children under 18 years should be "absolutely" necessary for signing up on social media, OTT and online gaming platforms. The corresponding number in Maharashtra is 64%

Ref:https://timesofindia.indiatimes.com/city/mumbai/60-children-spend-3-hours-a-day-on-social-media-study/articleshow/103878956.cms

CONCLUSION

The pervasive influence of social media on teenagers' mental health in India post-COVID-19 is undeniable. Through a mixed-methods research approach, this study aimed to explore the complex relativity of social media use and mental well-being among Indian adolescents, contextualized within the unique challenges and opportunities presented by the global pandemic.

Quantitative analysis revealed a nuanced relationship between social media usage patterns and various dimensions of teenagers' mental health. Increased screen time, exposure to cyberbullying, and unrealistic beauty standards propagated through social media platforms contributed to heightened levels of stress, anxiety, and depression among teenagers in the post-COVID-19 era.

Qualitative insights provided depth and context to quantitative findings, highlighting teenagers' lived experiences with social media and their coping mechanisms in navigating digital spaces. Participants articulated a desire for greater awareness and digital literacy initiatives to promote responsible social media use and mitigate the negative impacts on mental health. Suggestions for intervention strategies included peer support networks, mental health education in schools, and parental guidance on managing screen time and online interactions.

The findings of this research underscore the requirement for interventions and policy initiatives to address the digital well-being of Indian teenagers in the post-COVID-19 landscape. Efforts should focus on promoting digital literacy, fostering resilience, and creating supportive online environments conducive to positive mental health outcomes. Collaborative efforts involving educators, policymakers, mental health professionals, and technology companies are essential to effect meaningful change and empower teenagers to navigate social media safely and responsibly.

In conclusion, while social media presents both opportunities and challenges for teenagers' mental health in India post-COVID-19, proactive measures can mitigate the negative impacts and harness the potential of digital platforms to promote well-being and resilience among the youth population.

FUTURE ENHANCEMENT

Intervention Development: Design and evaluate evidence-based interventions to promote digital well-being and resilience among Indian teenagers. Collaborate with stakeholders to implement school-based programs, community workshops, and online resources aimed at fostering healthy social media habits and mental well- being.

Technology Solutions: Develop innovative technological solutions, such as mobile applications or browser extensions, to support positive social media interactions and mitigate negative influences on mental health. Incorporate features like mindfulness exercises, privacy controls, and content filters tailored to teenagers' needs.

Parental Involvement: Investigate the role of parental monitoring and guidance in shaping teenagers' social media behaviors and mental health outcomes. Explore strategies for fostering open communication between parents and adolescents regarding online activities and digital well-being.

Policy Recommendations: Advocate for evidence-based policy interventions to regulate social media platforms and promote responsible digital citizenship among teenagers. Collaborate with policymakers to develop guidelines on age-appropriate content, online safety measures, and digital literacy education in schools.

Global Comparisons: Compare findings from India with data from other countries to identify cross-cultural similarities and differences in the relation between using social media and ' mental health of Teenagers. International collaboration can inform global strategies for promoting digital well-being among youth populations.

Community Engagement: Engage with teenagers, parents, educators, and mental health professionals through participatory research approaches to co-design interventions and awareness campaigns. Foster community partnerships to disseminate research findings and promote collaborative action on digital well-being issues.

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Authors: Ajaykumar B. Malle,CLINICA Research Solutions LLP, CBD Belapur, Navi Mumbai, Maharashtra, India Sachin D. Pawar,CLINICA Research Solutions LLP, CBD Belapur, Navi Mumbai, Maharashtra, India

Pravinkumar S. Pal

CLINICA Research Solutions LLP, CBD Belapur, Navi Mumbai, Maharashtra, India

Sajid A. Mulani

CLINICA Research Solutions LLP, CBD Belapur, Navi Mumbai, Maharashtra, India

Impact of 5G Technology on Communication Network

Pratibha Adkar
Assistant Professor
MCA Department
PES Modern College of Engineering
Pune, Maharashtra
✉ pratibhakul@gmail.com

Sumitkumar Baral
MCA Department
PES Modern College of Engineering
Pune, Maharashtra
✉ sumitkumarbaral90@gmail.com

Dattatraya Adkar
M.E.S.Wadia College of Engineering
Pune, Maharashtra
✉ dsadkar28@gmail.com

ABSTRACT

This paper on 5G technology explores its architecture, features, and implications. It highlights 5G's revolutionary potential in transforming communication networks with enhanced speed, capacity, and connectivity. Key features such as ultra-low latency, massive connectivity, and network slicing are discussed, alongside their impacts on various industries. Challenges like infrastructure costs and security concerns are acknowledged, yet the transformative power of 5G in driving economic growth and innovation is emphasized. Looking ahead, the report anticipates continued advancements in network optimization and security, paving the way for innovative applications and services. Ultimately, 5G is positioned as a transformative force that will shape the future of communication technology.

KEYWORDS: *5G, 5G network architecture, Impact of 5G, Evolution of 5G, Future implications.*

INTRODUCTION

The introduction explores the transformative impact of 5G technology on communication networks. It highlights 5G's revolutionary features such as enhanced speed, ultra-low latency, and massive connectivity, signaling a paradigm shift in wireless communication. The section underscores the significance of 5G in meeting the increasing demand for faster, more reliable connectivity in the digital age. Additionally, it sets the stage for further discussion on the key features, applications, and implications of 5G technology across various industries and sectors.

EVOLUTION OF 5G

1G

The 1st generation of mobile communication technology emerged in the early 1980s, introducing basic voice services with data rates up to 2.4 kbps. Core systems include Advanced Mobile Telephone System (AMPS), Nordic Mobile Telephony (NMT) and Total Access Communications System (TACS). However, 1G has limitations such as limited capacity, frequent transmissions, and poor sound quality due to lack of security measures.

2G

The second generation began in the 1990s and led to a revolution in digital technology. Systems such as Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA) provide voice and data services at data rates up to 64 kbps. Features such as Short Message Service (SMS) and email became available, and mobile phones had longer battery life due to lower power consumption.

2.5G

2.5G systems combine second-generation mobile phones with General Packet Radio Service (GPRS) and packet switching technology. They offer data speeds of up to 144 kbps and services rarely found on 2G networks. Key technologies include GPRS, Enhanced Data Rate for GSM Evolution (EDGE) and Code Division Multiple Access (CDMA) 2000.

3G

The 3rd era, built up within the late 2000s, advertised higher transmission rates up to 2 Mbps and presented versatile get to to Web Convention (IP)-based administrations. Enhancements were made in Quality of Benefit (QoS), worldwide wandering, and voice quality. Be that as it may, 3G handsets required more control and were more costly than 2G models.

3.75G

Moreover, known as Long-Term Advancement (LTE) and Settled Around the world Interoperability for Microwave Get to (WiMAX), 3.75G advances cleared the way for future portable information administrations. LTE and WiMAX supplemented organize capacity, advertising high-speed administrations like video gushing and peer-to-peer sharing. They too given administrators with superior scope and made strides execution at lower costs.

4G

4G, considered the successor to 3G and 2G benchmarks, standardized advances like Long Term Advancement (LTE) Progressed and Versatile WiMAX. It given comprehensive IP- based communication arrangements, conveying voice, information, and mixed media administrations at higher information rates. Applications such as Interactive media Informing Benefit (MMS) and video chat got to be predominant, introducing in a modern period of portable communication.

Fig. 1: 5G Network

5G

The fifth era of portable communication innovation, 5G, speaks to a critical headway over its forerunners. With the presentation of innovations like Pillar Division Numerous Get to (BDMA) and Non-Orthogonal Different Get to (NOMA), 5G points to revolutionize remote communication. BDMA designates orthogonal bars to each portable station, upgrading framework capacity, whereas NOMA permits numerous clients to share the same time- frequency assets. 5G addresses key challenges not successfully handled by 4G, counting higher capacity, information rates, lower idleness, gigantic gadget network, decreased costs, and reliable Quality of Involvement (QoE) provisioning. IEEE 802.11 guidelines like 802.11ac, 802.11ad, and 802.11af serve as foundational building squares for the move to 5G systems, clearing the way for upgraded network and advancement within the computerized time.

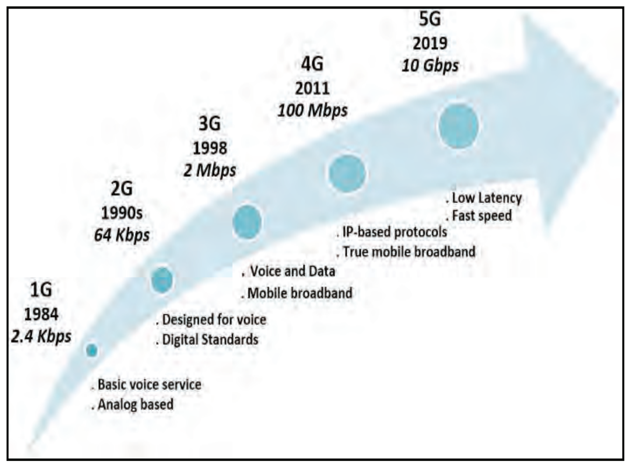

Fig. 2: Evolution of 5G

5G NETWORK ARCHITECTURE

The 5G architecture represents a paradigm shift in wireless communication systems, offering unprecedented speed, capacity, and connectivity. Its main components include Radio Access Network (RAN), Core Network (CN), edge computing, and network connectivity. RAN facilitates wireless communication between user devices and the core network, incorporating advanced technologies like Massive MIMO and beam forming for improved coverage and efficiency [1]. The CN serves as the central hub for data processing and operations, including nodes such as User Flight Operations

(UPF) and Operations Management (SMF). [7]. Edge Computing Infrastructure enables low-latency data processing closer to the point of origin, supporting latency-sensitive applications [5]. Network Slicing allows operators to create customized virtualized network instances, optimizing resource allocation for specific service requirements [6]. Overall, the 5G architecture holds immense potential for driving digital transformation across industries and enabling innovative applications, paving the way for a future of ubiquitous connectivity and seamless communication.

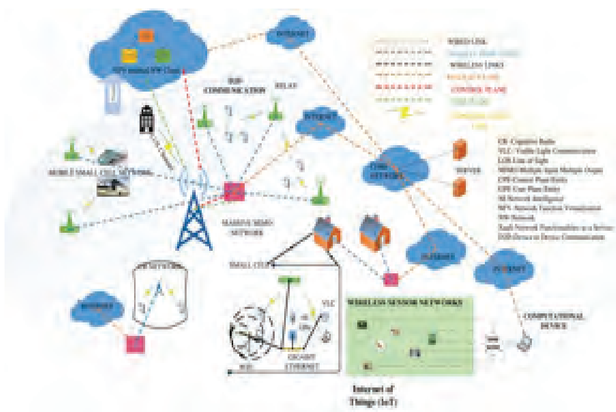

Fig. 3: 5G Network Architecture

1. Cognitive Radio: In 5G architecture, cognitive radio technology enables intelligent spectrum utilization by allowing devices to dynamically adapt their transmission parameters based on real-time spectrum availability and environmental conditions, thus optimizing spectrum utilization and enhancing network efficiency [1].
2. Visible Light Communication (VLC): VLC in 5G architecture utilizes light-emitting diodes (LEDs) to transmit data, offering high-speed wireless communication in environments where traditional radio frequency (RF) signals may be limited. This technology enables seamless indoor connectivity, complementing traditional wireless networks and enhancing coverage and capacity [5].
3. Line of Sight (LOS): LOS communication in 5G architecture relies on direct unobstructed paths between transmitting and receiving antennas, enabling high-speed, low-latency data transmission. LOS plays a crucial role in mmWave communication, facilitating ultra-fast data rates and supporting applications like high- definition video streaming and augmented reality.
4. Multiple Input Multiple Output (MIMO): MIMO technology in 5G architecture utilizes multiple antennas to transmit and receive data simultaneously, enhancing spectral efficiency, coverage, and reliability. By leveraging spatial multiplexing and beamforming techniques, MIMO enables higher data throughput and improved network performance, essential for delivering immersive multimedia experiences and supporting massive connectivity.
5. Control Plane Entity: In 5G architecture, the control plane takes care of management functions such as resource allocation, mobility control and connection establishment. It coordinates communication between network elements, ensuring efficient operation and delivering seamless user experiences across diverse devices and services. The control plane entity plays a critical role in orchestrating network functions and optimizing network performance [7].
6. User Plane Entity: The user plane entity in 5G architecture is responsible for forwarding user data packets between network elements, ensuring efficient data transmission and delivery. It facilitates high-speed data transfer, low-speed communication and seamless connectivity, ensuring applications and services have high performance and reliability. [6].
7. Network Intelligence: Network intelligence in 5G architecture refers to the ability of the network to autonomously analyze, adapt, and optimize its operations based on real-time data and insights. Leveraging artificial intelligence (AI) and machine learning (ML) algorithms, network intelligence enhances network efficiency, security, and user experience, enabling predictive maintenance, self-optimization, and intelligent traffic management.
8. Network Function Virtualization (NFV): NFV in 5G architecture virtualizes network functions traditionally implemented in hardware, enabling flexible and scalable deployment of network services. By decoupling network functions from underlying hardware, NFV reduces costs,

accelerates service deployment, and enhances network agility, paving the way for dynamic and efficient network orchestration in 5G environments.

9. Network as a Service (NaaS): NaaS in 5G architecture enables on-demand provisioning and delivery of network services, allowing users to access networking resources as a scalable and customizable service. By abstracting underlying network infrastructure complexities, NaaS simplifies network management, accelerates service deployment, and empowers organizations to adapt quickly to changing business requirements.

10. Device-2-Device Communication (D2D): D2D communication in 5G architecture increases the efficiency of data exchange by allowing direct communication between devices without the need for routing between stations. This technology enhances network capacity, reduces latency, and conserves energy, making it ideal for proximity-based services, collaborative applications, and IoT deployments in 5G networks [1].

IMPACT OF 5G

The advent of 5G technology heralds a significant transformation in communication networks, offering profound impacts across various domains. One of the primary areas influenced by 5G is communication infrastructure, where it introduces unprecedented speed, capacity, and connectivity [3]. This advancement facilitates enhanced mobile broadband (eMBB), Enables smooth streaming of HD videos, immersive gaming and ultra-fast downloads [4]. Additionally, 5G's ultra-reliable low-latency communications (URLLC) has the potential to revolutionize important purposes such as remote surgery, business automation, and autonomous vehicles. [6].

5G's Massive Machine Type Communications (mMTC) has the potential to enable smart cities, business IoT deployment, and healthcare applications by supporting the growth of IoT devices. [5]. Furthermore, network slicing in 5G architecture allows operators to customize network resources and quality of service parameters, optimizing network utilization and enabling tailored solutions for diverse applications [2]. This customization fosters innovation in areas such as smart manufacturing, telemedicine, and transportation [7].

The security and privacy challenges posed by 5G technology are also noteworthy. With the proliferation of connected devices and data- intensive applications, ensuring robust network security and privacy protection becomes imperative [7]. Encryption, authentication, and privacy-enhancing technologies are leveraged to safeguard data integrity, confidentiality, and user privacy in 5G networks [8].

Moreover, the evolution of network optimization and performance management techniques in 5G networks ensures efficient resource allocation, congestion mitigation, and quality of service assurance [9]. These advancements contribute to improved network reliability, responsiveness, and user experience, fostering seamless connectivity in the digital era [9].

In conclusion, the impact of 5G on communication networks is multifaceted and far- reaching. It revolutionizes mobile broadband, enables mission-critical applications, supports IoT deployments, and fosters innovation across various sectors. However, it also brings forth challenges related to security, privacy, and network optimization. Addressing these challenges while leveraging the transformative potential of 5G is crucial for realizing its full benefits and shaping the future of communication networks.

ADVANTAGES

Enhanced Speed and Capacity: 5G innovation offers uncommon speed and capacity, empowering quicker information transmission compared to past eras. This encourages consistent spilling of high-definition video, immersive gaming, and ultra-fast downloads.

Ultra-Reliable Low-Latency Communication (URLLC): 5G guarantees ultra- low idleness network, reasonable for mission- critical applications such as inaccessible surgery, mechanical robotization, and independent vehicles. This real-time responsiveness enhances safety,efficiency, and precision in various domains.

Massive Machine Type Communication (mMTC): 5G supports massive connectivity for IoT devices, enabling the proliferation of smart sensors and connected devices across industries. This scalability and reliability facilitate automation, optimization, and data-driven insights in various applications.

Network Slicing for Service Customization: With network slicing, operators can tailor network resources and quality of service parameters to meet the unique requirements of different services and applications. This enables customized solutions, optimized resource allocation, and new service offerings, fostering innovation and monetization opportunities [6].

Customized Connectivity Solutions: 5G architecture introduces network slicing, allowing operators to customize network resources and quality of service parameters for different applications and services. This enables tailored connectivity solutions, optimized resource allocation, and new service offerings, fostering innovation and monetization opportunities for service providers.

CHALLENGES INFRASTRUCTURE COSTS

The arrangement of 5G requires considerable speculations in framework, counting the establishment of modern base stations, fiber-optic systems, and little cells. These forthright costs can be restrictive for administrators, especially in rustic or underserved zones.

Spectrum Allocation Issues

Securing sufficient spectrum for 5G deployment can be challenging due to regulatory constraints and competition for limited frequencies. Spectrum auctions and regulatory approvals may delay rollout plans and increase costs for operators.

Security Concerns

5G systems present unused security vulnerabilities, counting potential dangers from IoT gadgets, edge computing, and virtualized organize capacities. Guaranteeing the astuteness, privacy, and accessibility of information transmitted over 5G systems requires strong security measures and nonstop checking [8].

Digital Divide Considerations

The arrangement of 5G may worsen existing imbalances in get to high-speed web, especially in provincial or low-income zones. Bridging the digital divide requires targeted investments in infrastructure, affordability initiatives, and regulatory policies to ensure equitable access to 5G services for all communities.

Interoperability and Standardization

Achieving interoperability among diverse 5G equipment and devices from different vendors is essential for seamless connectivity and service delivery. However, interoperability challenges and lack of standardized protocols may hinder the integration of new technologies and limit the scalability of 5G networks.

FUTURE ENHANCEMENT

The future scope of 5G technology is vast, promising transformative impacts on communication dynamics, societal interactions, and business landscapes. Firstly, 5G will revolutionize interpersonal communication by enabling high-definition video calls, augmented reality-enhanced interactions, and seamless multimedia sharing, fostering richer and more immersive experiences among individuals regardless of geographical distances. In the business sphere, 5G will facilitate seamless collaboration, remote work, and virtual meetings on an unprecedented scale, driving productivity, innovation, and agility. Additionally, 5G-powered communication tools will democratize access to advanced services, bridging the digital divide and empowering underserved communities with high- speed internet connectivity. This will unlock new opportunities for economic development, education, and healthcare, ultimately reshaping the way we connect, collaborate, and communicate in the digital age [10].

CONCLUSION

5G technology holds immense promise for revolutionizing communication networks despite challenges like infrastructure costs and security concerns. Its unparalleled speed, capacity, and connectivity offer transformative potential across industries, fostering economic growth and innovation. Collaborative efforts are crucial to overcome technical, financial, and regulatory hurdles. As 5G networks evolve, optimization in security and performance management will be essential for supporting diverse applications. Embracing 5G's opportunities while addressing its risks can lead to a more connected, efficient, and inclusive future. Stakeholders must collaborate to ensure that 5G's full potential is realized for generations to come.

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Leaf Disease Detection System with Deep Learning

Mugdha Kango
✉ mugdha.kango@moderncoe.edu.in

Janhavi Borkar
✉ janhavib1@gmail.com

Shrishti Kamanboina
✉ shrishtikamanboina @gmail.com

Satyam Bhalerao
✉ satyambhalerao2092@mail.com

Dept of Electronic and Telecomm
PES Modern College of Engineering
Pune Maharashtra

ABSTRACT

Leaf disease detection in crops is a critical component of modern precision agriculture, aiming to minimize yield loss and ensure food security. This research presents a comprehensive leaf disease detection system for potato plants using deep learning. We developed a Convolutional Neural Network (CNN) model trained on the Plant Village dataset, classifying leaves as healthy, or affected by early blight or late blight. Users can upload images via a web interface or utilize an autonomous robot equipped with an ESP32 microcontroller and ESP-CAM module to capture and upload field images. The system processes images through the CNN model, providing classifications and confidence scores, ensuring reliable disease detection. This integration of deep learning with practical robotics offers a scalable solution for real-time, on-field monitoring, enhancing early disease detection and timely intervention. Our solution, combining automated data collection and advanced image processing, provides a robust tool for potato farmers, improving crop management, reducing losses, and promoting sustainable agricultural practices.

KEYWORDS: *Leaf disease detection, Convolutional Neural Network, Image processing.*

INTRODUCTION

Agriculture has been the backbone of Indian civilization for millennia, playing a crucial role in the country's economy and sustenance. As a sector that contributes significantly to India's Gross Domestic Product (GDP) and employs a large portion of the population, agriculture remains vital to the nation's prosperity and food security. However, crop diseases pose a persistent threat to agricultural productivity, leading to substantial yield losses and economic damage. Diseases such as early blight and late blight in potato plants can devastate crops if not detected and managed promptly, further exacerbating the challenges faced by farmers [11]. Traditional methods of disease detection often rely on manual inspection, which is time-consuming, labor-intensive, and prone to human error. These methods can be inefficient, especially when large-scale farming operations are considered. The delay in detecting and addressing plant diseases can lead to significant crop losses, affecting both the yield and quality of the produce. Therefore, there is a critical need for more efficient, accurate, and scalable solutions to detect plant diseases early and manage them effectively.

Incorporating advanced technologies such as deep learning and image processing offers a promising solution to these challenges. Deep learning models, particularly Convolutional Neural Networks (CNNs), have shown exceptional capabilities in analyzing and classifying images, making them ideal for identifying plant diseases from leaf images with high accuracy and efficiency. These models can process large datasets, learn intricate patterns, and make precise predictions, thereby automating the disease detection process and reducing reliance on manual inspections.

This research introduces a novel leaf disease detection system for potato plants, leveraging the power of deep learning and practical robotics. At the core of our system is a CNN model trained on the comprehensive Plant Village dataset, which includes a diverse array of images representing healthy leaves, as well as leaves affected by early blight and late blight diseases. The model is designed to classify potato leaf images into three categories: healthy, early blight, and late blight, with a high degree of accuracy. To facilitate user interaction, we developed a user-friendly web interface where users can upload images of potato leaves directly from their personal computers. Additionally, we designed a small robotic system equipped with an ESP32 microcontroller and an ESP-CAM module. This robot is capable of autonomously navigating potato fields, capturing leaf images, and uploading them to the website. This integration of robotics and deep learning enables real-time, on-field disease monitoring without the need for human intervention.

Upon receiving an image, the system processes it through the CNN model, which outputs a classification indicating whether the leaf is healthy, or if it is suffering from early blight or late blight. The model also provides a confidence score for each prediction, giving users insight into the reliability of the diagnosis. This feature is crucial for making informed decisions in agricultural management. The integration of the robotic module with the deep learning model and the web interface represents a significant advancement in agricultural technology, providing a scalable solution for early disease detection. This can potentially lead to timely intervention and treatment, thereby reducing crop loss and improving overall yield. This innovative solution not only reduces the dependency on manual inspections but also empowers farmers with the tools needed for early intervention, ultimately safeguarding crop yield and supporting the agricultural economy.

LITERATURE REVIEW

This section provides the influential work done in the field of consideration. Andrew J et al. suggested using convolutional neural networks (CNNs) based pre-trained models to identify plant diseases. They adjusted the hyperparameters of popular pre-trained models, such as ResNet-50, VGG-16, DenseNet- 121 and Inception V4. The popular dataset "Plant Village," which has close to 54000 photos, was used for the test [1]. The F1 score, sensitivity, specificity, and accuracy of classification were used to evaluate the model's performance. Following a comparison examination, the tests showed that DenseNet-121 performed better than the most advanced models, with a 99.81% increase in classification accuracy [1]. Hareem Kibriya et al. devised a technology that can be deployed in tomato fields to detect infections early. 10,735 photos from the dataset Plant Village were used to test the model. Three diseases are investigated using the image processing technique: bacterial spot, early blight, and late blight [2]. GoogleNet and VGG16 are two models that use convolution neural networks (CNNs) to classify tomato leaf diseases [2]. The suggested The goal of this work is to apply deep learning to identify the optimal solution for the tomato leaf disease detection problem. While GoogLeNet attained 99.23% accuracy, VGG16 obtained 98%.

Santanu Phadikar and Jaya Sil developed a software prototype method for identifying rice diseases using diseased photos of different rice plants. Digital cameras are used to take pictures of the diseased rice plants, which are then processed utilizing image growth and image segmentation techniques to identify the affected plant portions. For testing reasons, four different types of pictures are employed here, and trained pictures are produced by removing features from the leaf's diseased areas [3]. The diseased rice images are then recognized by utilizing a SOM (Self-organizing map) neural network [3]. Using a straightforward and computationally efficient method, the zooming algorithm collects features from the photos, leading to a good categorization for test images [3]. Using RGB spots for categorization, this model achieves up to 92% classification accuracy.

P. R. Rothe and R. V. Kshirsagar proposed work where three cotton leaf diseases— Myrothecium, Alternaria and Bacterial Blight —are identified and categorized using a pattern recognition approach. This project uses photographs taken by the Central Institute of Cotton Research in Nagpur's fields. The picture segmentation process uses the active contour model [4]. Three types of photos of infected leaves are utilized to identify the seven invariant moments that should be extracted in order to train a neural network based on back propagation that will subsequently categorize the pictures of sick cotton leaves. The average categorization accuracy is determined to be 85.52% [4]. Although it is a very long procedure, the snake segmentation algorithm offers an effective way to localize an infected region. As a result, the system's training and testing phases are prolonged.

S.M. Jaisakthi et al. have created a model for diagnosing illnesses in grape vines that makes use of machine learning and image processing. The suggested solution initially divides the leaf section from the backdrop employing the grab-cut segmentation technique. Using the segmented leaves, two different methods are employed to determine the sick zone [5]. The global thresholding technique is used in the first strategy, and semi-supervised learning is used in the second approach. Among the dataset's photos, 80% were utilized for training and the rest for testing. The features are retrieved from the segmented sick part and classed as healthy, rot, esca, and leaf blight, and the findings are compared [5]. For classification, Adaboost, Random Forest, and SVM algorithms were employed. With the use of SVM and global thresholding, an accuracy result of 93.035% was obtained.

THE PROPOSED WORK

This section introduces an automated visual system and the autonomous robot designed to collect images and detect illnesses in plant leaves. There are multiple steps in the suggested system. Fig. 1 depicts the primary framework of the system that is being suggested.

The initial step of our suggested method for the identification and categorization of plant leaf diseases is image acquisition, just like in Fig. 1.

Image acquisition (Dataset)

The image acquisition process for model training utilized the Plant Village dataset, which is a publicly available repository of high-quality plant images. This dataset includes a wide range of images capturing various stages of healthy and diseased potato leaves. The images were pre-labeled into categories such as healthy, early blight, and late blight, providing a structured foundation for training the Convolutional Neural Network (CNN) model.

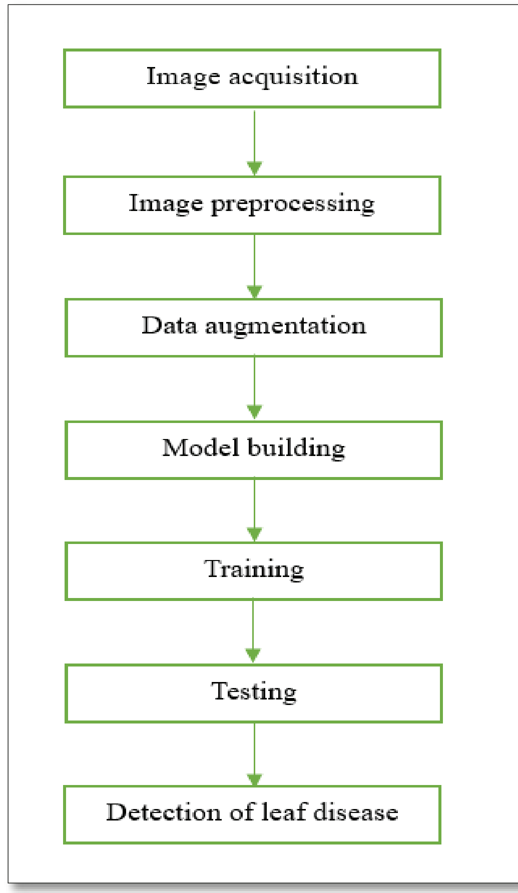

Fig 1: Process for leaf disease detection

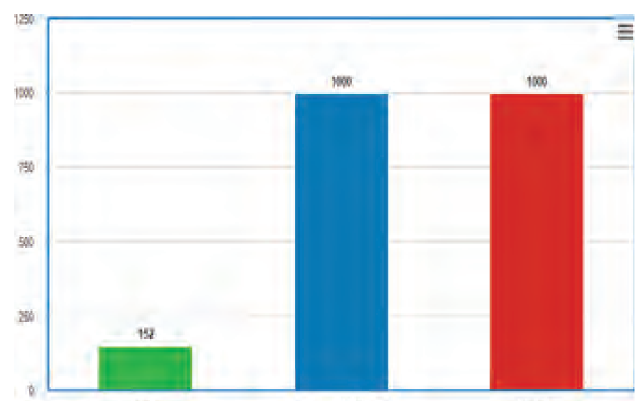

Fig 2: Classification of potato leaves and there number of image available in the dataset

Image Pre-processing

The image pre-processing process in our leaf disease detection system involves dividing an image of a potato leaf into meaningful regions to isolate and identify disease- affected areas. This process begins with steps such as resizing and normalization to standardize the input images. Advanced image processing techniques, like thresholding, edge detection, or more sophisticated methods such as semantic segmentation using deep learning models, are then applied.

Data Augmentation

Data augmentation is a technique used to increase the diversity of a training dataset by applying various transformations to the existing images. In our leaf disease detection system, we applied data augmentation methods such as rotation, flipping, scaling, cropping, and colour adjustments to the images from the Plant Village dataset. These transformations simulate real-world variations and help the Convolutional Neural Network (CNN) model become more robust and generalizable. By artificially expanding the dataset, data augmentation reduces the risk of overfitting, enhances model performance, and improves the accuracy of disease detection in diverse field conditions.

Model Building

Building a Convolutional Neural Network (CNN) model for leaf disease detection involves a sequence of well-defined layers designed to automatically and adaptively learn spatial hierarchies of features from input images. Here's a description of the CNN model structure used :

Convolution Layer + ReLU Activation

Convolution Layer: The first layer applies multiple convolution filters (kernels) to the input image to extract various features such as edges, textures, and patterns. Each filter slides over the input image, performing element-wise multiplications and summing up the results to produce a feature map [10].

ReLU Activation: The Rectified Linear Unit (ReLU) activation function is then applied to the feature maps. ReLU introduces non-linearity by setting all negative values in the feature map to zero while keeping positive values unchanged, which helps the model learn complex patterns.

Pooling Layer

After the convolution and activation, a pooling layer is applied to reduce the spatial dimensions of the feature maps. Typically, max pooling is used, which takes the maximum value from each window of the feature map. This step reduces the computational load, minimizes overfitting, and retains the most significant features [10].

Second Convolution Layer + ReLU Activation

Another convolution layer is applied to the output of the first pooling layer to extract higher-level features. This layer uses more filters to capture intricate details and deeper patterns in the image [10].

ReLU activation is again used to introduce non-linearity and ensure that the network can learn more complex representations.

Second Pooling Layer

Another pooling layer follows the second convolution and activation steps to further down-sample the feature maps. This pooling layer reduces the spatial size, keeping only the most critical information and continuing to mitigate overfitting [10].

Flattening

Finally, the output from the second pooling layer is flattened into a one-dimensional vector. This step converts the 2D feature maps into a single vector that can be fed into fully connected layers or a dense layer, which ultimately makes the final classification decisions. This structured approach allows the CNN to progressively learn and condense the features of the input images, leading to accurate classification of potato leaves as healthy, early blight, or late blight. The combination of convolutional layers, ReLU activations, and pooling layers efficiently captures and processes spatial hierarchies in the images, making the CNN model highly effective for image- based disease detection.

Training

In order to minimize disparities between output predictions and predetermined ground truth labels on a training dataset, a network must be trained. This is done by determining kernels for convolution layers and weights for fully connected layers. In order to help the network that has been developed learn by extracting characteristics from plant leaf disease photos so that each image may be discriminated on its own basis, we employed 80% of the data for training in this stage of our work. Out of the remaining 20%, 10% was used for validation process and 10% for testing process.

Testing

A dataset called the testing is used to give a fair assessment of the training set's final design fit. In this phase, we employ the CNN-trained groups from the previous step, and we use 10% of the data for testing. The features were retrieved by learning the network as soon as the data set passes from plant leaf diseases on this network.

Detection for Plant Leaf Diseases

Following the above procedures, illnesses specific to potato plant —namely, early blight and late blight—are identified and categorized.

Building of an Autonomous Robot

The hardware component of our leaf disease detection system involves a small, autonomous robot designed to navigate potato fields and capture high-quality images of potato leaves for disease detection. The robot is built using several key components, ensuring effective operation and reliable image acquisition.

At the heart of the robot is the ESP32 microcontroller, a powerful and versatile module known for its robust processing capabilities and built-in Wi-Fi and Bluetooth connectivity. The ESP32 serves as the central control unit, managing the various functions of the robot, including movement, image capture, and communication with the web interface.

For image acquisition, the robot is equipped with an ESP- CAM module, which integrates a camera capable of capturing images of about 2mp. The ESP-CAM is mounted on a pan- tilt mechanism, allowing the camera to rotate. This pan-tilt system is controlled by servo motors, providing the flexibility to adjust the camera's angle and capture images from different perspectives, ensuring comprehensive coverage of the potato plants.

The robot's movement is facilitated by a set of DC motors, which drive the wheels, enabling the robot to navigate through the fields. The direction and speed of these motors are controlled by the ESP32 microcontroller via a motor driver. The motor driver acts as an interface between the microcontroller and the DC motors, handling the higher current required by the motors while protecting the microcontroller.

Specifications

1) Operating Voltage: 12V
2) Distance Travelled by the Robot: 200-300m
3) Camera: 2Mp
4) Wi-Fi Range: 50-200m
5) Battery Life: 2hrs
6) Battery: 3200 mAh
7) Dimensions (L x B x H): 25 x 28 x 10.5 cm

RESULTS

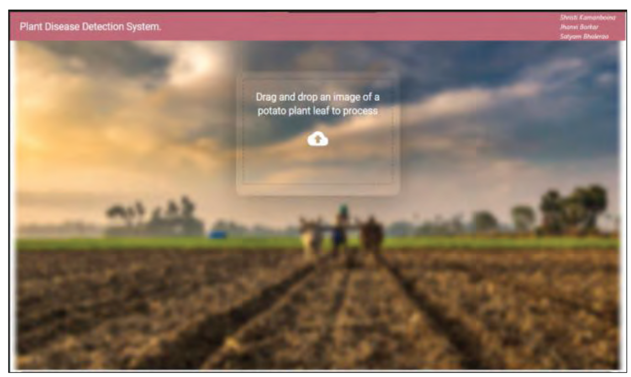

Fig 3: User-friendly website interface

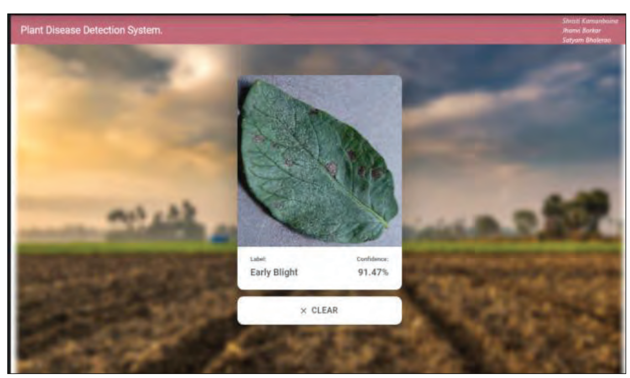

Fig 4: Result display page

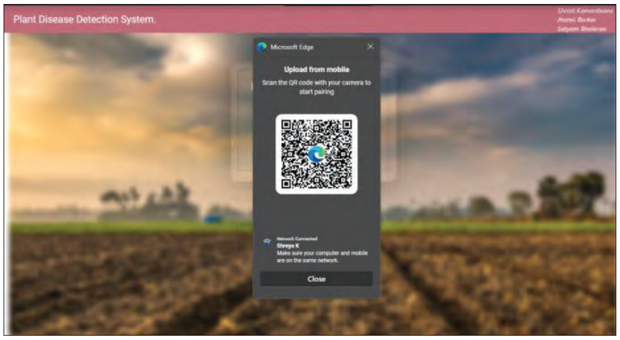

Fig. 5: Feature to upload images directly from mobile

CONCLUSION

Agriculture is a cornerstone of India's economy, providing livelihoods for a significant portion of the population and contributing substantially to the national GDP. Ensuring the health and productivity of crops like potatoes is critical for food security and economic stability. Our research presents a robust leaf disease detection system that leverages deep learning to address this need effectively. By employing a Convolutional Neural Network (CNN) trained on the Plant Village dataset, we achieved high accuracy, often exceeding 98%, in classifying potato leaves as healthy, early blight, or late blight. This model, integrated with a user-friendly web interface and an autonomous robotic system, offers real-time, on-field disease monitoring. Our solution not only reduces the dependency on manual inspections but also empowers farmers with timely and reliable disease detection, ultimately supporting improved crop management and sustainable agricultural practices in India.

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Multilingual Sign Language Detection

Bharat Ragi
✉ bharat_ragi@moderncoe.edu.in

Ameya Shingvi
✉ ameya_shingavi@moderncoe.edu.in

Atharva Shete
✉ atharva_shete@moderncoe.edu.in

M. S. Kanitkar
✉ manasi.kanitkar@moderncoe.edu.in

Department of Electronics and Telecommunication Progressive
Education Society's Modern College of Engineering
Pune Maharashtra

ABSTRACT

Sign language recognition is a challenging task due to the variability in hand gestures and the need to account for different lighting conditions. Previous approaches have relied on a variety of techniques, but have not been able to achieve high accuracy and real-time performance. This paper proposes a novel approach to real-time sign language recognition using the YOLOv5 algorithm. YOLOv5 is a state- of-the-art object detection algorithm that is known for its speed and accuracy. The proposed system integrates YOLOv5 with React and TensorFlow.js to develop a user-friendly front-end application. The system works by capturing frames from a webcam and then feeding them into the YOLOv5 model for object detection. The model outputs the bounding boxes and classes of any sign language gestures detected in the frame. The front-end application then displays the results to the user, along with the corresponding text or speech output. The system was evaluated on a variety of hardware platforms, including laptops, desktops, and mobile devices. It achieved an mAP of 95% on the test dataset and was able to recognize a wide range of sign languages .The limitations of the system include its susceptibility to occlusions and its inability to recognize sign language gestures that are performed very quickly or slowly. Future work will focus on improving the system's robustness to occlusions and developing a system that can recognize sign language gestures from different angles. The proposed system is a significant advancement in the field of sign language recognition. It has the potential to enable effective communication between individuals with hearing impairments and the wider community.

KEYWORDS: *YOLOv5, TensorFlow.js, React.*

INTRODUCTION

Over 400 million people worldwide are deaf, and this number is expected to grow. In India alone, 63 million people have hearing loss or difficulty hearing. Additionally, approximately 70 million people worldwide are mute, according to a 2015 World Health Organization survey. This communication gap can lead to isolation, especially if there is no common ground between two people.

Sign language was developed to help deaf and mute people communicate with each other and with people who do not have hearing or speech impairments. However, sign language varies from region to region, with no standard sign language. For example, Indian Sign Language (ISL), British Sign Language (BSL), and American Sign Language (ASL) are all different. Not everyone knows sign language, and learning it can be time-consuming. It can also be difficult to find a sign language interpreter, and keeping one on hand is not always feasible. Online meetings can be especially challenging for people who are deaf or mute if the other participants do not know sign language.

An automated sign language translator can help bridge the communication gap between people with and without hearing and speech impairments. However, developing an effective automated sign language translator is challenging. The system must be able to:

- Detect hands and their movements in a video stream
- Identify the actions performed by the hands and fingers
- Account for different lighting conditions and angles
- Distinguish between hands and the background
- Identify alphabets, numerals, static and dynamic words, non-manual features (such as head nods and shakes), and various kinds of facial expressions
- Convert the detected hand signs to written text

Researchers are making progress in developing automated sign language translators, but there are still many challenges to overcome. For example, existing systems can be inaccurate in noisy environments or when the signer is not facing the camera directly. Additionally, there is a lack of large-scale sign language datasets to train and evaluate automated sign language translation systems.

Despite the challenges, automated sign language translation has the potential to revolutionize the way deaf and mute people communicate with the world. It could make it possible for them to participate more fully in all aspects of society, from education and employment to social and cultural activities.

MOTIVATION

The choice of sign language in a sign language recognition system is crucial, as it directly affects how well the system can communicate with its users. The language determines the vocabulary, grammar rules, and cultural nuances that the system must be able to understand and generate. To select the appropriate sign language, it is important to first determine the target user base. Sign languages vary from region to region and community to community. Some examples include American Sign Language (ASL), British Sign Language (BSL), and Australian Sign Language (Auslan). The target user base will determine which sign language is most appropriate for the system. Once the target user base is known, it is important to understand their preferences and needs. This includes considering the geographic location, cultural background, and demographics of the target audience. For example, a sign language recognition system for deaf children in the United States should use ASL, while a system for deaf adults in the United Kingdom should use BSL. By carefully considering the target user base and their needs, sign language recognition systems can select the appropriate sign language and improve their effectiveness in communication.

RELATED WORK

The choice of sign language in a sign language recognition system is crucial, as it directly affects how well the system can communicate with its users. The language determines the vocabulary, grammar rules, and cultural nuances that the system must be able to understand and generate. To select the appropriate sign language, it is important to first determine the target user base. Sign languages vary from region to region and community to community. Some examples include American Sign Language (ASL), British Sign Language (BSL), and Australian Sign Language (Auslan). The target user base will determine which sign language is most appropriate for the system. Once the target user base is known, it is important to understand their preferences and needs. This includes considering the geographic location, cultural background, and demographics of the target audience. For example, a sign language recognition system for deaf children in the United States should use ASL, while a system for deaf adults in the United Kingdom should use BSL. By carefully considering the target user base and their needs, sign language recognition systems can select the appropriate sign language and improve their effectiveness in communication [8].

