VOLUME 47 • SPECIAL ISSUE • NO. 2 • OCTOBER 2024

ISSN 0971-3034

THE INDIAN JOURNAL OF TECHNICAL EDUCATION

Published by

INDIAN SOCIETY FOR TECHNICAL EDUCATION

Near Katwaria Sarai, Shaheed Jeet Singh Marg,

New Delhi - 110 016

INDIAN JOURNAL OF TECHNICAL EDUCATION

Volume 47 • Special Issue • No. 2 • October 2024

Indexed in the UGC-Care Journal list

INDIAN JOURNAL OF TECHNICAL EDUCATION

Published by
INDIAN SOCIETY FOR TECHNICAL EDUCATION
Near Katwaria Sarai, Shaheed Jeet Singh Marg
New Delhi - 110 016

Editorial

Generative AI: Allan Turing introduced the concept of "intelligent machinery" at the early years of the 20th century. Furthermore, through a number of groundbreaking discoveries in the field of artificial intelligence, scientists confirmed the Turing's breakthrough claim that "can machines think?" Since then, there has been a significant progress in machine learning algorithms. The way that machines comprehended and learned from a huge variety of data became easier with the advent of the perceptron in machine learning. Additionally, the world saw some exceptionally good expert systems being used in a variety of fields that unleashed and utilized artificial intelligence, like Dendral, to comprehend the molecular structure of any unknown organic substance.

Since, the 1990's and 2000's saw the rise in the internet and increase in the compute capacity of IT which made the Machine Learning, Neural Network and Deep Learning models more accessible to create distinctively more smarter and responsive systems.

Generative AI is a subclass of artificial intelligence that involves drawing two objects and using sophisticated computer techniques to develop them imaginatively and display them in a novel way. We can extract valuable information from the training data to generate fresh data using the powerful Gen AI models that researchers have developed. Generative pre-trained transformers, or GPT, were a significant improvement in Gen AI models.

Additional Gen AI models like DALL-E 2, GPT-4, and Copilot are transforming the human workflow. However, there are several urgent facts about this recently discovered process that must be handled carefully as they may reveal the coding's negative aspects. Discussions concerning the output's quality and utility have produced mediocre outcomes. It may also result in the creation of false information, such as realistically phony pictures, videos, or even text, which might be used to sway public opinion.

There are a several advantages and challenges for researchers while utilizing the Generative AI in their code.

New Delhi **Editor**

31st October 2024

Bharati Vidyapeeth's

Institute of Management & Information Technology
Navi-Mumbai-400614
Approved by AICTE New Delhi, Affiliated to University of Mumbai
NBA Accredited till June 2023.

Editorial Board

Contents

Unleashing the Power of AutoML: A Tree-Based Pipeline Optimization(TPOT) for Cluster-Based Predictive Analytics with Reference to the Electrical Vehicle Price Prediction

Manisha Madhukar More
Sr. Asst. Professor
Sri Balaji University
School of Computer Studies
Pune, Maharashtra
✉ Drmanishamore8@gmail.com

ABSTRACT

Our proposed research employs a Tree-Based Pipeline Optimization tool (TPOT) for the predictive modeling of EV prices. Unlike the traditional methods which are reliant on a single regression model or algorithm, TPOT facilitates the simultaneous process of multiple regression algorithms, which provides the diverse scope of machine learning techniques to optimize the pipeline or model performance. Our research illustrates the efficiency of the TPOT in EV price prediction with very superior accuracy as compared with the conventional methods. Our research explores and utilizes K-means clustering to segment our EV dataset and enhance the predictive analytics for price forecasting. The automated approach of the TPOT streamlines model selection and optimization, and also reduces the manual intervention of data analysts. Our research aims to highlight the seamless integration of TPOT with a very popular Streamlit library of Python framework for deployment the model and development of interactive web applications, enabling users to access and utilize models. The rigorous validation methods ensure the reliability of our model, which yields promising results with very minimal mean squared error(MSE). The TPOT, notably producing LinearSVR as the best-performing model with Gradient Boosting Regressor, which achieves significantly lower MSE with approximately 0.2755. The fine-tuning method was employed to reduce the MSE and finally, it was reduced to approximately 6.846-09 which is very close to zero (0), highlighting the effectiveness of TPOT in advancing predictive analytics. This study also aims to underscore the transformative potential of AutoML techniques, particularly TPOT across various regression tasks, which is fostering enhanced decision support systems and data-driven insights in regression analysis.

KEYWORDS: *TTree-Based Pipeline Optimization(TPOT), AutoML,Pipeline, Electric Vehicle(EV), Regression, MSE, Price prediction, LinearSVR, RidgeCV, K-means clustering.*

INTRODUCTION

The advent of automated machine learning(AutoML) techniques has revolutionized inrecent years in the landscape of predictive analytics which offers powerful solutions for simple as well as complex tasks across various domains. The AutoML technique in the realm of electric vehicle (EV) price prediction has garnered significant attention due to its potential to streamline the decision-making processes and drive the innovation of the automotive industry. The research study explores the efficiency of AutoML methodologies with the focus on the Tree-Based Pipeline Optimization Tool(TPOT) for enhancing the predictive modelling of EV price forecasting. The traditional approaches of predictive analytics rely on the manual model selection, manual algorithm selection and hyperparameter setting and it is time-consuming and may be human bias.

The rigorous experimentation an validation the performance of TPOT is meticulously evaluated which

highlights the robustness and reliability in predicting EV prices in minimal error. The compelling evidence of TPOT's effectiveness in predictive modeling our research paper aims to explore and adopt the AutoML technique for predictive analytics and decision support systems in diverse industries. Harnessing the power of AutoML's TPOT technique, the industries can streamline their predictive modeling, which saves time, and make more informed decisions based on accurate predictions. The integration of TPOT with model deployment with Streamlit further harnesses the usability of the model, which enables easy deployment of predictive pre-trained TPOT pipeline for real-world applications.

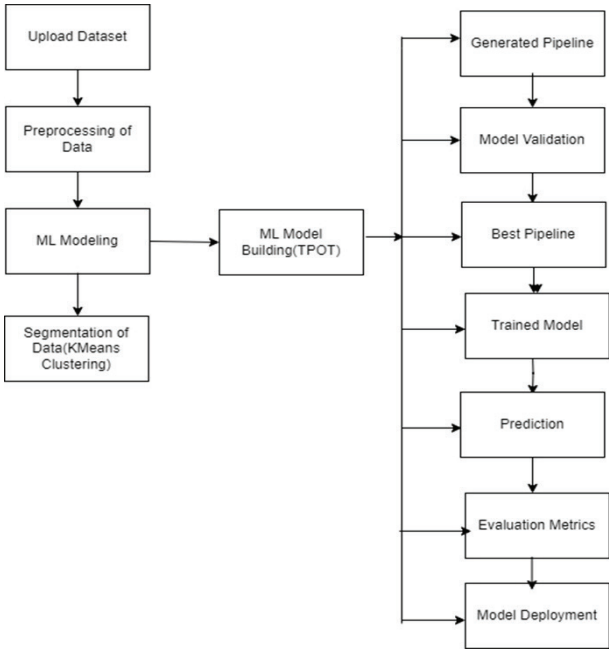


Fig. 1. Detailed View of Electric Vehicle Price Prediction Model

OBJECTIVES OF RESEARCH

To ascertain the research aim, following are objectives of research

1. Perform Clustering analysis of electric vehicle
2. Machine learning model building using Tree-Based Pipeline Optimization(TPOT) for Predictive Analytics
3. Selection of best pipeline model, evaluation and prediction

RELATED WORK

Tianquing Zhang et. al(2022), in their research study for automated machine learning for steel production a case study of TPOT for material mechanical property prediction have employed the TPOT anAutoMLtechnique on their MMPP processes for the real-world dataset. Laurent Parmentier et. al (2019), in their study, used TPOT-SH for faster on their larger size dataset. This has the capability to perform faster on larger data sets. Yang Ruijun et.al (2021), research on industrial control network security based on automatic machine learning, the study reveals that the AutoML TPOT model applied on KDD99 industrial control network data. The model selected the AdaBoost as best model with 92% accuracy rate. Luis Ferrira et.al.(2021), the AutoML technique is used to compared for ML, DL and XGBoost, in their study they have analysed 8 AutoML tools such as AutoKEras, AutoPyTorch, AutoSklearn, AutoGluon, H2O, Miner, TPOT and TransMogrifAI. Applied on 12 openML datasets for Regression, Binary, Evgenii A Neverov et.al. (2023), the AutoML methods in the task of wave data classification, used the AutoML for splving the problems of object classification. Benjamin Evans et. al.(2020), adaptive and near parameter free evolutionary approach of AutoML, due to hyperparameter tuning and automatic model selection the AutoML shows significant results without any human intervention. Katharina Lingelbach et. al.(2021), the exploration of convolutional, automated and deep learning for electrodermal activity based drivers stress recognition research paper, in the research of electrodermal activity for stress level to recognize drivers stress by using AutoML the K-nearest neighbour selected through the TPOT model with best accuracy. Akaramuthalvi J. B et.al.(2021), a paper presented in international conference, the AutoML TPOT model applied on a breast cancer dataset to classify the cancer cells in to cancerous and Non-cancerous. Rahayu Abdul Rahman et.al.(2023), the study conducted for the comparison of automated machine learning using TPOT for the prediction of academic dishonesty the researchers comprehensively compared these tools with accuracy and area under curve on real time cases of two universities in Indonesia. The TPOT and AutoML are powerful and generated the accuracy level between 70-93% of AUC. The validation results of prediction

models, demographic attributes presented more importance than the TBP attributes. Ahmad Alsharef et. al.(2022), the comparative analysis of ML models and AutoML models concludes that the AutoML is best solution for forecasting the real time data or time series data. George Westergaard et. al.(2024), Time Series Forecasting Utilizing Automated Machine Learning(AutoML): A Comparative Study on Diverse Datasets, concludes that AutoML is a powerful tool for large-size data sets such as Bitcoin and Covid-19 datasets.

SIGNIFICANCE OF PROPOSED WORK

The research holds significant promise in revolutionizing the electric vehicle industry. By leveraging advanced modeling, the research aims to provide accurate predictions of EV prices. It has immense importance for both consumers and EV manufacturers alike. For consumers, accurate price predictions empower informed decision-making when purchasing electric vehicles, ensuring they get the best value for their investment. For manufacturers, it enables them to set competitive pricing strategies based on market trends and demand. Moreover, the deployment of the model using Streamlit allows for seamless accessibility and usability, making the predictive analytics tool readily available to EV companies for price forecasting. Ultimately, the successful deployment of the model on Streamlit Cloud not only enhances the accessibility but also fosters collaboration and innovation within the EV industry, driving forward the adoption and development of sustainable transportation solutions.

METHODOLOGY USED

Feature Analysis

The electrical vehicle dataset is downloaded from the Kaggle dataset which has 103 rows and 14 columns. The 14th feature is our target variable which containsthe price in Euro, which is then converted into Indian currency. The other features include,

Brand – Brand of EV, Model – Model of EV,AccelSec – Acceleration time from 0 to 100 km/hr, TopSpeed – Speed of EV Km/hr,Range_Km – Distance travelled per charge, Efficiency_WhKm – Energy efficiency in watt-hours per km, FastCharge_KmH – Charging speed during fast charging in kilometre per hour, RapidCharge – Rapid charging capability Yes/No, PowerTrain – Type of power train AWD, RWD, PlugType – Plug used for charging, Type 2, CSS, CHAdeMO, BodyStyle – The body style or design, Sedam, SUV etc, Segment – Market segment, Seats – Number of seats available

PriceEuro – Price of vehicle in Eruo's

Clustering Analysis

Correlation matrix

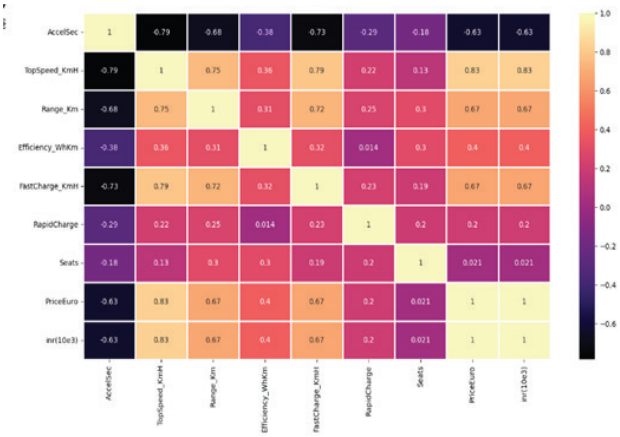


Fig. 2 Correlation Matrix

Strong positive correlation found in between top speed, range and price variable. Where strong negative correlation found in between acceleration time and both top speed and range. Number of seats has minimal correlation with other variables.

Clustering Analysis

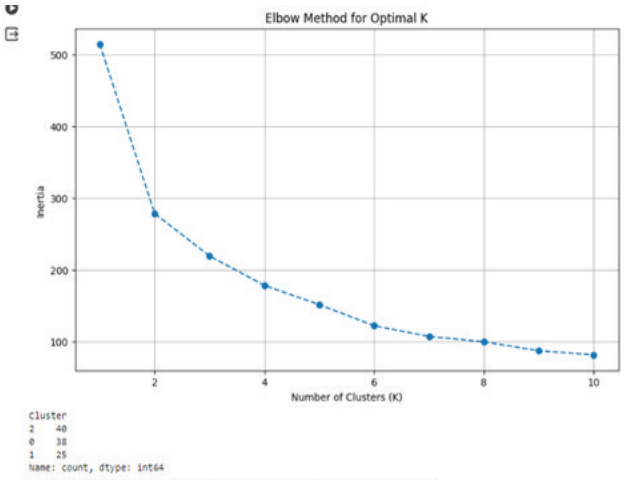


Fig. 3. Elbow Method demonstrates the number of Clusters in the Electric Vehicle Dataset

We employed KMeans clustering from the scikit-learn for segmentation on EV dataset based on the important features selected. We utilize the the pandas for data manipulation, scikit-learn for clustering and pre-processing and matplotlib for data visualization. The KMeans() function is used to partition our data into clusters and to assign the labels. Another method to standardize the features to ensure the equal contributions of data and features, StandardScaler() is used.

Elbow method is used to determine an optimal number of clusters buy computing inertia method for different cluster numbers which is visualized with the matplotlib library.After selecting the optimal number, KMeans clustering is applied, and cluster labels are added to the DataFrame for further analysis. The clustering results show that the electric vehicles have been grouped into three clusters:

Cluster 0 (49 vehicles): Vehicles in this cluster have moderate acceleration times, moderately high top speeds, and relatively long ranges.

Cluster 1 (34 vehicles): Vehicles in this cluster have slower acceleration times, lower top speeds, and shorter ranges compared to the other clusters.

Cluster 2 (20 vehicles): Vehicles in this cluster have the fastest acceleration times, highest top speeds, and longest ranges among the clusters.

Tree-Based Pipeline Optimization(TPOT) Model Building and Testing: Model Building

Machine learning model development involves a time consuming process of trial and error, where data scientists experiment with various algorithms and hyperparameters to achieve optimal performance. However, this manual approach can be inefficient and may not always lead to the best result. TPOT address these challenges by automating the entire model-building process, from feature selection to hyperparameter tuning.

TPOT Architecture

Data Preparation

The dataset is separated into X and Y features. Features such as Brand, Model are excluded from the features set as they are not utilized for prediction.

Pre-processing

Categorical attributes such as PowerTrain, PlugType, BodyStyle, Segment are identified for one-hot encoding. Numerical features are determined by excluding categorical attributes. A pre-processing pipeline is established using ColumnTransformer to manage feature transformations, incorporating variance thresholding and one-hot encoding for categorical data.

TPOT Regressor Configuration

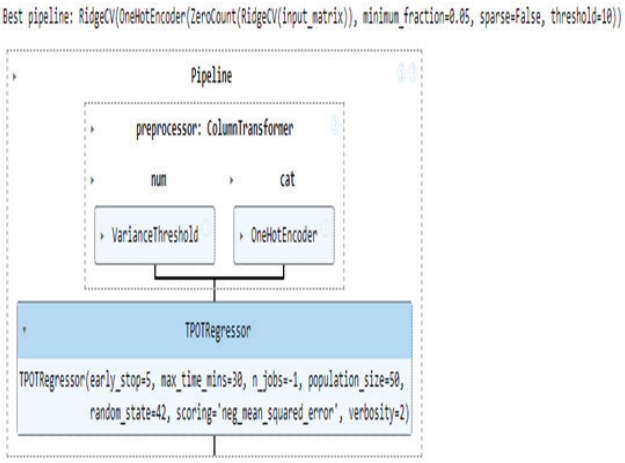


Fig. 3. TPOTRegressor Configuration

Table 1 outlines the key parameters employed in configuring the TPOT model, encompassing verbosity, scoring method, cross-validation folds, parallel processing, random state, population size, maximum optimization time, and early stopping criteria.

TPOT Configuration Parameters

The parameters used in model configuration are as, Berbosity : 2 which control feedback level, Scoring with minium error, then CV :5 which devide the data into folds, then N_jobs : -1 to utilize the CPU, random State : 42, the population size: 50, max time used is 30 min. and early stop is 5

TPOT Pipeline Definition:

A pipeline is formulated using scikit-learn's Pipeline module, comprising the specified pre-processing steps followed by the TPOTRegressor. A preprocessing step and a regressor are combined into a single workflow. The pre-processor component handels feature transformation and prepares the data for modelling, while the regressor

component incorporates the TPOTRegressor model configured with specified parameters.

Model Fitting

TPOT is trained on the training data i.e. X_train, y_train of EV dataset to automatically explore and determine the best machine learning pipeline.

TPOTRegressor Model Building Result

After executing the TPOT model, it conducted a total of 17 generations, with each generation refining the model based on cross-validation(CV) scores. The CV scores gradually improved with each generation, indicating enhanced predictive performance. However, after evaluating five additional generations without improvement, the optimization process ended prematurely.

Table 2: Different Pipelines Evaluated by TPOT

Pipeline	Accuracy Score
RandomForestRegressor	-4.730180537147778e+08
AdaBoostRegressor	-1.197761199038455e+08
DecisionTreeRegressor	-5.262857382120449e+08
ElasticNetCV	-1255.4001801260179
ExtraTreesRegressor	-9.960529122218087e+08
GradientBoostingRegressor	-6.367394490394797e+08
RidgeCV	-0.0073384018206004405
SGDRegressor	-3.679432695732605e+22
LinearSVR	-1.2553870125338218e+09
XGBRegressor	-8.584440958162959e+08
KNeighborsRegressor	-5.292465776495554e+08

TPOT streamlines the model building process by automating the trial and error methods. Traditional model development often involves manual exploration of various algorithms and hyperparameters, which can be time consuming and labor-intensive. However, TPOT leverages automated machine learning techniques to efficiently search through a wide range of models and hyperparameters.

Model Evaluation

After building the model, an evaluation step was carried out to access model performance using various metrics.

Table 3 summarizes the evaluation metrics obtained. These metrics indicate that the model performs exceptionally well. The low MSE, MAE, and RMSE values suggest that the model's predictions are very close to the actual values. Overall, these results indicate that the model is highly accurate and reliable in predicting the target variable i.e. to predict the price of an electrical vehicle.

Table 3: Evaluation Metrics

Metric	Value
Mean Squared Error (MSE)	0.000388
Mean Absolute Error (MAE)	0.014
Root Mean Squared Error (RMSE)	0.0197
R-squared (R2) Score	0.999999
Explained Variance Score	0.999999

TPOT Model Validation

Table 4 demonstrate the TPOT model validation result. The result demonstrates the significant improvements in MSE, MAE and RMSE compared to the previous model i.e. RidgeCV model, indicating better predictive performance. The R2 score and explained varience score also show near-perfect results, suggesting that the model captures most of the varience in the EV price prediction variable.

Table 4: TPOT Validation Result

Metric	Value
Best Pipeline	LinearSVR(GradientBoostingRegressor (input_matrix, alpha=0.75, learning_rate=0.001, loss=quantile, max_depth=2, max_features=0.85, min_samples_leaf=14, min_samples_split=8, n_estimators=100, subsample=0.75), C=0.5, dual=False, epsilon=0.001, loss=squared_epsilon_insensitive, tol=0.01)
Cross-Validation MSE	[-2.14010652, -0.86123755, -0.26705776]
Mean Squared Error	0.275521914
Mean Absolute Error	0.381125986

Root Mean Squared Error	0.524901814
R-squared (R2) Score	1
Explained Variance Score	1

TPOT Fine Tuning

The additional parameters in TPOT fine tuning enhance its evolutionary process:

Mutation Rate: 0.9 used to controls genetic mutation frequency. crossover_rate: 0.1 governs likelihood between pipeline.

subsample: 0.9, fraction of training data used for each pipeline generation. It speeds up optimizations and reduces computational load. These parameters allow precise adjustment, optimizing TPOT's search for the best pipeline. The model validation MSE result is 0.275521914, whereas the fine-tuning result is 6.846111812304841e-09. A lower MSE indicates better performance, which means that the fine-tuning result of 6.846111812304841e-09 is significantly better than the model validation result of 0.275521914. Therefore, the fine-tuned model is considered better in terms of prediction accuracy.

RESULTS AND DISCUSSIONS

During the exploration of the AutoML TPOT process, an array of pipelines featuring various regressors like RandomForesRegressor, AdaBoostRegressor, and GradientBoostRegressor was systematically examined. Notably RidgeCV and RandomForestRegressor emergedas recurrent contenders, underscoring their significance in the selection phase. Initially, RidgeCV was identified as optimal pipeline by TPOT algorithm, showcasing promising performance metrics, particularly reflected in its minimal mean squared error (0.0073). Among the pipelines, RidgeCV and RandomForestRegressor were evaluated frequently suggesting their relevance in the model selection process. The initial model RidgeCV exhibited an MSE of approximately -0.0073, while the subsequent model LinearSVR with GradientBoostingRegressor achieved a significantly lower MSE of approximately 0.2755. The fine-tuned model resulted in a remarkable low MSE of approximately 6.846-09, indicating substantial improvement over the previous models.Fine-tuning of TPOT configuration involved adjusting parameters such as mutation rate, crossover rate, and subsample size to optimize model performance these adjustments aimed to enhance the efficiency and effectiveness of the AutoML process in identifying the best-performing pipeline. The best pipeline model validation MSE was 0.275521914, while after fine-tuning the same model on some tuning parameters resulted it an impressively low MSE of 6.84611181230841e-09 which is actually very close to 0(zero). These significant improvements in results underscores the importance of parameter adjustment in defining and refining the pipeline model performance, enhancing the overall robustness of the predictive framework. The evaluation and fine-tuning of TPOT's process produced a highly optimized and best pipeline(LinearSVR) with a very remarkable and low mean squared error of 6.85e-09. The improvement of the initial validation MSE of 0.276 indicates the importance of the model in the fine-tuning process. The findings of TPOT have potential benefits in a robust and efficient approach to build a very superior predictive model for different types of repressor problems. Our research study demonstrates the unlocking predictive approach with Tree-Based Pipeline Optimization(TPOT) as an exceptional efficiency in streamlining the model construction with optimization in model accuracy. The model evaluation and fine-tuning process showcase the power of TPOT in achieving exceptional predictive performance and this indicates the revolutionizing in data-driven decision making.

Electrical Vehicle Price Prediction Using Best Pipeline

Our research study focused on electrical vehicles price prediction based on clusters performed by using K-Means clustering. We employed advanced machine learning techniques to carried out best pipelines. The TPOT best pipeline with all three clusters harnesses and relevance the price prediction for each cluster. The best f parameters selected to perform the clusters. Initially we have set the value of clusters using k=3, and we performed 3 clusters based of best five parameters such

as Acceleration, Fig. 4 demonstrates a sample screenshot of EV price prediction based on specific cluster.

Predictions for cluster 0:

eed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	Seats	inr(10e3)	Cluster	Predicted_Price
160	270	167	250	0	RWD	Type 2 CCS	Hatchback	C	5	2496.0000	0	29998.312261
145	170	168	190	1	RWD	Type 2 CCS	Hatchback	B	4	2745.3504	0	32995.519400
150	190	168	220	0	FWD	Type 2 CCS	Hatchback	C	5	2654.0800	0	31898.443574
150	275	164	420	0	FWD	Type 2 CCS	Hatchback	B	5	2469.5424	0	29680.290330
144	220	164	230	1	FWD	Type 2 CHAdeMO	Hatchback	C	5	2432.2688	0	29232.259298
165	250	153	210	0	FWD	Type 2 CCS	Liftback	C	5	2866.9888	0	34457.620477
130	195	166	170	1	FWD	Type 2 CCS	Hatchback	A	4	1782.2272	0	21418.719178
140	220	193	260	0	FWD	Type 2 CCS	SUV	B	5	2496.0000	0	29998.312258

Fig. 4: Sample Result of EV Price Prediction

To perform EV price prediction we have used pretrained best pipeline given by TPOT. We perform the prediction of EV with a specific cluster. Initially, we filtered our DataFrame by extracting data points associated with a specific cluster. The overall process involves, DataFramefiltration, pipeline prediction usingthe predict () method, and DataFrame creation for result and result visualization.

LIMITATIONS AND FUTURE ENHANCEMENT

Firstly, our research relies on only secondary data for model training and evaluation. To address this, we are conducting further research on primary data and exploring various features associated with electrical vehicles to find the model's robustness and generalizability. The model deployment could be done with Streamlit local host method as well and it could be possible by using Streamlit Cloud to release our model publically so all stakeholders can use it easily. With this accessibility and usability of the model and limitations for future enhancement, we are contributing sustainability to advancing the efficiency and applicability of predictive analytics in electrical vehicles.

CONCLUSIONS

Our research highlights the transformative impact of AutoML, specifically Tree-Based Pipeline Optimization (TPOT), in revolutionizing model construction and enhancing predictive accuracy within data science endeavours. Through rigorous evaluation and fine-tuning, TPOT emerges as a robust framework capable of automating intricate tasks such as model selection and hyper parameter tuning. These findings of the research also give the importance of automated methodologies or approaches in model development it showcases the data scientists to focus on accurate insights rather than manual tasks. The significance of performance improvements was observed by reducing the mean squared error values, which validated the effectiveness of TPOT for achieving superior predictive accuracy and providing more efficient data-driven solutions.

Our research underscores the broader implications of AutoML particularly TPOT adoption over the traditional methodologies which showcases the new paradigm in innovation in predictive analytics. With access to advanced machine learning and automating complex processes, this technique shifts toward revolution in data science. This revolution fosters collaboration and knowledge sharing within the data science community and also empowers the industries to leverage predictive analytics in informed decision-making as well as competitive advantage. We have navigated and defined by data abundance and complexity where the adoption of this AutoML methodologies particularly TPOT gives immense promises in driving data-driven innovation. The TPOT revolutionizes the manual model-building process but it has some limitations. The process of evaluation, validation, and fine-tuning is time-consuming as it performs 100 generations for given stet time. Perform multiple iterations until the final condition is met. Interrupting the execution prematurely only halts the current iteration and it leads to prolonged execution times.

REFERENCES

1. T. Zhang, J. Zhang, G. Peng and H. Wang, "Automated Machine Learning for Steel Production: A Case Study of TPOT for Material Mechanical Property Prediction," 2022 IEEE International Conference on e-Business Engineering (ICEBE), Bournemouth,

United Kingdom, 2022, pp. 94-99, doi: 10.1109/ICEBE55470.2022.00025.

2. L. Parmentier, O. Nicol, L. Jourdan and M. -E. Kessaci, "TPOT-SH: A Faster Optimization Algorithm to Solve the AutoML Problem on Large Datasets," 2019 IEEE 31st International Conference on Tools with Artificial Intelligence (ICTAI), Portland, OR, USA, 2019, pp. 471-478, doi: 10.1109/ICTAI.2019.00072.

3. Y. Ruijun, H. Lijun, H. Xueqi and Z. Bin, "Research on Industrial Control Network Security Based on Automatic Machine Learning," 2021 6th International Conference on Intelligent Informatics and Biomedical Sciences (ICIIBMS), Oita, Japan, 2021, pp. 149-153, doi: 10.1109/ICIIBMS52876.2021.9651616

4. L. Ferreira, A. Pilastri, C. M. Martins, P. M. Pires and P. Cortez, "A Comparison of AutoML Tools for Machine Learning, Deep Learning and XGBoost," 2021 International Joint Conference on Neural Networks (IJCNN), Shenzhen, China, 2021, pp. 1-8, doi: 10.1109/IJCNN52387.2021.9534091.

5. E. A. Neverov, I. I. Viksnin and S. S. Chuprov, "The Research of AutoML Methods in the Task of Wave Data Classification," 2023 XXVI International Conference on Soft Computing and Measurements (SCM), Saint Petersburg, Russian Federation, 2023, pp. 156-158, doi: 10.1109/SCM58628.2023.10159058.

6. B. Evans, B. Xue and M. Zhang, "An Adaptive and Near Parameter-free Evolutionary Computation Approach Towards True Automation in AutoML," 2020 IEEE Congress on Evolutionary Computation (CEC), Glasgow, UK, 2020, pp. 1-8, doi: 10.1109/CEC48606.2020.9185770.

7. K. Lingelbach, M. Bui, F. Diederichs and M. Vukelić, "Exploring Conventional, Automated and Deep Machine Learning for Electrodermal Activity-Based Drivers' Stress Recognition," 2021 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Melbourne, Australia, 2021, pp. 1339-1344, doi: 10.1109/SMC52423.2021.9658662.

8. Akaramuthalvi. J. B, Suja P., Comparision of Convolutional and Automated Machine Learning approaches for Breast Cancer Prediction, September 2021, Third International conference on Inventive Research in Computing Applications(ICIRCA), DOI:10.1109/ICIRCA51532.2021.9544863

9. R. A. Rahman, Surya Masrom, Masurah Mohamad, Eka Nurmala Sari, Fitriani Saragih, Abdullah Sani Abd Rahmand, 2023, Comparision of automated machine learning (AutoML) in predicting whistleblowing of academic dishonesty with demographic and theory of planned behaviour, MethodsX. 3023, Dec, 11:102364, DOI:10.1016/j.mex.2023.102364

10. Ahmad Alsharef, Karan Aggarwal, Sonia, Manoj Kumar and Ashutosh Mishra, 2022, Review of ML and AutoML Solutions to Forecast Time Series Data, Arch computing methods Eng. 29(7):5297-5311, DOI: 10.1007/s11831-022-09765-0, PMCID: PMC9159649

11. George Westergaard, Utku Erden, Omar Abdallah Mateo, Sullaiman Musah Lampo, Tahir Cetin Akinci, January 2024, Time Series Forecasting Utilizing Automated Machine Learning(AutoML): A Comparative Study on Diverse Datasets, MDPI Information 2024, 15(1), 39, DOI.org/10.3390/info15010039

12. Randal S. Olson, Nathan Bartley, Ryan J. Urbanowiez, Jason H. Moore, Evaluation of Tree Based Pipeline Optimization Tool for Automating Data Science, ACM Digital Library, GECCO 16 Procedings of the Genetic and Evolutionary Computation Conference 2016

Revolutionizing Cardiovascular Healthcare: Design, Fabrication, and FEA of Fiber Bragg Grating Sensors for Non-Invasive Real-Time Cardiac Monitoring in the Era of Healthcare 4.0

Maitri Mohanty, Premansu Sekhara Rath
Computer Science & Engineering
GIET University
Gunupur, Odisha
✉ maitri.mohanty@gmail.com
✉ premansusekhararath@giet.edu

Ambarish G. Mohapatra, Narayan Nayak
Electronics Engineering
Silicon University
Bhubaneswar, Odisha
✉ ambarish.mohapatra@gmail.com
✉ nnayak08@gmail.com

Dipak Ranjan Nayak
Electronics Engineering
Silicon University
Bhubaneswar, Odisha
✉ deepak.ranjan@silicon.ac.in

Nilam N Ghuge
Eletrical Engineering
JSPM'S BSIOTR
Pune, Maharashtra
✉ ghuge1974@gmail.com

Satyapriya Satapathy
Electronics Engineering
Silicon University
Bhubaneswar, Odisha
✉ satyapriya.satapathy@gmail.com

ABSTRACT

The article delves into how Fiber Bragg Grating (FBG) sensors and Internet of Things (IoT) technology are being fused together within the healthcare domain, with a particular focus on their application in cardiac monitoring. Healthcare 4.0, inspired by Industry 4.0, introduces technological innovations into conventional healthcare. Cardiovascular diseases (CVDs) are a significant global health concern, necessitating novel monitoring methods. FBG sensors, known for their small size, non-toxic nature, and high sensitivity, prove beneficial in cardiac monitoring, especially in challenging settings like MRI examinations. The article emphasizes the role of noninvasive and passive cardiac sensors in transforming healthcare applications. The combination of FBG sensors, polymer engineering, big data, machine learning, and IoT enables continuous and remote monitoring of patients' cardiac parameters, particularly in intensive care units (ICUs) and stressful scenarios like MRI sessions. Several studies demonstrate the efficacy of FBG sensors in diverse configurations and setups, highlighting their capability to accurately measure parameters like heart rate and respiration rate. The importance of Finite Element Analysis (FEA) in designing FBG sensors is highlighted, demonstrating how it contributes to understanding the structural behavior and optimizing sensitivity. The fabrication process of a PDMS polymer-embedded FBG sensor is detailed, emphasizing the significance of material selection and deposition techniques. In conclusion, the article proposes a comprehensive approach to cardiac monitoring, integrating FBG sensors, IoT, and advanced signal processing. The FBG sensor's flexibility, Biocompatibility, and sensitivity make it a promising tool for real-time monitoring of cardiovascular parameters, enhancing the efficiency of healthcare services, especially in critical care settings and diagnostic procedures.

KEYWORDS: *Healthcare 4.0, CVDs, FBG, polymer, PDMS, FEA, Biocompatibility, Cardiovascular Parameters, Early Disease Detection, IoT..*

INTRODUCTION

Healthcare 4.0, based on the ideas of Industry 4.0, ushers in a new era in which technological innovations are seamlessly incorporated into the conventional healthcare environment. Therefore, the healthcare sector is going through a dramatic shift as cutting-edge technologies converge together to impact how patients are cared for, diagnosed, and medicated in the future. Cardiovascular diseases (CVDs) are a major cause of death and an ongoing worldwide health concern [1]. This highlights the critical need for novel monitoring methods. According to recent figures, the incidence of heart illnesses has doubled, to a startling 28% [2]. By 2030, the World Health Organization (WHO) predicts that cardiovascular disease (CVD) will account for most unknown deaths in different countries [3]. To address the above aspects medical science research has developed several observational instruments and systems for tracking cardiac and respiratory problems in response to this worsening health catastrophe [4, 5].

A noninvasive and passive cardiac sensor is a device of technology that records vital information about heart function without necessitating invasive treatments or active involvement from users. It is intended to detect and monitor cardiac activity. So, in the modern day, the application of Fiber Optics communication has become a ground-breaking technology that is transforming remote healthcare applications, industrial telecommunications, and structural monitoring [6]. This innovative technology delivers outstanding performance, affordability, abundant bandwidth, and dependable connections. Fiber Bragg Grating (FBG) serves as a pivotal sensing component within optical sensors, finding utility across various domains from chemical and biological sensing to structural health monitoring [7]. In the realm of biomedical devices, FBG sensors have garnered significant attention, especially in the creation of equipment designed for cardiac monitoring in difficult settings. These sensors have shown to be particularly useful in situations when conventional sensors are limited, as in the case of electromagnetic field-induced MRI sessions. The FBG sensor's transformative attributes, including its small size, non-toxic nature, chemical inertness, spectral encoding, high sensitivity, lack of electrical connection, multiplexing capability, self-referencing, and cost-effectiveness, elevate its significance in healthcare applications. Continuous monitoring of cardiac parameters remains crucial, especially in Intensive Care Units (ICUs) catering to patients with chronic diseases. The traditional method of fixed-time interval monitoring, which is overseen by medical personnel, is laborious and difficult, requiring ongoing observation and prompt identification of issues. Also during MRI examinations, where high-quality imaging is crucial, FBG sensors prove to be advantageous as they do not compromise the imaging quality. Hence, the utilization of FBG sensor-based cardiac parameter sensing proves particularly beneficial in scenarios concerning coma patients, individuals with disabilities, those with implanted pacemakers, newborns and pediatric patients, individuals under anaesthesia, or those undergoing MRI procedures involving contrast media.

A paradigm shift in healthcare delivery has been brought about by the introduction of IoT, which has made healthcare more connected, data-driven, and patient-centric. So, the Internet of Things (IoT) in healthcare refers to the smooth integration of wearables sensors, medical devices, and other tools to form a network that allows for remote monitoring and real-time data sharing. In the modern era, it is entirely feasible to create a holistic healthcare solution by incorporating cutting-edge technologies such as FBG sensors, polymer engineering, big data analytics, machine learning, and the Internet of Things (IoT) to effectively tackle the prevailing challenges [8]. A system like this, supported by FBG sensors and IoT applications for cardiac parameter sensing, makes it easier to monitor patients in intensive care units around the clock and reduces the number of unneeded trips within a predetermined window of time.

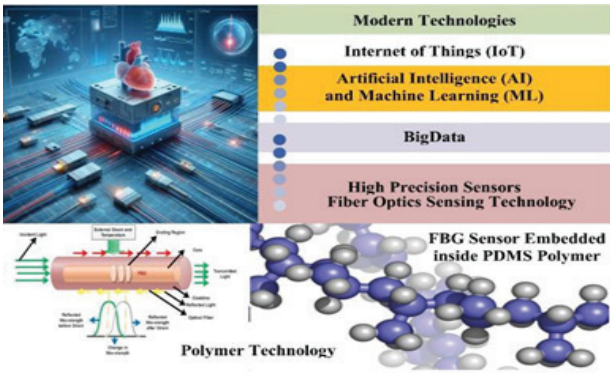


Fig. 1. Representation of Smart Cardiac System Using FBG Sensor

This novel method offers a promising solution for physicians and hospital personnel, greatly improving the effectiveness of healthcare services, especially when it comes to continuously monitoring the heart rate and respiration rate of critically ill patients in Intensive Care Units (ICUs) and stressful settings like MRI scenarios. Figure 1 illustrates a cardiac monitoring system leveraging advanced sensor technology and the Internet of Things.

A PDMS polymer-embedded FBG sensor blends the flexibility and biocompatibility of Polydimethylsiloxane (PDMS) with the strain and temperature sensing characteristics of Fiber Bragg Grating (FBG) technology. Because of its conformable nature, this sensor is suitable for a wide range of applications, including smart fabrics, wearable health devices, biomedical applications, and structural health monitoring. Flexibility enables it to take on several forms, while PDMS's biocompatibility allows it for uses involving interaction with biological systems. The FBG sensor's great sensitivity to strain and temperature changes guarantee precise and accurate measurements under a variety of conditions. All things considered, this integration offers a flexible answer for applications requiring sensitive and malleable sensors. Therefore, the appropriate design of a FBG sensor for cardiac parameters analysis is an important aspect in IOT-enabled sensing systems. This article discusses the design and dimensions of the PDMS embedded FBG sensor using appropriate FEA method. Therefore, the provided literature survey explores various sensor technologies and methods for extracting diverse vital parameters using Fiber Bragg Grating (FBG) sensors and advanced signal processing algorithms, incorporating cutting-edge technology.

In a 2019 [9] study by J. Nedoma et al., a Fiber Bragg Grating (FBG) sensor enclosed in a fiberglass casing was used, housed within a 30mm × 10mm × 0.8mm rectangular belt. When processing the sensor data, the FBG interrogation unit used a third-order Butterworth bandpass filter to filter out unwanted signals. RR curve detection utilized a centered and normalized signal with a median filter, and Heart Rate (HR) detection involved a 5-20 Hz cutoff frequency and a median filter for smooth readings. The relative errors for RR and HR in a real-world MRI setting with ten participants were 4.64% and 4.87%, respectively. In the same vein, the FBG sensor in the study by M. Krej and colleagues (2019) [10] is affixed to a laminate plate or acrylic glass that is placed on the patient's back. A fourth-order Butterworth digital filter is applied to the input signal within a designated frequency range to maintain its properties, and a scanning Fabry-Perot filter is utilized for interrogation. The dominant frequency is determined by the maximum module of the Discrete Fourier Transform (DFT). The method's range is determined by the buffer length, representing the maximum interval between detected characteristic moments of the respiratory cycle. A classifier, utilizing supervised machine learning techniques like support vector machines, neural networks, and random forests, identifies characteristic movements. The random forest model outperforms others in terms of accuracy, sensitivity, precision, and F1 score, with a RMSE measured at 1.48 rpm. Furthermore, J. Nedoma et al.'s survey in 2018 [11] explores systems using probes encased in biocompatible Polydimethyl Siloxane (PDMS), incorporating Fiber Optic Interferometer (FOI) and Fiber Bragg Grating (FBG) probes in a chest-positioned elastic band. The FOI probe measures heart rate using phonocardiography, and a bandpass filter (0-0.5 Hz) is employed for respiration rate (RR) determination. Heart rate (HR) is measured using a 20-80 Hz bandpass filter. The curves are smoothened using median filters (window size: 3 for RR, 7 for HR). The FBG probe (60×30×3 mm, 5 g) calculates RR through a third-order bandpass filter, signal normalization, and centering. In the laboratory setting, ten male and ten female subjects were tested in supine and sitting positions, with weights between 47 to 117 kg and heights between 148 cm and 197 cm. Similarly in the 2019 [12] study by Daniela Lo Presti et al., two FBGs (600mm x 40mm x 2.1mm) are positioned inside an elastic band. For measuring the respiration rate (RR) during quiet breathing, the sensor data is processed by a second-order bandpass filter (cutoff frequency: 0.5 Hz), by employing a custom algorithm to detect maxima. A fourth-order Butterworth bandpass filter (cutoff frequency: 0.6 Hz to 20 Hz) is employed for apnea-induced heart rate (HR) measurement, and minimal peaks are identified using a customized algorithm. The mean absolute errors for RR and HR in two- archer studies were less than 1.97% and 5.74%, respectively.

Furthermore, two arrays of FBG sensors, each with five FBGs, were implanted in an elastic belt in the 2020[13] study by A. Issatayevaet al. Signal analysis using a fast Fourier transform with 0.33 Hz filtering aims to identify the predominant pattern by detecting six synchronized positive or negative peaks. Incorrectly identified peaks (30% in this case) are disregarded, and the mean of the FBG pattern is calculated to determine the single breathing pattern. The experiment involved two volunteers in various positions, including sitting, lying, and running.

In a similar vein, KenOgawa, and colleagues (2018) [14] described the application of a single FBG sensor placed inside a fabric that covers the tricuspid region. This arrangement facilitated the simultaneous capture of PCG (Phonocardiogram), ACG (Apexcardiogram), and respiration signals, allowing for the evaluation of the lob- dup sound of the heart in the pericardium area. Respiration rate detection was achieved by first filtering the recorded data using a second-order Butterworth filter, configured with a low cutoff frequency of approximately 0.2 Hz. The PCG and ACG signals were then processed through a high- pass filter ranging from 35 Hz to 55 Hz, and medium bandpass filters spanning from 0.5 Hz to 5.0 Hz. Evaluation of these methods was carried out through an experiment involving a 25-year-old male subject seated, yielding promising results in comparison to a conventional reference device. Moreover, in a 2019 [15] study by Shouhei Koyama and Hiroaki Ishizawa, a 250µm FBG sensor near the radial artery of the wrist underwent denoising through Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMDAN) within the 0.5 Hz to 5.0 Hz frequency range. After normalizing the identified peaks on the Y-axis, which ranged from 0 to 1, the FBG signal was processed up to the fifth term on the X-axis, enabling the determination of the respiratory and cardiac rates. Likewise, Y. Haseda et al. introduced an FBG sensor embedded within plastic and silica optical fibers in 2019[16], aimed at filtering out noise from the raw data within a frequency spectrum of 0.5 Hz to 5 Hz. A first differentiation operation followed, and the breathing rate was calculated by detecting peak-to-peak intervals. Further processing, such as pulse separation, signal averaging, and normalization, was performed on the resulting pulse waveform, which resembled Acceleration PlethysmoGraphy (APG). Blood pressure and pulse wave parameters were determined using a calibration curve constructed through the partial least square regression method. Further, a technique utilizing a single FBG enclosed in a 3D printable flexible material covering the chest was presented by C. Tavares et al. in 2022 [17]. A bandpass filter (0.8 Hz to 2 Hz) is applied to the recorded signal to enable peak identification to determine RR and HR. Testing with six configurations, varying thickness, and infill percentage, revealed that the sensor with the least thickness and less filling exhibited higher sensitivity. The suggested sensor and the reference device showed satisfactory agreement in both normal breathing and apnea circumstances, according to experiments conducted on three healthy people. Moreover, in 2017, M. Fajkus et al. (2017) utilized a wavelength division technique with two FBGs enclosed in a PolydimethylSiloxane probe for measuring Respiratory Rate (RR), Heart Rate (HR), and body temperature [18]. The respiration rate in the time domain was determined through local maxima identification, followed by Fourier transform for RR calculation. Blood pressure and heart rate measurements used a Butterworth second-order bandpass filter (0.75 Hz to 5 Hz) and Fourier series analysis. Position-independent sensitivity was established by the sensor, with relative errors of 3.9% for RR, 0.36% for body temperature, and 96.54% values within ±1.96 standard deviations for HR detection, according to Bland-Altman analysis. Ciocchetti et al. (2015) conducted a study using two 1cm FBG sensors placed in a textile covering the upper thorax to measure chest wall excursion during breathing. The system, evaluated through wavelength shift analysis and Bland-Altman, demonstrated satisfactory performance in estimating respiratory parameters for four healthy subjects [19]. Elsarnagawy (2015) embedded FBG sensors in a nylon textile covering the torso, using bandpass filters and FFT to measure heart rate and respiration rate. The study explored potential optimization for measuring temperature and inhaled volumes in the future [20]. The provided Table 1 presents comprehensive details on a range of quantitative methods and diverse approaches for utilizing FBG sensors in monitoring vital sign data.