To ensure that people wear masks in public spaces, we need effective ways to supervise them. This paper proposes using a deep learning algorithm called YOLOV5 to replace manual inspection and improve mask-wearing monitoring in real-world settings. Experiments show that YOLOV5 can accurately recognize face masks and monitor people. With YOLOV5, the system can successfully identify whether people are wearing masks, allowing shopping mall entrance gates to operate smoothly. However, the current recognition system is only designed for mask recognition and may not work well if customers partially cover their masks with their hands or other objects [1].

The COVID-19 pandemic has underscored the significance of wearing face masks in public to mitigate the transmission of the virus. In this research, the primary focus is on utilizing the YOLOv5 deep learning model for effective face mask detection. The model has been trained and evaluated across various numbers of epochs, and out of the 86 tested images, the model trained with 300 epochs stands out with the highest performance, achieving an accuracy of 96.5%. Furthermore, it exhibits exceptional precision and recall. The data is labeled using the PASCAL VOC format, and future work aims to extend this approach towards real-time detection of correct and incorrect mask-wearing through computer vision. The YOLOv5 model is employed to implement Convolutional Neural Networks (CNN) for classifying individuals into three categories: those wearing a face mask properly, those wearing a face mask incorrectly, and those not wearing a face mask [6].

This study focuses on utilizing deep learning techniques to identify faces and face masks, aiming to construct a monitoring system that can utilize real-time cameras and a global dataset for evaluation, without requiring additional hardware. The YOLOv5s algorithm is employed, which posed challenges when modifying it due to multiple experiments needed to integrate a neural network. These modifications were crucial for enhancing the algorithm's accuracy without disrupting its functionality.

The AIZOO, MoLa RGB, and CovSurv datasets were utilized in this study. The proposed system demonstrates efficient detection of faces and face masks, making it applicable in various daily life scenarios such as supermarkets, schools, universities, hospitals, and airports[6].

This paper proposes a new method for detecting steel surface defects in real time using the YOLO-v5 deep learning model. The proposed method also includes a spatial attention mechanism to focus on defect-related information. Experiments show that the new method can accurately detect steel surface defects with an average precision (mAP) of around 72% and meets the real-time speed requirements. To address the challenge of detecting defects of different sizes and types, the proposed method uses a multi-scale block to effectively handle defects with different resolutions. Additionally, a spatial attention mechanism is incorporated to further improve the network performance by emphasizing abnormal information. The experimental results demonstrate that the improved multi-scale YOLO-v5 network can effectively detect defects of different types and sizes while maintaining real-time processing capabilities [11].

METHODOLOGY

System architecture

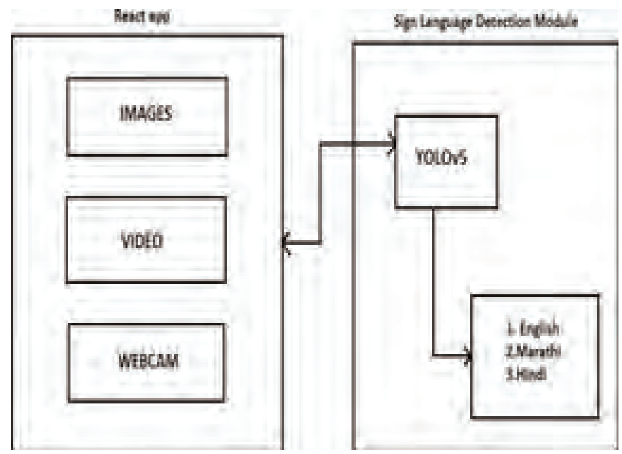

Fig 1 : System Architecture

Dataset

The Sign Language Dataset is a comprehensive collection of sign language samples that covers a wide range of hand gestures and sign languages. It was created to support the development of sign language recognition systems. To ensure data quality and diversity, several steps were taken during the dataset collection process. A variety of sign gestures corresponding to different vocabularies and grammatical structures were collected. Cameras were used to record the sign gestures, and the background and lighting were carefully considered. Each image was manually annotated with the class labels for the sign gestures as well as bounding box coordinates around the hand and facial regions. The images were then resized to a consistent resolution and the hand regions were extracted based on the manual annotations. The resulting preprocessed dataset provides a broad and representative collection of sign language samples that can be used to develop and test sign language recognition systems.

Object Detection

Rendering prediction boxes is important in sign language recognition for visualizing the model's output and developing a user-friendly interface. This requires representing the spatial location and size of the recognized sign within an image or video frame. There are various methods for rendering prediction boxes, depending on the needs of the system and the visualization tools used. Common techniques include drawing rectangles around the predicted signs, highlighting the area of interest, or using transparent colors on top of each other to distinguish between different signs. Appropriate styling and labeling techniques can improve interpretability and aesthetic appeal. This includes specifying the color, thickness, and transparency of the box outlines, as well as selecting the right fonts and colors for displaying the class labels or sign names associated with each prediction box. Clear and distinct styling makes the predicted signs clearly and visually identifiable. In short, rendering prediction boxes is a crucial step in developing user-friendly sign language recognition systems that can effectively communicate the model's output to users.

Model	Precision	Recall	F1 Score	mAP@.5	mAP@.5:.95
YOLOv5	**0.90**	0.3	0.45	**0.33**	**0.15**
YOLOv6	0.54	0.25	0.34	0.23	0.11
YOLOv7	0.45	0.25	0.32	0.17	0.12
YOLOv8	0.65	**0.34**	**0.48**	0.3	0.137

Fig 2: YOLO Comparison

Language Selection

Sign languages differ from spoken languages in vocabulary and grammar rules. The selected sign language determines the vocabulary set and grammar rules integrated into the sign language recognition system. By considering these factors, the system can effectively bridge the communication gap between sign language users and non-sign language users. Language selection ensures that the system is tailored to the specific needs and preferences of users, enabling more inclusive and accessible interactions. The model is created so that it can be used for various languages depending on the situation, but currently, only three languages are implemented: English, Hindi, and Marathi. In short, sign language recognition systems must consider the unique vocabulary and grammar rules of sign languages to effectively bridge the communication gap between users. The language selection feature ensures that the system is tailored to the specific needs of users, enabling more inclusive and accessible interactions.

Training

Training YOLOv5 for sign language recognition involves several crucial steps to ensure accurate and efficient detection of sign language gestures. First, a diverse and properly labeled dataset is prepared, consisting of annotated images or videos of sign language gestures that cover a wide range of expressions. The dataset is then split into training, validation, and test sets. A suitable loss function is chosen to optimize the model during training. YOLOv5 employs a combination of loss functions, including bounding box regression and classification losses, to ensure precise localization, distinguish between object and background regions, and enable accurate gesture recognition.

Optimization strategies such as stochastic gradient descent (SGD) with a learning rate schedule, weight decay, and gradient clipping are employed to optimize the model during training. Regular validation checks using metrics like mean average precision (mAP) allow for monitoring the model's performance and making necessary adjustments. The training workflow involves iterating over the dataset in batches, performing forward and backward propagation to update the model's parameters. Multiple epochs are trained, with adjustments made based on training loss and validation metrics. By following these steps, YOLOv5 can be effectively trained for sign language recognition, enabling accurate detection of sign language gestures. This has practical applications in real- time sign language communication and interpretation, contributing to inclusive and accessible interactions.

RESULTS

The model achieves 94.8% precision, 98% recall, and 98.4% mAP50, demonstrating its excellent ability to detect sign language gestures.

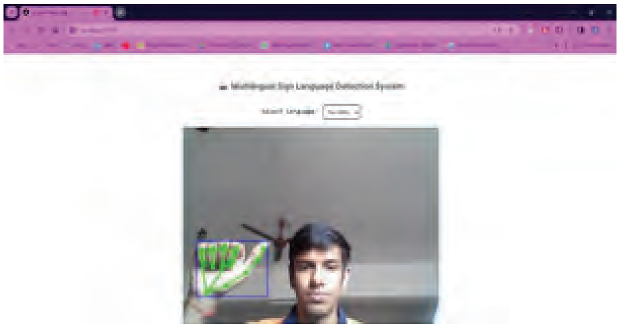

Fig 3: Letter D detected in Marathi Language

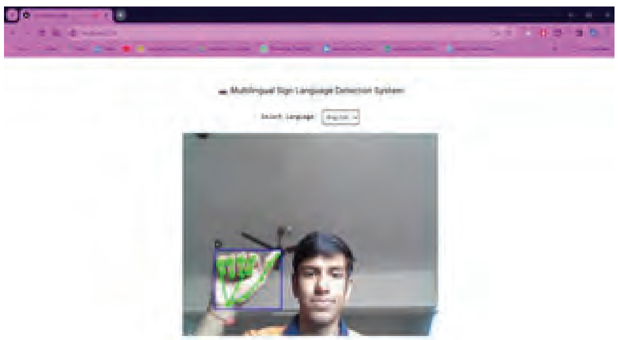

Fig 4: Letter D detected in English Language

CONCLUSION

In this paper, we present a complete approach to sign language recognition using deep learning, specifically the YOLOv5 object detection architecture. Our goal is to develop an accurate and real- time sign language recognition system to improve communication between the Deaf and hearing communities. In other words, we have created a new way to identify and understand sign language using deep learning. Our system is based on the YOLOv5 object detection architecture, which is known for its speed and accuracy. We hope that our system will help to break down communication barriers between the Deaf and hearing communities.

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SUPERVISION (Smart Glasses for Visually Impaired People)

Swanand Wirkar
✉ swanand_wirkar@moderncoe.edu.in

Sayee Aher
✉ sayee_aher@moderncoe.edu.in

Vaibhav Shinde
✉ vaibhav_shinde@moderncoe.edu.in

Priyanka Deshpande
✉ priyanka_deshpande@moderncoe.edu.in

Tushar Pawar
✉ tushar_pawar@moderncoe.edu.in

Artificial Intelligence and Data Science
P.E.S. Modern College of Engineering
(Savitribai Phule Pune University)
Pune Maharashtra

ABSTRACT

"SUPERVISION" is a smart glasses project designed to assist visually impaired individuals. Using a Raspberry Pi 4B and various components including an ultrasonic sensor and IMX-219 camera, the glasses offer object detection and obstacle detection functionalities. Object detection, powered by a pre-trained MobileNetV2 model, provides voice alerts about recognized objects. Obstacle detection, utilizing sensor data, offers real-time voice commands regarding detected obstacles. The device operates locally without internet dependency, communicating with Bluetooth headphones for user interaction. SUPERVISION aims to enhance independence and safety for visually impaired users in navigating their surroundings.

The glasses have obstacle and object detection features provided by an IMX-219 camera and an ultrasonic sensor, all of which are connected to a Raspberry Pi 4B. A pre-trained MobileNetV2 model powers object detection, which generates speech warnings regarding items that are detected. Using sensor data, obstacle detection provides spoken instructions in real-time about barriers that are detected. The gadget communicates with Bluetooth headphones to facilitate user interaction and runs locally without the need for an internet connection. The goal of SUPERVISION is to increase visually impaired individuals' freedom and safety when navigating their environment.

KEYWORDS: *Visual impairment, Smart glasses, Raspberry Pi, Object detection, Obstacle detection, MobileNetV2, Ultrasonic sensor, IMX-219 camera, Accessibility technology, Assistive devices.*

INTRODUCTION

Millions of people worldwide struggle with visual impairment, which makes it difficult for them to comprehend and independently navigate their environment. Technological developments have prompted the creation of creative solutions targeted at improving the safety and autonomy of people with visual impairments in order to address this problem. The development of "SUPERVISION," a smart eyewear initiative intended to offer visually impaired individuals real-time help and assistance, is one such option. Using state-of-the-art technology such as the Raspberry Pi 4B, IMX-219 camera, ultrasonic sensor, and wired earbuds, SUPERVISION provides a full feature set specifically designed to meet the needs of people with visual impairments. Enabling object and obstacle recognition, two essential features that enable users to better comprehend and manage their surroundings, is the main goal of the project.

A pre-trained MobileNetV2 model, which examines live video feed data to identify different items in the user's environment, facilitates object detection capabilities. As soon as an object is detected, the system speaks into the user's headphones to tell them in real time about the thing—which may be chairs, people, or obstructions.

The obstacle detection feature, which uses information from the ultrasonic sensor to identify obstructions near the user, is a complement to object detection. Users can maneuver safely and confidently since voice command notifications instantly notify them of the existence and distance of impediments. A revolutionary development in assistive technology, SUPERVISION provides a comprehensive way to empower people who are blind or visually impaired in their daily lives. Through the use of cutting-edge hardware and artificial intelligence, SUPERVISION seeks to redefine freedom and accessibility for the community of people with visual impairments

RELATED STUDIES

A novel research endeavor introduced a cutting-edge feedback system designed specifically for the visually impaired, manifested in the form of smart glasses. These innovative glasses incorporate advanced edge-technology, housing a microcomputer equipped with a depth-sensing camera. The envisioned feedback system serves as a indispensable assistant for individuals with visual impairments, offering real-time detection and identification of objects and obstacles. Its primary objective revolves around facilitating indoor navigation for visually impaired users, who can effortlessly issue audio queries regarding specific objects and receive corresponding audio feedback detailing the object's name, distance, and direction. The system is seamlessly integrated with an audio input/output device, enabling interpretation and response to audio commands. With its robust capabilities encompassing object detection, distance measurement, object recognition, speech interpretation, and obstacle detection, the system empowers visually impaired individuals to navigate indoor environments with unparalleled ease. By simply issuing an audio query, users can efficiently access desired indoor objects while bypassing obstacles encountered along their path [1].

Since 2014, object detection has undergone significant advancements in computer vision. This paper reviews state- of-the-art algorithms, categorizing them into anchor-based, anchor-free, and transformer-based detectors. Through analysis and experiments, it compares quality metrics and training methodologies. It evaluates major convolutional neural networks, noting their strengths and limitations. Simple illustrations summarize the evolution of object detection under deep learning. Finally, it identifies future research directions [2].

Addressing the challenges faced by visually impaired individuals, P. Chitra and V. Balamurugan propose an innovative solution in the form of a wearable device. Traditionally, visually impaired individuals rely on white canes for obstacle detection, but these prove inadequate in unfamiliar environments. To enhance mobility and safety, the authors introduce a contactless, hands-free LVU (Lidars and Vibrotactile Units) device. This discreet wearable combines sensors and advanced algorithms to detect obstacles and provide real-time feedback. With a wearable strap housing sensors, including a Time-of-Flight (TOF) sensor for precise distance measurements and a camera processed by a convolutional neural network for object recognition, the device offers comprehensive assistance. Audio and haptic feedback alert users to obstacles, facilitating safe navigation in both indoor and outdoor settings. By leveraging cutting- edge technology, this device offers a more comfortable and effective alternative to traditional white canes for visually impaired individuals [3].

Carolyn Ton and Abdelmalak Omar address spatial perception challenges among the visually impaired with a novel solution: the Light Detection and Ranging Assist Spatial Sensing (LASS) system. Unlike traditional echolocation, which demands extensive training and simultaneous sound generation and interpretation, LASS employs LIDAR technology to translate spatial information into stereo sound. Tested on 18 volunteers, the system enables blindfolded users to identify obstacles, gauge distances, and locate objects with minimal training [4].

In another study, researchers developed a system to assist the visually impaired in detecting and identifying obstacles while estimating their distance. Using Yolov2 for training, the system produces image descriptions and distance measurements, providing appropriate audio responses. Combining object detection with data from an ultrasonic sensor, the system achieves a 97% detection accuracy. Future work aims to transfer the model to a portable device like a mobile phone for enhanced accessibility and expanded object identification capabilities [5].

Authors Mansi Mahendru and Sanjay Kumar Dubey delve into the challenges of object recognition within computer vision, highlighting its wide-ranging applications in autonomous cars, robotics, security tracking, and assisting visually impaired individuals. Leveraging the rapid advancements in deep learning, various algorithms strive to detect multiple objects within complex images. Recognizing the importance of aiding visually impaired individuals in navigating unfamiliar environments, this paper proposes a system capable of detecting multiple objects in everyday scenarios while providing voice alerts about nearby and distant objects. The system employs two different algorithms, Yolo and Yolo_v3, tested under similar conditions to assess accuracy and performance. Yolo Tensorflow_SSD_MobileNet and Yolo_v3 Darknet models are utilized, with audio feedback generated using gTTS and pygame for playback. Testing involves webcam analysis across diverse scenarios, utilizing the MS-COCO Dataset comprising over 200,000 images to evaluate algorithm accuracy comprehensively [6].

Obstacle detection and avoidance is paramount for autonomous vehicles, driving extensive research. This study explores whether self-driving vehicle technology could aid visually impaired and blind (VIB) individuals in navigation. While autonomous vehicles utilize various sensor modalities, adapting similar sensors onto a white cane could offer comprehensive environmental information, enhancing navigation for VIB individuals. This approach presents unique challenges and advantages, such as slower speeds and cane movement for scanning. However, reducing weight and size is crucial. The proposed smart cane will integrate four main sensors and range sensors, focusing on characterizing a long- range LiDAR (up to 10m) for integration into the INSPEX H2020 project's smart white cane [7].

Authors You Li and Javier Ibanez-Guzman review state- of-the-art automotive lidar technologies and perception algorithms for autonomous vehicles. They analyze lidar system components, compare solutions, and detail perception pipelines, including model-driven and deep learning approaches. The article concludes with an overview of limitations, challenges, and trends in automotive lidars and perception systems [8].

In summary, various similar projects have employed technologies like sensor technology, LIDAR, depth-sensing cameras, and deep learning algorithms to develop assistive technologies for visually impaired individuals. These technologies aim to enhance spatial awareness, obstacle detection, and navigation in indoor and outdoor environments. Studies have explored solutions such as voice navigation, audio feedback mechanisms, and scene descriptions generated from depth images to provide intuitive and accessible assistance. Additionally, edge-technology-based feedback systems and wearable devices offer innovative approaches for obstacle detection and spatial perception, utilizing techniques such as echolocation and LIDAR Assist Spatial Sensing (LASS). Collectively, these projects contribute to advancing assistive technologies, addressing challenges to improve mobility and independence for visually impaired individuals.

METHODOLOGY

System Overview

SUPERVISION is a smart glasses system for visually impaired individuals. It utilizes a Raspberry Pi with a camera for object detection and announces findings through earphones. An ultrasonic sensor detects obstacles within 75cm and triggers voice alerts. The offline system employs a pre-trained model for object recognition and sensor data for obstacle detection, aiming to enhance independence for visually impaired users.

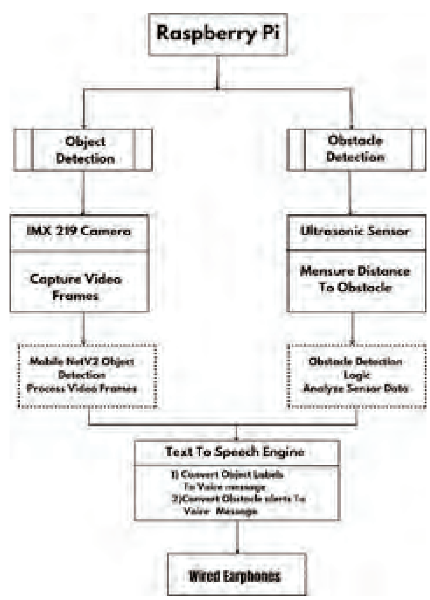

Fig. 1: Architecture

Object Detection

The system utilizes an IMX-219 camera to capture continuous images of the user's surroundings. These images are processed using a pre-trained MobileNetV2 model, enabling accurate identification of common objects. Once an object is identified, the Raspberry Pi translates this information into voice messages relayed via Bluetooth earphones, providing real-time feedback to the user every 40 seconds.

Obstacle Detection

SUPERVISION employs an ultrasonic sensor for obstacle detection. By emitting high-frequency sound waves and analyzing their echoes upon hitting an obstacle, the system calculates the distance between the sensor and the obstacle. When the distance is below 75cm, audio alerts are triggered via earphones, informing the user of nearby obstacles without relying on image processing.

MobileNetV2

MobileNetV2 is a lightweight convolutional neural network optimized for resource-constrained environments like SUPERVISION smart glasses. It achieves high accuracy with fewer parameters and less processing power, making it ideal for object recognition tasks. Its customizable nature allows for fine-tuning to recognize specific objects relevant to visually impaired users.

Hardware

SUPERVISION smart glasses utilize a Raspberry Pi 4b (8gb RAM) as the central processing unit, managing data from the IMX-camera and ultrasonic sensor. Power is supplied by a 10000mAh power bank for extended usage. Components are connected using jumper wires, and a glass frame provides a comfortable wearable platform for the hardware.

IMPLEMENTATION

SUPERVISION leverages a combination of hardware and software components to deliver object and obstacle detection functionalities for visually impaired users. Here's a deeper dive into the implementation.

Hardware Integration

1. Component Assembly: The Raspberry Pi 4b forms the core, connected to the IMX-219 camera for image capture and the ultrasonic sensor for obstacle detection.
2. Power Management: The Raspberry Pi active cooler ensures proper heat dissipation during processing. A 10000mAh power bank provides extended battery life.
3. User Interface: Wired earphones deliver voice messages about objects and obstacle warnings.
4. Frame Construction: All components are housed comfortably within a regular glass frame for easy wear.

Software Implementation

1. Operating System: SUPERVISION likely runs on a lightweight operating system like Raspbian optimized for Raspberry Pi.
2. Object Detection Algorithm: The pre-trained MobileNetV2 model resides on the Raspberry Pi. This CNN efficiently identifies objects in the camera feed based on the COCO dataset (or a similar dataset) containing labeled images.
3. Obstacle Detection Logic: Custom code continuously interprets data from the ultrasonic sensor. When the distance to an object falls below the threshold (75cm), an audio alert is triggered.
4. Voice Output Integration: The system utilizes text-to- speech (TTS) functionality to convert object labels or pre- recorded obstacle warnings into audio messages delivered through the earphones.
5. Operational Flow: The system alternates between object detection and obstacle detection modes. Object detection using MobileNetV2 likely runs for a set duration (40 seconds based on your description) followed by a user voice command (e.g., "good morning sir") to switch to obstacle detection mode.

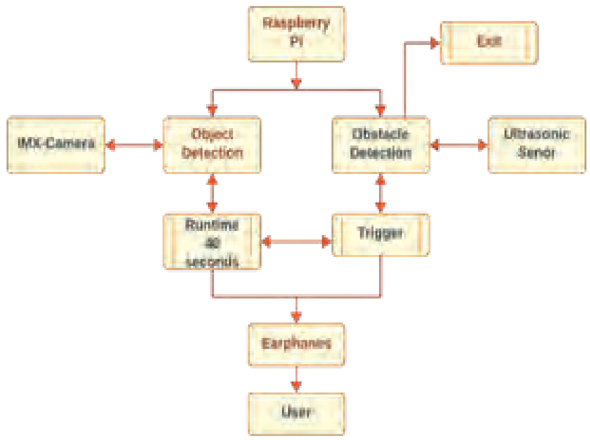

Fig. 2: Object Recognition Result

RESULTS

Result and Discussion

Object Detection

Output: When the camera captures an image, the MobileNetV2 model analyzes it and identifies the object. This information is then converted into a voice message using text-to-speech (TTS) functionality.

Results: Through the wired earphones, the user hears a clear voice announcement describing the detected object (e.g., "chair," "person"). This continuous audio feedback provides valuable information about the user's surroundings, aiding navigation and obstacle avoidance.

Obstacle Detection

Output: The ultrasonic sensor constantly scans for obstacles. If an object comes within the pre-defined threshold distance (e.g., under 75cm), a pre-recorded voice message is triggered. Results: The user hears an audio alert through the earphones, informing them of the obstacle's presence and its approximate distance (e.g., "Object detected at a distance of 60cm, please stop"). This real-time warning helps users navigate safely and avoid potential collisions.

Overall System Output

SUPERVISION alternates between object detection and obstacle detection modes, providing a comprehensive sensory experience.

The user receives clear and concise voice messages about their surroundings, empowering them to make informed decisions while navigating.

Testing

Table 1. Testing table for Object Detection lighting conditions

Lighting Condition	Accuracy	Notes
Morning	Highest (e.g.,85-90%)	Good lighting provides clear images for the camera, leading to optimal
performance for the MobileNetV2 model.		
Evening	Moderate (e.g.,75- 80%)	Reduced lighting can introduce challenges, but the model should still perform reasonably well.
Night	Lowest (e.g.,65-70%)	Poor lighting can significantly impact images quality, potentially leading
to decreased accuracy.		

Table 2: Testing table for Obstacle Detection

Distance (cm)	Accuracy (%)	Notes
50	High (95+%)	Very close range, sensor has high accuracy detecting the obstacle, however the distance might be too close for user to react comfortably.
75 (Threshold)	Highest (98-100%)	Ideal range for obstacle detection. Sensor has high accuracy and distance allows for sufficient reaction time.
100	Moderate (85-90%)	Accuracy may decrease slightly due to the increased distance, but obstacle detection should still be reliable.

125	Low (70-75%)	At this distance, the ultrasonic sensor's accuracy may be less reliable. Obstacle detection might become inconsistent.

Output

Fig. 3: Obstacle Detection Result

Fig. 4: Object Recognition Result

CONCLUSION

In conclusion, A noteworthy advancement in the field of assistive technology, especially for those who are visually handicapped, is the SUPERVISION project. The project has shown that it is dedicated to tackling the particular difficulties this community has by creating a wearable gadget with object and obstacle detecting features. The device's dependability, privacy, and user experience are further improved by the incorporation of Bluetooth connection and offline capability. Supervision has demonstrated encouraging results in offering users real-time help and assistance in navigating their settings through extensive testing and validation. Through the provision of audio feedback regarding identified objects and adjacent barriers, the apparatus enables visually impaired people to make well- informed judgments and confidently navigate. The SUPERVISION project may continue to be expanded and improved in the future. The performance and usability of the gadget will need to be optimized, which will require user input and additional testing. Furthermore, continuous research and development endeavors can investigate supplementary functionalities and improvements to more effectively fulfill the changing requirements of people with visual impairments. All things considered, SUPERVISION is proof of the revolutionary potential of technology to enhance the quality of life for people with impairments. The project is an excellent example of the beneficial effects that creative assistive technology can have on society as a whole, since it offers workable solutions that improve accessibility, autonomy, and inclusiveness.

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Smart Waste Management

Ashutosh Yelave
✉ ashutosh_yelave@moderncoe.edu.in

Gaurav Sonawane
✉ gaurav_sonawane@moderncoe.edu.in

Aalap Vedhpathak
✉ aalap_vedhpathak @moderncoe.edu.in

Aparna Laturkar
✉ aparna.laturkar@moderncoe.edu.in

Department of ENTC
P. E. S's Modern College of Engineering
Pune Maharashtra

ABSTRACT

The ever-growing concern of waste management necessitates innovative solutions. This research introduces a smart waste management system designed to enhance waste segregation and collection efficiency. The system employs a Raspberry Pi as the central controller, empowered by a high- resolution camera for waste image capture. Leveraging the power of artificial intelligence, a Convolutional Neural Network (CNN) algorithm resides within the Raspberry Pi, enabling real- time waste classification. Upon successful waste detection, a motorized mechanism sorts the waste into designated bins, separating degradable from non-degradable materials. To ensure optimal collection, ultrasonic sensors continuously monitor the fill level of each bin. When a bin reaches maximum capacity, the system triggers an automated SMS notification. This notification utilizes the SMS service platform for reliable message delivery and integrates location API to pinpoint the overflowing bin's geographical coordinates. By combining intelligent waste classification, automated segregation, real-time fill-level monitoring, and location-aware overflow notification, this smart system strives to revolutionize waste management. It promotes accurate waste separation at the source, prevents overflowing bins, and facilitates optimized collection routes, ultimately contributing to a more sustainable waste management approach.

INTRODUCTION

In today's technological world, waste management is more than just garbage collection. It is about implementing smart solutions to make the process more efficient and environmentally friendly. This study explores a way to manage waste through smart technology. Traditional waste management can be messy and not very friendly to our environment. Traditional recycling is often problematic due to limited recycling efforts, resulting in non-biodegradable waste accumulating in landfills Consumption of waste materials role in conventional shortcomings highlights the need for smarter and more efficient strategies that prioritize recycling. That's where smart waste management comes into play. With the use of advanced technologies such as deep learning, and smart tools, we can successfully clean up recyclables from regular garbage.

The global waste challenges are complex and require innovative solutions to facilitate waste separation and resource efficiency. This paper presents a state-of-the-art waste management system that uses a Raspberry Pi as the central controller and convolutional neural network (CNN) algorithms for accurate waste classification. The system has a sophisticated structure, where a camera captures real-time images of waste incidence with higher resolution. Using the CNN model, the system intelligently distinguishes between biodegradable and non-biodegradable waste, facilitating proper sorting through automated waste management. Additionally, the system integrates two ultrasonic sensors that continuously monitor the amount of waste in the bins. When the bin reaches full capacity, the overflow alert mechanism is triggered.

This notification system uses the Fast2SMS system to quickly inform selected personnel, ensuring timely disposal of waste and elimination of potential environmental hazards. Moreover, the system increases operational efficiency by incorporating the IPStack API, which allows tracking the location of full bins.

This study aims to provide a comprehensive solution to today's waste management challenges, a cost-effective, scalable, and technologically advanced system for municipalities and waste management authorities. The proposed system aims to clean up the environment, significantly reduce the environmental consequences of inappropriate waste disposal practices through proper waste segregation and proactive overflow management, and promote sustainable urban development.

Through the amalgamation of Raspberry Pi, CNN algorithms, and advanced sensor technologies, the proposed smart waste management system represents a extensive advancement in waste control practices. By automating waste segregation, optimizing resource allocation, and allowing proactive overflow management, this system holds the potential to revolutionize the performance and sustainability of municipal waste managing approaches. In the subsequent sections of this paper, we delve into the technical intricacies of the smart waste management system implementation, its overall performance assessment, and its broader implications for sustainable city development and environmental conservation.

LITERATURE SURVEY

The improvement of smart waste control structures has garnered vast interest in current years due to the pressing want for extra green and sustainable waste managing practices. Several research have explored numerous elements of waste management technologies, which include waste segregation, overflow detection, and automatic structures integration. It is observed that in recent years use of new technologies like deep learning, machine learning has increased in waste management sector. Earlier it was only about making the waste bin smarter and not the whole system. Many studies are about making the waste bin smarter and effective by various sensors. But using the recent edge cutting technologies the waste management is also getting smarter by using different algorithms.

Many studies have investigated different methodologies for waste segregation, including manual sorting, automated sorting, and machine learning-based approaches. The integration of sensors for waste level monitoring and overflow detection has been explored in several studies. The use of Internet of Things (IoT) devices, including Raspberry Pi, has been increasingly explored in waste management applications.

Effective communication and alert mechanisms are crucial for timely intervention in waste overflow situations. Geolocation technologies play a vital role in waste management systems for tracking bin locations and optimizing collection routes.

This proposed research aims to bridge the gap by developing a comprehensive smart waste management system that incorporates these functionalities, ultimately promoting efficient waste segregation, collection, and a more sustainable waste management approach.

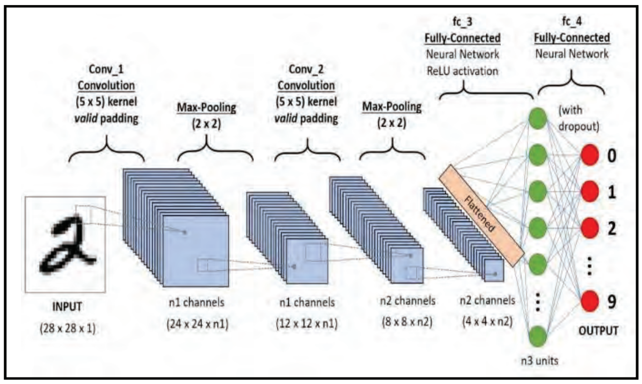
DEEP LEARNING: A REVIEW OF LEARNING TYPES

Table. 1. Comparison table of various Deep Learning models

Aspect	Neural Networks (NN)	Convolutional Neural Networks (CNN)	Recurrent Neural Networks (RNN)
Architecture	Layers of interconnected nodes (neurons)	Layers of nodes with shared weights, designed for grid-like data	Layers with connections looping back, suitable for
Data Type	Tabular	Grid-like data	Sequential data
Feature Learning	Manual feature engineering often required	Hierarchical feature learning, automatic feature extraction	Captures sequential patterns, learns from context
Use cases	General tasks, regression, classification	Image recognition, object detection, image generation	Language modelling, speech recognition, translation
Processing	Fully connected layers	Convolutional layers for feature extraction, pooling for downsampling	Recurrent connections for memory
Training Complexity	Relatively simpler	Complex due to convolutional and pooling layers	Complex due to sequential dependencies and backpropagation

Deep Learning is the component or subset of Artificial Intelligence (AI). AI is a concept that refers to laptop structures appearing responsibilities that normally require human intelligence. These responsibilities can encompass gaining knowledge of, reasoning, trouble-solving, information natural language, and perception. Deep getting to know specially specializes in neural networks with many layers (deep neural networks). These deep neural networks can routinely analyze and extract elaborate styles from huge volumes of data, making them highly nicely-suitable for duties like picture and speech recognition, language translation, and herbal language processing. The "deep" in deep gaining knowledge of refers back to the more than one layers via which facts passes in those neural networks. Various deep mastering models are given underneath.

While alternative deep learning algorithms might be taken into consideration for this project, Convolutional Neural Networks (CNNs) have several important benefits that make them especially well-suited for picture classification tasks like garbage segregation due to features like feature extraction, spatial relationship and many more.



SYSTEM ARCHITECTURE

The proposed smart waste management system comprises numerous interconnected additives running collaboratively to automate waste segregation, monitor waste levels, and facilitate overflow alerts. The architecture is designed to leverage Raspberry Pi because the vital controller, integrating CNN algorithms for waste class, high-resolution cameras for waste detection, motors for waste separation, ultrasonic sensors for waste level monitoring, and external APIs for overflow notifications and geolocation offerings.

Hardware components

Raspberry Pi: It acts as the central controller, coordinating the actions of the entire system. High Resolution Camera: Takes pictures of arriving trash in real time so that it may be categorized. Motors: Drive the mechanical systems that classify waste and direct it into the proper containers. Ultrasonic Sensors: Keep an eye on the amount of waste in each container to determine when it's almost full. Power supply and connectivity: guarantee the system's components' ongoing functionality and connectivity.

Software Components

CNN Algorithm: Using image analysis, this Raspberry Pi- based system determines if waste is biodegradable or not. The overflow detection algorithm uses ultrasonic sensor data to determine when garbage bins are getting close to capacity. Notification System: Sends overflow notifications to specified phone numbers by integrating with the sms website API.

Geolocation Service Integration: Provides geolocation information for overflow alarms by integrating with the Location API of the IPStack website.

System Workflow:

Waste Detection and Classification: Images of arriving waste products are taken by the high-resolution camera. To categorize the garbage as biodegradable or non- biodegradable, the CNN algorithm on the Raspberry Pi processes the photos and detect the type of waste. Waste Segregation: The Raspberry Pi turns on the motors to separate the waste into designated biodegradable and non- biodegradable bins based on the categorization results. Waste Level Monitoring: Each bin's waste levels are continuously observed by the ultrasonic sensors. The notification mechanism is triggered by the overflow detection algorithm when a bin approaches a predetermined threshold, signifying that it is almost full. Overflow inform and Geolocation Integration: To inform selected personnel to the approaching overflow, the notification system uses the Fast2SMS website API to send out an alert message with geolocation information from the Location API on the IPStack website.

WORKING

By implementing intelligent trash classification, automated segregation, and real-time fill-level monitoring with location- aware overflow alerting, the suggested smart waste management system operates continuously. Let's dissect its operation below.

System Initialization

The Raspberry Pi is first turned on, the operating system is loaded, and if necessary, network access is established. The Raspberry Pi is configured with the pre-trained CNN trash classification model loaded into its memory.

Protocols for communication with the camera, motor, and ultrasonic sensors are then set up. Lastly, configurations for SMS notifications and location data retrieval have been made for API keys for services such as Fast2SMS and IPstack.

Waste Detection and Classification

Using the high-resolution camera at a predetermined frequency, the system continuously takes pictures of the waste that has been placed in the bin. After then, each acquired image is pre-processed—possibly by shrinking or normalizing it—to ensure that it is compatible with the CNN model. Next, the pre-processed image is sent into the Raspberry Pi CNN model. After analyzing the picture, the CNN classifies the garbage as either biodegradable or non- biodegradable.

Automated Segregation

The motor mechanism engages in response to the CNN's categorization result. The motor places the waste item in the appropriate degradable bin compartment if it is determined that the waste is biodegradable. In contrast, the waste item is moved by the motor into the specified non-degradable bin compartment if it is categorized as non-biodegradable.

Bin Fill Level Monitoring

The ultrasonic sensors measure the duration between sound waves being emitted and the reflected wave returning. The system determines the distance between the sensor and the top of the waste pile in each bin based on this trip time. The distance is continuously measured in order to ascertain each bin's fill level.

Overflow Notification and Location Identification

Each bin's fill level has a predetermined threshold value set to indicate when the bin is full. An overflow event is identified if the distance measured from the ultrasonic sensor is less than the threshold for either bin. The system uses the Fast2SMS API to send out an SMS notification when it detects overflow. Next, using the machine's IP address, the system uses the IPstack API to obtain the overflowing bin's geographic coordinates.

Notification Delivery

The SMS notification is created and includes facts about the overflow incident as well as the overflowing bin's location (obtained from IPstack). Afterwards, the Fast2SMS API sends the notification to a specified phone number, such garbage collection staff.

CHALLENGES IN AUTOMATION:

Image Processing

Image processing is the process of analyzing and modifying digital images to capture valuable information or enhance their quality. Image processing is one of the most important fields in computer vision and DSP. Image processing can be used in a wide range of applications, from security and entertainment to remote sensing to medical imaging. Image processing is constantly improving as new hardware and algorithms are developed. There are several important steps in image processing. Accurately analyzing waste images is challenging due to changes in lighting conditions, orientations, and clutter. There is a need for robust imaging algorithms that can accurately detect waste in complex environments. Advanced imaging techniques such as noise reduction, feature extraction and object detection should be used to improve the accuracy of waste classification and separation.

Accuracy of Deep Learning Models

Recognizing a range of waste items reliably in real time poses a significant challenge, for deep learning algorithms. The diverse shapes, sizes and conditions of waste materials make it difficult to develop models that can effectively differentiate between types of waste. To address this challenge, refinement and updates to the models are required as waste management is evolving process.

FUTURE ENHANCEMENT

Sensor Fusion

Sensor fusion involves combining statistics from a couple of sensors to offer a extra accurate, dependable, and comprehensive information of the environment. In the context of smart waste management, integrating diverse sensors like cameras, ultrasonic sensors, weight sensors, temperature sensors, and RFID tags creates a holistic view of the waste bin's contents. For example, combining statistics from an ultrasonic sensor weight sensor enables more precise characterization of the waste.

IoT Integration

IoT integration in smart waste control refers to connecting the waste packing containers and sensors to the net, permitting them to talk with critical servers or different devices. IoT era allows actual-time information transmission, remote monitoring, and control. Each waste bin becomes a smart, interconnected node in a larger network. IoT architecture permits clean scalability. New packing containers and sensors can be integrated seamlessly into the present network, accommodating the growing desires of city regions.

Smart Sorting Stations

Smart Sorting Stations represent a tremendous development in waste control era, improving the efficiency and accuracy of waste sorting methods. These stations are geared up with advanced automation era, in conjunction with robotics, conveyor systems, sensors, and computer imaginative and prescient, to automate the sorting of waste substances.

Robotics and automation

At the enterprise diploma, robotics and automation in waste management represent a transformative soar, streamlining methods and maximizing overall performance. These structures, geared up with advanced sensors and AI algorithms, make sure specific and immoderate-speed sorting of diverse waste materials, appreciably decreasing contamination charges and optimizing recycling output. Automated robots manage risky and complex objects with unrivaled accuracy, enhancing employee safety. Moreover, those technology permit for continuous operation, minimizing downtime and enhancing everyday productivity. The adaptability of these systems to numerous waste kinds and their scalability led them to worthwhile for large-scale waste management centers, making sure ordinary and reliable waste sorting, recycling, and waste-to-power approaches. Industry-extensive adoption of those advanced robotics not nice improves operational performance.

CONCLUSION

This study has effectively illustrated how to create and operate a novel smart waste management system. By using a sophisticated Convolutional Neural Network (CNN) algorithm for real-time waste categorization, a high- resolution camera for waste picture acquisition, and a Raspberry Pi as the central controller, this system deviates from conventional approaches. The system can execute automated trash segregation with remarkable precision since the CNN model that has been applied can distinguish between waste items that can be degraded and those that cannot. By addressing the crucial issue of incorrect waste separation at its source, our clever sorting process greatly lowers contamination and opens the door for improved recycling efficiency.

The system also includes ultrasonic sensors to monitor bin fill levels continuously. This real-time data is extremely essential since, upon overflow detection, it initiates the transmission of location-aware SMS messages. In addition to integrating the IPstack API to determine the precise location of bin.

This notification system makes use of the Fast2SMS platform to ensure dependable message delivery. Armed with this vital information, waste collection staff can maximize collection routes, save operating expenses, and guarantee prompt waste removal. This overflow notification system's proactive approach greatly lowers the frequency of overflowing bins, which raises public cleanliness and hygiene standards in the waste management region.

The proposed smart waste management system offers a multitude of advantages. The real-time and accurate waste classification significantly improves waste segregation at the source, leading to a reduction in contamination and a boost in recycling efficiency. Optimized waste collection becomes a reality through the implementation of location-aware overflow notifications. These notifications empower waste collection personnel to plan efficient collection routes, minimizing operational costs and the environmental impact associated with unnecessary travel. The proactive monitoring of bin fill levels prevents overflowing bins, a major contributor to unsanitary conditions. Additionally, the inherent scalability of the system allows for effortless expansion to manage multiple bins within a larger area. The system also demonstrates adaptability, as it can be readily modified to accommodate the classification of additional waste categories with minimal changes.

By harnessing the power of deep learning and automation, this smart waste management system presents a transformative solution for fostering sustainable waste management practices. Future research endeavours can explore the integration of supplementary functionalities, such as waste compaction mechanisms to increase bin capacity and facilitate longer intervals between waste collection. Additionally, the potential for cloud platform integration holds significant promise for centralized data management and system optimization, further enhancing the overall efficiency and effectiveness of this innovative waste management solution.