Table 1 Various FBG sensor technology and methods for monitoring vital sign parameters

Sl. no	Autho rs Details	Sensor technology	Using methods for parameter extraction
1	J. Nedoma et al. (2019) [9]	FBG is encapsula-ted inside a fiberglass	HR and RR Detection using Third-order Bandpass filter.
2	M. Krej et al. (2019) [10]	FBG was placed on a plate of acrylic glass.	Fourth-order Butterworth digital filter and an adaptive window for respiration cycle identification.
3	J. Nedoma et al. (2018) [11]	FBG encap-sulated in Polydi-methylS iloxane (PDMS).	Third-order Butterworth median filter, coupled with signal normalization for HR and RR assessment.
4	Daniela Lo Presti et al. (2019) [12]	FBG is encapsulated inside Dragon skin@20 silicone Rubber	HR and RR Detection: A Second-order Butterworth filter.
5	Issatayeva et al. (2020) [13]	FBG sensor is placed on the chest belt and abdominal area.	Utilization of both Fast Fourier Transforms and a custom algorithm for the analysis of breathing rate (BR).
6	Ken Ogawa et al. (2018) [14]	FBG sensor is placed on the tricuspid area.	Second-order Butterworth, medium bandpass, and high pass filters are employed to monitor RR, PCG, and ACG.
7	S. Koyama et al. (2019) [15]	FBG sensor is placed inside a wrist.	HR and RR Detection: Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMDAN) method.
8	Y. Haseda et al.(2019) [20, 16]	FBG is placed inside a chest belt.	Filtering with first differentiation is used to detect breath rate.
9	C. Tavares et al. (2022) [17]	A solitary Fiber Bragg Grating (FBG) is enclosed within a 3D printable flexible.	HR Detection: A Bandpass filter with a peak detection.
10	M. Fajkus et al. (2017) [18]	FBGs encapsulated in Polydimethyl Siloxane polymer	HR and RR Detection: Fourier Transform and Bandpass filtering

MATERIALS AND METHODS

FBG sensors function by leveraging a periodically modulated refractive index along the optical fiber's propagation axis. This modulation allows the sensor to detect reflected light wavelengths, acting as a selective reflection filter, as illustrated in Figure 2. The link between the wavelength of the incident light, the grating period (Λ), and the effective refractive index (ŋ_eff) of the fiber core is established by Bragg's law [21]. The Bragg wavelength (λ_B) is crucial and is given by the Equation 1.

$$\lambda_B = 2\eta_{eff}\Lambda \tag{1}$$

To further elaborate, the sensitivity of the FBG sensor to external factors such as strain and temperature is represented through mathematical expressions. This following equation (ΔλB)/λB consider the effects of applied deformation (Δℰ) and temperature change (ΔT).

$$\frac{\Delta\lambda_B}{\lambda_B} = \left(\frac{1}{\Lambda}\frac{\partial\Lambda}{\partial\mathcal{E}} + \frac{1}{\eta_{eff}}\frac{\partial\eta_{eff}}{\partial\mathcal{E}}\right)\Delta\mathcal{E} + \left(\frac{1}{\Delta}\frac{\partial\Lambda}{\partial T} + \frac{1}{\eta_{eff}}\frac{\partial\eta_{eff}}{\partial T}\right)\Delta T \tag{2}$$

When the change in temperature is zero, the change in Bragg wavelength with applied strain is represented as

$$\frac{\partial\eta_{eff}}{\eta_{eff}} = \eta_{eff}^2[P_{12} - \nu(P_{11} - P_{12})] \tag{3}$$

$$P_e = \frac{\eta_{eff}^2}{2}[P_{12} - \nu(P_{11} + P_{12})] \tag{4}$$

Where, ρe represents coefficient of optical-strain in the fiber medium, Pij represents strain optical components of tensor and ∨ is Poisson's ratio.

Combining equation (3) and (4), variation of Bragg wavelength is represented as

$$\Delta\lambda_R = (1 - P_e)\lambda_R \Sigma \quad (5)$$

The strain sensitivity coefficient (ρe) and the strain optical components of the tensor (Pij) play a role in characterizing the sensor's response to mechanical deformation. When the applied strain is zero, the variation in Bragg wavelength with temperature (ΔλB) is expressed in terms of the temperature sensitivity coefficients (α and β) which is given by the following equation

$$\Delta\lambda_B = \lambda_B \left(\frac{1}{\eta_{eff}} \frac{\partial \eta_{eff}}{\partial T} + \frac{1}{\Lambda} \frac{\partial \Lambda}{\partial T} \right) \Delta T \quad (6)$$

$$\lambda_B(\alpha + \beta)\Delta T = K_T \lambda_B \Delta T \quad (7)$$

$$\alpha = \frac{1}{\Lambda} \frac{\partial \Lambda}{\partial T} \quad (8)$$

$$\beta = \frac{1}{\eta_{eff}} \frac{\partial \eta_{eff}}{\partial T} \quad (9)$$

$$K_T = \alpha + \beta \quad (10)$$

This signifies the sensor's ability to detect temperature-induced changes in the reflected wavelength. The choice of FBG material is crucial in practical sensor design to achieve the best possible sensitivity. To guarantee that the FBG sensor functions well in a variety of applications, the strain and temperature sensitivity coefficients are essential components of this selection process. All things considered, the mathematical foundation of the FBG sensor offers a thorough comprehension of its behavior and makes it easier to customize it for certain sensing needs.

FINITE ELEMENT ANALYSIS AND CONSIDERATIONS

The advent of the Finite Element Method (FEM) marked a transformative milestone in engineering, providing a reliable numerical approach to address boundary value problems. FEM involves dissecting intricate physical systems into more manageable elements coupled at nodes [22, 23]. This decomposition facilitates the application of mathematical equations derived from continuum mechanics, allowing a comprehensive evaluation of the system's overall response. This technique is widely used in many different engineering fields, including heat transport, fluid dynamics, electromagnetic, and structural analysis. In the context of structural analysis, the equilibrium equation takes the form as shown in equation 11.

$$[K]\{u\} = \{F\} \quad (11)$$

Where

represents nodal displacements.

{F} is the vector of applied forces.

[K] Represents the stiffness matrix.

This equation encapsulates fundamental concepts enabling engineers to simulate and evaluate complex structures, particularly advancing capabilities in design optimization and predictive modeling.

The stiffness matrix for linear elastic isotropic materials in 3D finite element analysis can be expressed using Poisson's ratio (ν) and Young's modulus (E). Denoted as [ε][K], this matrix establishes the correlation between stress (σ) and strain (ε) in the material. In this context, ν signifies Poisson's ratio, E represents Young's modulus, and the matrix coefficients establish connections between stresses and strains in diverse directions, with the matrix's symmetry mirroring the intrinsic symmetry of material behavior.

FABRICATION OF FBG SENSOR.

A crucial aspect in crafting the sensor element is the deposition process [24]. The three main steps of the PDMS polymer procedure used in this study are the weighing, bubble removal, and mixing processes. Table 2 shows the composition of PDMS polymer based FBG sensor.

Table 2. The PDMS-based FBG sensor composition

Sl. No.	Components	Volume
1.	Polymeric base (Part-A)	5ml
2.	Curing agent (Part-B)	0.5ml

The snapshot of Figure 3 shows the mixing process of the two parts (Part-A and Part-B). Similarly, Figure 4 illustrates the elimination of air bubbles from the PDMS mixer using laboratory desiccators.

Fig. 3. Mixing of PDMS polymer (Part A and Part B)

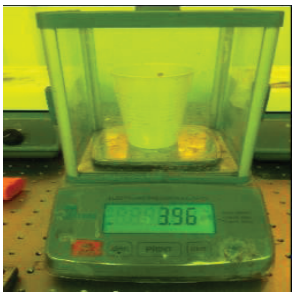


Fig. 4. Removal of excess Bubbles using vacuum desiccators.

As shown in figure 5, a die has to be produced to carry out the PDMS deposition. Figure 6 displays an enlarged image of the prepared die. Experimentation involves testing two materials, common acrylic and ceramic, for depositing the PDMS polymer under predefined temperature conditions. The ultimate deposition of the final PDMS version utilizes a ceramic die, showcased in Figure 7.

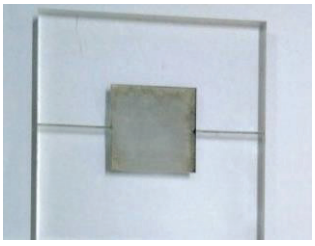


Fig. 5. 4 cmX4cm die for PDMS deposition

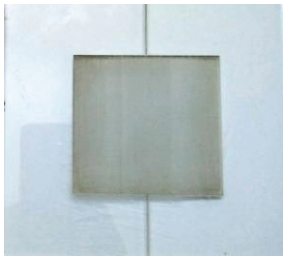


Fig. 6. 4cmX4cm die for PDMS deposition (Magnified Portion)

Fig. 7. Deposited polymer after the curing procedure (Ceramic) – 4cmX4cm

Figure 8 provides a detailed view of the ultimate iteration of the PDMS polymer, encapsulating the FBG sensor within the polymer element.

Fig. 8. Deposited polymer after the curing procedure – 4cmX4cm

RESULT AND DISCUSSION

COMSOL Multiphysics software is employed to simulate diverse designs incorporating coupled physics such as mechanics, acoustics, electromagnetic fields, fluid flow, heat transfer, chemical reactions, and more [24, 25]. Also, the PDMS polymer design undergoes simulation using the COMSOL Multiphysics software tool, exploring various characteristics. A 4cmX4cm 3D structure is subjected to Finite Element Analysis (FEA), depicted in Figure 9, with the corresponding meshing illustrated in Figure10. The Contour of Total Displacement (m), Streamline, and Material Displacement Field is visualized in Figure 11, providing insights into the structural behavior. The dimensions, material specifications, and additional design factors applied in the FEA model are detailed in Table 3 and Table 4.

Table 3. Dimensional parameters of the 3D model

Parameters	Dimension
Active Length (L)	40 mm
Active Width (W)	40 mm
Active Thickness (t)	2 mm

Table 4. Design parameters of the FBG sensor element

Simulation Set-up	Parameter
Material	Polydimethylsiloxane (PDMS)
Applied frequency	0.33 Hz
Acts/min	20 acts per minute

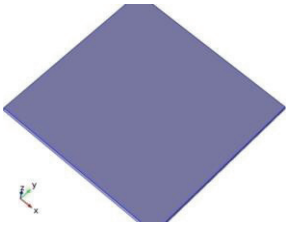


Fig. 9. 3D model of the sensor element

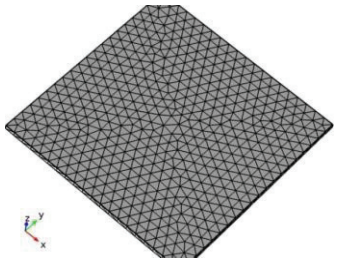


Fig. 10. 3D meshing of the sensor structure

In a similar context, Figure 12 displays the contour of the Finite Element Analysis (FEA) model, illustrating the total displacement (m). Additionally, Figure 13 presents the contour of the FEA model along with the total stress distribution across the 3D structure. The figures (11, 12, and 13) collectively reveal a concentration of maximum strain at the central portion of the 3D structure. As a result, achieving the best sensitivity in measurements requires positioning the Fiber Bragg Grating (FBG) sensor directly at the center of the structure, as highlighted in Figure 13. Here, the FBG sensor element is securely attached to the fabricated PDMS sheet.

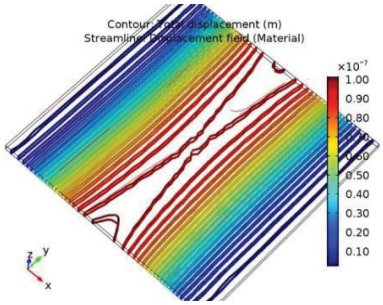


Fig. 11. Contour: Total displacement (m) Streamline: Displacement field (Material)

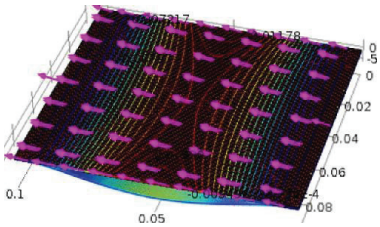


Fig. 12. Contour of the FEA model: Total displacement (m)

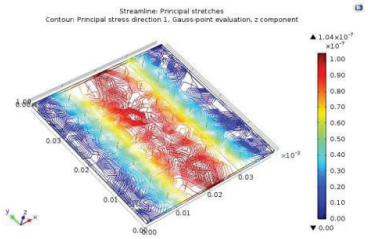


Fig. 13. Contour of the FEA model and Principal stress analysis

The finalized FBG sensor element, with the PDMS polymer material and requisite fiber splicing (FC/APC), is illustrated in Figures 14. The sensor element, once developed, undergoes testing in a laboratory setting with real-time signal recording depicted in Figure 15. The recording employs a custom LabVIEW Graphical User Interface (GUI) application, as demonstrated in Figure 16, designed specifically for real-time acquisition of the FBG sensor signal.

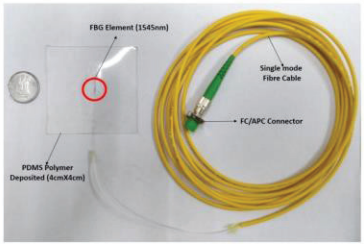


Fig. 14. Final version of the complete FBG sensor element sandwiched between PDMS polymer material (4cmX4cm) after performing the required fibre splicing (FC/APC)

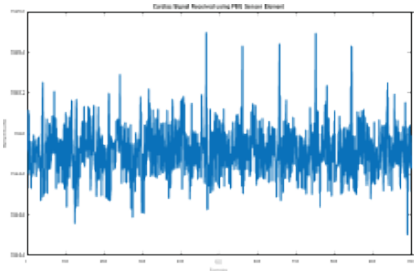


Fig. 15. Recorded FBG signal for the extraction of the cardiac parameters

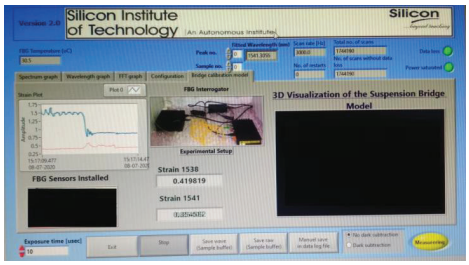


Fig. 16. Modified LabVIEW based GUI application developed at Silicon Institute of Technology

CONCLUSION

Utilizing Finite Element Analysis (FEA), a Fiber Bragg Grating (FBG) sensor is crafted to facilitate real-time monitoring of various cardiovascular parameters including Heart rate, Respiration rate, oxygen concentration, and chest expansion. Delving into the thermal and elastic attributes of the sensor element through FEA offers a comprehensive comprehension of stress and strain distribution, aligning precisely with design specifications. Experimental findings advocate for the employment of PDMS polymer material for real-time acquisition of cardiac signals during medical evaluations. Thorough evaluation of individual sensor responses is conducted, affirming the efficacy of the FBG sensor element. Seamless real-time acquisition of cardiac signals is achieved, distinctly highlighting the R-wave within the cardiac signal pattern. Employing robust signal processing or machine learning techniques enables accurate estimation of the P, Q, S, and T waves from the raw signal data. Additionally, the designed sensor element is tailored to seamlessly integrate with the Internet of Things (IoT) platform, facilitating streamlined monitoring of cardiac parameters for ICU patients and individuals undergoing MRI examinations.

REFERENCES

1. S. Update, "Heart disease and stroke statistics—2020 update: a report from the American Heart Association," Circulation, vol. 141, no. 9, pp. e139-e596, 2020.
2. F. G. Hage and W. AlJaroudi, "Cardiovascular disease in the literature: A selection of recent original research papers," Journal of Nuclear Cardiology, vol. 25, pp. 1895-1897, 2018.
3. U. M. Jadhav, "Cardio-metabolic disease in India—the up- coming tsunami," Annals of translational medicine, vol. 6, no. 15, 2018.
4. C. Deaton et al., "The global burden of cardiovascular disease," European Journal of Cardiovascular Nursing, vol. 10, no. 2_suppl, pp. S5-S13, 2011.
5. L. K. McCorry, "Physiology of the autonomic nervous system," American Journal of Pharmaceutical Education, vol. 71, no. 4, 2007.
6. F. Sessa et al., "Heart rate variability as a predictive factor for sudden cardiac death," Aging (Albany NY), vol. 10, no. 2, pp. 166, 2018.
7. S. Umesh and S. Asokan, "A brief overview of the recent bio- medical applications of fiber Bragg grating sensors," Journal of the Indian Institute of Science, vol. 94, no. 3, pp. 319-328, 2014.
8. M.M. Werneck, R.C.S.B. Allil, B.A. Riberiro and F.V. de Nazare, 'A guide to fiber Bragg grating sensors. Current trends in short-and long-period fiber gratings', pp 1-24,2013.
9. J. Nedoma et al., "Vital sign monitoring and cardiac triggering at 1.5 tesla: A practical solution by an MR-ballistocardiography fiber-optic sensor," Sensors, vol. 19, no. 3, p. 470, 2019.
10. M. Krej et al., "Detection of respiratory rate using a classifier of waves in the signal from an FBG-based vital signs sensor," Elsevier, 2019.
11. J. Nedoma et al., "Magnetic resonance imaging compatible non- invasive fiber-optic sensors based on the Bragg gratings and interferometers in the application of monitoring heart and respiration rate of the human body: A comparative study," Sensors, vol. 18, no. 11, p. 3713, 2018.
12. D. Lo Presti et al., "Cardio-respiratory monitoring in archery using a smart textile-based on flexible fiber Bragg grating sensors," Sensors, vol. 19, no. 16, pp. 3581, 2019.
13. A. Issatayeva et al., "Fiber-optic based smart textiles for real-time monitoring of breathing rate," Sensors, vol. 20, no. 12, pp. 3408, 2020.
14. K. Ogawa et al., "Simultaneous measurement of heart sound, pulse wave, and respiration with a single fiber Bragg grating sensor," in 2018 IEEE International Symposium on Medical Measurements and Applications (MeMeA), IEEE, pp. 1-5, 2018.
15. S. Koyama et al., "Vital sign measurement using FBG sensor for new wearable sensor development. In Fiber Optic Sensing- Principle, Measurement and Applications," IntechOpen, pp. 1-16, 2019.

16. Y. Haseda et al., "Measurement of pulse wave signals and blood pressure by a plastic optical fiber FBG sensor," Sensors, vol. 19, no. 23, pp. 5088, 2019.

17. C. Tavares et al., "Respiratory and heart rate monitoring using an FBG 3D-printed wearable system," Biomedical Optics Express, vol. 13, no. 4, pp. 2299-2311, 2022.

18. M. Fajkus et al., "A non-invasive multichannel hybrid fiber-optic sensor system for vital sign monitoring," Sensors, vol. 17, no. 1, pp. 111, 2017.

19. M. Ciocchetti, C. Massaroni, P. Saccomandi, M. A. Caponero, A. Polimadei, D. Formica, and E. Schena, "Smart textile based on fiber Bragg grating sensors for respiratory monitoring: Design and preliminary trials," Biosensors, vol. 5, no. 3, pp. 602-615, 2015.

20. T. Elsarnagawy, "A simultaneous and validated wearable FBG heartbeat, and respiration rate monitoring system," Sensor Letters, vol. 13, no. 1, pp. 48-51, 2015.

21. C. Hong, Y. Zhang, and L. Borana, "Design, fabrication and testing of a 3D printed FBG pressure sensor," IEEE Access, vol. 7, pp. 38577-38583, 2019.

22. A. K. Aziz, Ed., The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations. Academic Press, 2014.

23. X. Wang et al., "Femtosecond laser-based processing methods and their applications in optical device manufacturing: A review," Optics & Laser Technology, vol. 135, p. 106687, 2021.

24. J. K. Sahota et al., "Fiber Bragg grating sensors for monitoring of physical parameters: A comprehensive review," Optical Engineering, vol. 59, no. 6, pp. 060901-060901, 2020.

25. M. Pieper and S. Schulz, "Teaching Simulation Methods with COMSOL Multiphysics®," Engineering Education, vol. 1, no. 3, p. 4, 2014.

Road Lane Detection in A Self Driven Vehicles using Computer Vision

Suhasini Vijaykumar
Professor
✉ Suhasini.bvimit@gmail.com

Shubham Gajanan Ghule
MCA Student
✉ Shubhamghule297@gmail.com

Omkar Baban Dahifale
MCA Student
✉ omkardahifale@gmail.com

Bharati Vidyapeeth Institute of Management
and Information Technology
Navi Mumbai, Maharashtra

ABSTRACT

Vehicle lane detection is software designed to detect and warn if the driver's vehicle has deviateded from the lane. The system will constantly monitor the position of vehicle relative to the train line and give an audible or visual warning to the driver when necessary. In our project, we present a way to improve the traffic line to see and view things. This is important to ensure that other groups do not experience too many collisions. The line should be clearly visible even when other factors are taken into account. Detection of objects by improving detection equipment will give drivers confidence even in different lighting conditions and different environments. Think about how you can provide a safe environment for a safe environment and less traffic.

KEYWORDS: *Open CV, Deep learning, Object detection.*

INTRODUCTION

Road detection is an important component of computer vision that plays an important role in driving, advanced driver assistance systems (ADAS) and road safety. It involves identifying and following road signs to facilitate navigation, lane keeping and decision making. The research highlights the need for a comprehensive action plan to save lives, as India currently ranks highest globally in traffic accident fatalities. As per the report came from analysis of some experts, the main reasons behind this trend of the accidents are to avoid veering helmets, Seat belts, rapid urbanization and not taking safety measures seriously while driving. In 2015 Brasilia Declaration on Road Safety has been signed by India, where India took oath, The goal is to decrease the number of fatal traffic accidents by half by 2020. Traditional search methods rely on image processing techniques such as edge detection, Hough transform and region segmentation. While these methods provide a basis, they often face problems such as changing lighting conditions, clogging, and difficult roads .Additionally, their performance is limited in time application. Recent advances in deep learning, especial Neural networks(CNN), have revolutionize row search algorithms. These deep learning based methods show good accuracy and robustness in identifying errors in different environments. This article focuses on implementing row search methods using OpenCV (a popular computer library available in Python Goals include evaluating the performance of computer vision models and deep learning, evaluating the performance of different prioritization techniques and design models, and evaluating the reality effectiveness of video advertising. The main functionality of this technology is to display road line locations and potentially implement advanced lane-switching detection to reduce road concussions in the future. [1].

LITERATURE REVIEW

Lane detection algorithms have advanced significantly with deep learning techniques, enhancing precision and resilience through various architectures, data augmentation techniques, and training procedures. Here are some key findings from the literature Lane detection has shifted towards the use of Convolutional Neural

Networks (CNNs) as the primary architecture. Models like LaneNet, ENet, and UNet have demonstrated superior performance compared to traditional methods. These architectures leverage the hierarchical features learned from convolutional layers to accurately detect lane markings. The region of interest model's edge gradient and color filter are combined to offer a reliable lane line extraction method[2]. Deep learning models for lane detection are trained using data augmentation techniques like random rotation, scaling, brightness modification, and perspective transformation to improve model adaptation to road conditions and lane marker variances. Many lane detection systems frame the problem as a semantic segmentation task, where each pixel in the image is classified as belonging to a lane or background. Semantic segmentation models like DeepLab and SegNet have shown promising results in accurately delineating lane boundaries. End- to-end learning approaches, where the entire lane detection pipeline is learned directly from raw input images to output lane predictions, have gained traction. These models eliminate the need for handcrafted features and intermediate processing steps, leading to more streamlined and accurate lane detection systems. Transfer learning techniques, such as fine- tuning pre-trained models like VGG, ResNet, or MobileNet on lane detection datasets, have been effective in improving model performance, especially with limited annotated data. Attention mechanisms, inspired by human visual attention, have been integrated into lane detection models to focus on relevant regions of the image for accurate lane detection, particularly in challenging scenarios with occlusions or complex backgrounds. Researchers have also focused on optimizing lane detection models for real-time performance, aiming for high frame rates suitable for applications like autonomous driving and ADAS. Techniques such as model pruning, quantization, and hardware acceleration have been explored to achieve real-time inference.

PROBLEM DEFINITION

Road lane detection is a critical component of computer vision systems, especially in the context of autonomous driving and driver- assistance technologies. The primary problem addressed in this research is the accurate and robust detection of lane markings under diverse environmental conditions and complex road scenarios. One of the key challenges is the variability in environmental conditions such as lighting, weather, and road surface conditions. Lane markings can appear differently under different lighting conditions (daytime, nighttime, shadows), affecting their visibility and detectability. Roads are not always straight and may have curves, intersections, merges, and lane diversions. Detecting and tracking lane markings accurately in these complex scenarios is challenging, especially for traditional computer vision techniques. Noise from sensor sources, road debris, and occlusions from other vehicles can obscure or distort lane markings, leading to false detections or missed detections. Robust lane detection algorithms should be able to handle such noise and occlusions effectively. For applications like autonomous driving and ADAS, real-time processing is crucial. Lane detection algorithms must achieve high frame rates while maintaining accuracy and reliability to support timely decision-making by the vehicle's control system. Lane detection systems should generalize well across different road types (highways, urban roads, rural roads) and adapt to changes in lane markings, such as temporary markings in construction zones or faded markings due to wear and tear. Accurate lane detection is essential for ensuring the safety and reliability of autonomous vehicles and driver- assistance systems. Errors in lane detection can lead to incorrect lane-keeping decisions, potentially resulting in accidents or unsafe driving behavior as shown in Fig 1.

Addressing these challenges requires the development of advanced lane detection algorithms that leverage deep learning techniques, robust preprocessing methods, and real-time optimization strategies. By overcoming these challenges, we aim to contribute to the development of more reliable and efficient road lane detection systems for enhanced road safety and autonomous navigation. The objectives of this research endeavor to address the challenges outlined in the problem definition and contribute to advancing the state-of-the- art in lane detection algorithms. First to develop and implement a road lane detection system using OpenCV and Python, integrating both traditional computer vision techniques and deep learning approaches and evaluate the performance of traditional computer vision techniques (e.g., edge detection, Hough transform) in comparison to deep learning-based approaches (e.g., CNN-based

models) in terms of accuracy, robustness, and real-time processing capabilities. Second to analyze the effectiveness of different preprocessing steps, such as color space conversion, noise reduction, contrast enhancement, and image normalization, in improving lane detection accuracy and robustness. Later to compare and analyze the performance of different deep learning model architectures for lane detection, including but not limited to LaneNet, ENet, UNet, and custom-designed CNN architectures. The Hough Transform is a technique that can be employed to distinguish the characteristics of various shapes within a visual representation[4].

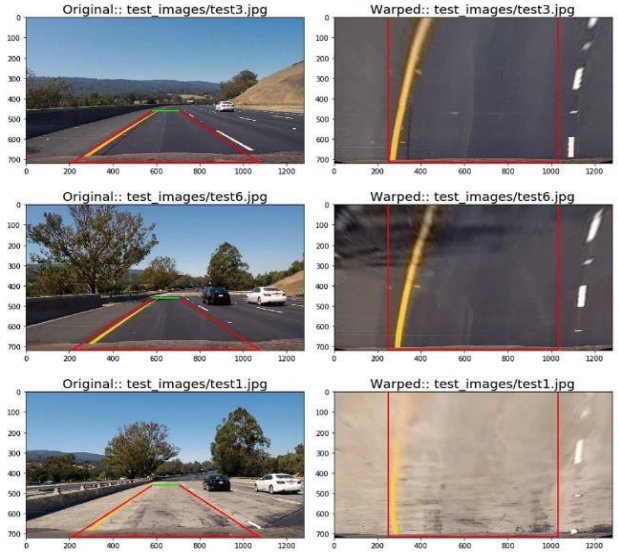


Fig 1. Not Detecting Curved Lanes

RESEARCH METHODOLOGY

The research methodology for this study is structured to ensure a systematic approach to road lane detection using OpenCV in Python, integrating traditional computer vision techniques and deep learning algorithms. Gather a diverse dataset of road images and videos containing annotated lane markings. The video was distorted back onto the vehicle perspective after calculating the lane's radius of curvature and separation from the center[5]. The dataset covers various environmental conditions, road types, and lane configurations to ensure comprehensive training and testing. Perform preprocessing steps on the collected data, including color space conversion, noise reduction using techniques like Gaussian blur or median filtering, contrast enhancement, and image normalization. The raw photos undergo distortion correction, grayscale conversion, gradient application, and deep learning application[6]. These preprocessing steps aim to improve the quality and consistency of the input data for subsequent processing.

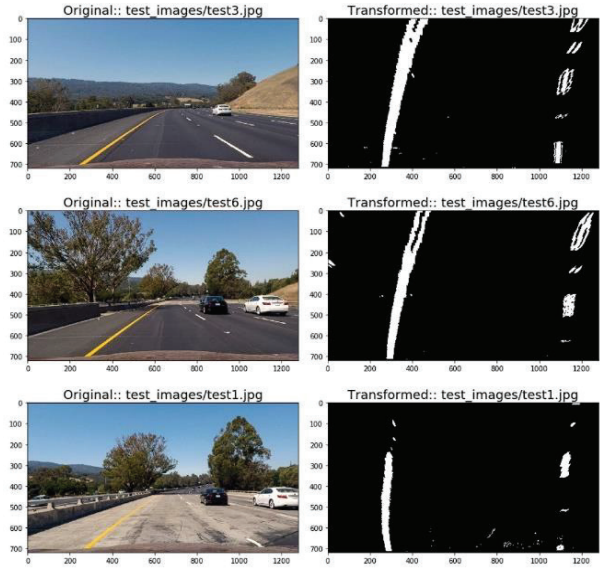


Fig 2. Transformed output

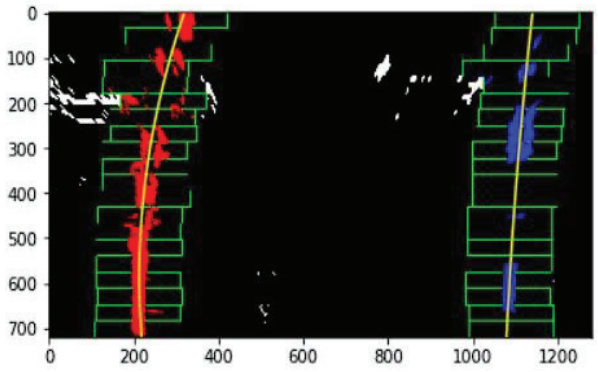


Fig 3. Polynomial fitting of lane lines

Extract relevant features from preprocessed images using techniques such as edge detection (e.g., Canny edge detector) or feature descriptors (e.g., SIFT, SURF). These features will serve as input for both traditional computer vision algorithms and deep learning models. Develop and implement the road lane detection system using OpenCV in Python. This includes integrating traditional computer vision techniques like Hough transform for line detection, region of interest (ROI) selection, and perspective transformation, along with deep learning models such as CNNs for lane marking

identification as shown in Fig . The image's curving lines will be straightened by undistorting each frame, enhancing the clarity of distinguishing lane lines[3]. Train the deep learning models on the annotated dataset using appropriate training methodologies. Michal Ruzicka and Petr Masek's [7] proposes a proposed lane detection system that uses hyperparameter optimization, transfer learning from pre-trained models, and data augmentation techniques to enhance performance, with quantitative measures including F1 score, accuracy, precision, and recall.

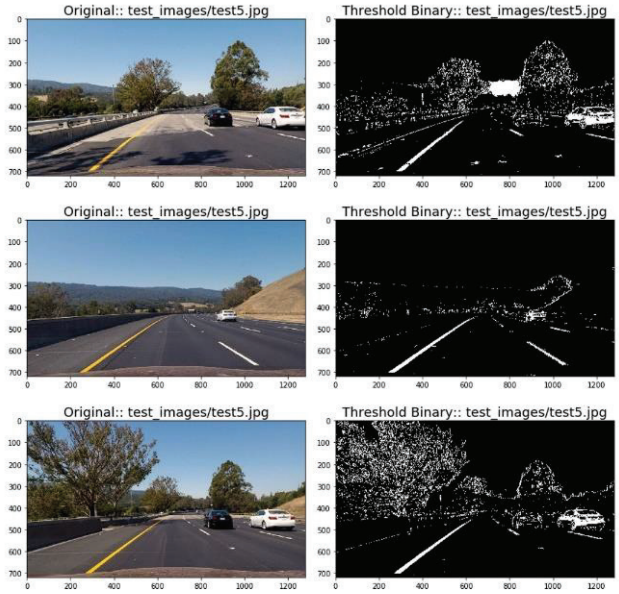


Fig. 4. Thresholded output

Conduct extensive testing across different environmental conditions, road scenarios, and video streams to assess the system's robustness and generalization capabilities. Test the real-time performance of the lane detection system on live video streams, measuring key metrics such as frames processed per second (FPS), latency, and computational resource utilization. The sliding window search is used to identify windows with colored lane lines, which are indicated by green boxes[8]. Ensure that the system meets real-time processing requirements for practical. The study compares deep learning-based methods and conventional computer vision techniques in terms of accuracy, robustness, and real-time processing capabilities, highlighting their advantages and disadvantages. The outputs as shown in Fig 2, Fig 3 and Fig 4.

ANALYSIS

The analysis phase of this research study involves a comprehensive evaluation of the road lane detection system developed using OpenCV in Python. The analysis encompasses various aspects, including algorithm performance, real-time processing capabilities, robustness under diverse conditions, and comparison with existing solutions as shown in Fig 5, and Fig 6. Comparing deep learning and conventional computer vision techniques, this study evaluates their accuracy, precision, recall, and F1 score, comparing the output from various algorithms.

Fig 5. Lane Detection on Road

Measure the real-time processing capabilities of the lane detection system on video streams, capturing metrics such as frames processed per second (FPS), latency, and computational resource utilization. Evaluate the system's responsiveness and efficiency in handling real-time applications. A robustness testing was conducted under various environmental conditions, including changes in lighting (daytime, nighttime, shadows), weather conditions (rain, fog), road surface variations, and occlusions (other vehicles, objects). The system's ability to maintain accurate lane detection across these diverse scenarios is assessed. The developed lane detection system with existing commercial or open-source solutions in terms of performance metrics, computational efficiency, and real-world applicability was assesses and areas where the proposed system outperforms existing solutions were identified. The trade-offs between traditional computer vision techniques and deep learning-based approaches in terms of accuracy, computational complexity, training time, and generalization capabilities were analysed. It was observed that the image distortion

will appear when the straight lines of an image appear to be deformed or curved unnaturally[9]. Th findings were validated and conclusions through techniques such as model quantization, parallel processing, and hardware acceleration (e.g., GPU, FPGA) to improve real-time processing performance and reduce computational overhead were conducted. The human-machine interaction elements, such as driver feedback mechanisms or visual aids, to enhance user experience and safety in driver-assistance systems. Investigate methods for cross- domain adaptation, enabling the system to generalize well across diverse road types, regions, and driving conditions without extensive retraining was also considered.

Fig. 6. Vehicle Detection on Road

CONCLUSION

In conclusion, this research paper presents an investigation into road lane detection using OpenCV in Python. Through experimentation and analysis, we have evaluated the performance of traditional computer vision techniques and deep learning models. While traditional methods offer simplicity and speed, deep learning approaches demonstrate superior accuracy and robustness, especially in challenging environments. The study highlights the importance of continuous research and development in advancing road lane detection systems for safer and more efficient transportation solution.

REFERENCES

1. Madan, A. K., and Divyansha Jharwal. "Road lane line detection using OpenCV." International research journal of modernization in Engineering Technology and Sciences (IRJETS) (2022).
2. Wang, Zaiying, Ying Fan, and Hao Zhang. "Lane-line detection algorithm for complex road based on OpenCV." 2019 IEEE 3rd Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC). IEEE, 2019.
3. Punagin, Akash, and Sahana Punagin. "Analysis of lane detection techniques on structured roads using OpenCV." International Journal for Research in Applied Science and Engineering Technology 8 (2020): 2994-3003.
4. Nannuri, Venkata Shiva Prasad, et al. "Self Driving Lane Detection Car Using Python and Opencv on Raspberry Pi [R]." EasyChair 2 (2021): 021.
5. Dinakaran, K., et al. "Advanced lane detection technique for structural highway based on computer vision algorithm." Materials Today: Proceedings 45 (2021): 2073-2081.
6. Rathore, Aditya Singh. "Lane detection for autonomous vehicles using OpenCV library." International Research Journal of Engineering and Technology 6.1 (2019): 1326- 1332.
7. Haque, Md Rezwanul, et al. "A computer vision based lane detection approach." International Journal of Image, Graphics and Signal Processing 10.3 (2019): 27.
8. Pandey, Aditi, and Radhey Shyam. "Analysis of road lane detection using computer vision." Int J Softw. Comput. Testing (2023): 7-14.

Integration of AI-driven Relaying Optimization Strategies at the MAC Layer into Cooperative Communication Systems

Smruti Pore
Assistant Professor
Department of Electronics and Telecommunications
DKTE Society's Textile and Engineering Institute
Ichalkarnaji, Maharashtra
✉ sapore@dkte.ac.in

Pradip Chandrakant Bhaskar
Professor
Department of Technology
Shivaji University
Kolhapur, Maharashtra
✉ pcb_tech@unishivaji.ac.in

ABSTRACT

Cooperative communication systems are promising solutions for improving wireless network performance, especially in challenging environments with limited resources and high mobility. However, traditional approaches struggle to adapt to dynamic network conditions. Researchers are now using AI-driven relaying optimization strategies, leveraging machine learning and neural networks to dynamically adjust relaying decisions based on real-time channel conditions, traffic load, and node mobility. This leads to improved throughput, reduced latency, and enhanced energy efficiency. Recent advancements have developed novel AI-driven models tailored specifically for cooperative communication systems, using sophisticated algorithms to learn complex patterns from historical data and make intelligent relaying decisions in real time. These models can effectively optimize relaying performance and adapt to changing network dynamics. Evaluations show promising results, but there is still room for further research and development. Future efforts may focus on refining AI models, incorporating additional input parameters, and exploring novel optimization techniques to enhance efficiency and reliability. The integration of AI-driven relaying optimization strategies at the MAC layer holds great potential for transforming wireless network operations in the future.

KEYWORDS: *AI driven relaying optimization, Cooperative communication, MAC layer protocol, Network performance.*

INTRODUCTION

Cooperative communication systems are designed to address the challenges of dynamic network conditions, such as varying channel states, fluctuating traffic loads, and mobile node environments. The Medium Access Control (MAC) layer, responsible for coordinating communication among nodes, is at the heart of these systems. However, optimizing relaying strategies at this layer presents a significant challenge due to the complexity of network dynamics and the need for real-time decision-making. Existing MAC protocol design approaches often rely on predefined rules or heuristics, which may not adapt well to changing network conditions. In recent years, the integration of AI-driven relaying optimization strategies into the MAC layer has shown promise in addressing this challenge. By leveraging machine learning techniques, such as neural networks, these strategies can learn from historical data and adaptively optimize relay selection, leading to improved throughput, minimized latency, and enhanced energy efficiency. The evaluation of AI-driven relaying optimization strategies is crucial, as it helps validate their effectiveness in real-world settings.

Cooperative Communication

Cooperative communication in wireless networks allows single antenna users to share antennas, providing spatial diversity. However, it has high latency and may not guarantee diversity order. Relay selection protocol mitigates these issues, ensuring diversity order [1].

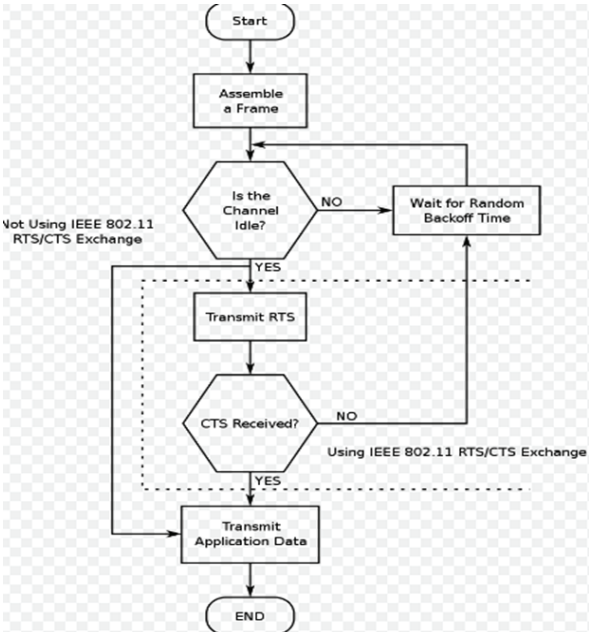


Fig 1. CSMA/CA

LANs due to differences in transmit power, receive sensitivity, distance, and location. The key principles of CSMA/CA include carrier sensing, random backoff, and acknowledgment mechanisms. These techniques help reduce collisions and improve network efficiency. However, CSMA/CA has limitations, especially in high contention and congestion scenarios. It also does not guarantee fairness among competing devices, as devices with longer backoff intervals may experience increased latency.

CSMA/CD

CSMA/CD medium access control protocol means a Carrier Sense Multiple Access with Collision Detection mostly used in wired Ethernet networks to handle collisions when multiple devices transmit data simultaneously over a shared medium. It operates by following steps: carrier sensing, collision detection, and backoff and retransmission.

CSMA/CD is not commonly used in wireless communication systems due to challenges such as signal attenuation, multipath propagation, and hidden terminal problems. Instead, wireless networks typically use CSMA/CA, which focuses on avoiding collisions rather than detecting and resolving them.

In the context of cooperative communication systems and the integration of AI-driven collision avoidance strategies, the focus should be on enhancing CSMA/CA or developing new MAC protocols tailored to the unique challenges and requirements of cooperative communication. These protocols would leverage AI techniques to predict and mitigate collisions, optimize relay selection, and improve overall network performance, rather than relying on collision detection mechanisms like CSMA/CD.

Local collision occurs at the NIC, while remote collision occurs when a frame shorter than the minimum length is transmitted. The channel capture effect occurs when one user of a shared medium "captures" the medium for a significant time, denying other users use of the medium.

COLLISION AVOIDANCE STRATEGIES

AI-driven collision avoidance strategies can enhance data transmission efficiency and network performance in cooperative communication systems. These strategies include transmission scheduling, dynamic contention window adjustment, power control, channel selection, priority-based access mechanisms, adaptive relay selection, learning-based MAC protocols, and cross-layer optimization. AI models can predict collision probabilities, schedule transmission times, adjust contention window size, optimize transmission power, and analyze channel conditions. Priority-based access mechanisms ensure devices with higher priority data have preferential access to the medium. Learning-based MAC protocols use machine learning techniques to adapt to network dynamics and optimize collision avoidance performance.

The hidden node problem in wireless networking occurs when a node is visible to a wireless access point but not to other nodes, requiring RTS/CTS handshaking. Collision avoidance features prevent data collisions, improve network efficiency, reduce data errors, increase throughput, and ensure fairness. However, there are disadvantages such as increased latency, network overhead, limited scalability, and complexity in implementing these protocols.

Collision Avoidnace Strategy	AI-Driven Transmission Scheduling
	Dynamic Contention Window Adjustment
	Transmission Power Control
	Channel Selection and Switching
	Priority-Based Access Mechanisms
	Adaptive Relay Selection
	Learning-Based MAC Protocols
	Cross-Layer Optimization

Fig. 2. Collision Avoidance Strategies

The CSMA/CD protocol minimizes data collisions[3] by ensuring only one node transmits data simultaneously. CSMA/CA uses collision avoidance detection to improve network throughput and delay performance. An optimization algorithm based on scheduling and backoff algorithms is introduced to solve collision problems in the second transmission, including four steps: highest priority-based access mechanism, Priority based access mechanism as shortest remaining time priority, and non-preemptive job scheduling algorithm as shortest job first, and also the first-come-first-served algorithm as depicted in figure no.2.

AI-driven collision avoidance strategies can enhance data transmission efficiency and network performance in cooperative communication systems. These strategies include AI-driven transmission scheduling, dynamic contention window adjustment, power control, channel selection, priority-based access mechanisms, adaptive relay selection, learning-based MAC protocols, and cross-layer optimization. AI models predict collision probabilities, scheduled transmission times, adjust the contention window size, optimize channel selection, and learn machine learning techniques to adapt to network dynamics.

LITERATURE REVIEW

After Systematic analysis, researcher traced that future algo-trading may increase to 95% and so identified GAP as:

Cooperative Communication

The study suggests semantic-forward relay for cooperative communications in sixth-generation (6G) wireless networks, enhancing network robustness against intra-link errors and improving recovered information quality even in bad channel conditions[13]. The study introduces EA-WRAA, a wireless resource allocation algorithm aimed at enhancing user video experience in high-speed mobile networks. It considers network fluctuations, user mobility speed, and environmental factors, adjusting video resolution and bitrate accordingly. EA-WRAA outperforms other algorithms in User QoE, SSIM, and CDF, while maintaining high SSIM values[14]. The paper explores the performance of a wireless and power line communication hybrid relay system using NOMA technology, highlighting the need for further improvements in fairness and reliability[2]. The hybrid relay system's transmission reliability is optimized using a cross-layer optimization model utilizing multi-objective programming to determine the optimal power distribution factor under various parameters. The paper introduces a probabilistic routing model for opportunistic networks, utilizing node meeting probabilities, managing network overload, and incorporating efficient message detection for energy efficiency and reliability[6]. This study explores the use of distributed MAC protocols in wireless networks to address interference and jamming issues. It focuses on hill climbing distributed MAC, which doesn't require a central coordination system and reduces transmission power. The study found that spatial reuse of channels improved by 3%–29% and multichannel throughput by 8% using distributed MAC protocol. Nash equilibrium performed well, focusing on energy utility in the network by individual players. Fuzzy logic improved channel selection by 17% and secondary users' involvement by 8%. Game theory optimization for distributed MAC may increase network performance, with optimal cuckoo search improving throughput by 90% and reducing delay by 91%. Network survival relies on efficient usage of valid patis and avoiding

transmission failures and time slots' effective usage[12]. The study introduces a novel relay selection criterion non-orthogonal multiple access (NOMA) scheme for future wireless communication networks in multi-cell scenarios for improved performance of cell-edge users in wireless communication networks, outperforming existing criteria and requiring less complexity[8].

MAC Layer Protocol

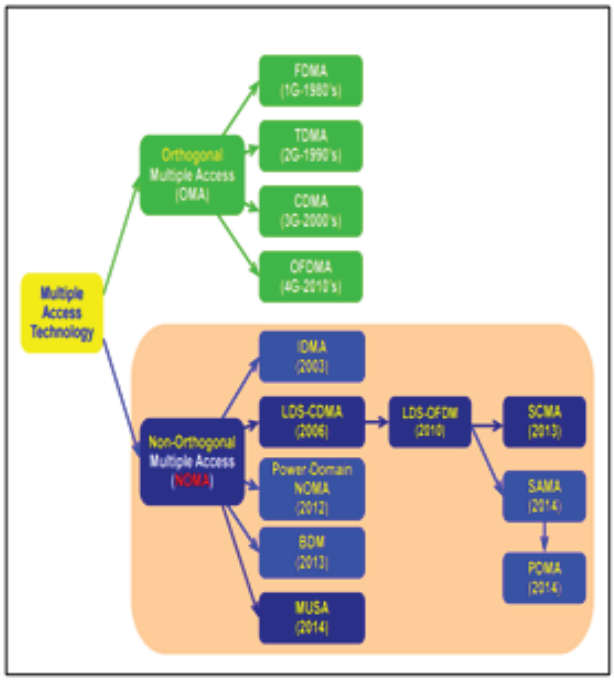


Fig. 3. Multiple Access Technology[9]

Figure no.3 compares OMA, C-NOMA, and Non-CNOMA techniques for uplink and downlink channel fading. It reveals that (NOMA) technique achieves higher rate pairs than OMA-OFDMA, especially in un-symmetric rate pairs. Numerical simulations show (NOMA) outperforms OMA at high SNR levels, with superior performance in more efficient channel conditions.