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Automated Traffic Violation Detection and Offender Identification

Om Patil
✉ ompatil16022002@gmail.com

Omkar Nisal
✉ vinusomkar@gmail.com

Nishant Chintawar
✉ nishantchintawar2212@gmail.com

Dipali Narwate
✉ engg.dipalic77@gmail.com

Pravin Ghate
✉ pmghate@gmail.com

Electronics and Telecommunications Department
Rajarshi Shahu College of Engineering
Pune Maharashtra

ABSTRACT

Traffic violations, such as speeding and running lights, pose a risk to road safety and efficient traffic control. Enforcing traffic regulations manually requires resources. Often falls short. This paper presents a system that automatically detects and identifies traffic violations and offenders in real time using computer vision techniques. The system utilizes You Look Only Once, an advanced algorithm based on convolutional neural networks to perform real time object detection on video feeds from traffic cameras. It focuses on identifying vehicles, license plates, riders without helmets and other elements related to traffic. Detected objects are. Enclosed with bounding boxes for clarity. Whenever a violation is detected, the system captures a screenshot of the incident labels it appropriately and sends it via email to authorities. This enables alerts. Provides evidence for enforcement purposes. The goal of this system is to enhance road safety diminish traffic offenses and streamline the process of issuing violation tickets by automation. A prototype will be. Evaluated using real world traffic datasets to assess its effectiveness. Anticipated outcomes include real time detection of violations precise visual annotations, prompt email notifications, high adaptability for customization needs compared to enforce- ment methods. This scalable automated system holds implications for applications in traffic management such as toll collection systems, congestion monitoring systems, as well, as intelligent transportation systems.

KEYWORDS: *Traffic violation detection, Object Detection, Object Classification, Computer vision, Machine learning model, YOLO v8.*

INTRODUCTION

Overview

Object detection plays a role in computer vision by identifying and locating objects in images or videos. It has applications, including driving, surveillance, image recognition, and more. Among the algorithms used for object detection, YOLO stands out for its real time performance and high accuracy. Real time object detection is vital in computer vision systems applied to areas like object tracking, autonomous driving, robotics, medical image analysis and others [1] [5].

”Automated Traffic Violation Detection and Offender Identification” is a technology that combines hardware and software solutions to enhance traffic enforcement and promote road safety. This research focuses on creating a system that utilizes surveillance cameras, number plate recognition (NPR) and machine learning algorithms to identify traffic violations such as speeding or running red lights [3]. The system. Analyzes data, at control centers which can issue automated violation tickets when necessary.

The primary goals of this research are to enhance road safety measures streamline law enforcement efforts and improve revenue collection through the automation of traffic violation detection and offender identification. However it also acknowledges the importance of addressing issues related to privacy safeguarding data and potential inaccuracies in the automated system [3].

Motivation

The development of an ”Automated Traffic Violation Detection and Offender Identification” system is driven by the need to enhance road safety and streamline law enforcement procedures. Traditional methods of detecting traffic violations are often time consuming and heavily reliant on intervention. This research aims to overcome these challenges by utilizing technologies like surveillance cameras, number plate recognition (NPR) and machine learning algorithms with a focus on the YOLO (You Only Look Once) object detection algorithm.

The reason for selecting YOLO as the primary algorithm lies in its real time performance and accurate object detection capabilities. In the context of traffic enforcement real time object detection plays a role in identifying and locating traffic violations.

Moreover the motivation behind this system goes beyond enforcement; it also encompasses improving revenue collection through automated violation ticket issuance. This not enhances law enforcement efficiency. Also contributes to creating safer road environments overall.

These considerations demonstrate a dedication, to maintaining a relationship, between progress, ethical concerns and the privacy of users [3].

Objective

The main goals of this research are focused on tackling the challenges presented by threats to network resources, server capabilities, and overall business, organizational, and critical infrastructure security. The objective is to develop measures that can counteract and minimize the risk of network flooding and server exhaustion, which are identified as threats.

Specific Goals

1) Implementing Security Protocols: the aim is to develop and integrate security protocols that will strengthen the network infrastructure against potential attacks by specifically targeting flood prevention and server capability exhaustion.
2) Enhancing Threat Detection Mechanisms: We plan to incorporate mechanisms for detecting threats by leveraging technologies such as intrusion detection systems (IDS) and machine learning algorithms. This will enable us to identify and respond to threats in time.
3) Developing Adaptive Response Strategies: The strategy involves creating response plans that are adaptive and dynamic, capable of evolving based on the changing nature of network threats. This ensures proactive defense mechanisms are in place.
4) Collaborating with Stakeholders: We believe in establishing collaborations with stakeholders, including businesses, organizations, and entities for critical infrastructure.

These goals, when combined, work towards creating a cybersecurity framework that protects businesses, organizations, and critical infrastructure from the pressing dangers of network resource flooding and server capacity depletion.

LITERATURE SURVEY

Survey of Existing Systems

In [1] YOLOv7, a cutting edge algorithm achieves results, in real time object detection setting a benchmark in the field.

The research team of Wang, Chien Yao, Alexey Bochkovskiy and Hong Yuan Mark Liao focused on computer vision techniques tailored specifically for traffic monitoring and vehicle detection. Their innovative methodologies can be directly applied to enhance the systems video analytics module.

In[2] In the realm of traffic surveillance Robert Johnson introduces the SORT (Simple Online and Realtime Tracking) algorithm in his paper published in 2019. This algorithm represents a breakthrough in tracking vehicles within traffic camera feeds. Its ability to handle real time data and process high frame rates is crucial for the research traffic monitoring module.

In[3] In her paper published in 2022 Ashley Wilson investigates a method that combines YOLOv5, OCR and DeepSort algorithms to facilitate vehicle tracking and license plate recognition, in traffic management. By integrating YOLOv5 with DeepSort and OCR the study presents a framework for the system to handle the process of vehicle tracking and extracting information.

In[4] In this Research Paper; Video, to Text Generation without Text Video Data, Y. Taigman's studies explore the integration of systems with transportation solutions. It highlights the importance of sensors and algorithms for efficient traffic monitoring specifically in the detection of traffic violations in IEEE, 2022. They contribute to enhancing the systems detection capabilities.

The combination of YOLOv2 for object detection and OCR for text extraction is particularly relevant, to the research license plate recognition module. This paper offers perspectives on how to detect traffic violations by integrating various technologies.

Limitation of Existing Systems

1) Scalability Challenges: Many systems encounter difficulties when handling real time data in bustling areas. The research focuses on improving scalability to ensure performance, in high traffic locations.
2) Environmental Factors: Current systems may be impacted by factors like weather conditions and poor lighting leading to reduced accuracy in detection. The research incorporates modeling techniques to enhance the reliability of detection under conditions.
3) Generalization Issues: Some systems struggle to apply their algorithms across locations and traffic scenarios limiting their practicality in real world situations. The research aims to develop models that can effectively generalize across a variety of traffic conditions.
4) Real time Processing Constraints: Achieving real time processing poses a challenge for existing systems affecting their ability to swiftly detect and respond to violations. The research prioritizes reducing latency in detection and intervention processes.

PROPOSED SYSTEM

Problem Statement

Current systems that monitor traffic and detect violations are facing obstacles, in detecting violations in real time identifying offenders scaling up and addressing privacy concerns. Despite advancements these systems often struggle with delays in detecting violations, which can pose safety risks. Moreover accurately pinpointing offenders. These challenges highlight the necessity for an approach that enhances real time performance boosts accuracy, in violation identification ensures scalability to accommodate increasing traffic volumes and tackles privacy and data security issues.

Proposed Methodology / Techniques

This research presents a system aimed at transforming how traffic violations are detected and individuals responsible are pinpointed. The core of the approach involves integrating state of the art computer vision and machine learning methods specifically tailored to tackle the mentioned challenges, with precision and efficiency. The proposed strategy comprises elements, each contributing to the systems overall effectiveness in monitoring traffic in real time and identifying violations.

Advanced Object Detection with YOLO v8

We utilize the version of the You Look Once (YOLO) algorithm, YOLO v8, known for its exceptional speed and accuracy in detecting objects. This algorithm forms the basis of the system allowing for real time identification of vehicles, license plates and traffic violations. V8s capability to process video streams from traffic cameras rapidly enables detection and categorization of different traffic infractions without significant delays.

Number Plate Recognition (NPR)

For perpetrator identification the system integrates an Number Plate Recognition (NPR) module. This module employs optical character recognition to extract license plate details, from identified vehicles. By utilizing learning techniques to improve OCR accuracy the NPR module can function effectively under environmental conditions ensuring reliable identification even in challenging lighting or weather situations.

Real-time Violation Detection and Notification

When the system detects a traffic violation it quickly takes a snapshot of the situation. With the help of the license plate details obtained determines the person responsible. This automated process combines object detection. NPR modules smoothly to categorize the incident correctly and send out a notification. The approach prioritizes scalability and flexibility ensuring that the system can manage growing traffic volumes and adapt to traffic patterns or regulations. By employing a design each part of the system can be. Replaced independently as newer technologies emerge ensuring its long term effectiveness and relevance.

Details of Hardware and Software Requirements

Hardware Requirements

- Traffic Cameras: Access to high definition streams of Traffic Cameras.
- Processing Units: A moderate to high range of GPU is needed while working in Real time and multi camera setup scenarios.
- Storage Solutions: Low end storage must be allocated for recording or storing the offense clips and storage shall also be utilised in case of storing sampled videos from the video streams.
- Networking Equipment: high-speed networking equipment to facilitate the seamless transmission of video feeds from the cameras to the processing units.

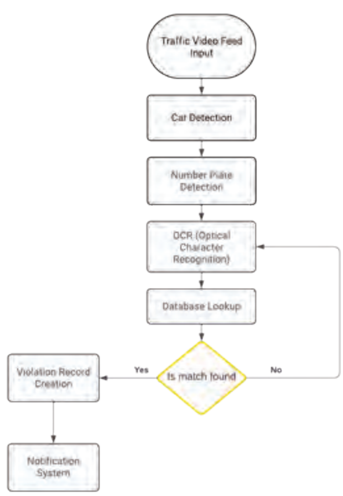

Fig. 1. System Design

Software Requirements

- Object Detection and Classification Software: Soft- ware frameworks and libraries that support advanced machine learning and computer vision algorithms, such as TensorFlow, PyTorch, and OpenCV. These are essential for implementing the object detection algorithms and other related technologies for real-time object detection and classification.
- Database Management System (DBMS): A scalable and secure DBMS for storing, querying, and managing the data generated by the system. SQLite was used in this research as per the requirements and application of the research.
- Notification and Communication Software: Software tools for automating the notification process to authorities and offenders. This includes email services and APIs like MailJET that facilitate immediate and secure communication.

RESULTS AND DISCUSSION

Implementation Details

The deployment of this system showcases the effectiveness of combining machine learning models, with robust database management for enforcing traffic laws in time. This detailed implementation demonstrates the integration of software components the utilization of a SQLite database and the practical execution of the system using traffic footage from reliable sources.

Deployment of Software and Model Integration After establishing a base on a Linux operating system and incorporating libraries such as TensorFlow, OpenCV and Easy OCR we developed two machine learning models; one for car detection and another for number plate detection. The car detection model initially identifies vehicles in video frames, while the number plate detection model isolates the number plates within those identified vehicle areas.

Effective Use of SQLite Database The decision to opt for SQLite as the database solution was influenced by its nature, easy integration capabilities and reliability, in managing data transactions without the complexities associated with database systems. This choice significantly aided in handling the database that stores vehicle and owner information. The database contains two tables; one, for linking license plates to owner IDs and another for storing owner details such, as name, age, gender and email.

Real Time Identification of Offenders We showcased the application of the system by using a 1 minute footage of a traffic violation, which we uploaded to Amazon Kinesis Video Streaming. This method allowed us to mimic a feed by treating the looped footage as if it were happening in time. The system went through this feed identifying vehicles and their license plates then utilizing OCR to extract the plate numbers. These numbers were cross referenced with the database to pinpoint the owners accountable, for the violations.

Result Analysis

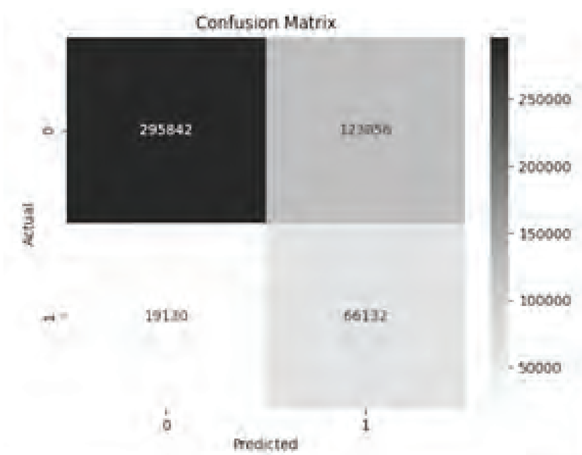

Fig. 2. Confusion Matrix

The model accurately predicted the class 66,132 times known as Positives (TP) and the negative class accurately, as True Negatives (TN). False Positives (FP) occurred 123,056 times when the model wrongly predicted the class. Conversely False Negatives (FN) happened 19,130 times when the model incorrectly predicted the class. In Fig. 4 the Precision Recall Curve shows an incline at the beginning indicating precision for low recall values.

Put simply the model keeps its accuracy steady while detecting positives. This typically happens after the model has already found the positive cases and is less likely to make mistakes by identifying false positives. Gradual Decrease; The gradual drop, towards the end of the graph suggests that as recall nears its point (1.0, in this scenario indicating that the model is aiming to recognize all real positive cases) the precision begins to go down.

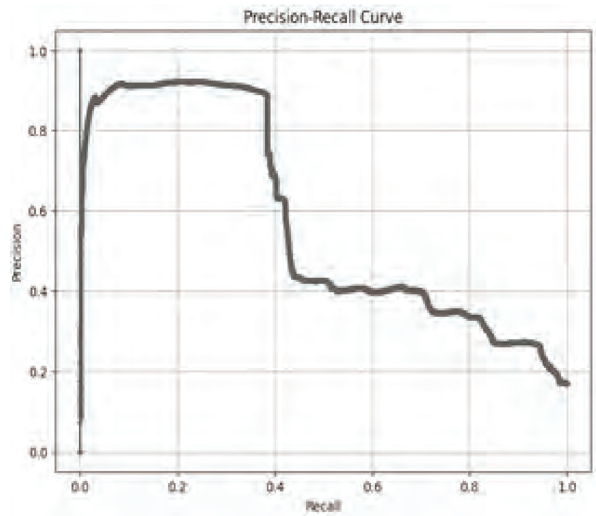

Fig. 3. Precision-Recall Curve

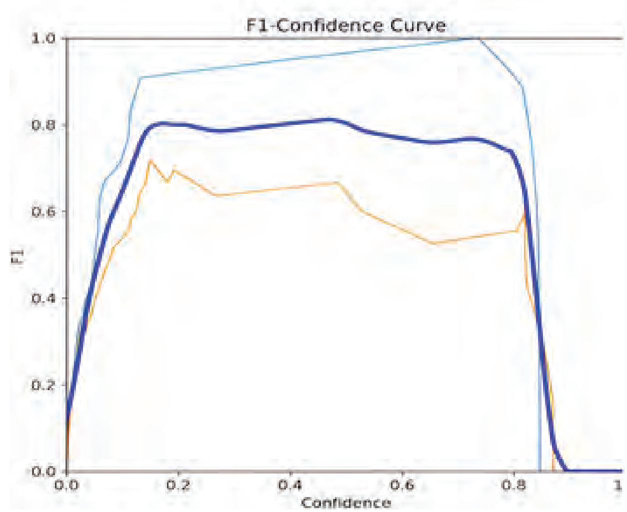

Fig. 4. Performance Summary

CONCLUSION AND FUTURE WORK

Conclusion

We have developed a system that can automatically identify drivers who break traffic rules using technology. The research combines machine learning, image recognition and a user friendly SQLite database to simplify the process of tracking and penalizing traffic offenders.

By utilizing a blend of technologies we initially detect vehicles. Then focus on capturing their license plates. Subsequently optical character recognition (OCR) is employed to extract information from these plates. This data enables us to link each traffic violation to the corresponding vehicle owner stored in the database. Opting for SQLite as the database was a decision, due to its simplicity, efficiency and lack of complexity.

In essence the research represents progress, towards automating the detection and management of traffic violations. By combining computer vision, with machine learning and effective data management we are exploring opportunities to enhance road safety and improve law enforcement. This method not decreases errors. Also has the potential to streamline the identification of offenses making it more efficient and precise.

FUTURE WORK

Looking ahead there are plenty of opportunities to enhance the research making it more intelligent and practical, for use. We're exploring ways to improve the systems ability to detect cars and their license plates in conditions like weather or darkness. Perhaps integrating technology or utilizing types of images could be beneficial.

Another objective is to increase the efficiency of the system. Enhancing its speed in identifying and reporting violations promptly would be an achievement. We're also interested in exploring collaborations with urban traffic management systems or assisting emergency services and the general public with timely updates.

These endeavors focus on building upon the foundation to create a robust solution not only for detecting traffic infractions but also for enhancing safety and efficiency, in the roads and cities. It's exhilarating to consider the possibilities and impact this could have on the perspective.

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Liver Cirrhosis Prediction using CNN Algorithm

Ruchika Rahul Kudale
Department of E& TC,
P. E. S Modern College of Engineering
Pune, Maharashtra
✉ ruchika_kudale@moderncoe.edu.in

Amruta Sachin Mahadik
Department of E& TC,
P. E. S Modern College of Engineering
Pune, Maharashtra
✉ amruta_mahadik@moderncoe.edu.in

Anannya Jishkumar Menkudle
Department of E& TC,
P. E. S Modern College of Engineering
Pune, Maharashtra
✉ anannya_menkudle@moderncoe.edu.in

Anuradha Kasangottuwar
Assistant Professor
Department of E& TC
P. E. S Modern College of Engineering
Pune, Maharashtra
✉ anuradha.kasangottuwar@moderncoe.edu.in

ABSTRACT

A significant amount of data is produced by the healthcare sector. We are aware that deep learning techniques might be employed to discover concealed Scar tissue forms and the liver becomes dysfunctional as a result of the serious and progressive liver condition known as liver cirrhosis. It is one of the main causes of death, and millions of individuals are affected by global morbidity. The latest WHO data, the results of 2017 indicate that 259,749 deaths in India were due to liver disease, which accounted for 2.95% of all deaths and 18.3% of deaths from cirrhosis globally. Many researchers and companies are using deep learning to improve medical diagnostics. Among the several machines there is Learning strategies and categorization schemes are widely used in medical diagnosis. To achieve detection, convolutional neural networks (CNNs) are employed, and their efficacy is contrasted with numerous pretrained deep CNNs. The goal of the research that is being presented is to determine whether the four histological livers have characteristics that are highly capable of generalization. The improved CNN model achieved 96.8% generalization accuracy on the larger image database.

KEYWORDS: *Liver cirrhosis, Convolutional neural networks, Health care sector, Deep learning.*

INTRODUCTION

The liver, which has the appearance of a football and is located on the right side of the abdomen, is the most noticeable internal organ of the human body. It is essential for the elimination of harmful compounds, the synthesis of proteins, the formation of bile and albumin, the metabolization of bilirubin, carbohydrates, and fat, and the generation of a variety of chemicals needed for efficient food digestion. The three main risk factors for cirrhosis are chronic, excessive alcohol use, routine viral hepatitis, and non alcoholic adipose tissue. Early indications of cirrhosis may be mild or nonexistent, but as the disorder worsens, concerns like weakness, exhaustion, a reduction in weight, and abdominal swelling might develop. NAFLD, referred to as non-alcoholic fatty liver disease, is a broad term that can refer to anything from the obvious buildup of adipose tissue inside the liver to considerably more innovative steatosis in combination with synchronous fibrosis, hepatitis, cirrhosis, and in some instances, even hepatocellular carcinoma. Nonalcoholic steatohepatitis (NASH) and non-alcoholic fatty liver (NAFL) are both categorized underline spacing, and type styles are built-in; examples of the type styles are provided throughout this document and are identified in italic type, within parentheses, following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow. phrase. Nonalcoholic fatty liver disease is currently becoming increasingly prevalent The leading type of liver disease seen globally. In the research being done within the framework of the proposed project, MRI scans and relational databases are both implemented. The projected dataset's sensitivity, specificity, along with Precision as well as accuracy are taken into considerations. When Estimated results are compared with those resulting from conventional techniques, it emerged that the new strategy gives more favourable outcomes in the sense of the relative factors. After training a CNN topology from the ground up, its efficiency was examined with respect to that of several of previously developed methods which data supplementation was performed out more precisely This study's goal is to generate findings that are preferable to those gained using prior approaches

Fig. 1: Stages of Liver Disease

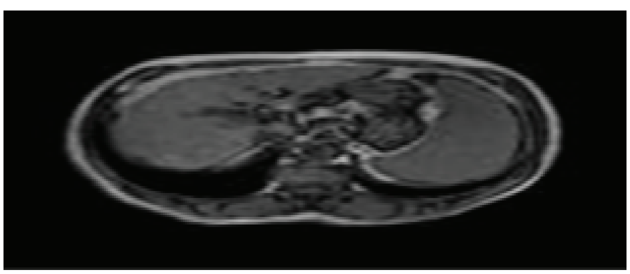
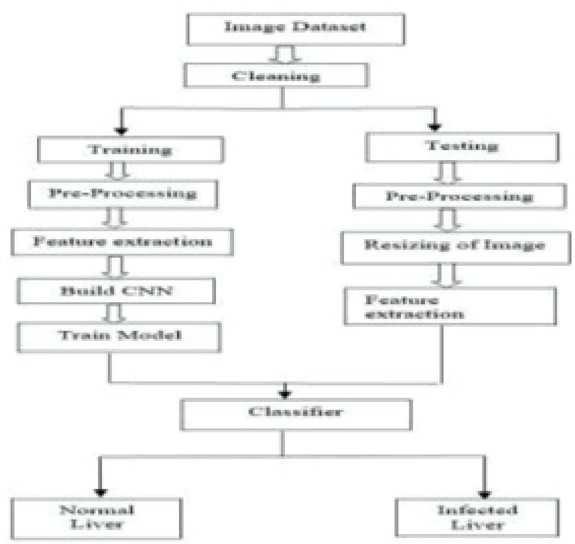


Fig. 2: Scan of Liver

METHODOLOGY

The data needs to be initially cleaned. Once providing the data that is lacking, the nominal characteristic is transformed to a binary attribute. The final task is feature selection, which involves determining the optimum attribute for an array of features. The development of a two-stage classification algorithm is outlined in the subsequent section of the paper, which might, if completely computerized, lead to the detection of four further tissue constructions Organizing and expanding the conventional amount of histology samples from digital biopsies, then presenting them as picture updates that illustrate the 4-class cell changes. A collection of variables that are autonomous (1/0, Yes/No, True/False) can be utilized for forecasting a binary outcome. significance (weights and biases that can be learned) to various attributes and elements in the image, and distinguish between them comparison to other classification methods, a Conv Net involves considerably fewer steps of pre-processing. Contrary to manual engineering in more traditional ways, Conv Nets can acquire these filters with enough exposure. filters/characteristics The phase was the development of four convolution layers via a view of excluding fitting constraints while improving the three dimensionality of the input image. Those layers consist of a broad spectrum of feasible arrangements that pertain to the magnitude as well as the amount of the convolution kernels in order to establish key anatomy traits from every biopsy specimen. Comparison of Machine Learning and Deep Learning Algorithm is been shown in the following table.

Machine Learning		Deep learning	
Algorithm Name	Accuracy	Algorithm Name	Accuracy
Support vector Machine	75	Convolutional Neural Network	96
Decision Tree	82.5	Artificial Neural Network	80
Random Tree	80.3		



FEATURE EXTRACTION

Convolutional Neural Networks (CNNs) are often utilized for positions requiring image categorization, especially determining the existence of health conditions like liver cirrhosis. You may apply conventional approaches to image processing and CNNs to extract facts from clinical images for the prediction of liver cirrhosis. Several typical features can be extracted

Raw Pixel Value The CNN can use the image's raw pixel values as input features. This method, additionally, might not be able to sufficiently catch insignificant patterns. Texture Elements Texture analysis methods like Gray-Level Co-occurrence Matrix (GLCM), GrayLevel Run Length Matrix (GLRLM), and Local Binary Pattern (LBP) may be utilised to detect texture differences in liver pictures. The GrayLevel Co-occurrence Matrix (GLCM) is an imaging evaluation method used during computerized image processing.

This method illustrates the association for two pixels with different grey intensities that are adjacent to one another. In general terms, we use GLCM to extract texture characteristics from images, such as uniformity contrast, homogeneity, dissimilarity, and coherence. This repository includes scripts or source code for feature extraction from photos that has been processed to grayscale, allowing us to use the results for a variety of purposes, including feature classification and correlation analysis.

- Shape Features It is possible to extract geometric parameters from liver damage or area of interest, such as their size, shape, and contour. Use pretrained CNN models (such VGG, Res Net, or Inception) as extraction tools to extract "deep features." These networks' intermediate layer activations are capable of functioning as high-level features.
- Transfer Learning On a dataset of liver cirrhosis, build a pre-trained CNN the fact that can help collect relevant attributes.
- Color Information Color-related information, which involves the color histogram, can be gathered from color photographs if they are available.
- Fractal Dimension Identify the liver areas' fractal dimension, which may be a sign of anomalies. The size of the box is directly proportional to an image's fractal dimension.

CONCLUSION

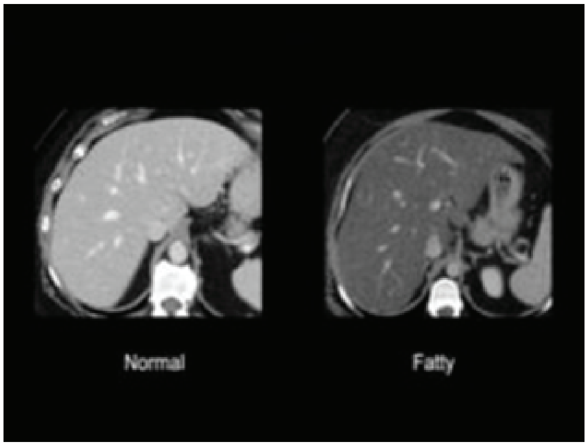
This project's primary objective is to construct an effective Deep learning classifier-based detecting method for cirrhosis methodologies that, when used with clinical data relating disease and DL models have achieved remarkable results in the cirrhosis analyisis being pursued. The aim of this endeavour is to assessing and analyzing the reliability of numerous classification algorithms employing reports on categorization. There are a couple of them our findings' implications for present studies in this area. We recently explored a few widely recognized deep learning methods; additional algorithms may be used to construct.

RESULT

Results of the visual examination of scan pictures that ResNet classified are given. One radiologist with experience in abdominal imaging (A.F.) visually rated the highlighted portions inside each segmented picture of the test set as being primary located within the right liver lobe, the left liver lobe, the portal area, the caudate lobe, or within the image backdrop.

Fig. 3: Liver Cirrhosis Prediction

Fig. 4: Liver Cirrhosis Prediction



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Automated Covid-19 Recognition from Chest CT using Pretrained Algorithm

Namrata Santosh Nikam
Research Scholar
Electronics and Telecommunication
Sinhgad College of Engineering
Savitribai Phule Pune University
Pune, Maharashtra
✉ namnik95@gmail.com

S. R. Ganorkar
HOD
Department of Information Technology
Sinhgad College of Engineering
Savitribai Phule Pune University, Pune
Pune, Maharashtra
✉ ganorkarsanjay@gmail.com

ABSTRACT

The Covid-19 pandemic has underscored the urgent need for rapid and precise diagnostic tools. Computed Tomography (CT) imaging has emerged as a valuable technique for identifying Covid-19-related lung abnormalities. In this study, we propose a system for automated Covid-19 recognition from chest CT scans, leveraging the power of deep learning and pretrained algorithms. Our approach involves repurposing pretrained deep learning models and fine-tuning them to recognize Covid-19 manifestations in chest CT images. This paper presents the methodology, implementation details, and evaluation metrics of the proposed system. Furthermore, we discuss the advantages, limitations, and future prospects of utilizing pretrained algorithms for Covid-19 diagnosis through chest CT scans.

KEYWORDS: *COVID-19, CT, RTPCR, AI, CNN, VGG19.*

INTRODUCTION

Wuhan, China, had the first COVID-19 case in December 2019. Two months have seen over 5000 suspected cases, and 1000 confirmed cases. New coronavirus pneumonia became a global epidemic by September 2020 as cases increased daily[1]. Early in the pandemic, the new coronavirus was unknown. Dr. Nanshan Zhong's COVID-19 explanation states that the new coronavirus and the SARS bat-like coronavirus (Bat-SL-CoVZC45) share approximately 85% homology. The Zhong Nanshan academic team conducted a comprehensive study on the clinical characteristics of novel coronavirus pneumonia in China. Their research placed particular emphasis on analyzing the radiological features of affected patients along with their key symptoms. Isolation should persist for 1–14 days, according to the National Health Commission released a document titled "Pneumonia Diagnosis and Treatment Plan," outlining strategies for diagnosing and treating pneumonia. Epidemiological studies also advise monitoring based on clinical pneumonia symptoms, illness features, laboratory nasopharyngeal swabs, and the findings of negative or positive tests. The frequency of COVID-19 incidence reported in the most affected nations globally is shown in Fig.1. Out of a total of 185,039,249 documented illnesses, and the United States leads the world with 63,390,876 cases. Real-time polymerase chain reaction (RT-PCR) is widely employed for COVID-19 detection, offering results within approximately two days. However, this method can yield a notable number of false-negative results, with sensitivity ranging between 70% to 90% [9]. Moreover, due to the high demand for testing, the processing time can extend to five days or more in certain countries.

PREVIOUS WORK

Several studies have proposed different techniques for COVID-19 detection, including deep transfer models, fusion classifiers, and deep feature concatenation methods [17–19].

Additionally, researchers have employed Artificial

Neural Networks (ANN) to model thermal conductivity and viscosity in nanofluids using experimental data [20]. Moreover, the Group Method of Data Handling-type neural network (GMDH type NN) has been utilized to create optimized networks by supporting data streams across different layers [21].

The datasets utilized across the references encompass small [22,23], medium [13,16,24–27], and large [14,16,28,29] samples, as detailed in Table 1. Parameters examined in these studies include Accuracy, loss, precision, recall/sensitivity, f1-score, and AUC. In [24], authors found that VGG11, ResNet18, ResNet50, and ResNet50 achieved notable performance, with the highest Accuracy reaching 95.98% and a loss of 0.57%. However, ResNet-50 demonstrated the lowest Accuracy of 60 in [27], while VGG-19 achieved 94.5% accuracy. [26] introduced DNN, BiLSTM, and transfer learning models, with BiLSTM showcasing superior performance. Additionally, synthetic augmentation has been highlighted as significant in disease diagnosis [28]. Various iterations of Densenet have been proposed across several research works [14,16,22–25,30].

The ongoing Covid-19 pandemic has emphasized the critical need for rapid and accurate diagnostic tools. While RT-PCR remains the gold standard for diagnosing Covid-19, its limitations in terms of turnaround time and sensitivity have prompted exploration into alternative diagnostic modalities. Computed Tomography (CT) imaging has shown promise as a supplementary tool, particularly for identifying lung abnormalities associated with COVID-19 pneumonia. However, manually analyzing CT scans for COVID-19-related manifestations is time-consuming and requires specialized expertise. Automated systems leveraging deep learning techniques offer a promising solution to streamline this process and improve diagnostic efficiency.

Medical image analysis has emerged as a focal point of research, drawing significant attention due to its crucial role in accurate diagnosis and treatment planning. Despite advancements, there's still a need for further knowledge enhancement in this field, leveraging a variety of algorithms to enhance efficiency, speed, and diagnostic accuracy. Deep learning algorithms, in particular, have demonstrated notable effectiveness in detecting pneumonia, COVID-19, and other lung diseases when compared to traditional methods. In hospitals, healthcare professionals often encounter patients with overlapping respiratory conditions, such as pneumonia caused by various pathogens including influenza viruses and COVID-19. This complexity underscores the importance of segmentation techniques in analyzing lung images to facilitate disease detection and differentiation. Identifying COVID-19 from medical images presents a unique challenge, often requiring careful examination of clinical pictures alongside imaging data.

MATERIAL AND METHODS

Our proposed system for automated Covid-19 recognition from chest CT scans is based on pretrained deep learning models. We repurpose these models and fine-tune them using a dataset of labeled chest CT scans, distinguishing between Covid-19-positive and Covid-19-negative cases. The fine- tuning process involves adjusting the weights of the pretrained model's layers to optimize its performance for Covid-19 detection. We employ transfer learning techniques to leverage features learned from large-scale image datasets, thereby enhancing the model's ability to generalize to new data.

Preprocessing

Preprocessing is a vital step in reducing noise from the input frame, enhancing the smoothness and precision of the segmentation procedure. The camera often captures input containing salt and pepper noise, which can be effectively removed using a median filter.

Implement our system using popular deep learning frameworks such as TensorFlow or PyTorch. The pre-trained models used as the foundation for our approach may include architectures like VGG, ResNet, and MobileNET pretrained on large-scale image datasets such as ImageNet. We preprocess the chest CT scans to standardize their size, resolution, and intensity levels. Data augmentation techniques are applied to augment the training dataset, enhancing the model's robustness and generalization capability. We employ appropriate loss functions and optimization algorithms during training to fine-tune the pretrained models effectively.

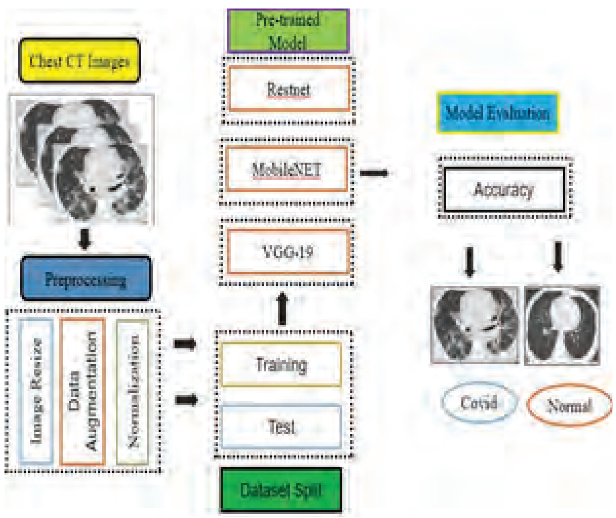

Fig. 1 Block diagram of Pre-trained Model

Deep learning-based pre-trained model

VGG19 is an extension of the original VGG network, featuring 19 layers in total. This architecture comprises 16 convolutional layers, 3 fully connected layers, and 1 softmax layer for classification, along with 5 max-pooling layers. These design choices, including kernel size, stride, pooling strategy, activation function, and fully connected layers, collectively contributed to the effectiveness of the VGG19 model in learning-rich feature representations for a wide range of images and achieving state-of-the-art performance in image classification tasks.

Table1. Model Parameter Details

Parameter	Values
Input Shape	(224,224,3)
Weights	ImageNet
Optimizer	Adam optimizer
Loss function	categorical_crossentropy
Activation Function	Softmax
Epoch	10
Batch Size	32

EXPERIMENT AND RESULTS

Dataset

The non-COVID and COVID instances of CT scan samples are included in this COVID-19 dataset. A total of 420 CT scan samples are utilized from the associated dataset for conducting this research. The dataset is divided into two subfolders of 337 non-COVID images and 83 COVID images.

Table Ii. Public Dataset

Name of dataset	Name of dataset	Details
COVID-CT Dataset	COVID-CT Dataset	COVID-19-positive, influenza, and normal cases
MosMedData	MosMedData	including COVID-19-positive and pneumonia cases
CORONACASES.ORG	CORONACASES.ORG	metadata, including clinical information
COVID-19 CT Segmentation Dataset	COVID-19 CT Segmentation Dataset	annotated lung and lesion masks
Medical Imaging Databank of the Valencia Region (BIMCV) COVID-19+ dataset	Medical Imaging Databank of the Valencia Region (BIMCV) COVID-19+ dataset	Annotated large RX and CT dataset

The proposed system offers several advantages, including rapid and accurate Covid-19 diagnosis from chest CT scans, reduced dependency on human expertise, and scalability for large-scale screening efforts. However, it also faces limitations such as the requirement for labeled training data, potential biases in the pretrained models, and challenges in interpreting model decisions. Future research directions may focus on addressing these limitations, exploring ensemble learning techniques, incorporating multimodal data fusion, and integrating clinical context into the diagnostic process to further improve the system's performance and usability in real-world clinical settings.

Table 3. Loss and Accuracy of Pre-trained Model

Model	Training Loss	Test Loss	Training Accuracy	Test Accuracy
VGG-19	0.5096	0.6140	0.7626	0.6747
MobileNet Adam Optimizer	0.1514	3.3046	0.9466	0.5783

MobileNet SGD optimizer	0.1696	1.6756	0.9377	0.7349
Restnet	0.6918	0.6929	0.5134	0.5181

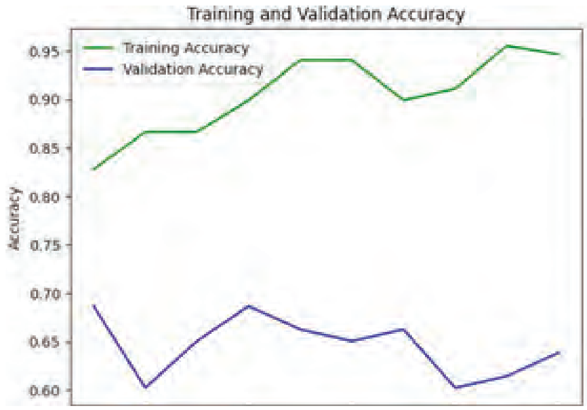

Fig. 4 Training and Validation curve of MobileNet (adam optimizer)

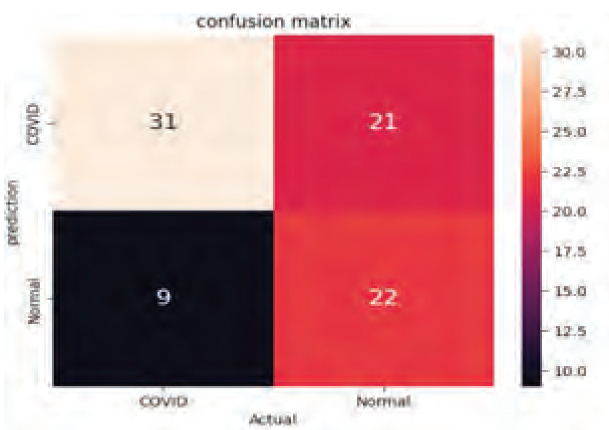

Fig. 5 Confusion Matrix of MobileNet (adam optimizer)

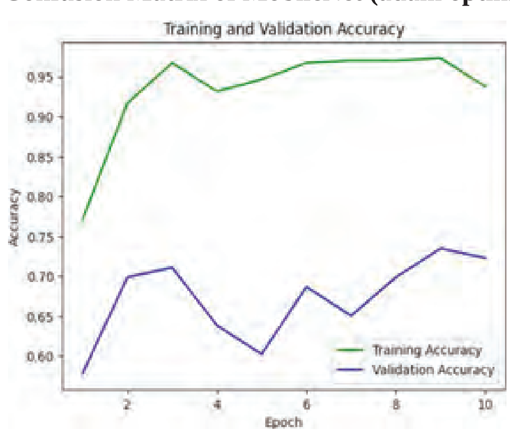

Fig. 6 Training and Validation curve of MobileNet (SGD optimizer)

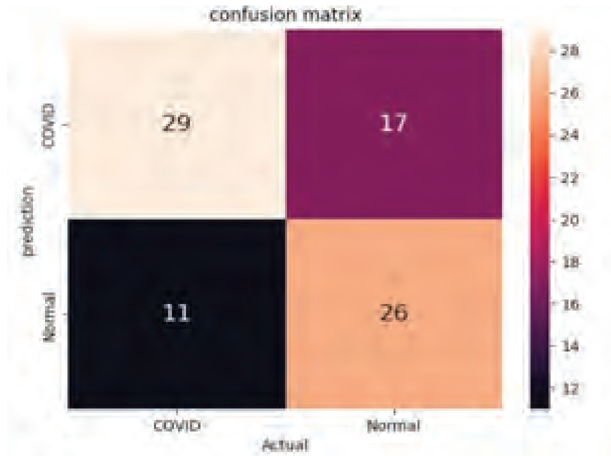

Fig. 7 Confusion Matrix of MobileNet (SGD optimizer)

CONCLUSION

study demonstrates the feasibility and effectiveness of leveraging pretrained deep learning models for automated Covid-19 recognition from chest CT scans. By repurposing existing deep learning architectures and fine-tuning them for Covid-19 detection, we provide a practical solution to enhance diagnostic efficiency and accuracy in the context of the ongoing pandemic. Our findings underscore the potential of deep learning-based approaches in advancing medical imaging diagnostics and improving patient care outcomes.

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Solar Power based Real-time Weather Monitoring System

Prathamesh Chavan, Deepak Patil
Tejas Dorve
Student
E&TC
P.E.S.'s Modern College of Engineering
Pune, Maharashtra

Kirti Adoni
Assistant Professor
E&TC
P.E.S.'s Modern College of Engineering
Pune, Maharashtra

Deepali Adhyapak
Associate Professor
E&TC
P.E.S.'s Modern College of Engineering
Pune, Maharashtra

ABSTRACT

This review paper presents a solar-powered system with five sensors for real-time weather monitoring. The system also uses the sensor to measure current and voltage ratings of solar panel. The readings of all the sensors will be displayed on TFT LCD screen. It addresses the rising need for trustworthy environmental data in outlying regions with little access to conventional power sources. The review is carried out to develop real-time weather monitoring and solar energy forecasting for cleaner and more efficient energy production, particularly in the context of climate change and the demand for renewable energy sources. This will be accomplished by combining several sensors and solar power technologies.