AI-driven relay optimization Strategies

The research paper presents a power-dividing-based relaying technology with FD Decode and forwarding capability, optimizing spectrum efficiency using SIC and MRC algorithms, and addressing performance-maximizing issues. The Energy recap method is an energy-efficient wireless communication system that optimizes resource allocation and reduces job execution duration. It's applied to relay transmission in the SWIPT scheme, improving signal quality and channel capacity [11]. For D2D communication, the study proposes a deep neural network (DNN) and cognitive radio-driven power control strategy. The two stages of the plan are as follows: the DNN(deep neural network) maximizes transmission power, and cognitive radio chooses secondary users or cellular mobile equipment. The authors suggest AI-driven methods for IoT cellular networks, such as power control aware systems and fully connected neural networks specifically for sub-band allocation. Many measures are used to evaluate the suggested scheme's efficacy[10].

Existing Research Efforts

Researchers have developed AI-driven MAC protocols that optimize resource allocation, scheduling, and contention resolution in wireless networks. These protocols dynamically adapt to changing network conditions and traffic patterns, improving overall performance. Experiments in the real world and simulation experiments have been carried out to assess these protocols' effectiveness. Performance evaluation metrics include throughput, latency, collision rate, fairness, energy efficiency, scalability, adaptability to dynamic conditions, and robustness to interference. Benchmarking studies establish performance benchmarks for AI-driven MAC protocols, while case studies provide insights into their practical implications. Open challenges include security and privacy concerns, scalability to large networks, interoperability with existing standards, and real-time AI algorithm optimization.

The study analyzes particle swarm optimization and genetic algorithms performance in distribution systems, finding that Swarm optimization is affected by the size of the swarm and the inertia weight, while genetic algorithms perform better in protection coordination, system selectivity, and efficiency [7].

Challenges

Protection coordination in distribution systems is a challenge, with traditional methods like particle swarm optimization and genetic algorithms often convergent due to poor control parameter selection. Future research

should focus on standard coefficients, hybridizing metaheuristic methods, sensitivity analysis, and input variable combinations in artificial intelligence models. Adaptive neuro-fuzzy inference systems have shown promising results, making them faster, more accurate, and more efficient solutions for protection coordination problems efficiency [6].

RESEARCH METHODOLOGY

The study aims to integrate AI-driven relaying optimization strategies at the MAC layer into cooperative communication systems. It involves defining the objectives, reviewing existing literature, selecting relevant AI-driven strategies, creating a system model, implementing and integrating the strategies, designing scenarios, defining performance metrics, conducting simulations, analyzing results, and evaluating the effectiveness. The study also conducts data analysis and evaluation, comparing results with baseline scenarios and existing approaches. The findings are then discussed and concluded, highlighting the feasibility, effectiveness, and practical implications of the proposed approach. Future research directions are identified, and the findings are documented in a detailed report or research paper. This methodology can lead to improved performance and efficiency in wireless network systems. The findings can be used to inform future research and enhance the integration of AI-driven relaying optimization strategies in cooperative communication systems.

The General Framework of Relaying Performance Optimization Implementation using AI is-

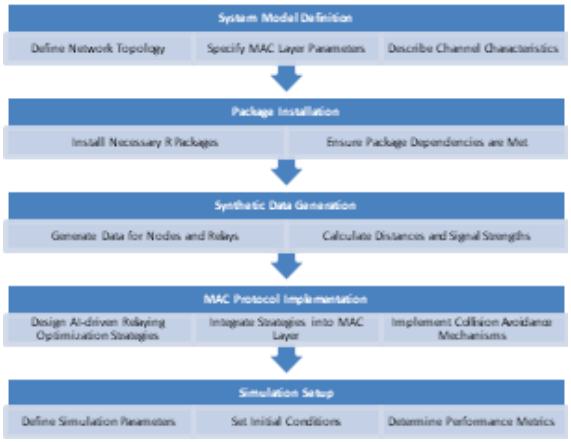


Fig. 3. Relaying Performance Optimization Framework

The system model involves defining network topology, specifying MAC layer parameters, and describing channel characteristics. Package installation is crucial, and synthetic data is generated to represent nodes and relays. AI-driven routing optimization strategies are developed, integrating into the MAC layer for dynamic resource allocation and collision avoidance. Collision avoidance mechanisms are introduced to detect and mitigate collisions. Simulation parameters are defined, and initial conditions are set. Performance indicators used to assess the system's performance under different conditions and settings include throughput to reflect productivity, packet delivery ratio to estimate transmission of packets, delay from end to end, fairness, and energy consumption.

Proposed prototype development for optimization of Realaying Performance

System Model -> Data Set-> MAC Protocol Implementation -> Simulation

N/W, MAC, Channel->Data Processing-> Quantifying Data-> AI-driven relaying optimization for Collision Avoidance -> Simulation

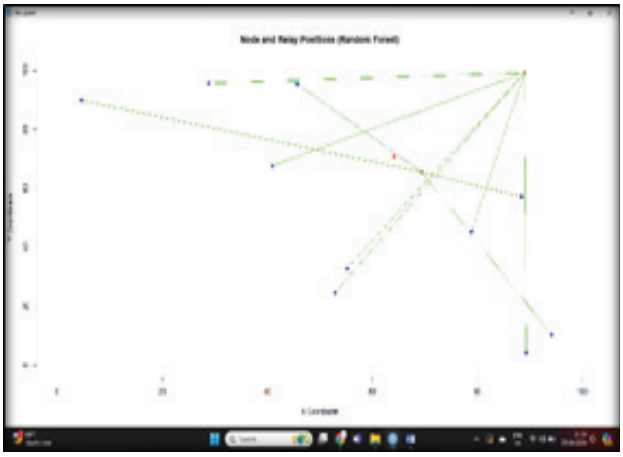


Fig. 4. Random Forest Relaying

The MAC Protocol Implementation stage focuses on designing and integrating AI-driven relaying optimization strategies using the Random Forest algorithm. This involves training the Random Forest model with synthesized data to optimize relay selection in cooperative communication systems. The model is trained on a bootstrap sample of data and feature randomness is introduced for better generalization. The

model is then integrated into the MAC layer, ensuring efficient data transmission. Collision avoidance mechanisms are also implemented to prevent packet collisions and manage contention. Techniques like carrier sensing, random backoff, and contention window adjustment are used to manage contention and reduce collisions.

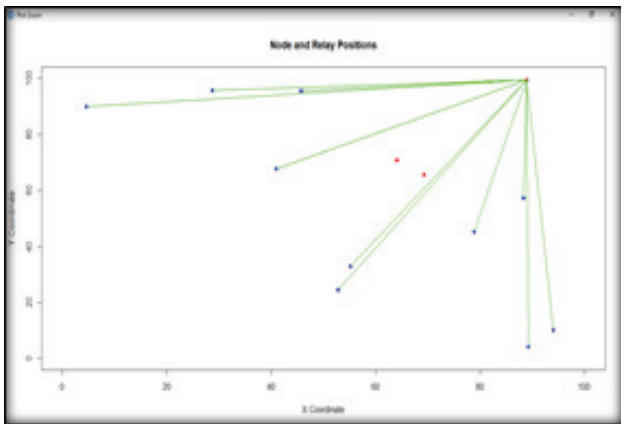


Fig. 5. Gradient Boosting Relaying

The process involves designing an AI-driven MAC protocol using neural networks, focusing on objectives like maximizing throughput, minimizing latency, and optimizing energy efficiency. Key parameters like channel state information, traffic load, and node mobility are considered. Neural networks are chosen due to their ability to learn complex patterns and adapt to changing conditions. The neural network architecture is tailored to the protocol's requirements, and the model is trained using real-world data. The model is integrated into the MAC layer of cooperative communication systems, minimizing computational overhead and latency.

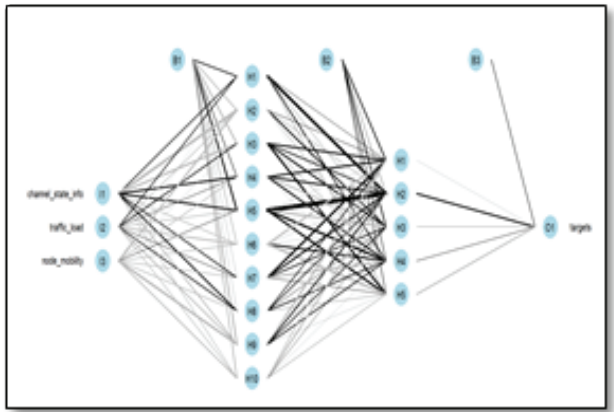


Fig. 6. Neural Network Model Implementation Plot

To minimize the discrepancy between the expected outputs and the actual objectives, the neural network must be trained by modifying the weights and biases of its connections. Visualizing the neural network architecture provides insights into its complexity, including the number of layers and neurons, which can help understand its learning capacity. Once trained, the neural network can make predictions on new data, allowing for real-world applications such as classification or regression tasks.

Table 1: AI-Driven MAC Protocol Neural Network Model Composition

Input Parameters, Target and Result				
Channel State Info	0.8	0.7	0.6	0.5
Traffic Load	100	150	200	250
Node Mobility	2	3	4	5
Target	0.9	0.8	0.7	0.6
Result	0.89	0.81	0.69	0.61

Table no.1 displays the input parameters, targets, and outcomes of a neural network implementation that was created to maximize relaying efficiency in a cooperative communication system.

Input Parameters

Channel State Information: This represents the channel's quality, which falls between 0.5 and 0.8. Greater values indicate improved channel conditions.

Traffic Load

This represents the amount or volume of data transmitted in the network, measured in subjective units.

Node Mobility

This indicates how quickly nodes move around the network. Higher values indicate quicker node mobility

Target

These are the intended or desired results, or targets or goals, for the optimization procedure. They probably stand for a performance parameter that has to be increased or lowered(maximized or minimized) in this situation.

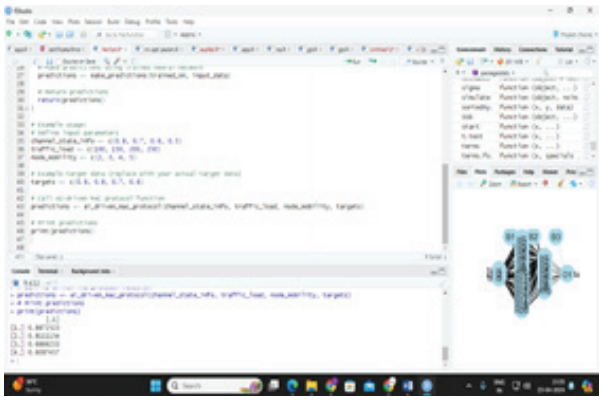


Fig. 7. Prototype Implementation

Result

Based on the supplied input parameters, the values in this column indicate the output or predictions produced by the neural network model. The values seem to be very constant between various input settings, indicating that the neural network model produces comparable outcomes under varied circumstances.

These predictions deliver the projected MAC protocol performance metrics (throughput, latency, energy efficiency), depending on the input parameters (node mobility, traffic load, and channel state information). Under such particular conditions, the expected performance of the MAC protocol is projected to be better the higher the predicted value.

The predictions generated from the AI-driven MAC protocol using neural networks as observed in figure no. 7, offer insights into the anticipated performance of the system across different scenarios. Each prediction corresponds to a specific combination of input parameters, including channel state information, traffic load, and node mobility. For instance, the prediction of 0.8944291 for the first set of parameters suggests a relatively high expected performance level, possibly indicating efficient throughput, minimal latency, or optimized energy usage. Conversely, the prediction of 0.6090428 for the fourth set of parameters implies a comparatively lower performance expectation. These predictions serve as valuable indicators for understanding how the MAC protocol might behave under varying network conditions, guiding further optimization efforts and adjustments to enhance overall system performance and efficiency.

FUTURE SCOPE FOR RESEARCH

Figure 8 represents that the core concepts and methodologies related to optimization and prediction in AI-driven relaying systems include Genetic Algorithm, Optimization, AI-driven relaying Optimization, Dynamic Relaying Classification/Patterns, Machine Learning, and Prediction. The neural network models' predictions provide insightful information about the anticipated performance of the system in various circumstances, directing future optimization efforts and improving network efficiency as a whole. AI-driven MAC protocols have the potential to significantly increase the efficiency and dependability of communication networks as research in this field progresses, which will ultimately benefit a wide range of applications in different sectors.

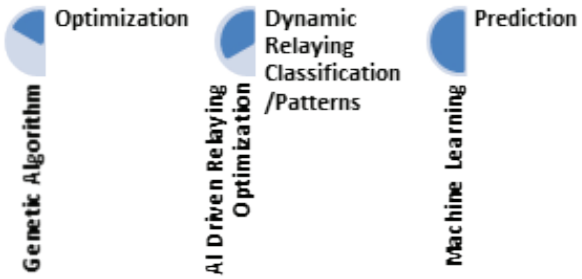


Fig. 8. Hybrid Model for Realying Optimization

Genetic Algorithm is a metaheuristic optimization algorithm inspired by natural selection, while Optimization is the process of finding the best solution from all feasible solutions. AI-Driven Relaying Optimization involves dynamically adjusting relay configurations based on changing network conditions to improve performance. Machine Learning algorithms analyze data and make intelligent decisions regarding relay configurations. Prediction techniques estimate future outcomes based on historical data or patterns.

CONCLUSION

The technique was proposed and implemented as an experiment to come up with a Novel concept for AI-driven relaying performance optimization in cooperative communication networks. The designed AI-driven prototype for the proposed neural network-based model gives simplification and improvement in transmission efficiency. Relaying efficiency in

communication networks may be increased using AI-driven MAC protocols that leverage neural networks. By applying sophisticated algorithms and machine-learning techniques, these protocols may maximize throughput, reduce latency, promote energy economy, and adjust to changing network conditions.

REFERENCES

1. Alkhayyat A., Hammood D. A. and Mahmoud M. S. (2020), "Relay Selection Algorithm in Cooperative Communication System," 2020 3rd International Conference on Engineering Technology and its Applications (IICETA), Najaf, Iraq, pp. 226-230, doi: 10.1109/IICETA50496.2020.9318889
2. Chen, Zhixiong, Tianshu Cao, Pengjiao Wang, and Junhao Feng. 2024. "Research on Hybrid Relay Protocol Design and Cross-Layer Performance Based on NOMA" Applied Sciences 14, no. 7: 3044. https://doi.org/10.3390/app14073044
3. Gao, Z., Zhang, N., & Han, H. (2018). Analysis and Design of Collision Avoidance Optimization Algorithm Based on CSMA/CA., https://doi.org/10.2991/cecs-18.2018.16?sid=semanticscholar
4. Khalil, A., & Zeddini, B. (2024). Cross-Layer Optimization for Enhanced IoT Connectivity: A Novel Routing Protocol for Opportunistic Networks. Preprints. https://doi.org/10.20944/preprints202404.0342.v1
5. Langazane S. N., Saha A. K., 2022, "Effects of Particle Swarm Optimization and Genetic Algorithm Control Parameters on Overcurrent Relay Selectivity and Speed," in IEEE Access, vol. 10, pp. 4550-4567, doi: 10.1109/ACCESS.2022.3140679.
6. Noori Shirazi, M.B., Zahabi, M.R. (2024), Sum-Rate and Energy Efficiency Optimization by Novel Relay Selection in a NOMA-Based Cooperative Network in the Presence of Interference. Wireless Pers Commun 134, 225–248. https://doi.org/10.1007/s11277-024-10905-x
7. Physical Communication, Volume 64, 102321, ISSN 1874-4907, https://doi.org/10.1016/j.phycom.2024.102321.
8. Rathod T., Tanwar S.(2024), A DNN-orchestrated cognitive radio-based power control scheme for D2D communication,
9. Salar I. Ahmed1, Siddeeq Y. Ameen(2024), 5G Mobile Communication Performance Improvement with Cooperative-NOMA Optimization, International Journal of Computing and Digital Systems ISSN (2210-142X), 1571001387.pdf (uob.edu.bh)
10. Salvin, G. L., & Linsely, J. A. (2024). QoS optimization for full-duplex enabled relaying system with consecutive interference annulment. Automatika, 65(2), 463–472. https://doi.org/10.1080/00051144.2023.2297482
11. Subramanyam, R., Jancy, Y.A. and Nagabushanam, P. (2024), "Cooperative optimization techniques in distributed MAC protocols – a survey", International Journal of Pervasive Computing and Communications, Vol. 20 No. 2, pp. 285-307. https://doi.org/10.1108/IJPCC-07-2022-0256
12. W. Lin, Y. Yan, L. Li, Z. Han and T. Matsumoto(2024), "Semantic-Forward Relaying: A Novel Framework Toward 6G Cooperative Communications," in IEEE Communications Letters, vol. 28, no. 3, pp. 518-522, doi: 10.1109/LCOMM.2024.3352916
13. Wang, Luyao, Jia Guo, Jinqi Zhu, Xinyu Jia, Hui Gao, and Ye Tian. 2024. "Cross-Layer Wireless Resource Allocation Method Based on Environment-Awareness in High-Speed Mobile Networks" Electronics 13, no. 3: 499. https://doi.org/10.3390/electronics13030499
14. https://www.geeksforgeeks.org/collision-avoidance-in-wireless-networks/

Predicting Liked Percentage of Book using Artificial Neural Network and Voting Regressor in Book Recommendations

Suhasini Vijaykumar
Manish Kumar Dubey
Shambhu Shankar Rai
Jyoti Kharade
Mansi Borhade

Bharati Vidyapeeth's Institute of Management and Information Technology
Maharashtra

ABSTRACT

The purpose of this study is to remodel the prediction of liked percentage in the book recommendation with the approach of Artificial Neural Network (ANN). This model integrates several important factors such as genres, authors, rating as the feature variables and liked percent as the target variable so that the ANN model can make accurate prediction of liked percentage of the book. By using Good Reads Best Book Ever dataset, the research focuses on the improvement in the accuracy of predicting liked percentage as compared to other traditional methods. In addition to ANN, the study also focuses on improving the model performance using Voting Regressor which further uses two base models- Random Forest Regression and Gradient Boosting Regression to optimize the mean squared error and which can also help in enhancing the book recommendation. These measures help to contribute to the vast user reading experience which can be considered as satisfactory.

KEYWORDS: *Artificial Neural Networks, Book recommendations, Predictive analysis, Good reads, Ensemble learning.*

INTRODUCTION

It is getting more challenging in today's tech-driven world to get the right book suggestions for the readers due to large number of people turning to online platforms for book recommendations. What if an online tool could help the users make better decisions by recommending what content to read? This is where the Recommendation System proves useful for the readers to find remarkable literature and keep them connected to the online platform. Reading preferences along with suitable liked percentage makes it even more accurate and enjoyable ensuring the users tastes are closely aligned.

LITERATURE REVIEW

This part will describe similar work on the recommender systems and use of various filtering, machine learning and deep learning techniques. The first paper on collaborative filtering techniques was Tapestry in 1992 [5]. The system did record users' reactions and contributed by providing the records to other users as feedback. The first paper on collaborative filtering techniques was Tapestry in 1992 [5]. The system did record users' reactions and contributed by providing the records to other users as feedback. The first paper on collaborative filtering techniques was Tapestry in 1992 [5]. The system did record users' reactions and contributed by providing the records to other users as feedback. The study by Mahmoud Harara et al, discusses Artificial Neural Network model to predict the rating of a book. They attempt to present a comprehensive survey constituting Neural Network model to address the challenges of complex connections between the different features of books and ratings received from the readers, which can serve as a road map for research and to practice in that specific area.[1] The study by Ping Zhao, Xinfeng Ye, et al, discuss ANN model to accurately predict the users rating scheme that considers both similarity-based rating and the ratings given by the users.[2] Considering that the above measures are not enough to evaluate the appropriateness of the

recommendations. The crucial factor is to consider the real input data to get the real output. The studies apply deep learning techniques such as Artificial Neural Networks, Random Forest Regression, and Gradient Boosting Regression for comparison of evaluation metrics such as Mean Square Error and R2 score to decide which of them gives the best performance in terms of accuracy to get the predictions of liked percentage of a book for users.

RESEARCH METHODOLOGY

This study aims to predict liked percentage(s) for book suggestions using an approach known as Artificial Neural Networks (ANN). The dataset, for this study consists of 52,478 entries and 51,856 liking percentages gathered from the Good Reads dataset. The research question of "How can we predict liked percentage using Artificial Neural Network (ANN) and Ensemble Learning Techniques to recommend books?" has been studied in detail. 90% of the dataset is utilized for training and 10% of the dataset instances are used for network validation.

Dataset Description

The data is gathered from Good Reads Best Books Ever books dataset having attributes of 52,478 books. book id - books unique identifier; title - name of the book; author - author name who wrote the book; genre - different book categories; language - the language in which book is available; rating - overall score assigned to the book on predefined criteria; pages - total number of pages in book to indicate its volume; publisher - the entity responsible to produce and distribute book; publish date - the date on which the book was published; liked percent - percentage of readers who expressed positive sentiments; cover image - visual representation of book's cover design; price - monetary cost associated with purchasing the book.

The flow of the system is shown in Figure 1. The Good Reads raw dataset is collected from an open source which existed in a complex format, later extracting data to a simpler format. The basic exploration of the dataset is done such as checking the first five and last five rows of the dataset, checking the dimensions of the data (number of rows and columns), checking the non-null values and datatype of each feature present, plotting the correlation matrix to find out the positive and negative correlation between the variables.

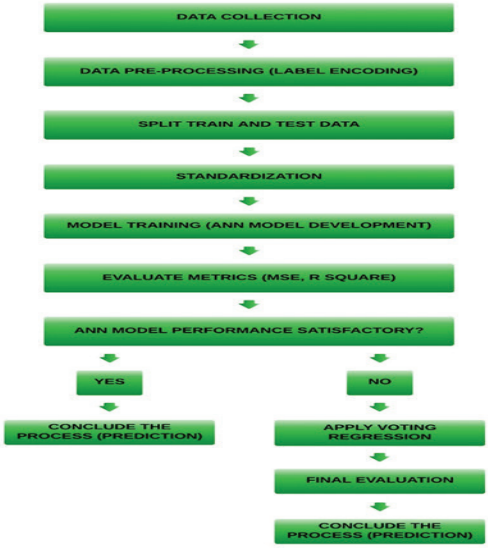


Fig. 1. ANN Flowchart

The columns in the dataset have been renamed for easy reference, irrelevant columns are dropped, the further required columns are pre-processed accordingly, outliers for every numerical column (book id, rating, pages, liked percent, price) are checked and null or missing values are removed for smoother process. The positive and negative relationship between feature variables is analysed with the help of heatmap, as shown in Figure 2 which says that ratings and liked percent show positive correlation among themselves. The categorical variables (genre, author) are encoded using a label encoder wherein the label encoder converts categorical variables into numerical representations by assigning a unique integer to each category.

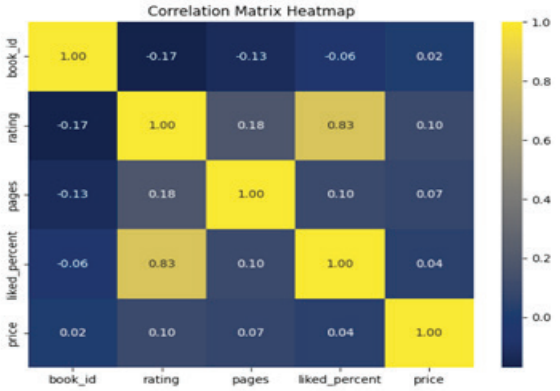


Fig. 2. Correlation Matrix Heatmap

Encoded Value = f(Category) Example: f(Adventure) = 0; f(Fantasy) = 1; f(Horror) = 2 ; f(Fiction) = 3

The data is split into a training dataset and a testing dataset. The feature variables (encoded genre, encoded author, rating) are defined into X and the target variable (liked percent) is defined into y. Later, the variance of the target variable is calculated to be 19.91%. The numerical features are standardized and are centred approximate to mean with standard deviation unit; the attribute's mean becomes 0 and result has standard deviation unit and it also reduces the impact of outliers. The model is trained using Artificial Neural Network with an input layer having 3 input features namely the genre, the author, and the rating as shown in Figure 3.

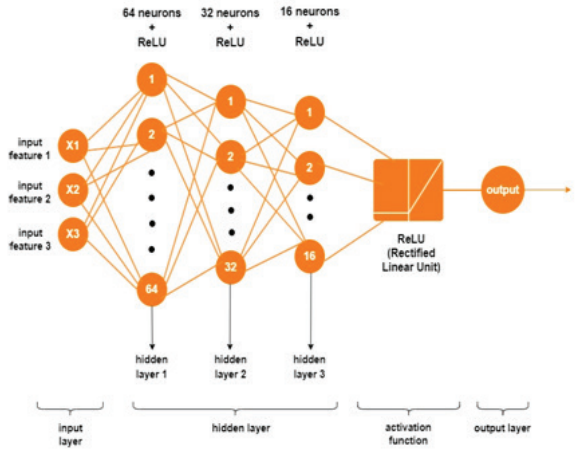


Fig. 3. Artificial Neural Network Model

The input features go to each neuron of hidden layer 1 (64 neurons), hidden layer 2 (32 neurons) and hidden layer 3 (16 neurons) where it takes the output from previous layer as the input, and output layer has 1 neuron as it is predicting continuous variable. The activation function used is Rectified Linear Unit (ReLU) as it replaces negative values to zero. This leads to an optimization process enabling neural networks to learn and adapt more effectively.

The compilation of the model is done with the 'Adam' optimizer, with metrics as Mean Square Error. The model is trained and evaluated by giving 80 epochs, batch size as 32, validation split as 0.1 and verbose 1 to test the accuracy of the model. It shows the Mean Absolute Error, Mean Square Error and R2 as 1.61, 4.02 and 0.73 (73% accuracy) respectively. The data is split into training and testing sets followed by which the individual models Random Forest Regressor, and Gradient Booting Regressor are initialized wherein these models act as estimators for the ensemble model. The Voting Regressor ensemble model is created that takes a list of tuples having a unique name for the model and model object. The ensemble model is trained by using the training data and after the training is completed, predictions are made on the testing data. The model is evaluated using the metrics Mean Square Error and R2. The scores are 3.41 and 0.76 respectively.

The 'Voting Regressor' method is used to combine the predictions of two base models Random Forest Regressor and Gradient Boosting Regressor. The Random Forest Regressor (first base model) is an ensemble of decision trees where they work together to solve a complex problem with different perspectives and later by combining those insights, we can make better predictions. The Gradient Boosting Regressor (second base model) is an ensemble of weak learners (decision trees) where each tree corrects the errors of the previous ones. The Voting Regressor combines both models and calculates the average of each model's separate predictions as depicted in Figure 4

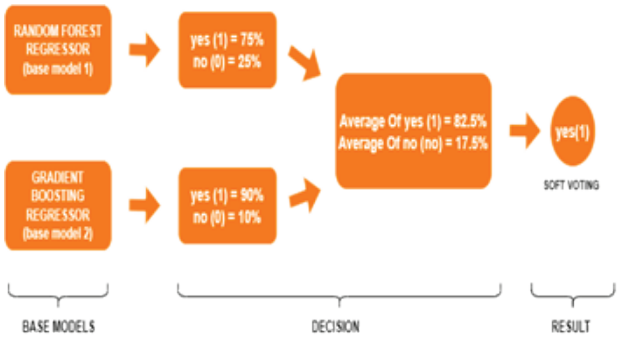


Fig. 4. Voting Regression (Ensemble Model) Flowchart

The Voting Regression (also known as Soft Voting process) model calculates the average predictions of every base model (Random Forest Regression and Gradient Boosting Regression). The model which has the highest total average from the combination of all base models is considered as the final result. The probability of Yes (1) is high than the probability of No (0) of each base model, therefore, Yes (1) is the final result or prediction for the model. The advantage of Random Forest Regressor and Gradient Boosting Regressor combination is that it benefits from the

strengths of both models i.e Random Forest Regressor reduces overfitting and Gradient Boosting Regressor reduces bias and improves accuracy. The ensemble model predictions done on the testing data are assessed using Mean Absolute Error (MAE), Mean Square Error, and R2 which gives 1.42, 3.41, and 0.76 (76% accuracy). The user sets the values of each feature to get the prediction of the book's liked percentage value, then those values are encoded according to the training data, further the encoded values are again standardized to ensure that input features are on similar scales. With this, the book recommender model predicts the liked percentage of a specific book using Artificial Neural Network (ANN) and Voting Regressor model.

ANALYSIS AND FINDINGS

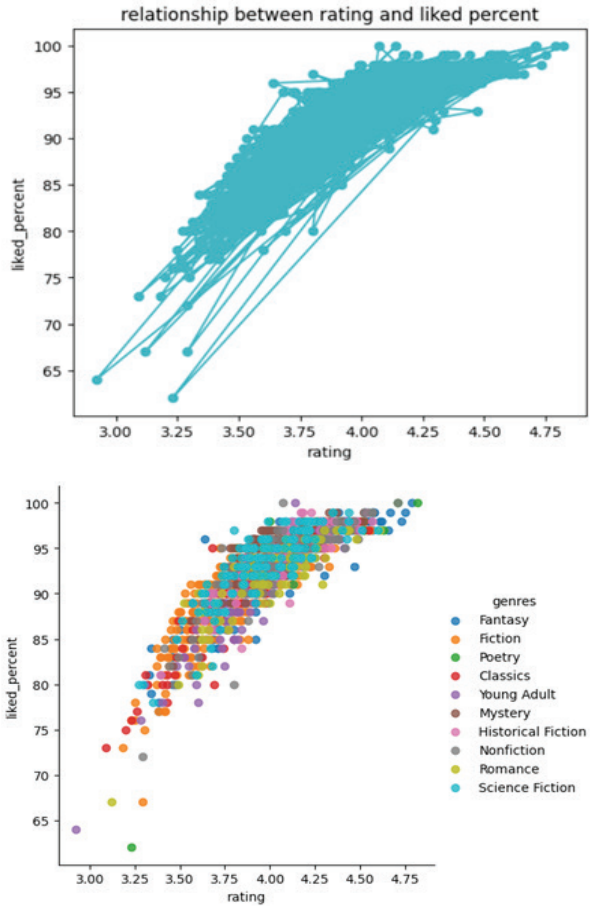


Fig. 5. Correlation between the rating and the liked percentage

Figure 5 shows a positive correlation between rating and liked percent; as the rating tends to increase, the percentage also increases. The books that are rated higher are the ones which people tend to like the most. The distribution of ratings and liked percent across different genres shows that genres such as Science Fiction and Fantasy tend to have higher ratings and liked percent and they are most popular genres amongst them all.

The Figure 6. shows the graph of liked percent over the years shows that around 1900 to 1940 there was a decrement in books liked percentage, however after 1940 there was an increment till around 1960. Then post 1960, there were heavy fluctuations in liked percentage of books between 1960 to 2020.

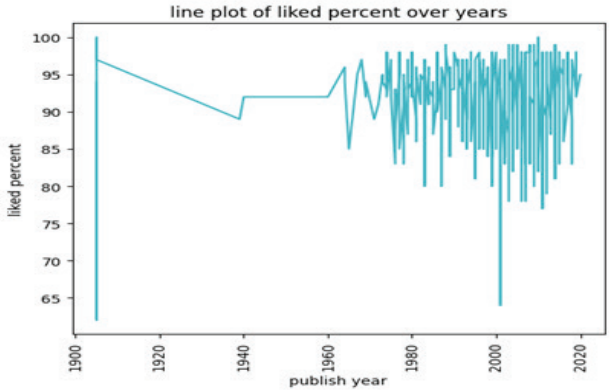


Fig. 6. Line plot of liked percent

The Figure 8. shows the graph of liked percent over the years shows that around 1900 to 1940 there was a decrement in books liked percentage, however after 1940 there was an increment till around 1960. Then post 1960, there were heavy fluctuations in liked percentage of books between 1960 to 2020.

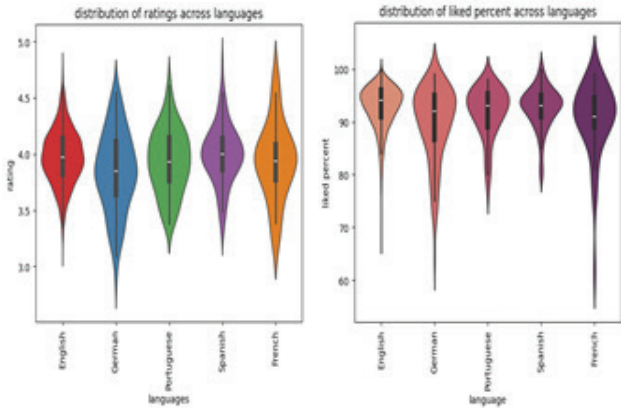


Fig. 7. Ratings and liked % across Languages

From the Figure 7 we can observe the white dot present which indicates the data have some outliers in the middle and the lower ends of the plot. In the distribution of ratings across languages, English and French language have equal distribution of ratings. In the distribution of liked percent across languages, French and German language have more elongated distribution as compared to English, Portuguese and Spanish.

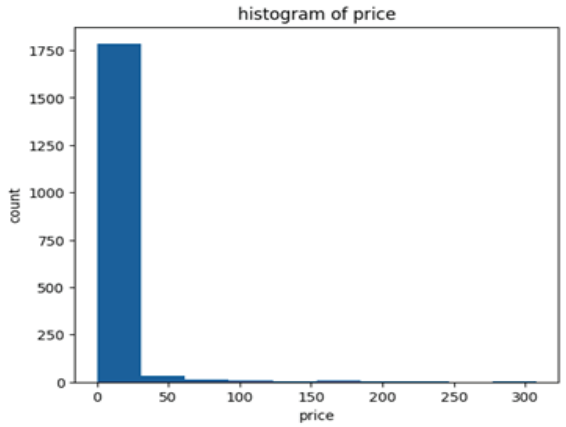


Fig. 8. Histogram of price

The Figure 8 shows the distribution of book price, is skewed towards low price range between $50 to $100. The liked percent of books, shows positive skewness where more books are liked between 70% to 80% as shown in Figure 9. The Figure 10 depicts the years of books published, showing the number of books published have increased over the past 20 years. The rating histogram shows zero skewness as in the Figure 11.

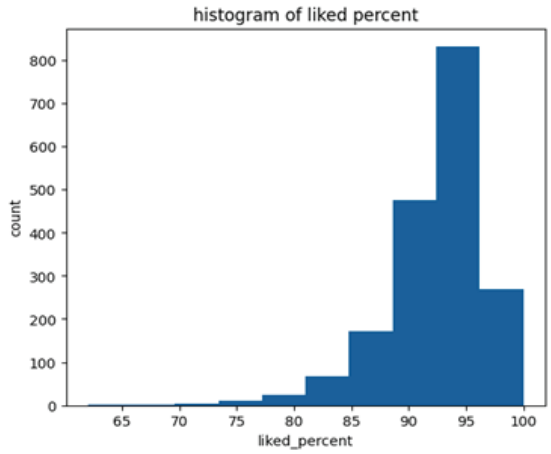


Fig. 9. Histogram of liked percent

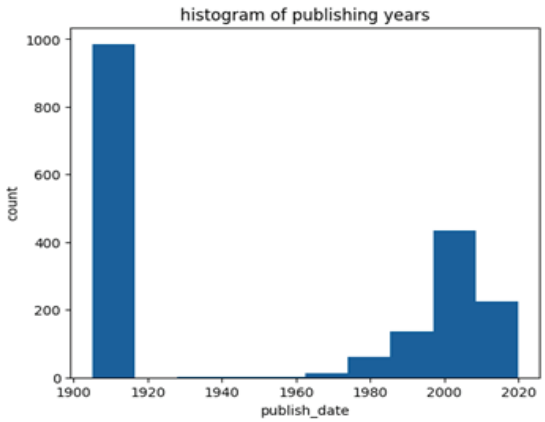


Fig. 10. Histogram of publishing years

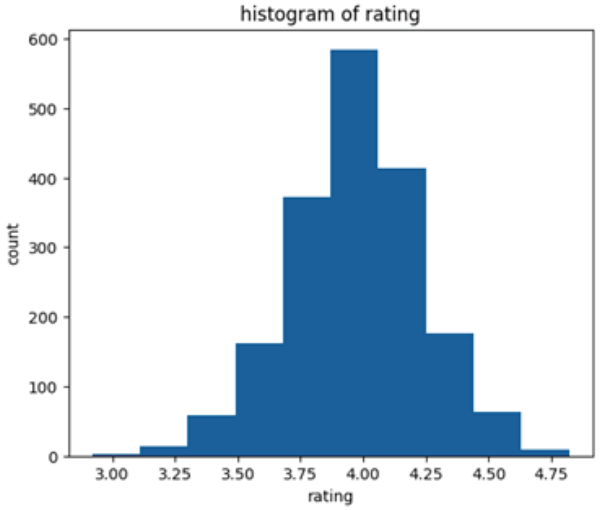


Fig. 11. Histogram of rating

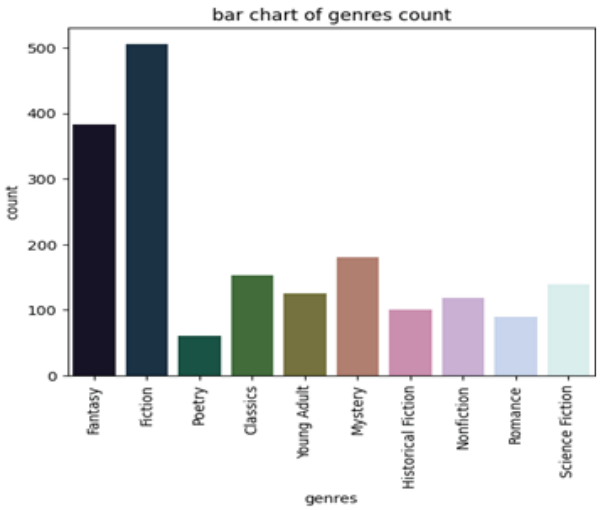


Fig. 12. Bar Chart of Genres count

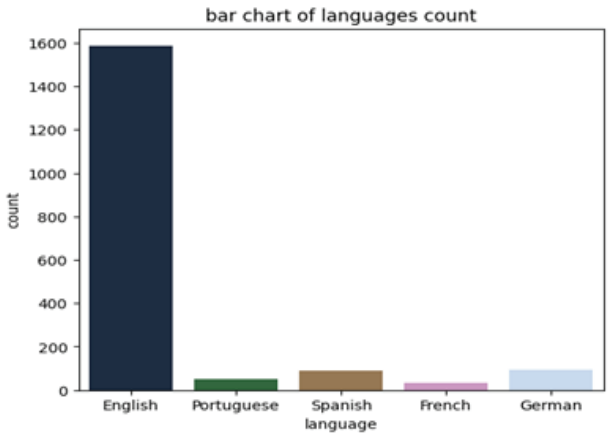


Fig. 13. Bar Chart of Languages count

The genres such as Fiction and Fantasy have highest number of books as shown in Figure 12. The figure 13 shows the languages such as English has highest count of books with French language with lowest count of books. The stacked bar chart shows the count of book distribution of genres in each language as in Figure 17.

The model, experimented with Artificial Neural Network (ANN) gives 73% accuracy and later, the application of Voting Regressor, an Ensemble Learning Technique improved the model accuracy to 76%. With utmost ease, the users can determine the liked percentage of a particular book. The main goal of this study is to examine a model that can more accurately predict the percentage of positive or negative reviews for a book. The model underwent experimentation using both Artificial Neural Networks and Voting Regressor approach, which proved to have better accuracy rate.

CONCLUSIONS

The study found that a system makes estimates about how much people like books by using Artificial Neural Network, Voting Regressor with Random Forest, and Gradient Boosting Regression as ensemble models. The system is evaluated using Mean Square Error and R2, getting scores of 3.41 and 0.76. The Voting Regressor combines the predictions of two base models, Random Forest, and Gradient Boosting, to be more exact. The combination of Random Forest Regressor and Gradient Boosting Regressor reduces overfitting and bias, improving accuracy. The model's accuracy improved to 76% after incorporating Voting Regressor, allowing users to determine the liked percentage of a book as shown in the table below.

Formulae \ Model	ANN (Artificial Neural Network) Model	Voting Regressor Ensemble Model (used to improve accuracy)
mean absolute error = $\frac{1}{n}\sum_{i=1}^{n}\lvert y_{true,i} - y_{pred,i}\rvert$	1.61	1.42
mean squared error = $\frac{1}{n}\sum_{i=1}^{n}(y_{true,i} - y_{pred,i})^2$	4.02	3.41
r2 score (r^2) = $1-\frac{\sum_{i=1}^{n}(y_{true,i}-y_{pred,i})^2}{\sum_{i=1}^{n}(y_{true,i}-y_{true})^2}$	0.73 (73%)	0.76 (76%)

REFERENCES

1. M. Harara and S. S. Abu-Naser, "Unlocking Literary Insights: Predicting Book Ratings with," International Journal of Engineering and Information Systems (IJEAIS), vol. 7, no. 10, pp. 22-27, 2023
2. P. Zhao and X. Ye, An Artificial Neural Network for Predicting Service Rating in the Presence of, IEEE International Conference on Services Computing (SCC), 2015, pp. 608-615.
3. Sewar Khalifeh, "A Book Recommender System Using Collaborative Filtering Method," DATA'21: International Conference on Data Science, E-learning and Information Systems 2021, pp. 131-135, 2021.
4. D. Jain, "R-squared in Regression Analysis in Machine Learning," Geeks For Geeks, [Online]. Available: https://www.geeksforgeeks.org/ml-r-squared-in-regression-analysis/.
5. S. M. B. B. A. N. Dersin Daimari, "Favorite Book Prediction System Using Machine Learning Algorithms," JAETS, vol. 4, no. 2, pp. 983-991, 2023.

Unveiling Twisted Doubling Hessian Curve Cryptography for Enhanced Security in Software Defined Networks Intrusion Detection System

Zahirabbas J. Mulani
Bharati Vidyapeeth Institute of Management and Information Technology
University of Mumbai
Mumbai, Maharashtra
✉ zahirabbas.mulani@mithibai.ac.in

Suhasini Vijaykumar
Bharati Vidyapeeth Institute of Management and Information Technology
University of Mumbai
Mumbai, Maharashtra
✉ suhasini.kottur12@gmail.com

ABSTRACT

Software Defined Networks is an innovative epoch of network management, offering agility and programmability where traditional methods were rigid. However, it faces challenges due to potential vulnerabilities within the control plane's operating system. A successful compromise of this system could grant attackers a comprehensive overview of the network, akin to a detailed map. This visibility could be exploited to gain centralized control, potentially disrupting or manipulating network traffic. Furthermore, robust authentication, authorization, and access control mechanisms are essential to prevent unauthorized access and strengthen the overall security posture of SDN deployments. This work proposes a secure user access system for mobile users. The system employs a multi-factor registration process, requiring both personal information and device details. This data is used to generate unique key pairs and QR codes for each user. The QR codes serve as a second layer of verification and are stored securely with a corresponding cryptographic hash. This hash is then distributed to the user, the network switch, and the system controller. Login utilizes a three-factor approach: username, password, and a digital signature generated using the user's private key on a retrieved hash. The network switch verifies the signature, granting access only upon successful verification. We propose a Twisted Doubling Hessian Curve Cryptography which strengthens the overall system security posture and requires less time for encryption and decryption compared to present AES, RSA, ECC, and RSA cryptography solutions in the Ubuntu mininet testbed.

KEYWORDS: *Software defined networks, Intrusion detection system, Curve cryptography, Authentication and authorization.*

INTRODUCTION

The future is primed for a shift from traditional networks to Software-Defined Networking (SDN) due to its enticing advantages: flexibility, scalability, clear network visibility, and cost-efficiency. Market projections anticipate a significant surge in SDN adoption, with the market scope anticipated to jump from $14 billion in 2020 to more than $33 billion in 2025 [1]. While current organizations are humble [2], a critical shift towards SDN is not too far off. Be that as it may, this change accompanies a critical proviso uplifted weakness to attacks. Not at all like conventional organizations, SDN separates the control plane from the information plane. This detachment offers more noteworthy adaptability and programmability [10]. The key SDN component Controller characterizes how traffic streams, designs network gadgets, and screens generally speaking organization's well-being, Data Plane (Switches and Routers) devices handle the actual forwarding of data packets based on instructions received from the controller. Unlike traditional networks with independent routing decisions, SDN switches function as intelligent forwarding elements and the Application component of SDN allows for the development and deployment of network applications on top of the controller [11]. These applications leverage the network's programmability to perform various

functions like security enforcement, load balancing, and traffic optimization.

Network Intrusion Detection Systems (NIDS) have become a vibrant tool for both academic and industry researchers. Most of the existing systems concentrate on attack detection based on received packet patterns [3-6]. It doesn't concentrate on the behaviour of the user for a Volumetric Attack. Most of the existing system doesn't concentrate on the data security of the flow entry table to prevent the data from insider attack [7-9]. In this proposed system the users register with personal details, get key pairs and a QR code uploaded to secure storage. Login involves username, password, QR code scan, and digital signature verification for secure access. TDHCC proposed herein boosts the security of packet transmission from a mobile user. It achieves faster encryption of data packets compared to RSA and ECC, therefore enhancing the overall system performance.

RELATED WORK

The security landscape of next-generation networks like SDN,5G-IoT is poised for a dramatic escalation in complexity. Ensuring both network security and reliability demands a paradigm shift in our approach, with robust node authentication taking center stage as the foundation of a secure ecosystem [21]. Several research works have been conducted in for secure packet authentication, TH-DH leverages the properties of twisted Hessian curves to offer a variant of the Diffie-Hellman key exchange, potentially improving efficiency or security. This application constructed with Maple [13] uses a key agreement protocol to securely establish a shared secret between two parties. Each party has a unique public-private key pair based on a twisted Hessian curve. This secret key can be used directly for encryption or to generate another key for secure communication over unencrypted channels. Authors in [6] presented an SDN-based Intrusion Detection System (IDS) that utilized Support Vector Machines and Selective Logging for Internet Protocol (IP) Traceback. SVM was utilized for intrusion detection by classifying data points into different categories to identify anomalous traffic patterns. IP traceback was used to identify the real source of packets in the event of an attack. The results enhanced the system's ability to trace malicious activities effectively. Authors in [19] proposed a novel authentication mechanism called HessianAuth for resource-constrained Internet of Things (IoT) devices in IPv6 over Low-power Wireless Personal Area Networks. The key contribution lies in leveraging Hessian curves for elliptic curve cryptography (ECC) operations, aiming for better efficiency compared to traditional methods. Authors in [20] presents an interesting approach to secure D2D communication in 6LoWPANs with HessianAuth. The use of distributed authentication and the focus on resource efficiency are valuable contributions. Addressing the weaknesses mentioned above, particularly providing a deeper dive into Hessian curves and exploring real-world implementation possibilities, would strengthen the research and pave the way for practical application. Authors in [21] delves into the complexities of heterogeneous. In [23], the authors deliver a valuable message about the importance of secure ECC implementation. Elliptic Curve Cryptography (ECC) has revolutionized the landscape of secure data transmission. Compared to traditional symmetric cryptosystems, ECC offers significant performance advantages. Its brilliance lies in achieving equivalent security levels with a remarkably smaller key size. This translates to faster processing speeds, higher throughput, and reduced resource requirements, making it ideal for resource-constrained environments [24]. The Elliptic Curve Cryptography (ECC) algorithm can be broken down into four hierarchical layers, each handling distinct cryptographic operations [25].