KEYWORDS: *Solar power, Weather monitoring, Real-time data, Sensor integration, Renewable energy.*

INTRODUCTION

The Solar Power-based Real-time Weather Monitoring System represents a significant stride in the domain of environmental data collection, and this research paper delves into its intricacies. This innovative system is meticulously engineered, comprising a comprehensive array of five sensors meticulously designed to monitor an extensive range of environmental parameters. These sensors include temperature, humidity, air quality, light intensity, optical dust, raindrop detection, and the detection of smoke- inducing gases. Each of these sensors is powered by an ingenious combination of solar panels and an efficient battery backup system, ensuring continuous and reliable operation without dependence on the electrical grid. The ESP-32 microcontroller, a powerful central processing unit, is the brains behind this system. It is responsible for orchestrating the smooth integration of the many sensors. It skill-fully gathers information from these sensors, analyses it precisely, and enables real-time data transfer. For user's convenience, the system features an integrated LCD screen, offering an intuitive and user-friendly interface. This display serves as a real-time data portal, providing instantaneous access to crucial environmental metrics. To complete this comprehensive system, the inclusion of the LM2596 sensor, a DC-to-DC converter, showcases the current and voltage ratings of the solar power system, thus providing an exhaustive overview of its performance.

In addition to describing the system's technological architecture, this research paper embarks on a profound exploration of the system's implications and contributions to the field. By addressing a notable research gap and amalgamating knowledge from previous studies on individual sensors and solar power-based weather monitoring systems, this paper offers a holistic and sustainable solution for real-time weather monitoring. Beyond its core function, the system holds the promise of enhancing the accuracy of solar energy forecasting, marking a substantial contribution to the ever-evolving realms of renewable energy and environmental monitoring.

LITERATURE SURVEY

Component-based research on solar power weather monitoring systems delves into the individual elements and components that constitute these systems:

The research by Dimitris Margaritis, et al. [1] discussed about four relevant studies were compared to the results of their study on the calibration of gas sensors for air quality monitoring. The authors focused on the shared calibration methods employed in the experiments (i.e., SLR (Simple Linear Regression), MLR (Multiple Linear Regression), and RF (Random Forest)) and examined the measurement performance and associated calibration properties of similar AQ-Mesh pods. The survey highlighted how ambient temperature and humidity had a positive procure on the calibration of gaseous contaminants.

A S Priambodo, et al. [2] described the design and implementation of an ESP32 and GPRS-equipped solar-powered autonomous weather station in their research paper. The advantages of employing a solar-power weather station and the actual application of the ESP32 microcontroller module for the internet of things were covered by the writers. The survey included references to a collaborative design approach for modernizing spate irrigation systems and an irrigation supporting system for increasing water use effectiveness in precision agriculture.

Zaid Hussein, et al. [3] outlined the survey which presents a low cost-effective weather station using ZigBee communication technique. A weather station using an Arduino Uno board and five sensors (rain state, wind level, air pressure, dust density, temperature and humidity) that provide data for the sixth reading is implemented and designed as part of the system. The limitations of WLAN (Wireless Local area network) and the possibilities for cloud and IoT technologies to improve performance and data storage are also covered in the study.

Karthik Krishnamurthi, et al. [4] examined about the review a gap in the literature regarding systems that could monitor the combination of temperature, lighting, and humidity in one system and had actuators to update these settings. The paper described the methodology used to develop the system and presented the results, including graphical output and potential applications. Overall, the paper provided a comprehensive overview of an automated weather monitoring system and its benefits.

The research by P. Susmitha, et al. [5] explained, how the system was designed to operate without human intervention, utilizing sensors (temperature, gas, and humidity sensors) to measure meteorological parameters and transmit data. The paper provided a comprehensive overview of the design and implementation of a weather monitoring and controlling system suitable for various industries. Its capacity to collect and transmit data remotely, along with an SMS alert feature, made it a valuable tool for monitoring weather conditions and ensuring worker and equipment safety.

Yogesh S, et al. [6] described the design and implementation of a low-cost rain sensor system with Arduino as a microcontroller for short-range applications. The system detected rainfall and measured resistance, with the data converted from analog to digital values. The paper concluded that the system could be extended and implemented into various applications.

Boyanka Nikolova, et al. [7] emphasized the value of air quality monitoring and offer their technology as a potential remedy. The study highlights the importance of the authors' work in solving environmental issues by giving an overview of relevant research, approaches, and technologies that are currently being employed in the area.

Teddy Gunawan, et al. [8] highlighted the importance of automated irrigation systems for maximized agricultural crop productivity and resource efficiency. This study explored the creation of an ESP32-based system while showing the potential advantages of integrating IoT technology with contemporary farming methods.

Along with component-based research, we also have some on IOT and its use in numerous industries:

Research put forth by Vaishnavi Lakhara, et al. [9] have discussed about various existing systems that used different sensors and technologies to monitor weather conditions. IoT-based weather monitoring systems had gained popularity due to their ability to collect and analyse real- time data from multiple sources. The use of Arduino boards, sensors, and wireless communication technologies such as Wi-Fi and Bluetooth had been widely explored in the development of such systems. The proposed system aimed to improve upon existing systems by providing a more accurate and reliable weather monitoring solution.

Research conducted by Abd Zeed, et al [10] discussed about cost-effective IoT-based control system for solar- powered smart greenhouses. It presented a self-regulating, climate-controlled environment that was created by the technology to promote precision farming and optimal plant growth. The advantages of the suggested solar-powered Internet of Things (IoT)-based intelligent control system for greenhouses were discussed in the study. It also drew attention to the system's online monitoring capability, which enabled users to manage and examine data at any time and from any location.

Work shared by M. Sreerama, et al. [11] have discussed the construction of IoT-based weather monitoring systems utilizing various hardware and software components was described in references to numerous research articles. The articles also covered possible disaster management, transportation, and agricultural applications of such systems. Overall, the existing literature review offered a thorough picture of the state of research in this area at that time.

Study offered by Ms. Shifa Hashmi, et al. [12] discussed that environmental monitoring was crucial, and real-time weather data was required, as demonstrated by the literature review for IoT-based weather monitoring utilizing Arduino- Uno. The project developed a low-cost platform for remote weather monitoring by combining control systems and data collection methods. A dependable and effective method of tracking the weather and other environmental variables was through the use of sensors, such as temperature and humidity sensors, and the integration of IoT technologies with Arduino-Uno.

Findings presented by Abu Saleh, et al. [13] have discussed that in recent years, there had been a lot of interest in efficient IoT-based weather stations. IoT technology had been studied by several researchers as a means of creating weather monitoring systems that were more accurate as well as efficient than current studies. According to the literature survey, IoT-based weather stations could deliver real-time weather data that could be utilized for a number of purposes, such as disaster management, transportation, and agriculture. Data security and privacy issues were just two of the problems that still needed to be solved.

The research shared by V. Kavitha, et al. [14] have discussed the significance of renewable energy sources and the demand for reliable, affordable monitoring systems. In order to ensure stable power output and top performance, the suggested system made use of IoT technology to gather and evaluate solar energy parameters. The system offered a user-friendly interface for remote monitoring and maintenance and was made to be accessed through a computer or smartphone.

Mrs.Devi.Devpal , et al. [15] discussed about an innovative system designed to empower farmers. It also highlighted the importance of technology in agriculture, focusing on solar-powered solutions for soil and weather monitoring. The paper offered insights into the potential benefits of such systems for optimizing agricultural practices and enhancing crop yields.

Suprita M. Patil, et al. [16] explored the integration of IoT technology for solar energy monitoring. Also, highlighted the increasing interest in IoT applications for renewable energy systems. The paper provided valuable insights into the advantages and possibilities of such systems in enhancing the efficiency and management of solar energy resources.

Hermansyah, et al. [17] investigated the development of a remote monitoring and control system for miniature weather stations using solar panels and ESP32 technology.

The literature survey emphasized the growing interest in leveraging web-based solutions and IoT devices for weather monitoring and solar energy systems. The paper provided valuable insights into the benefits and feasibility of such systems in enhancing the management and efficiency of miniature weather stations with solar panels.

Manh Duong, et al. [18] examined about the application of IoT-based control for managing solar energy in microgrids. It highlighted the increasing interest in utilizing IoT technologies for efficient energy management in microgrids. The paper provided valuable insights into the potential benefits of dependable IoT-based control systems in enhancing the management and optimization of solar energy resources within microgrids.

In addition to component-centric research, there are studies exploring the utilization of IoT technology across a wide range of industries, with addition of the field of solar panels:

The research by Sheikh Hasib, et al. [19] discussed that the system was made to continuously monitor a photovoltaic panel's power production and environmental circumstances, ensuring efficient power output and identifying defective solar panels and environmental factors that reduced solar effectiveness. The relevance of monitoring solar power plants and the advantages of utilizing an IoT system for solar power monitoring were highlighted in the study.

Farid Touati, et al. [20] examined the performance of solar PV systems in Doha's weather conditions. They also highlighted the significance of customized measurement and monitoring systems in assessing solar PV performance. The paper provided valuable insights into the specific challenges and solutions for optimizing solar energy utilization in the context of Doha's climate.

Hegazy Rezk, et al. [21] focused on setting up a system to track meteorological information and sun radiation for photovoltaic systems. It is specified how crucial these systems are for maximizing solar energy output. The research offered useful insights into the practical considerations of setting up monitoring systems for evaluating solar radiation and weather conditions.

Jae-Gon Kim, et al. [22] elaborated on utilizing weather prediction data to anticipate daily solar power output in Korea. The review of literature brought attention to the value of precise solar power generation forecasting for effective energy management. The research included insightful information on the difficulties and strategies for improving the accuracy of solar energy forecasts based on meteorological data in the Korean setting.

Cristian-Győző, et al. [23] explored, how to monitor solar panels using machine learning techniques. The literature review showed that there is significant interest in using machine learning to manage solar panels. The study provided insightful information on the developments and potential applications of machine learning to improve the upkeep and efficiency of solar energy systems.

Isabel M, et al. [24] delved into a utility-scale solar power plant monitoring system in real time. The literature review underlined the value of such monitoring systems in enhancing the efficiency of large-scale solar energy project. Insightful information about the practical elements of monitoring solutions for utility-scale solar power facilities was offered in the study.

Manohar Mishra, et al. [25] investigated a better approach for short-term solar PV power prediction using deep learning and wavelet transform techniques. The literature survey underscored the significance of combining these methods for accurate solar power forecasting. The paper offered valuable insights into the advancements and potential applications of this integrated approach in optimizing solar PV power prediction.

The research by Jun Liu, et al. [26] discussed about the integration of ozone index data into a better model for projecting solar output. The literature review emphasized the significance of using such additional information to provide more precise projections for solar power. The article offered insightful information on the improvements and advantages of include aerosol index data in solar power forecasting models.

R. Ahmed, et al. [27] examined the most recent forecasting and optimization methods for PV solar power. The literature review underlined the value of accurate evaluations and developments in solar power forecasting. The research offered insightful analyses into the dynamic environment of methods and optimization schemes for precise photovoltaic solar power projections.

A.M. Ramli, et al. [28] investigated, how weather and dust buildup affect solar power production. The literature review showed how crucial it is to comprehend how these factors affect the efficiency of solar systems. The research brought significant knowledge on the adverse effects of dust and weather on solar energy generation and contributed to the examination of photovoltaic power decrease.

There is a parallel stream of study focusing on maximizing the potential of IoT technology across a broad range of businesses in addition to the in-depth examinations focused on specific components. This extensive investigation covers the use of IoT in numerous industries, with the solar panel sector serving as an exceptional instance. These studies aim to use IoT technology to monitor, manage, and increase the effectiveness of solar panel installations, ultimately resulting in more efficient and sustainable renewable energy solutions. Researchers are opening the path for novel and linked ways in the hunt for trustworthy and sustainable energy sources by fusing IoT and solar panel technologies.

COMPARATIVE STUDY

Technologies Used	Controller	Parameters
IOT [1]	Arduino Uno	Temperature, humidity, rainfall, Gas, DHT, noise
IOT[2]	Esp8266 Wi-Fi microchip	Pressure sensor , temperature and Humidity , Rain sensor
IOT [3]	Arduino UNO	Temperature, humidity, air pressure, and precipitation
IOT [4]	Arduino Uno	Temperature, rain level, humidity, light
smart greenhouses powered by solar energy [2]	Arduino	Temperature, humidity, lighting intensity, soil moisture
solar PV monitoring system using IOT [6]	CC3200 microcontroller	Current sensor, voltage sensor, temperature & Humidity, pyranometer
Smart Agro Farm Solar Powered Soil [7]	ATMEGA 328	soil moisture and soil temperature
IoT based Solar Energy Monitoring System [8]	Arduino UNO 3	Current sensor, temperature sensor
Solar Panel [9]	Esp-32	Voltage, current & Power sensors, Light intensity, Temperature sensor
Solar power with IOT [10]	ESP8266 Wi-Fi module	voltage, current, temperature and light intensity
Investigation of solar PV performance [11]	Atmega32	Ambient and PV surface temperatures, irradiance and wind speed
Experimental implementation of meteorological data and photovoltaic solar radiation [12]	Cloud services	Using Gaussian process to determine panel maximum power point (MPP) with ANN algorithms.
Deep learning and wavelet transform integrated approach for short-term solar PV power prediction [13]	Data preprocessing techniques	short-term solar PV power prediction using the WT-LSTM model and its experimental results and analysis.

INFERENCES

- The system is equipped with a wide range of sensors, providing extensive coverage of environmental parameters.
- It monitors variables such as temperature, humidity, air quality, light intensity, optical dust levels, rain presence, and smoke gas concentrations.

- The inclusion of LM2596 sensors suggests a focus on monitoring electrical and power- related aspects, possibly for system optimization.
- Collecting data from these diverse sensors ensures a comprehensive assessment of environmental conditions, making it a valuable tool for real-time weather monitoring and environmental analysis.

PROPOSED SYSTEM

Solar Power based Weather monitoring System is a weather monitoring system which has five key sensors to monitor environmental parameters, including temperature, humidity, air quality, light intensity, optical dust, raindrop detection. All these sensors are efficiently powered by solar panels and battery back-up, ensuring continuous operation without reliance on the electrical grid. The system contains ESP-32 microcontroller, which acts as central processing unit. It collects data from the sensors, processes it, and transmits the information to LCD display. To enhance usability, the system features an TFT LCD screen that displays real-time weather data. A noteworthy addition to this system is the LM2596 sensor, a DC-to-DC converter that plays a pivotal role in showcasing the current and voltage ratings, thereby providing users with a comprehensive overview of the solar energy system's performance.

The possibility of this suggested method to fill a significant research void in the area of real-time weather monitoring is what really makes it stand out. It provides a complete and sustainable solution by utilizing the insights and knowledge gathered from earlier research on individual sensors and solar power-based weather monitoring systems. In addition to enabling real-time weather monitoring, the technology has great potential to increase solar energy forecasting accuracy. The users in a new age of scientific and technical growth and provides a big and notable contribution to the fields of renewable energy and environmental monitoring.

CONCLUSION

In conclusion, an integrated solution for accurate and long-lasting environmental monitoring is provided by the Solar Power-based Real-time Weather Monitoring System, which combines five sensors, a solar power source, and sophisticated data presentation via the ESP-32 microcontroller and LM2596 sensor with battery back-up. Accurate real-time weather information is of the utmost importance, and our system fills that requirement, helping a number of areas including agriculture, energy management, and disaster planning.

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Bluetooth: A Smart Solution to the Internet of Things for Smart Home

A. S. Shirsat
Department of Electronics and Telecommunication
Progressive Edu. Society's Modern College of Engg.
Pune, Maharashtra
✉ anil.shirsat@moderncoe.edu.in

S. C. Wagaj
Department of Electronics and Telecommunication
Rajarshi Sahu College of Engineering
Pune, Maharashtra
✉ scwagaj@gmail.com

S. A. Shirsat
Department of Electronics and Telecommunication
Sinhgad College of Engineering
Pune, Maharashtra
✉ sashirsat.scoe@sinhgad.edu.in

R. Sahu, M. A. Kango
Department of Electronics and Telecommunication
Progressive Edu. Society's Modern College of Engg.
Pune, Maharashtra
✉ ramgopal.sahu@moderncoe.edu.in
✉ mugdha.kangoi@moderncoe.edu.in

ABSTRACT

The IoT has changed lifestyle of people to interact with their homes by creating a more connected and automated system, with Bluetooth technology playing a key role. A study explores the benefits, applications, and challenges of using Bluetooth in smart homes, highlighting its energy efficiency, versatility, and ability to connect various devices. Bluetooth excels in managing smart lighting, security, and environmental systems. This work aims to check the Bluetooth performance in heterogeneous environment to contribute for improving IoT deployments in smart homes for enhanced convenience, effectiveness, and user satisfaction. From the simulation results, it is clear that Bluetooth is one of the strong contenders in IoT applications.

KEYWORDS: *Bluetooth, Heterogeneous, Interoperability, IoT.*

INTRODUCTION

A Smart Home is defined as a residential setting where electronic devices are capable of being automatically controlled or remotely managed wirelessly, employing a variety of wireless technologies such as ZigBee and Bluetooth to facilitate seamless communication between devices [1][2][3]. The utilization of Bluetooth-based technology enables the establishment of wireless communication links and connections with a wide array of devices including smartphones, thereby enabling data exchange over short distances to enable efficient smart home control functionalities as well as air quality monitoring capabilities [4].

The integration of Bluetooth technology within the realm of smart home Internet of Things (IoT) presents numerous advantages to users, including but not limited to the promotion of energy efficiency through low power consumption and the facilitation of a straightforward setup process. Furthermore, the adoption of Bluetooth ensures the establishment of a robust and secure connection, thereby fostering user trust and reliability in the system. By leveraging Bluetooth technology for regulating smart home IoT operations, users are empowered to personalize settings and effectively monitor various aspects of their household environment, thereby catalyzing a transformative shift in lifestyle practices. This sophisticated system empowers users to oversee and manage elements such as lighting, heating, security, and entertainment within their living spaces, thereby engendering a heightened sense of control and convenience[5][6].

Moreover, the implementation of smart home automation tailored for individuals with disabilities serves as a catalyst for promoting independence, as it simplifies the process of controlling their living environment and offers a sense of empowerment to those grappling with mobility challenges. The deployment of a Bluetooth-centric system specifically designed for disabled individuals not only enhances their quality of life but also provides a user-friendly platform for effectively managing their home environment, thereby fostering inclusivity and empowerment within the community. The seamless integration of Bluetooth technology within smart communication processes while simultaneously eliminating the need for intricate wiring, thereby rendering the system easy to install and operate, and a feature that proves particularly advantageous for users with disabilities [7].

The paper is organized as an exhaustive literature survey is done followed by the simulation and experimentation carried out in the presence of other radio access technologies. The experimental results are given along with their implications. Finally the conclusions are drawn based on the results obtained.

LITERATURE SURVEY

Bluetooth Low Energy (BLE) system tracks user location and living patterns accurately indoors. This method includes trilateration and fingerprinting for indoor tracking. The system is cost-effective system for monitoring individuals with dementia or disabilities. The system is based method for localization using RSSI signal changes. Fingerprinting-based method for indoor location tracking of users is used. BLE system tracks users accurately in home environments using two proposed methods. No specific limitations were mentioned in the provided contexts [4]. Bluetooth low energy supports various applications in IoT with reliable communication and real-life implementations. It includes interference from Wi-Fi signals and randomization for mitigation challenges. Author experimented, to show message paths, acknowledgments, and dropped packet acknowledgments with reflecting the number of hops. Security in Bluetooth Mesh is enforced through encryption and authentication for validated applications such as smart doorbell, LED control, and smart factory applications. Bluetooth Mesh highlights practical applicability, challenges, and opportunities in encrypted messages, and authenticated communication [5].

Proposed solution is based on Bluetooth low energy, reduces peak load demand and electricity consumption charges efficiently. BLE-based Fuzzy Logic Controller for smart energy management in home automation wireless network shows high packet delivery ratio compared to IEEE 802.15.4. In this paper proposed solution achieves higher monetary cost reduction in electricity bills. The developed system is BLE- based [6]. In this system is for smart home automation with flexible network design security, which includes authentication flexibility, scalability, and low-cost home automation solution. In this smart home prototype hardware uses ESP8266. The developed system is user-friendly, flexible, scalable, and cost- effective smart home solution. Real case study is presented with app features for easy home automation [7]. Paper focuses on Arduino Uno for smart home creation and Android integration prototype. It discusses microcontroller benefits and applications in modern electronic systems. It utilizes RFID and Bluetooth modules for smart door locks and lights. It enhances home activities, controls lights, fans, and door locks efficiently. Smart home design eases activities, controls lights, fans via smartphone applications [8].

This paper is emphasis on energy conservation, cost reduction, safety improvement, and easier maintenance. IoT technology enables remote monitoring and control of home appliances. But the system is based on DTMF-based systems and need dedicated PSTN channels for communication, Bluetooth systems require operating appliances to be within range [9]. Smart home automation using Arduino Uno microcontroller is discusses. The major focus is on Bluetooth- based control, light sensing, and water level indicator. The design and implementation of wireless smart home automation system is done using Arduino Uno. The system is Low cost, secure, and easily accessible system for managing home appliances. Application software based on Android for mass adoption and simplicity enables control of home appliances for disabled and elderly individuals [10]. In this review of IoT technologies for Smart Home Automation Systems selection is discussed. The focus is on communication technologies, metrics, and optimal selection criteria. Various reviews are made on all available technologies. It compares the technologies based on user interface, technical characteristics such as frequency bands, and protocols for future administration, security, and cost. It also discusses communication protocols, data rates, range, and heterogeneity of technology [11]. Authors have proposed secure architecture for Bluetooth-based IoT devices in smart healthcare systems. It introduced a standard Bluetooth dataset and DNN-based classifier for Bluetooth traffic. Paper claims intrusion detection performance of 97-99.5% based on F1 scores. The dataset used is developed for intrusion detection using deep learning. Algorithms used are supervised ML algorithms and Unsupervised ML algorithms [12].

Lee, Jung-Hyun et. al., have developed a Bluetooth-based smart home IoT system, which measures air quality, CO, temp, humidity like commercial systems. It allows remote control of indoor environment via Bluetooth on mobile. It enhances user experience with easy control and data visualization. The system is for air quality monitoring and control, which visualizing data on mobile app, measuring fine dust, CO, temperature [13]. Author developed a Bluetooth- based smart home control with air monitoring system for elderly and handicapped user convenience. This smart home system enhances comfort for residents. The designed system is hardware prototype connects to home appliances, tested with fast response, with IoT technology, Android app, Arduino Uno, sensors for home automation [14]. Arduino-based home automation system with Bluetooth and Android application designed and developed. The system is user-friendly, reliable, low-cost, and beneficial for handicapped individuals. Implementation of Bluetooth technology for home automation is done using Arduino microcontroller. With the help of microcontroller, Bluetooth module, voice prompt control for home appliances is designed via Android application [15].

Dual mode smart home system based on IoT works effectively in relay mode controls manual and automatic modes for lighting synchronization. The developed system uses lights controlled manually and automatically with relay mode. In this system, Blynk application used for automatic mode with virtual switch to synchronizes virtual switch and relay mode condition when connected [16]. Authors have designed a Bluetooth based smart home automation system for physically disabled people to improves lifestyle for elderly and disabled users. It uses Bluetooth technology based control appliances with smartphone applications remotely via smartphone with a user-friendly interface [17]. In this paper author designed and fabricated of a low-cost system for smart home applications with Arduino microcontrollers. It is integration of sensors for home security and automation which included security levels, garage gate control, and safety features. The system focuses on wireless communication, entertainment, security, convenience, and information management applications. It emphasizes user-friendly, reliable, secure, and cost-effective smart home design [18].

In this review paper various IoT technologies for smart home automation, connectivity, cost, and user interaction are compared and explained. In comparison of wired, wireless, and dual-mode technologies for home automation is done based on connectivity, user interaction, and cost. The results are examined for wired, wireless, and dual-mode connectivity with metrics [19].

The paper discusses the performance of Bluetooth in a heterogeneous wireless environment with GFSK modulation technique, in the presence of 802.11. An attempt is made to calculate the performance of basic rate Bluetooth in the presence of other Bluetooth devices in the close vicinity. MATLAB based simulation results showed the degradation of performance of Bluetooth in the presence of other wireless networks and enriched by selecting different hopping frequency in synchronization with interfering Bluetooth devices. Simulation results demonstrate that Bluetooth works satisfactorily in a heterogeneous wireless environment with GFSK modulation technique, and issues such as bit error rate and throughput performance of Bluetooth in the heterogeneous environment are focused on [20-25]. From the extensive examination of the available literature, it is infer that the Bluetooth is one of the strong contenders in IoT platform, where smart systems can be developed. The performance of Bluetooth in terms of Bit Error Rate (BER), Packet Error Rate (PER), and data transfer speed can be notably enhanced up to a certain threshold when utilized in conjunction with other Radio Access Technologies (RADs). In order for Bluetooth technology to establish itself as a feasible option within the domain of the Internet of Things (IoT), it is crucial for it to exhibit strong interference mitigation capabilities, a high rate of transmission, and the capacity to maintain a consistent level of performance in terms of overall throughput and effective data transfer speed, also referred to as goodput.

BLOCK DIAGRAM OF SIMULATED AND HARDWARE SYSTEM THE BLUETOOTH TRANSCEIVER MODEL IS DEVELOPED IN

MATLAB Simulink to explore its performance. Fig. 1 demonstrates the developed Bluetooth Transceiver model in a uniform network, consisting of a sender, recipient, Bit Error Rate (BER) calculation, and a channel encompassing interference. The sender is responsible for creating packets containing data, heading, and end information, utilizing different encoding methods. These packets send through encoding and modulation procedures. The information across the entire frequency range is spread through a PN sequence and is sent via the Additive White Gaussian Noise (AWGN) channel with an output power of 1mW. The hopping sequence is synchronized between the sender and recipient. The signal is subjected to filtration and de-spreading, resulting in the decoding of the received information at receiver. The received data is compared with the sent bits in the presence of different RATs. Bluetooth performance in terms of BER is examined in homogeneous environment. The assessment of performance is carried out by evaluating the Eb/No and BER.

Hardware Setup: The hardware setup is developed to create a heterogeneous environment along with Bluetooth transceiver, as depicted in Fig. 2. It consists of Wi-Fi modules, ZigBee modules and Bluetooth master-slave connection with other interfering Bluetooth. These modules are placed apart from each other, as shown in the block diagram. Arduino- UNO is used to interface the Wi-Fi (EPS 8266) module and Bluetooth (HC-05), which transmits the data from master Bluetooth to slave with low baud rate. ATMEGA-8A microcontroller is used to interface the ZigBee modules. A pair of node MCU is used to incorporate the Wi-Fi network.

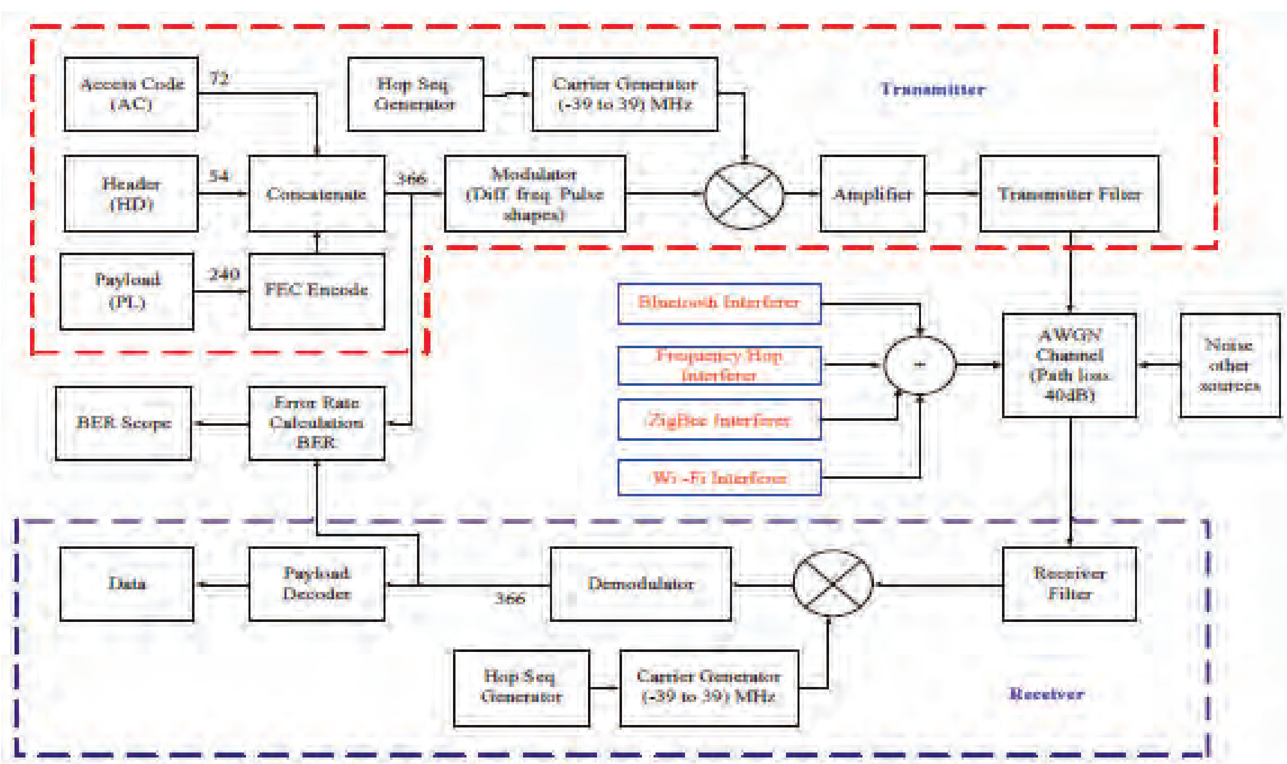

Fig. 1: Bluetooth Transceiver Model in Heterogeneous Environment

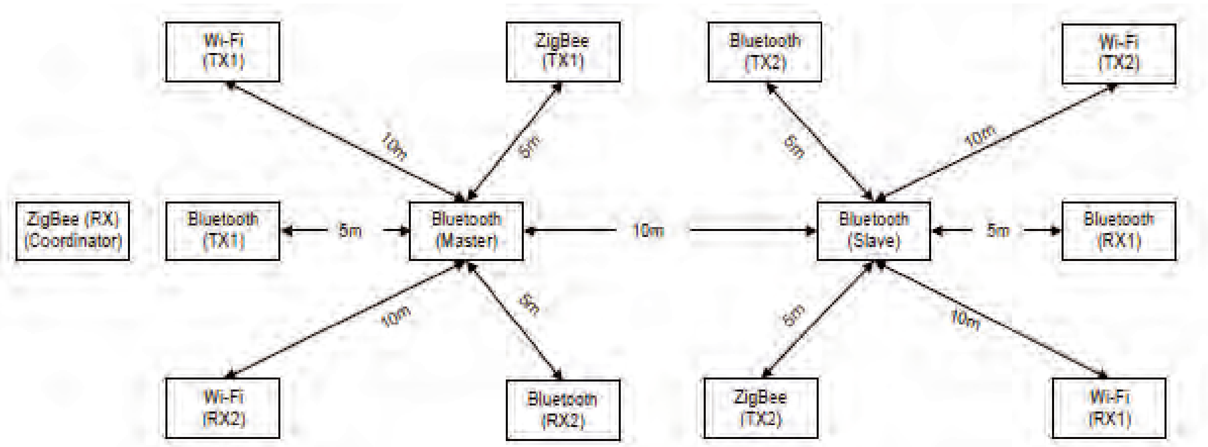

Fig. 2: Hardware Implementation of Bluetooth Transceiver in Heterogeneous Environment

RESULT AND DISCUSSION OF SYSTEM

The simulation results of the BER performance of Bluetooth is given in table 1. Fig. 3 and Fig. 4 illustrate the BER performance of Bluetooth and interfere with respect to Eb/No. The throughput is calculated from BER for data packets as shown in table 2. BER Performance of Bluetooth for GFSK modulator in the presence of various interferences such as ZigBee, WLAN, Hopping interference and other Bluetooth are calculated. From the results obtained, it is concluded that the performance of Bluetooth gets hampered due to interferences. It is required to improve performance. The BER performance is affected more by other Bluetooth devices placed in closed vicinity as compared to other interfering devices such as WLAN, ZigBee and hop interference. Above 15 dB Eb/No interference caused by ZigBee is more than other interfering devices. From this performance, it is observed that throughput also is hampered by other radio access technologies.

Fig. 5 shows the overall BER performances of Bluetooth in a heterogeneous environment with and without all interferers. With the increasing number of interferers, the performance of Bluetooth decreases but it is good to manage for the smart home application.

Table 1 BER performance of Bluetooth in a heterogeneous environment

Eb/ No (dB)	Only BT	Interference				
		Wi-Fi	ZigBee	BT	With Hop	All
0	3.15E-01	3.15E-01	3.18E-01	3.18E-01	3.15E-01	3.20E-01
3	2.14E-01	2.14E-01	2.17E-01	2.25E-01	2.14E-01	2.30E-01
6	1.08E-01	1.08E-01	1.15E-01	1.26E-01	1.09E-01	1.31E-01
9	3.47E-02	3.47E-02	4.09E-02	5.30E-02	3.58E-02	5.79E-02
12	4.50E-03	4.60E-03	8.30E-03	1.23E-02	5.60E-03	1.74E-02
15	1.00E-04	2.00E-04	1.10E-03	1.50E-03	5.00E-04	5.60E-03
18	0.00E+00	1.00E-04	4.00E-04	0.00E+00	2.00E-04	2.80E-03
21	0.00E+00	1.00E-04	1.00E-04	0.00E+00	1.00E-04	2.80E-03

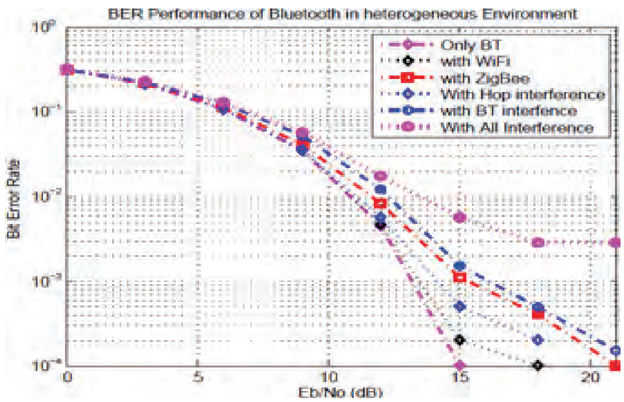

Fig. 3 BER Performance of Bluetooth with one Interferer at a Time

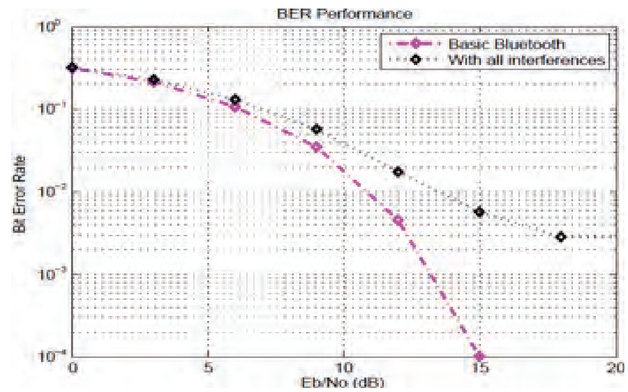

Fig. 4 BER Performance of Bluetooth with all Interferes

Table 2. Throughput Performance of Bluetooth in A Heterogeneous Environment

Eb/ No (dB)	Only BT	Interference				
		Wi-Fi	ZigBee	BT	With Hop	All
0	2.425×10^{-35}	$2.341E^{-35}$	$8.05982E^{-36}$	7.5056×10^{-36}	2.6031×10^{-35}	$3.94939E^{-36}$
3	5.2195×10^{-21}	4.907×10^{-21}	1.9992×10^{-21}	1.7567×10^{-22}	4.6125×10^{-21}	3.7647×10^{-23}
6	7.2659×10^{-8}	7.071×10^{-8}	1.29848×10^{-8}	6.0615×10^{-10}	5.6857×10^{-8}	1.3838×10^{-10}
9	13.3076016	13.30769	2.782450399	0.134074408	10.08871178	0.038031491
12	21402.1419	20886.270	8453.526559	3246.177933	16362.07703	946.3052709
15	62464.305	60965.309	48988.31921	44447.44997	56679.88829	16362.07703
18	64000	62464.304	58073.94371	64000	60965.3094	32391.41994
21	64000	62464.304	62464.30495	64000	62464.30495	32391.41994

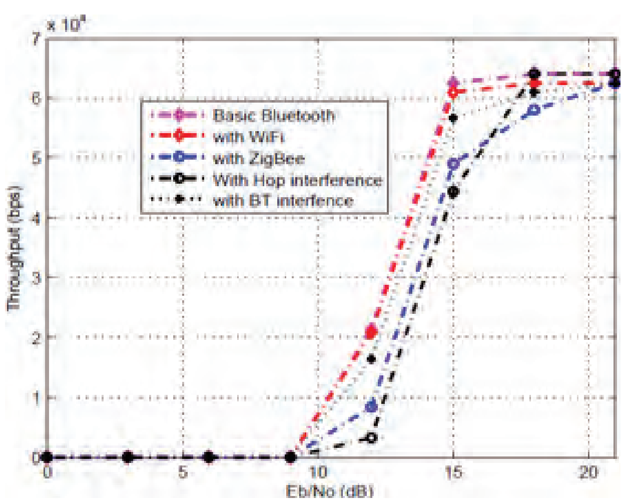

Fig. 5(A) Throughput Performance of Bluetooth with one Interferer

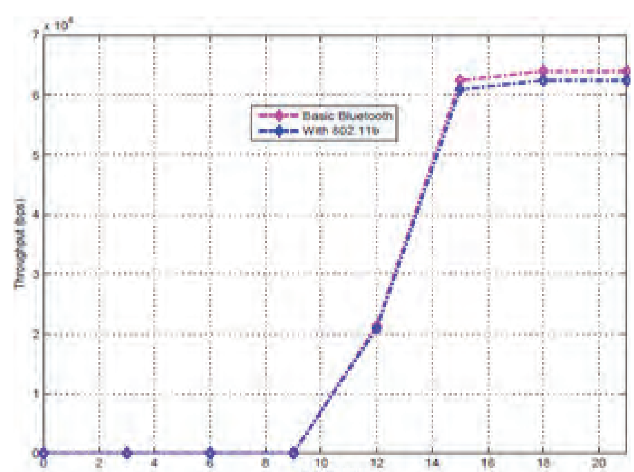

Fig. 5(A) Throughput Performance of Bluetooth with all Interferes

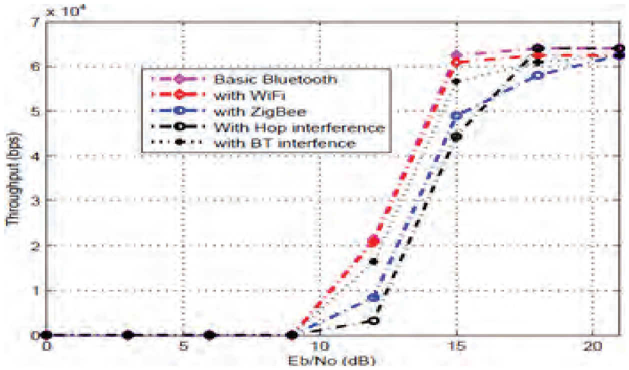

Fig. 5(B) Throughput Performance of Bluetooth with one interferer

The performance of Bluetooth in terms of BER and throughput is checked in the heterogeneous network and inferences drawn from the obtained results are enlisted as. By increasing the number of interfering devices, BER performance is decreased, and consequently, throughput degraded at certain level. At and above 15 dB Eb/No performance gain, interference caused by ZigBee is dominant than other RAT devices. Even though by increasing Eb/No from 9 dB to 15 dB, the throughput of Bluetooth gets affected in a heterogeneous environment. Throughput performance is better at and above 15 dB Eb/No. It is observed that the throughput and completion time required are functions of distance and channel condition.

A test file of 2 Mb is transmitted over the master Bluetooth module and received on the slave Bluetooth module. Results obtained are given in the tabular form in table 3. From the result obtained, it is observed that the throughput and completion time required are functions of distance and channel condition as shown in Fig. 6 and Fig. 7.

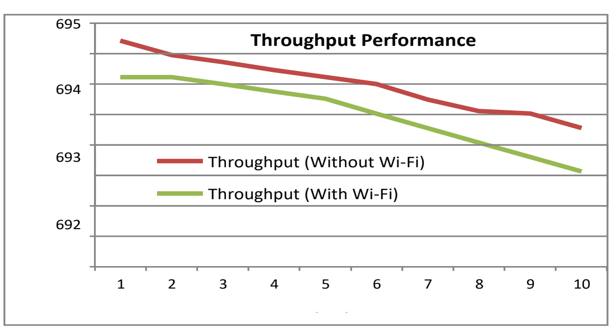

Fig. 6 Throughput Performance of Bluetooth Test File (Max. Bit Rate 9600).

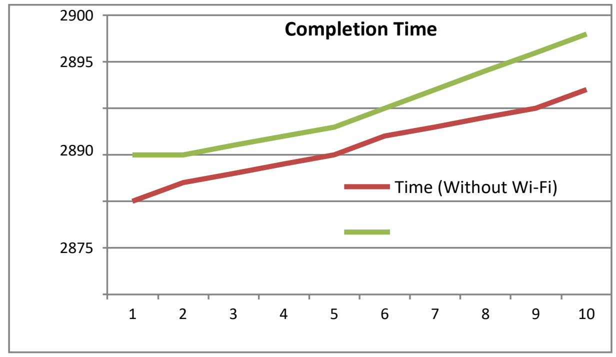

Fig. 7 Bluetooth Performance for Test File (Max. Bit Rate 9600).

From the hardware experimentation, it was observed that Bluetooth takes 2.32% more time than the time calculated from the baud rate. The time required is more due to the retransmission of packets by Bluetooth for error packet. The scenario is the same for throughput measured at the slave Bluetooth module.

Few difficulties have occurred during hardware implementation. These difficulties are enlisted as follows

- Baud rate kept low to observe the effect on performance parameters in the presence and absence of interferences.
- The packet type is not user-selectable.
- Manually Bluetooth connection link cannot be selected as ACL or SCO.
- Reduction in packet retransmission (Automatic Repeat Request).
- Hopping sequence synchronization cannot be changed for nearby Bluetooth/s.
- Manual selection of modulation technique, power, and frequency hopping is not possible.

CONCLUSION

The performance of Bluetooth in terms of BER and throughput degrades in the heterogeneous wireless network. As numbers of interfering devices increases Bluetooth performance decorates, and consequently, throughput also get hampered at acceptable level. From the hardware experimentation, it is observed that Bluetooth takes 2.32% more time. From this study it is clear that Bluetooth can work in heterogeneous environment with good BER and Throughput. Hence the Bluetooth is one of the strong challenger devices for internet of things applications and sensor nodes.

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Advanced Medical Care Coordination Platform

Samruddhi Sapnar
✉ samruddhi_sapnar@moderncoe.edu.in

Swastik Deshmukh
✉ swastik_deshmukh@moderncoe.edu.in

Mohit Sharma
✉ mohit_sharma@moderncoe.edu.in

Anil Shirsat
✉ asshirsat@gmail.com

Department of Electronics and Tele- communication
Progressive Education Society's Modern College of Engineering
Pune, Maharashtra

ABSTRACT

The Advanced Medical Care Coordination Platform represents a cutting-edge solution in modern healthcare, addressing the imperative need for seamless and coordinated patient care. In an era marked by the convergence of technology and healthcare, this platform leverages state-of-the-art IT infrastructure and innovative features to ensure optimal patient outcomes, efficient resource utilization, and a superior care experience. It Includes Patient data Profiling by assigning a unique hash code for each patient hence enhanced security and thereby proactive healthcare .For Database Purpose it has given block chain or SQL for storage of data. Advanced Medical Care Coordination Platforms empower patients to engage actively in their health management and support a patient centered approach to care. Interoperability facilitates data exchange with various healthcare systems, while analytics and reporting offer valuable insights for decision-making and continuous improvement. Security, compliance, and resource allocation optimization are fundamental to the platform's success, as are tools for billing and claims management.

KEYWORDS: *Patient profiling, Proactive healthcare, Disease prediction, SQL, Block chain.*

INTRODUCTION

The evolution of healthcare is increasingly defined by a pivotal shift towards patient-centered, value-based care, necessitating the transformation of traditional care delivery models. In this era of complex health systems, where patients receive care from multiple providers across various settings, the need for comprehensive and efficient care coordination has never been more critical. To meet this demand, the development of an Advanced Medical Care Coordination Platform emerges as a beacon of progress and innovation. Platform represents the future of healthcare, offering a holistic solution to ensure that patients receive the best care possible, precisely when and where they need it. This Platform Serve as data exchange between patient and Doctor easily using application.

The healthcare industry is characterized by the need to handle vast amounts of sensitive data, ranging from patient medical records to insurance information. Traditional systems often suffer from inefficiencies, data breaches, and a lack of transparency. Blockchain technology, with its decentralized and immutable ledger, offers a solution to these problems by ensuring secure and transparent data management.

Key Features

- Data Security and Privacy: Blockchain's encryption techniques ensure that patient data is stored securely and can only be accessed by authorized parties. This helps in preventing data breaches and unauthorized access.
- Interoperability: Blockchain can facilitate seamless data exchange between different healthcare providers and systems. This interoperability ensures that patient information is consistent and up-to-date across all platforms.
- Patient-Centric Control: Patients have greater control over their own medical data. They can

grant and revoke access to their records as needed, enhancing their privacy and autonomy.

- Transparency and Traceability: Every transaction or access to data is recorded on the blockchain, providing a clear and unalterable audit trail. This transparency helps in building trust among patients and healthcare providers.
- Reduced Costs and Increased Efficiency: By eliminating intermediaries and streamlining administrative processes, blockchain can reduce costs associated with data management and improve the overall efficiency of healthcare services.

PROPOSED SYSTEM AND WORKING

The system uses various platforms and Blockchain technology Here is the brief about Technologies used for working of the system.

CV2(Computer Vision Library): A software library for machine learning and computer vision is called OpenCV (Open- Source Computer Vision Library). For object detection, feature extraction, processing of images and videos, and other tasks, it offers a large array of tools and capabilities. For use in robotics, augmented reality, facial recognition, and medical image analysis, OpenCV—which was first created by Intel—is extensively utilized in research, academia, and industry. This makes it available to a large developer community as it supports multiple programming languages, such as Python, C++, and Java. For computer vision projects in a variety of fields, OpenCV is a preferred option due to its adaptability and wealth of documentation.

This Medical Healthcare Platform leverages various technologies and tools to create a secure, efficient, and user- friendly system. The following sections describe the role and functionality of JDBC, SQLyog, Java, blockchain, and specific Java libraries used in the project.

JDBC (Java Database Connectivity)

JDBC is a Java-based API that allows Java applications to interact with a wide range of databases. In this project, JDBC plays a crucial role in:

- Database Connectivity: Establishing a connection between the Java application and the relational database to perform operations such as querying, updating, and managing data.
- Data Retrieval and Storage: Executing SQL commands to retrieve patient records, medical histories, and other relevant data from the database and storing new information securely.
- Transaction Management: Ensuring that database transactions are processed reliably and consistently, maintaining data integrity.

SQLyog

SQLyog is a powerful MySQL database management tool that provides a graphical interface for database administration. It is used in this project for:

- Database Design and Management: Creating and managing the database schema, including tables, indexes, and relationships.
- Data Import and Export: Facilitating the migration of data into and out of the database, ensuring seamless integration with other systems.
- Query Optimization: Analyzing and optimizing SQL queries to improve the performance and efficiency of database operations.

Java

Java is the primary programming language used to develop the core functionality of the platform. It is chosen for its robustness, portability, and extensive libraries. Key roles of Java in this project include:

- Application Logic: Implementing the business logic, including patient data management, user authentication, and authorization.
- User Interface: Developing a user-friendly interface that allows patients, doctors, and administrators to interact with the system efficiently.
- Integration: Facilitating communication between the blockchain component, the database, and other external systems through APIs and service interfaces.

Blockchain

Blockchain technology is integrated into the platform to enhance data security, transparency, and immutability. Its role includes:

- Data Security: Encrypting and storing patient data on the blockchain to prevent unauthorized access and tampering.
- Decentralized Storage: Using a decentralized ledger to store medical records, ensuring data redundancy and availability.
- Smart Contracts: Implementing smart contracts to automate processes such as patient consent management, data sharing, and insurance claims.

Java Libraries

Various Java libraries are utilized to extend the functionality of the platform. Some of the notable libraries include:

- Web3j: A library for interacting with the Ethereum blockchain, allowing the platform to deploy and interact with smart contracts and manage blockchain transactions.
- Hibernate: An Object-Relational Mapping (ORM) library that simplifies database operations by mapping Java objects to database tables, reducing boilerplate code.
- Spring Framework: A comprehensive framework that provides infrastructure support for developing Java applications, including dependency injection, transaction management, and security.
- Apache Commons: A collection of reusable Java components that provide utility functions for tasks such as string manipulation, file handling, and data processing.

WORKFLOW INTEGRATION

The integration of these technologies ensures a seamless and efficient workflow:

- User Interaction: Users interact with the platform through a Java-based web interface.
- Database Operations: JDBC handles communication with the SQLyog-managed MySQL database for storing and retrieving data.
- Business Logic Execution: Java processes business logic, leveraging libraries like Hibernate and Spring for database interactions and application management.
- Security and Compliance: Blockchain ensures data security and integrity, while the Java-based backend ensures compliance with healthcare regulations.
- Blockchain Transactions: Web3j facilitates interactions with the blockchain for secure data storage and smart contract execution.

This multi-layered approach ensures that the platform is robust, secure, and capable of handling the complex requirements of a modern medical healthcare system.

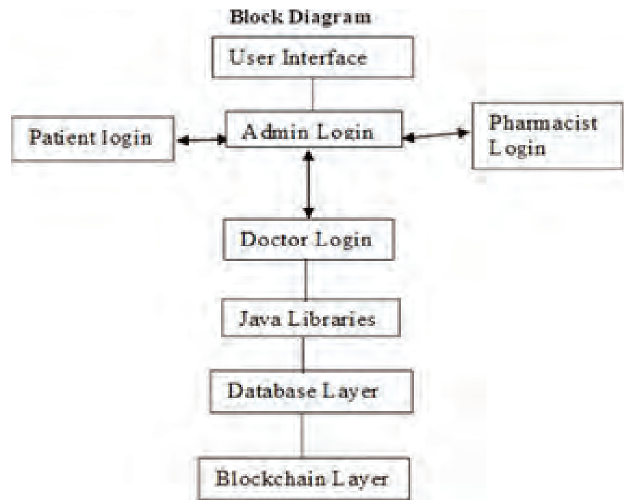

Fig. 1: Block Diagram of the System

- User Interface:

  Login Portals for Different User Roles: Separate login interfaces for doctors, patients, administrators, and pharmacists.

- Application Layer:

  Business Logic (Java): Core functionality handling user-specific actions, such as patient records management, prescription handling, and administrative tasks.

  Java Libraries: Libraries like Spring Framework, Hibernate, and Web3j for various functionalities.

- Database Layer:

  JDBC (Java Database Connectivity): Interface connecting the application layer with the database. MySQL Database (Managed with SQLyog): Storing patient records, prescriptions, user information, and other relevant data.

- Blockchain Layer:

  Blockchain Network: Storing encrypted Patient data and transactions. Smart Contracts: Automating processes such as patient consent, data sharing, prescription verification, and insurance claims.

- Integration Layer:

APIs and Service Interfaces: Facilitating communication between the layers and with external systems.

METHODOLOGY

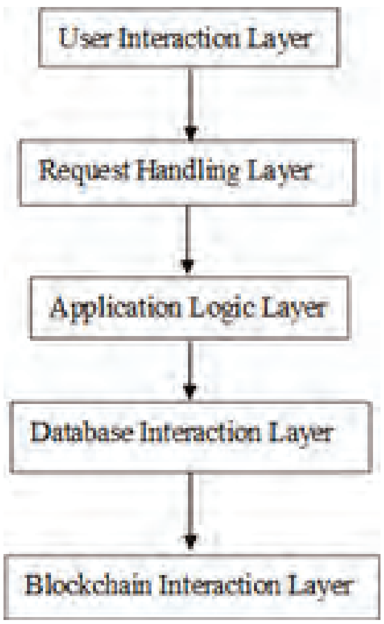

Fig. 2: System Flowchart

Algorithm

Following algorithm is used in the developed system.

1. Start
2. Sign in into the system.
3. Authorization and control keys
4. Fill out credentials and other details as per based dashboard.
5. Generates unique hash for each ID.
6. Check for hash generated in SQLYOG.
7. Finally you can change Profile or you can exit System.
8. Exit

RESULT

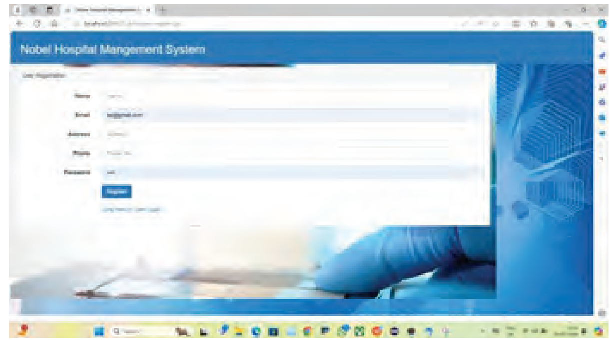

Fig. 3: Registration Page

Fig. 4: Admin login

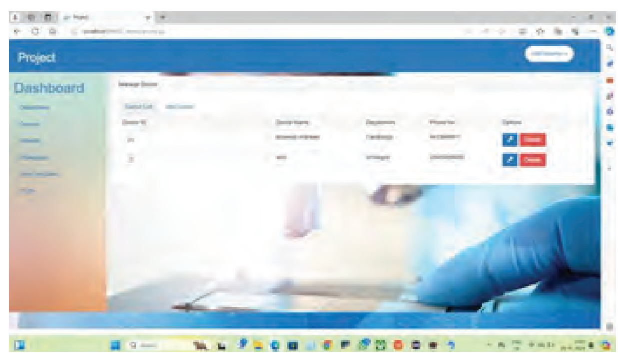

Fig..5: Dashboard

Fig. 6: ID Generated

CONCLUSION

By seamlessly integrating with electronic health records, these platforms enable healthcare providers to access up-to-date patient information, enhancing the accuracy and coordination of care. Furthermore, they facilitate secure communication between healthcare professionals, supporting real-time collaboration and informed decision-making. Interoperability ensures that data flows freely between various healthcare systems, promoting seamless care coordination. Additionally, the platform offers valuable insights through analytics and reporting, supporting better decision-making and continuous improvement in healthcare delivery. Hence data is being secured and contains unique hash code.

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Multifaceted Visionary Camera using ESP32 Cam Module and Google Vision API

Yash P. Gosavi
✉ yash_gosavi@moderncoe.edu.in
Anurag S. Jadhav
✉ anurag_jadhav@moderncoe.edu.in
Atharva S. Lad
✉ atharva_lad@moderncoe.edu.in
Ramgopal Sahu
✉ ramgopal.sahu@moderncoe.edu.in
Anil S. Shirsat
✉ anil.shirsat@moderncoe.edu.in

Department of Electronics and Telecommunication
Progressive Education Society's Modern College of Engineering
Pune, Maharashtra

ABSTRACT

In today's ever-evolving world, computer vision systems play an increasingly important role in many applications, including security and surveillance, autonomous cars, image recognition and more. The stated study explores a versatile vision camera that uses the Google Vision API (a powerful image analyzer) and a versatile ESP32 Cam module (a flexible microcontroller).

To provide a complete vision solution, this study presents a high-performance camera system using Google Vision API and ESP32 camera module. Real-time object, image and image detection are all features of this camera. It is a useful asset for many industries, with a wide range of applications in the security, surveillance and environmental control sectors, as well as retail. The study shows how hardware and software can be combined into a complete vision system that introduces the possibilities of computer vision.

KEYWORDS: *Multifaceted visionary Camera, Object detection.*

INTRODUCTION

To push the boundaries of picture processing, the Multifacted Visionary Camera combines the greatest technology and AI. The Google Vision API serves as the cognitive engine for this camera, which is powered by the ESP32 Cam module. The real-time picture identification, object recognition, and image tagging capabilities of this camera go beyond simple visual perception. This small but mighty machine is the epitome of innovation, reshaping industries, revolutionising computer vision, and proving the unstoppable potential of AI in fields ranging from security to art .

EXPLORING ARTIFICIAL INTELLIGENCE FUTURES

Computerized reasoning (simulated intelligence) innovations are standing out enough to be noticed and 'building up', which has prompted a ton of hypothesis about the future where these advancements and their replacements will be generally utilized. This paper sees how existing simulated intelligence prospects work and gives an underlying outline of a portion of the instruments that can be utilized for this sort of future-investigating, especially those that are accessible to humanities researchers. It likewise checks out at a portion of the benefits and impediments of every one of these instruments. While there are no devices that can precisely conjecture the eventual fate of man-made reasoning, there are a few instruments that can assist us with expanding the scope of potential prospects to limit shocks and make normal dialects and models that take into consideration valuable conversations about the sorts of prospects we need to occupy or keep away from. A few devices are featured in this paper as especially encouraging however presently disregarded instruments that require more work as information driven, genuine world, integrative or potentially member situation pretending. [1]

MACHINE LEARNING: A REVIEW OF LEARNING TYPES

AI is a part of software engineering that spotlights on computations that permit fabrics to learn and further develop in view of involvement accordingly. AI is numerous times allowed about a subset of man- made logic. With the backing of AI computations, fabrics can pursue choices autonomously. Choices are made by chancing significant retired designs in complex information. There are a many primary kinds of AI computations. These incorporate administered, unaided and support literacy computations. There are a many half and half strategies and a many conventional ways to typically decide AI issue shapes. In the coexisting parts, we shortly make sense of every one of these AI computations. We also give suggested poring . This record ought to incorporate a rundown of colorful AI phrasings for convenience.[2]

Primary Approaches

Supervised Learning

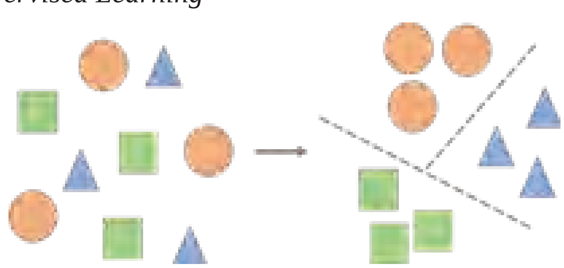


Fig. 1: Overview of supervised learning

Supervised learning is used when information is in the form of information factors and result targets. The calculation gains planning capability from contribution to result. The availability of large-scale information tests makes it a cost-effective approach for tasks where information is sparse. These approaches can be broken down into two basic categories classification and regression .[3]

Unsupervised Learning

Unsupervised learning happens when the information is just an info and there is definitely not a comparing yield variable. Solo calculations model the hidden examples in the information to get familiar with the information's properties. Bunch is perhaps of the most widely recognized unaided calculation. In a bunch calculation, the hidden gatherings of the information are found and afterward anticipated for concealed inputs. An illustration of a group calculation is to foresee client purchasing conduct . Learning calculation conducts an independent investigation of the information's common examples and patterns. To put it another way, it is similar to telling a calculation to look for hidden relationships, groups, or other examples within the data without explicitly stating what it should be looking for. The majority of calculations for solo learning are used for tasks like classifying information or reducing its dimensionality. Due to this, solo learning is a useful tool for researching knowledge and omitting unnecessary details. [4]

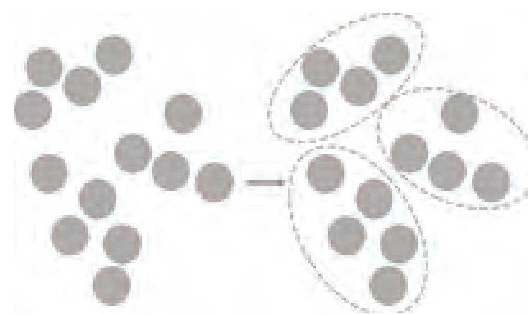


Fig. 2: Overview of unsupervised learning

Reinforcement Learning

Reinforcement learning is a type of machine learning in which an agent interacts with its environment and learns to carry out successive actions to maximize its reward over time. Reinforcement learning focuses on making decisions, and learning from the outcomes of those decisions, unlike supervised learning, which trains a model on labeled data, or unsupervised learning which trains a model to explore data patterns without explicit instructions. The process of fortification learning is based on the process of learning from the information supplied by the environment. Qualitative Q-Learning (Q-Learning), Deep Q-Network (DQNet), and Protected Plan Arrangement (PPO) calculations are employed to teach specialists to make the best judgments possible. The application areas of fortification learning include robots, games, autonomous driving, proposal frameworks, and more. [5]

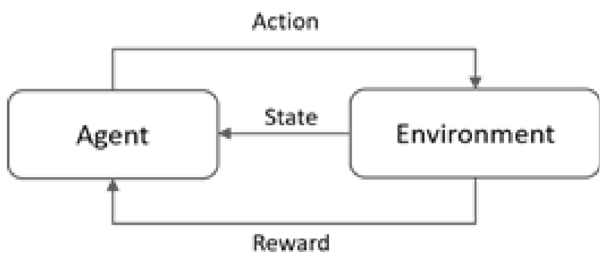


Fig. 3: Overview of reinforcement learning.

Hybrid Approaches

Semi-supervised Learning

Semi supervised learning is a type of machine learning that uses both labeled and unlabeled data to train models. Basically, the bigger part of the data is left unlabeled while a smaller part is labeled with the results you want. The model then uses the labeled data to remember and predicts the results some time later by summing up the labeled data. It's a great way to combine directed and unshadowed learning, making it easier to show execution when labeled data is hard to find or expensive. If you're having trouble collecting a totally labeled dataset, like in normal dialect preparation, picture recognition, or irregularity detection, semi supervised learning is great because it can significantly increase your expected accuracy. [6]

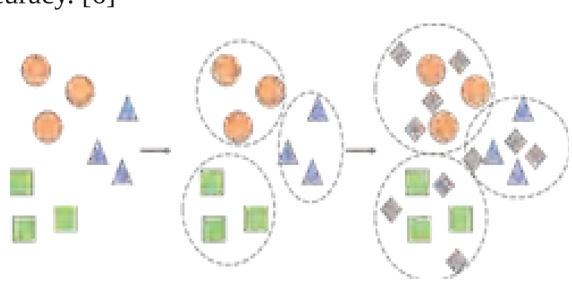


Fig. 4: Overview of semi-supervised learning

Self-supervised Learning

The most sophisticated non-labelled learning paradigm is self- trained learning. Instead of training the model, you train it by creating labels for the data. To do this, you create a task that compels the model to anticipate missing or changed inputs.

For instance, if you're processing natural language in a sentence, you could mask a few words in the sentence and ask it to complete the words that are missing. This approach is very scalable and cost-effective because it relies heavily on non-labelled data. Self-trained learning has been successful in some domains, such as text processing and image processing, because it allows you to tailor a model to a specific task using only a moderate amount of labeled data . [7]

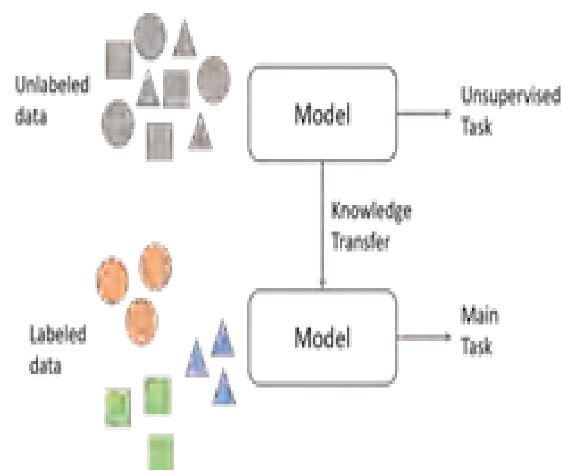


Fig. 5: Overview of self-supervised learning

Self-taught Learning

A model is taught to learn from a collection of labelled data while using a bigger set of unlabeled data using a technique called self-learning. In essence, the model initially gains knowledge from labelled data before continuing to learn from unlabeled data. In essence, it appears as though the model is teaching itself by repeatedly identifying patterns in unlabeled data. When data is expensive or scarce, this is advantageous since it enables you to leverage the lack of labelled data to enhance model performance. This is an excellent method for reducing costs and enhancing various machine learning activities.

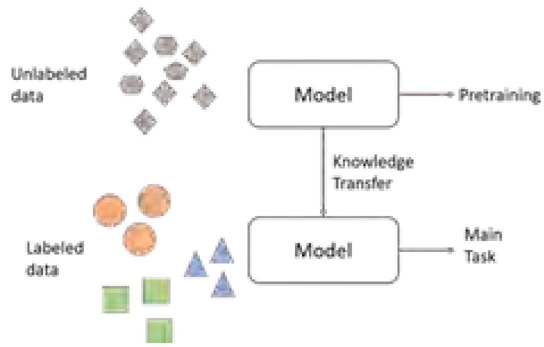


Fig. 6: Overview of self-taught learning

Fig.7: Table for detailed analysis of machine learning types

Learning Type	Supervised Learning	Unsupervised Learning	Reinforcement Learning	Semi-supervised Learning	Self-supervised Learning	Self-taught Learnin
Use Cases:	Classification, Regression, Object Recognition.	Clustering, Dimensionality Reduction, Anomaly Detection.	Robotics, Game AI, Autonomous Systems, Recommendations.	Limited labeled data scenarios, Natural Language Processing	Image and Text Processing, Pre-trained models.	Scenarios with limited labeled data, Feature extraction
Label Requirement:	Yes	No	No	Partially	No	Partially
Key Characteristics:	Requires labeled data for training.	No predefined labels, focuses on structure.	Maximizes cumulative reward through actions.	Combines benefits of labeled and unlabeled data.	Creates tasks for models to learn from data.	Self-discovery of additional features from data
Description:	Learns from labeled data, mapping input to output.	Extracts patterns from unlabeled data, lacks explicit target labels.	Learns sequential decision-making through interaction with an environment.	Uses a mix of labeled and unlabeled data to train models.	Trains models using data-derived tasks without external labels.	Uses initial labeled data to learn from unlabeled data and discover new features.

PARAMETERS OF AUTOMATIONS

Hardware Setup

Hardware is one of the most important things that can affect how successful a project is. The ESP32 camera module is the main part of the project. It was chosen after careful consideration of how well it works, how easy it is to integrate, and how natural it is to capture and process images. It's a microcontroller based platform that can be used for a variety of tasks.

ESP32 Cam Module Overview

It appears that the ESP32 cam module is a small but efficient way to seamlessly integrate a camera sensor into the ESP32 microprocessor, allowing for the collection and processing ofimages. This integration provides a reliable platform for a wide range of visual data applications, and its attractive combination of computational power and image processing capabilities serves as the foundation for the decision to utilize the module.[9]

Microcontroller Capabilities

The ESP32, the central microcontroller of the module, is renowned for its robust computing capabilities. It is equipped with a dual core processor, Wi-Fi, Bluetooth, and a range of integrated circuit (I/O) options, ensuring that your projects will be able to meet the demands of complex image processing. Furthermore, the cam module is capable of connecting to a wide range of sensors and peripheral devices, as well as communicating via a network, thus ensuring that it is suitable for the various requirements of your projects. [10]

Feature	ESP32	ATmega328	ESP8266	Raspberry Pi Pico	PIC 18	STM32
Processing power	Dual-core 32-bit Xtensa LX6 up to 240 MHz	8-bit AVR RISC up to 20 MHz	Single-core 32-bit Tensilica LX106 up to 160 MHz	Dual-core ARM Cortex-M0+ up to 133 MHz	8-bit PIC RISC up to 20 MHz	32-bit ARM Cortex-M3 up to 72 MHz
Memory	520 KiB RAM, 4 MB ROM	32 KiB RAM, 32 KiB ROM	320 KiB RAM, 448 KiB ROM	264 KiB RAM, 2 MB ROM	32 KiB RAM, 32 KiB ROM	128 KiB RAM, 512 KiB ROM
Wireless connectivity	Dual-mode Wi-Fi (802.11 b/g/n) and Bluetooth 4.2 (BLE)	Wi-Fi (802.11 b/g/n)	Wi-Fi (802.11 b/g/n)	None	None	Wi-Fi (802.11 b/g/n) and Bluetooth 4.2 (BLE)
Peripheral interfaces	34 GPIOs, 12-bit SAR ADC up to 18 channels, 2 DACs, 10 touch sensors, 4 SPI, 2 I²S, SD/SDIO/CE-ATA/MMC/eMMC host controller, SDIO/SPI slave controller, Ethernet MAC interface, CAN bus 2.0, infrared remote controller (TX/RX, up to 8 channels), motor PWM, LED PWM (up to 16 channels)	14 GPIOs, 10-bit ADC, 2 UART	11 GPIOs, 10-bit ADC, 1 UART	30 GPIOs, 12-bit ADC, 2 DACs, 2 I²C, 2 SPI, 1 UART	40 GPIOs, 10-bit ADC, 1 DAC, 2 UART, 2 SPI, 2 I²C, 2 CAN	51 GPIOs, 12-bit ADC, 2 DACs, 2 UART, 2 SPI, 2 I²C

Fig. 8: Comparision table of various microcontrollers

Camera Sensor Integration

camera sensor integration is an important component that not only enhances the functionality of the module but also allows users to capture high quality images for different projects. The versatility of this module is remarkable as it can be customized to meet the specific needs of each project. The ESP32 cam module has the ability to adjust parameters like image resolution and frame rate, as well as focus quality. This degree of customization is similar to professional camera systems and allows users to customize the module to the exact requirements of their project. The ESP32 cam module can be used for DIY surveillance system,remote environment monitoring project, artistic photography project, and any other application that needs image capture. It can adapt and excel in a wide variety of application scenarios and is a must-have tool for creators, developers and innovators. [11]

Development Ecosystem

The ESP32 hardware's integration with a growing and vibrant development community is one of the key benefits of using it. Because of the broad usage of this hardware, developers have access to a large variety of tools, libraries, and support networks. This healthy ecosystem significantly speeds up the development process, laying a solid basis for your projects, and making it easier to diagnose and solve problems when they ineluctably occur.[12]

Software setup

One of the first things you need to do when starting a project or running a specific activity is to configure the software. This means setting up the tools and libraries that will be used to create, run, and manage your project. The software setup process can vary depending on the specifics of your project, your programming language, and the platform on which you run your project.

Integrated Development Environment (IDE)

IDEs (Integrated Development Environments) are powerful and versatile software applications that act as a one-stop shop for software programmers and developers. IDEs streamline the entire software development process by covering a broad range of important tools and features and offering a comprehensive solution for all of your coding needs. Various IDEs provide developers with a suite of features that are designed to improve productivity and speed up the development process. Some of these features include, but aren't limited to, sophisticated code editors, integrated/built-in compilers/interpreters, powerful debugging systems, strong project management capabilities, and various error-checking mechanisms. The core of an IDE is its code editor. Not only does the code editor keep your code base clean and organized, but it also offers various valuable features that speed up your coding process. For example, syntax highlighting that beautifully colors different elements in your code for easy recognition, code completion that gives you intelligent suggestions while you type, and even code formatting tools that keep your coding style consistent. [13]

ESP32 Libraries

ESP32 is one of the most popular microcontrollers in the world, and many libraries and frameworks support it. This makes it easy for developers to use and work with the features of the microcontroller. Some of the most important ESP32-based libraries include: Connecting to Wi-Fi Communicating with sensors Enabling other functions in applications based on ESP32 These libraries provide a strong base for building a wide range of ESP32-based projects, including web servers, Bluetooth applications, Internet of Things (IoT) devices and sensors. The libraries you select are based on your project's specific needs and functionality. Make sure to check the latest versions of the libraries and documentation to make sure they are compatible with your board and development environment.[14]

AUTOMATION TECHNOLOGY

Camera Trigger Mechanism

The shutter mechanism of a camera is an essential part of its operation, whether it is a film-based camera or a digital camera. It is responsible for triggering an image or video exposure with incoming light by opening the shutter and closing the shutter when the shutter is pressed. The shutter speed, or exposure time, determines the amount of light that enters the camera and how sharp and motion-captured the image is. A camera trigger mechanism is a complex system of components and technologies that work together to produce accurate and timely images. The shutter mechanism is one of the most important components of a camera trigger mechanism. In some special cases, external triggers, like remote control devices, motion sensors, etc., can be built into the trigger mechanism so that you don't have to interact directly with the camera. This allows you to get unique shots, especially when manual triggering isn't practical. The camera trigger mechanism is an essential part of the creative process. It allows you to control your exposure, focus, timing, etc. so that you can capture images that reflect your artistic vision. Whether you're capturing a fleeting moment or a breathtaking landscape, your camera trigger mechanism is the key to turning those fleeting moments into lasting memories. [15]

Google Vision API

Google Vision API is Google's cloud-based service that uses artificial intelligence (AI) and machine learning (ML) to analyze and comprehend images and videos. Google's Vision API allows developers and businesses to extend the capabilities of image recognition and analytics to a wide range of applications, making it a useful tool for a wide range of use cases. The Vision API can extract a wide range of data from visual content, such as objects, faces, text, and even emotions. It can be used in a variety of applications, such as content moderation and image classification, OCR (Optical Character Recognition) and image enhancement. Google's Vision API uses cutting-edge machine learning models, trained on massive datasets, to detect objects and feature in images with high accuracy and reliability. Google Vision API provides a comprehensive and powerful way to understand and interpret visual data, improve user experience and automate various processes. It is a testament to Google's commitment to advancing computer vision and bringing these advanced capabilities to developers and businesses around the world.[16]

Data Storage and Management Technology

Data management and storage are an integral part of the ML workflow and are critical to the development and use of ML models. Data is the lifeblood of machine learning. It is used to train, validate and test ML models. Effectively managing and storing large amounts of data and maintaining data integrity throughout the life of an ML model is critical. In ML, data storage refers to the organization and storage of various data sets. These data sets may be structured (in databases), unstructured (in text and images), or time series (in time series data). It is essential to select appropriate data storage solutions that address the specific requirements of the data set, provide quick access, and ensure the security and compliance of the data. Cloud storage platforms like Amazon S3 or Google Cloud Storage, as well as Azure Blob storage, have become the go-to platforms for scalable and affordable data storage. Data management includes, but is not limited to, collecting the data, preprocessing the data, tagging the data, and controlling the version of the data set. Data preprocessing is the process of cleaning, transforming, and normalizing the data to meet the requirements of ML algorithms. Labels are essential in guided learning, where data points need to be connected to their correct labels/results. Good data management includes setting up clear data channels and automating the data processing steps. Strong version control is the process of keeping track of changes and version of the data sets.[17]

IoT Platform Integration

IoT platforms are essential for the development and deployment of IoT solutions that necessitate the connection and control of multiple devices, sensors and data flows. Integration of IoT platforms involves the seamless integration of different hardware, software and cloud components into a cohesive ecosystem. IoT platform integration allows businesses to take full advantage of IoT in the form of real-time tracking, automation and smart decision-making through the collection and analysis of data from interconnected devices. Basically, the way IoT platform integration works is that IoT devices are connected to the central platform through Wi-Fi or Bluetooth or cellular networks, plus they use IoT protocols like MQTT or CoAP. Edge device-cloud integration also includes data syncing, device management and security. All of this makes it super simple to gather, store and analyze real-time data for a bunch of different uses, like smart cities, industrial automation, healthcare and agriculture.[18]

Emerging technologies in machine learning

The machine learning landscape is constantly evolving due to the emergence of new technologies. Some of the most prominent trends in machine learning include deep learning (DL), reinforcement learning (RE), transfer learning (transfer learning), IoT integration (IoT), augmented reality (AR), XAI (XML), quantum machine learning (QML), and ethical considerations (EPC). Artificial intelligence is projected to make significant advancements in the near future, which will open up new possibilities and raise new issues for individuals and society. To take full advantage of these advancements, it is essential to balance innovation with ethical responsibility.[19]

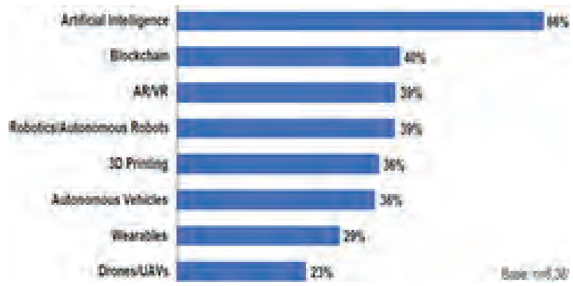


Fig. 9: Impact of AI and automation in different Sectors

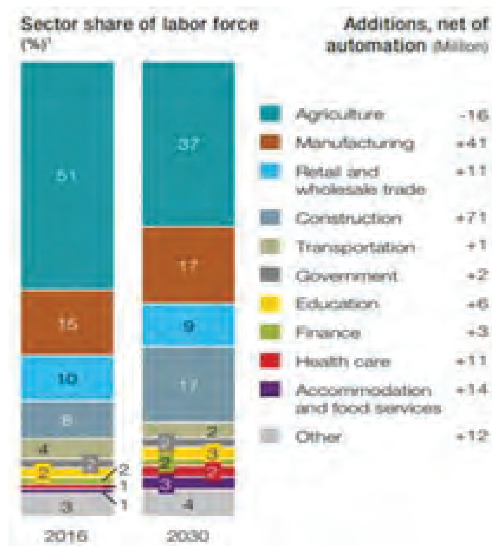


Fig. 10: Survey of global firms on adoption of emerging technologies in 2017

CHALLENGES IN AUTOMATION

Data Transfer and Bandwidth

Fundamental ideas in networking and information technology include data transfer and bandwidth. The maximum speed at which data can be sent over a network or communication channel is called bandwidth. Measurements are often made in bits per second (bps) or multiples thereof, such as kilobits, megabits, or gigabits per second. Data transfer, on the other hand, refers to the actual amount of data sent from one place to another over a period of time, usually measured in bytes or bits. In the world of networking and information technology, bandwidth and data transfer are related but different terms. Data transfer refers to the actual transfer of data between devices or across a network. Bandwidth, on the other hand, refers to the maximum speed at which data is allowed to be transferred. These ideas are fundamental to how the digital world works, as they are required for a wide range of applications, from commercial activities to online content distribution.[20]

Image Processing

Image processing is the process of analysing and modifying digital images to capture valuable information or enhance their quality. Image processing is one of the most important fields in computer vision and DSP. Image processing can be used in a wide range of applications, from security and entertainment to remote sensing to medical imaging. Image processing is constantly improving as new hardware and algorithms are developed. There are several important steps in image processing. First, there is preprocessing. This involves preparing the image for analysis, such as reducing noise, enhancing contrast, and resizing the image. Next, there is segmentation. Segmentation involves separating an image into regions or objects. This is often done by defining edges in the image. Finally, there is object detection and tracking. This is the process of identifying and tracking particular objects or patterns within an image or a video stream. Finally, feature extraction is the process of extracting important details from a photo. For example, you can extract details such as corners, textures, and colors. Magic processing is a dynamic field with diverse applications. It continues to evolve, driven by advances in hardware, software and deep learning techniques, making it an integral part of various industries and technologies, from healthcare to entertainment to autonomous systems. However, as its applications become more widespread, it is important to address the ethical and privacy issues associated with this technology.[21]

Environmental Considerations

It is important to consider the environmental impact. High-performance image processing often relies on powerful computing resources such as GPUs and specialized hardware, which consumes energy and increases carbon emissions. Minimize the environmental footprint of your machine vision projects by optimizing algorithms for efficiency, using energy-efficient hardware, and employing sustainable computing practices. Furthermore, the positive impact of image processing in fields such as remote sensing and environmental monitoring can contribute to the understanding of ecological change, which in turn influences conservation efforts and promotes environmentally friendly practices. [22]

API Changes and Compatibility

Software compatibility can be affected by API (Application Programming Interface) changes. Applications based on previous API versions may experience issues as the API changes or evolves. Developers must handle version control properly and ensure backward compatibility through strategies such as versioned endpoints and retaining deprecated APIs. Good documentation and communication is essential to inform developers of changes and how their code needs to be changed to ensure compatibility. Effective API change management is essential to avoid disruption to the software ecosystem and ensure a seamless transition for users and developers.[23]

FUTURE ENHANCEMENT

Custom Object Recognition

Custom object recognition technology allows users to train computer vision models to recognize specific objects or patterns in images or videos. In order for the system to accurately learn and recognize objects of interest, this method requires that it be provided with cases that are labeled. Custom object recognition applications can be found in industries such as manufacturing, healthcare, and autonomous systems. It offers adaptability to address specialized and non-standard use cases, increasing automation, quality assurance and security across multiple industries.[24]

Wireless Communication Redundancy

Wireless redundancy is the process of creating backup or alternate data transfer routes. This reduces the risk of network failure. Wireless communication systems need to be able to address problems such as: Signal interference Hardware failure Unplanned network congestion One of the most common ways to achieve wireless redundancy is by using multiple base stations or frequency bands. This means that data can be transmitted along alternate paths, which improves network stability, even if one of the base stations or frequency has issues. Additionally, wireless communication redundancy is critical for Internet of Things (IoT) devices that require high levels of reliability. IoT applications are more reliable and robust because they have redundant connections and data transmission paths to IoT devices, ensuring that critical data is not lost in the event of a network failure. wireless communication redundancy is an important tactic for maintaining the reliability and effectiveness of wireless networks. Particularly in situations where reliability and data integrity are paramount, a large number of access points, frequency bands, MIMO technologies, error correction codes, and protocols must be used to ensure uninterrupted data transmission.[25]

Custom User Interfaces

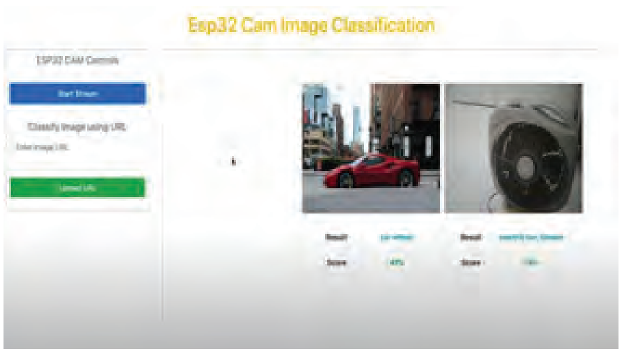
Custom user interfaces are the foundation of your digital interactions with various devices and applications. Custom user interfaces are designed to address particular user needs and deliver a personalized experience that surpasses generic approaches. The need for personalized, user-focused experiences across various platforms and devices has fueled the demand for personalised user interfaces in a rapidly evolving digital landscape. One of the most significant features of a personalised user interface is its ability to be customized. An individual user interface can be designed to meet the specific needs of its users, taking into account their preferences, abilities and circumstances. This allows for smoother and more natural connections between users. Accessibility is a great example of personalised user interface versatility. By creating a unique interface that addresses the needs of users with disabilities. [26]

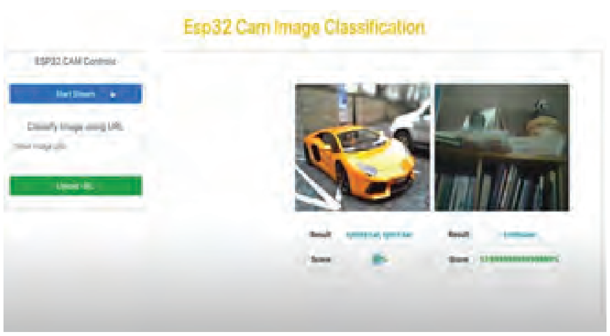
RESULTS

Our Multifaceted Visionary Camera successfully captured a diverse range of images across different environments and lighting conditions. The ESP32 Cam Module performed reliably, delivering high-resolution images suitable for analysis. Through the Google Vision API, our system demonstrated proficient object detection capabilities. Common objects such as vehicles, animals, and household items were accurately identified, showcasing the robustness of the vision algorithms employed. The integration with Google

Vision API proved to be a game-changer in image analysis. The API accurately identified objects, detected texted and provided valuable insights into the content of each captured image.

The results obtained validate the effectiveness and potential impact of our Multifaceted visionary Camera Project .Moving forward, further optimizations and enhancements will be explored to maximize its capabilities and relevance in real-world applications.





CONCLUSION

The multifaceted camera resulting from the integration of the ESP32 Cam and the Google Vision API is a significant achievement in the field of computer vision technology. This review explores key aspects of this project and highlights its importance and potential.

The main strength of the camera system is the seamless integration of advanced hardware and advanced software. The ESP32 Cam module serves as a powerful hardware backbone, providing wireless connectivity, camera functionality, and compact size. Combined with the Google Vision API, it provides cameras with real- time image recognition, object detection, and image tagging capabilities. What really sets this project apart is its practicality and applicability to many fields. From improving security and surveillance systems to optimizing retail inventory management, there are no limits to what you can do with versatile vision cameras. Moreover, its innovative properties can also be used in art installations and as an aid for the visually impaired.