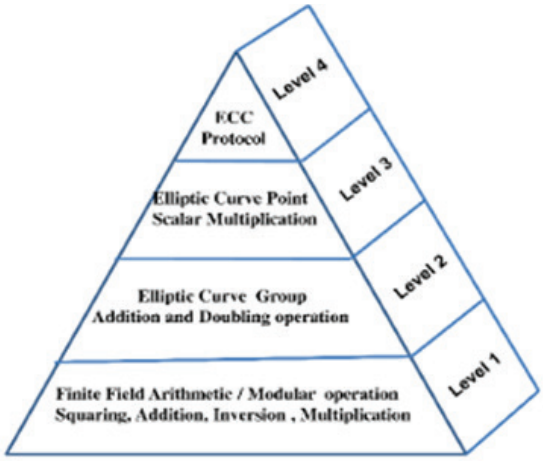


Fig. 1 Multifaceted Layers of ECC Security [26]

Level 1 carries elementary tasks like exponentiation and squaring involving calculations within a limited field that essentially acts as the base for ECC operations. The point addition and multiplication in Level 2, scalar point multiplication in Level 3, and finally Level 4 perform encryption and decryption processes to ensure a secure channel of transmission in today's digital landscape, secure communication hinges on robust Public Key Cryptography (PKC) algorithms. Two prominent contenders in this space are RSA and ECC [27]. Both are public-key cryptography algorithms, but with distinct math. RSA's security relies on the difficulty of factoring large numbers, while ECC leverages the elliptic curve discrete logarithm problem (ECDLP). Other models were subsequently created with multi-layered approaches that ensures robust user authentication and strengthens the overall system security.

PROPOSED SYSTEM

The system prioritizes secure user access through a multi-factor registration process. Mobile users are required to register, providing personal information and detailed device specifications. This information is used to generate a unique key pair for each user. Additionally, a QR Code is created, serving as a secondary verification layer. After that, this QR Code will be uploaded to the IPFS server. Next, this server generates the Hashcode and sends it to the registered mobile user, SDN Switch layer, and Controller Layer. After successful registration of users, they must login with the server using a username, password, and QR Code. During login time, the user must digitally sign the Hashcode from the IPFS server using their private key with the help of Exponential Isogeny Diffie Hellman-based Digital Signature Algorithm. Here, to improve the digital signature creation process, the secret will be generated using Exponential Isogeny Diffie Hellman and this will be used in the Digital Signature Algorithm. Next, this digitally signed signature will be verified in the switch layer. After successful verification of the user only, the requested task by the mobile users will be sent to Switches. Next, all the mobile user's task requests will be sent to the Distributed SDN Control layer. Before that, the mobile users will be digitally verified and assigned to the SDN Controller.

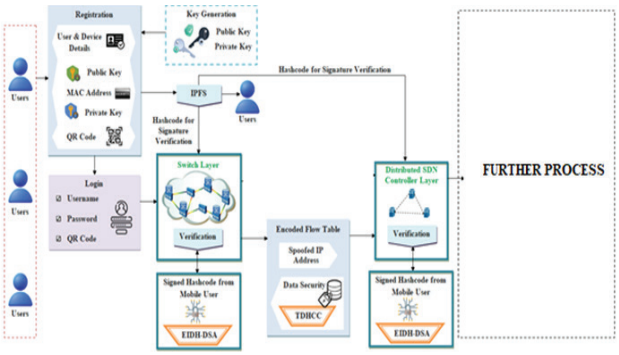


Fig. 2. Proposed model with Twisted Doubling Hessian Curve Cryptography (TDHCC) for Enhanced Packet Security

Notation

p,q - Large, secure prime numbers, n - Modulus (product of primes, $n=p\cdot q$),$\phi(n)$ - Euler's totient function ($\phi(n)=(p-1)(q-1)$),G - Elliptic Curve generator point, a,b - Alice's and Bob's private keys (random integers), respectively, e - Public exponent (co-prime with $\phi(n)$),d - Private exponent ($d\equiv e^{-1}(\mathrm{mod}\phi(n))$),KF - Fernet symmetric key,M - Plaintext message,C – Ciphertext, IPFS - InterPlanetary File System,EIDH-DSA - Exponential Isogeny Diffie Hellman-based Digital Signature Algorithm,TDHCC - Twisted Doubling Hessian Curve Cryptography

Input: Two parties (Alice and Bob) with private keys a_Alice and a_Bob, respectively, corresponding to their public keys P_Alice and P_Bob on a twisted Hessian curve.

Output: A shared secret key K_AB established by Alice and Bob.

Key Generation

1. Generate two large, secure primes p and q using a Miller-Rabin primality test.
2. Calculate the modulus $n=p\cdot q$.
3. Compute Euler's totient function $\phi(n)=(p-1)(q-1)$.
4. Choose a public exponent e such that $1<e<\phi(n)$ and $\gcd(e,\phi(n))=1$ (co-prime).
5. Calculate the private exponent d using the Extended Euclidean Algorithm: $d\equiv e^{-1}(\mathrm{mod}\phi(n))$.
6. Alice's public/private key pair: (e,n)/(d,n).

7. Bob's public/private key pair: (e,n)/(d,n) (same public key for this simplified model).

Encryption (assuming secure ECC integration)

Establish a shared secret key KS using a secure Elliptic Curve Diffie-Hellman (ECDH) key exchange mechanism. Derive a Fernet key KF from the shared secret key KS (key derivation function - KDF). Finally encrypt the message M with the Fernet key KF using the Fernet library: C=FK(M).

Decryption (assuming secure ECC integration)

Recover the shared secret key KS by means of the private key and the received public key (ECDH).Derive Fernet key KF from the shared secret key KS and Decrypt the ciphertext C with the Fernet key KF using the Fernet library: $M=F_K^{-1}(C)$.

EXPERIMENTATION

Elliptic curve cryptography (ECC) offers a powerful and efficient solution for securing data transfers by meeting stringent security and confidentiality requirements. It enables mutual authentication between tags and readers while ensuring the integrity of the data [22]. Twisted Edwards Curves and Hessian Curves both offer potential performance benefits, particularly in doubling and tripling operations, compared to traditional Weierstrass curves. secure user authentication in SDN environments often employs techniques like Elliptic Curve Diffie-Hellman key exchange with Digital Signature Algorithm (EDH-DSA).

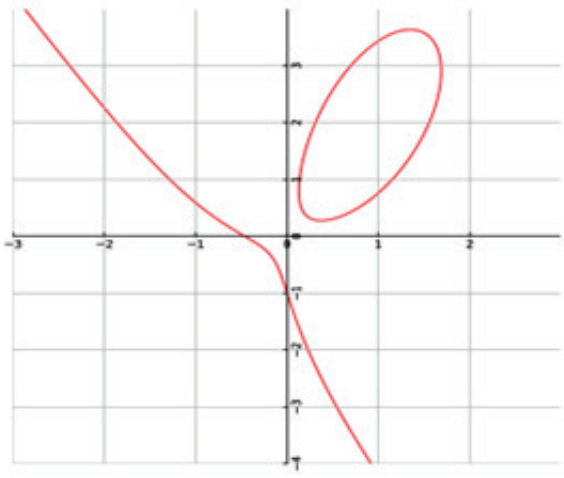


Fig. 3 A Twisted Hessian curve of equation $10x^3+y^3+1=15xy$

A Hessian curve in projective coordinates can be elegantly expressed by the equation: $X^3 + Y^3 + Z^3 = d * XYZ$ ($d \neq 0$, $27 - d^3 \neq 0$). The Sylvester addition formula, applied to Hessian curves, enhances resistance to side-channel attacks during point doubling and subtraction. [14]. Twisted Hessian curves offer an efficient amalgamated addition formula, enhancing point doubling and tripling effectiveness across various characteristic fields. [15]. Supplementary research on optimizing arithmetic operations on (twisted) Hessian curves can be found in references [16-18].

ANALYSIS

Comprehensive survey by [12] emphasizes the importance of robust user authentication to mitigate various security threats in SDN environments. By implementing strong user authentication with ECC, this work contributes to a more secure and resilient SDN infrastructure. This research explores a novel user authentication system specifically designed for Software-Defined Networks (SDN) environments. The proposed system leverages EDH-DSA to establish secure user access. The analysis likely involves comparisons between the TDHCC based approach and existing user authentication methods in SDN. Here's a breakdown of the potential evaluations based on the provided graphs. Figures 4 & 5 likely compare the proposed system's resistance against various attack vectors to other existing authentication methods. They might also assess the overall security posture achieved by the TDHCC based approach within the SDN environment. Figures 6 & 7 focus on encryption and decryption times. These figures could potentially demonstrate that the TDHCC approach offers faster processing compared to traditional methods, translating to improved overall system performance for user authentication tasks in SDN. Figures 8 & 9 represents Memory usage during encryption and decryption processes across diverse user authentication methods. These figures could indicate that TDHCC based system offers advantages in terms of memory efficiency, which can be a serious factor for resource-constrained SDN environments. our research proposes that user authentication system, built upon TDHCC cryptography, attains a well-rounded balance

between security, performance, and resource efficiency. Proposed technique has attributes such as high attack-resistant ability, more processing speed, and less use of memory compared with the previous methods, which is very promising with respect to security solution in SDN.

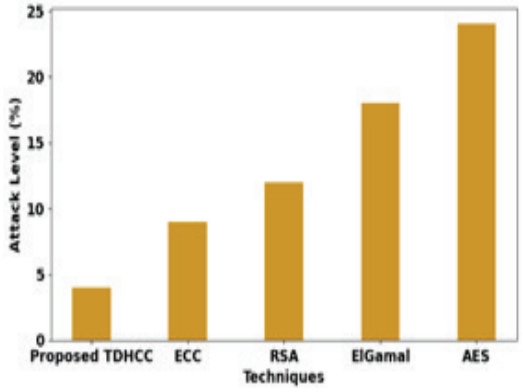


Fig. 4. Comparing our results with other methods for attacks

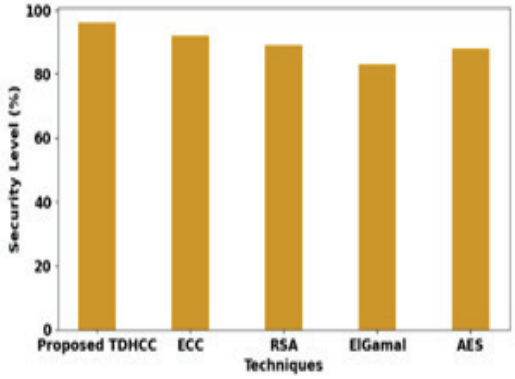


Fig. 5. Comparing our results with other methods with security

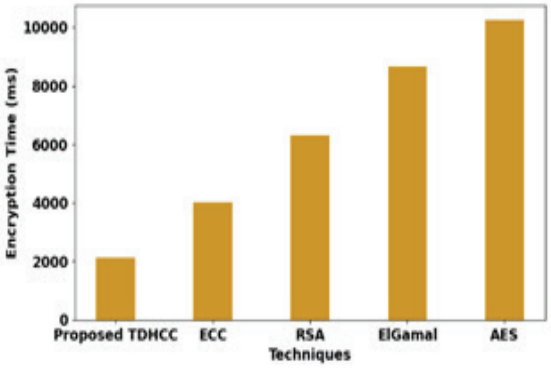


Fig. 6. Comparing proposed method Encryption time other methods

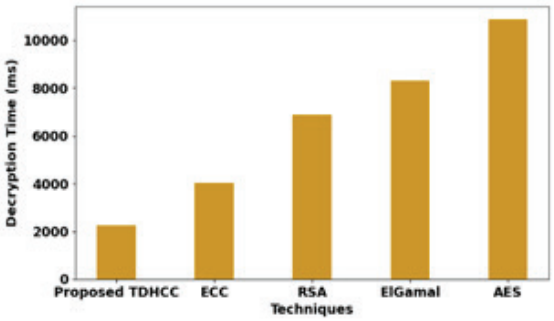


Fig. 7. Comparing proposed method Decryption time other methods

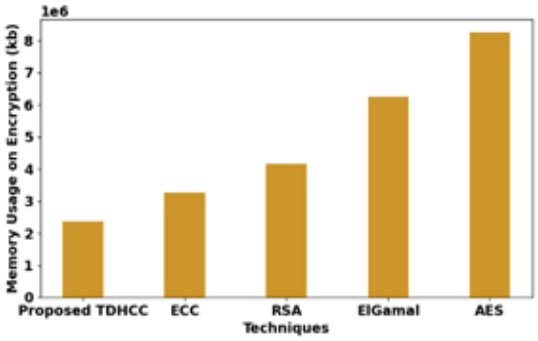


Fig. 8. Comparing proposed method Encryption memory usage with other methods

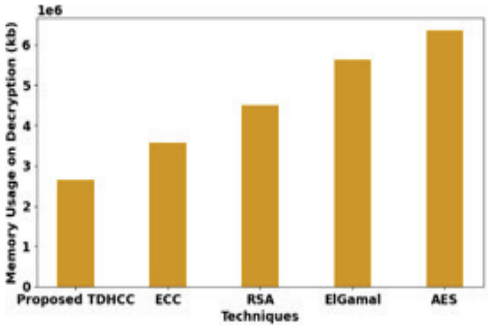


Fig. 9. Comparing proposed method Decryption memory usage with other methods

CONCLUSION

The proposed scheme presents a novel safe user access system for mobile users in SDN environments, Twisted Doubling Hessian Curve Cryptography offers robust security due to the mathematical complication of the underlying elliptic curve. Compared to traditional cryptography like RSA, ECC delivers corresponding security levels with smaller key sizes, dropping computational overhead. This is particularly applicable

for resource-constrained mobile user devices commonly found in SDN deployments. This research covers the way for more secure and efficient user access within SDN deployments, fostering a more secure and dynamic network management paradigm. For our upcoming effort we project to extend and inculcate these proposed solutions to Software defined network's Intrusion detection system which will use novel resilient machine learning algorithm to detect the attack.

REFERENCES

1. Software Defined Networking Market Size, Share and Global Market Forecast to 2025 | COVID-19 Impact Analysis," Marketsandmarkets.com, 2020. [Online]. Available: 14 Feb 2021.
2. Hou Leqing, " How to Realize the Smooth Transition from Traditional Network Architecture to SDN", In 2020 5th International Conference on Mechanical, Control and Computer Engineering (ICMCCE), pp. 1948-1952. IEEE, 2020.
3. Rauf, B., Abbas, H., Sheri, A. M., Iqbal, W., & Khan, A. W. (2020). Enterprise integration patterns in SDN: A reliable, fault-tolerant communication framework. IEEE Internet of Things Journal, 8(8), 6359-6371.
4. Comer, D., & Rastegarnia, A. (2019). Externalization of packet processing in software defined networking. IEEE Networking Letters, 1(3), 124-127.
5. Ramadhan, A. J. (2021). T-S3RA: Traffic-aware scheduling for secure slicing and resource allocation in SDN/NFV enabled 5G networks. arXiv preprint arXiv:2107.05056.
6. Hadem, P., Saikia, D. K., & Moulik, S. (2021). An SDN-based intrusion detection system using SVM with selective logging for IP traceback. Computer Networks, 191, 108015.
7. Nallusamy, P., Saravanen, S., & Krishnan, M. (2021). Decision Tree-Based Entries Reduction scheme using multi-match attributes to prevent flow table overflow in SDN environment. International Journal of Network Management, 31(4), e2141.
8. Cao, J., Xu, M., Li, Q., Sun, K., & Yang, Y. (2022). The attack: Overflowing sdn flow tables at a low rate. IEEE/ACM Transactions on Networking.
9. Tang, D., Zheng, Z., Li, K., Yin, C., Liang, W., & Zhang, J. (2023). Ftop: An efficient flow table overflow preventing system for switches in sdn. IEEE Transactions on Network Science and Engineering.
10. Hou Leqing, " How to Realize the Smooth Transition From Traditional Network Architecture to SDN",In 2020 5th International Conference on Mechanical, Control and Computer Engineering (ICMCCE), pp. 1948-1952. IEEE, 2020.
11. Sultana, Nasrin, Naveen Chilamkurti, Wei Peng, and Rabei Alhadad. "Survey on SDN based network intrusion detection system using machine learning approaches", Peer-to-Peer Networking and Applications 12, no. 2 (2019): 493-501.
12. S. Scott-Hayward, G. O'Callaghan and S. Sezer, "Sdn Security: A Survey," 2013 IEEE SDN for Future Networks and Services (SDN4FNS), Trento, Italy, 2013, pp. 1-7, doi: 10.1109/SDN4FNS.2013.6702553.
13. Grini, Abdelali & Chillali, Abdelhakim & Mouanis, Hakima. (2020). CRYPTOGRAPHY OVER TWISTED HESSIAN CURVES OF THE RING ${F}_{Q}[EPSILON]. Advances in Mathematics: Scientific Journal. 10. 235-243. 10.37418/amsj.10.1.24.
14. M. Joye and J.-J. Quisquater, "Hessian elliptic curves and side-channel attacks," in International Workshop on Cryptographic Hardware and Embedded Systems, pp. 402–410, Springer, 2001.10.1007/3-540-44709-1_33.
15. D. J. Bernstein, C. Chuengsatiansup, D. Kohel, and T. Lange, "Twisted Hessian curves," in International Conference on Cryptology and Information Security in Latin America, pp. 269–294, Springer, 2015.10.1007/978-3-319-22174-8_15
16. D. Jao, S. D. Miller, and R. Venkatesan, "Do all elliptic curves of the same order have the same difficulty of discrete log?," in International Conference on the Theory and Application of Cryptology and Information Security, pp. 21–40, Springer, 2005.10.1007/11593447_2
17. E. Teske, "An elliptic curve trapdoor system," Journal of Cryptology, vol. 19, no. 1, pp. 115–133, 2006.10.1007/s00145-004-0328-3
18. D. X. Charles, K. E. Lauter, and E. Z. Goren, "Cryptographic hash functions from expander graphs," Journal of Cryptology, vol. 22, no. 1, pp. 93–113, 2009.10.1007/s00145-007-9002-x
19. Dey, D., & Ghosh, N. (2023). HessianAuth: A Secure and Efficient Authentication Mechanism for Resource-Constrained IoT Networks.

20. Dey, D., Chandra, S., & Ghosh, N. (2023, January). HessianAuth: An ECC-based distributed and efficient authentication mechanism for 6LoWPAN networked IoT devices. In Proceedings of the 24th International Conference on Distributed Computing and Networking (pp. 227-236).

21. K. Sood, S. Yu, D. D. N. Nguyen, Y. Xiang, B. Feng and X. Zhang, "A Tutorial on Next Generation Heterogeneous IoT Networks and Node Authentication," in IEEE Internet of Things Magazine, vol. 4, no. 4, pp. 120-126, December 2021, doi: 10.1109/IOTM.001.2100115.

22. Gabsi, S., Beroulle, V., Kieffer, Y., Dao, H. M., Kortli, Y., & Hamdi, B. (2021). Survey: Vulnerability analysis of low-cost ECC-based RFID protocols against wireless and side-channel attacks. Sensors, 21(17), 5824.

23. Benssalah, M., Sarah, I., & Drouiche, K. (2021). An efficient RFID authentication scheme based on elliptic curve cryptography for Internet of Things. Wireless Personal Communications, 117(3), 2513-2539.

24. B. Rashidi, "A Survey on Hardware Implementations of Elliptic Curve Cryptosystems," Arxiv, December (2017) 1–61.

25. K. V Patel and M. V Shah, "Implementation of Generic and Efficient Architecture of Elliptic Curve Cryptography over Various GF(p) for Higher Data Security," AJET. 9(2) (2020) 1–7. [10] MD. Hankerson, A. Menezes, and S. Vanstone, "Guide to Elliptic Curve Cryptography," New York, NY, USA: Springer-Verlag, 2004.

26. K. V. Patel and M. V. Shah, "Analysis of Efficient Implementation of Elliptic Curve Cryptography Architecture for Resource Constraint Application," The International Journal of Innovative Technology and Exploring Engineering, 10(12) (2021) 28–35.

27. MD. Hankerson, A. Menezes, and S. Vanstone, "Guide to Elliptic Curve Cryptography," New York, NY, USA: Springer-Verlag, 2004.

A Survey on the Academic Website's Threats, Attacks, and Its Effects with Respect to Its Stakeholders

Nidhi
Assistant Professor
Bharati Vidyapeeth Institute of Management and Information Technology
Navi Mumbai, Maharashtra
✉ mca.nidhipoonia@gmail.com

Sachin Kadam
Professor
Institute of Mgmt and Entrepreneurship Development
Bharati Vidyapeeth (Deemed to be University)
Pune, Maharashtra
✉ sachin.a.kadam@bharatividyapeeth.edu

ABSTRACT

Academic website security cannot be overstated, considering the critical role these websites play in facilitating education, research, collaboration, and the dissemination of knowledge. Academic websites often contain sensitive information such as student records, research data, and financial transactions. Users or stakeholders when approaching an academic institution's website, it's important they assess the security and reliability of the site to protect their personal and sensitive information. It's important for the user should be aware of threats and attacks they could face. In the paper, the literature review and the survey from the user's academics were conducted, and as a result, the list of threats and attacks related to the academic website was identified. So that by analyzing these threats and effects, users can more effectively assess the security of academic websites and make informed decisions about engaging with them, thereby protecting their personal information and enhancing their overall online safety.

KEYWORDS: *Academic website threats, Academic website stakeholders, attacks on academic websites, Academic website user threats effects.*

INTRODUCTION

Academic institutions rely on their websites to maintain academic integrity and trustworthiness. Security breaches, data tampering, or unauthorized access can undermine the credibility of academic resources, publications, and research findings hosted on these websites. Any disruption or downtime resulting from security incidents can disrupt the continuity of academic operations and impede the learning process. Academic websites are prime targets for cyber-attacks due to the valuable data they contain and the potential for financial gain or reputational damage. Academic institutions are subject to various regulatory requirements and data protection laws governing the collection, storage, and processing of personal and sensitive information. Securing access to these resources is essential for safeguarding the intellectual property rights of faculty members, researchers, and the institution as a whole. A secure academic website inspires trust and confidence among stakeholders. Therefore, it is a requirement to detect academic website threats concerning its stakeholders and find critical among them and their vulnerabilities.

LITERATURE REVIEW

The paper by Li, X. et.al discusses web applications that are vulnerable to security attacks as many new techniques are there and the paper aims to systematize the techniques which are already there and talks about future research [1]. Kulyk, M. et.al purposes aim to raise awareness about web application security, this paper provides application threats details and protections that are crucial in modern higher education, their security must be considered to avoid significant consequences [2]. Mohaidat, A. I. et.al in the paper talks about cyber-attacks by assessing them using a scanning tool for vulnerability and its prevention [3]. Rafique, S. et.al researcher gives insight that the number of security

vulnerabilities in web applications has increased and to detect these vulnerabilities, a systematic mapping study is needed to analyze existing research in the paper proposed solutions are mapped against existing research in web application security vulnerability detection approaches [4]. Appiah, V. et.al in the paper the research focus on enhancing website security by identifying vulnerabilities and proposing solutions, assessed five Ghanaian web hosts using tools like Nmap, Nikto, and Nessus, and in the result, all hosts identified security flaws, and a solution was proposed to mitigate these issues, crucial for protecting computing systems and data [5]. This review by Cheng, L. et.al discusses data breaches, recent incidents, prevention techniques, challenges, and promising solutions for detecting and preventing data loss in organizations due to the growing volume of data [6]. Phishing attacks are prevalent cybercrimes, necessitating the development of methods to detect threats in IoT devices, requiring universal techniques for assessing device cybersecurity using data analysis [7].

RESEARCH GAP

From a literature survey, we found that Academic institutions' websites in India have information security threats and are vulnerable. These threats allow an attacker to gain some level of control of the site and stakeholders of academic websites should be aware of threats and the effects they can face while assessing academic websites.

PROBLEM STATEMENT

Research Objectives

- To detect the threats to an educational institute website by literature review.
- To survey the possible threats stakeholders can face accessing academic websites.
- To list the possible threats and attacks an academic website user can face while assessing it by literature review and survey from stakeholders.

RESEARCH METHODOLOGY

This research is shown in Figure 1 a hybrid approach consisting of multiple research strategies as appropriate to the objectives under consideration.

Fig. 1. Research Flow

Data Collection of Academic Website Threats

Secondary Data Collection: From literature review threats the academic website can face are collected. In a literature review list of threats is collected from research papers, blogs, articles, theses, newspapers, etc.

Primary Data Collection

Research Information: A survey is conducted with the users of academic websites by using a Questionnaire (Basic information and open-ended questions are asked about threats they feel or observe which is possible while assessing academic websites. The sample size is 384 (approximately) and the survey is conducted using Simple Random Sampling. Stakeholders and their role in assessing the website. Students/ Prospective Students, Faculty/Staff, Administrators, Alumni, Parents/Guardians, Guests/Visitors, Website developer and IT Administrator.

RESULT AND FINDINGS

Possible Threats on Academic Website: Web applications used by academic institutions face a range of threats due to their interconnectedness, and the delicate nature of the data. Threat data is collected by using the survey tool questionnaire from users/stakeholders of academic websites. From the analysis of data in the research possible list of threats is formed from the data provided in open-ended questions collected from the users of the academic website asking types of attacks they faced and awarded. Analysis of the questionnaire divided the threats into five categories as shown in Figure 3.

Figure 3. Academic Website Threats

Findings: The list of possible Cybersecurity threats is given in Table 1. and the findings.

Table 1. List of Possible Threats collected from the survey

List of Possible Cybersecurity Threats on Academic Website Users	
Data Breaches	Academic institution applications contain sensitive personal information such as Adhaar cards, names, and financial information and unapproved access to educational data can cause identity theft.
Phishing Attacks	Attackers might send emails posing as the academic institution and application portal to trick students into providing personal information.
Malware	Students or administrative staff might inadvertently download malicious software that can steal data and corrupt files, it also provides a backdoor to secure systems.
List Possible Privacy Concerns Threats on Academic Website Users	
Inadequate Data Protection	If the application platform doesn't adhere to strict data protection laws, there is a risk that personal information may be mishandled.
Third-party Data Sharing	Applications may share data with third parties without explicit consent leading to privacy violations.
List of Possible Website and Application Flaws Threats on Academic Website Users	
Poorly Secured Websites	Websites without HTTPS, poor authentication measures, and outdated software can easily compromise their Security.
SQL Injection	It involves inserting malicious code into databases via poorly designed application forms and leads to data exposure or loss.
Cross-Site Scripting (XSS)	XSS allows invaders to insert client-side scripts when the stakeholder views the web, potentially bypassing access controls.
List of Possible Operational Risks Threats on Academic Website Users	
Downtime	High traffic volumes during peak academic application times can overload servers Leading to downtime and preventing students from submitting applications on time.
User Error	Simple user errors, like entering data incorrectly or navigating away from incomplete sessions lead to loss of data or incomplete applications.
List of Possible Social Engineering Threats on Academic Website Users	
Impersonation and Fraud	Attackers might impersonate college admissions officials to extract personal or financial information from applicants.
Misinformation	Fake websites mimicking real college application portals can deceive students into submitting their personal information.

Findings Possible Attacks on Academic Websites

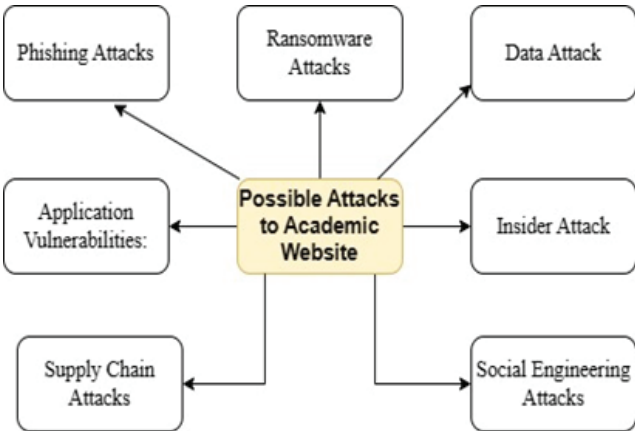


Fig. 4. Possible Website Attacks

Academic website users can face various types of attacks, collected from surveys from website users Figure 4. Shows the types of attacks they faced. Ranging from technical exploits to social engineering tactics. Table 2. List of possible attacks that academic website users might encounter.

Table 2. List of Possible Attacks on Academic Websites

List of Possible Attacks on Academic Website Users		
a.	Phishing Attacks	Cybercriminals often use phishing emails to trick students, faculty, or staff into enlightening sensitive information [8].
b.	Ransom-ware Attacks	Academic institutions are targeted by ransomware attacks, where attackers encrypt the institution's data and demand payment, it can disrupt the application process and compromise sensitive information [9].
c.	Data Attack	Academic institutions store huge data about students, faculty, and staff and data breaches can occur due to various factors, including insecure systems, insider threats, or targeted cyber-attacks [10].
d.	Application Vulnerabili-ties	Vulnerabilities in academic institution applications allow to collection of sensitive information or conciliation of the integrity of the application process [11].
e.	Insider Attack	Employees or students with access may misuse their privileges to steal data, manipulate application records, or disrupt the application process [12].
f.	Supply Chain Attacks	Service providers that academic institutions rely on for application-related services may themselves be targeted by cyber-attacks, leading to compromises in the academic institution's systems or data [13].
g.	Social Engineering Attacks	Attackers may use social engineering techniques to manipulate individuals into providing access to academic institution application systems or disclosing sensitive information [14].

Findings Possible Effects on Academic Website: Table 3. and Figure 5. have shown a list of the effects of threats on academic websites which can impact not only the technical infrastructure but also the reputation, trust, and functionality of the academic institution as a whole. Therefore, proactive measures to prevent, detect, and respond to security threats are essential for the reliability of academic websites.

Fig. 5. Effects of Threats on Website

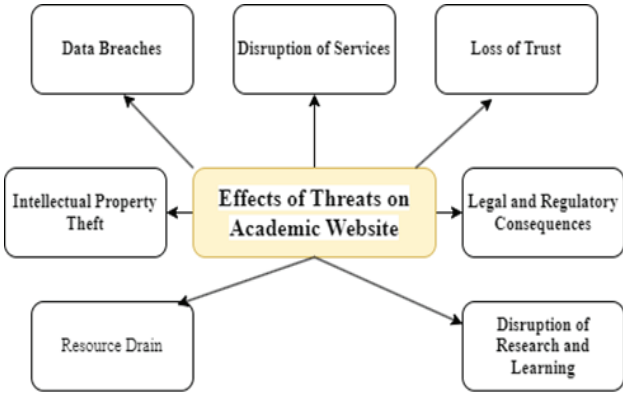


Table 3. Effects of Threats on Academic Websites

Effects of Threats on Academic Websites		
Sr. No.	**Threats**	**Effects**
a.	Data Breaches	Threats lead to identity theft, scams, or unlicensed access to confidential information[13].
b.	Disruption of Services	Threats (DDoS) attacks or malware infections can disrupt the normal functioning of academic websites, it prevent students, faculty, and researchers from accessing important resources [14].
c.	Loss of Trust	If users perceive an academic website as insecure or unreliable due to security threats, they may lose trust in the institution or organization hosting the website [14].
d.	Intellectual Property Theft	Academic websites Security threats may facilitate the theft of this intellectual property, undermining the academic institution's competitiveness and potentially leading to financial losses [15].
e.	Legal and Regulatory Consequences	Institutions may face legal and regulatory consequences for failing to adequately protect sensitive information and reputation [15].
f.	Resource Drain	Academic institutions may need to invest in cybersecurity measures and hire experts to mitigate.

g.	Disruption of Research and Learning	Academic websites an essential platforms for students, faculty, and researchers, and threats that disrupt these services [12].

CONCLUSION

Academic website threats can have several detrimental effects on users and institutions. It can have data breaches which can damage the institution's reputation and trust among current and prospective students, parents, and alumni. If hackers gain access to applicants' personal information, they may use it for identity theft purposes. This can result in financial losses and legal liabilities for both the affected individuals and the institution. Stakeholders may suffer financial harm and reputation damage as a result of these fraudulent actions and Hackers could tamper with application data, such as altering grades, test scores, or personal statements, to sabotage applicants' chances of admission or eligibility for scholarships and financial aid. Security incidents, such as denial-of-service (DoS) attacks or website outages caused by vulnerabilities, can disrupt the application process and prevent applicants from submitting their materials on time. To mitigate these risks, users and academic institutions must prioritize cybersecurity measures, communicate transparently with applicants about security protocols and incident response procedures, and provide resources and support to assist individuals affected by security breaches. This identified list of threats and attacks may aware the users aware to be vigilant about these attacks in the future. Additionally, future research on preventive actions concerning different stakeholders should be done to secure them from these attacks.

REFERENCES

1. Li, X., & Xue, Y. (2011). A survey on web application security. Nashville, TN USA, 25(5), 1-14.
2. Kulyk, M., & Myttseva, O. Role of Web Application Security in the Modern Educational Process at Higher Education Institutions
3. Mohaidat, A. I., & Al-Helali, A. (2024). Web Vulnerability Scanning Tools: A Comprehensive Overview, Selection Guidance, and Cyber Security Recommendations. International Journal of Research, 10(1), 8-15.
4. Rafique, S., Humayun, M., Hamid, B., Abbas, A., Akhtar, M., & Iqbal, K. (2015, June). Web application security vulnerabilities detection approaches A systematic mapping study. In 2015 IEEE/ACIS 16th International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/ Distributed Computing (SNPD) (pp. 1-6). IEEE.
5. Appiah, V., Asante, M., Nti, I. K., & Nyarko-Boateng, O. (2018). Survey of websites and web application security threats using vulnerability assessment. Journal of Computer Science, 15(10), 1341-1354.
6. Cheng, L., Liu, F., & Yao, D. (2017). Enterprise data breach: causes, challenges, prevention, and future directions. Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 7(5), e1211.
7. Baballe, M. A., Hussaini, A., Bello, M. I., & Musa, U. S. (2022). Online Attacks Types of Data Breach and CyberAttack Prevention Methods. Current Trends in Information Technology, 12(2).
8. Brewer, R. (2016). Ransomware attacks: detection, prevention and cure. Network security, 2016(9), 5-9.
9. Nanda, S., Lam, L. C., & Chiueh, T. C. (2008, September). Web application attack prevention for tiered internet services. In 2008 The Fourth International Conference on Information Assurance and Security (pp. 186-191). IEEE.
10. Ohm, M., Sykosch, A., & Meier, M. (2020, August). Towards detection of software supply chain attacks by forensic artifacts. In Proceedings of the 15th international conference on availability, reliability and security (pp. 1-6).
11. Gupta, S., Singhal, A., & Kapoor, A. (2016, April). A literature survey on social engineering attacks: Phishing attack. In 2016 international conference on computing, communication and automation (ICCCA) (pp. 537-540). IEEE.
12. Skjervold, E., Hafsøe, T., Johnsen, F. T., & Lund, K. (2009, October). Delay and disruption tolerant web services for heterogeneous networks. In MILCOM 2009-2009 IEEE Military Communications Conference (pp. 1-8). IEEE.
13. Dave, M., & Saxena, A. B. (2017, October). Loss of trust at IAAS level: Causing factors & mitigation techniques. In 2017 International Conference on Computing and Communication Technologies for Smart Nation (IC3TSN) (pp. 137-143). IEEE.
14. Wall, D. S., & Yar, M. (2013). Intellectual property crime and the Internet: Cyber-piracy and'stealing'information intangibles. In Handbook of internet crime (pp. 255-272). Willan.
15. Coppel, J. (2000). E-commerce: impacts and policy challenges.

Enhancing Photovoltaic Efficiency through the Design and Performance Analysis of an Automatic Solar Tracking System

Anita Mohanty
Electronics Engineering
Silicon University
Bhubaneswar, Odisha
✉ anitamohanty776@gmail.com

Debi Prasad Pradhan
Electronics Engineering
Silicon University
Bhubaneswar, Odisha
✉ gitupradhandkd@gmail.com

Subrat Kumar Mohanty
Electronics & Communication Engineering
Einstein Academy of Technology & Management
Bhubaneswar, Odisha
✉ skmohanty0509@gmail.com

Bhagyalaxmi Jena
Electronics & Communication Engineering
Indian Institute of Tech. (Indian School of Mines)
Dhanbad, Jharkhand
✉ bhagyalaxmijena76@gmail.com

Pradyumna Kumar Tripathy
Computer Science and Engineering
Silicon University
Bhubaneswar, Odisha
✉ pradyumnatripathy@gmail.com

Ambarish G. Mohapatra
Electronics Engineering
Silicon University
Bhubaneswar, Odisha
✉ ambarish.mohapatra@gmail.com

ABSTRACT

The escalating energy demands, coupled with environmental concerns, highlight the urgent need for more efficient renewable energy technologies. This study addresses this challenge by investigating the enhancement of photovoltaic (PV) efficiency through the scheme and implementation of an automatic solar tracking system (ASTS). Utilizing a microcontroller-based mechanism with light sensors, the ASTS dynamically changes the orientation of solar panels to maximize sunlight exposure throughout the day. Comparative analysis between fixed and tracking system installations reveals a substantial increase in energy output by the tracking system—approximately 25.66% more than its stationary counterparts. The paper offers a thorough examination of the design process, system architecture, and experimental outcomes, affirming the efficacy of the Automatic Solar Tracking System (ASTS) in enhancing solar energy capture. By highlighting the practical advantages of dynamic solar panel positioning, this study contributes to the progression of renewable energy solutions and informs upcoming advancements in solar energy infrastructure.

KEYWORDS: *Photovoltaic efficiency, ASTS, Renewable energy, Solar panel orientation, Microcontroller, Light sensors.*

INTRODUCTION

The increasing energy demand alongside the imperative to address climate change has driven the quest for sustainable and efficient energy sources. Among renewable energy technologies, solar power stands out as particularly promising given its vast potential and relatively minimal environmental impact. Despite these advantages, the widespread adoption of solar power is hindered by the relatively low efficiency and high capital cost of photovoltaic (PV) systems compared to conventional fossil fuel sources. Solar panels, comprising photovoltaic cells, serve as the cornerstone of this technology, converting solar radiation into electricity. Over the years, the adoption of solar panels has witnessed a remarkable evolution, transitioning from static, fixed-position installations to sophisticated automatic solar tracking systems.

This shift has been primarily driven by the pursuit of maximizing energy capture and improving overall efficiency.

Initially, solar panels were predominantly installed in fixed positions, with their orientation optimized based on geographical considerations such as latitude and tilt angle. While these fixed installations provided a foundational framework for solar energy utilization, they inherently suffered from suboptimal energy capture due to limited adaptability to varying solar angles throughout the day. As a result, the energy output of fixed solar panels was constrained by their static positioning, thereby limiting their efficacy in harnessing solar radiation [1].

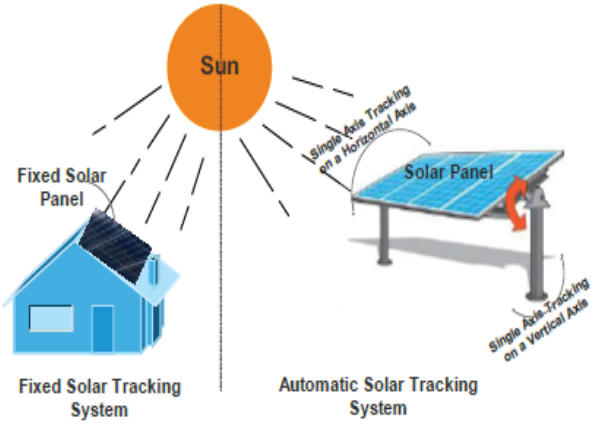


Fig. 1. Major types of Solar Tracking System

Recognizing this limitation spurred the development of automatic solar tracking systems, designed to dynamically regulate the orientation of solar panels to continuously track the sun's path, as depicted in Fig. 1. The introduction of automatic tracking represented a pivotal advancement in solar energy generation, promising substantial improvements in efficiency and energy output. Through the utilization of advanced control algorithms and precise tracking mechanisms, automatic solar tracking systems facilitate accurate solar panel alignment with the sun's movement, optimizing solar radiation exposure throughout the day [2].

The evolution from fixed to automatic solar tracking systems (ASTS) represents a pivotal advancement in the field of solar energy technology, promising substantial improvements in energy output and overall system efficiency. Solar tracking technology is not new, but its application has been limited due to additional costs and increased mechanical complexity. However, recent advancements in sensor technology, microcontrollers, and algorithm development have made solar trackers more feasible and cost-effective. Previous studies have shown that solar trackers can increase the energy output of photovoltaic panels by 20 to 40%, making a compelling case for their use in residential and commercial solar energy systems [3].

Moreover, the implementation of solar trackers not only increases the immediate output but can also enhance the long- term return on investment for solar installations by maximizing energy generation over the lifespan of the system. This is particularly important in geographic regions with high solar potential, where maximizing output can significantly impact energy costs and sustainability goals.

This solar tracker is an electromechanical device designed to follow the apparent path of the Sun by orienting a solar panel or concentrator array directly toward the sunlight. The genesis of solar trackers dates back to the early 1960s in Chile, where the initial versions ranged from a purely mechanical system in 1962, which offered minimal gains, to a more advanced model in 1963 that incorporated automatic irradiation sensing [5, 6]. Following its conceptualization, the idea was commercialized with the submission of the inaugural patent for a solar tracker in 1980. This pioneering design showcased an analog control system integrated with a duo of photosensors [7], signifying a noteworthy advancement in its evolution.

In the last forty years, solar tracking technology has undergone notable progress, marked by several important features like the number of movement axes, incorporation of electronic systems, utilization of feedback mechanisms, and tracking strategies [4]. Solar trackers are engineered with either one or two movement axes. Single-axis trackers, predominantly oriented towards the north, are available in diverse configurations including horizontal (HSAT), horizontal with tilt (HTSAT), vertical (VSAT), inclined (TSAT), and polar inclined (PSAT) variations [4]. Single-axis

trackers, while simpler and less expensive to build and control, typically offer less precise tracking compared to their two-axis counterparts but can still significantly outperform static systems, as evidenced by reports indicating up to 50% higher energy yields [8, 9].

Two-axis trackers, known for their superior tracking accuracy due to their more complex design and control systems, have been shown to achieve efficiencies 25% greater than single-axis systems [10]. These systems utilize advanced control algorithms and can incorporate predictive controls that minimize tracking errors [11]. Cost-effective two-axis trackers often employ Arduino-based control systems, which can still yield notable efficiency improvements [12].

Trackers are also categorized based on their control systems: passive trackers adjust their position mechanically in response to non-uniform solar irradiation, exemplified by a system that uses the expansion of gas to shift its balance towards optimal sunlight alignment [13]. Although passive trackers are simpler and consume no electricity, their tracking ability is somewhat limited. In contrast, active trackers use electronic components such as microcontrollers, sensors, and motors to achieve precise positioning and maximize solar energy capture, as demonstrated in various recent studies [9, 10, 12].

This overview encapsulates the progression and diversification of solar tracking technology, highlighting both its historical development and current implementations across different system designs. The motivation for this study stems from the potential improvements in energy output demonstrated by tracking systems in preliminary research. For instance, Yang and Xiao (2023) reported improvements in energy capture by 20-30% compared to fixed systems [14]. This proposed work explores the feasibility, design, and efficacy of an ASTS aimed at maximizing the photovoltaic efficiency of solar panels, thus contributing to the broader goal of making solar energy more viable and efficient. Table 1 presents an overview of the primary characteristics of the examined solar trackers, with references marked by an asterisk (*) indicating the use of Arduino Uno as the electronic control unit.

Table 1: Characteristics of Different Solar Tracking Systems

Type of Tracker	Axis	Advantages	Disadvantages	Common Usage
Fixed Tilt [15]	None	Low cost, minimal maintenance, Low complexity	Lower energy production	Residential, small-scale commercial
Single-Axis [16]	Horizo-ntal	25-35% more energy than fixed systems, Moderate cost	Mechanical parts require maintenance, Medium complexity	Large fields, utility-scale
Dual-Axis [17-18]	Two axes	Up to 40% more energy than fixed systems, High cost	High complexity, higher maintenance	Scientific, high-precision locations
Tilted Single-Axis [19]*	Single, tilted	Better at higher latitudes	Higher cost than horizontal single-axis, medium complexity	Residential, commercial
Azimuth-Altitude Dual Axis [20-21]	Two axes	Precise control, maximizes energy, very high cost	Most complex, expensive	Advanced research, luxury residential
Polar Aligned Single-Axis [22]*	Single, polar	Simpler than dual-axis, effective near the Equator, Moderate cost	Less effective at higher latitudes, Medium complexity	Equatorial regions

The main contributions of this proposed method are outlined as follows:

- Development of a Low-Cost, High-Efficiency Solar Tracker without an increase in initial investments by the users.
- Enhancement in the energy output of photovoltaic systems of solar panels in the new tracking system is approximately 25%.
- Optimized Design tested for solar trackers in different Geographical Locations for various sunlight patterns.

Evaluate the environmental implications of solar trackers by analysing resource consumption and panel lifespan.

Through the design and performance analysis of an ASTS, this study endeavours to elucidate the tangible benefits and efficacy of dynamic solar panel positioning in enhancing photovoltaic efficiency. By comprehensively evaluating the design, functionality,

and performance metrics of the proposed tracking system, valuable insights can be gleaned to inform future advancements in solar energy infrastructure and facilitate the widespread adoption of renewable energy solutions.

Implementing a scalable and flexible framework in the design of the ASTS sets the stage for seamless integration with upcoming technologies like the IoT and AI in the future. These contributions are significant as they not only enhance the scientific understanding of solar tracking mechanisms but also provide practical solutions and insights that could lead to wider adoption and optimization of solar energy systems globally.

Implementing a scalable and flexible framework in the design of the ASTS sets the stage for seamless integration with upcoming technologies like the IoT and AI in the future. These contributions are significant as they not only enhance the scientific understanding of solar tracking mechanisms but also provide practical solutions and insights that could lead to wider adoption and optimization of solar energy systems globally.

THE PRINCIPLE BEHIND PHOTOVOLTAIC CELL

A solar cell, or photovoltaic (PV) cell, is a device that transforms solar energy into electricity through photovoltaic action. The term "solar cell" refers specifically to devices created to harness the energy from sunlight, whereas "photovoltaic cell" is employed more generally when the light source is not specified. Fig.2 depicts the current and power- voltage characteristics of a photovoltaic cell.

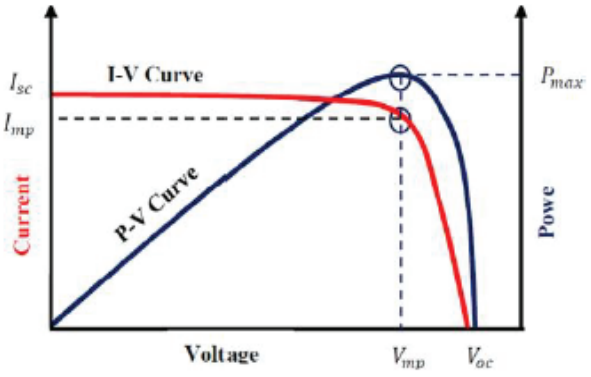


Fig. 2. Photovoltaic cell I-V and P-V characteristic curve [23]

The I-V characteristic of a PV cell can be represented using the equation that includes both photo-generated current and the effects of a real diode:

$$I = I_L - I_0\left(e^{\frac{q(V+IR_S)}{nkT}} - 1\right) - \frac{V+IR_S}{R_{sh}} \quad (1)$$

Where the current through the solar cell is I, the light generated current (or photo current) is I_L, the reverse saturation current of the diode is I_0, the voltage across the solar cell is V, the series resistance of the cell is R_s, the shunt resistance of the cell is R_{sh}, q is the charge of an electron (1.602×10^{-19} Coulombs), n is the ideality factor of the diode (typically 1 to 2), k is the Boltzmann's constant (1.38×10^{-23} J/K), T (^{0}K) is the temperature of the cell.

The power output from the solar cell can be calculated using:

$$P = V \times I \quad (2)$$

Where P is the power in watts.

When the solar panel hits with sunlight, photons are absorbed by semiconductor materials like silicon, causing electrons to become dislodged from their atoms, resulting in negatively charged electrons flowing in a single direction to generate electricity. In Figure 2, "I_{sc}" and "V_{oc}" denote the current at the panel's short-circuit and the voltage at its open circuit, respectively. Similarly, "I_{mp}" and "V_{mp}" refer to the current and voltage at the maximum power point, respectively.

PROPOSED SYSTEM DESIGN

The block diagram in Fig. 3 represents an ASTS designed to maximize photovoltaic efficiency. Solar panels, the primary electricity-generating components, dynamically adjust their orientation via servo motors to optimize sunlight capture, with their movements directed by a microcontroller. This microcontroller processes data from light sensors, which monitor sunlight intensity and direction, ensuring panels align optimally with the sun. The system additionally incorporates a stationary solar panel configuration serving as a control group for assessing performance enhancements. Additionally, a data collection and comparative analysis component gathers and evaluates performance metrics from both tracking and fixed installations to quantify

the efficiency gains of the tracking system. This setup highlights how each component interacts to enhance the system's overall functionality and efficiency.

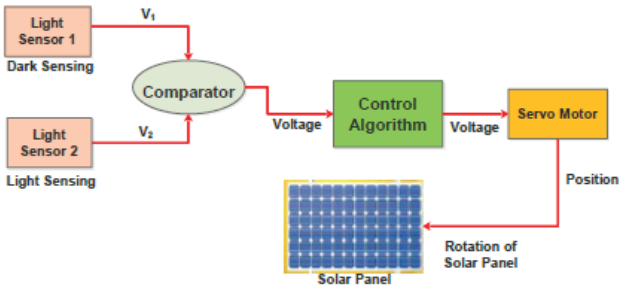


Fig. 3. Block diagram of the proposed system

The vital components of this proposed system are solar panels, a servo motor, an Arduino microcontroller, and LDR.

Solar Panel

Solar panel assemblies composed of photovoltaic (PV) cells are devices designed to convert sunlight directly into electricity by leveraging the photovoltaic effect of semiconductor materials like silicon [2]. The ability of a solar panel to capture sunlight effectively largely hinges on the angular alignment of the sun with respect to the panel [5].

To optimize sunlight absorption, solar tracking systems are employed to keep the panels aligned at a perfect 90-degree angle to the sun's rays. The efficiency of these panels, which measures how effectively they translate solar energy into electrical energy, is calculated by:

$$\eta = \frac{P_{\max\,(output)}}{P_{input}} \times 100\% \quad (3)$$

Here, $P_{input} = G \times A$ represents the power input from the solar irradiance. It is calculated by the product of the solar irradiance (G, in W/m^2) and the area of the solar panel (A, in m^2). $P_{max\ (output)}$ is the maximum power output calculated as:

$$P_{\max\,(output)} = V_{mp} \times I_{mp} = V_{oc} \times I_{sc} \times FF \quad (4)$$

Here in terms of V_{oc} (open-circuit voltage) and I_{sc}(short circuit current), $P_{max\ (output)}$ is often approximated using the fill factor (FF).

Thus, the efficiency equation in terms of V_{oc}, I_{sc}, and FF becomes:

$$\eta = \frac{V_{oc} \times I_{sc} \times FF}{G \times A} \times 100\% \quad (5)$$

This formula highlights the technological advancements in solar panels that maximize power generation and overall energy conversion efficiency.

DC motor

When an electrically charged conductor interacts with an external magnetic field, it experiences a force determined by both the current flowing through the conductor and the strength of the magnetic field. In the field of motion control, the SG90 mini servo motor stands out as a straightforward and efficient means of guiding movement. This compact servo is indispensable for applications demanding accurate regulation of both speed and direction.

The SG90 operates efficiently across a voltage range typically from 4.8V to 6V, making it ideal for lighter applications requiring less power. The SG90 is specifically designed for precision and utilizes a simple control interface through PWM (Pulse Width Modulation). This allows it to manage the positional alignment accurately, which is critical for applications such as small robotic arms or other hobbyist projects requiring low power. It features a lightweight design with plastic gears and a compact 3-wire setup, including a signal wire for PWM input, making it straightforward to integrate into various electronic projects.

The SG90 operates at a PWM frequency of about 50 Hz, which translates to a period of 20 milliseconds (ms). The linear relationship between the servo angle and pulse width, for precise applications is

$$Pulse\ Width\ (ms) = 1.0 + 0.001 \times \frac{\theta}{180} \times 1000 \quad (6)$$

where θ is the desired angle in degrees

For example, the position of the servo arm is determined by the width of the pulse within each 20 ms cycle:

- 1.0 ms pulse: Moves the servo to 0° (or its minimum position)
- 1.5 ms pulse: Moves the servo to its neutral position, typically 90°
- 2.0 ms pulse: Moves the servo to 180° (or its maximum position).

LDR

The Light Dependent Resistor (LDR), commonly referred to as a photoresistor, plays a vital role in numerous solar tracking systems. Its main purpose is to sense light intensity, enabling the adjustment of solar panel positions for optimal sunlight exposure. Functioning as a resistor, its resistance diminishes with increasing light intensity and vice versa, as described by Equation 10.

The characteristic of LDR can be expressed mathematically by the following general equation:

$$R = R_0 . e^{(-S.I)} \quad (7)$$

Where the resistance of the LDR in ohms (Ω) is R while exposed to light, I is the light intensity measured in lux, R_0, and S are material-specific constants that depend on the composition and properties of the LDR. Here R_0 represents the resistance value when no light is present (essentially the dark resistance), and S is a constant that describes how quickly the resistance decreases as light intensity increases.

LDR's made from a high-resistance semiconductor material that absorbs photons and, depending on their energy, free electrons to flow through the material. Thus, in bright light, the resistance of an LDR is low, and in dark conditions, its resistance is high.

Arduino Board

The Arduino Uno is an indispensable tool for developing solar tracking systems, equipped with an ATmega328P microcontroller, which operates optimally within a 5V input voltage and features 14 digital I/O pins, 6 of which support PWM for precise motor control. Its 6 analog input pins facilitate the integration of light sensors such as LDRs or photodiodes, essential for detecting sunlight intensity and positioning. The Uno's capability for handling timers and delays makes it ideal for adjusting solar panels incrementally to follow the sun's arc, maximizing energy absorption. With a robust user community and extensive libraries, the Arduino Uno provides a scalable, efficient, and cost-effective platform for prototyping and deploying solar tracking systems, ensuring that developers have ample support for bringing their renewable energy solutions to life.

PROTOTYPE IMPLEMENTATION

The proposed Automatic Solar Tracking System (ASTS) operates entirely autonomously, ensuring that the solar panel remains oriented toward the sun as long as it is visible. Unlike traditional systems that rely on the Earth's position, the ASTS uniquely utilizes the sun as its primary reference point. Its active LDR sensors continuously monitor sunlight levels and adjust the panel's position to maximize exposure, under the control of a microcontroller-based system. If the sun is obscured, such as during cloudy weather, the panel's sensors lose visibility. However, once the clouds disperse, the system scans the sky and realigns the panel vertically to face the sun once more. This ensures optimal efficiency throughout the day.

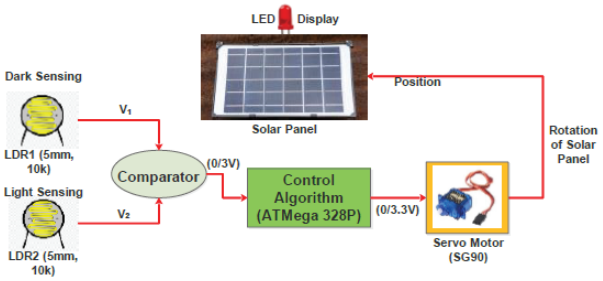


Fig. 4. System block diagram including electronic components

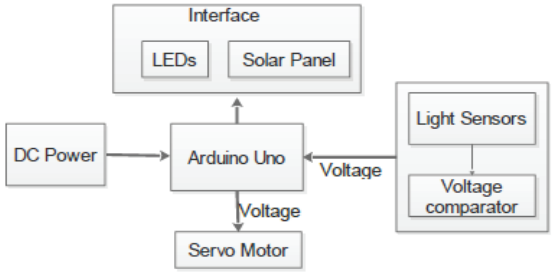


Fig.5. Block representation of the electronic system

The system proposed (shown in Fig. 4) comprises a single- axis mechanical structure with one degree of freedom. It includes one servo motor and two light sensors that follow the apparent position of the Sun. Additionally, an LED is utilized to indicate the generation of 5 volts by the solar panel based on the sun's position.

The electronics system can be categorized into five primary modules, depicted in Fig.5. The core of control and processing functions is centralized around an

ATmega328P microcontroller which is a low-power, high-performance chip with 32 Kb of flash memory and 2Kb of SRAM. Its role is to facilitate communication among the various blocks using analog and digital signals, as well as communication protocols.

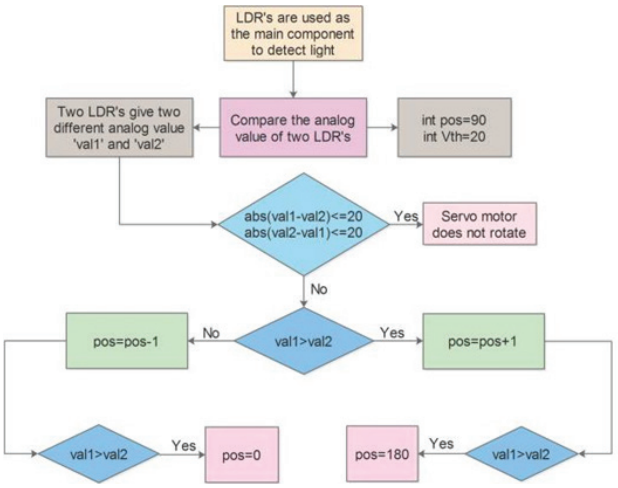


Fig.6. Flow chart showing the operation behind the automatic solar tracking system

The operational flowchart for the ASTS is depicted in Fig. 6. LDRs installed at the corners of the solar panel are utilized to detect the brightness of incoming light. LDRs demonstrate lower resistance in response to higher light levels. These sensors are employed to compare the light intensity incident upon them. A motor connected to the panel adjusts its position based on the sun's position. The panel is positioned to continuously monitor the light strength on the LDRs. The motor repositions the panel towards the LDR receiving the highest light intensity. If the right LDR detects more light, the solar panel travels gradually to the right; conversely, if the left LDR detects more light, the panel shifts slowly to the left. At noon, when sunlight is directly overhead, both sides receive equal light, and the panel remains stationary without motor activation.

EXPERIMENTAL RESULT ANALYSIS

The specification of components used for the implementation of the prototype is given in Table 5.

Table 5: Specification Sheet of Components

Component	Specification	Quantity
Solar Panel	7X7cm, 5V	1
Servomotor	5 V micro servo motor (5G90)	1
LDR (4mm)	Operating voltage: 3-5V Output digital voltage: 0-5	2
LED	Operating voltage: 3V	1
ATmega328P	5V input, 14 digital I/O pins	1
Single core cable	30 gauge	As per requirement

Figure 7 showcases both the circuit analysis and prototype implementation of the proposed Automatic Solar Power Tracking System. The circuit is realized and evaluated using Proteus-8 Professional, depicted in Figure 7 (a).

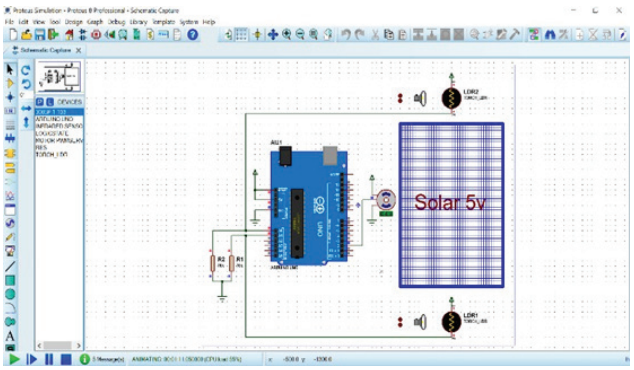


Fig.7(a) Circuit implementation

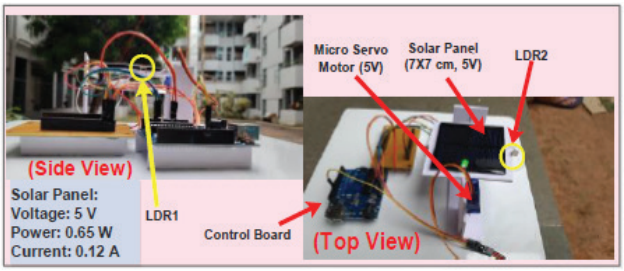


Fig.7 (b) Prototype implementation

Throughout typical summer days, rainy days, and winter daylight conditions, data from the ASTS are collected and analyzed. Table 2, Table 3, and Table 4 provide summaries of the observations and readings. They outline the LDR resistances corresponding to solar light intensity, temperature changes at various times of the day, and a comparison of power output between a fixed solar panel and a single-axis solar panel across three distinct seasons.

Table 3: Experimental Results for Summer Day

Time	LDR1 (KΩ)	LDR2 (KΩ)	Temp. (0C)	Fixed Panel Power (W)	Single Axis Panel Power (W)
07:00AM	46	74	22	1.8	3.22
08:00 AM	45	75	25	3.3	4.5
09:00 AM	48	78	28	3.9	5.8
10:00 AM	45	69	30	6.4	6.9
11:00 AM	42	56	35	7.43	7.87
12:00 PM	44	49	40	7.95	8.2
01:00 PM	47	45	41	8.78	9.43
02:00 PM	165	160	42	8.6	9.8
03:00 PM	174	164	39	8.32	9.5
04:00 PM	169	171	38	7.8	8.2
05:00 PM	173	168	36	5.75	7.24

Table 4: Experimental Results for Rainy Day

Time	LDR1 (KΩ)	LDR2 (KΩ)	Temp. (0C)	Fixed Panel Power (W)	Single Axis Panel Power (W)
07:00AM	184	191	17	0.5	1.2
08:00 AM	197	187	18	0.8	1.5
09:00 AM	47	55	19	1.0	1.8
10:00 AM	46	66	19	1.2	2.0
11:00 AM	44	72	22	1.3	2.2
12:00 PM	48	80	23	1.5	2.5
01:00 PM	173	161	24	1.6	2.7
02:00 PM	167	155	21	1.7	2.8
03:00 PM	182	172	20	1.8	2.9
04:00 PM	196	175	19	1.9	3.0
05:00 PM	224	197	22	2.0	3.1

Table 5: Experimental Results for Winter Day

Time	LDR1 (KΩ)	LDR2 (KΩ)	Temp. (0C)	Fixed Panel Power (W)	Single Axis Panel Power (W)
07:00AM	231	227	17	0.332	0.876
08:00 AM	214	197	18	0.851	1.32
09:00 AM	45	67	18	1.472	2.287
10:00 AM	46	66	19	1.768	2.675
11:00 AM	44	72	21	2.12	2.752
12:00 PM	180	138	22	2.77	3.326
01:00 PM	186	175	22	2.09	3.298
02:00 PM	168	159	23	2.345	3.091
03:00 PM	173	165	22	2.68	3.22
04:00 PM	186	177	22	2.543	3.189
05:00 PM	236	238	20	2.42	3.06

The observed output power from the fixed solar panel and single axis tacking solar panel are plotted in Fig.8, Fig.9, and Fig.10 for a summer day, rainy day, and winter day respectively.

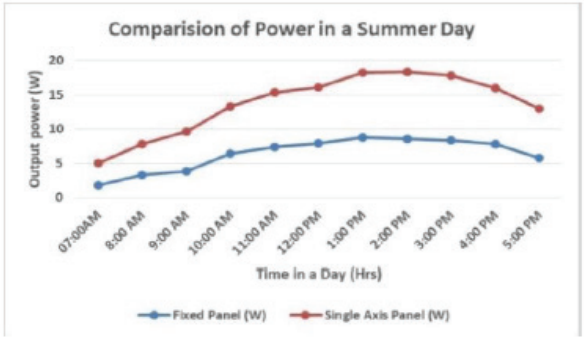


Fig. 8. Variation in Output Power on a Summer Day

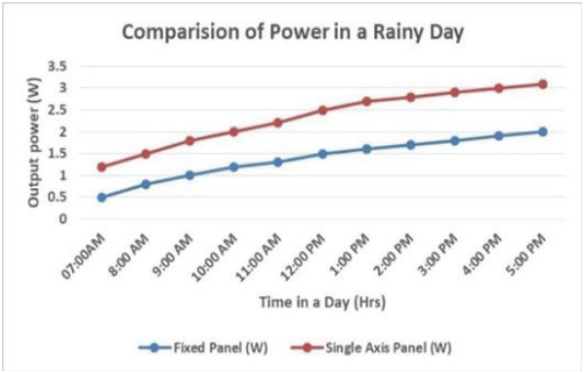


Fig. 9. Variation in Output Power in a Rainy Day

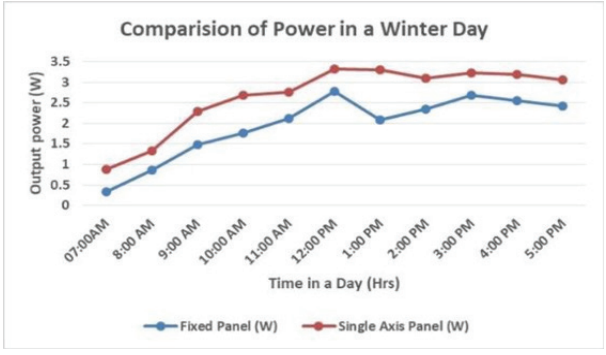


Fig.10. Variation in Output Power in a Rainy Day

From Fig.8, Fig.9, and Fig.10, it is observed that for the same time and same environment the output power is more in single-axis tracking solar panels.

For one year, the average power for fixed and single-axis solar panels was calculated for three seasons. Table 6 lists the average power throughout the year and the efficiency of the single-axis solar panel.

Table 6: Average Power of Fixed Solar Panel and Single Axis Panel for A Summer Day, Rainy Day, and Winter Day

Day	Fixed Solar Panel	Single Axis Panel	Efficiency (η)
Summer Day (March-June)	6.68 W	6.68 W	25.66%
Rainy Day (Jul-Oct)	1.27 W	2.56 W	
Winter Day (Nov-Feb)	2.65 W	2.98 W	
Total average power	10.6 W	13.32 W	

Statistical analysis

Table 7: F-Test on the Power Output of the Proposed Solar Tracking System in Three Different Seasons

Power Output on a Summer Day (W)	Power Output on a Rainy Day (W)	Power Output on a Winter Day (W)		SS	df	MS
3.22	1.2	0.876	Between groups of data collected each day in 3 seasons	172.46	2	86.23
4.5	1.5	1.32				
5.8	1.8	2.287				
6.9	2.0	2.675				
7.87	2.2	2.752				
8.2	2.5	3.326				
9.43	2.7	3.298	Within groups of data collected each day in 3 seasons	55.5	30	1.85
9.8	2.8	3.091				
9.5	2.9	3.22				
8.2	3.0	3.189				
7.24	3.1	3.06				
Mean= 7.3327 Std. Deviation= 2.1086	Mean= 2.3364 Std. Deviation= 0.6423	Mean= 2.6449 Std. Deviation= 0.8315	SS is Sum-of-squares, df is Degrees of freedom, MS is Mean Squares The significance level (α) is selected as 0.05. F=46.61173, p<0.00001			

Relating a one-way ANOVA test to this proposed automated solar tracking system involves understanding how this statistical analysis can be used to assess the effectiveness or impact of power output on the system's performance. When conducting a one-way ANOVA test, the interpretation of the p-value is crucial for determining whether the observed differences between the groups (power output of solar panels in three different seasons) are statistically significant.

The null hypothesis is rejected as the p-value is less than the significance level α. So accept the power output of the automated solar tracking system for further use with efficient output in all seasons.

CONCLUSION AND FUTURE WORK

The Automatic Solar Tracking System (ASTS) presented in this study offers an innovative approach to maximizing solar panel efficiency by autonomously orienting towards the sun's position using active LDR sensors and a microcontroller- based control system. Unlike traditional systems, the ASTS operates independently of Earth's position, ensuring optimal exposure to sunlight throughout the day, even under variable weather conditions. Experimental results demonstrate the system's effectiveness in enhancing power output, with single-axis panels consistently outperforming fixed panels across different seasons. Statistical analysis, including one- way ANOVA testing, validates the system's performance across diverse environmental conditions, highlighting its reliability and efficiency. Furthermore, the prototype implementation of the ASTS showcases its practical application in real-world scenarios, with circuit analysis conducted in Proteus-8 Professional. The system's adaptability is evident in the experimental results, demonstrating its robust performance across varying weather conditions and seasons. Statistical analysis, including the F- test on power output, supports the system's reliability and efficiency, with results indicating its suitability for widespread deployment in solar energy infrastructure. Overall, the ASTS represents a promising solution for maximizing solar energy utilization and advancing sustainable energy initiatives in diverse environmental contexts.

REFERENCES

1. W. Strielkowski, L. Civin, E. Tarkhanova, M. Tvaronaviciene, Y. Petrenko, "Renewable Energy in the Sustainable Development of Electrical Power Sector: A Review", Energies, vol.14, no. 24, pp. 1-24, 2021.
2. A. Asslam, N. Ahmed, S. A. Qureshi, M. Assadi, N. Ahmed, "Advances in Solar PV Systems; A Comprehensive Review of PV Performance, Influencing Factors, and Mitigation Techniques", Energies, vol. 15, no. 20, 2022.
3. A. Awasthi, A. K. Shukla, M. Manohar S.R., G. Richhariya, "Review on sun tracking technology in solar PV system", Energy Reports, vol. 6, no. 11– 12, pp. 392-405, 2020.
4. W. Nsengiyumva, S. G. Chen, L. Hu, X. Chen, "Recent advancements and challenges in solar tracking systems (STS): A review", Renewable and Sustainable Energy Reviews, vol. 81, pp. 250–279, 2018.
5. H. M. A. Hayat, S. Hussain, H. M. Ali, N. Anwar, M. N. Iqbal, "Case studies on the effect of two-dimensional heliostat tracking on the performance of domestic scale solar thermal tower", Case Studies in Thermal Engineering, vol. 21, 2020.
6. J. da Rocha Queiroz, A. da Silva Souza, M. K. Gussoli, et. al, "Construction and Automation of a Microcontrolled Solar Tracker", Processes, vol. 8, no. 10, 2020.
7. B. D. Verma, A. Gour, M. Pandey, "A Review Paper on Solar Tracking System for Photovoltaic Power Plant", International Journal of Engineering Research & Technology, vol.9, no.2, 2020.
8. N. Katrandzhiev, N. Karnobatev, "Algorithm for single axis solar tracker", In Proceedings of the 2018 IEEE XXVII International Scientific Conference Electronics—ET, Sozopol, Bulgaria, 13–15 September 2018, pp. 1–4.
9. G. Mehdi, N. Ali, S. Hussian, A. A. Zaidi, A. H. Shah, M. M. Azeem, "M.M. Design and fabrication of automatic single axis solar tracker for solar panel", In Proceedings of the 2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (ICoMET), Sukkur, Pakistan, 30–31 January 2019, pp. 1–4.
10. A. Sawant, D. Bondre, A. Joshi, P. Tambavekar, A. P. Deshmukh, "Design and analysis of automated dual axis solar tracker based on light sensors", In Proceedings of the 2018 2nd International Conference on I- SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC) I-SMAC (IoT in Social, Mobile, Analytics, and Cloud) (I-SMAC), Palladam, India, 30–31 August 2018; pp. 454–459.
11. M. Ikhwan, Mardlijah, C. Imron, "Model predictive control on dual axis solar tracker using Matlab/Simulink simulation", In Proceedings of the 2018 International Conference on Information and Communications Technology (ICOIACT), Yogyakarta, Indonesia, 6–7 March 2018; pp. 784–788.
12. T. Kaur, S. Mahajan, S. Verma, Priyanka, J. Gambhir, "Arduino based low cost active dual axis solar tracker", In Proceedings of the 2016 IEEE 1st International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), Delhi, India, 4–6 July 2016; pp. 1-5.
13. G. Mwithiga, S. N. Kigo, "Performance of a solar dryer with limited sun tracking capability", Journal of Food Engineering, vol. 74, pp. 247–252, 2006.
14. Z. Yang, Z. Xiao, "A Review of the Sustainable Development of Solar Photovoltaic Tracking System Technology", Energies, vol. 16, no. 23, pp.1- 31, 2023.
15. S. Sinha, S. Singh Chandel, "Analysis of fixed tilt and sun tracking photovoltaic–micro wind based hybrid power systems", Energy Conversion and Management, vol. 115, pp. 265-275, 2016.
16. S. Gutierrez, P. M. Rodrigo, J. Alvarez, A. Acero, A. Montoya, "Development and Testing of a Single-axis Photovoltaic Sun Tracker through the Internet of Things", Energies, vol. 13, no. 10, 2020.
17. E. K. Mpodi, Z. Tjiparuro, O. Matsebe, "Review of dual axis solar tracking and development of its functional model", Procedia manufacturing, vol.35, pp. 580-588, 2019.
18. M. T. B. Mostafa, T. Alam, Md. A. Hosain, "Design and performance analysis of a dual axis solar tracker," 2019 IEEE 1st International Conference on Energy, Systems and Information Processing (ICESIP), Chennai, India, pp. 1-4, 2019. DOI: 10.1109/icesip46348.2019.8938338.
19. A. Musa, E. Alozie, S. A. Suleiman, J. A. Ojo, A. L. Imoize, "A review of time-based solar photovoltaic tracking systems", Information, vol. 14, no. 4, 2023.
20. S. Shufat, E. Kurt, A. Hancerliogullrai, "Modeling and design of azimuth-altitude dual axis solar tracker

for maximum solar energy generation", International Journal of Renewable Energy Development, vol. 8, no. 1, 2019.

21. N. D. G. Concepcion, A. R. Villanueva, A. K. Dalumpines, G. Magwili, M. C. Pacis, "Design of an Azimuth-Altitude Dual Axis Tracking System (AADAT) for Energy Solar Harvesting using Photovoltaic V-trough Concentrator," 2020 11th IEEE Control and System Graduate Research Colloquium (ICSGRC), Shah Alam, Malaysia, pp. 144-149, 2020. doi: 10.1109/ICSGRC49013.2020.9232608.

22. W. Batayneh, A. Bataineh, I. Soliman, S. A. Hafees, "Investigation of a single-axis discrete solar tracking system for reduced actuations and maximum energy collection", Automation in Construction, vol. 98, pp. 102- 109, 2019.

23. T. Rajesh, K.S. Tamilselvan, A. Vijayalakshmi, Ch. Narendra Kumar, K. Anitha Reddy, "Design and implementation of an automatic solar tracking system for a monocrystalline silicon material panel using MPPT algorithm", Materials Today: Proceedings, vol.45, no.2, pp.1783-1789, 2021.

2ECC & Its Security Implications

Purna Chandra Sethi
Department of Computer Science
Rama Devi Women's University
Bhubaneswar, Odisha
✉ pcsethi@rdwu.ac.in

Ashok Kumar Bhoi
Dept. of Comp. Sci. & Engg.
Government College of Engineering
Kalahandi, Odisha,
✉ ashokbhoiserc@gmail.com

Prafulla Kumar Behera
Dept. of Comp. Sci. and Apps
Utkal University, Vani Vihar
Bhubaneswar, Odisha
✉ pkbehera.cs@utkaluniversity.ac.in

ABSTRACT

In this fast growing digital era, majorities of the activities are switched from the traditional approach to online mode. Accordingly, internet-based attacks have also increased significantly. In order to reduce these internet-based attacks and increase the data confidentiality, many researchers are proposing various hybrid cryptography algorithms considering the strong security features and integrating them together. Here, we have tried to propose a new hybrid algorithm that uses ECC (Elliptic Curve Cryptography) for achieving higher level of information security called as 2ECC (Double ECC) which is based on two times implementation of the ECC algorithm i.e. the encrypted result undergoes further encryption using another pair of keys to produce the resultant cipher text. The ECDH algorithm is used for public key exchange among the users. ECDH is the Elliptic Curve version of Diffie-Hellman approach for key exchange. The proposed 2ECC algorithm is used for encryption as well as decryption. The proposed 2ECC algorithm is implemented by generating two pair of public-private key pairs and the same are used for encryption and decryption. The central objective of this research work is to enhance information security level by achieving the higher level of confidentiality in comparison to the traditional ECC algorithm.

KEYWORDS: *ECC, 2ECC, ECDS, ECDH.*

INTRODUCTION

Cryptography algorithms are used by many researchers in order to secure information from attack. Cryptographic transformations focus on conversion of plain text (Message) to cipher text for achieving information security. Many popular algorithms are being implemented by many researchers in their applications. Basically adaptation of cryptography algorithms is done with respect to the key length as well as number of keys used during implementation [1]. Selection of cryptography algorithm for implementation differs from application to application. According to [1], ECC algorithm provides higher security than any other asymmetric key cryptography techniques. ECC uses too less size key for achieving same level of information security [2]. So, ECC is used in many applications for achieving information security.

With the growth of different cryptography algorithm, the number of cryptography attacks also increased significantly in past three decades. So, there is a high demand for different hybrid cryptography algorithm for achieving higher level of information security. This research work was motived from 2DES algorithm which is done by two times application of the DES algorithm with reduced key length as compared to the traditional approach. Here, we proposed the 2ECC which is based on two times application of the ECC algorithm. The ECC algorithm is used for generating the keys and the same is used for encryption and decryption. In order to enhance the level of security, instead of ECC

algorithm, we have proposed 2ECC which is based on two times implementation of ECC algorithm. The signature preparation and authentication is done using the proposed 2ECC algorithm.

The detailed outline of the research paper is stated as: The brief description of different popular cryptography algorithms are done in Section-2 as literature survey followed by the brief description of ECC algorithm in Section-3. Section-4 provides description of the suggested 2ECC approach. The exploratory examination is portrayed in section-5 where the correlation among the conventional ECC approach and the proposed 2ECC methodology are specified. Section-6 contains the Comparison result and subsequently conclusion followed by the future scope is stated in Section-7.

LITERATURE SURVEY

Symmetric Key Cryptography

This cryptographic method is also called as private key or secret key cryptography. Here, the sender and the receiver use the same private key. Various substitution cipher, transposition cipher, DES, AES, etc. are some of the most popular symmetric key cryptography algorithms [2, 3]. Different algorithms such as Diffie-Hellman key algorithm is applied to securely share the private key among the users over an insecure channel.

Asymmetric Key Cryptography

Due to sharing of private key over an insecure channel, symmetric key cryptography is prone to attack. Hence, various asymmetric key approaches are adopted by different cryptography researchers. Public-private key pair is used for achieving more security using asymmetric key cryptography in comparison to any symmetric key cryptography algorithm. The public key shared by the receiver is used for encryption at sender side, while the private key which is kept secret is used for decryption at receiver end [2, 3]. RSA, Elgamal cryptosystem, Schnorr digital signature algorithm, Digital signature algorithm, ECC, etc. are some of the popular asymmetric key cryptography algorithm.

Hybrid Cryptography Algorithms

By considering the security features of various cryptography algorithms, many hybrid cryptography algorithms are being proposed by many researchers [4-8]. The security features are adapted and implemented together for attaining higher level of information security than the individual algorithm.

In [4], the authors proposed a hybrid cryptography algorithm which is based on the integrated scheme of MD5, RSA and AES algorithm. In [5], the authors proposed a hybrid cryptography algorithm that uses integration of ECC, AES, XOR-DUAL RSA and MD5. ECC and AES algorithms are integrated together to provide encryption and authentication and integrity are achieved using XOR-DUAL RSA and MD5 respectively. The authors claimed that the integrated hybrid approach results in improved performance regarding computational time and the size of the cipher text. In [6], the authors proposed a cryptographic system that uses AES, blowfish, RC6, BRA algorithms for achieving block security. LSB steganography is used for key management and is transferred over email. In general hybrid algorithm will provide higher level of security but the implementation as well as key management will be more complex. So, there is a high demand for trade-off between algorithm implementation and key management an. Consequently, instead of block cipher implementation, group security algorithms are considered by researchers [1, 7-10].

In [1], the authors proposed a hybrid cryptography algorithm on the clustered data instead of individual information. The selected common gram (2-gram) elements are identified and the ECC algorithm is applied on the common gram element which provides the group security and reduces the time complexity significantly. The common gram elements are the common elements which are present in each of the information of cluster and the whole information are maintained with respect to the common gram. By applying ECC algorithm on the common gram element, the group security is achieved. The paper [7, 8] focuses on network traffic classification in order to achieve faster and secure network service. The authors proposed a hybrid security mechanism which is based on hierarchical pattern matching algorithm. Here, the common grams among the elements are searched first and then the SHA-256 algorithm is implemented on that for achieving group security. Since reverse engineering in SHA-256 is nearly impossible without prior knowledge, the authors used this algorithm for their applications.

Paper [9] is an extension of [7] which is applied using UPnP (Universal Plug and Play) protocol in zero-configuration environment. The main aim of this approach is to achieve group security as well as support zero-configuration so that the total available network resources especially bandwidth won't be pre-allocated. i.e., even if a user is exists in a network but if it doesn't has any data for transmission, then the bandwidth is not assigned leading efficient utilization of network bandwidth. Generalized ring signature algorithm is applied in order to achieve security of information. In [10], the authors proposed to reduce false alerts in order to optimize the resource utilization. Group security could be applied in order to achieve information security along with optimized resource utilization.

Each cryptography algorithm has its own application field. In contrast to other cryptography algorithms, the ECC algorithm offers enhanced security while requiring smaller key sizes. Due to this reason, ECC algorithm has attracted many researchers for implementation. The proposed hybrid cryptography algorithm using double ECC not only provides higher level information security in comparison to the traditional ECC approach but also provides confidentially, Integrity and availability which is called as the 3-pilars of information security.

ECC ALGORITHM

The traditional ECC algorithm involves the following three steps:

1. ECC Key Generation
2. ECC Encryption
3. ECC Decryption

ECC Key Generation

This algorithm is a close analogue to Diffie-Hellman algorithm used for key exchange. The ECC Key Generation step can be described as follows:

Global Public Components

a. Eq(a,b) is the Elliptic Curve (EC) with 'a', 'b' as the parameters defining the curve's shape and properties and 'q' is the integer field value which is in the form of GF(2m).

b. G is any EC point having order greater than n.

Sender Key Generation (User-A)

- Let, nA be the private key, where nA<n
- Calculate the public key of user-A:

$P_A = n_A \times G$

iii. Receiver Key Generation (User-B)

- Let, nB be the private key, where nB < n
- Calculate the public key of user-B:

$P_B = n_B \times G$

The Secrete key of user-A could be calculated as:

$K_A = K = n_A \times P_B$

The Secrete key of user-B could be calculated as:

$K_B = K = n_B \times P_A$

Hence the secret key is exchanged as $K = K_A = K_B$.

ECC Encryption Algorithm

- Consider 'M' as the message.
- Initially, 'M' is encoded into a point (PM) satisfying the elliptic curve.
- For encryption of PM, a positive random integer 'K' is selected such that the cipher text (cipher coordinate) CM will be: $CM=\{KG, P_M+KP_B\}$. The co-ordinates of the point CM is shared with the receiver.

ECC Decryption Algorithm

For decipherment, the first point is multiplied with secret key of receiver, i.e. $KG \times n_B$. For decryption of message, receiver's private key n_B is used. The 2nd point co-ordinate is subtracted in order to get the co-ordinate of the message. This can be represented as:

$P_M + KP_B - (KG \times n_B) = P_M + KP_B - KP_B = P_M$ ($\because P_B = G \times nB$)

Where, PM denotes the pain text message represented in the form of co-ordinates of the point.

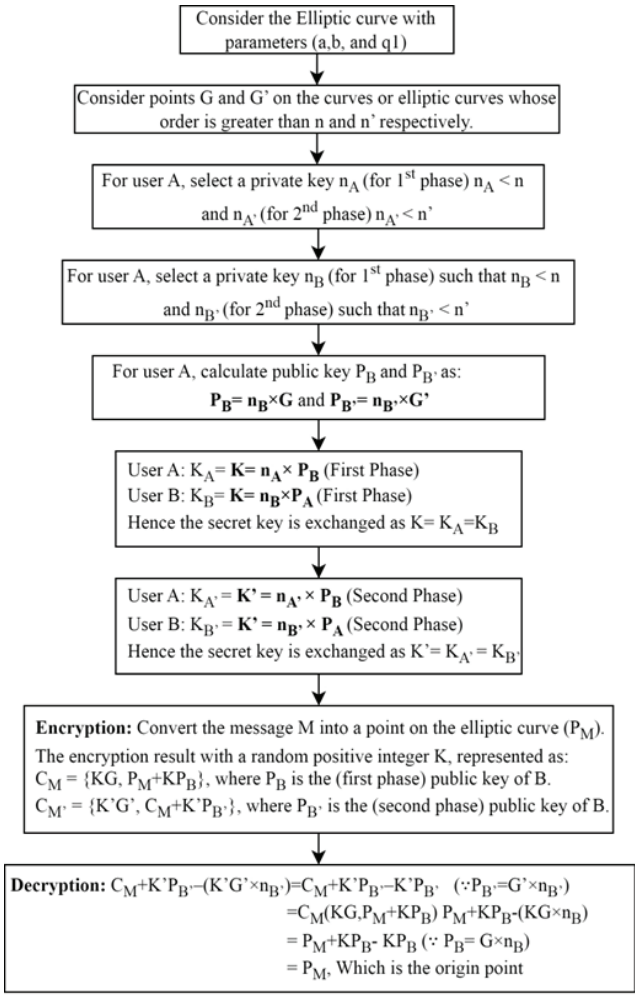
2ECC- THE PROPOSED RESEARCH WORK

The proposed algorithm will work similar to ECC algorithm. In this proposed research work, instead of a single elliptic curve, two elliptic curves are used.

Here, two pair of public-private keys is considered for implementation of the proposed algorithm. Hence, both key pairs are generated in similar manner and shared for data encryption and decryption. The encrypted data undergoes second phase of encryption using the second key pair and the same is used decryption which undergoes further decryption in order to get the plain text. This involves three basic steps, such as:

1. 2ECC Key Generation
2. 2ECC Encryption
3. 2ECC Decryption

The flowchart illustrating the proposed research is depicted in figure 1.



*A-Sender, B-Receiver

Fig 1: Flow diagram of the proposed 2ECC Algorithm

2ECC Key Generation

Global Public Components

- $E_{q1}(a,b)$ is the EC with (a,b,q1) as parameter and q1 is any prime field which is of the form of 2m.
- G is the point satisfying the EC with order greater than n.
- $E_{q2}(KG, P_M + KP_B)$ is the EC with $(KG, P_M + KP_B, q2)$ as parameter, where q2 is any prime (of the form of 2m) and PM the coordinate of the point satisfying the elliptic curve equation used for the message.
- G' is any coordinate on EC with order greater than n'.

Sender (User-A) Key Generation

- Choose a pair of private keys nA, nA', such that nA < n and nA' < n', where n and n' is the boundary value of the first EC and second EC respectively.
- Calculate the public key (PA) as: $P_A = n_A \times G$
- Calculate the public key (PA') as: $P_A' = n_A' \times G'$

Receiver Key Generation (User-B)

- Choose a pair of private keys nB, nB', such that nB < n and nB' < n'
- Calculate the public key (P_B) as: $P_B = n_B \times G$
- Calculate the public key (P_B') as: $P_B' = n_B' \times G'$

The user-A Secrete key can be calculated as:

$K_A = K = nA \times P_B$

$K_A' = K' = nA' \times P_B'$

The user-B Secrete key can be calculated as:

$K_B = K = nB \times P_A$

$KB' = K' = nB' \times P_A$

Hence the secret key is exchanged as $K = K_A = K_B$

$K' = K_A' = K_B'$

The cipher text result of the first phase of ECC is used as the input for the second phase in order to get the resultant cipher text. The Global Public Elements and the key generation process will remain same for both users (Sender-A and Receiver-B).

2ECC Encryption Algorithm

- Consider 'M' as the message.
- Initially, the message 'M' is encoded into a coordinate (P_M) satisfying the EC.
- For the first phase encryption of the message in the form of point P_M, a random positive integer K is selected such that the cipher text (C_M) in the form of coordinate is: $C_M = \{KG, P_M + KP_B\}$
- Now, CM will undergo second phase of encryption using K' which as another random positive integer resulting cipher point C_M' represented as: $C_M' = \{K'G', C_M + K'P_B'\}$. This point will be sent to the receiver.

2ECC Decryption Algorithm

For decryption, the cipher coordinate is multiplied with the receiver's secret key in two phases, i.e. K'G'×nB' followed by KG×nB. So, the private key pair nB' and nB are used. Then subtract it from 2nd point co-ordinate in order to get CM followed by same process to get the message in the form of plain text message P_M. This can be represented as:

$C_M + K'P_B' - (K'G' \times nB') = CM + K'P_B' - K'P_B'$ ($\because P_B' = G' \times nB'$)

$= C_M (KG, P_M + KP_B)$

$P_M + KP_B - (KG \times nB) = P_M + KP_B - KP_B$ ($\because P_B = G \times nB$)

$= P_M$, which is the original point

IMPLEMENTATION OF THE ALGORITHM

The implementation of the algorithm is done by taking the ASCII value of the each character and converting them to equivalent points with respect to some field value. Here, we have considered the field value as 13. The equation of elliptic curve considered for implementation is:

$y^2 = x^3 + 2x + 4$ over F_{13}

The seventeen points including point at infinite that satisfied the elliptic curve are: (0,2), (0,11) (2,4), (2,9), (5,3), (5,10), (7,6), (7,7), (8,5), (8,8), (9,6), (9,7), (10,6), (10,7), (12,1), (12,12) . The coordinates of the elliptic curve is depicted in the figure 2.

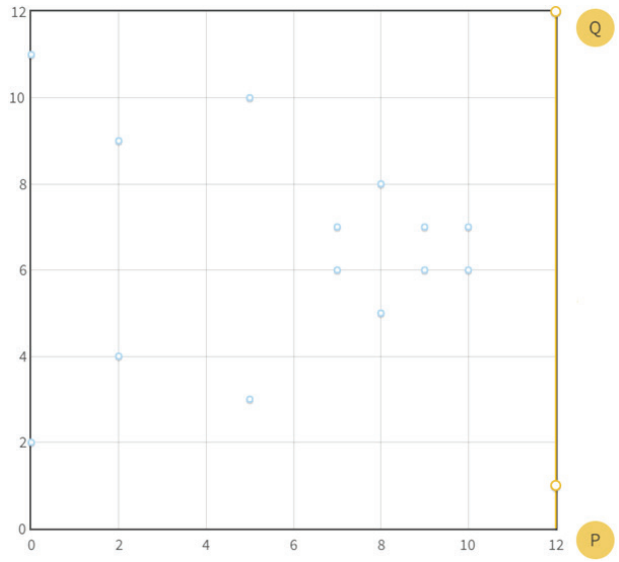


Fig 2: Coordinates of EC for F_{13}

The initial points considered as [1]G that satisfies the above elliptic curve over F13 is A(2,4). By point doubling (2A=[2]G), the successive point (8,5) is generated. Accordingly, the successive points are generated by sequential addition of points, i.e. nA will be generated by addition of A with (n–1)A. In case, if point addition is not possible due to divided by zero operation, then the points are regenerated by corresponding addition operation, i.e. [2]G+[n–2]G and so on. The resultant points generated over the field F_{13} by considering the elliptic curve $y^2 = x^3 + 2x + 4$ are depicted in the table 1 given below:

Table 1: Generated points over the field F_{13}

ASCII Code (Decimal Value)	Symbol	[k]G	Mapped Point
0	NULL	[1]G	(2,4)
1	SOH	[2]G	(8,5)
2	STX	[3]G	(7,6)
3	ETX	[4]G	(0,2)
4	EOT	[5]G	(12,12)
5	ENQ	[6]G	(9,6)
6	ACK	[7]G	(5,10)
7	BEL	[8]G	(10,6)
8	BS	[9]G	(10,7)
9	TAB	[10]G	(5,3)
:::	:::	:::	:::

48	0	[49]G	(8,8)
49	1	[50]G	(2,9)
50	2	[51]G	(0,0)
51	3	[52]G	(2,12)
52	4	[53]G	(8,5)
53	5	[54]G	(7,6)
54	6	[55]G	(0,2)
55	7	[56]G	(12,12)
56	8	[57]G	(9,6)
57	9	[58]G	(5,10)
:::	:::	:::	:::
65	A	[66]G	(8,8)
66	B	[67]G	(2,9)
67	C	[68]G	(0,0)
68	D	[69]G	(2,12)
69	E	[70]G	(8,5)
70	F	[71]G	(7,6)
:::	:::	:::	:::
90	Z	[91]G	(9,6)
:::	:::	:::	:::
97	A	[98]G	(0,11)
98	B	[99]G	(7,7)
99	C	[100]G	(8,8)
100	D	[101]G	(2,9)
101	E	[102]G	(0,0)
102	F	[103]G	(2,12)
:::	:::	:::	:::
122	Z	[123]G	(0,2)
:::	:::	:::	:::
126	~	[126]G	(5,10)
127	DEL	[127]G	(10,6)

The second equation of elliptic curve considered for implementation is: $y^2 = x^3 + 2x + 3$ over F_{17}

The twenty two points including point at infinite that satisfied the elliptic curve are: (2,7), (2,10) (3,6), (3,11), (5,6), (5,11), (8,2), (8,15), (9,6), (9,11), (11,8), (11,9), (12,2), (12,15), (13,4), (13,13), (14,2), (14,15), (15,5), (15,12), (16,0) . The coordinates of the elliptic curve is depicted in the figure 3.