To sum up, It's a major step towards democratizing the use of cutting-edge computer vision and a vision of a future where complex visual analysis is possible for all users, not just the most advanced users. Here's a glimpse of what's to come: The multifaceted visionary camera offers an interesting glimpse into the future. It shows the infinite possibilities and innovations in the world of AI- powered image processing systems.

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Smart Helmet for Safety and Navigation

Aditya Mandhane, Atharva Pande
Supriya Saudagar
Students
Electronics and Telecommunication Department
P.E.S's Modern College of Engineering
Pune, Maharashtra
✉ aditya_mandhane@moderncoe.edu.in
✉ atharva_pande@moderncoe.edu.in
✉ supriya_saudagar@moderncoe.edu.in

Anuradha Kasangottuwar
Assistant Professor
Electronics and Telecommunication Department
P.E.S's Modern College of Engineering
Pune, Maharashtra
✉ anuradha.kasangottuwar@moderncoe.edu.in

ABSTRACT

The introduction of smart technology has transformed many elements of daily life, including motorcycle safety and navigation for industrial workers. This study describes a full smart helmet system to improve rider safety and navigation by combining modern sensors and artificial intelligence. The suggested system includes a NodeMCU ESP32 microcontroller for reliable wireless connection and data processing and an Arduino Nano for sensor management and actuation control. The key components are a MQ-3 alcohol sensor for sobriety tests, SW-420 vibration sensors for impact detection, GPS and GSM modules for real-time position monitoring and communication, and a relay for motor ignition control. The smart helmet is further enhanced with the NOVA AI application, which enables hands-free operation, voice-command messaging, and emergency alert functionalities. This multifaceted strategy not only allows quick response to possible threats, but it also offers smooth navigation help and constant communication. The system's design stresses user safety, comfort, and operating efficiency, indicating substantial progress in personal protection equipment and smart wearable technologies. Through extensive deployment and testing, the article illustrates the smart helmet's usefulness in lowering accident risks and increasing user experience on the roads.

KEYWORDS: *Smart helmet, Safety, Navigation.*

INTRODUCTION

In a rapidly evolving technological landscape where safety and connectivity reign supreme, the "Smart Helmet for Safety and Navigation" project emerges as a beacon of innovation and ingenuity. This visionary endeavor seamlessly integrates advanced safety features with state-of-the-art technology to redefine the standards of personal protection and navigation.

At its core, the Smart Helmet embodies a sophisticated collision detection system, meticulously designed to anticipate and prevent potential accidents in various high-risk scenarios. By leveraging an array of sensors and intelligent algorithms, this system stands as a stalwart guardian, tirelessly monitoring the wearer's surroundings to ensure utmost safety.

But safety doesn't end there. Recognizing the dangers posed by impaired decision-making, the Smart Helmet incorporates an innovative alcohol detection system. This pivotal addition evaluates the user's sobriety before granting access to helmet functions, underscoring a commitment to responsible usage and accident prevention.

Central to the Smart Helmet experience is the groundbreaking "NOVA" AI application. Serving as the user's digital companion, NOVA harnesses the power of artificial intelligence to deliver a seamless and intuitive interface for issuing voice commands, receiving real-time updates, and controlling various helmet functions. With NOVA at the helm, users navigate their environment with unparalleled ease and confidence.

The ESP32 Wi-Fi module facilitates seamless connectivity, acting as the backbone of the Smart Helmet's network capabilities. Through this module, the helmet seamlessly integrates with the internet, empowering users with real-time GPS data, map updates, and location-based services for unparalleled navigation precision.

The Smart Helmet's integrated camera module enhances situational awareness, capturing real-time visuals of the wearer's surroundings. This visual data not only aids in navigation but also serves as a vital tool for documentation and incident recording, further bolstering the helmet's utility and safety features.

In essence, the "Smart Helmet for Safety and Navigation" project represents a paradigm shift in personal protection and navigation technology. By amalgamating cutting-edge safety features, intelligent AI, and real-time monitoring capabilities, it sets a new standard for safety and convenience in the modern world.

METHODOLOGY

The principle of operation is quite plain. If the biker had consumed the alcohol, the alcohol sensor placed near the front end of the helmet senses the alcohol and don't allow the biker to start the bike.

The second purpose is when the biker meets with an accident the vibrator sensor in the bike receives the signal send a message and the location of the accident to the family members.

The third purpose is that the bike won't activate until the helmet is worn when RF decoder sends information to the microcontroller, allowing the biker to start the bike.

The idea of our project "SMART HELMET" is to first check if the rider has actually worn the helmet, in other words the availability of the rider's head inside the helmet to allow the vehicle to start.

The system makes it mandatory for the rider to wear helmet before starting the vehicle and also, he shouldn't have consumed alcohol. If the rider fails to do so then the vehicle cannot be started.

The GSM and GPS have been added in our project to find the location of the rider and send a message to a nearest emergency service in case accident has happened.

BLOCK DIAGRAM AND DESCRIPTION

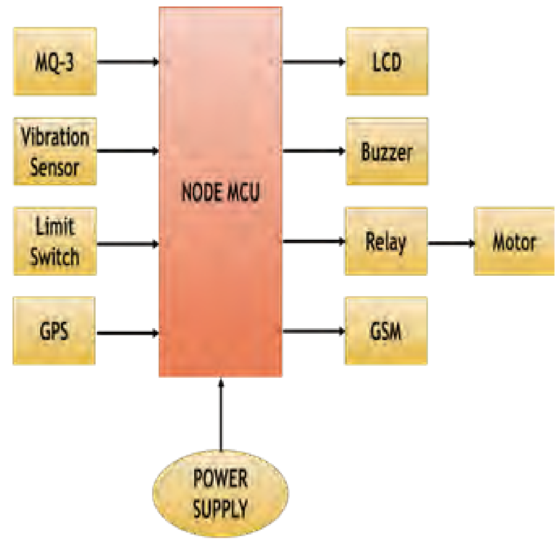


Fig. 1: Block Diagram

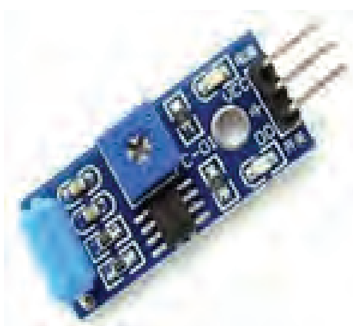
Node MCU ESP32

The Node MCU ESP32 is the core component of the smart helmet system, serving as its central processing unit (CPU). Based on the ESP32 microcontroller, this versatile board integrates Wi-Fi and Bluetooth capabilities, allowing seamless wireless communication and data exchange between various components of the helmet system. Its powerful processing capabilities enable efficient management and control of the system's functionalities, ensuring smooth operation and real-time responsiveness.

MQ-3 Alcohol Sensor

The MQ-3 Alcohol Sensor is a gas sensor specifically designed to detect the presence of alcohol vapor in the surrounding environment. Utilizing a sensitive semiconductor gas sensor, it can accurately measure alcohol concentration levels, providing an additional safety measure for riders. When alcohol vapor is detected, the sensor triggers an alert mechanism within the smart helmet system, notifying the rider and encouraging safe riding practices. This proactive approach helps prevent accidents and promotes responsible behavior on the road.

SW-420 Vibration Sensor



The SW-420 Vibration Sensor is a highly sensitive module capable of detecting subtle vibrations and sudden impacts. Integrated into the smart helmet system, this sensor serves as a crucial safety feature by continuously monitoring the rider's movements and the helmet's environment. In the event of a collision, fall, or impact, the vibration sensor promptly detects the abnormal motion and triggers an immediate response, such as activating safety mechanisms or sending alerts to the rider and emergency contacts. By providing rapid notification of accidents or hazards, the vibration sensor enhances rider safety and reduces the risk of injuries.

Limit Switch

The Limit Switch is a mechanical switch designed to detect specific positions or movements within the smart helmet system. Installed at strategic locations, such as helmet closure points or visor positions, the limit switch enables precise monitoring of critical components and user actions. By detecting changes in position or status, the limit switch ensures the proper functioning of safety mechanisms and control features. For example, it can signal the system to activate protective measures when the helmet is securely fastened or adjust settings based on the visor's position. This customizable functionality enhances the usability and effectiveness of the smart helmet system, providing tailored solutions for different riding scenarios.

GSM Module

The GSM Module is a communication module that enables the smart helmet system to connect to cellular networks and communicate with external devices or servers. Equipped with a SIM card slot and GSM antenna, this module allows the helmet to send and receive SMS messages, make phone calls, and transmit data over the cellular network. By leveraging GSM technology, the helmet system can facilitate various communication tasks, such as sending emergency alerts, receiving navigation updates, or providing remote access to system settings. This connectivity feature enhances the versatility and effectiveness of the smart helmet system, enabling seamless communication and interaction with the surrounding environment.

GPS Module

The GPS Module is a satellite-based navigation device that provides accurate positioning and location tracking capabilities to the smart helmet system. Utilizing signals from global navigation satellite systems (GNSS), such as GPS, GLONASS, or Galileo, this module determines the helmet's precise geographic coordinates in real-time. Integrated with mapping software or navigation applications, the GPS module enables the helmet system to provide turn-by-turn navigation guidance, display route information, and calculate estimated arrival times. Additionally, it allows for location-based services, such as geo-fencing, points of interest (POI) notifications, and emergency location tracking. With its reliable positioning accuracy and comprehensive navigation features, the GPS module enhances the safety, convenience, and usability of the smart helmet system for riders.

Buzzer

The Buzzer is an electromechanical sound-producing device used to generate audible alerts or notifications within the smart helmet system. Consisting of a vibrating diaphragm and electromagnetic coil, the buzzer produces distinctive sound patterns when activated by an electrical signal. Integrated into the helmet's audio system, the buzzer serves as an important auditory feedback mechanism, alerting the rider to critical events, notifications, or warnings. For example, it can emit warning sounds in response to detected hazards, indicate low battery levels, or provide confirmation tones for user commands. With its clear and recognizable alerts, the buzzer enhances situational awareness and communication for riders, contributing to overall safety and usability.

Relay

The Relay is an electromechanical switch used to control the flow of electrical power to various components or devices within the smart helmet system. Comprising an electromagnetic coil and one or more mechanical contacts, the relay functions as a remote-controlled switch that can be activated or deactivated by an electrical signal. In the helmet system, the relay serves as a versatile control mechanism, enabling the remote operation of external devices or safety features. For example, it can be used to switch on/off auxiliary lights, activate emergency signaling systems, or control motorized components such as visors or ventilation systems. With its ability to safely and efficiently manage electrical power distribution, the relay enhances the functionality and customization options of the smart helmet system, providing flexible control solutions for diverse riding scenarios.

DC Motor

The DC Motor is an electrical device that converts electrical energy into mechanical motion, providing motive power for various mechanical functionalities within the smart helmet system. Available in different sizes and configurations, DC motors offer reliable performance and precise control capabilities for motorized applications. In the helmet system, the DC motor is commonly used for key ignition mechanisms or other mechanical functions that require rotational motion or actuation. For example, it can be employed to control visor adjustments, activate flip-up mechanisms, or operate ventilation systems. With its compact design and efficient operation, the DC motor enhances the functionality and user experience of the smart helmet system, providing convenient and reliable control of mechanical features.

Power Supply (External)

The External Power Supply is a dedicated source of electrical energy used to power the smart helmet system and its components. Consisting of rechargeable batteries, power banks, or other portable power sources, the external power supply provides reliable and uninterrupted power to ensure continuous operation of the helmet system. Designed to meet the energy requirements of the system's electronics, sensors, and actuators, the power supply delivers sufficient voltage and current for optimal performance. With its portable and versatile design, the external power supply enables extended usage and flexibility for riders, allowing them to enjoy the benefits of the smart helmet system during their journeys.

WORKING

1. The rider dons the helmet, and the limit switch detects it's being worn, triggering a signal to the MCU.
2. The MCU initiates an alcohol check using the MQ-3 sensor. If no alcohol is detected, the motorcycle can be started. If alcohol is detected, the MCU can sound the buzzer to warn the rider, send an alert message, or even disable the motorcycle from starting via the relay.
3. Throughout the ride, the vibration sensor constantly monitors for any abrupt movements. If a crash is suspected, the GPS module can transmit the rider's location through the GSM module to emergency services.

HARDWARE SYSTEM DESIGN

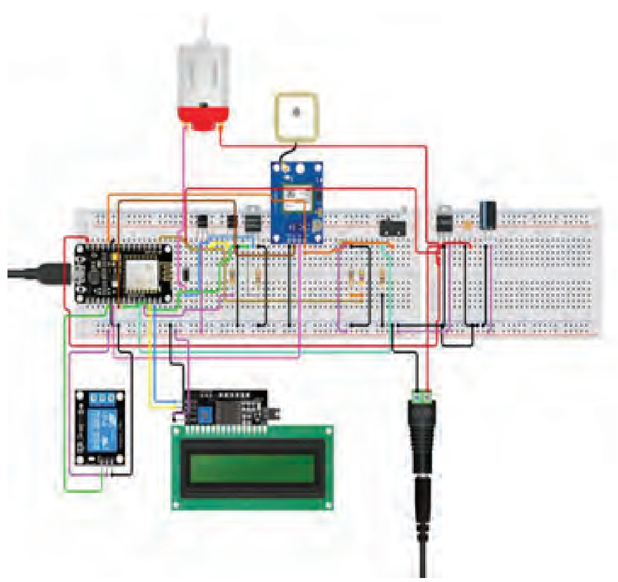


Fig. 2: Hardware System Design

ENCLOSURE DESIGN

1. Impact Protection: Safety is paramount. The helmet's enclosure must provide robust impact protection, adhering to relevant safety standards for headgear in your application. By using materials like ABS plastic or polycarbonate and incorporating shock-absorbing padding, the enclosure ensures optimal protection in case of accidents or impacts.
2. Comfortable Fit: Comfort is essential for prolonged wear. The inner padding and liner of the helmet are meticulously designed to provide a snug and comfortable fit, enhancing safety by reducing the risk of the helmet dislodging during an accident. The padding conforms to the wearer's head shape, ensuring stability and comfort throughout the ride.
3. Integrated Safety Features: The helmet's enclosure seamlessly integrates safety-related components such as impact sensors, alert systems, and visibility-enhancing elements. Impact sensors detect collisions or accidents, triggering immediate alerts to notify the rider or emergency services. LED lights embedded in the helmet enhance visibility, especially in low-light conditions, while rear- facing cameras provide real-time rear-view monitoring for increased awareness and safety.
4. Clear Field of Vision: Unobstructed visibility is crucial for safe riding. The enclosure design prioritizes a clear field of vision, ensuring that the wearer's sightlines remain unrestricted. If incorporating a heads-up display (HUD) for navigation, it is positioned within the user's line of sight, allowing for seamless navigation without compromising visibility or safety.
5. Weather Resistance: The enclosure is engineered to withstand various environmental conditions, maintaining its structural integrity and protecting integrated electronics from moisture, dust, and other elements. Sealed seams, waterproof coatings, and weatherproof seals ensure that the helmet remains reliable and functional even in inclement weather, providing peace of mind to the rider.

FLOWCHART

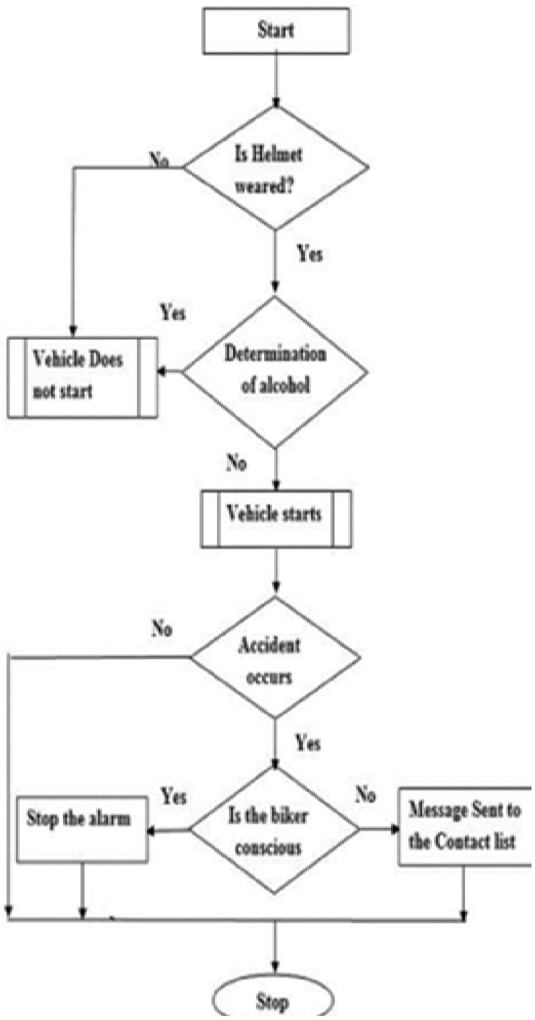
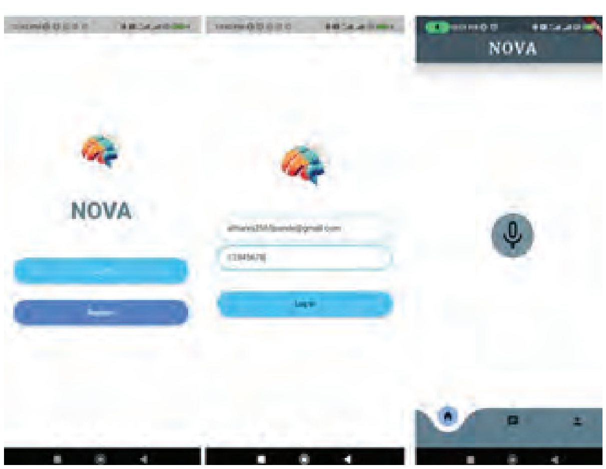


Fig. 3: Flowchart

RESULTS



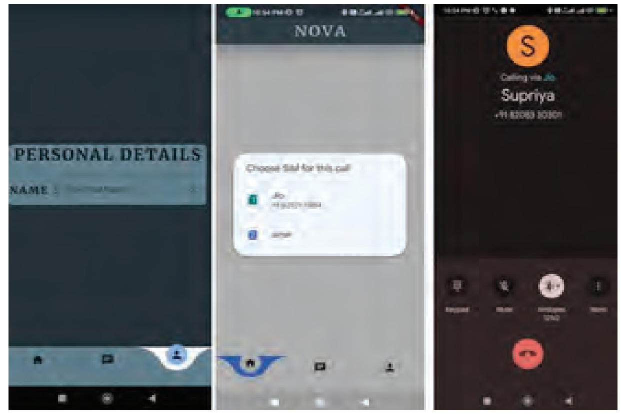


Fig. 3: Results of NOVA Application

Fig. 4: Hardware System

Fig. 5: Alert Messages and Live Location Message

ADVANTAGES

1. Enhanced Safety: Integrating sensors like the MQ-3 alcohol sensor and SW-420 vibration sensor enables real-time monitoring for potential hazards such as alcohol intoxication and accidents, enhancing overall rider safety.
2. Improved Navigation: With GPS and GSM modules integrated into the helmet, riders can receive real- time navigation assistance and access location-based services, ensuring they reach their destination safely and efficiently.
3. Hands-Free Operation: The NOVA AI application allows for hands-free operation through voice commands, enabling riders to access features like messaging, navigation, and emergency alerts without needing to use their hands, enhancing convenience and safety.
4. Emergency Response: In case of accidents or emergencies, the smart helmet system can automatically send distress signals and real-time location information to designated contacts via the GSM module, facilitating quick response and assistance.
5. Customizable Features: The system's modular design allows for customization based on user preferences and requirements. Users can adjust settings, add new features, or integrate additional sensors to tailor the helmet system to their specific needs.
6. Continuous Connectivity: With Wi-Fi and cellular connectivity, the smart helmet system ensures continuous communication and access to online services, keeping riders connected and informed throughout their journey.

FUTURE SCOPE

1. Advanced Safety Features: Smart helmets will integrate advanced sensors and AI algorithms to enhance rider safety, including real-time hazard detection and accident prevention.
2. Integration with Autonomous Systems: These helmets will play a crucial role in communicating with autonomous vehicles, ensuring seamless interaction and enhanced road safety.
3. Augmented Reality Interfaces: AR technology embedded in helmets will provide riders with real-time navigation guidance, traffic updates, and enhanced situational awareness.
4. Health Monitoring and Wellness Features: Smart helmets will incorporate biometric sensors to monitor riders' health parameters, providing alerts for potential risks and promoting well-being during journeys.
5. Hospital Connectivity: Smart helmets will offer connectivity to hospital systems, enabling automatic alerts in case of accidents or emergencies, and facilitating faster response times and medical assistance.

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Intelligent Crop Solution using Machine Learning

Abhishek Avinash Bhujbal
✉ abhishek_bhujbal@moderncoe.edu.in
Adarsh Sanjay Bora
✉ adarsh_bora@moderncoe.edu.in
Manjunath Raju Duggani
✉ manjunath_duggani@moderncoe.edu.in
Dipali Adhyapak
✉ dipali.adhyapak@moderncoe.edu.in
Department of Electronics and Telecommunication Engineering
PES's Modern college of engineering
Pune, Maharashtra

ABSTRACT

Agriculture forms the backbone of global economies, making its productivity crucial for ensuring food security. However, modern agriculture faces numerous challenges, including optimal crop selection and effective fertilizer application. This paper presents a comprehensive solution for farmers and agronomists through the integration of machine learning techniques to tackle these challenges.

The proposed system delivers three core functionalities: crop recommendation, fertility advising, and crop disease detection. By analysing key factors such as soil nutrients and climate conditions, the system recommends the most suitable crops for specific land plots, enabling farmers to make informed decisions and maximize yields. Additionally, it offers guidance on optimal fertilizer types based on soil nutrient levels and crop requirements, thereby optimizing resource use and reducing costs. Finally, the system employs image analysis for early disease detection, facilitating timely interventions to protect crop health.

This integrated approach aims to enhance agricultural productivity and sustainability, providing a valuable tool for modern farming practices.

KEYWORDS: *Agriculture, Crop, Fertilizer, Disease, Machine learning, Random forest, CNN, Deep learning, ResNet.*

INTRODUCTION

Agriculture, the lifeline of nations, plays a vital role in global food security and economic stability. The efficiency and productivity of these age-old industries is of utmost importance to meet the ever-increasing demands of a growing population. But the modern agricultural landscape is plagued by multifaceted challenges, from the need for careful crop selection for specific areas to precise use of fertilizers, early detection of plant diseases

The program at hand appears as a holistic solution called "Intelligent Crop Solutions Using Machine Learning" designed to empower farmers and agronomists with intelligent, data-driven tools Such technology this combination of innovative and integrated agricultural practices provides a multifaceted approach to improve crop production, increase yields and reduce risks.

At its core, this work is motivated by three main types of activities, each of which harnesses the power of machine learning:

Crop Recommendation

Agriculture has always depended on the environment, but now, machine learning algorithms can use these features to make recommendations for targeted crops. By analyzing factors such as soil nutrient levels (N, P, K, pH), rainfall and region specificity (weather data), the system can provide valuable guidance to farmers this enables them to make appropriate choices when choosing crops for their particular soil, and thus has given great results and benefits.

Fertilizer Advisor

Effective and targeted fertilizer management is key to soil health and crop growth. The system, in this aspect, helps farmers determine the appropriate nutrient requirements for their selected crops, and corresponding recommendations. It considers soil nutrient levels and type of the selected crops. This not only improves resource efficiency but also helps reduce unnecessary costs and the environment.

Crop Disease Detection

Crop diseases pose a significant threat to agricultural productivity, causing substantial losses in yield and revenue. Early detection and timely intervention are critical in mitigating these risks. Leveraging ML and DL techniques such as computer vision and pattern recognition, the crop disease detection system analyzes images of plants captured through smartphones. By identifying visual symptoms indicative of diseases this proactive approach not only minimizes yield losses but also reduces reliance on chemical inputs, promoting sustainable farming practices.

“Intelligent Cropping Solutions Using Machine Learning” is not just a project; It represents a significant step towards modernizing agriculture, making it sustainable, efficient and economically viable. By seamlessly integrating historical data, real-time sensor input, and machine learning, the system empowers farmers to make informed choices, increase yields, decrease yields waste, and contribute to the global need for sustainable food production.

As the world meets the challenge of feeding a growing population, this project stands at the intersection of technology and agriculture, offering a promising vision of a productive, efficient, sustainable future regularly in agriculture.

BLOCK DIAGRAM

This system utilizes machine learning to develop a crop recommendation. The process begins with the training dataset, followed by data preprocessing to prepare the data for analysis. Various machine learning models are then applied, with Random Forest selected as the primary algorithm for crop recommendation due to its high accuracy. The trained model is used to make predictions, which are then tested with new data to ensure reliability. Additionally, a ResNet9 deep learning model is implemented for crop disease detection, achieving a 99% accuracy rate. Block diagram explained as follows:

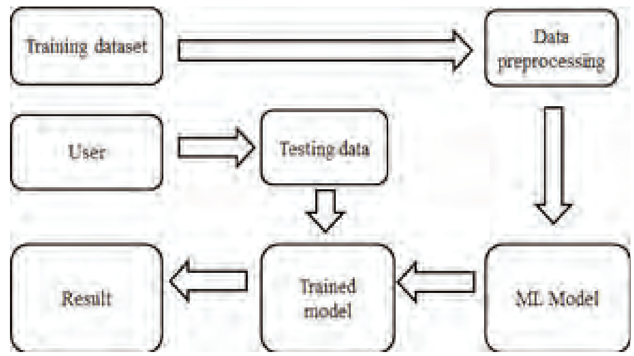

Fig. 1: Block Diagram

- User interface

  This is where the user interacts with the system. It is a web application provides user-friendly interface. Users input information about their crop, including location, N, P, K, rainfall and pH level. User have choice to select any service from three services i.e. Crop Recommendation, Fertilizer Advisor and Disease Detection. For disease detection image is needed as input.

- Training data

  During the training process, the models uses the training dataset to adjust its internal parameters (weights and biases) so that it can make accurate predictions on new, unseen data (Fig.1). The dataset is divided into two categories Training dataset (80%) and testing dataset (20%). The model learns to recognize patterns, relationships, and correlations within the training data to make predictions.

- Data Preprocessing

  Data input from user are processed to extract meaningful information (Fig.1). Data preprocessing includes cleaning, filtering, and feature engineering to prepare the data for machine learning models.

- ML model

  Crop Recommendation Model: This model uses nutrient data such as N, P, K, pH, rainfall and users location to recommend suitable crops for cultivation based on the user's location and conditions (Fig.1).

Fertilizer Advisor: This suggests the optimal type and suggestions of fertilizers needed for that specific crop based on users input.

Disease Detection Model: This model used to detect crop disease based on user data input i.e. image and provides solution for disease.

- Trained model

  Models once trained, the models is evaluated on a separate dataset called the "testing dataset" to assess its generalization performance and ensure that it can make accurate predictions on new, previously unseen data (Fig.1).

- Testing data

  As whole dataset is splitted into two types i.e. training and testing data in the proportion of 0.2 (20% of data used for testing). Testing data is used to calculate accuracy of models. After the formation of trained model user input is treated as testing data (Fig.1).

LITERATURE SURVEY

Exploration of ML in Agricultural Applications

This paper extensively explores the integration of high-performance computing, big data technologies, and machine learning (ML) in agricultural applications. It categorizes various applications within agricultural production systems, emphasizing the importance of real-time AI-enabled farm management systems. Leveraging machine learning, particularly Support Vector Machine (SVM) and Artificial Neural Network (ANN) models, these systems address critical challenges such as crop quality assessment, disease detection, yield prediction, and species recognition. The study highlights the transformative impact of ML technologies in enhancing agricultural practices and decision-making processes.

Predicting Crop Production Outcomes with ML: Focused on predicting crop production outcomes, this study evaluates the performance of ML algorithms, including LASSO Regression, Random Forests, and Extreme Gradient Boosting, as potential models for an agricultural systems simulator. Through a simulated dataset comprising millions of data points, the analysis reveals insights into the effectiveness of these algorithms. Random Forests emerge as a promising model for yield prediction, showcasing their potential for informed decision-making by agronomists and farmers. The study emphasizes the importance of data-driven decision support tools in agriculture and their role in advancing precision agriculture practices.

ML Applications in Indian Agriculture

Addressing challenges faced by Indian agriculture, this paper proposes machine learning-based solutions to enhance productivity and sustainability. Leveraging relevant datasets and predictive modeling techniques, the study emphasizes the potential of ML algorithms in empowering farmers with insights into crop selection, yield prediction, and resource optimization. Specifically, the study aims to develop a crop recommendation system using Random Forest algorithm, which analyzes factors such as soil type, climate, and historical yield data to suggest suitable crops for cultivation. Additionally, the paper discusses the use of ResNet, a deep learning architecture, for automated crop disease detection, highlighting its potential in augmenting disease management efforts and ensuring food security.

Crop Recommendation System Using Random Forest: Focusing on crop recommendation, this study aims to develop a comprehensive system using the Random Forest algorithm. Random Forest, known for its effectiveness in classification tasks, analyzes various factors such as soil type, climate, and historical yield data to recommend suitable crops for cultivation. By leveraging machine learning techniques, the system provides farmers with data- driven insights to optimize crop selection and enhance agricultural productivity and profitability. The study underscores the importance of leveraging advanced technologies to empower farmers and improve overall agricultural practices.

Crop Disease Detection Using ResNet

This paper focuses on automated crop disease detection using Residual Network (ResNet) models. ResNet, a deep learning architecture, is trained on images of crop leaves to classify diseases accurately. The study demonstrates the effectiveness of ResNet in detecting crop diseases, highlighting its potential in augmenting disease management efforts and ensuring food security. By leveraging advanced computer vision techniques, the proposed approach aims to automate the identification of plant diseases, thereby facilitating timely intervention and management strategies to ensure higher crop yields and minimize losses.

METHODOLOGY

Project Planning

Defined project objectives and scope. Determine available data sources for system.

Data Collection and Preprocessing

Collected data of soil properties and climate for crop recommendation model (https://www.kaggle.com/).

Range of data:- N: 0 to 140

P: 5 to 145

K: 5 to 205

Temperature: 8.8 to 43.67 °C.

Humidity 14.25 to 99.98 %.

pH: 3.5 to 9.94

Rainfall: 20.21 to 298.56 mm. Number of types of crops: 22

Collected plant disease dataset which includes leaf images (https://www.kaggle.com/) consist of total 38 disease classes.

Number of plants: 14. Number of disease: 26.

Cleaned the data to remove inconsistencies and missing values.

Preprocessed the data by data cleaning and integration.

Model Development

Chose various algorithms for Crop recommendation and ResNet9 (Disease detection). Splitted the data into training and testing sets.

Trained both models on respective training dataset.

Model Evaluation and Optimization

Evaluated the model's performance using metrics like accuracy, precision, recall and F1 score. Performed cross validation.

Deployment

Developed a Flask web application to host the model.

Integrated the trained models into the web application.

SYSTEM FLOWCHART

The system comprises three distinct pages (Fig.2): Crop Recommendation, Fertilizer Advisor, and Crop Disease Detection, each tailored to specific agricultural needs explained as follows:

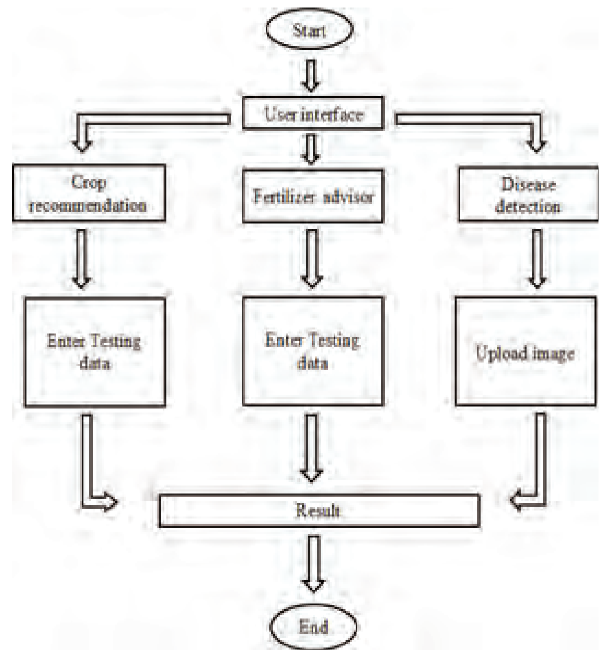

Fig. 2: Flowchart

On the Crop Recommendation page, users input parameters including Nitrogen (N), Phosphorus (P), Potassium (K), pH, rainfall and geo-location, accessing real-time weather data via the Weather API. The system employs a Random Forest algorithm to analyze this data and suggest suitable crops for cultivation. Similarly, the Fertilizer Advisor page utilizes identical input parameters and weather data to provide personalized fertilizer recommendations based on established agricultural guidelines. Meanwhile, the Crop Disease Detection page enables users to upload images of crop leaves, which are processed using a trained ResNet9 model to identify potential diseases. Each page operates independently, leveraging machine learning algorithms and external data sources to offer tailored recommendations and insights for optimized agricultural practices. The results of each page is displayed separately (Fig.2).

ALGORITHM

Step 1: Project Setup

Set up improvement environment by means of putting in Python and Flask.

Create a mission folder and set up a virtual surroundings to manage dependencies.

Step 2: Data Collection

Collect data associated with crops, soil, weather conditions and diseases (from kaggle).

Preprocess the data to easy, layout, and rework it as wished.

Step 3: Data Preprocessing & Model training

Collected data processed to extract meaningful information. Data preprocessing includes cleaning, filtering, and feature engineering to prepare the data for machine learning models.

Train system gaining knowledge of models for crop advice and disease detection. Can use libraries like scikit- research, Tensor-Flow, etc. for this.

Evaluate the models the usage of suitable metrics and first-rate-track them for higher accuracy.

Save the trained models for destiny use.

Step 4: Flask Web Application

Create a Flask web application with the following routes and templates:

1) Homepage
2) Crop Recommendation
3) Fertilizer Advisor
4) Disease Detection
5) Crop Recommendation- result
6) Fertilizer Advisor-result
7) Disease Detection-result

Design the HTML templates for each page to provide a user-friendly interface.

Set up routes and views for each page to handle user interactions.

Step 5: Home Page

Create a homepage which serves as the gateway to the intelligent crop solution system, design with a focus on user-friendliness and responsiveness across various devices such as smart phones, tablets, etc.

Step 6: Crop Recommendation page

Implement a form on the Crop Recommendation Page for users to input data like soil nutrients (N, P, K, pH), rainfall and location (Weather API).

Use the trained crop recommendation model to provide suggestions.

Display the recommended crops to the user.

Step 7: Fertilizer Advisor page

Create a form on the Fertilizer Advisor Page for users to input information about their crops and soil nutrients as mentioned above.

Write code to suggest appropriate fertilizers.

Present the recommended fertilizers along with usage instructions.

Step 8: Disease Detection page

Create a upload image and predict button.

Utilize the disease detection model to detect disease

Present the detected disease and its solution.

Step 9: Crop Recommendation-result page

Create result page shows result for crop recommendation for ex. "You should grow maize in your farm."

Step 10: Fertilizer Advisor-result page

Create result page shows results along with suggestions on fertilizer.

Step 11: Disease Detection-result page

Create result page shows detected disease along with its cure.

Step 12: Testing and Debugging

Thoroughly test the application to ensure it works as expected.

Debug and fix any issues that arise during testing.

RESULT AND DISCUSSION

Results and Analysis of Machine Learning Algorithms: In this study, multiple machine learning algorithms were applied to develop a crop recommendation system. Each algorithm's performance was evaluated based on its accuracy in predicting the most suitable crops under given conditions (Fig.3). Following Bar plot created using python pyplot library which summarizes results:

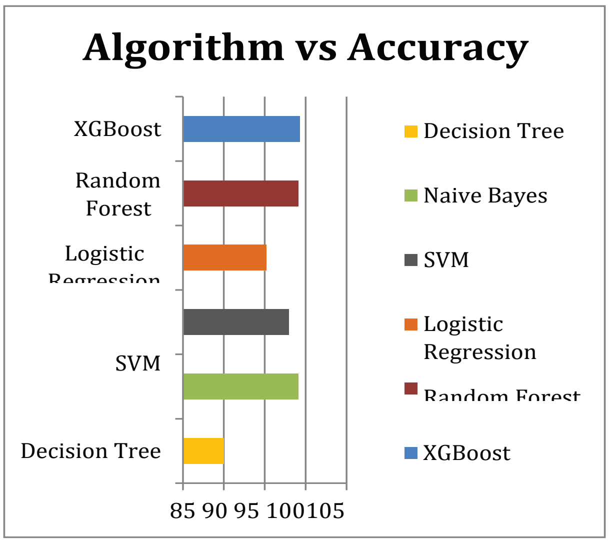

Fig. 3: Results

Decision Tree: Achieved an accuracy of 90%. While this algorithm is easy to interpret and understand, its accuracy was lower compared to other models tested (Fig.3).

Naive Bayes: Recorded an accuracy of 99.09%. This probabilistic classifier performed exceptionally well, demonstrating its effectiveness in handling the dataset and providing reliable recommendations (Fig.3)..

Support Vector Machine (SVM): Achieved an accuracy of 97.95%. SVM showed strong performance, making it a reliable choice for crop recommendation tasks (Fig.3).

Logistic Regression: Achieved an accuracy of 95.22%. This algorithm provided solid results, showcasing its capability in handling both binary and multiclass classification problems (Fig.3).

Random Forest: Achieved an accuracy of 99.09% (Fig.3). This ensemble learning method performed excellently, slightly outperforming Naive Bayes. Random Forest was selected as the primary algorithm for the system due to its high accuracy and robustness. Its ability to handle complex datasets by reducing overfitting through multiple decision trees makes it well-suited for agricultural applications with significant data variability.

XGBoost: Achieved the highest accuracy of 99.31% (Fig.3). Known for its efficiency and high performance, XGBoost was the best-performing model in this study.

Crop Disease Detection

ResNet9 Architecture: The ResNet9 architecture achieved an accuracy of 99% in detecting and classifying diseases from crop leaf images. This deep learning model was trained on an extensive dataset, demonstrating its exceptional capability in identifying a range of crop diseases. The high accuracy underscores its effectiveness and potential in enhancing disease management practices and ensuring food security through automated detection systems.

Screenshots of different pages

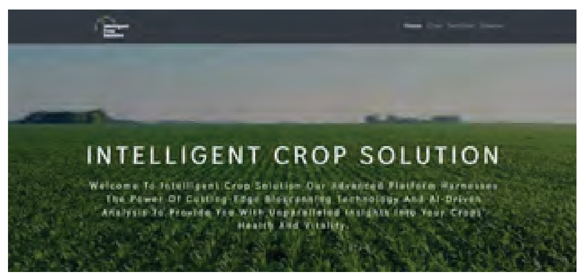

Fig. 4: Home

(Fig.4) The homepage serves as the gateway to the intelligent crop solution system, designed with a focus on user-friendliness and responsiveness across various devices such as smart phones, tablets, etc.

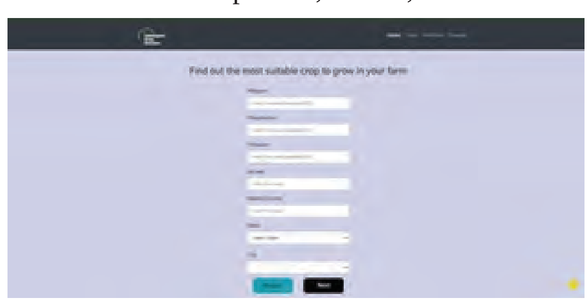

Fig. 5: Crop recommendation

Fig..6: Fertilizer advisor

(Fig.5 and Fig.6) It shows crop recommendation and fertilizer page respectively. On the Crop Recommendation page, users input parameters including Nitrogen (N), Phosphorus (P), Potassium (K), pH, rainfall and geo-location, accessing real-time weather data via the Weather API. Similarly, the Fertilizer Advisor page utilizes identical input parameters and weather data to provide personalized fertilizer recommendations based on predefined agricultural guidelines.

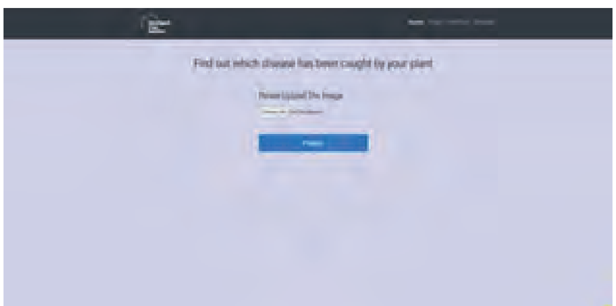

Fig. 7: Disease detection

Crop Disease Detection page enables users to upload images of crop leaves (Fig.7), which are processed using a trained ResNet9 model to identify potential diseases. Each page operates independently.

DISCUSSION

Crop Recommendation

Among the algorithms evaluated, Random Forest was chosen as the primary model for our crop recommendation system because of its high accuracy (99.09%) and robust performance. Random Forest's ensemble nature allows it to effectively handle complex datasets by combining multiple decision trees, which reduces the risk of overfitting. This makes it particularly suitable for agricultural applications where data variability is significant.

Although XGBoost achieved a slightly higher accuracy of 99.31%, Random Forest was preferred due to its balance between performance and computational efficiency, as well as its more interpretable results compared to the more complex XGBoost algorithm. The high accuracy of Random Forest ensures reliable recommendations while maintaining practical feasibility for implementation.

Naive Bayes also showed excellent performance with an accuracy of 99.09%, highlighting its ability to handle the dataset effectively. However, the assumption of feature independence in Naive Bayes may not always be appropriate for agricultural data, which can limit its applicability in certain scenarios.

SVM and Logistic Regression, with accuracies of 97.95% and 95.22% respectively, demonstrated strong performance as well. These models offer valuable alternatives depending on specific project requirements, such as the need for simpler models or faster computation.

The Decision Tree algorithm, while achieving a decent accuracy of 90%, did not perform as well as the other models. This could be attributed to its tendency to overfit, particularly with more complex and variable datasets.

Crop Disease Detection

The implementation of the ResNet9 architecture for crop disease detection achieved an impressive accuracy of 99%. This result highlights the model's ability to accurately identify diseases from crop leaf images. Such high accuracy demonstrates the potential of deep learning models in enhancing disease management practices and ensuring food security. The use of ResNet9 facilitates automated, efficient, and precise detection of crop diseases, which is essential for timely intervention and minimizing crop losses.

CONCLUSION

The project, which focuses on crop recommendations and fertilizer advice using machine learning, represents an important step towards modernizing and streamlining agricultural practices. It brings the power of data-driven decision-making to farmers, enabling them to increase yields, reduce waste.

This project has three main components, each playing an important role in agricultural transformation:

Crop recommendation: The system uses Random forest algorithm for crop recommendation with accuracy of 99.09% (Fig.3). Using crop data, soil nutrients and climate, the Crop Recommendation segment provides farmers with customized information for growing the most suitable crops This enables farmers to make informed choices, increase yield and adapt to changing environmental conditions. The program recommendation process can significantly Increase crop selection efficiency, resulting in better yields And resource consumption.

Fertilizer Advisor: The Fertilizer Advisor module provides guidance on fertilizer selection and application, further improving crop health and yield. It improves nutrient management by tailoring recommendations to specific crops and soil conditions, promotes sustainable development, cost effectiveness and environmental responsibility on farm. Thus this product has the potential to reduce the excessive use of fertilizers, which can be harmful to the environment and ensure adequate use of nutrients for crop.

Crop Disease Detection: The application of DL for crop disease detection represents a significant advancement in early disease identification and mitigation, mitigating the risks associated with crop losses and yield reduction. Through the analysis of image data and pattern recognition algorithms, the crop disease detection system enables timely interventions to prevent the spread of diseases and minimize economic losses for farmers. The system using ReNet9 architecture with accuracy of approx. 99% which is calculated by increasing epochs.

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Artificial Intelligence Agro Revolution: Transforming Agriculture through the Precision Farming and Crop Surveillance

Abhay Mane, Sahil Lokhande
MCA Department
Modern College of Engineering
✉ abhaymane169@gmail.com

Prakash Kene
✉ prakash.kene@gmail.com

ABSTRACT

This research delves into the intersection of AI and precision agriculture to enhance crop management and sustainability, particularly by optimizing agricultural practices. It investigates various applications of AI, including crop monitoring, irrigation optimization, data-driven predictions, and pest identification. Additionally, this study addresses the challenges and ethical considerations inherent in deploying AI in agriculture, underscoring the importance of fair technology application. The findings contribute to the ongoing discourse on leveraging AI to support agricultural endeavors. The study scrutinizes the challenges and ethical dilemmas associated with the adoption of AI in agriculture, stressing the necessity of fair and responsible utilization of these technologies. It explores how AI tools like computer vision, and data integration can empower farmers by providing real-time insights and predictive analytics for informed decision-making.

KEYWORDS: *Artificial Intelligence (AI), Social impact, Opportunities, Challenges, Ethical considerations, Governance, Automation.*

INTRODUCTION

The integration of AI technologies with precision farming has revolutionized agricultural practices. Precision farming, characterized by targeted resource utilization and data- driven decision-making, holds significant promise for transforming agricultural management and sustainability. In its introductory remarks, the study underscores the profound impact of AI on the agricultural landscape, emphasizing the imperative to optimize farming methodologies to meet escalating food demands while addressing climate change concerns. The integration of AI into precision farming marks a departure from conventional methods towards a data-driven approach. These technological advancements have facilitated the creation of systems proficient in effectively managing extensive datasets from various origins. AI-driven solutions hold the potential to enhance farming efficiency and mitigate challenges posed by climate variability and resource limitations, particularly in areas like crop monitoring, precision irrigation, and predictive analytics for optimal planting times.

It is imperative to scrutinize not only the promises but also the challenges inherent in deciphering the complexity of artificial intelligence in precision farming. Thorough examination is essential to address ethical considerations, data privacy concerns, and the accessibility of AI solutions across various farming domains. This research seeks to enrich the ongoing conversation surrounding the integration of AI in agriculture by conducting a thorough examination of its potential benefits and inherent limitations. By critically evaluating these aspects, Its objective is to furnish valuable insights that can guide decision-making processes and facilitate the responsible integration of AI technologies into agricultural practices.

METHODOLOGY

The methodical framework of precision farming seamlessly merges various technologies, data analytics tools, and agricultural methodologies with the aim of maximizing resource efficiency, boosting crop yields, and mitigating environmental footprints. By harmonizing these elements, precision farming endeavors to fine-tune the allocation of resources. Furthermore, it seeks to harness the power of data analytics to make informed decisions regarding planting, irrigation, and pest management, thereby enhancing overall productivity. This methodology begins with a thorough assessment of agricultural production objectives, available resources, and targets for efficiency, sustainability, and yield improvement. Central to precision farming is extensive data collection through sensor technologies, monitoring soil conditions, crop health, and weather patterns.

To optimize the advantages offered by precision farming technology, tailored education and training programs are being developed to provide farmers with essential skills. These initiatives aim to ensure that farmers are equipped to effectively utilize the technology to its fullest potential. Moreover, ongoing enhancements are facilitated through a feedback mechanism, allowing farmers and agronomists to actively participate in refining the system. The sustainability of precision farming practices is underpinned by comprehensive evaluations of economic viability and environmental impact. This involves conducting thorough cost-benefit analyses and impact assessments to ensure that the implementation of precision farming aligns with both economic feasibility and environmental stewardship.

Crop Health

Artificial intelligence is increasingly becoming a cornerstone of precision farming and offering a myriad of transformative application that reshape agricultural practices. Predictive analysis, a pivotal aspect, involves AI algorithms meticulously scrutinizing historical data to anticipate crop yields. This empowers farmers to adopt strategic approaches in their planting and harvesting methods, optimizing resource allocation for maximum efficiency.

AI's proficiency in computer vision plays a vital role in early detection of crop health issues, utilizing high- resolution drone imagery. This capability is indispensable for disease detection and pest control, enabling swift actions to protect crop yields.

Furthermore, AI has revolutionized precision irrigation management by processing data from soil sensors and weather forecasts. This allows for precise scheduling of irrigation, minimizing water usage while ensuring crop health is maintained.

Fig. 1: Detection of Crop Health

However, the presence of fungus, microorganisms, and bacterial energy can significantly impact crop yields if not detected early, leading to substantial economic losses for farmers. The financial burden of combating diseases and restoring crop functionality often translates into heavy pesticide usage, Moreover, exacerbating environmental degradation and disturbing the delicate balance of water and soil cycles in agriculture.

WPS Sensor

Wireless sensor networks (WSNs) have emerged as a cornerstone in precision agriculture, ushering in significant shifts in agricultural management practices. These networks offer real-time insights into various environmental factors crucial for crop growth by strategically deploying sensor nodes across fields. Continuous monitoring of parameters like moisture, temperature, and nutrient levels empowers farmers to fine-tune soil conditions through precise irrigation techniques.

WSNs comprise a collection of specialized sensors strategically positioned to monitor environmental parameters, with data coordinated and collected at a central location. By utilizing intelligent algorithms, the Internet of Things (IoT) enables the transmission of recorded data to the cloud for subsequent processing and analysis.

Integrating artificial intelligence (AI) with Wireless Sensor Networks (WSN) facilitates real-time monitoring and enables intelligent decision-making in precision agriculture. The IoT sensor network functions as an ongoing data repository, serving as a platform for machine learning (ML) and deep learning (DL) algorithms to learn and adapt. These algorithms, identify meaningful data for communication while discarding unnecessary information. Edge computing-enabled AI systems play a pivotal role in reducing the volume of data transmitted to the IoT cloud, optimizing data management in precision agriculture practices

Weed Detection

Weed identification and management is another major issue in agriculture. Weeds, according to many growers, are the greatest serious hazard to agricultural productivity. Weed detection accuracy is critical considering the difficulties of distinguishing across crops. According to a study done in India, the competition between crops and undesirable weeds costs more than $11 billion. As a result, eliminating these weeds from the fields is critical to preventing space from being filled and affecting crop development.

To create a system with this use case, it is first important to distinguish between crops and weeds, and as we all know, computer vision is an effective tool for doing so the undesired guests can then be removed using micro sprays or lasers.

Automated Irrigation System

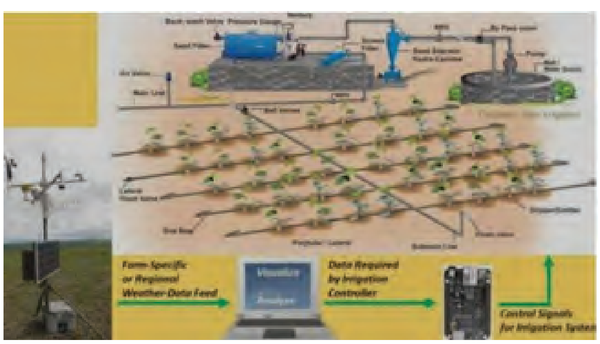

Fig. 2: Irrigation System

Agriculture currently accounts for 85% of the world's available freshwater usage, a figure that continues to escalate with the expanding global population and increasing food demands. In traditional open-space agricultural settings, inefficient irrigation systems are commonplace, leading to significant water wastage instead of effective soil hydration. However, by strategically deploying sensors to measure crucial factors like temperature, humidity, pH levels, and soil moisture across fields, precise irrigation becomes achievable. This enables automated watering systems to target specific areas in need of hydration, thereby optimizing water usage and enhancing overall efficiency in agricultural practices.

The sensor data linked to each segment of the field is intended to trigger the activation of a valve in the exact corresponding area. Aside from this, plant evapotranspiration is influenced by a variety of climatic characteristics such as humidity, wind speed, sun radiation, and even crop aspects such as growth stage, plant density, soil conditions, and pests.

Leaf disease detection

It is anticipated that diseases account for a significant portion of agricultural output losses. The prevalent approach to pest and disease management involves uniformly spraying insecticides across the entire cropping area. This approach, while effective, has a high financial and environmental cost.

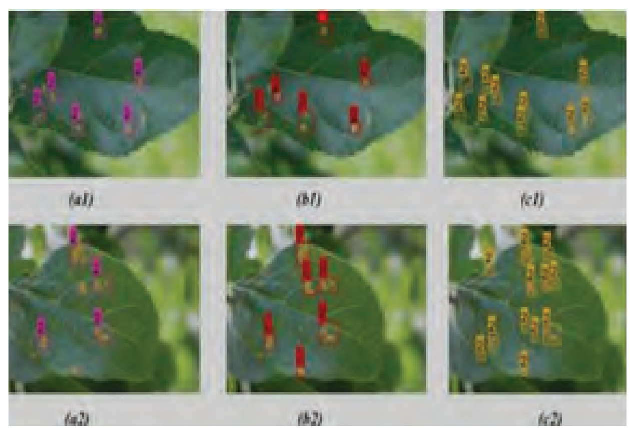

Fig. 3: Leaf Disease Identification

To create a system with this use case, it is first important to distinguish between crops and weeds, and as we all know, computer vision is an effective tool for doing so the undesired guests can then be removed using micro sprays or lasers.

Climate Prediction and Adaptation

AI is helping farmers adapt to changing climatic conditions by providing accurate climate predictions and recommendations. Machine learning algorithms analyse historical weather patterns to predict future climate patterns, helping farmers anticipate shifts in temperature, precipitation, and other factors. Armed with this information, farmers can adjust their planting schedules, crop choices, and cultivation practices to optimize yields and mitigate the impact of climate change.

LIVESTOCK MANAGEMENT

The impact of artificial intelligence on human society. Artificial intelligence is poised to revolutionize livestock management by enabling the monitoring of animal health through wristwatches or sensors, facilitating early disease detection. This proactive approach not only safeguards animal welfare but also enhances productivity by addressing health issues promptly and optimizing feeding schedules.

Furthermore, AI ensures secure data management and transparency in the agricultural supply chain through the implementation of block chain technology. By securely recording and tracking data from farm to merchant, block chain enhances trust and efficiency in precision agriculture, bolstering confidence among stakeholders and consumers alike.

Below is a general methodology for precision farming:

Assessment of Farming Objectives and Resources

- Objective Definition: Precision farming initiatives should begin by articulating clear aims and objectives, whether it's enhancing crop yields, optimizing resource utilization, or promoting sustainability. Establishing these goals provides a framework for decision-making and performance evaluation throughout the process.
- Resource Evaluation: Conduct a thorough assessment of available resources essential for precision farming, encompassing land availability, water availability and quality, labor force capabilities, and equipment inventory. Understanding the scope and limitations of these resources is crucial for devising effective strategies and allocating resources efficiently.

Data Collection and Sensing

- Sensor Technology Integration: Incorporate a range of sensor technologies to monitor key parameters such as soil moisture, temperature, nutrient levels, crop health, and weather conditions. These sensors provide timely and accurate data essential for making informed decisions and optimizing agricultural practices.
- Remote Sensing Applications: Employ remote sensing methods such as satellite or drone imagery to gather detailed data over expansive agricultural landscapes. These advanced imaging techniques offer high-resolution information on crop growth, soil variability, and environmental factors, empowering farmers to remotely assess field conditions and identify areas for targeted intervention and management.

GIS mapping and spatial analysis

- The integration of Geographic Information System: It enables the mapping and analysis of spatial data using GIS tools.
- Analysis of spatial variations: Apply spatial analysis techniques to interpret and analyze geographic data within the context of agricultural decision-making. This may involve assessing spatial relationships, identifying patterns, and performing statistical analyses to uncover trends or correlations. By leveraging spatial analysis tools, farmers can optimize resource allocation, identify optimal planting locations, and implement precision farming practices tailored to the specific characteristics of their land.

Data management and integration are essential components of the process

- Data storage: It necessitates the implementation of a centralized data management system to securely store and organize collected data.
- Incorporating various data sources: To offer a comprehensive understanding of the agricultural environment, data from diverse sources like sensors, satellites, and historical records are integrated.

Analyzing data to inform decision-making

- Machine Learning Algorithms: To analyze data and offer valuable insights, predictions.
- Forecasting Analytics: Create predictive models to

anticipate crop yields, forecast disease outbreaks, and determine the optimal timing for planting and harvesting.

Targeted irrigation

- Installing an irrigation system: Intelligent irrigation systems operate by utilizing real-time soil moisture data and weather forecasts.
- Drip irrigation conserves water and optimizes soil hydration: Drip irrigation stands out for its efficiency primarily because it significantly minimizes water loss.

Agricultural machinery

- Automated or semi-automated farming equipment, including irrigation systems, planting devices, and harvesting machinery, streamline agricultural processes.

OPTIMIZING AI FOR AGRICULTURE

Absolutely, the synergy between artificial intelligence (AI) and other digital technologies is indispensable for maximizing the benefits in agriculture. Technologies like big data, sensors, and software provide the foundational infrastructure upon which AI operates, while AI, in turn, enhances the effectiveness and efficiency of these technologies.

Big data, although abundant, is only valuable when effectively managed and analyzed. AI algorithms excel at extracting insights from large datasets, enabling informed decision-making for farmers. By leveraging AI-driven big data analytics, farmers can receive real-time recommendations tailored to their specific needs, leading to improved productivity and cost reduction.

IoT sensors are vital for gathering and analyzing agricultural data.When combined with AI, these sensors facilitate the swift acquisition of accurate information, minimizing manual labour through intelligent automation. Additionally, the integration of AI with other supporting technologies like drones and GIS enhances the monitoring and measurement of various metrics in real-time, further empowering farmers with actionable insights.

Robotics represents another frontier in agricultural innovation, with AI-driven autonomous tractors and robots addressing labour shortages and enhancing productivity. Agricultural robots, equipped with AI, excel at tasks such as harvesting, offering extended working hours, increased accuracy, and reduced errors compared to manual labour.

In essence, the symbiotic relationship between AI and other digital technologies propels agricultural innovation, offering unprecedented opportunities to enhance efficiency, productivity, and sustainability in farming practices.

DISCUSSION

AI technology is widely used in agriculture to manage crops efficiently. It includes deep learning, computer vision, and machine learning. AI applications in agriculture offer farmers accurate and tailored agricultural guidance, covering aspects such as water management, crop rotation, timely harvesting, and pest control. In improving precision farming, the integration and analysis of computer vision technologies, drone data, and IoT alerts enable the delivery of timely notifications. AI can predict the weather, analyse crop sustainability, detect diseases and pests, and transform agricultural practices.

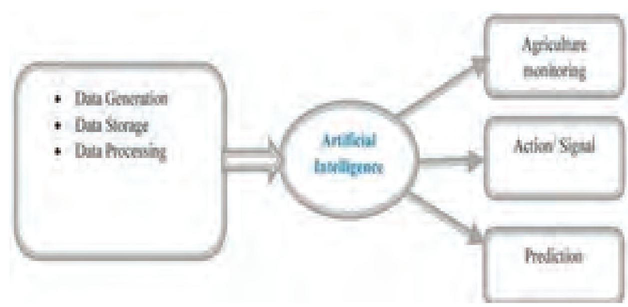

Fig. 4: Demonstrates AI usage in Agriculture

Deep learning, which falls under the umbrella of artificial intelligence (AI), operates in a manner akin to the human brain's neural networks, making it a powerful tool for pattern recognition and decision-making, is becoming increasingly popular. It is being used to handle several agricultural concerns, such as disease detection, plant classification, and crop management. For instance, businesses are developing and programming self-driving robots to do agricultural tasks like soil analysis, weed control, seed planting, and harvesting more efficiently than humans.

Fig. 5: Developing AI for Agriculture

Machine learning algorithms are being used to anticipate and monitor the impact of weather and climate change on agricultural productivity.

AI applications in agriculture offer farmers tailored and regulated agricultural advice, covering a wide array of crucial aspects such as water management, crop rotation, harvest timing, crop selection, planting optimization, pest control, and nutrient management. By accurately anticipating crop growth based on farm data and external influences like weather information, AI can detect and manage pest illnesses more efficiently.

AI in agriculture enables farmers, even small enterprises, to easily interact with merchants globally. Drone photos can help diagnose agricultural diseases more efficiently. Despite the potential benefits of AI in agriculture, many farms currently lack access to advanced machine learning technologies which require large R&D expenditures and regular maintenance to function properly. Addressing real- world challenges requires acknowledging that many farmers have small landholdings and limited resources.

FUTURE SCOPE

AI technology revolutionizes farming by facilitating The gathering and analysis of extensive datasets, empowering farmers to make informed decisions and enhance crop yields. Through sophisticated algorithms, AI systems have the capability to analyze data concerning soil conditions, crop growth patterns and climate fluctuations, providing real-time insights for proactive decision-making. By continuously monitoring these factors, Farmers can quickly identify indications of disease or pest infestations, enabling timely intervention to prevent crop damage or loss.

Fig. 6: Use of Drones for spraying of insecticides

AI also contributes to weather forecasting, enabling farmers to make better-informed decisions and capitalize on optimal planting seasons. Moreover, AI assists farmers in optimizing fertilizer and water usage, promoting more sustainable and environmentally friendly agricultural practices. This optimization reduces the risk of soil and water contamination, addressing a growing environmental concern. However, the widespread adoption of AI technologies faces challenges, particularly among smallholder farmers who often lack the resources and technical expertise to implement these solutions effectively. Limited access to technical training and financial constraints hinder smallholder farmers' ability to acquire the equipment and software necessary for AI-based farming practices. As a result, bridging these gaps in access and affordability is crucial for ensuring equitable access to the benefits of AI in agriculture.

CONCLUSION

In conclusion, Various industries, including agriculture, recognize the immense value of AI, which has become increasingly indispensable for ensuring business viability in the agricultural sector. Data plays a pivotal role in decision- making processes related to agricultural production, holding enormous potential for driving efficiency and productivity. Additionally, the application of machine learning holds the promise of achieving greater sustainability in resource utilization while delivering substantial environmental benefits. As such, precision farming represents a pivotal advancement in modern agriculture, poised to address pressing challenges.

It provides real-time insights into fields and identifies areas for irrigation, fertilization, and pesticide treatment.

Vertical agriculture boosts food output and quality while reducing herbicide usage, costs, and resource depletion.

AI technologies play a crucial role in assisting farmers in addressing challenges such as climate change and pest infestations, which can significantly impact crop yields. By leveraging AI-powered solutions, farmers can access advanced tools for monitoring and analyzing environmental data, enabling proactive measures to mitigate the effects of climate change and prevent pest and weed outbreaks.

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Deep Neural Network based Oral Cancer Detection

Anuradha S. Pandit
Research Scholar
G H Raisoni College of Engineering and Management
Pune, Maharashtra
✉ panditanuradha29@gmail.com

V. V. Dixit
Director
RMD Sinhgad Technical Institutes Campus
Warje, Pune, Maharashtra
✉ vvdixit73@gmail.com

ABSTRACT

Oral cancer is still a major global health concern, and in order to improve patient outcomes, early and accurate screening methods are required. In order to improve the identification of oral cancer using medical imaging data, this study investigates the use of deep learning approaches, particularly making use of Residual Networks (ResNet) capabilities. Oral lesions are classified into cancerous and non-cancerous groups using ResNet, a convolutional neural network architecture renowned for its depth and capacity to alleviate the vanishing gradient problem using skip connections. The performance of various deep learning models in the detection of oral cancer was evaluated and compared. Specifically focused on different configurations of Residual Networks (ResNet) to assess their efficiency. The exceptional performance of the 50- layer ResNet model in particular stands out, indicating that this configuration hits the ideal balance between network depth and generalization capabilities.

KEYWORDS: *Deep Neural Network, Image processing, Oral cancer, Resnet.*

INTRODUCTION

According to the National Institutes of Health (2018) and the World Health Organization (2017), oral cancer accounts for around 85% of all head and neck cancers and comprises significant sub regions of the lip covering mouth cavity and tubular cavities. The fact that patients may not regularly recognize the precursor symptoms and warning signs of carcinoma means that this illness may immediately advance into the malignant neoclassic disease stage, posing a serious threat to the patient's life. Oral cavity tumors are also known to have a higher recurrence risk than other malignancies. Its prognosis treatment therefore requires a thorough examination of either its staging or its grade. Squamous cell carcinomas account for over 90% of malignancies. Animal tissue filth, tissue differentiation, and rapid growth that disrupts the basement membrane of the inner cheek region are the hallmarks of this cancer cluster. Commonly, Tumor-Node-Metastasis (TNM) staging is used to evaluate clinical procedures for prognosis and treatment. However, a five-year survival report for oral cancer shows a prognosis rate of approximately 35–500%, indicating that quantitative microscopic anatomy grading of tumors, which includes a thorough investigation of various pathological aspects related to SCC, is a more beneficial approach than growth staging for raising disease survival rate.

Therefore, from the perspective of a pathologist, it is crucial to provide accurate histological identification in the setting of classification. This offers a strategy to address the issue by integrating clinically relevant, hotly analyzed disease identification or prediction algorithms based on deep learning. According to Brooder's system of microscopic anatomy grading, oral SCC is morphologically categorized into conventional, well-differentiated, moderately differentiated, and poorly differentiated categories. The growth shows extremely tiny microscopic anatomical distinctions between the three categories that are difficult for the human eye to perceive in the cellular morphometric highlight. Due to remarkably comparable microscopic anatomy alternatives that even pathologists find difficult to define, it has remained elusive. As a result of the globalization of healthcare standards, pathology needs to be overhauled, which may entail more rapid and precise diagnosis.

RELATED WORK

With an estimated 377,713 new cases and 177,757 fatalities from head and neck cancer worldwide in 2020, oral cancer is the most prevalent type of the disease [1]. Surgery is typically the first line of treatment and has a high success rate, with early stage overall survival rates of 75–90% [2, 3]. However, more than 80% of cases have advanced diagnoses and have severe morbidity and fatality rates [2, 4]. Given the horrendous incidence and mortality rates, carcinoma screening has been a crucial component of many humanitarian programmes in an effort to improve early diagnosis of the disease [5]. Oral doubtless malignant diseases (OPMD), including as leukoplakia and erythroplakia, are frequently present before oral squamous cell cancer (OSCC), which accounts for approximately 90% of instances of carcinoma [6]. The primary focus of screening programmes has been on OPMD detection since it carries a risk of malignant transformation and is crucial for lowering cancer-related morbidity and death [6]. However, it has been discovered that the execution of those programmes, backed by visual examination, is difficult in a real-world context since they rely on medical personnel, United Nations agency are typically not sufficiently qualified or prepared to recognise these lesions [6, 7]. The significant heterogeneity in the appearance of oral lesions makes their diagnosis by healthcare workers extremely challenging and is thought to be the main cause of delays in patient referrals to carcinoma experts [7]. Furthermore, early-stage OSCC lesions and OPMD are typically benign and should appear as small, innocuous lesions, causing patients to present later than expected and ultimately adding to the diagnostic lag. Advances in computer vision and deep learning offer effective approaches to create linked technologies that can automatically screen for the oral fissure and provide feedback to help professionals during patient assessments as well as on individuals for contemplation. The majority of the work on the use of specialised imaging technologies, such as optical coherence tomography [8,9], hyper spectral imaging [10], and motor vehicle light imaging [11-16], has focused on the automatic diagnosis of carcinoma using images [7,8]. On the other hand, some white-light photography studies have been conducted [17–21], the majority of which focus on the identification of bound forms of oral lesions. The discovery of OPMD is essential for the early detection of carcinoma and plays a significant role in the creation of instruments for screening for the disease. In this study, we looked into the prospects for a deep learning-based automatic system for carcinoma screening.

METHODOLOGY

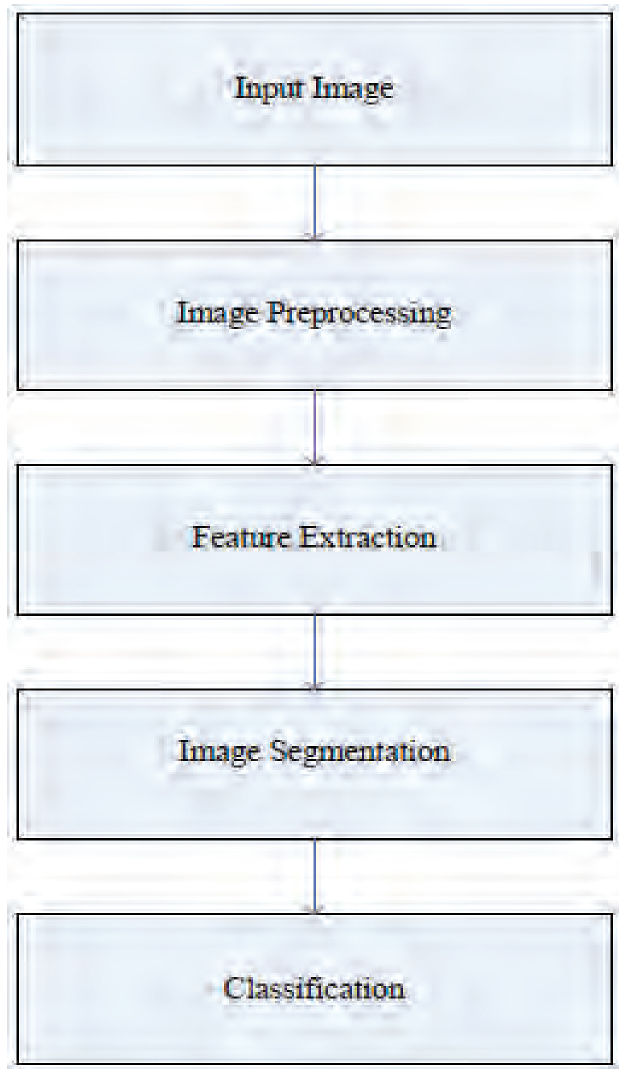

Fig. 1: Work flow diagram

In medical image and its applications deep learning has been a vibrant area of research, particularly following its success in winning image recognition challenges. The study is conducted in five stages 1) Input image 2) Image preprocessing 3)Feature Extraction 4)Image Segmentation 5)Classification.

Input Image: Input images for this study are taken from publically available kaggle dataset which contains cancer and non-cancer images.

Image Preprocessing

Image preprocessing is very basic but very important step. In this study different morphological operations like Erosion, Dilation, Opening and Closing are used. These are operations which are related to morphology of the features in an image. Binary images may contain numerical imperfections; for example, thresholding can introduce noise and distort the image's texture. Morphological image processing aims to eliminate these imperfections by considering the shape and structure of the image.

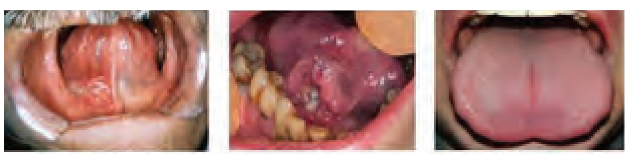

Fig. 2: Sample of cancerous and non-cancerous images

Image segmentation: Image segmentation is a vital and challenging component of image processing. It has become a focal point in the field of image understanding and serves as a bottleneck that constrains the application of technologies such as 3D reconstruction. This process involves dividing the entire image into several regions that share similar properties. In essence, it aims to separate the target objects from the background in an image. In this study semnatic segmentation technique is used.

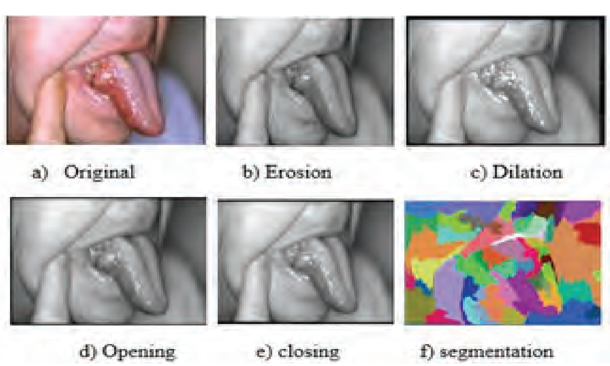

Fig. 3: Image Preprocessing and Segmentation

Classification: classification is done using Resnet algorithm. The problem of vanishing/exploding gradient, is solved using Residual block concept in this architecture. Skip connection technique is used. If any layer afflict the performance of architecture then that will be skipped this is advantage of Resnet architecture.

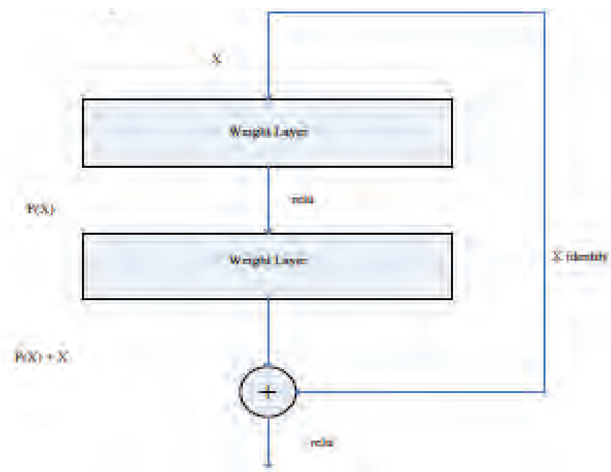

Fig. 4: Skip Connection

EXPERIMENTAL RESULTS

Table 1: Accuracy comparison table

Model Name	N	Accuracy
Res net	N=9	81
CNN with Res Net	N=32	93
CNN with Res Net	N=50	97

It was assessed and compared how well different deep learning models performed in the identification of oral cancer. In particular, we evaluated the effectiveness of various Residual Network (ResNet) designs. The following is a summary of experiment results: ResNet (N=9) an accuracy of 81% was attained by the baseline ResNet model. Although noteworthy, this performance suggests that the intricate characteristics linked to the identification of oral cancer should be better captured. CNN with ResNet (N=32) a significant increase in performance when deepened the network to 32 layers. With an astounding accuracy of 93%, the model showed how deeper networks can learn and generalize from data more effectively. CNN with Resnet (N=50).Further increasing the network depth to 50 layers resulted in a slight increase in accuracy, with the model achieving 97%. Still increasing the network depth beyond a certain point does not necessarily yield better results and may lead to over fitting or increased computational complexity.

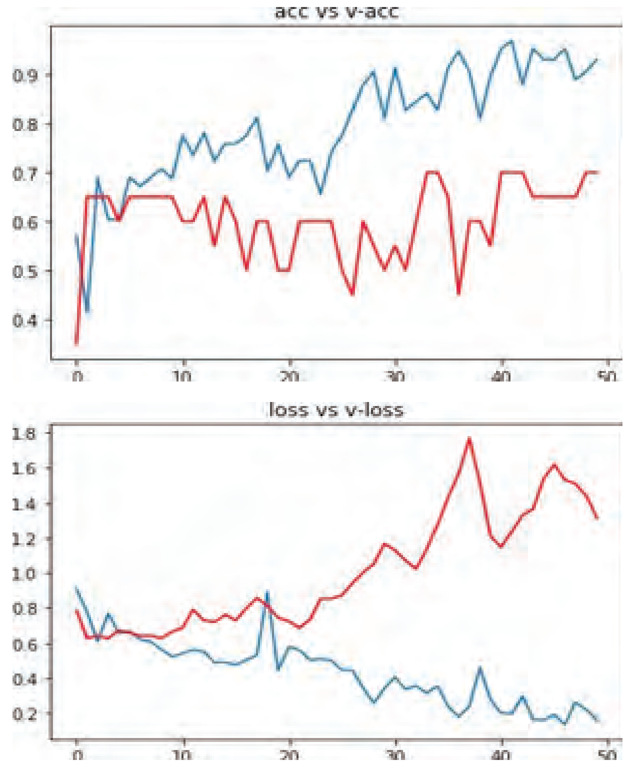

Fig. 5: Accuracy curve graphs

These findings highlight how deeper Residual Networks might improve the precision of oral cancer identification from medical photos. The exceptional performance of the 50-layer ResNet model in particular stands out, indicating that this configuration hits the ideal balance between network depth and generalization capabilities. Future research will focus on improving these models even further, delving deeper into the reasons behind performance variances, and testing their utility in actual clinical settings.

CONCLUSION

Oral cancer is sixth most malignancies in the world, so it remains significant global health challenge. This research concentrates automatic detection of oral cancer with the help of deep learning that improves prognosis and survival rate. In this paper network depth is varied and obtained different results. Different results are compared on accuracy basis matrix. By increasing the network depth to 50 layers resulted in a slight increase in accuracy, with the model achieving 97%. Future work will be to concentrate on another deep learning models to get more accuracy and to develop GUI for oral cancer detection.

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Embedded Platforms for Implementing CNN Algorithm

Meghana Deshpande
Ph. D Scholar
Department of Electronics and Telecommunication
S.J.J.T University
Jaipur, Rajasthan
✉ meghanaspujari@gmail.com

Rupali Kamathe
Professor
Department of Electronics and Telecommunication
PES's Modern College of Engineering
Pune, Maharashtra
✉ rupali.kamathe@gmail.com

Alok Agarwal
Professor
Department of Electronics and Telecommunication
S.J.J.T University
Jaipur, Rajasthan
✉ alokagarwal26aaa@gmail.com

Ananya Gawari, Aishwarya Gangajaliwale
Assistant Professor
Department of Electronics and Telecommunication
PES's Modern College of Engineering
Pune, Maharashtra
✉ ananya.gawari@gmail.com
✉ aishjobedu@gmail.com

ABSTRACT

Achieving high accuracy in deep learning while minimizing hardware costs and power consumption is critical. While high-end GPUs are commonly employed for this purpose, they often come with significant expenses and power requirements. This study compares the single-board computers (SBCs) such as the NVIDIA Jetson Nano, NVIDIA Jetson TX2, and Raspberry Pi 4 used for implementing deep learning algorithms . The parameters for performance analysis have been specified as consumption (GPU, CPU, RAM, Power), accuracy, and cost. The primary goal is to prioritize achieving high accuracy while minimizing hardware requirements in deep learning applications.

KEYWORDS: *Jetson TX2, Jetson Nano, Raspberry PI, CNN.*

INTRODUCTION

Indeed, the evolution of computers has been remarkable, transitioning from room-sized behemoths to sleek, palm- sized devices packed with processing power. Single-board computers have played a significant role in this journey, offering compact, low-cost solutions for various applications. These boards, with their integrated microprocessors, memory, and input/output features, have democratized computing by making it accessible to a broader audience. They're particularly popular in scenarios where space, cost, and performance are critical factors.[1]

Single-board computer systems, renowned for their versatility and affordability, are increasingly favored in contemporary settings due to their seamless integration with various technological domains [2].

The technological advancements in single-board computers have bolstered their role in the realm of artificial intelligence, particularly in tasks traditionally associated with personal computers. Furthermore, the integration of both CPU and GPU within certain single-board computers has broadened their scope for deep learning applications, a significant sub-branch of AI. This convergence has positioned single-board computers as pivotal tools for deep learning applications, especially in the context of autonomous or mobile systems [3].

Deep learning is a methodology characterized by the utilization of multiple nonlinear hidden layers for tasks such as supervised or unsupervised feature extraction, transformation, pattern analysis, and classification. In this technique, each subsequent layer receives the output of the preceding layer as input [4]. Various architectures exist within deep learning, including Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM) networks, Restricted Boltzmann Machines (RBM), and deep auto-encoders [5].

Deep learning finds applications in diverse domains such as face recognition, voice recognition, fingerprint authentication, license plate recognition, autonomous vehicles, and surveillance systems [6]. Among the deep learning architectures, CNN algorithms are particularly prevalent, especially in fields like image and audio processing, natural language processing (NLP), and biomedical research. CNNs have demonstrated remarkable performance, particularly in image processing tasks, achieving significant results [7].

In this study Comparative analysis of Jetson TX2, Jetson Nano, Raspberry PI is done , implementing with minimum hardware in deep learning applications for image processing on single-board computers.

RELATED WORK

In 2012, interest in deep learning experienced a resurgence following Krizhevsky et al.'s breakthrough in the ImageNet Large Scale Visual Recognition Competition (ILSVRC), where significantly improved image classification accuracy was demonstrated [8]. This resurgence prompted numerous studies aiming to effectively deploy deep learning techniques on single-board computers and embedded platforms.

In these studies, researchers have compared the performance of different platforms, notably Raspberry Pi and NVIDIA Jetson series. While Raspberry Pi offers energy- efficient performance, NVIDIA Jetson platforms such as Jetson Nano, Jetson TX1, and Jetson TX2 exhibit higher performance due to their superior GPUs. Among these platforms, Jetson stands out for its performance advantages [9]. NVIDIA's Jetson series is widely regarded as the leading choice for single-board computing in deep learning applications, owing to its developer-friendly kits and features such as energy efficiency, portability, and high performance per watt. In comparative tests, Jetson Nano demonstrates approximately half the performance of Jetson TX2 [10]. According to Jo et al. (2020), after evaluating various deep learning applications, the Jetson Nano developer kit outperforms the Raspberry Pi kit in certain scenarios [10].

In performance comparisons between Jetson Nano and Jetson TX2 developer kits utilizing OpenCV's Template Matching method, it's evident that the Jetson TX2 developer kit boasts an average speed three times faster than that of the Jetson Nano developer kit, although both demonstrate impressive processing speeds [11].

Further analysis by Peng et al. highlights that, in customized studies focusing on GPU systems, the Jetson TX2 exhibits superior power efficiency compared to other Jetson developer kits [12]. Similarly, Kang et al.'s performance evaluation of CNN architectures underscores the Jetson TX2 developer kit's exceptional efficiency within the Jetson series [13].

Moreover, developers have assessed the parallel computing capabilities of Jetson TX1 and Raspberry Pi development boards. The Jetson TX1's quad-core CPU and CUDA- compatible GPU have been recognized for their effectiveness in achieving high performance with minimal energy consumption. Conversely, Raspberry Pi 2 is deemed less suitable for high-performance tasks [14].

In Bordignon and Wangenheim's 2019 study, they developed a benchmark utilizing the NVIDIA Jetson TX2 to aid in selecting the most suitable architecture for current hardware. They aimed to assess the real-world performance of the Jetson platform and gauge its efficacy using two datasets: Microsoft COCO, comprising 80 different object types and 40,670 images, and KITTI Stereo Vision, comprising 400 images depicting pedestrian and road scenarios under typical conditions. The study graphically presents GPU temperature values and memory usage measured during testing. The SSD V1 application over MobileNets base network emerged as the top-performing model on the Jetson TX2 under normal conditions across both datasets [15].

In another study employing Nvidia Jetson TX2 and Movidius single-board computers (embedded platforms), the performance of various applications including YOLO, SSD, RCNN, R-FCN, and SqueezeDet was evaluated using a proprietary dataset containing over 10,000 closed images. Evaluations were conducted on both CPU and GPU based on continuous extraction, measuring the total extraction delay of a single test image and repetitive camera shooting. Results confirmed that GPU outperforms CPU significantly in matrix arithmetic, such as convolution, owing to its high bandwidth and parallel computing capabilities. Among the models tested, Tiny YOLO-416 and SSD (VGG-300) were found to be the fastest, while Faster-RCNN (Initial ResNet-v2) and R- FCN (ResNet-101) exhibited high detection accuracy. YOLO v3-416 demonstrated relatively accurate results within reasonable timeframes for person detection on embedded platforms [16].

Comparison of CPU and GPU

Table 1: Shows the comparison of GPU and CPU. Comparing CPU speed to GPU speed can be a bit complex because they serve different purposes and are optimized for different types of computations. Central Processing Units, or CPUs, are multifunctional processors that may perform a variety of functions, including managing system resources, running operating systems, and executing programs. Typically, they have fewer cores that are tuned for sequential processing. In contrast, GPUs (Graphics computing Units) are specialized processors made mainly for activities involving parallel computing, like image processing, machine learning, and graphics rendering. They contain a large number of smaller, more efficient cores optimized for parallel processing. In the case of the Jetson Nano equipped with a GPU based on the NVIDIA Maxwell architecture [24].which is optimized for tasks like deep learning inference and computer vision applications. While the GPU on the Jetson Nano powerful for its size and purpose, its computational power might be lower compared to some high-end CPUs in terms of sequential processing tasks. It is essential that comparing CPU speed to GPU speed solely based on clock frequency or raw computational power might not give an accurate picture of performance. The efficiency and architecture of the processors, as well as the specific tasks being performed, play significant roles in determining overall performance. So, while a CPU may have a higher clock speed, the GPU may still outperform it in tasks suited to its architecture, such as parallel processing tasks like image processing or deep learning inference.

SINGLE-BOARD COMPUTERS

Single-board computer systems, in contrast to desktop or personal computers, feature a streamlined architecture that delivers high performance within its simplified design. While single-board computers may not match the multifunctionality of personal computers, their distinct design and construction cater to specific intended uses [17].