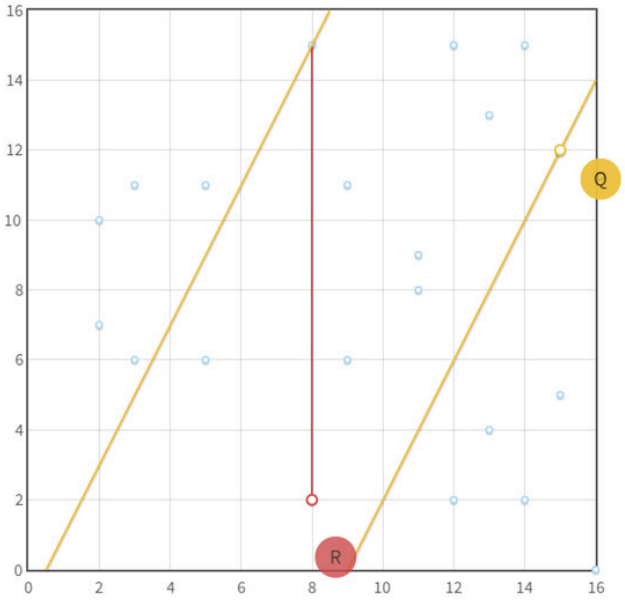


Fig 3: Coordinates of EC for F_{17}

Table 2: Generated points over the field F_{17}

ASCII Code (Decimal Value)	Symbol	[k]G	Mapped Point
0	NULL	[1]G	(2,3)
1	SOH	[2]G	(9,9)
2	STX	[3]G	(5,9)
3	ETX	[4]G	(14,7)
4	EOT	[5]G	(3,8)
5	ENQ	[6]G	(3,9)
6	ACK	[7]G	(11,11)
7	BEL	[8]G	(5,0)
8	BS	[9]G	(10,7)
9	TAB	[10]G	(7,1)
:::	:::	:::	:::
48	0	[49]G	(6,5)
49	1	[50]G	(11,0)
50	2	[51]G	(5,11)
51	3	[52]G	(10,14)
52	4	[53]G	(4,6)
53	5	[54]G	(13,12)
54	6	[55]G	(6,5)
55	7	[56]G	(11,0)
56	8	[57]G	(5,11)
57	9	[58]G	(10,14)

:::	:::	:::	:::
65	A	[66]G	(13,12)
66	B	[67]G	(6,5)
67	C	[68]G	(11,0)
68	D	[69]G	(5,11)
69	E	[70]G	(10,14)
70	F	[71]G	(4,6)
:::	:::	:::	:::
90	Z	[91]G	(6,5)
:::	:::	:::	:::
97	A	[98]G	(11,0)
98	B	[99]G	(5,11)
99	C	[100]G	(10,14)
100	D	[101]G	(4,6)
101	E	[102]G	(13,12)
102	F	[103]G	(6,5)
:::	:::	:::	:::
122	Z	[123]G	(5,11)
:::	:::	:::	:::
126	~	[126]G	(13,12)
127	DEL	[127]G	(6,5)

The algorithm involves three the subsequent steps:

1. 2ECC Key Generation
2. 2ECC Encryption
3. 2ECC Decryption

The standard ECC approach for the whole process containing the key generation, encryption and decryption is implemented using the extended form of EC Digital Signature (ECDS) algorithm. The proposed 2ECC is an extension to the standard ECC approach. Here, two pairs of keys are generated that are used during the encryption and decryption process.

Key Generation

The cipher text result of the first phase ECC is used as the message for the second phase input in order to get the resultant cipher text. The Global Public Elements (G and G') will remain same for both users (A and B). The Diffie-Hellman algorithm is applied for sharing the Global Public Key.

Global Public Elements

- $E_{q1}(a,b)$ is the EC with (a,b,q1) as parameter, where q1 is any prime integer of the form of 2^m.
  - ❖ Let, q1=13, a=2 and b=4. So, the EC with (2,4,13) as parameter is $E_{13}(2,4)$.
- G is a point on the EC with order greater than n.
  - ❖ Let, G(2,4) is a point on EC.
- $E_{q2}(KG,P_M+KP_B)$ is the EC with $(KG,P_M+KP_B,q2)$ as parameter, where q2 is any prime integer of the form of 2^m and PM is the point on the EC with respect to the message.
  - ❖ Let, K=5 and q2=17. So, the EC with parameters (5(2,4), PM+KPB, 17) is $E_{17}(5(2,4),P_M+5P_B)$, where, P_M is the message represented in the form of point on the EC, and P_B is the public key of Bob.
- G' is a point on the EC with order greater than n'.
  - ❖ Let G'(2,3) is a point on the resultant EC.

Sender side Key Generation (User A)

- Select a pair of private keys nA, nA', such that nA < n and nA' < n', where n and n' is the boundary value of the first EC and second EC respectively.

Let, nA=3 and nA'=5 be the pair of private keys of Alice.

- Calculate the first public key (P_A) as: $P_A = nA \times G$

Accordingly, the first public key of Alice (P_A) will be: $P_A=3(2,4)=(7,6)$

- Calculate the public key (P_A') as: $P_A' = nA' \times G'$
- Calculate the second public key (P_A') as:

$P_A' = n_A' \times G'$

Accordingly, the second public key of Alice (P_A') will be: $P_A' = 5(2,3) = (3,8)$

Receiver side Key Generation (User B)

- Select a pair of private keys nB,nB', such that nB < n and nB' < n'

  Let, nB=4 and nB'=7 be the pair of private keys of Bob.

- Calculate the public key (P_B) as: $P_B=n_B \times G$

So, the first public key of Bob will be:

$P_B = 4(2,4)=(0,2)$

- Calculate the public key (P_B') as: $P_B'=n_B' \times G'$

So, the second public key of Bob will be:

$P_B'=7(2,3)=(11,11)$

The user A key can be calculated as:

$K_A=K=n_A \times P_B= n_A \times n_B \times G$

$K_A'=K'=n_A' \times P_B' = n_A' \times n_B' \times G'$

The user B key can be calculated as:

$K_B= K= n_B \times P_A= n_B \times n_A \times G = n_A \times n_B \times G$

$K_B'=K'=n_B' \times P_A'= n_B' \times n_A' \times G'= n_A' \times n_B' \times G'$

Hence the pair of keys are exchanged as:

$K= K_A= K_B$

$K'= K_A'= K_B'$

2ECC Encryption Algorithm

- Consider the message 'M' as ="HELLO".
- The message 'M' is encoded into coordinate (PM) on the EC $y^2 = x^3+2x+4$ over F13 as: H(12,12), E(8,5), L(10,7), L(10,7), O(12,1).
- For the first phase encryption of the message in the form of point PM, a random positive integer K is selected such that the cipher coordinate (CM) is:

$C_M =\{KG,P_M+KP_B\}$

$=\{5G, P_M+5\times 4G\}$

$=\{5G, P_M+20G\}$

Table 3: ECC Encryption Result

ASCII Char.	K[G]	Mapped Point in E_{13}	ECC Encryption result $(C_1, C_2) \equiv (KG, P_M + KP_B)$
H	73[G]	(12,12)	(5G, 93G)
E	70[G]	(8,5)	(5G, 90G)
L	77[G]	(10,7)	(5G, 97G)
L	77[G]	(10,7)	(5G, 97G)
O	80[G]	(12,1)	(5G, 100G)

- Now CM will undergo second phase of encryption using K' using another random positive integer resulting cipher point CM' represented as:

$C_M'= \{K'G, C_M+K'P_B'\}$.

This point will be sent to the receiver.

Table 4: 2ECC Encryption Result

ASCII Char.	K'[G']	ECC Encryption result (KG,P_M+KP_B)	Mapped 2ECC Encryption result in E17 in the form of $C_M'= \{K'G, C_M+K'P_B'\}$
H	73[G']	(5G, 93G)	(7,7)
E	70[G']	(5G, 90G)	(9,14)
L	77[G']	(5G, 97G)	(5,2)
L	77[G']	(5G, 97G)	(5,2)
O	80[G']	(5G, 100G)	(10,11)

2ECC Decryption Algorithm

For decryption, the first point is multiplied with receiver's secret key in two phases, i.e. $K'G' \times n_B'$ followed by $KG \times n_B$. So, the private key pair n_B' and nB are used. Then subtract it from 2nd point co-ordinate in order to get CM followed by same process to get the message in the form of plain text message P_M. This can be represented as:

$$C_M+K'P_{B'}-(K'G' \times n_{B'}) = C_M+K'P_{B'}-K'P_{B'} \quad (\because P_{B'}=G' \times n_{B'})$$
$$= C_M (KG, P_M+KP_B)$$

$$P_M+KP_B-(KG \times n_B) = P_M+KP_B-KP_B \quad (\because P_B=G \times n_B)$$
$$= P_M$$

Where, P_M is the coordinate equivalent for the message

The decryption result will be:

Table 5: 2ECC Decryption Result

Cipher Text C_M' Mapped in E_{17}	2ECC Decryption Result (KG,P_M+KP_B)	Mapped Value K'[G']	The Plain Text Message
(7,7)	(5G, 93G)	73[G']	H
(9,14)	(5G, 90G)	70[G']	E
(5,2)	(5G, 97G)	77[G']	L
(5,2)	(5G, 97G)	77[G']	L
(10,11)	(5G, 100G)	80[G']	O

COMPARISON ANALYSIS

The comparison chart can be represented as given below:

Table 6: Comparison of ECC and 2ECC Approach

RSA-Based Scheme (Size of key in bits)	ECC-Based Scheme (Size of key in bits)	2ECC-Based Scheme (Size of key in bits)
512	112	12+12=24
1024	160	17+17=34
2048	224	24+24=48
3072	256	28+28=56
7680	384	42+42=84
15360	512	56+56=112

The comparison chart for the proposed 2ECC algorithm with the traditional ECC algorithm and the RSA is depicted in the comparison chart depicted in the figure-4.

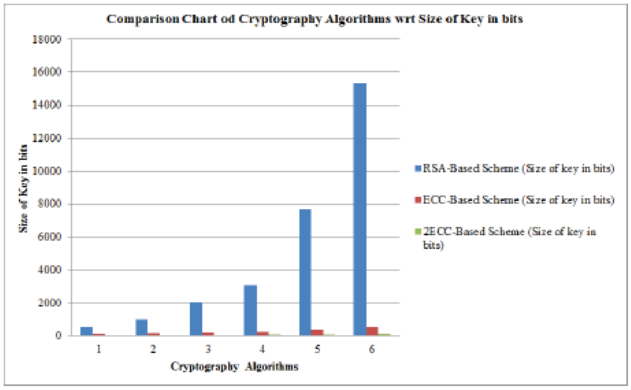


Fig. 4. Comparison chart of ECC and 2ECC Approach

CONCLUSION

The traditional ECC algorithm provides high level security in comparison to all other cryptography algorithms. In this research work, I have tried to present a new enhanced cryptography algorithm called 2ECC which is implemented by considering the resultant output of ECC and further the same algorithm is applied in order to encrypt the result. By such approach the key size reduced significantly in order to provide same security. The main drawback of this process is that, traditional ECC algorithm is difficult implement. By considering two times implementation of ECC, the difficulty in computation also increases significantly. So, on chip memory management for the algorithm implementation will lead to significant increase in speed for the proposed method implementation.

REFERENCES

1. Sethi, P.C., Sahu, N. & Behera, P.K. "Group security using ECC". Int. j. inf. tecnol. (2021). https://doi.org/10.1007/s41870-021-00613-1
2. Bernard Menezes, "Network Security and Cryptography", 3rd Edition, P110-112
3. Sahoo, A., Mohanty, P., Sethi, P.C. (2022). Image Encryption Using RSA Algorithm. In: Udgata, S.K., Sethi, S., Gao, XZ. (eds) Intelligent Systems. Lecture Notes in Networks and Systems, vol 431. Springer, Singapore. https://doi.org/10.1007/978-981-19-0901-6_56
4. Sadiq Aliyu Ahmad, Ahmed Baita Garko, "Hybrid Cryptography Algorithms in Cloud Computing: A Review", Electronics Computer and Computation (ICECCO) 2019 15th International Conference on, pp. 1-6, 2019.
5. Y. Alkady, M. I. Habib and R. Y. Rizk, "A new security protocol using hybrid cryptography algorithms", 2013 9th International Computer Engineering Conference (ICENCO), 2013, pp. 109-115, doi: 10.1109/ICENCO.2013.6736485.
6. P. V. Maitri and A. Verma, "Secure file storage in cloud computing using hybrid cryptography algorithm", 2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), 2016, pp. 1635-1638, doi: 10.1109/WiSPNET.2016.7566416.
7. Sethi, P.C., Behera, P.K., "Secured packet inspection with hierarchical pattern matching implemented using incremental clustering algorithm", 2014 International Conference on High Performance Computing and Applications (ICHPCA), 2014, pp. 1-6, doi: 10.1109/ICHPCA.2014.7045309.
8. Sethi, P.C., Behera, P.K. "Internet Traffic Classification for Faster and Secured Network Service", International Journal of Computer Applications (IJCA), Volume 131 – No.4, December2015, pp. 15–20
9. Sethi, P.C. "UPnP and Secure Group Communication Technique for Zero–configuration Environment construction using Incremental Clustering", International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 12, December – 2013, ISSN: 2278–0181, pp. 2095–2101.
10. Sethi, P.C., Behera, P.K. "Anomaly detection and optimization using scalable and flexible network data characterization". Global Transitions Proceedings, Volume-2, Issue-1, June 2021, pp. 67-72, https://doi.org/10.1016/j.gltp.2021.01.009.

Enhancing Diabetes Prediction through Machine Learning Optimization Strategies

Priya Chandran
Bharati Vidyapeeth's Inst of Magt. & Inform. Tech.
Navi Mumbai, Maharashtra
✉ priyaci2005@gmail.com

Anu Thomas
SIES College of Arts, Science and Commerce
Navi Mumbai, Maharashtra
✉ anuthomas.official@gmail.com

Suhasini Vijaykumar
Bharati Vidyapeeth's Inst of Magt. & Inform. Tech.
Navi Mumbai, Maharashtra
✉ suhasini.kottur12@gmail.com

Tushar Sharma
Bharati Vidyapeeth's Inst of Magt. & Inform. Tech.
Navi Mumbai, Maharashtra
✉ tusharsharmavj@gmail.com

ABSTRACT

Diabetes, a prevalent metabolic disorder, poses significant global health challenges, necessitating accurate prediction and management strategies. This research paper investigates how Backpropagation Neural Networks (BPNN) can be utilized in conjunction with various regularization and optimization methods to examine diabetes. The study aims to address gaps in understanding optimal configurations and feature selection for BPNN models. The implementation involves thorough training of BPNNs using the backpropagation algorithm, supplemented by regularization and optimization techniques to enhance model performance and prevent over fitting. Furthermore, the study explores the impact of dropout regularization on BPNN performance, emphasizing its role in preventing overfitting and enhancing model generalization.

KEYWORDS: *Machine learning, Diabetes prediction, BPNN, Regularization.*

INTRODUCTION

Diabetes, characterized by elevated blood sugar levels and associated organ damage, presents a significant global health challenge [1]. Computer-based systems leveraging clinical data offer promising avenues for disease identification and management [2]. ADA diagnoses data on criteria such as fasting plasma glucose (FPG) levels exceeding normal [3]. Type 1 diabetes, often diagnosed in individuals under 30, necessitates insulin therapy due to inadequate insulin production [4, 5, 6, 7, 8]. Uncontrolled glucose levels can lead to severe complications like cardiovascular diseases, neuropathy, and nephropathy [9]. Given the alarming prevalence of diabetes, accurate prediction models are crucial for early intervention and prevention strategies. Artificial Neural Networks (ANNs), particularly Backpropagation Neural Networks (BPNNs), offer robust tools for diabetes prediction, leveraging factors such as genetic predisposition and lifestyle habits [10].

Early detection and intervention play a crucial role in mitigating the long-term complications associated with diabetes. As we delve into the complexities of diabetes, understanding its epidemiology, risk factors, and the evolving landscape of research and treatment becomes imperative. The role of machine learning models in predicting diabetes is multifaceted and can bring several benefits to both patients and healthcare providers. Machine learning models play a crucial role in diabetes prediction by leveraging data-driven approaches to improve early detection, personalized risk assessment, clinical decision-making, treatment optimization, and patient outcomes.

LITERATURE REVIEW

Numerous studies have explored diabetes prediction using machine learning techniques, notably the Pima Indians Diabetes Dataset (PIDD). Kaur and Kumari (2020) compared various machine learning algorithms on this dataset, including Radial Basis Function (RBF) kernel SVM and ANN [1]. Maniruzzaman et al. (2020) employed Logistic Regression (LR) to identify diabetes

risk factors and explored classifiers like Naive Bayes and Decision Trees [2]. Kopitar et al. (2020) and Maniruzzaman et al. (2020) investigated regression models like Glmnet and classification models like Adaboost and Random Forest for type 2 diabetes prediction [3]. Albahli (2020) proposed a hybrid approach using K-means clustering and ensemble learning, while Yahyaoui et al. (2019) compared traditional machine learning with deep learning techniques [6, 7]. Zou et al. (2018) and Dinh et al. (2019) utilized decision trees, random forests, and supervised machine learning models for diabetes prediction [6, 9]. Choubey et al. (2017) employed Naive Bayes with Genetic Algorithm, emphasizing early diabetes detection [8]. Joshi and Chawan (2018) and Rajeswari and Prabhu (2019) focused on SVM classification for high accuracy in diabetes prediction [10]. Nilashi et al. (2017) developed intelligent models using machine learning techniques like SOM and NN, while Perveen et al. (2016) utilized ensemble methods for diabetes detection [11, 12]. Kazerouni et al. (2020) compared SVM, K-NN, ANN, and LR for T2DM diagnosis [13].

The review underscores the breadth of approaches in diabetes prediction, with BPNNs standing out as a fundamental tool. Diabetes presents as a multifaceted metabolic ailment characterized by elevated blood sugar levels, necessitating the anticipation of future glucose levels grounded in factors like dietary patterns, physical activity, prescribed medications, and individual physiological attributes. In this domain, backpropagation, coupled with neural networks, emerges as a potent instrument for scrutinizing and prognosticating intricate data relationships.

METHODOLOGY

In the field of diabetes management, backpropagation finds application predominantly in crafting predictive models employing artificial neural networks (ANNs). We have used BPNN algorithm with regularization and optimization techniques to implement machine learning model for diabetes prediction. Throughout the training regimen, backpropagation meticulously adjusts the weights of connections linking neurons within the network, guided by the disparities between predicted outcomes and actual results. This iterative refinement process enables the neural network to acquire knowledge and enhance its prognostic capabilities progressively.

BACKPROPAGATION ALGORITHM

Error at Output Layer:

$\delta j=(yj-aj)\cdot f'(zj)$

where δj is the error at neuron j in the output layer,yj is the target output,f′ is the derivative of the activation function.

Error at Hidden Layers:

$\delta j=(\sum kwjk\cdot\delta k)\cdot f'(zj)$ where δj is the error at neuron j in a hidden layer,wjk is the weight connecting neuron j to neuron k,δk is the error at neuron k in the following layer.

Filter Methods evaluate features individually based on their statistical properties. Metrics such as correlation coefficients, variance, or statistical tests like chi-square and ANOVA are commonly used. For example, the Pearson correlation coefficient measures the linear relationship between variables, while variance indicates the spread of data points around the mean. By ranking features using these criteria, filter methods assist in selecting promising candidates for model inclusion.

$$r=\sum i=1n(xi-x^-)2\sum i=1n(yi-y^-)2\sum i=1n(xi-x^-)(yi-y^-)$$

where n is the number of observations, xi and yi are individual data points for variables X and Y respectively. $\bar{x}$ and $\bar{y}$ are the means of variables X and Y respectively.

Wrapper Methods, on the other hand, assess feature subsets by employing specific machine learning algorithms. Feature Elimination techniques build and evaluate models using different feature combinations. The subset that achieves the best performance according to predefined metrics, such as accuracy or cross-validation score, is selected. Embedded Methods integrate feature selection into the model construction process itself. These methods utilize regularization techniques within machine learning algorithms, such as Lasso (L1regularization) and Ridge (L2 regularization) regression models. Less relevant features' coefficients are penalized, effectively pushing them towards zero during training. This automatic feature selection during model construction results in a more concise and interpretable final model.

Lasso (L1 Regularization): It combines a penalty, which

is the sum of squared errors (SSE). The formula for the Lasso objective function is as follows:

Loss function=SSE+λ∑j=1p|βj| Where λ is the regularization parameter that controls the strength of regularization and p is the number of features. βj represents the coefficient of the *h*jth feature. Lasso regularization encourages sparse solutions by driving less relevant feature coefficients towards zero, effectively performing feature selection during model training.

Ridge (L2 Regularization):

Loss function=SSE+λ∑j=1pβj2 Where λ is the regularization parameter controlling the strength of regularization. p is the number of features. βj represents the coefficient of the *h*jth feature. Ridge regularization penalizes large coefficients, leading to smoother solutions and mitigating multicollinearity issues.

Dataset

We have used Diabetes dataset for implementing machine learning model for prediction. The dataset features are given in table 1. The dataset contains information on various individuals, including their medical history and demographic characteristics. It could be used for research into factors contributing to diabetes, predictive modelling for diabetes diagnosis, or evaluating the effectiveness of interventions or treatments.

Table 1. Dataset Features

Serial Number	Topic	Description
1	Pregnancies	This variable indicates the number of times the individual has been pregnant.
2	Glucose	Represents the plasma glucose concentration measured in a 2-hour oral glucose tolerance test.
3	Blood Pressure	Indicates the diastolic blood pressure (mm Hg) of the individual.
4	Skin Thickness	Refers to the thickness of the skinfold at the triceps (mm).
5	Insulin	Represents the 2-hour serum insulin level (mu U/ml)
6	BMI (Body Mass Index)	Represents the individual's body mass index, calculated as weight in kilograms divided by height in meters squared (kg/m^2).
7	Diabetes Pedigree Function	A function that scores the likelihood of diabetes based on family history.
8	Age	Represents the age of the individual in years
9	Outcome	This is the target variable, indicating whether the individual has diabetes (1) or not (0)

IMPLEMENTATION

The Implementation of backpropagation, bolstered by regularization and optimization techniques, holds significant promise, particularly in complex tasks such as diabetes management. Backpropagation, a cornerstone algorithm in neural network training, facilitates the adjustment of connection weights based on errors between predicted and actual outcomes. Regularization techniques, like L1 and L2 regularization, are integrated into the training process to prevent overfitting by imposing penalties on large weight values. Researchers expedite subsequent analysis and modelling tasks without sacrificing data fidelity. The proposed model is shown in fig 1. Backpropagation is a key algorithm used in training artificial neural networks (ANNs), particularly in the context of supervised learning tasks. which allows for efficient optimization of the network's parameters through gradient descent.

Moreover, optimization algorithms play a vital role in refining the model's parameters during training to minimize the loss function. Techniques like stochastic gradient descent (SGD), Adam, and RMSprop are commonly employed to navigate the high-dimensional parameter space efficiently. By adjusting the learning rate and momentum, these optimization algorithms enable backpropagation to converge to an optimal solution more swiftly and effectively. In the context of diabetes management, where the input space is multidimensional and dynamic, these optimization techniques contribute to the development of accurate predictive models capable of capturing the intricate relationships between various factors influencing blood sugar levels.

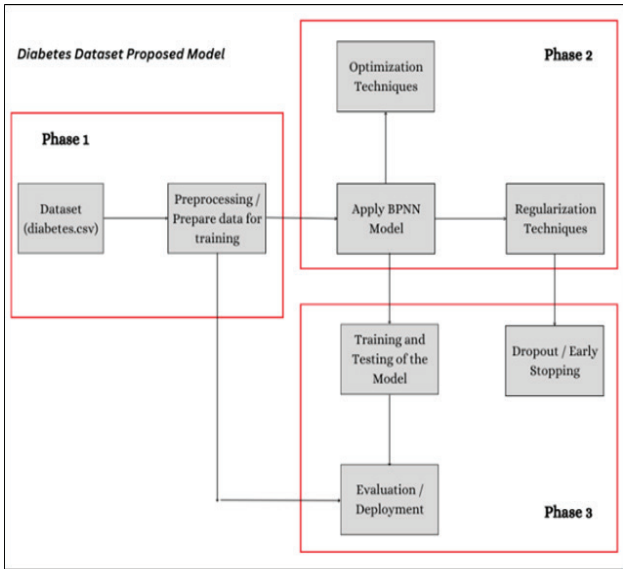


Fig. 1. Proposed Model

RESULTS AND DISCUSSIONS

Table 2 shows the results of the implementation. Feature selection was conducted employing both filter and wrapper methods as well as embedding techniques. The performance of BPNN is compared with SVM, Logistic Regression, Decision Tree and KNN algorithms. Both filter wrapper and embedding feature selection methods are applied on algorithms and the results are compared. BPN with filter wrapper method gives an accuracy of 0.76 compared to embedding method with an accuracu of 0.68.

Table 2: Comparison of Performance

Classifier	Feature Selection	Accuracy	Precision , Recall	Sensitivity	Specificity
BPNN	Filter Wrapper	0.731	0.75,0.82	0.64	0.79
	Embedding	0.66			
SVM	Filter Wrapper	0.7666	0.78,0.88	0.94	0.12
	Embedding	0.54			
Logistic Regression	Filter Wrapper	0.71	0.81,0.80	0.752	0.68
	Embedding	0.64			
Decision Tree	Filter Wrapper	0.733	0.83,0.76	0.788	0.54
	Embedding	0.682			
KNN	Filter Wrapper	0.73	0.75,0.82	0.64	0.79
	Embedding	0.66			

A Backpropagation Neural Network is a type of artificial neural network commonly utilized for supervised learning tasks such as classification and regression. In this network architecture, layers of interconnected nodes, representing neurons, process information. The training of BPNNs relies on the backpropagation algorithm, which iteratively adjusts the network's weights to minimize the discrepancy between its predicted output and the actual output. This iterative process involves propagating the error backward through the network, updating the weights based on the gradient of the error function with respect to each weight. Through repeated iterations, the network refines its predictions, enhancing its performance in various machine learning tasks. Fig 2 shows the BPNN training loss and validation loss for each epoch. Model loss with a dropout rate and model accuracy is shown in fig3 and fig 4 respectively.

Logistic Regression algorithm models the probability that the dependent variable (or target) belongs to a particular category as a function of the independent variables (or features). Decision Tree is the process of constructing a tree selecting the best split at each node based on a criterion that measures the genetics of the target variable within the resulting subsets. K-Nearest Neighbours (KNN) is a simple, yet effective algorithm used for both classification and regression tasks in machine learning.

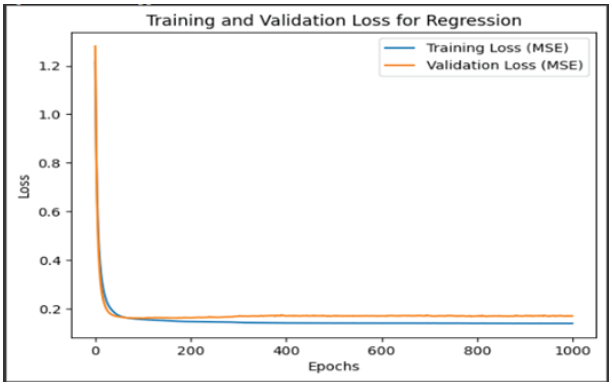


Fig 2. Model Validation and Loss

In the pursuit of optimizing the performance of a simple feed forward neural network, a comprehensive analysis was conducted by experimenting with different dropout rates. Dropout regularization is a crucial technique in neural network training that involves randomly deactivating a certain percentage of neurons during each iteration, preventing overfitting, and enhancing model generalization. The objective of this analysis was to understand how varying dropout rates impact the network's learning dynamics and overall predictive capabilities.

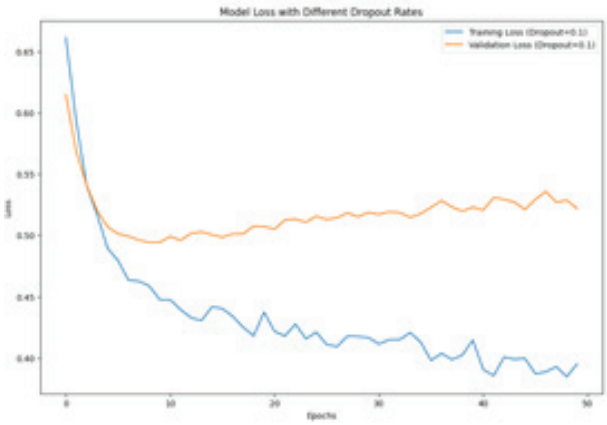


Fig 3. Model Loss with Dropout

Feature selection techniques applied for KNN, SVM and BPNN are shown in fig 5 , fig 6 and fig 7 respectively. The results of the implementation show that BPNN gives an accuracy of 0.76 with filter wrapper

feature selection and the accuracy is 0.73, 0.71,0.73 and 0.73 for SVM, Logistic Regression, Decision Tree and KNN respectively with filter wrapper feature selection method.

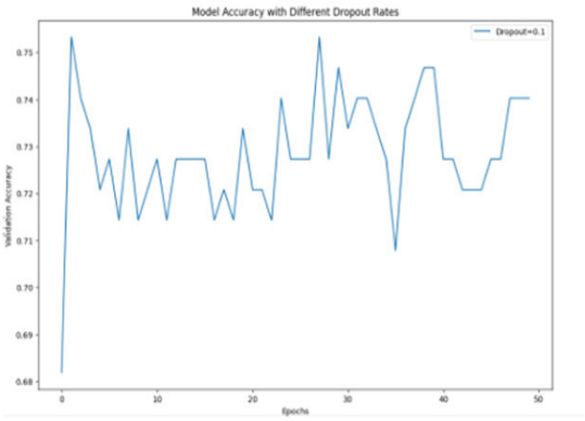


Fig 4. Model Accuracy with optimization

CONCLUSION

The study conducted a comprehensive exploration of diabetes prediction utilizing Backpropagation Neural Network with various regression and optimization techniques. The research addressed this need by leveraging machine learning algorithms to predict diabetes based on research analysis. Various studies have employed a range of machine learning techniques including BPNN, SVM, LR, KNN and Decision tree. The findings underscore the importance of employing diverse algorithms and methodologies for effective diabetes prediction and management.

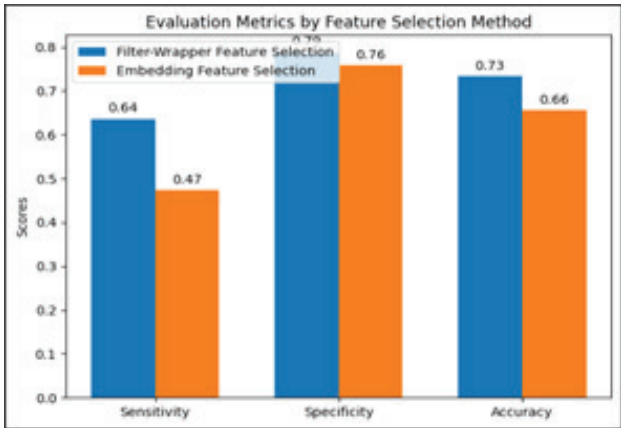


Fig 5. Feature Selection for KNN

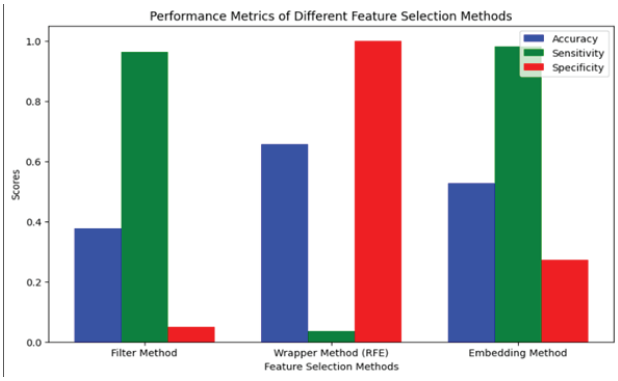


Fig 6. Feature Selection for SVM

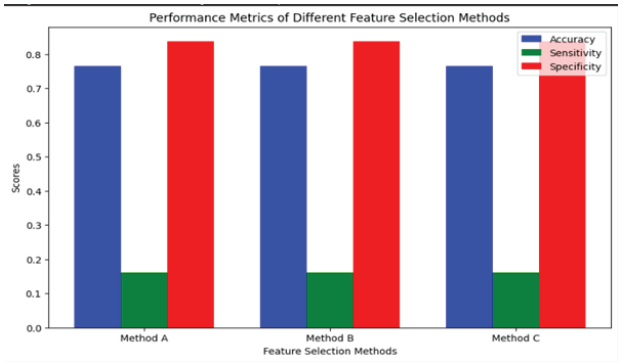


Fig 7. Feature Selection for BPNN

REFERENCES

1. Kaur, H., & Kumari, M. (2020). A Comparative Study of Machine Learning Algorithms for Diabetes Prediction Using Pima Indians Diabetes Dataset. International Journal of Computer Applications, 175(10), 34-38.
2. Maniruzzaman, M., Rahman, M. A., Momen, S., & Hossain, M. S. (2020). Predictive Modeling for Diabetes Using Different Machine Learning Techniques. International Journal of Computer Applications, 174(2), 18-23.
3. Kopitar, L., Žalik, B., & Štiglic, G. (2020). Comparison of Regression Models for Predicting Type 2 Diabetes Mellitus: A Comparative Study. Journal of Medical Internet Research, 22(5).
4. Albahli, S. (2020). A Hybrid Approach for Detecting Type 2 Diabetes Mellitus Using K-Means Clustering and Ensemble Learning Techniques. IEEE Access, 8, 118570-118583.
5. Yahyaoui, I., Berrada, M., & Oujaoura, M. (2019). A Comparative Study of Traditional Machine Learning and Deep Learning Approaches for Diabetes Prediction.

International Journal of Advanced Computer Science and Applications, 10(12), 379-384.

6. Zou, Q., et.al (2018). Predicting Diabetes Mellitus with Machine Learning Techniques. Frontiers in Genetics, 9, 515.

7. Dinh, A., Lee, H., Lee, S., & Lee, Y. (2019). Supervised Machine Learning Models for Cardiovascular, Prediabetes, and Diabetes Detection. International Journal of Environmental Research and Public Health, 16(15), 2747.

8. Choubey, P., Singh, P., & Gupta, A. (2017). Early Prediction of Diabetes Using Naive Bayes and Genetic Algorithm. International Journal of Engineering Research and Applications, 7(10), 22-25.

9. Joshi, K., & Chawan, P. M. (2018). Comparative Study of SVM, Logistic Regression and ANN for Diabetes Prediction. International Journal of Computer Applications, 180(31), 7-10.

10. Rajeswari, R., & Prabhu, R. K. (2019). Diabetes Mellitus Prediction Using Support Vector Machine. International Journal of Engineering and Advanced Technology, 9(1), 6438-6442.

11. Nilashi, M., Ibrahim, O., Ahani, A., & Shahmoradi, L. (2017). Hybrid Intelligent Models for Stock Price Forecasting Using MLPNN, RBF, and GHSOM Networks. Technological Forecasting and Social Change, 117, 251-264.

12. Perveen, S., Shahbaz, M., & Keshav, A. (2016). Ensemble Techniques for Diabetes Prediction. International Journal of Computer Science and Information Security, 14(9), 739-745.

13. Kazerouni, A. F., Shokoohi, Y., Sadeghi, S., & Fakharzadeh, S. S. (2020). Comparative Study of Machine Learning Techniques for Diagnosis of Type 2 Diabetes Mellitus. Journal of Diabetes Research, 2020, 1-9.

Secure Cloud Storage using Data Provenance Technique and Blockchain Technology

Vikram Patalbansi
Research Scholar
Pacific Academy of Higher Education and Research University (PAHER)
Udaipur, Rajasthan
✉ vijkrampatalbabnsi14@gmail.com

Jayshree Jain
Professor
Pacific University
Udaipur, Rajasthan
✉ dr.jayshreejain@gmail.com

G. Prasnna Laxmi
Professor
SOCSE
Sandip University
Nashik, Maharashtra
✉ prasanna.gandi@sandipuniversity.edu.in

ABSTRACT

Mobile Cloud Computing (MCC) includes mobile users giving up control of their data to remote cloud servers or storage systems. All people, including major businesses, desire to adopt cloud computing with maximum data security. Thus, data security and privacy are the biggest challenges for data owners and cloud service providers. The owner of stored data does not control it. Before storing data on a cloud server, encrypt it to prevent unauthorized access. Data is encrypted into ciphertext using sophisticated encryption keys. The authorized user may easily decrypt the data using the same keys. The key generation process, Key Management Systems (KMS), encryption algorithm implementation, data hashing methods, and key size affect encryption strength. Cloud storing of encryption and decryption keys is prohibited due to privacy and legal issues. In our thesis work, we fragment data to solve cloud server storage issues. We encrypt each piece and safeguard our cloud data using blockchain technology and sophisticated security. This way, we may encrypt our data without giving the cloud service provider full control.

KEYWORDS: *Cloud security, Privacy, Mobile computation offloading, Distributed storage Security system, Blockchain, Data provenance technique.*

INTRODUCTION

Cyber-attacks like ransomware, malware, phishing, and DoS have led to data breaches in companies worldwide. Cyber and forensic professionals are developing security protocols and algorithms to combat these attacks. Most companies store data on cloud-based platforms, making it crucial for providers to provide secure platforms. Users choose storage platforms based on factors like user privacy, pricing, censorship concerns, improper data handling, encryption, longevity, resilience to errors, and system components breakdowns. Robust security solutions for storage are essential to instill consumer trust and prevent hacking attempts.

Cloud storage repositories are categorized into Controlled Cloud Storage and Decentralized Cloud Platforms. Decentralized storage networks maintain anonymity through encryption and fragmentation techniques. IPFS, a decentralized network, uses blockchain technology for data security, privacy, and integrity. However, centralized systems pose risks of data leaks and identity theft due to the connection between devices and servers.

Mobile Cloud Computing (MCC) allows information storage in a distant cloud server using mobile devices. Cybercrimes like ransomware, malware, and phishing have breached databases. To protect data, Cyber and Forensic Professionals are developing encryption protocols and algorithms. Cloud service providers must offer secure platforms, tagged user text, and encryption to improve content integrity and privacy. Cloud storage services like Google Drive, Dropbox, and Microsoft OneDrive allow international file sharing.

This work proposes a security technique for storing cloud data, integrating secrecy, integrity, and availability. It emphasizes the importance of ensuring data remains inaccessible to unauthorized entities and that authorized users have explicit authority to access data. The thesis paper aims to address strategies to prevent data breaches and protect valuable organizational assets from significant commercial losses.

Factors Influencing Cloud Security

[1]Mobile Cloud Computing systems face challenges in storing data on cloud servers, including optimizing virtualization space, managing data movement, controlling concurrency, and ensuring compatibility with operating systems. Users entrust sensitive information to the cloud, but potential vulnerabilities in virtualization software and inadequate access control and data management protocols can lead to data leaks or leaked information.

LITERATURE REVIEW

This section provides a summary of the study methodologies provided by different researchers for ensuring data security in cloud computing.

In their study, Mojtaba Rafiee et al. [4] introduced the concept of private set operation (PSO) as a symmetric key primitive in cloud computing for the purpose of retrieving encrypted data. How is the query secured and verified while accessing data from cloud storage? It is not mentioned by them. The correct ways for securing data during retrieval from a cloud server are not well defined. The authors Kanav Sadawarti et.al. [3] presented a method for storing data in cloud storage using classic techniques such as RSA and AES, and then using MBFD. However, they did not specify the use of a robust secure key management system (KMS). [7] Ivavlo Chenchev, the author, suggested using several SHA hash algorithms for cloud data hashing at different tiers of cloud storage using the Merkle-root tree format, which is a kind of binary tree structure. However, they did not provide any secure methods for obtaining the data. If hackers possess knowledge of the sequential arrangement of data storage across cloud servers, they may get all the data in that specific sequence. R. Udendharan[9] employs homomorphic and location-based encryption and decryption algorithms to provide data security in cloud storage. Utilizing location-based decryption improves data security, but, the absence of mobile device authentication and the use of duplicate identification of mobile devices enables data retrieval from cloud storage via location-based encryption and decryption. In their work, Nasrin Sohrabi et al.[10] put up the hypothesis of a blockchain-based decentralized storage system that operates independently of a centralized control unit. However, their approaches include storing the encryption and decryption keys along with the data in the master node. In the event that the master node is compromised, hackers have the ability to access all the data by using these keys.

In addition, Hong Giang Do et al.[5] introduced the concept of blockchain-based security. However, they did not provide clear guidelines on accessing data in blockchain-based storage systems, nor did they address the issues of key management and device authentication.

PROPESED METHODOLOGY

Part A: **Encryption During Data Transit**

Our hypothesis suggests enhancing customer trust in cloud storage by enhancing privacy, authentication, secrecy, and security. We propose a secure data provenance using Blockchain, utilizing a proprietary key generation method and a three-factor authentication system for mobile device-cloud server communication.

1. User authentication and identification.
2. Smartphones utilize IMEI, whereas computers and iPods use MAC addresses.
3. Internet access requires an IMSI or SIM card.
4. Mobile devices load the Authentication API.
5. Virtual smart card refers to using browser cookies

instead of a client-server program to access online apps.

6. Biometrics module.
7. The cloud service provider gives consumers a unique ID called the Universal Integrated Closed Circuit (UICC). It is a hardware chip for mobile devices with extensible slots.
8. Cloud Server.

Web Application Server (WS) b) Authentication Server

Figure below summarizes VIdent paired key generation.

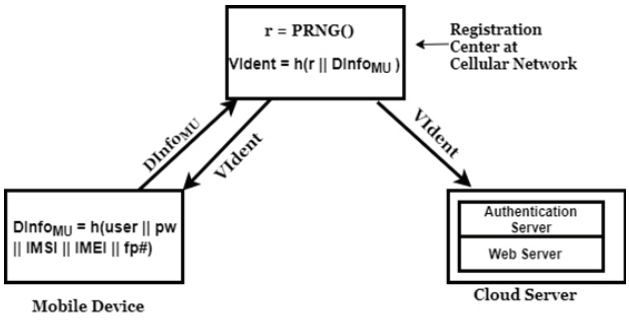


Fig. 1 Generation of Paired Key VIdent

The proposed solution is a blockchain-based data provenance system to enhance mobile user data security on cloud storage or servers. It allocates tokens to each segment of recorded information, ensuring confidentiality. The architecture uses an incremental cryptographic technique to protect fragmented data chunks. A Key Management System (KMS) is used to encrypt and decode stored data, preventing data loss or vulnerability.

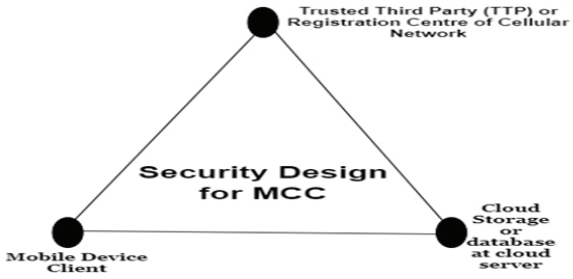


Fig. 2 Network Structure of Mobile Cloud Computing

Consider a prime number 'q' with a primitive root 'α' smaller than 'q'. End devices jointly decide 'α' and 'q' values, which are publicly visible to all entities.

Thus, using Diffie-Hellman Key Exchange formulas, we can determine the mobile device and cloud server public keys.

The equation YMU = αXMU mod q is applicable to mobile devices.

The equation YCS = αXCS mod q applies to the Cloud Server.

The private key values XMU and XCS of mobile devices and cloud servers are secret. Mobile devices and cloud servers exchange YMU and YCS public keys.

The Diffie-Hellman Key Exchange technique is used to calculate the packet secret key (SKM) for mobile devices.

The equation is SKMU = (YCS)XMU mod q.Mobile device encryption key for packet transfer.

The modulo q product of (YMU)XCS is SKCS. The cloud server's secret encryption key protects packets.

The Diffie-Hellman Key Exchange protocol requires the same secret key for both endpoints, SKMU and SKCS. Mobile devices and cloud servers share this key, requiring registration for cloud services.

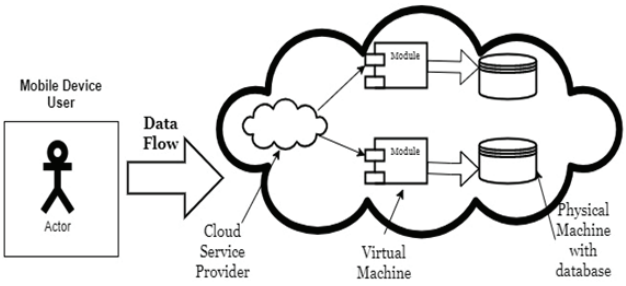


Fig. 3 Data Flow diagram from Mobile to Cloud Server

Mobile Cloud Computing (MCC) connects mobile consumers with cloud service providers via internet cellular or wireless networks. Users send files to remote servers, who access their outsourced data via cloud storage. Cloud service providers handle requests using algorithm-equipped virtual computers. However, data transfer across public and unprotected networks exposes them to corruption, manipulation, privacy breaches, and disruptions. Mobile Device and Cloud Server have separate cryptographic keys.

Mobile Cloud Computing enables data storage on mobile devices, but data can be compromised by

hackers or brute force attacks. Cryptography techniques like incremental cryptography and HMAC are used to protect data. The Cellular Network Registration Center calculates VIdent public keys, and using Diffie-Hellman Key Exchange formulae, the Mobile User (or Data Owner) secret key SKMU and Cloud Service Provider secret key SKCS are determined. Authorized users receive a UICC code from the cloud service provider, enabling only authorized users to interact with the cloud server.

Part B: Encryption at the Cloud Server Storage System

[23]Mobile user data is collected and grouped into chunks for cloud storage, each with a unique encryption key. Encrypted parts are disseminated using distributed Blockchain technology, preventing unauthorized access. Any compromise interrupts the chain, ensuring secure storage and protection of user data.

The thesis proposes securing mobile data via cloud storage using Blockchain and Secure Data Provence methods from database systems. It explores how Blockchain technology can enhance Mobile Cloud Computing security, ensuring data preservation and protection against attacks.

Cloud service providers use blockchain security and secure data provenance technologies to decrypt and re-encrypt packets, ensuring data storage without a central authority. This allows authorized users to monitor file changes, enabling post-investigation methods. Blockchain technology also records ownership, custodial history, and user access, allowing for secure storage in blockchain blocks.

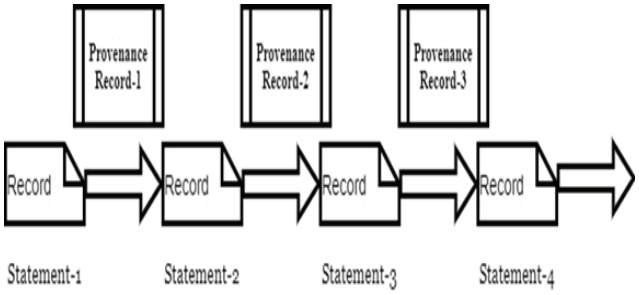


Fig. 4 Data Provenance Records Structure

Trust Third Party (TTP) verifies mobile device and cloud server identities, creating public key vIDs for access controllers. Blockchain hashing constructs cipher key block for decryption.

Bi = SHA (Di, VIDent) where 1<= i <= n

Cloud storage server encrypted packets are stored using the Secure Hash Algorithm with unique encryption keys. Each user's VIdent key is unique. Block Bi is confined to a specific user for a specific time, with each block referencing the previous block's hashed value.

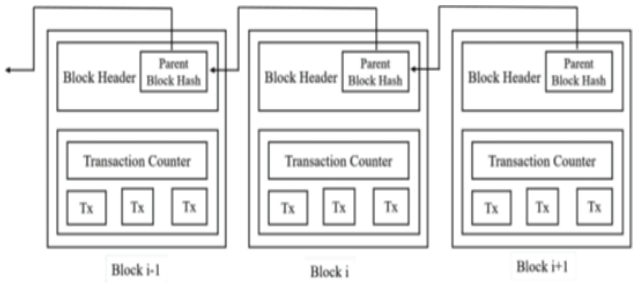


Fig.5 Blockchain of Block in cloud storage

The cloud storage blockchain's performance is enhanced by linking provenance records for each data packet. Blocks, like Ethereum blockchains, are formed by hashing packet contents and public keys, ensuring transaction integrity.

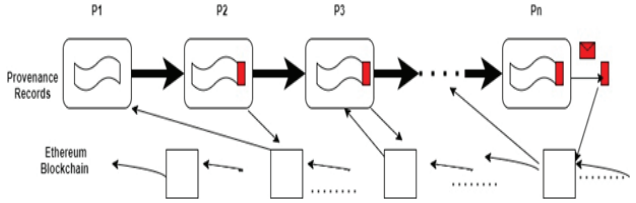


Fig. 6 Ethereum Blockchain Based Data Provenance Records

Blockchain-based data provenance architecture uses a chain of blocks, each connected by cryptographic hashes, to ensure secure and privacy. Each block contains private corporate data, with unique tokens for identification. Blocks are linked and stored decentralized, immutably, and each block is linked and stored immutably. Authorized users can check block authenticity while accessing cloud server records.

DEVELOPMENT OF A SECURE DATA PROVENANCE BLOCKCHAIN

Cloud servers use SKCS and VIdent as Secret Keys, XCS and YCS as private and public keys. Block Bi is

stored in blockchain format and encrypted using SHA-256. Data blocks are configured using Secure Hash Algorithm Function values, serial number, random value, and timestamp.

Oi = SHA-256 (Bi || Di || Ti || NonceRi || Txi)

where 1 <= i <= n.

Mobile users' data streams use SHA-256 Hash function to generate unique tokens and random numbers. Blocks are allocated an ACL and encrypted before being distributed in cloud storage. Each block maintains object reference and token number, allowing direct access to content or data.

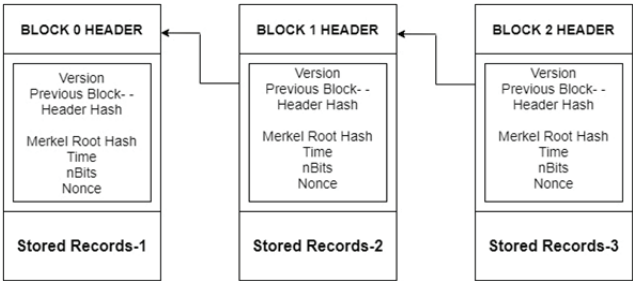


Fig. 7 Data Provenance Records Blockchain

The Access Control List (ACL) model, encrypted using AES 256 by the cloud server SKCS private key, identifies data owners and users for cloud storage data access.

ACL = AES-256(ACL, SKCS)

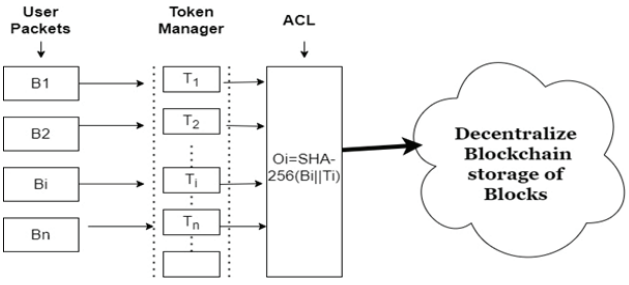


Fig. 8. Access Control List

Cloud servers check Access Control Lists (ACL) for data downloads, requiring malicious users to decrypt the ACL. This is challenging due to the complexity of token serial number-block object mapping, and unauthorized users require exclusive token numbers.

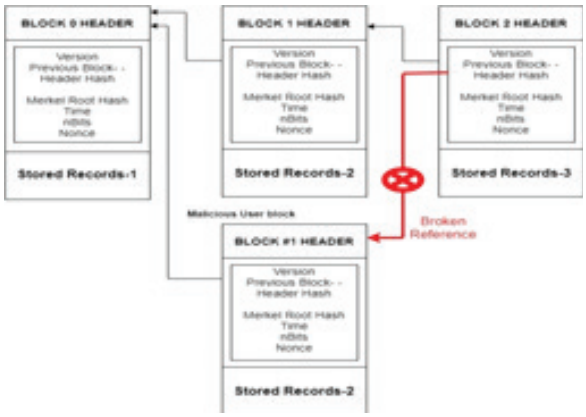


Fig. 9 Broken Chain of Data Provenance

DATA DOWNLOAD PHASE FOR DATA USER

Users request data from cloud servers by contacting the provider, who verifies their access using the Access Control List. The data owner provides validated credentials and access rights. Users consult the owner, who gives them a public key and instructs the server to update the ACL. After authentication, the cloud server obtains the block from the blockchain and encrypts it with the user's private key.

SECURITY ANALYSIS AND CONCLUSION

The proposed theory adds an encryption layer for mobile device data production, wireless transfer, blockchain-based cloud storage, and cloud server data download. This ensures data cannot be decoded without encryption keys, and prevents attackers from accessing the entire dataset. The theory also creates blocks for encrypted segments, preventing future access and informing data owners.

REFERENCES

1. Document clustering for efficient and secure information retrieval from Cloud. By Rohit Handa , C. Ram Krishna , Naveen Aggarwal DOI : 10.1002/cpe.5127 Wileyonlinelibrary.com/journal/cpe
2. Partitioning Oracle Attacks by Julia Len Paul Grubbs Thomas Ristenpart Cornell Tech, USENIX Security 2021.
3. Secure Cloud Computing Platform Advantaged by Data Encryption and CS Optimized Ffbpnns Kanav

Sadawarti, Satish Saini, Turkish Journal of Computer and Mathematics Education Vol.12 No.12 (2021), 979-988

4. Private Set Operations Over Encrypted Cloud Dataset and Applications Mojtaba Rafiee* and Shahram Khazaei Department of Mathematical Sciences, Sharif University of Technology, Tehran 11155-1639, Iran, The British Computer Society 2020, Section D: Security in Computer Systems and Networks The Computer Journal, Vol. 00 No. 0, 2020. doi: 10.1093/comjnl/bxaa123

5. Blockchain-based System for Secure Data Storage with Private Keyword Search, by Hoang Giang Do, Wee Keong Ng, School Of Computer Science and Engineering , Nanyang Technological University, 2017 IEEE 13th World Congress on Services, DOI 10.1109/SERVICES.2017.23

6. Application of Homomorphic Encryption in Blockchain Data Security, Jingjing Chen, Fucheng You, Beijing Institute of Graphic Communication Beijing China, EITCE 2020, November 6–8, 2020, Xiamen, China, © 2020 Association for Computing Machinery. ACM ISBN 978-1-4503-8781-1/20/11 https://doi.org/10.1145/3443467.3443754

7. Ivaylo Chenchev. 2019. Security Improvement in a Modified Merkle-tree. In Proceedings of 9th Balkan Conference on Informatics (BCI'19). September 26–28, 2019, Sofia, Bulgaria. ACM, New York, NY, USA, 6 pages. h<ps://doi.org/ 10.1145/3351556.3351569

8. Pratima Sharma, Rajni Jindal, and Malaya Dutta Borah. 2020. Blockchain Technology for Cloud Storage: A Systematic Literature Review. ACM Comput. Surv. 53, 4, Article 89 (August 2020), 32 pages. https://doi.org/10.1145/3403954

9. R.Udendhran, Department of Computer Science and Engineering, Bharathidasan University, Trichy, India. A Hybrid Approach to Enhance Data Security in Cloud Storage, ICC '17, March 22 2017, Cambridge, United Kingdom , © 2017ACM. ISBN 978-1-4503-4774-7/17/03 DOI: http://dx.doi.org/10.1145/3018896.3025138

10. Nasrin Sohrabi, Xun Yi, Zahir Tari, and Ibrahim Khalil. 2020. BACC: Blockchain-Based Access Control For Cloud Data. In Proceedings of the Australasian Computer Science Week Multiconference (ACSW 2020), February 4–6, 2020, Melbourne, VIC, Australia. ACM, New York, NY, USA, 10 pages. https://doi.org/10.1145/3373017.3373027

11. R.Nivetha and S. Immaculate Shyla , Analyzing Data Security Issues and Solutions in Cloud Computing , International Journal of Advanced Research in Science, Communication and Technology (IJARSCT) , Volume 2, Issue 1, February 2021 , DOI: 10.48175/568

12. Sathyabalaji N | Komarasamy G | Daniel Madan Raja S , Secure and privacy-preserving keyword search retrieval over hashed encrypted cloud data, Int J Commun Syst. 2019;e4274., https://doi.org/10.1002/dac.4274 , wileyonlinelibrary.com/journal/dac

13. Abdulrahman Alreshidi , Aakash Ahmad , Ahmed B. Altamimi , Khalid Sultan and Rashid Mehmood , Software Architecture for Mobile Cloud Computing Systems, Future Internet 2019, 11, 238; doi:10.3390/fi11110238 www.mdpi.com/journal/futureinternet

14. Huiming Yu, Nakia Powell , et.al Cloud Computing and Security Challenges, ACM SE 12, March 29 - 31 2012, Tuscaloosa, AL, USA Copyright 2012 ACM 978-1-4503-1203-5/12/03…$10.00.

15. C. Selvakumar, G. Jeeva Rathanam , M. R. Sumalatha, Department of Information Technology, 978-1-4673-4529-3/12/$31.00_c 2012 IEEE

16. Karen Scarfone , Murugiah Souppaya, Matt Sexton, Guide to Storage Encryption Technologies for End User Devices , Recommendations of the National Institute of Standards and Technology, NIST Special Publication 800-111

17. Jinan Shen , Xuejian Deng and Zhenwu Xu, Multi-security-level cloud storage system based on improved proxy re-encryption,EURASIP Journal onWireless Communications and Networking (2019) 2019:277 https://doi.org/10.1186/s13638-019-1614-y

18. Aisha A. Abba, Aisha Muhammad, Kashim K. Mohammed, Department of Computer Science Middlesex University Flic-en-flac, Mauritius, Cloud Security, at: https://www.researchgate.net/publication/349303347, January 2021 DOI: 10.13140/RG.2.2.13876.58242

19. Yaser Mansouri, Adel Nadjaran Toosi, and Rajkumar Buyya. 2017. Data Storage Management in Cloud Environments: Taxonomy, Survey, and Future Directions. ACM Comput. Surv. 50, 6, Article 91 (December 2017), 51 pages. https://doi.org/10.1145/3136623

20. Rao, K. R., Ray, I. G., Asif, W., Nayak, A. and Rajarajan, M. (2019). R-PEKS: RBAC Enabled PEKS for Secure Access of Cloud Data. IEEE ACCESS, 7, pp. 133274-133289. doi: 10.1109/ACCESS.2019.2941560

21. Sanjeet Kumar Nayak · Somanath Tripathy , SEDS: secure and efficient server-aided data deduplication scheme for cloud storage, International Journal of Information Security, 2019 https://doi.org/10.1007/s10207-019-00455-w

22. Nelson Santos(&) and Giovanni L. Masala, Big Data Group, School of Computing, Electronics and Mathematics, Plymouth University, Plymouth PL4 8AA, UK, Big Data Security on Cloud Servers Using Data Fragmentation Technique and NoSQL Database, Springer International Publishing AG, part of Springer Nature 2019, G. De Pietro et al. (Eds.): KES-IIMSS-18 2018, SIST 98, pp. 5–13, 2019. https://doi.org/10.1007/978-3-319-92231-7_1

23. Dinesh R , Ezra Vivin A et.al. A MULTI-SERVER DATA SECURITY WITH PUBLIC AUDITING IN CLOUD COMPUTING, International Conference on Frontiers in Materials and Smart System Technologies, IOP Conf. Series: Materials Science and Engineering 590 (2019) 012007 IOP Publishing, doi:10.1088/1757-899X/590/1/012007

The Green Mask: A Critical Review of Greenwashing, Authenticity and Governance Challenges in Corporates' ESG Strategies

Rashmi Jha
Associate Professor
Global Institute of Technology & Management
Gurugram University
Gurugram, Haryana
✉ rashmijha1909@gmail.com

Aman Jha
Student (MBA Executive)
University of Liverpool
Liverpool, UK
✉ jhaamanbusiness@gmail.com

ABSTRACT

This novel research paper examines the complex relationship between corporate governance and greenwashing, with an emphasis on how good governance can alleviate the dishonest practice of greenwashing. Greenwashing / Green Sheen is a kind of advertisement or marketing SPIN (Situation, Problems, Implications and Need-payoff) which falsely make use of green marketing and green PR to convince and persuade the common public to trust that the company's goals, policies and products are safe to use and environment friendly. Consequentially, it poses a significant threat and risks to corporate credibility and stakeholder trust. Hence the paper analyses the pervasiveness and consequences of greenwashing across industries with interesting case studies like Zara, H&M and Patagonia. It aspires to contribute to an understanding of how corporate solid governance frameworks in organizations might help counter greenwashing concerning stakeholder engagement, accountability and transparency.

Overall, the results support better sustainability performance and lesser "greenwashing" of companies due to improved corporate governance practices. The future research will mainly relate to developing standardized ESG metrics and how technologies and regulatory bodies forge a new face for sustainability reporting. This paper aims to contribute to the discussion regarding the articulation of corporate responsibility with an accountability and sustainable business practices to provide a roadmap to companies to mitigate the pitfalls of greenwashing.

KEYWORDS: *Corporate governance, Green mask, Greenwashing, Environmental, Social and governance (ESG), Sustainability, Transparency, Stakeholder engagement, Regulatory frameworks.*

INTRODUCTION

Beware, you may be the next victim of greenwashing. The increasing concern for sustainability and corporate social responsibility in business today has worsened the problem of greenwashing. Greenwashing may be defined as the act of overstating the environmental claims of an organization to seem environmentally friendly when such is not the case. Deceptions of such nature harm consumer trust and misrepresent to stakeholders. As shown below in Figure 1 below, it all starts with a simple AD and ends with a Greenwashing SCANDAL.

Fig. 1. The Sins of Greenwashing [Source: Appendix 1]

However, corporate governance is to ensure that companies are engaged in sustainable and ethical

activities. Hence this research probes the relation that exists between corporate governance and greenwashing, of which good governance should be able to counterbalance such deceitful methods.

THE GREEN MASK: A CRITICAL REVIEW OF GREENWASHING, AUTHENTICITY AND GOVERNANCE CHALLENGES IN CORPORATE ESG STRATEGIES

Greenwashing, described in the 1980s as a practice in hotel environmental conservation projects placing premium on cost-cutting over projects with real significance, has taken a turn. That is, De Freitas Netto et al. (2020) further detailed that greenwashing is a set of dishonest strategies disseminated with the aim of confusing stakeholders by concealing actual elements of environmental responsibility[1]. In our day-to-day life, common people getting fooled and duped by Greenwashing in the beautiful cover of "Green Mask" as depicted in Figure 2.

Fig. 2. The Green Mask Concept used in Marketing [Source: Appendix 2]

As identified by Montgomery, Lyon and Barg in 2023, this includes several practices such as selective disclosure, meaningless pledges and symbolic management[2].

Symbolic Management Vs Authenticity: Symbolic management is one of the most common techniques that companies engage in to inflate their environmental commitment. As Montgomery et al. [2] detail out, symbolic management offers firms the strategic ability to project their ESG policies in a way that would not lead to substantial reformation.

Fig. 3. Environmental, Social & Corporate Governance (ESG) Solutions [Source: Appendix 3]

As shown in Figure 3 above, ESG authenticity, therefore, must be expressed through the measurement and clear communication of the environmental goals, with the actions in coherence with the values of the stakeholders. In 2023 Santos, Coelho, and Marques further argue that authentic ESG policies go the extra step of providing quantitative measures of impact [3].

Those companies looking to present authenticity developed strong governance structures genuinely, using public transparency and third-party verification. In contrast, symbolic management gives only the appearance of commitment and in fact can have the effect of undermining stakeholder trust over time as actual corporate practices are revealed.

Reputation Risk Management - Understanding Stakeholders' Roles: This implies that businesses that do shallow ESG work are sitting under colossal reputation risks. As Isaacs and Costa I Coromina argue, such greenwashing can inflict deadly reputational damage, kill loyalty to a brand and eventually lead to a shrinking market share [4]. The consumers, investors, and advocacy groups are increasingly becoming wise to these duplicitous practices and indeed demanding that corporations operate with increased transparency and accountability.

However, reputational risk drives a handful of businesses to raise their ESG bar. Stakeholders are said to exert accountability pressure for successful implementation of sustainability actions toward creating organizational reputations that would legitimate moving away from greenwashing to actual and substantial efforts by the businesses.

Governance and Integration of ESG: Governance structures of companies bear a significant influence

on the development of the ESG strategy. For example, superficial governance techniques like the establishment of weak environmental committees that lack any kind of authority and prove to have conflicting interests, can propel the rise of greenwashing in the ranks. Now, all over the world, "Effective Governance" befits the ESG agenda. This is what true ESG requires, as good governance should be transparent, accountable, and regularly reviewed.

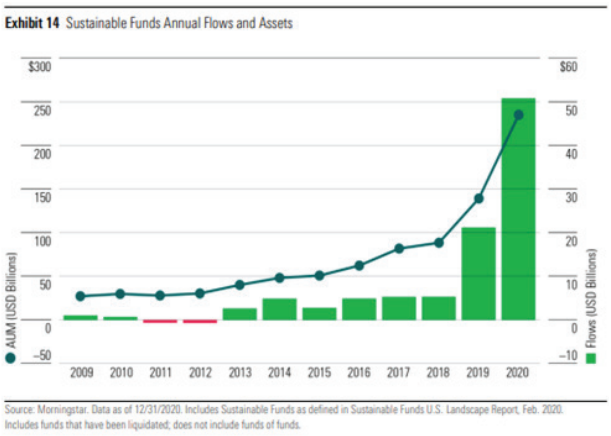


Fig. 4. Sustainable Investment for Greenwashing in USA [Source: Appendix 4]

As given a closer look at the trend in Figure 4, in USA, sustainable investing for Greenwashing increasing exponentially in the latest coming years. In 2020, fund flows reached $51.1 billion and eclipsed $259 billion in AUM. Santos et al. [3] have it that good mechanisms of enforcing commitment include those whereby the pay of the executive is related to sustainability measures, auditing of the ESG performance and frameworks for engaging stakeholders.

In addition, the third-party verification to be included in ESG reporting is going to help in resisting selective disclosure and symbolic management so the corporations find it harder to mislead stakeholders.

Synthesis and Future Research Directions: Although diverse definitions and understandings of frameworks are in place for greenwashing, most writers agree to the bad effect of the phenomenon on the real ESG efforts and stakeholder trust. Authenticity and symbolic management are two opposing extremities and governance frameworks help businesses navigate towards genuineness. Reputation risk is a double-edged sword. It could foster true development or reveal the superficiality of practices.

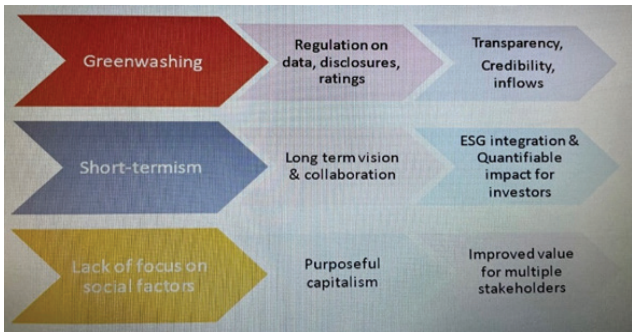


Fig. 5. Evolution in ESG Investing Reduce Greenwashing Substantially for better outcomes over time [Source: Appendix 5]

In the above diagram Figure 5, the current shortcomings and the future direction of the progress shown in the favour of stakeholders. Finally, the embedding of knowledge from academia, industry, and regulatory bodies can help organizations shift from symbolic compliance to concrete, demonstrable environmental results.

DIVING INTO FIRMS

Zara, a fast-fashion brand hit with accusations of "greenwashing" is Zara, which developed the supposed "sustainable" fashion lines for some garments. The items are made using captured carbon emissions to produce some of the polyester in the garment's composition, amounting to only 20% of the garment's total composition, in collaboration with LanzaTech which has a minimal impact towards sincere sustainability[5]. It is just like a drop in the ocean.

Critics argue this shifts the limelight to more serious issues of overproduction and fast consumption on the brand's part, considering Zara produces 12000 new designs and more than 450 million clothing items per day [6]. Arguments by Zara usually were more since they use materials that are "eco-friendly" but without proof that the sustainability is practiced, or the effects are minimized on a significant level [7].

H&M has also become the subject of debate for cheating consumers with its "Conscious Collection," which it claims has a better performance in sustainability than it does. Besides, research found contradictions

in commitments, such as the use of synthetic fibers in H&M's range of conscious products.

Further, Quartz research found a contradiction: a dress that claimed to use 20% less water to make took more water to manufacture, clearly contradicting sustainability promises[8]. Annual clothing manufacturing is 3 billion, which shows great implications in waste; such clothing is usually recycled after decades.

There have also been legal issues in such cases as Chelsea Commodore v. H&M, where the brand was charged with fraudulent and misleading sustainability marketing[9]. This has even gone on to gain increased scrutiny by some of the regulatory bodies like the Netherlands Authority for Consumers and Markets, which in many instances requested H&M to change or pull several of its sustainability claims to avoid giving misleading information to consumers [10].

Authentic Sustainability Efforts of Patagonia- The actual sustainability of Patagonia is exhibited through the vision "to save our home planet" as responsible business practice [11]. Comprehensive sustainability initiatives are rooted in their key principles such as quality, integrity, environmentalism and justice. The sustainability strategy comprises some of the actions like making a switch to organic cotton, self-taxing the earth and contributing at least 1% of the annual revenues to the green causes through the 1% for the Planet initiative [11].

The Patagonia garment collection is made up of 98% recycled materials. The single figure has portrayed the extraordinary commitment of the company to sustainability. For example, Patagonia turned used fishing nets into gear, saving the oceans from 1,419 tons of plastic waste.

This is the sort of environmental impact Patagonia has been able to have [12]. Patagonia uses only organic virgin cotton since 1996 which saves water and reduces CO2 emissions by 48% per kilogram versus conventional cotton. The use of organic cotton is a way in which Patagonia shows its dedication to reducing environmental impact [12]. More than 85% of what Patagonia makes is manufactured in Fair Trade Certified factories, respecting the workers and ensuring that there will be no unethical manufacturing.

This further manifest how much Patagonia respects the rules of fair labor. For the period from May 2022 to May 2023, 83,794 Patagonia garments were restored in the repair center as part of the Worn Wear initiative, which is aimed at product longevity and waste reduction. Worn Wear® is one of the prime examples of sustainability promotions by Patagonia through the initiative to get its garments fixed [12].

Overall, ZARA and H&M greenwashing tactics throw light towards symbolic management whereas PANTAGONIA's genuine sustainability initiatives points towards integration of ESG into their operational practices.

DISCUSSION OF CORPORATE GOVERNANCE AND BOARD PRACTICES

Contributors of Greenwashing

Lack of Transparency: One of the basic tenets of good corporate governance, transparency, forms the cornerstone of accountability in sustainable operations. Boards failing to insist on full and honest disclosure of the measures taken on the environment create an environment that nurtures greenwashing.

Without this transparency, companies can present their statistics and figures only with a positive hue, all the while hiding the negative impacts that prove harmful to stakeholders and their trust [4].

As examined via Zara's example, the brand is promoting their sustainable line without fully disclosing the limited impact created. In the case of emissions fraud by Volkswagen where misleading data on environmental factors severely affected stakeholder's trust [13].

Misaligned Incentives: Incentive structures that prioritize short-term financial gains over long-term sustainability is one of the most common causes of greenwashing. Boards that are seeking immediate business gains pressure management to greenwash or fake sustainability achievements as seen in case of Zara and H&M where both companies want to benefit from overproduction.

In doing so, there are always frequent and inflated assertions that cannot stand up to scrutiny. In H&M's case, incentives to increase sales quickly can lead to

overblown sustainability claims that are misleading, such as the deceptive water-usage figures in their "Conscious Collection" [8]. A good example is when ExxonMobil set out aggressive 'Net Zero' ambitions but exclusions on Scope 3, meaning that misaligned incentives can facilitate greenwashing [4].

Opaque Reporting Practices: An absence of standardized reporting frameworks fosters greenwashing by allowing companies to make selective disclosures. In the absence of comprehensive and regular reporting, companies can provide a falsely positive picture of their environmental performance by focusing on positive measures and playing down negative consequences.

Such an approach runs counter to the credibility of ESG claims and allows business programs to be executed without proof of long-term viability [4]. As can be examined from Zara's case - partial claims of the environmental benefits of their products without comprehensive reporting led to greenwashing [5].

Mitigation Strategies

Enhanced Disclosure Processes Strategies : Boards should adopt measures for enhanced disclosure that creates transparency and accountability. Key among the standardized reporting systems are the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB). GRI allows organizations to report extensively and consistently with SASB on environmental impact [14].

The organizations must disclose comprehensively on Scopes 1, 2, and 3 emissions for accountability, not headline claims. Third-party audits also build the credibility and trust of stakeholders in information provided [4].

Stakeholder Engagement Strategies: The most effective way to prevent greenwashing is regular and frequent engagement with multiple audiences. Boards are to be transparent in their sustainability aims and progress. Employees, investors, and local communities should be able to comment.

The engagement builds confidence and ensures that the environmental statements are supported by real activities. In fact, it is a fact that Patagonia has a reputation for strong stakeholder engagement and, as such, is constantly in dialogue with customers and communities on the way forward in ensuring that its sustainability drive remains on course in line with the demands and expectations of stakeholders.

Forming Separate ESG Committees at the Board Level and Linking the Pay of Executives to Long-Term Sustainability Goals: It effectively make ESG issues a core operational element of the business [15]. In case of Patagonia embeds sustainability in its corporate governance by tying the remuneration of the highest executive tier to long-term environmental goals, applying a steward ownership model that has proven fit for duplication by John Lewis, Bosch, and IKEA with great success [16].

Role of Regulations

International Frameworks and Agreements influence corporate governance standards while mitigating the practice of greenwashing. Initiatives, including the TCFD, lay down the rules of the game regarding the disclosure by businesses of climate-related financial risks and opportunities [17].

Adoption of such standards can lead to harmonization of sustainability reporting across borders, thereby increasing transparency and responsibility. Moreover, international agreements such as the Paris Agreement suggest that governments develop regulations that promote genuine environmental activities, thereby indirectly reducing greenwashing activities as depicted by Montgomery, Lyon & Barg in 2023[2].

Pan-National Regulatory Initiatives: Pan-National Regulatory Initiatives spearheaded by the United Nations and other international bodies will generate a coherent response to greenwashing. These can and should proceed apace with the development of global standards for sustainability reporting, and further the promotion of trans-boundary coordination in enforcement. An example is the United Nations Global Compact, which gives a framework for the operations of corporations to be aligned with universal principles on human rights, labor, the environment, and anti-corruption, in a way supporting genuine sustainability efforts while protecting them against charges of greenwashing. Hence, global compacts or local compacts incorporating these principles could be set.

CONCLUSION & RECOMMENDATIONS

The novel research findings show that corporate governance is a significant variable affecting the incidence of greenwashing. Poor monitoring and unbalanced incentives, along with lack of transparency, raise the propensity of the firm to have fake green claims. Good governance, such as board independence, existence of ESG committees, and reporting quality, reduces greenwashing and increases firm credibility. Drivers of the practices also are the national and international regulatory frameworks.

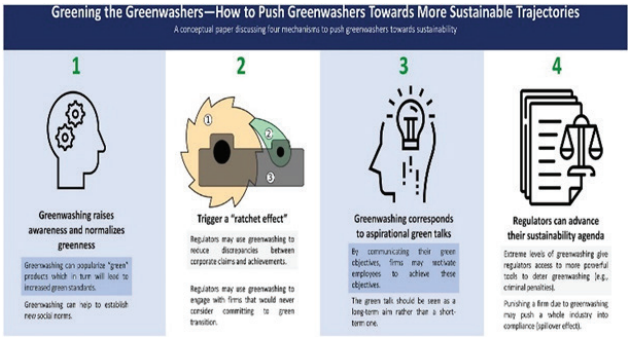


Fig. 6. Greening the Greenwashers for Sustainable Trajectories [Source: Appendix 6]

To achieve the defined objectives of the paper, we need to green the greenwashers towards the more sustainable futuristic green solution at every level as shown in above diagram 6. At individual director's level, for directors to have the ability to conduct a proper appraisal of sustainability endeavors, they must be current on ESG-related issues. As Isaacs & Coromina maintained in 2022 that ongoing training ensures that they are informed on recent developments and benchmarks and therefore reduces the potential for greenwashing [4]. There is a need for holding directors personally accountable for the monitoring of sustainability to ensure that the requirements for transparent governance are met. A board-level ESG committee could provide a strategic focus on sustainable goals, enhance the accountability of management and serve as the forum for feedback from stakeholders.

The actual encouragement toward real ESG reporting and movement may be by relating executive compensation to long-term sustainability goals other than short-term profit. Dedicated usage of standardized reporting frameworks such as GRI or SASB will establish standardized reporting formats and guidelines that create consistency and transparency in ESG reporting across industry sectors. National governments should also impose strict ESG reporting standards, with penalties for inaccuracies, as in the EU with the CSRD [18]. Pan-national regulatory agencies must be in the position to enforce independent audits of business ESG reports to guarantee validity in the practice of sustainability. Companies are expected to create a roundtable dialogue with multiple stakeholders: investors, communities, and nongovernmental organizations (NGOs) for the creation and revision of their sustainability strategy [19].

REFERENCES

1. G. De Freitas Netto, A. Sobral, E. Ribeiro, and S. Soares, "Concepts and forms of greenwashing: A systematic review," Environmental Sciences Europe, vol. 32, no. 1, pp. 1-12, 2020.
2. L. Montgomery, T. Lyon, and D. Barg, "Greenwashing as strategic behavior: Sustaining deception in firms' environmental claims," Journal of Business Ethics, vol. 168, no. 2, pp. 273-295, 2023.
3. L. Santos, D. Coelho, and A. Marques, "The role of corporate governance in mitigating greenwashing: Evidence from the EU," Corporate Governance: The International Journal of Business in Society, vol. 23, no. 1, pp. 119-135, 2023.
4. T. Isaacs and M. Costa I Coromina, "Reputation risks and greenwashing: A corporate governance perspective," Journal of Corporate Finance, vol. 66, pp. 101932, 2022.
5. T. Hirji, "Zara's carbon-capture clothing is greenwashing, critics say," Bloomberg, 2022. Available: https://www.bloomberg.com/news/articles/2022-01-05/zara-s-carbon-capture-clothing-is-greenwashing-critics-say
6. Earth.org, "The greenwashing of Zara's sustainability claims," Earth.org, 2022. Available: https://earth.org/the-greenwashing-of-zaras-sustainability-claims/
7. J. Leach, "Zara's greenwashing tactics exposed," Eco-Age, 2022. Available: https://eco-age.com/news/zara-greenwashing-exposed/
8. M. Syafiqah, "H&M's conscious collection: The greenwashing controversy," Quartz, 2022. Available: https://qz.com/hm-conscious-collection-greenwashing-controversy
9. S. Sierra, "H&M hit with greenwashing lawsuit over

sustainability claims," Fashion Law, 2022. Available: https://www.thefashionlaw.com/hm-hit-with-greenwashing-lawsuit-over-sustainability-claims/

10. Segal, M. (2022). H&M to Remove Sustainability Labels from Products Following Investigation by Regulator. [online] ESG Today. Available at: https://www.esgtoday.com/hm-to- remove-sustainability-labels-from-products-following-investigation-by-regulator/ .
11. M. McKinsey, "Patagonia's path to responsible business," McKinsey Quarterly, 2023. Available: https://www.mckinsey.com/business-functions/sustainability/our-insights/patagonias-path-to-responsible-business
12. Patagonia, "Our Footprint," [Online]. Available: https://www.patagonia.com/our-footprint/. [Accessed: 23-Jun-2024].
13. L. J. Lynch, E. Bird, and C. Cutro, "The Volkswagen Emissions Scandal," Darden Business Publishing, Virginia, 2018. Available: https://ideas.darden.virginia.edu/vw-emissions-and-the-3-factors-that-drive-ethical-breakdown.
14. www.globalreporting.org, "GRI - GRI and SASB reporting 'complement each other'," 2021. Available: https://www.globalreporting.org/news/news-center/gri-and-sasb-reporting-complement-each-other/.
15. M. Spierings, "Linking Executive Compensation to ESG Performance," The Harvard Law School Forum on Corporate Governance, 2022. Available: https://corpgov.law.harvard.edu/2022/11/27/linking-executive-compensation-to-esg-performance/.
16. N. Etcell, "Patagonia: rethinking corporate governance through steward-ownership," Bates Wells, 2023. Available: https://bateswells.co.uk/updates/patagonia-rethinking-corporate-governance-through-steward-ownership/.
17. TCFD, "Task Force on Climate-related Financial Disclosures," 2023. Available: https://www.fsb-tcfd.org/.
18. N. Berland et al., "Misaligned Incentives and Greenwashing," Journal of Business Ethics, 2022.
19. M. Kaptein and R. Van Tulder, "Toward Effective Stakeholder Dialogue," Business and Society Review, vol. 108, no. 2, pp. 203–224, 2017. doi: 10.1111/1467-8594.00161.

APPENDIX

1. "Everything about Greenwashing" Pinterest. [Online]. Available: https://i.pinimg.com/originals/a9/f6/6c/a9f66cb3a1eeb31ff5fcc99e3c74648b.jpg. [Accessed: Jun. 24, 2024].
2. "7UP Greenwashing Example," Greenwashing Critiques. [Online]. Available: https:// blogs.stlawu.edu/greenwashingcritiques/files/2014/04/7UP.png. [Accessed: Jun. 24, 2024].
3. Environmental, Social, and Corporate Governance," ConceptDraw. [Online]. Available: https://www.conceptdraw.com/solution-park/resource/images/solutions/management-esg/MANAGEMENT-ESG-Environmental-Social-and-Corporate-Governance.png. [Accessed: Jun. 24, 2024].
4. E. Kennedy, "Earth Day and ESG Investing: Watch Out for Greenwashing," LinkedIn. [Online]. Available: https://www.linkedin.com/pulse/earth-day-esg-investing-watch-out-greenwashing-erin-kennedy/. [Accessed: Jun. 24, 2024].
5. J. Balva, "ESG Investing and Sustainable Finance," LinkedIn. [Online]. Available: https://www.linkedin.com/pulse/esg-investing-sustainable-finance-jolly-balva-cfa/. [Accessed: Jun. 24, 2024].
6. Dejan Glavas , Gilles Grolleau , Naoufel Mzoughi, "Greening the greenwashers – How to push greenwashers towards more sustainable trajectories," Elsevier. [Online]. Available: https://ars.els-cdn.com/content/image/1-s2.0-S0959652622048752-ga1_lrg.jpg. [Accessed: Jun. 24, 2024].

Decentralized Application Model for Secured Internet of Thing Networks using Blockchain Technology

Narednra Kumar Chintalacheruvu
✉ chnkumar95@gmail.com

Amit Prakash
✉ amitprakash.ece@nitjsr.ac.in

Department of Electronics & Communication Engg.
National Institute of Technology
Jamshedpur, Jharkhand

ABSTRACT

In recent years, Blockchain Technology has been extensively used across several network domains, and researchers are exploring its potential applications. Decentralised Application (DApp) can be operated using smart contracts that run on a Blockchain network, making it secure and immutable. In this paper, the DApp that utilises the Ethereum Blockchain technology has been presented and discussed. The implementation is carried out using the Ganache Development Framework in conjunction with the Solidity Programming Language. The Ethereum Smart Contracts constitute all the functionalities of this application. The user-end application was developed using the web3.js API. The DApp perspective is to be operated in smart homes on a blockchain network where every operation is being appended as blocks in the blockchain.

KEYWORDS: *Blockchain, Decentralised application, Ethereum, Smart contract, IoT.*

INTRODUCTION

The initial application of Blockchain technology occurred in 2008 with the introduction of Bitcoin, a widely recognised cryptocurrency by Satoshi Nakamoto [1], and the use of Blockchain technology has become prevalent in the creation and advancement of a diverse array of applications and cryptocurrencies, each serving distinct objectives. Cryptocurrency can bypass financial organizations. A Blockchain is a global distributed ledger that keeps track of every event or transaction with a particular asset, and every node is aware of it. After a successful event or transaction at a node, it is validated and a block is formed with a cryptographic hashing algorithm. This validation is called mining. Then, the first block is generated and is called the Genesis block. Mining validates the events using the cryptographic hashing algorithm and creates blocks. Each block contains data of the event or transaction, the previous hash, and the present hash. There is no previous hash for the genesis block since it is the beginning. Then, the present hash of the genesis block acts as the previous hash of the second block alongside its data and its present hash. The present hash of the second block will be the previous hash of the third block, which contains its data and present hash. Likewise, a chain is formed by these blocks, creating a blockchain, as shown in Figure 1.

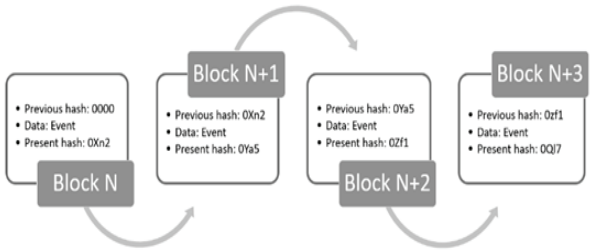


Fig. 1. Blockchain Creation

A wide variety of Blockchain applications have been developed in sectors like Financial, Healthcare, Information systems, Internet of Things (IoTs), etc., [2]. The impact of blockchain on banking and financial sectors and also the challenges faced are discussed [3]. Security is a present-day concern all around the world. IoTs have a lot of challenges, security concerns [4] and privacy issues [5] to be addressed and achieved. Blockchain plays a pivotal role in enhancing security. It provides reliability in managing the security [6]. The

security of digital currency data can also be achieved using blockchain [7]. Data secrecy can be achieved by storing highly confidential data in a blockchain-based digital videos [8]. This technology is also applied in data science and Cyber security [9], [10]. A secured network for IoTs can also be achieved using the distributed blockchain network [11], [12]. The prime investigations are the technical challenges, recent advances, and possible future trends of blockchain technology [13]. A blockchain-based computing platform named Ethereum Network enables blockchain developers to build and deploy decentralized applications with smart contract functionality. Ethereum was developed using Solidity programming [14]. An Ethereum network can be interacted in two ways, i.e., by transferring money and storing data. Networks are formed by one or more data, and each node is a machine running on an Ethereum client, which can be run from any node.

Each node contains the full copy of the blockchain, i.e., the record of every transaction that took place. A user can communicate by

a) Wallet (Ropston, Rinkeby, Local virtual currency, etc.). When we deploy our Ethereum-based cryptocurrency, we make transactions from one account to another, e.g., from Node 1 to Node 2, done by wallet only.

b) Developers use web3.js to interact where network modifications can be made in the running.

Further, a brief introduction of the present technology and its various parameters are discussed in Section 2. Section 3 depicts the experimental model used for the application in Blockchain network technology. Section 4 discusses the results and its outcome, followed by the conclusion in Section 5.

TECHNOLOGICAL OVERVIEW

A user using Ethereum technology can create a blockchain application (DApp) where the core is a "Smart Contract". It is a piece of code that performs business logic, which is very secure with no intermediary and is self-executable. Smart Contract can store data and can combine more than one application. IoTs trust the third-party companies that provide the IoT services, which might become a problem. It can be dangerous and be a security threat soon. If the IoT device is enabled with the smart contract, the data will be in the blockchain network, and it cannot be hacked because it is securely hashed by cryptology, avoiding third parties. Using an Ethereum platform, a smart contract-based private key management system[15] has been developed to implement security in IoTs, and an intelligent traffic system [16] can be developed. Data integrity can be achieved by using the IoT blockchain platform [17]. For a private network, a Raspberry Pi device can be adequately implemented with the Ethereum blockchain technology [18], enabling the experimental studies for IoT implementations [19]. Manipulation of data and extraction of secured data from a video can be done using the Smart Contract [20]. A blockchain-based logging of IoT sensor data and a system for monitoring by deploying smart contracts are used to develop trusted IoT ecosystems [21]. A private smart contract (Hawk) [22] developed is not stored in the financial transactions for public view. Trusted decentralized transitions for supply chain management are also achieved [23], [24].

Furthermore, a flexible and transparent application for blockchain implementation is made using DApps. Ethereum empowers a different approach for such implementations using blockchain that differs from the conventional blockchain proceedings. DApps were built for various requisitions such as personal health records, voting, registration, booking, etc. In Table 1, in brief, various blockchain applications, e.g., a decentralized approach for election voting system [25] through the Ethereum blockchain platform [26], Interplanetary file system (IPFS) an alternative private health record system using blockchain is developed [27] for securing the health record data, an online car reservation system for easy travel and secured payment methods [28] using React JS and Next JS, a DApp for an IoT [29] deployed on the Rinkeby test network etc. have been presented.

However, the Rinkeby test network was deprecated in October 2022. Henceforth, the operation of a smart home on a blockchain network using local virtual currency provided by Ganache is proposed in this paper. On deployment, Ganache provides ten accounts, each consisting of 100 fake ethers, to perform transactions. This can be further connected to the Ethereum main net in future studies.

Table 1. Comparison of the Blockchain-based DApp

Author	Application	DApp	Observations
Abidn *& et al.,* [19]	IoT	No	Ethereum Blockchain Network uses Smart contract for managing IoT devices
Neelam Singh *& et al.,* [25]	Voting	Yes	Decentralized approach for election voting system through the Ethereum account
D. Sentausa *& et al.,* [27]	Health Record	Yes	The personal health record of users is stored into the Interplanetary File System in blockchain
N. Dhamani *& et al.,* [28]	Car Booking	Yes	Blockchain-based web application for car booking
Soto-Ortiz *& et al.,* [29]	IoT	Yes	A DApp prototype is developed with sensors deploying the smart contract on the Rinkeby test net.
Proposed	IoT	Yes	Smart home operation based on a blockchain network using local virtual currency provided by ganache in the local network

EXPERIMENTAL MODEL

Some highly secured perimeters, like Presidential residences, military bases, structural buildings, etc., are fully automated with IoTs. They are easily vulnerable and can be hacked. To prevent such intrusions from happening, a blockchain-based network can be developed. The Smart Contract is the key that can only be accessed by the authorized, and the operations can be carried out through the blockchain network. The operation can be maintained by DApps so that every transaction is recorded by updating the blocks and cannot be tampered with because each node is connected and is operated over blockchain through the DApps, as shown in Figure 2.

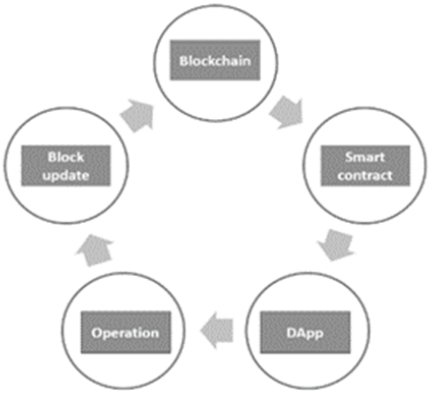


Fig. 2: DApp operation over blockchain

A Smart Contract is created and deployed using any cryptocurrency. Each entity is connected to IoT, and its operation creates "ON and OFF" switches in the DApps. To develop any DApps, the Solidity code, Front end (HTML code or User interface), and Link between both using web3.js are essential. When a switch is clicked, it will connect both solidity and front end. Ganache is the account provider that operates the web3 platform. The solidity program is deployed as a Smart Contract and is connected to web3.js, which is called from the network and is deployed in the Blockchain network provided by Ganache. Further, a decentralized application is created by installing the required platforms. The Blockchain environment is set up by installing node JS with the latest Node and Node Package Manager (NPM) versions, installing Ganache, and running Ganache-CLI.

```
PS E:\Project\SmartHomeApp> .\node_modules\.bin\ganache-cli
Ganache CLI v6.12.2 (ganache-core: 2.13.2)

Available Accounts
==================
(0) 0xBA198fD19662Cbd2FC9CC03c2a23180401Fb9087 (100 ETH)
(1) 0xDe6b0cC2D81afA88EfeE6E143DAb92f1dBE7f747 (100 ETH)
(2) 0x29c819A1f164668E0895531B2CE4ef3979083F36 (100 ETH)
(3) 0x1a0879Ed5ee72642Af7772e725A25d5a63333b82 (100 ETH)
(4) 0xe3D13672187c94b2a04FA0a29481f19620C38CB6 (100 ETH)
(5) 0xf677CA55AEbB659A12B6B030037967C6DAbcdF03 (100 ETH)
(6) 0x7ac78227C237F58449B0DDA7902CA6602854FD35 (100 ETH)
(7) 0x3802DA3558bcCE6a3c5Ea77E123b6CB17d443191 (100 ETH)
(8) 0x778538F2a565237aF32Fe1d49437d6249856D886 (100 ETH)
(9) 0xa623C0CFB605cA23463A1137Ee183d85Ba154D4f (100 ETH)
```

Fig. 3. Ganache is providing accounts with fake Ethers

As shown in Figure 3, ten accounts are created, each providing 100 fake Ethers for transactions, i.e., a private blockchain network is created. The gas price, gas limit, etc., are shown in Figure 4, which is a private network. Further, the solidity terminal and HTTP server must be installed to provide interaction with the program and DApp.

```
Gas Price
==================
20000000000

Gas Limit
==================
6721975

Call Gas Limit
==================
9007199254740991

Listening on 127.0.0.1:8545
```

Fig. 4. Gas price and limit for transactions

A private blockchain network is obtained for transactions. Enter into the node and define web3 using the local host. Generate the byte code and abi (Application Binary Interface) files. Use the account address and abi to deploy the smart contract, as shown in Figure 5, to perform the required operations. Further, the HTML and Java code for DApp is developed.

The smart contract obtained is to be deployed in JavaScript to develop the DApp. Connect the JavaScript with the HTML code and run the HTTP server. A local server with an HTTP address is generated. Click on the http server link and open it. This results in the DApp creation.

```
name))]
... }).send({
... from: '0xBA198fD19662Cbd2FC9CC03c2a23180401Fb9087',
... gas: 1500000,
... gasPrice: web3.utils.toWei('0.00003', 'ether')
... }).then((newContractInstance) => {
... deployedContract.options.address = newContractInstance.opt
ions.address
... console.log(newContractInstance.options.address)
... });
Promise {
  <pending>,
  [Symbol(async_id_symbol)]: 657,
  [Symbol(trigger_async_id_symbol)]: 653,
  [Symbol(destroyed)]: { destroyed: false }
}
> 0x7dFA72317bb7cCdA916CC8D38848B1b381966bC1
>
```

Fig 5. Smart Contract address after deployment

EXPERIMENTAL RESULT AND OBSERVATION

Finally, with the execution of the HTTP server, the DApps are opened, as shown in Figure 6, and it performs the function. It is observed that the Ganache provides the transactions in the network. All transactions performed on the webpage/DApps are logged in the Blockchain network, as shown in Figure 7.