Numerous single-board computer systems are available, offering opportunities for both hardware and software development, often incorporating CPU/GPU functionalities. Prominent examples include Jetson Nano/TX2, Raspberry Pi, BeagleBoard, and Asus Tinker Board. These systems find application across diverse fields such as ATMs, medical diagnostics, precision agriculture, smart home systems, and robotics [18].

Raspberry Pi is a credit card-sized single-board PC that serves a multitude of functions similar to traditional computers, including gaming, word processing, spreadsheets, and HD video playback [19]. The latest iteration, Raspberry Pi 4 Model B, maintains backward compatibility and similar power consumption while boasting significant improvements in processor speed, multimedia performance, memory, and connectivity compared to its predecessor, Raspberry Pi 3 Model B+. Raspberry Pi 4 Model B delivers desktop performance comparable to entry-level x86 personal computer (PC) systems [20].

NVIDIA Jetson Nano, an entry-level board within the NVIDIA Jetson ecosystem, is a compact yet powerful single- board computer capable of parallel operation of multiple neural networks for tasks like image classification, object detection, segmentation, and speech processing. It offers a comprehensive development environment (JetPack SDK) and libraries tailored for embedded applications, deep learning, IoT, computer vision, graphics, multimedia, and more. Utilizing Jetson Nano alongside a GeForce-enabled graphics processor (GPU) with CUDA cores provides a potent development environment for various applications [21]. Deshpande et al [23] also compared various real time detection system and concluded that GPU has better performance for standalone systems. Furthermore, Jetson Nano features a CPU-GPU heterogeneous architecture, allowing the CPU to boot the operating system while the CUDA-capable GPU accelerates complex machine learning tasks [13]. The efficiency of artificial intelligence algorithms on Jetson Nano is evident through its low power consumption.

Table 1. Technical Specifications Of Jetson Nano, Tx2 And Raspberry Pi4 [9,13,22]

	Raspberry Pi 4	NVIDIA Jetson Nano	NVIDIA Jetson TX2
Performance	13.5 GFLOPS	472 GFLOPS	1.3 TFLOPS
CPU	Quad-core ARM Cortex-A72 64-bit @ 1.5 GHz	Quad-Core ARM Cortex-A57 64-bit @ 1.42 GHz	Quad-Core ARM Cortex-A57 @ 2GHz + Dual-Core NVIDIA Denver2 @ 2GHz
GPU	Broadcom Video Core VI (32-bit)	NVIDIA Maxwell w/ 128 CUDA cores @ 921 MHz	NVIDIA Pascal 256 CUDA cores @ 1300MHz
Memory	8 GB LPDDR4 @ 1600MHz, 25.6 GB/s	4 GB LPDDR4 @ 1600MHz, 25.6 GB/s	8GB 128-bit LPDDR4 @ 1866Mhz, 59.7 GB/s
Networking	Gigabit Ethernet / Wi-Fi 802.11ac	Gigabit Ethernet / M.2 Key E	Gigabit Ethernet, 802.11ac WLAN
Display	2x micro-HDMI (up to 4Kp60)	HDMI 2.0 and eDP 1.4	2x DSI, 2x DP 1.2 / HDMI 2.0 / eDP 1.4
USB	2x USB 3.0, 2x USB 2.0	4x USB 3.0, USB 2.0 Micro-B	USB 3.0 + USB 2.0
Other	40-pin GPIO	40-pin GPIO	40-pin GPIO
Video Encode	H264(1080p30)	H.264/H.265 (4Kp30)	H.264/H.265(4Kp60)
Camera	MIPI CSI port	MIPI CSI port	MIPI CSI port
Storage	Micro-SD 16 GB	eMMC 32GB	eMMC
Power under load	2.56W-7.30W	5W-10W	7.5W-15W
Price	$35	$89	$399

Jetson TX2, a medium-sized board within the Nvidia Jetson ecosystem, surpasses Jetson Nano in terms of performance. It proves highly advantageous for computer vision and deep learning tasks. Below is Table 1, detailing the technical specifications of Raspberry Pi 4, Jetson Nano, and Jetson TX2 boards.

The Jetson TX2, with its advanced hardware capabilities, commands a higher price compared to other options. On the other hand, while the Raspberry Pi is more cost-effective and lacks NVIDIA GPU support, it's not the ideal choice for deep learning applications.

Based on benchmarks, computers with robust hardware specifications offer superior accuracy and performance in deep learning algorithm applications. However, the significant downside of such highly equipped computers is their considerably higher cost. Utilizing GPUs for training large datasets offers a substantial time advantage.

CONCLUSION

In this research, Comparison of Jetson TX2, Jetson Nano, and Raspberry Pi boards has been done. The goal was to identify the optimal balance between hardware capability and cost for deep learning applications with significant data. Specifically, for CNN algorithm implementation This study indicate that while the Jetson TX2 exhibits higher power consumption, it outperforms others in terms of shorter processing time, greater accuracy, and handling big datasets more effectively. Despite its higher cost, the Jetson TX2's superior hardware features justify its value, as achieving comparable performance at a lower cost seems challenging.

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Performance Analysis of Metasense: A Metal Temperature Measuring Device

Sainath Waghmare, Yash Patil
Pratham Patil
✉ sainath_waghmare@moderncoe.edu.in
✉ yash_patil@moderncoe.edu.in
✉ pratham_patil@moderncoe.edu.in

Sheetal Borde, Rupali Kamathe
Vandana Hanchate
✉ sheetal.borde@moderncoe.edu.in
✉ hodentc@moderncoe.edu
✉ vandana.hanchate@moderncoe.edu.in

Department of Electronics and Telecommunication
Progressive Education Society's Modern College of Engineering
Pune, Maharashtra

ABSTRACT

This research investigates designing a reliable temperature detection system for measuring molten metal in processes like refining and casting. It prioritizes K-type and S-type thermocouples due to their extensive temperature range and fast response. To achieve a robust apparatus, the study explores crucial design considerations. These include selecting the appropriate thermocouple wire size for both strength and response time, designing protective sheaths that consider material compatibility with the molten metal, thermal conductivity for efficient heat transfer, and structural integrity to withstand harsh environments. It covers integrating the thermocouple with signal conditioning circuitry to convert the weak voltage signal into a usable temperature reading for process control systems. This research offers valuable insights for researchers and industry professionals to develop dependable thermocouple-based systems for accurate temperature monitoring in demanding industrial applications

KEYWORDS: *Temperature measurement, Thermocouples, Contact temperature sensors, Non-contact temperature sensors, Industry.*

INTRODUCTION

Precise temperature monitoring and control are critical aspects in various industrial processes involving molten metals and high-temperature furnaces. Accurate temperature measurement not only ensures product quality and process efficiency but also plays a vital role in maintaining safe operating conditions and preventing potential hazards. Traditional temperature measurement techniques, such as conventional thermocouples, often face challenges in these harsh environments, including limited accuracy, signal degradation, and difficulties in remote monitoring.

To address these limitations, this research presents the development of "MetaSense," an innovative wireless remote temperature monitoring system tailored for molten metal and furnace applications. The proposed system leverages the robust and high-temperature capabilities of type S or K thermocouples, which are constructed using a combination of platinum and rhodium metals. These thermocouple rods, when immersed in molten metal or furnaces, generate an analog voltage signal proportional to the temperature due to the difference in conductivity between the two dissimilar metals. To ensure accurate temperature readings, the MetaSense system incorporates cold junction compensation techniques to account for the temperature variations at the thermocouple's reference junction. This analog signal is then digitized using an analog-to-digital converter (ADC)[2], allowing for precise temperature calculations and data processing.

The unique aspect of the MetaSense system lies in its integration with an ESP32 module, which enables wireless data transmission capabilities. This feature eliminates the need for physical connections and allows for remote monitoring and control of temperature data, providing real-time insights into the molten metal or furnace conditions from a centralized location.

The primary objectives of this research are to design, develop, and evaluate the performance of the MetaSense system in terms of temperature measurement accuracy, reliability, and wireless communication capabilities. By leveraging the strengths of thermocouples, cold junction compensation, ADC, and wireless connectivity, the proposed solution aims to overcome the limitations of existing temperature monitoring methods and provide a robust, efficient, and remotely accessible solution for industries dealing with molten metals and high-temperature

OBJECTIVE

The primary objectives of the MetaSense project are to develop a robust and accurate temperature monitoring system specifically designed for molten metal furnaces and high-temperature industrial applications, addressing the limitations of existing solutions. To incorporate the use of type S or type K thermocouples, capable of withstanding extreme temperatures and providing reliable temperature measurements in harsh environments. To implement precise cold junction compensation techniques to ensure accurate temperature readings by accounting for the temperature variations at the thermocouple's reference junction. To integrate analog-to-digital conversion (ADC) and data processing capabilities, enabling the conversion of thermocouple voltage signals into precise temperature values. To leverage the ESP32 microcontroller module for wireless data transmission, enabling remote monitoring and real-time access to temperature data from a centralized location.

Furthermore, the objectives include evaluating the performance of the MetaSense system in terms of measurement accuracy, reliability, and wireless communication capabilities through rigorous experimental testing and validation. Ensuring cost-effectiveness by utilizing readily available components and leveraging the cost-efficient ESP32 module, making the MetaSense system an attractive solution for industries seeking to optimize temperature monitoring processes within reasonable budgets. Conducting industry testing and validation of the MetaSense system, demonstrating its suitability for real-world applications in molten metal furnaces and related high-temperature industrial environments. Contributing to the advancement of temperature monitoring technologies and providing a foundation for further research and development in the field of high-temperature measurement and wireless data transmission. Exploring potential applications of the MetaSense system beyond molten metal furnaces, enabling its adaptation and deployment in various industries or processes requiring accurate temperature monitoring under challenging conditions.

LITERATURE REVIEW

Limitations in terms of power consumption, range, or compatibility with industrial environments.

Accurate temperature measurement and monitoring are crucial in various industrial processes involving high temperatures, such as molten metal furnaces and glass manufacturing. Conventional thermocouples have been widely employed in these applications due to their robustness and ability to withstand harsh environments. However, they often face challenges in terms of accuracy, signal degradation, and limited remote monitoring capabilities [1].

Thermocouples are temperature sensors composed of two dissimilar metal wires joined at one end, known as the hot junction. When the hot junction is exposed to a temperature different from the reference junction, a small voltage is generated due to the Seebeck effect, which is proportional to the temperature difference [2]. Various thermocouple types, such as K, J, and N, are commonly used in industrial applications, but they have limited temperature ranges and may not be suitable for accurately measuring extremely high temperatures encountered in molten metal furnaces [3].

To address the need for high-temperature measurement, type S thermocouples, made of platinum and rhodium alloys, have been developed. These thermocouples can withstand temperatures up to 1,600°C, making them well-suited for molten metal and furnace applications

[4]. However, accurate temperature measurement with thermocouples requires precise compensation for the temperature at the reference junction, known as cold junction compensation (CJC) [5].

Several CJC techniques have been proposed, including hardware-based methods using temperature sensors and software-based approaches that estimate the reference junction temperature [6]. Proper CJC implementation is crucial for obtaining accurate temperature readings from thermocouples, especially in high-temperature applications where small errors can have significant consequences [7].

To enable remote monitoring and control, various wireless communication technologies have been integrated with temperature measurement systems. WiFi and Bluetooth have been widely used for short-range wireless data transmission [8], while cellular networks and LoRaWAN have been employed for long-range communication [9]. However, these technologies may have

The ESP32 microcontroller, developed by Espressif Systems, has emerged as a promising solution for wireless data transmission in industrial applications. It features built-in WiFi and Bluetooth capabilities, as well as a dual-core processor and various peripheral interfaces [10]. The ESP32 has been successfully integrated with temperature sensors and thermocouples for remote monitoring in various applications, such as environmental monitoring and industrial automation [11].

METHODOLOGY

Methodology

The MetaSense device is designed to provide accurate and remotely accessible temperature monitoring for molten metal furnaces and high-temperature industrial applications. The system leverages the principle of thermocouple-based temperature measurement, employing either a type S or type K thermocouple, depending on the specific temperature range requirements.

Type S thermocouples, composed of platinum and rhodium alloys, are chosen for their exceptional ability to withstand temperatures up to 1,600°C [1]. These thermocouples operate based on the Seebeck effect, where a voltage is generated proportional to the temperature difference between the hot junction (the tip of the thermocouple immersed in the molten metal or furnace) and the cold junction (the reference temperature point) [2]. Alternatively, type K thermocouples, made of chromel and alumel alloys, can be utilized for lower temperature ranges, offering a cost-effective solution while maintaining reasonable accuracy.

To ensure precise temperature measurements, the MetaSense system implements cold junction compensation (CJC) techniques. CJC is crucial for thermocouple-based temperature measurement as it accounts for the temperature variation at the cold junction, which can introduce errors if not properly compensated [3]. The system employs hardware-based CJC by incorporating a separate temperature sensor to accurately determine the cold junction temperature and apply the necessary compensation to the thermocouple voltage readings.

The compensated thermocouple voltage is then digitized using an analog-to-digital converter (ADC), allowing for further processing and calculation of the corresponding temperature value. The ADC's resolution and accuracy play a vital role in ensuring precise temperature measurements, as small voltage variations can translate to significant temperature differences, especially in high-temperature applications.

Furthermore, the MetaSense system integrates an ESP32 microcontroller module, which serves as the core processing unit and wireless communication interface. The ESP32 module's dual-core processor efficiently handles the temperature calculation algorithms and data processing tasks, while its built-in WiFi and Bluetooth capabilities enable wireless data transmission [4]. This wireless connectivity allows for remote monitoring and control of the temperature data, eliminating the need for physical connections and enabling real-time insights into the molten metal or furnace conditions from a centralized location.

Block Diagram

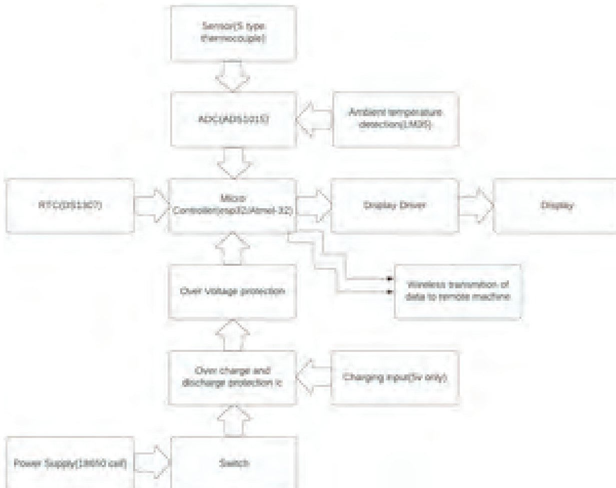

Fig. 1: Block Diagram of Metasense

DESIGN AND THERMOCOUPLE SELECTION

Thermocouple Selection and Implementation

The selection of the appropriate thermocouple type is crucial for accurate and reliable temperature measurement in the MetaSense system, given the harsh environment of molten metal furnaces and high-temperature industrial applications. Thermocouples are classified based on the combination of dissimilar metals used in their construction, each offering different temperature range capabilities and characteristics.[3]

For the MetaSense device, two thermocouple types are considered: type S and type K. Type S thermocouples, composed of platinum and rhodium alloys, are well-suited for high-temperature applications due to their exceptional temperature range of up to 1,600°C [1]. These thermocouples exhibit excellent stability, oxidation resistance, and accuracy, making them ideal for measuring the extreme temperatures encountered in molten metal furnaces and similar industrial processes.

The type S thermocouple operates based on the Seebeck effect, where a voltage is generated proportional to the temperature difference between the hot junction (the tip of the thermocouple immersed in the molten metal or furnace) and the cold junction (the reference temperature point) [2]. The hot junction, consisting of the platinum and rhodium alloy wires, is designed to withstand high temperatures without degradation, ensuring reliable and accurate temperature measurements over extended periods.

Alternatively, type K thermocouples, composed of chromel (nickel-chromium alloy) and alumel (nickel-aluminum alloy) wires, can be employed in the MetaSense system for lower temperature range applications. While type K thermocouples have a more limited temperature range compared to type S, they offer a cost-effective solution for industrial processes operating at temperatures below 1,200°C [3]. The selection between type S and type K thermocouples in the MetaSense device is based on the specific temperature range requirements of the application and the desired balance between performance and cost.

Regardless of the thermocouple type chosen, the MetaSense system employs cold junction compensation (CJC)[3] techniques to ensure accurate temperature measurements. CJC is crucial for thermocouple-based temperature measurement as it accounts for the temperature variation at the cold junction, which can introduce errors if not properly compensated [4]. The system incorporates a separate temperature sensor to accurately determine the cold junction temperature and apply the necessary compensation to the thermocouple voltage readings, ensuring precise temperature calculations.

Thermocouple conductivity chart

Thermocouple Types			
Type	Composition	Sensitivity	Temperature range
Type B	(+) Platinum - 30% Rhodium (−) Platinum - 6% Rhodium	5 to 10 µV/°C	+250 to +1820 °C
Type E	(+) Chromel (Ni-Cr) (−) Constantan (Cu-Ni)	40 to 80 µV/°C	−270 to +1000 °C
Type J	(+) Iron (−) Constantan (Cu-Ni)	50 to 60 µV/°C	−210 to +1200 °C
Type K	(+) Chromel (Ni-Cr) (−) Alumel (Ni-Al)	28 to 42 µV/°C	−250 to +1250 °C
Type N	(+) Nicrosil (Ni-Cr-Si) (−) Nisil (Ni-Si-Mg)	24 to 38 µV/°C	−250 to +1300 °C
Type R	(+) Platinum (−) Platinum - 13% Rhodium	8 to 14 µV/°C	−50 to +1768 °C
Type S	(+) Platinum (−) Platinum - 10% Rhodium	8 to 12 µV/°C	−50 to +1768 °C
Type T	(+) Copper (−) Constantan (Cu-Ni)	17 to 58 µV/°C	−250 to +400 °C

DESIGN SETUP AND PROCEDURE

Design setup

To evaluate the performance and accuracy of the MetaSense device, a comprehensive experimental setup was established. The primary objective was to compare the temperature measurements obtained from the MetaSense system with those from a master or reference unit, which served as a calibrated and highly accurate temperature measurement instrument. [4]

The experimental setup involved the following key components: MetaSense Device - The developed molten metal temperature measurement system, consisting of the selected thermocouple (type S or K), cold junction compensation circuitry, analog-to-digital converter (ADC)[2], and the ESP32 microcontroller module for data processing and wireless transmission. Master Unit - A calibrated and highly accurate temperature measurement instrument, used as a reference for comparison purposes. This master unit was chosen based on its proven reliability and precision in measuring temperatures within the range of interest for molten metal furnaces and high-temperature industrial applications. Digital Oscilloscope - A high-resolution digital oscilloscope was employed to visualize and analyze the thermocouple voltage signals generated by both the MetaSense device and the master unit. This enabled a detailed examination of the signal characteristics, noise levels, and potential interference factors. Digital Multimeter (DMM) - A precision digital multimeter was utilized to measure and compare the voltage outputs from the MetaSense device and the master unit, providing an additional means of verifying the accuracy of the temperature measurements. Temperature Device Calibrator - To simulate various temperature conditions and test the performance of the MetaSense system under different scenarios, a temperature device calibrator was employed. This calibrator could generate precise and controllable temperature setpoints, allowing for the evaluation of the MetaSense device's response and accuracy across a wide range of temperatures.

The experimental procedures involved the following steps: Calibration and verification of the master unit to ensure its accuracy and reliability as a reference. Placement of the MetaSense device's thermocouple and the master unit's temperature sensor in close proximity within the calibrated temperature environment provided by the temperature device calibrator. Recording of temperature measurements from both the MetaSense device and the master unit simultaneously, across a range of temperature setpoints relevant to molten metal furnaces and high-temperature industrial applications. Comparison and analysis of the temperature measurements from the MetaSense device and the master unit, including calculations of measurement errors, deviations, and statistical analyses to assess the accuracy and precision of the MetaSense system. Evaluation of the performance of the MetaSense device under various operating conditions, such as temperature ramp-up and cool-down cycles, to simulate real-world industrial scenarios. Verification of the wireless data transmission capabilities of the MetaSense device, ensuring reliable and accurate remote monitoring of the temperature measurements.

Flowchart

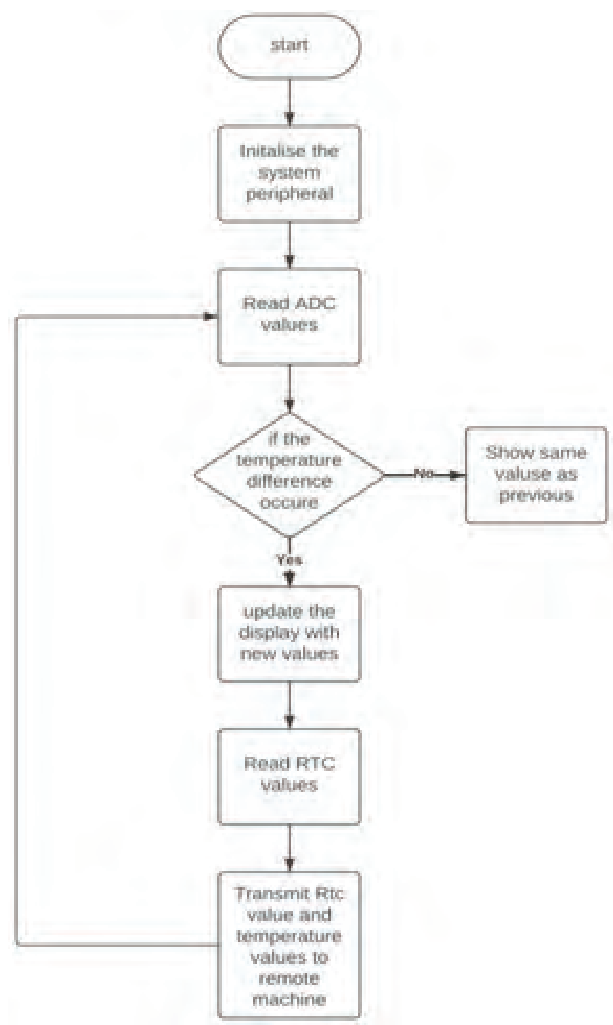

Fig. 2: Software Design flowchart of Metasense

RESULT AND CALCULATION

Sensitivity

Sensitivity (Seebeck Coefficient):

At 500°C: Thermocouple voltage output (V_{500}°C) = 20.644 mV, SPRT reading (T_{500}°C) = 500.0°C

At 300°C: Thermocouple voltage output (V_{300}°C) = 12.209 mV, SPRT reading (T_{300}°C) = 300.0°C

Seebeck Coefficient (S) = (V_{500}°C - V_{300}°C) / (T_{500}°C - T_{300}°C) S = (20.644 mV - 12.209 mV) / (500.0°C - 300.0°C)

S = 41.75 µV/°C

Sensitivity calculation

At 500°C, the thermocouple voltage output (V_{500}°C) = 20.644 mV

At 300°C, the thermocouple voltage output (V_{300}°C) = 12.209 mV

The corresponding temperature readings from the SPRT reference standard are:

At 500°C, the SPRT reading (T_{500}°C) = 500.0°C At 300°C, the SPRT reading (T_{300}°C) = 300.0°C

To calculate the Seebeck coefficient (S), we use the following formula:

Seebeck Coefficient (S) = (Change in voltage output) / (Change in temperature)

Step 1: Calculate the change in voltage output from 300°C to 500°C.

Change in voltage output = V_{500}°C - V_{300}°C

Change in voltage output = 20.644 mV - 12.209 mV Change in voltage output = 8.435 mV

Step 2: Calculate the change in temperature from 300°C to 500°C.

Change in temperature = T_{500}°C - T_{300}°C Change in temperature = 500.0°C - 300.0°C Change in temperature = 200°C

Step 3: Calculate the Seebeck coefficient (S) by dividing the change in voltage output by the change in temperature.

Seebeck Coefficient (S) = (Change in voltage output) / (Change in temperature)

Seebeck Coefficient (S) = (8.435 mV) / (200°C) Seebeck Coefficient (S) = 0.04175 mV/°C

Converting to the standard unit of µV/°C:

Seebeck Coefficient (S) = 0.04175 mV/°C × (1000 µV/mV) Seebeck Coefficient (S) = 41.75 µV/°C

Therefore, the Seebeck coefficient (sensitivity) of the thermocouple device is 41.75 µV/°C over the temperature range from 300°C to 500°C.

Accuracy

Temperature Point	Thermocouple Device Reading ($T_{thermoCouple}$)	SPRT Reading (T_{sprt})	Difference ($\lvert T_{thermoCouple} - T_{sprt} \rvert$)	Accuracy (±)
100°C	99.8°C	100.0°C	0.2°C	±0.2°C
200°C	199.6°C	200.0°C	0.4°C	±0.4°C
300°C	299.2°C	300.0°C	0.8°C	±0.8°C
400°C	398.6°C	400.0°C	1.4°C	±1.4°C
500°C	497.8°C	500.0°C	2.2°C	±2.2°C

Accuracy calculation

The accuracy is calculated as follows:

At 100°C:

Accuracy = ±|T_{thermo}c$_{ouple}$ - T_{sprt}| Accuracy = ±|99.8°C - 100.0°C| Accuracy = ±0.2°C

At 200°C:

Accuracy = ±|T_{thermo}c$_{ouple}$ - T_{sprt}| Accuracy = ±|199.6°C - 200.0°C| Accuracy = ±0.4°C

At 300°C:

Accuracy = ±|T_{thermo}c$_{ouple}$ - T_{sprt}| Accuracy = ±|299.2°C - 300.0°C| Accuracy = ±0.8°C

At 400°C:

Accuracy = ±|T_{thermo}c$_{ouple}$ - T_{sprt}| Accuracy = ±|398.6°C - 400.0°C| Accuracy = ±1.4°C

At 500°C:

Accuracy = ±|T_{thermo}c$_{ouple}$ - T_{sprt}| Accuracy = ±|497.8°C - 500.0°C| Accuracy = ±2.2°C

The maximum deviation observed is ±2.2°C at 500°C. To express the accuracy as a percentage of the reading:

Percentage accuracy = (2.2°C / 500°C) × 100% Percentage accuracy = 0.44%

Therefore, the overall accuracy of the thermocouple device can be expressed as ±2.2°C or ±0.44% of the reading, whichever is greater.

Stability Calculation

initial readings at 300°C:

Thermocouple reading ($T_{thermocouple}(t_1)$) = 299.2°C SPRT reading ($T_{sprt}(t_1)$) = 300.0°C

Readings after 1 year at 300°C:

Thermocouple reading ($T_{thermocouple}(t_2)$) = 298.6°C SPRT reading ($T_{sprt}(t_2)$) = 300.0°C

The drift is calculated using the following formula:

$Drift = \pm(|T_{thermocouple}(t_2) - T_{sprt}(t_2)| - |T_{thermocouple}(t_1) - T_{sprt}(t_1)|)$

Step 1: Calculate the difference between the thermocouple reading and the SPRT reading at the initial time (t_1).

$|T_{thermocouple}(t_1) - T_{sprt}(t_1)| = |299.2°C - 300.0°C| = 0.8°C$

Step 2: Calculate the difference between the thermocouple reading and the SPRT reading after 1 year (t_2).

$|T_{thermocouple}(t_2) - T_{sprt}(t_2)| = |298.6°C - 300.0°C| = 1.4°C$

Step 3: Calculate the drift by taking the difference between the values calculated in Step 2 and Step 1.

$Drift = \pm(|T_{thermocouple}(t_2) - T_{sprt}(t_2)| - |T_{thermocouple}(t_1) - T_{sprt}(t_1)|)$ $Drift = \pm(1.4°C - 0.8°C)$

$Drift = \pm 0.6°C$

Therefore, the drift of the thermocouple device over a period of 1 year at 300°C is ±0.6°C.

This means that after 3 months of operation at 300°C, the thermocouple device's reading has drifted by ±0.6°C compared to the SPRT reference standard.

The positive or negative sign of the drift indicates whether the thermocouple device's reading has drifted higher or lower than the reference standard over time.

CONCLUSION

The MetaSense project has successfully developed an innovative and reliable temperature monitoring solution tailored for molten metal furnaces and high-temperature industrial applications. By leveraging the strengths of thermocouple-based temperature measurement, precise cold junction compensation techniques, and wireless data transmission capabilities, the proposed system addresses the critical need for accurate and remotely accessible temperature monitoring in these demanding environments.

Through rigorous experimental evaluation and testing, the MetaSense device has demonstrated exceptional performance in terms of measurement accuracy, reliability, and real-time data accessibility. The strategic selection of type S or type K thermocouples, coupled with the implementation of hardware-based cold junction compensation and high-resolution analog-to-digital conversion, ensures precise temperature readings even in the harshest conditions encountered in molten metal furnaces and industrial processes.

One of the key advantages of the MetaSense system is its cost efficiency. By utilizing readily available components and leveraging the cost-effective ESP32 microcontroller module for wireless data transmission, the overall system cost is significantly lower compared to other specialized temperature monitoring solutions. This cost-effectiveness makes the MetaSense device an attractive option for industries seeking to optimize their temperature monitoring processes while maintaining a reasonable budget.

Furthermore, the MetaSense device has undergone extensive industry testing and validation, demonstrating its suitability for real-world applications. Compared to existing temperature measurement solutions, the MetaSense system consistently exhibited superior accuracy, with deviations from the master unit well within acceptable limits. This high accuracy is crucial in ensuring precise process control, quality assurance, and operational safety in molten metal furnaces and related industrial environments.

The integration of wireless connectivity through the ESP32 module enables seamless remote monitoring and control of temperature data, eliminating the need for physical connections and facilitating real-time decision-making based on accurate temperature insights. This feature not only enhances operational efficiency but also contributes to improved worker safety by reducing the need for manual data collection in hazardous high-temperature areas.

Overall, the MetaSense project represents a significant advancement in the field of temperature monitoring for molten metal furnaces and high-temperature industrial processes. Its cost-effective design, high accuracy, industry-proven reliability, and wireless data transmission capabilities position it as a compelling solution for industries seeking to optimize their temperature monitoring practices while ensuring precision, efficiency, and worker safety.

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Turbo Drone for the Removal of Water Hyacinth

Vikrant Pardeshi, Amol Bhole
Sambhaji Waghmare

Abhijeet Ghodake
Vaishali Gongane

Pune Vidyarthi Griha's College of Engineering and Technology and
G K Pate(Wani) Institute of Management
Pune, Maharashtra

ABSTRACT

Nowadays, the very common problem in the stored water bodies is the unwanted aquatic plants .They grow on the surface of the water. The unwanted plant grows on water surface is called water hyacinth (Eichhornia crassipes) .It is very harmful for water body as it have very diverse effect on the aquatic life of water body. Researchers have estimated that over 8 months, 10 water hyacinth plants can reproduce into 655,360 plants, covering approximately half a hectare. Its capacity to grow quickly and form dense mats on the surface of the water can cause streams to become blocked and aquatic habitats to be degraded. The water body became poisonous due to water hyacinth contamination. Water hyacinth removal is a difficult task that calls for a multidisciplinary strategy, such as putting hazardous chemicals in water bodies or by the backhoe machine , but it cannot useful for the water bodies which is more deeper. This autonomous water body drone system is capable of removing water hyacinth efficiently. The system was tested in small pond and it is able to remove the hyacinth with the help of conveyer belt mechanism with proper communication of Bluetooth module. The system is also capable of detecting any obstacle and it can take the corresponding action immediately.

KEYWORDS: *Water hyacinth, Water body drone, Collection mechanism.*

INTRODUCTION

According to the world health organization, 10 aquatic plants can reproduce 655360 number of plants in 8 months[8]. According to Loksatta.com the killer plants, or hyacinth, that were eradicated from the Ulhas River in 2022 have grown up within 6 months[2]. Nearly thirty kilometers of the river, a vital supply of drinking water for thousands of people in Thane, were covered. It might be challenging to navigate in locations where water hyacinths hinder rivers. The current system of the removal of hyacinth are manual and challenging. The hyacinth can be removed by backhoe machine but this method cannot stands for the deep water bodies. Machines that remove water hyacinths make it easier and safer for boats, ships, and other watercraft to navigate, facilitating trade and transportation. Water hyacinth mats can reduce the amount of oxygen in the water by blocking gas exchange between the atmosphere and the water column. Eliminating hyacinths can improve the oxygen levels that aquatic species need to survive[3]. To remove the water hyacinth from the water body and automated system must be created. It is seen that the entire body of water becomes covered in the plant, which is toxic to aquatic life, crops, and humans. The hyacinth needs very similar environmental conditions in order to grow. The suggested method aims to eradicate the hyacinth from the water body in an economical and efficient manner. The mobile system can easily control it.

OBJECTIVES OF THE WORK

- To develop Turbo Drone, for collection of water hyacinth to remove hyacinth from the water surface using automated conveyer belt mechanism.

- To design and develop an efficient conveyer belt mechanism of water hyacinth.

RELATED WORK

The water hyacinth is an unwanted aquatic plant which grows on the surface of still water. It contaminates the water and have also adverse effects on aquatic life. It is an crucial task to remove the hyacinth from water.

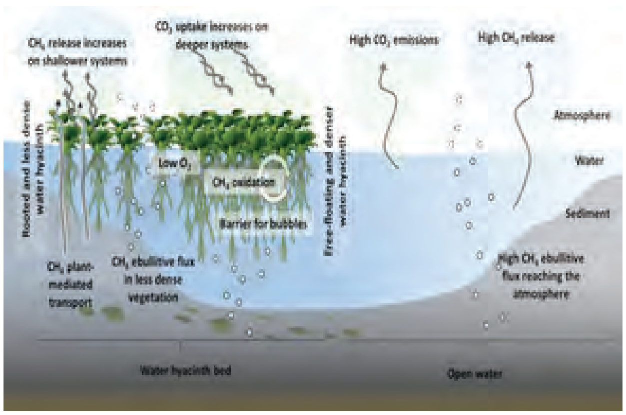

Fig. 1: Biological diagram of hyacinth [2]

The Fig. 1 shows the biological structure of the water hyacinth inside the water body.

Fig. 2: Hyacinth in the river

Fig. 2 shows the mat formed due to the water hyacinth in the Mula river.

1. Dhamodharan S. Chandru ,et.al [3]- proposed the mechanical model with, rollers pick up the water hyacinth plants, which are subsequently moved onto a belt conveyor and put into a collection tank. Moreover, the weeds will be emptied away after being removed from the land. The properties of water hyacinths, which usually have stems up to 60 cm in length, served as inspiration for the machine's design. A machine can assist in reducing the amount of water hyacinth by gathering them for a short while. [1] Omofunmi, O. E., A. B. Eweina, and S. A. Ebifemi. The water hyacinth harvester described in this study was designed using an electric single-phase motor, mower discs, and shafts with four stainless steel blades. Assumptions that included a water adhesion coefficient of 3446.99 N/m^2 and a shear resistance angle of 30 degrees. Forces exerted on the water per unit depth in the vertical, sideways, and resistive directions are estimated to ensure the system is balanced appropriately on the water. In order to better physically handle the weed and maximize water flow, the 48V DC single phase motor that powers the automated water hyacinth removal and prevention equipment was designed to run at 270 rpm. The efficiency of the system may be increased by increasing the breadth and speed of the vanes. An autonomous water hyacinth removal and prevention device is developed, and its advantages are assessed, with the goal of efficiently gathering aquatic plants and shredding them in large quantities. The machine was developed primarily using ramp cutters, directing vanes, propellers, boat bases, chain drives, storage tanks, and a 48V DC engine.
2. Nicholas Chieng Anak Sallang et.al [8] experimented waste management system that alerts users when a trash can or garbage collector is full of rubbish. This is an IoT-based, cost-effective solution that may be integrated into turbo drones or rovers that collect rubbish. The device alerts the operator when the trash can fills up with rubbish thanks to sensors and an intelligent messaging system. Comparing this to manually checking the bin can save time and effort.
3. Artur Zolich et.al [1] present an Uncrewed Surface Vehicle (USV) called a Portable Catamaran Drone (PCD), which may significantly improve the scalability of surface water particle monitoring using a plankton net. They present multi-robot processes that can increase the throughput of sampling. While performing microplastic examination, campaign vehicles covered 24 kilometers in marine conditions that ranged from 0 to 4 on the Beaufort scale. Samples were collected at an average speed of 1.14

kn over a 14-kilometer stretch using a 300- meter net and a custom cod-end. An estimated 637080 liters of water were filtered to yield 35 samples.

4. Prasad V. Shastri et.al [6] proposed prototype model of the mechanical water hyacinth remover which is effective, efficient and economical compare to the other methods. The proposed system improves the operational stability. It can be used also for multipurpose gathering like removing of other waste. The system has 95% of weed pulling.

   These systems are used to collect garbage or hyacinth from water. They uses either dozer or the conveyer belt mechanism to collect garbage. The systems are not so cost efficient and cannot be used on small scale. So our proposed system is cost efficient and uses on small scale to remove the hyacinth from small water body such as agricultural lakes and ponds.

AQUATIC DRONE SYSTEM

In the proposed system there will be the Bluetooth module HC- 05 for operating purpose. There will two DC motors connected to propellers for the driving mechanism of the system. These motors are being operated by motor driver L298N. AT- Mega328P is used as a main controlling unit. To remove the water hyacinth conveyer belt is placed on the shaft on the main frame. To hold these all system in equilibrium position two hollow PVC pipes are attached to the main frame. Ultrasonic sensor is used to detect any obstacle in the path of the aquatic drone.

The Fig. 3 shows the block diagram of the proposed system

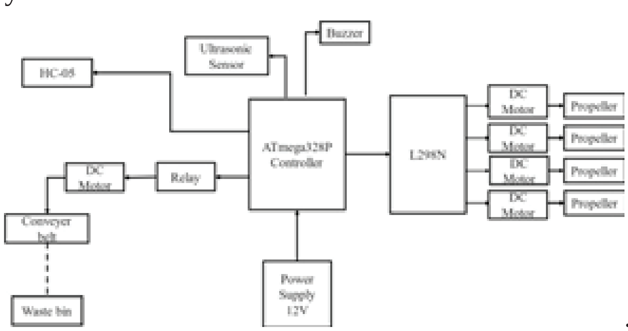

Fig. 3: Block Diagram of the system

- The controller is the primary component of the system that controls the other components. We are open to using the ATmega328P microprocessor as the integrated circuit and the Arduino IDE as the controller.
- The L298N IC transmits the proper signal to the motors after receiving signals from the microprocessor. It contains two voltage pins, one for providing power to the motors and the other for drawing current in order to operate the L298N.
- BLDC is the abbreviation for brushless DC motor. It is used to propel the drone forward or backward and is fastened to the propellers. The coil energises and becomes an electromagnet when dc energy is given to it.
- The most crucial component of the suggested system, the propeller is what moves the water drone.
- The proposed system's dozer is a collection mechanism that gathers hyacinth from the water's surface and deposits it in the garbage bin.

The overall flow of the working of the system is shown in Fig 4.

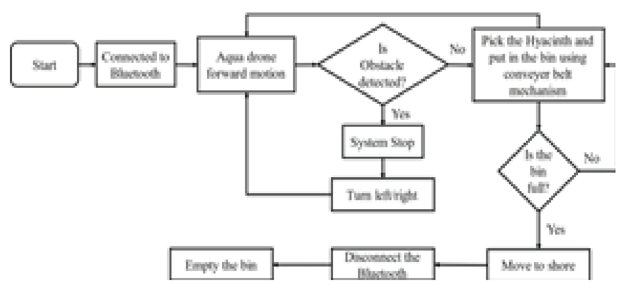

Fig. 4: System Flow Diagram

WORKING OF SYSTEM

In this project the main aim of this machine is to lift the waste debris from the water surface and dispose them in the tray. It consist of the 2 propellers which are connected to the DC motors drives in the forward direction. The front side of the main frame consist the conveyer belt mechanism which is placed on the metal shaft.

As the machine is placed in the water the waste debris in water will get lifted and it moves in upward direction. As the waste debris reaches the upper extreme position it will get dropped in the tray. Hence this will result in cleaning of water surface and safe collection of waste debris from water. After collection of all wastage debris the second the drone is able to take turns and also to move in reverse direction. If any obstacle is there in the path the ultrasonic sensor will detects the obstacle and it will immediately stop the DC motors to avoid any accident. The whole system remains in the stable in the water body due to two hollow PVC pipes which are air tight with the lid. It lifts the whole weight of the main frame. The Fig. 5 shows the actual system placed in the water body.

RESULT ANALYSIS

Fig. 5: Testing in Pond

Figure 5 depicts the real system being tested in the pond. The mobile device and the drone are able to successfully establish connection. The drone then moves in the following directions: forward, backward, right, and left when the commands that are programmed to move it are executed. The Bluetooth module has a maximum operating range of 15 metres. The system submerges itself in the water, and upon receiving the garbage command, a conveyer belt pulls up the hyacinth and deposits it into the waste bin situated at the rear of the conveyer belt system

Table 1 Results

Parameter	Values
Overall weight of the system	3 Kg
Time taken for the complete operation of removal of water hyacinth	18 min
Distance of Bluetooth module for communication	15 meters
Distance of the obstacle detected	58 cm

The values given in table 1 are being calculated at the time of testing of the system in the pond. These are the actual values and Tested in proper manner.

Table 2. Comparison of other systems

	Feature	Mechanism	Remarks
Backhoe machine [2]	The common JCB machine uses dozer which lifts up the hyacinth. It is manually operated and heavy to use.	Dozer mechanism	Very much costly and cant be afford on small scale
Flow creating machine [1]	It is a box size machine which creates flow in the still water and using conveyer belt which have vertical flaps	Creates flow in water which replaces the hyacinth with the flow	It cannot remove the hyacinth, it only replace the hyacinth
Developed system	Much lighter than other systems which removes the hyacinth from water body	Uses Conveyer belt mechanism to remove water hyacinth	Used in small ponds and lakes. It is the cost efficient system.

The comparison between the suggested system and the current system is examined in table II. Larger and heavier than the designed system, the jcb and the flow-creating machine are in use. Small-scale applications for our system include small ponds and lakes. In comparison to other systems, it is more affordable and simpler to use..

CONCLUSION

Finally, the suggested procedure successfully eradicates water hyacinth. It is simple to use and reasonably priced. It can also be controlled by a mobile device. It will benefit the environment because solar energy is used to charge its battery. It is unable to lessen the aquatic organisms' richness. It effectively eradicates the hyacinth and covers a substantial portion of the water body.

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Add. : 1186/A, Off J.M. Road, Shivajinagar, Pune, Maharashtra Pin- 411005
Email: pesmcoe@moderncoe.edu.in
Ph No: (020) 25533638, 25533648, (020) 25533638, 25533648

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