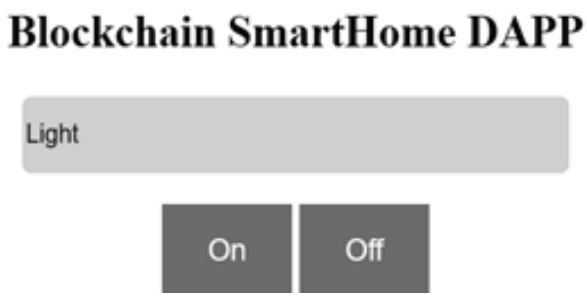


Fig. 6. Blockchain DApp

The input of the items registered in the smart home was given, and a particular operation of On/Off was made. The transaction address will be changing with respect to the operation performed. Every operation is registered in the block, as shown in Figure 7, and each of them is created by the block representing the block numbers.

```
Listening on 127.0.0.1:8545
> eth_accounts
eth_sendTransaction

  Transaction: 0x883de9e51fc89ca09a62103270bfa85277ee0e78
93f0ba038a1e8e5b9f8d66f8
  Contract created: 0x7dfa72317bb7ccda916cc8d38848b1b3819
66bc1
  Gas usage: 148579
  Block Number: 1
  Block Time: Wed Aug 30 2023 11:43:43 GMT+0530 (India St
andard Time)
```

Fig 7. Blocks recorded when a transaction is performed

It can be observed that the total gas utilized for the transaction and the time stamp are also recorded, making the transaction secure and utmost difficult to interfere with. Therefore, automated IoTs for highly secured block transactions can be completed in the blockchain-based network, storing data that cannot be accessed by any unauthorized party.

CONCLUSION

This paper presents and discusses a decentralized automated smart home applications based on the Ethereum Blockchain technology with the local virtual currency provided by the accounts created by Ganache. The result shows the process through which a network is operated by creating blocks on every transaction. These highly sensitive blocks are secured by using Blockchain technology. Further, this can be implemented on IoT devices like Raspberry Pi or Arduino using the Ethereum mainnet with the actual cryptocurrency. Every operation carried out through the IoT is then appended into blocks by blockchain model implementation and is visible in the main net for validation of the transaction done. The sensor data is noted in the blocks, and sharing this data with the authorised personnel through this block data can be done. Through this, the data in automated IoTs can be established successfully with high security and reliability.

CONFLICT OF INTEREST

The authors confirm that this article's content has no conflicts of interest.

ACKNOWLEDGEMENT

Authors acknowledge the National Institute of Technology Jamshedpur, India for providing the research opportunity and facilities.

REFERENCES

1. S. Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," Cryptography Mailing list at https://metzdowd.com, Mar. 2009.
2. M. Krichen, M. Ammi, A. Mihoub, and M. Almutiq, "Blockchain for Modern Applications: A Survey," Sensors, vol. 22, no. 14, pp. 5274, Jul. 2022, doi: 10.3390/s22145274.
3. Pemith Waidyaratne, "A Review on Blockchain Technology and the Impact on Finance Sector by Blockchain Technology," 2022, doi: 10.13140/RG.2.2.24977.10088.
4. Md. M. Hossain, M. Fotouhi, and R. Hasan, "Towards an Analysis of Security Issues, Challenges, and Open Problems in the Internet of Things," IEEE World Congress on Services, Jun. 2015, pp. 21–28. doi: 10.1109/SERVICES.2015.12.
5. R. H. Weber, "Internet of Things – New security and privacy challenges," Computer Law & Security Review, vol. 26, no. 1, pp. 23–30, Jan. 2010, doi: 10.1016/j.clsr.2009.11.008.
6. X. Wang, A. Badshah, S. Tu, and M. Waqas, "Blockchain-Based Security Management Platform," 2nd Asia Symposium on Signal Processing (ASSP), Nov. 2021, pp. 118–121. doi: 10.1109/ASSP54407.2021.00026.
7. M. Xie, Z. Liao, and L. Huang, "Data Security Based on Blockchain Digital Currency," 3rd International Conference on Smart BlockChain (SmartBlock), Oct. 2020, pp. 5–10. doi: 10.1109/SmartBlock52591.2020.00009.
8. H. Zhao, Y. Liu, Y. Wang, and Y. Huang, "Hiding Data into Blockchain-based Digital Video for Security Protection," 3rd International Conference on Smart BlockChain (SmartBlock), Oct. 2020, pp. 23–28. doi: 10.1109/SmartBlock52591.2020.00012.
9. B. Thuraisingham, "Blockchain Technologies and Their Applications in Data Science and Cyber Security," 3rd International Conference on Smart BlockChain (SmartBlock), Oct. 2020, pp. 1–4. doi: 10.1109/SmartBlock52591.2020.00008.
10. R. Salama, F. Al-Turjman, C. Altrjman, S. Kumar, and P. Chaudhary, "A Comprehensive Survey of Blockchain-Powered Cybersecurity- A survey," International Conference on Computational Intelligence, Communication Technology and Networking (CICTN), Apr. 2023, pp. 774–777. doi: 10.1109/CICTN57981.2023.10141282.
11. Z. Gong-Guo and Z. Wan, "Blockchain-based IoT security authentication system," International Conference on Computer, Blockchain and Financial Development (CBFD), Apr. 2021, pp. 415–418. doi: 10.1109/CBFD52659.2021.00090.
12. F. Alkurdi, I. Elgendi, K. S. Munasinghe, D. Sharma, and A. Jamalipour, "Blockchain in IoT Security: A Survey," 28th International Telecommunication Networks and Applications Conference (ITNAC), Nov. 2018, pp. 1–4. doi: 10.1109/ATNAC.2018.8615409.
13. "An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends | IEEE Conference Publication | IEEE Xplore." Accessed: Aug. 30, 2023. [Online]. Available: https://ieeexplore.ieee.org/document/8029379
14. C. Dannen, Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners. Berkeley, CA: press, 2017. doi: 10.1007/978-1-4842-2535-6.
15. S. Huh, S. Cho, and S. Kim, "Managing IoT devices using blockchain platform," 19th International Conference on Advanced Communication Technology (ICACT), Feb. 2017, pp. 464–467. doi: 10.23919/ICACT.2017.7890132.
16. Q. Ren, K. L. Man, M. Li, and B. Gao, "Using Blockchain to Enhance and Optimize IoT-based Intelligent Traffic System," International Conference on Platform Technology and Service (PlatCon), Jan. 2019, pp. 1–4. doi: 10.1109/PlatCon.2019.8669412.
17. L. Hang and D.-H. Kim, "Design and Implementation of an Integrated IoT Blockchain Platform for Sensing Data Integrity," Sensors, vol. 19, no. 10, pp. 2228, May 2019, doi: 10.3390/s19102228.
18. E. Fernando, Meyliana, and Surjandy, "Blockchain Technology Implementation in Raspberry Pi For Private Network," International Conference on Sustainable Information Engineering and Technology

(SIET), Sep. 2019, pp. 154–158. doi: 10.1109/SIET48054.2019.8986053.

19. M. H. Z. Abidin, S. Suchaad, K. Mashiko, and N. Ismail, "Ethereum Blockchain Network Implementation for IoT Platform," International Journal of Integrated Engineering, vol. 11, no. 7, Art. no. 7, Nov. 2019.

20. E. M. Sifra, "Security Vulnerabilities and Countermeasures of Smart Contracts: A Survey," IEEE International Conference on Blockchain (Blockchain), Aug. 2022, pp. 512–515. doi: 10.1109/Blockchain55522.2022.00080.

21. J. Lockl, V. Schlatt, A. Schweizer, N. Urbach, and N. Harth, "Toward Trust in Internet of Things Ecosystems: Design Principles for Blockchain-Based IoT Applications," IEEE Transactions on Engineering Management, vol. 67, no. 4, pp. 1256–1270, Nov. 2020, doi: 10.1109/TEM.2020.2978014.

22. "Hawk: The Blockchain Model of Cryptography and Privacy-Preserving Smart Contracts | IEEE Conference Publication | IEEE Xplore." Accessed: Aug. 30, 2023. [Online]. Available: https://ieeexplore.ieee.org/document/7546538

23. R. C. Koirala, K. Dahal, and S. Matalonga, "Supply Chain using Smart Contract: A Blockchain enabled model with Traceability and Ownership Management," 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence), Jan. 2019, pp. 538–544. doi: 10.1109/CONFLUENCE.2019.8776900.

24. S. Malik, V. Dedeoglu, S. S. Kanhere, and R. Jurdak, "TrustChain: Trust Management in Blockchain and IoT Supported Supply Chains," IEEE International Conference on Blockchain (Blockchain), Jul. 2019, pp. 184–193. doi: 10.1109/Blockchain.2019.00032.

25. N. Singh, P. Rohila, K. Anwar, T. Alam, and V. Rawat, "An Advanced Full Stack Decentralized Approach for Secure Election Voting Process," 2nd International Conference on Innovative Sustainable Computational Technologies (CISCT), Dec. 2022, pp. 1–6. doi: 10.1109/CISCT55310.2022.10046508.

26. R. Taş and Ö. Ö. Tanrıöver, "Building A Decentralized Application on the Ethereum Blockchain," 3rd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT), Oct. 2019, pp. 1–4. doi: 10.1109/ISMSIT.2019.8932806.

27. D. Sentausa and D. Habsara Hareva, "Decentralize Application for Storing Personal Health Record using Ethereum Blockchain and Interplanetary File System," 1st International Conference on Technology Innovation and Its Applications (ICTIIA), Sep. 2022, pp. 1–6. doi: 10.1109/ICTIIA54654.2022.9935996.

28. N. Dahmani, S. A. Alex, S. G. Sadhana, S. G. Jayasree, and T. P. A. Jinu, "Welcome Wagons: A Block Chain based Web Application for Car Booking," IEEE/ACS 19th International Conference on Computer Systems and Applications (AICCSA), IEEE Computer Society, Dec. 2022, pp. 1–6. doi: 10.1109/AICCSA56895.2022.10017821.

29. S. I. Soto-Ortiz, P. J. Salazar-Pérez, and K. L. Guadalupe-Gallardo, "Development of a DAPP (decentralized application) on Rinkeby Network for the registration of Sensors of an Internet of Things (IoT) Environment," IEEE International Conference on Engineering Veracruz (ICEV), Oct. 2022, pp. 1–5. doi: 10.1109/ICEV56253.2022.9959718.

Research and Development of an Innovative System to Forecast Secondary School Students Academic Accomplishments

Shravani Pawar
Asst. Prof.
Bharati Vidyapeeth's Inst. of Mgmt & Infor. Tech.
Navi Mumbai, Maharashtra
✉ pawarshravani81@gmail.com

Sheetal V. Deshmukh
Asst. Prof.
Bharati Vidyapeeth's Deemed University, YMIM
Karad., Maharashtra
✉ shital.deshmukh@bharatividyapeeth.edu

ABSTRACT

The educational institution aims to improve the prediction methodology for student academic performance, as current research on suitable factors affecting academic success is lacking. The traditional teaching model focuses on information transmission, while the behaviorist approach emphasizes basic skills before higher-order thinking. Factors like age, gender, and family characteristics significantly impact academic performance. Cognitive factors are extracted from a student performance dataset, preprocessed for quality improvement. Machine learning techniques like Naïve Bayes, Support Vector Machine (SVM), and Convolutional Neural Network (CNN) are employed for classification. Naïve Bayes yields 78.76% accuracy but has drawbacks. SVM provides 83.15% accuracy with speed and dataset size limitations. CNN, inspired by the human neural network, outperforms others with 92.64% accuracy in predicting students' cognitive skills, implemented using the R tool. Predicting cognitive skills becomes vital to monitor students' evolving knowledge states.

Cognitive factors are extracted from a student performance dataset in the UCI machine learning repository. The raw data undergoes pre-processing to enhance its input data quality. The chosen machine learning task guides algorithm selection and data representation in the form of a model. Various approaches, including Naïve Bayes, Support Vector Machine, and Convolutional Neural Network, are employed for feature training and the classification of cognitive factors.

KEYWORDS: *CNN, Educational institute, Social, Gender, Age, Academic performance, Cognitive skills, Student demographics, Attendance, Self-awareness, CGPA, External & internal assessment.*

INTRODUCTION

Education is a crucial aspect fostering skills, abilities, and knowledge essential for individual, community, and national growth. An educated individual contributes to community well-being and achieves personal goals. Academic performance, influenced by factors like classroom participation, assignments, homework, tests, exams, and extracurricular activities, reflects students' achievements. Educational institutions employ advanced strategies such as extra classes, innovative teaching methods, technology integration, and rewards for good performance to enhance academic outcomes. Rewarding students fosters motivation and encourages them to improve their academic performance.

FACTORS INFLUENCING THE ACADEMIC PERFORMANCE OF THE STUDENTS

Academic performance reflects the attainment of educational goals measured through exams or continuous assessments. Identifying factors predicting performance, such as test anxiety, environment, motivation, and emotions, is crucial for modeling institutional achievement.

Teachers and students are pivotal assets for academic institutions, with their performance serving as a key link between the two. Without students' performance, progress and achievements are unattainable for both

teachers and institutions. Extensively studied by researchers globally, student performance is a complex aspect influencing academic, social, psychological, economic, and environmental cohesion. Various factors, ranging from environmental and economic to social and psychological, impact student performance, with interactions between teachers and students playing a crucial role. Literature surveys highlight the diverse influences, including course experience, effort, motives, and learning strategies, shaping students' academic performance. (Farooq Salman Alani, 2021)

Economic factors significantly impact students' academic performance, influencing their grades. Factors like societal economic position, parent's income, and social status can positively or negatively affect students' educational success. Students across universities strive to attend classes, utilize available facilities, and improve their performance in pursuit of high grades. (Abdulrazzaq Tuama Hawa, 2021) The availability of facilities and funding resources plays a crucial role in influencing students' performance and educational outcomes in their respective universities. In the quest for academic success, students increasingly rely on information and communication services to interact with peers and institutions worldwide.

CONVOLUTIONAL NEURAL NETWORK

Deep learning, a subset of machine learning, employs multi-level neural network architectures and non-linear transformations to model complex abstractions in data. It focuses on predicting student academic performance by considering factors like travel time, study time, parent relationships, and health. Despite being computationally intensive, recent Deep learning is becoming more and more popular because to GPU-based solutions. Deep learning methods that are widely used include convolutional and recurrent neural networks. We use four different types of layers in the proposed convolutional neural network (CNN) method for document classification: fully connected (FC), pooling (POOL), convolutional (CONV), and rectified linear units (ReLU). The CONV layer processes inputs from the dataset by computing the output of neurons connected to local input regions. The activation function is applied element-wise by the ReLU layer. Spatial dimension down sampling is done by the pooling layer. In the fully connected layer, the volume size and class size that result are obtained. The CNN procedure entails these successive steps, and the input layer contains the complete dataset.

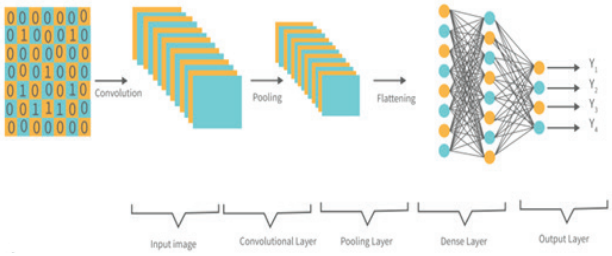


Fig. 1. Architecture of Convolutional Neural Network

Convolution layer

Convolutional kernels make up the convolutional layer of a convolutional neural network (CNN), to sum up. During the forward pass, these kernels, or filters, are convolved over the input features in both width and height. Every kernel works on tiny 2D patches of the input and is composed of a layer of connection weights. The end product is a two-dimensional activation map, in which each unit denotes the convolution operation's output for a particular input patch.

A student performance dataset from the UCI repository provides the Convolutional Neural Network (CNN) with input attributes such as age, the number of people in the family, the time it takes to travel, the amount of time spent studying each week, additional educational assistance, support for education within the family, the quality of family relationships, free time available after school are all important considerations.. The numeric attributes have values ranging from 0 to 5, and binary attributes have values "yes" or "no." These features are fed into the convolutional layer for further processing in the neural network.

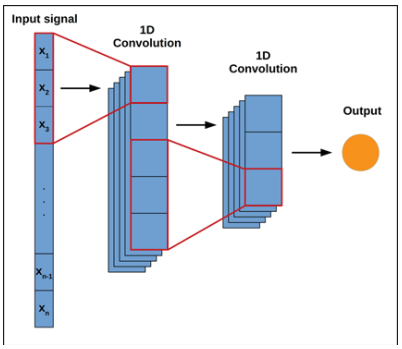


Fig. 2. Convolutional Layer

Rectified Linear Unit (ReLU) layer

After each Convolutional Layer in a Convolutional Neural Network (CNN), a nonlinear activation layer is conventionally applied to introduce nonlinearity. Historically, functions like tanh and sigmoid were used, but ReLU (Rectified Linear Unit) layers are preferred due to faster training and computational efficiency. ReLU helps address the vanishing gradient problem, enabling more effective training.

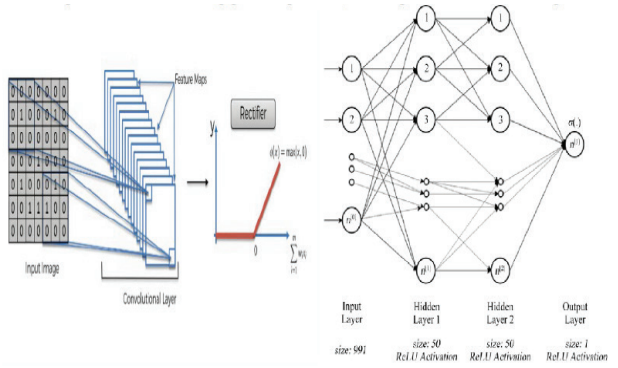


Fig. 3. Rectified Linear Unit (ReLU) layer

The ReLU layer applies the function f(x) = max (0, x) to the input values. In this context, student cognitive skills are divided into four partitions: Low, Average, Good, and Excellent. These partitions are based on ranges from 0 to 5, 6 to 10, 11 to 15, and 16 to 20, respectively. These nonlinear relationships are then converted into linear ones in the prediction models, where the range is from 0 to 20. Student-related characteristics range from 0 to 5.

Pooling layer

Reducing the input volume's width and height is usually accomplished by a Convolutional Neural Network (CNN) pooling layer. Choosing a representative value from a set of neighbouring values in the input is the pooling procedure. Max Pooling and Average Pooling are the two most popular varieties of pooling layers.

Maximum Pooling

In max pooling, the greatest value is used as the representative value for each local area of the input.

This partially provides translation invariance by preserving the most important properties in the local area.

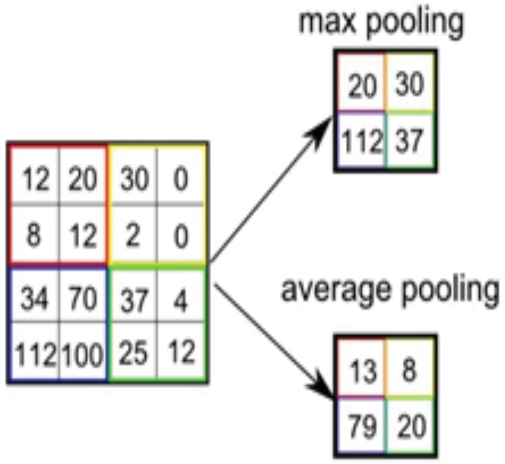


Fig. 4. Pooling Layer for CNN Architecture

Mean Combination

The average value of the local area is calculated and utilized as the representative value in average pooling.

It often lessens the dimensionality of the input and smoothest out the characteristics.In a CNN design, pooling layers are placed

inbetween successive convolutional layers. They contribute to lowering the number of parameters and computational load in succeeding layers by lowering the spatial resolution of the learned features. Furthermore, pooling helps to strengthen the network and lessen its sensitivity to changes in the input.

LeNet Architecture

Although multi-layer networks, like LeNet5, can learn from complex and high-dimensional data, they are well suited for image identification tasks. Three fully connected layers and five convolutional layers make up LeNet5's eight layers. A 5x5 receptive field provides input to each of the 25 inputs that make up a unit in a plane. Every unit in a plane has the same weight vector, and this local region is transferred to the first hidden layer. Neighboring units from the preceding layer's output are kept at the same location in the feature map.Neurons in the convolution layer, which makes up the first layer, produce sigmoid activation. During computing, overlapping receptive fields happen, which improves feature extraction.

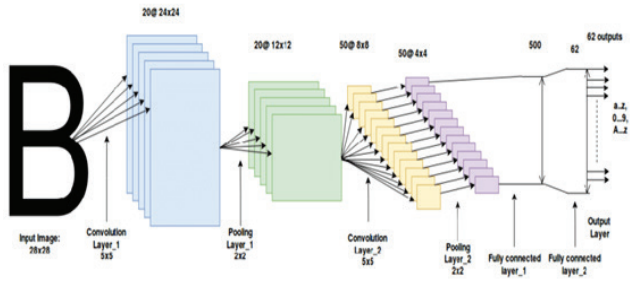


Fig. 5. LeNet Architecture

The same input image is subjected to various weight vector applications to produce distinct feature maps. Taking a 2x2 area as input, calculating the average, multiplying by trainable coefficients, adding a trainable bias, and applying a sigmoid function are the steps involved in subsampling in the second layer. After convolution, there are still the same amount of feature maps, but layer by layer, the spatial resolution gets lower. Backpropagation is the method used to produce learning.

Goal of the study

The purpose of this study is to look into how information and communication technology (ICT) is Currently being used in Raigad District schools. It also looks at secondary school students' academic performance within the same district, identifying important factors that affect their learning results.

Furthermore, the research aims to design and develop an expert system for predicting the academic performance of secondary school students in Raigad District. The final phase involves the validation of the system to ensure its accuracy and reliability. Through these objectives, the study aims to provide valuable insights into the relationship between ICT implementation, various influencing factors, and academic achievements in the context of Raigad District's secondary education landscape.

Objectives of this Paper

1. To study the present scenario of ICT implementation in schools of Raigad District.
2. To study the academic performance of the secondary school students in Raigad District.
3. Identify the parameters that influence the academic performance of secondary school students in Raigad district.
4. To design & develop the expert system to predict academic performance of secondary school students in Raigad District.
5. To validate the system.

METHODOLOGY

The research will be conducted in various public and private secondary schools located in Raigad district, Maharashtra.

- The type of research conducted will be exploratory in nature, as it seeks to explore valuable information conducive to the learning process of students.
- Research methods will primarily involve surveys conducted through well-designed questionnaires, supplemented by personal interviews and scheduled methods.
- The study sample will be carefully selected from a diverse range of private and public schools within Raigad district to ensure a comprehensive and representative response.

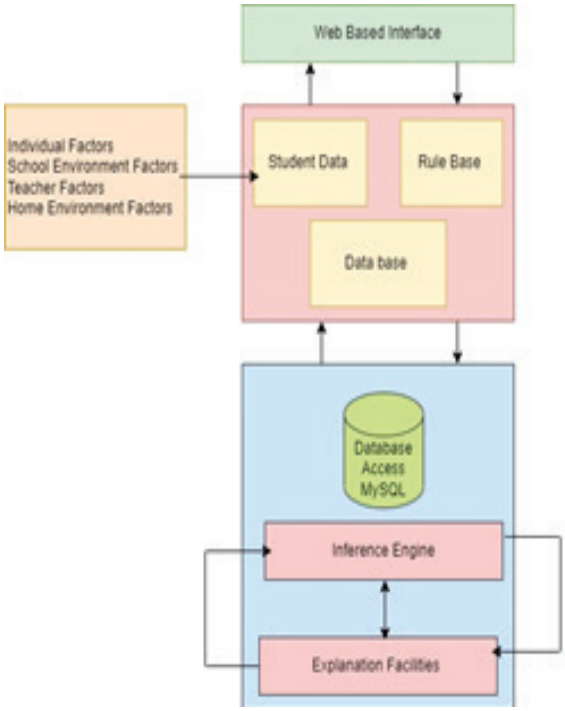
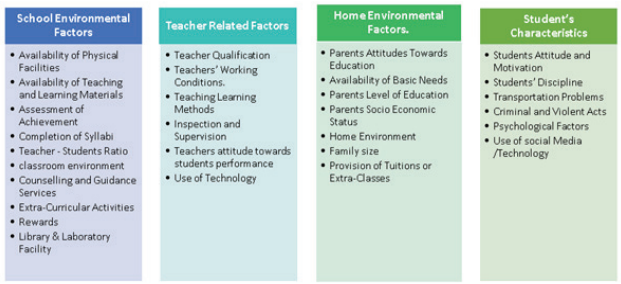


Fig. 6. Methodology Flowchart

Parameters that influence the academic performance of secondary school students



Pilot Survey using SPSS

SPSS (Statistical Package for the Social Sciences) is a statistical software package widely used for data analysis. While SPSS involves a graphical user interface (GUI) for most operations, certain statistical analyses and procedures can be expressed mathematically. Here are a few examples:

Creating a questionnaire survey for secondary school involves crafting questions that capture relevant information about students' experiences, opinions, and perceptions. Remember to pilot-test the questionnaire with a small group to identify any potential issues or unclear questions before distributing it widely. Adjustments can then be made based on the feedback received during the pilot phase.

- What factors do you believe influence your academic performance the most? (e.g., family support, teachers, peers, personal study habits)
- How do you handle stress related to academic expectations?

Questionnaire Survey

- "What was the focus of the research on the effect of continuous assessment techniques on secondary school students' academic performance?"
- "Why were a descriptive research design chosen for this survey, and how did the short interval of time impact data collection?"
- "How was the population defined in this research, and who comprised the population at the secondary school level?"
- What comprised the research variables, specifically focusing on techniques of continuous assessment and academic performance?
- "How was questionnaire relevance ensured, and what methods ensured validity and reliability, involving expert input and statistical software post-pilot testing?"
- "How does the emphasis on continuous assessment in this study differentiate it from previous research, which has predominantly focused on formative and summative assessments?"
- "How does the research demonstrate the significant impact of oral and written tests on students' academic performance?"
- "What methods are considered important in determining children's direct observation, including conversations, oral, and written questions?"
- "How do oral and written tests improve students' academic performance, especially the written exam assessing awareness, talents, and abilities?"
- How did the current study observe the impact of recipe exercise on cognitive performance, and what were the findings regarding this effect?
- What's the impact of continuous assessment on excitement in the learning process and its role in engaging students and teachers in continuous learning?
- "How can school administration enhance student involvement in classroom activities through the provision of a flexible learning environment?"

CONCLUSION

1. Most educators and stakeholders acknowledge the importance of leveraging technology to predict academic performance in secondary school students..
2. Users agree that the system's intuitive design, efficient navigation, and reliable performance make it a valuable tool for educational institutions.
3. Many educators are now utilizing this expert system to gain insights into student performance, allowing for more targeted interventions and support.

4. They feel confident in the system's ability to provide accurate predictions and actionable recommendations, thanks to the privacy and security measures implemented.
5. The system provides comprehensive data analysis, including trends, patterns, and predictive models. This enables educators to understand the underlying factors influencing student performance and address them proactively.
6. The system is designed to be scalable and flexible, accommodating the needs of different educational institutions, from small schools to large districts. Its adaptability ensures that it can evolve with changing educational demands and technological advancements.
7. It includes mechanisms for continuous improvement, such as feedback loops and updates based on user input and technological advancements, ensuring that the system remains relevant and effective over time.

REFERENCES

1. Stem Attitudes Of Students As Predictor Of Secondary School Technology And Design Course Achievement, Kamil Arif Kırkıç , Feriha Uludağ , Received: March 23, 2021 Accepted: July 09, 2021
2. Impact of Continuous Assessment Techniques on Students' Academic Performance at Secondary School Level, Muhammad Asghar Ali , Kosar Younas , Muhammad Mushtaq relationship with their achievement. The (n=3200) students participated in this correlational study that were randomly selected from 80 schools of Punjab. Data were collected through the Academic Engagement Scale (AES) that consisted of 26 Likert-type statements. Validity was made sure Examining Relationship between Secondary School Students' Academic Engagement and their Academic Achievement: A Case of Punjab, Journal of Arts and Social Sciences, JASS, Dr. Nisar Abid, Dr. Amna Saeed, Dr. Mumtaz Akhter, 30.12.2022
3. Factors Affecting Students Academic Performance: A Case Study of Sohar University, Farooq Salman Alani , Abdulrazzaq Tuama Hawas ,
4. Using machine learning to predict factors affecting academic performance: the case of college students on academic probation, Check For Updates, Lamees Al-Alawi, Jamil Al Shaqs , Ali Tarhini , Received: 30 May 2022 / Accepted: 27 February 2023
5. Relationship between Intelligence Quotient, Academic Motivation and Academic Performance in Secondary School Students, Journal of Scientific Research & Reports, Ekenedilichukwu Ilo , Chibuike Onyejesi , Received 29 July 2021 Accepted 08 August 2021 Published 12 August 2021
6. Student Per formulator: Predicting Students' Academic Performance at Secondary and Intermediate Level Using Machine Learning , Shah Hussain , Muhammad Qasim Khan , Received: 22 June 2020 / Revised: 12 April 2021 / Accepted: 21 April 2021 / Published online: 3 June 2021
7. Data Mining for Student Performance Prediction in Education , Ferda Ünal , Predicting Academic Performance: A Systematic Literature Review , Arto Hellas*, Petri Ihantola*, Andrew Petersen*, Vangel V. Ajanovski, Mirela Gutica, Timo Hynninen, Antti Knutas, Juho Leinonen, Chris Messom, Soohyun Nam Liao, July 2–4, 2018.
8. Predictive Abilities of Curiosity, Creativity, and Motivation on Academic Performance of High School Students in Ghana , Research Article , Hindawi , Inuusah Mahama , Bakari Yusuf Dramanu , Kenneth Asamoah-Gyimah , Received 25 November 2022; Revised 12 January 2023; Accepted 4 February 2023; Published 22 February 2023
9. Retracted: Enhancement of Predicting Students Performance Model Using Ensemble Approaches and Educational Data Mining Techniques, Retraction, WILEY / Hindawi, Mahmoud Ragab, Ahmed M. K. Abdel Aal, Alio. Jafri, Nehla F. Omran, Published 13 December 2023
10. Potential Future Directions in Optimization of Students' Performance Prediction System, Review Article, Hindawi, Sadique Ahmad, Mohammed A. El-endi , Shahid Anwar , Rizwan Iqbal , Received 19 February 2022; Accepted 26 March 2022; Published 17 May 2022
11. Predictive modelling and analysis of academic performance of secondary school students: Artificial Neural Network approach, international Journal of Science and Technology Educational Research, Amoo M. Adewale, Alaba O. Bamidele and Usman O. Lateef, July, 2017

12. Predicting Secondary School Students' Performance Utilizing a Semi-supervised Learning Approach, Ioannis E. Livieris, Konstantina Drakopoulou, Vassilis T. Tampakas , Tassos A. Mikropoulos , Panagiotis Pintelas ,

13. A Systematic Literature Review of Student' Performance Prediction Using Machine Learning Techniques, Article, Education Sciences, Balqis Albreiki , Nazar Zaki , Hany Alashwal , Received: 12 July 2021 Accepted: 12 September 2021 Published: 16 September 2021 ,

14. Need for Interpretable Student Performance Prediction, Manjari Chitti, Padmini Chitti, Manoj Jayabalan ,

15. An intelligent system to predict academic performance based on different factors during adolescence, A. T. M. Shakil Ahamed, Navid Tanzeem Mahmood, Rashedur M Rahman, Received 1 April 2016 Accepted 15 March 2017

16. Special Issue of First International Conference on Innovations in Engineering Sciences (ICIES 2020) Analysis of Student Academic Performance through Expert systems, Kandula Neha, Dr. S Jahangeer Sidiq, 09S September 2020

17. Analysis and Prediction of Students' Academic Performance and Employability Using Data Mining Techniques: A Research Travelogue, ISRES, Maria Elisa Linda, Nizwa Riah Elcullada , November 04-07, 2021

18. Application expert system career guidance for students, G Supriyanto, I Widiaty , A G Abdullah , Y R Yustiana, Research Article.

19. Predicting Academic Performance Using an Efficient Model Based on Fusion of Classifiers, Ansar Siddique, Asiya Jan, Fiaz Majeed, Adel Ibrahim Qahmash , Noorulhasan Naveed Quadri ,Mohammad Osman Abdul Wahab , Received: 21 October 2021 Accepted: 9 December 2021 Published: 13 December 2021 ,

20. Toward Predicting Student's Academic Performance Using Artificial Neural Networks, Yahia Baashar , Gamal Alkawsi , Abdulsalam Mustafa , Ammar Ahmed Alkahtani , Yazan A. Alsariera , Abdulrazzaq Qasem Ali , Wahidah Hashim , Sieh Kiong Tiong , Received: 23 October 2021 Accepted: 27 November 2021 Published: 26 January 2022 ,

21. Learning Analytics to Determine Profile Dimensions of Students Associated with Their Academic Performance, Andres Gonzalez-Nucamendi, Julieta Noguez 1 , Víctor Robledo-Rella , Rosa María Guadalupe García-Castelán ,David Escobar-Castillejos , 19 October 2022

22. Factors that influence academic performance of students: an empirical study, mhlonishwa khumalo , Research Article,

23. Artifcial intelligence enabled prediction model of student academic performance in online engineering education, Pengcheng Jiao, · Fan Ouyang, · Qianyun Zhang4,· Amir H. Alavi, 11 August 2022

24. The Development of Academic Achievement and Cognitive Abilities: A Bidirectional Perspective, Peng, Rogier A. Kievit, Number 1, 2020

An Ad-hoc Network Security through Simulated Behavior Analysis of Nodes

Ayesha Mujawar, Riyajuddin Mujawar
Bharati Vidyapeeth Institute of Management
Sangli, Maharashtra
✉ ayeshamulla78@gmail.com
✉ riyajuddin1676@gmail.com

Pratibha Deshmukh, Sharwari Jadhav
Bharati Vidyapeeth's Inst. of Mgmt and Infor. Tech.
Navi Mumbai, Maharashtra
✉ pratibha.deshmukh@bharatividyapeeth.edu
✉ sharwarijadhav2004@gmail.com

ABSTRACT

A Mobile ad-hoc networked nodes are battery powered. Therefore it always needs power or energy after some time to restart to continue the work. Their unpredictable behavior may causes discharge of energy. From security point of view of the network, analysis of behavior of nodes is more important. There are so many important parameters affecting the performance of network. If we consider energy parameter; it affects a lot as nodes in ad-hoc network are battery powered nodes. Based on their behavior, network can be analyzed. An attacker or malicious node wastes other nodes energy by making them busy in malicious activity with fake requests. So their battery may go down. Whereas a selfish node preserves its energy to perform some malicious activity and can cause harm to the network. Therefore node energy is an important parameter in an ad-hoc network. Based on it this paper focuses on analysis of energy with and without fuzzy approach through simulation to analyze, manage and security of the network.

KEYWORDS: *Ad-hoc network, Selfish, Malicious, Nodes, Simulation.*

INTRODUCTION

An ad-hoc network contains the nodes which are free to move. Its mobile or dynamic nature does not specify boundary for protection. Due to dynamicity, mobile nodes join or leave the network at random. This nature arise different types of vulnerabilities for the network. Therefore they may undergo to perform malicious activities like packet drop or loss, energy consumption, improper use of bandwidth etc. Such behavior causes different types of threat for security of such type of network. It affects the network performance parameters like packet delivery ratio (PDR), throughput [7], end to end delay (E2ED) etc.

Here simulation approach has been applied to analyze the behavior of node with fuzzy and non-fuzzy approach.

BEHAVIOURAL ANALYSIS OF NODES IN NETWORK

A node in mobile ad hoc network can be characterized by its behavior. Therefore a node which does not work up to the mark may cause different types of vulnerabilities in the network. Such node is known as a Misbehavior node. A Misbehavior node can be a selfish node or a malicious node. A selfish node consumes more network resources during working in the network. It saves its own resources. Whereas a malicious node behave abnormally this disrupts the normal behavior of the network.

A normal behavioral node utilizes proper energy to carry out smooth function in network environment. Whereas a malicious node wastes other nodes energy which is harmful to the network. Here Speed of a node also affects a lot due to its mobile nature. Increase in speed consumes more amount of energy; whereas decrease in speed consumes less energy. It overall decreases the performance of the network. Thus there is a relation between energy, speed, ratio of packet delivery and end to end delay. Due to dynamicity in network in terms of connectivity as well as resource availability, it leads to different types of attacks [8][9]. Therefore there is a

need for detection and prevention of different types of attacks in such type of network.

ANALYSIS METHODOLOGY

If malicious nodes present big in number; their speed, mobility causes severe problems in terms of packet drop affecting the normal behavior of the network. Speedy node with high mobility consumes more amount of bandwidth, energy like factors. For its analysis network simulator can be used for securing a network. Network Simulator provides an Integrated Development Environment as a tool to analyze the behavior of node. Various scenarios are created to analyze the performance of the network.

For simulation, different simulators [2][4]are available; but preferably for research ns-2 (Network Simulator-2) and ns-3 (NetworkSimulator-3) are used. Here ns-2 simulator is used. NS2 is free and open source software. It supports different protocols compatible for both wired as well as wireless networks. Following Figure 1shows sample scenario in ns-2.

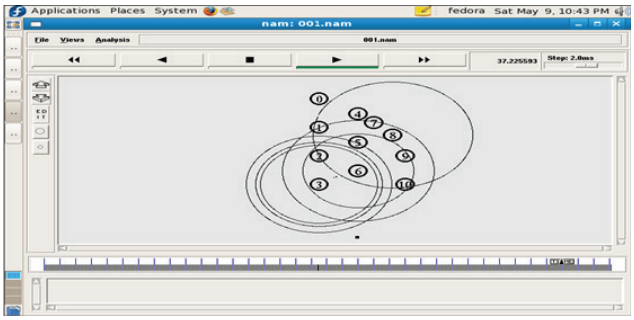


Fig. 1. NS-2Scenario Sample

For analyzing the behavior of nodes here energy, speed and mobility parameters are considered. Based on the obtained result network performance is analyzed. Here Speed is varied from 10ms to 100ms. For different number of nodes by deciding source, mediator and destination, scenarios are created using ns-2. Following Table 1 shows various cases of mobility.

Table 1: Mobile Nodes Mobility Cases

Sr. No.	Cases	Description
1	Src Mov	When Source nodes are moving, Mediator and Destination nodes are stationary
2	Med Mov	When Mediator nodes are moving, Sources and Destination nodes are stationary
3	Dest Mov	When Destination nodes are moving, Sources and Mediator nodes are stationary
4	SM Mov	When Source and Mediator nodes are moving, Destination nodes are stationary
5	SD Mov	When Source and Destination nodes are moving, Mediator nodes are stationary
6	MD Mov	When Mediator and Destination nodes are moving, Source nodes are stationary
7	Mobility	All Source, Mediator and Destination nodes are moving

For different speed, mobility cases; energy spent by mediator and Packet Delivery Ratio is calculated. Obtained Energy, Packet Delivery Ratio and Speed at specific activity of mobility is averaged. Following Table shows sample packet delivery ratio and energy spent by mediators. It is averaged for different speed.

Table 2: PDR For Different mobility cases and Speed variation

Speed	Packet Delivery Ratio (PDR)							Avg PDR
	Mobility	Src Mov	Med Mov	Dest Mov	SM Mov	MD Mov	SD Mov	
10	99.334	99.499	99.342	99.520	99.520	99.368	98.712	99.328
20	98.980	99.152	99.337	99.104	99.585	99.090	99.130	99.197
30	99.275	98.870	99.162	99.212	99.238	99.07	99.394	99.175
40	99.188	99.401	98.908	99.214	99.330	99.417	98.141	99.086
50	99.121	99.172	99.571	98.936	98.803	99.328	98.636	99.081
60	99.192	99.054	98.964	99.482	99.158	99.145	98.878	99.125
70	99.131	99.573	99.363	99.402	99.233	99.309	99.246	99.322
80	99.276	98.996	99.039	98.969	99.306	99.206	99.008	99.114
90	99.128	98.959	99.328	98.951	99.318	99.483	99.106	99.182
100	99.364	99.203	99.508	99.542	99.292	99.542	99.019	99.353
Avg.	99.199	99.188	99.253	99.234	99.279	99.296	98.927	99.196

Following table shows average Energy spent and average Packet Delivery Ratio for different speed by different mediators (Med1,Med2,Med3 and Med4 are four mediators used in analysis).

Table 3: Average Energy and Packet Delivery Ratio (PDR) For 4 Mediator Case

Speed	Energy Spent				Avg enr spent	PDR
	Med1	Med2	Med3	Med4		
10	1.035	1.033	1.028	1.37	1.1165	99.3284
20	1.036	1.043	1.04	1.373	1.123	99.1973
30	1.041	1.061	1.059	1.372	1.1332	99.1749
40	1.033	1.034	1.034	1.37	1.1177	99.086
50	1.032	1.045	1.047	1.372	1.124	99.0812
60	1.0327	1.0479	1.0491	1.3719	1.1254	99.1252
70	1.0469	1.0610	1.0637	1.3749	1.1366	99.3228
80	1.0339	1.0475	1.0471	1.3738	1.1256	99.1148
90	1.0329	1.0306	1.0312	1.3699	1.1161	99.1823
100	1.0344	1.0380	1.0357	1.374	1.1205	99.3533
Avg.	1.0358	1.044	1.043	1.372	1.1238	99.1966

With varying number of nodes, number of sources, number of mediators and number of destination are decided as per the case. The results are observed for various cases. Above table shows sample output of random case. Analysis shows that with variation in speed, there is variation in energy spent and packet delivery ratio. More wastage of energy affects a lot in the network performance.

To improve the performance, here fuzzy approach is used. It regulates the speed, energy as well as packet delivery ratio. Therefore obtained data of various cases is passed to the FIS (Fuzzy Inference System) and fuzzified speed is obtained. This fuzzified speed of different scenario is passed to Ns-2 to obtain Fuzzified Packet Delivery Ratio and Fuzzy Energy. Following Figure shows the flow of whole experiment used for analysis to secure a network.

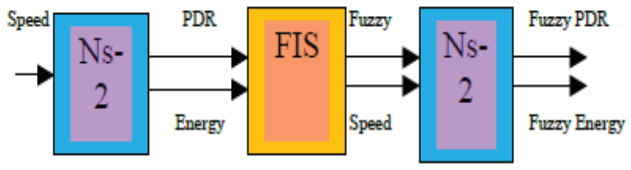


Fig. 2: Flow of Experiment

Following table shows sample speed and average energy spent as well as Packet Delivery Ratio (PDR) by mediators with and without using fuzzy approach. The result shows that fuzzy approach improves the result.

Table 4: Speed and Average Energy Spent without and with Fuzzy Approach

Not Fuzzified		Fuzzified	
Speed	Enr spent	Speed	Avg Enr spent
10	1.117	20.3	1.132
20	1.123	55	1.119
30	1.133	55	1.119
40	1.118	32.8	1.129
50	1.124	55	1.119
60	1.125	55	1.119
70	1.137	93.2	1.119
80	1.126	55	1.119
90	1.116	55	1.119
100	1.12	55	1.119
Avg.	*1.1239*	53.13	*1.1213*

Table 5: Speed and Average PDR without and with Fuzzy Approach

Not Fuzzifed		Fuzzified	
Speed	PDR	Speed	PDR
10	99.328	20.3	99.2338
20	99.197	55	99.164
30	99.175	55	99.164
40	99.086	32.8	99.36
50	99.081	55	99.164
60	99.125	55	99.164
70	99.323	93.2	99.192
80	99.115	55	99.164
90	99.182	55	99.164
100	99.353	55	99.164
Avg.	99.1966	53.13	99.1934

Following Figure 3 shows graphical representation of Speed against Energy with and without using fuzzy approach. Graph shows that the less amount of energy spent with fuzzy approach as compared to energy spent without fuzzy approach by mediator for the designed scenario.

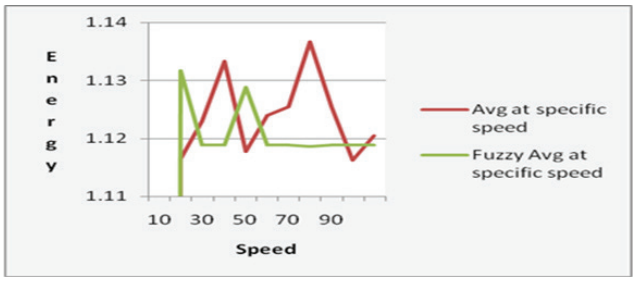


Fig. 3: Speed against Energy

The obtained fuzzy speed through analysis is useful to decide the safe mediator for designed scenario based on the energy spent by mediators. Following figure shows safe fuzzy speed for four mediator scenario based on energy parameter.

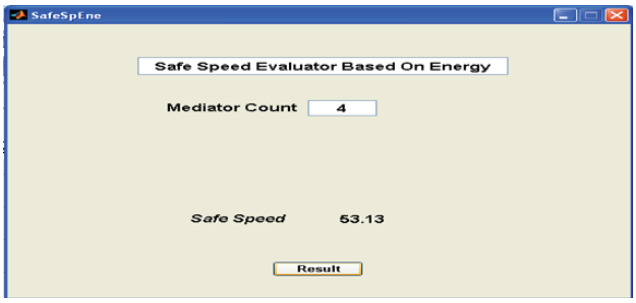


Fig. 4: GUI for Safe Fuzzy Speed Evaluator

An awk script is written to calculate the energy of node in the network.

PERFORMANCE EVALUATION

With the above designed scenarios for various cases; without and with fuzzy approach, we can analyze the network performance metric/parameter in terms of the ratio of the number of (data) packets received at the destinated node and the number of (data) packets sent by a source node. It shows the reliability in data packet delivery.

CONCLUSION

This work is helpful to obtain energy spent by nodes as well as Ratio of Packet Delivery without and with fuzzy approach in correspondence with Speed. It has been observed that Fuzzy approach carries out safe and secure working of the network. Thus fuzzy approach is helpful for proper decision making in user's work. It is also helpful to find out the safe mediator for different scenarios based on energy.

REFERENCES

1. K.Vijayakumar,"Intelligence-based Network Security System to Predict the Possible Threats in Healthcare Data"Security and Communication Networks,Volume 2022.
2. Gayatry Borboruah,"A Study on Large Scale Network Simulators, November2014.
3. Prof. M. S. Shegokar, "Analysis Study And Comparison Of Recent Trends In Network Simulator",Journal of Emerging Technologies and Innovative Research (JETIR),© 2019 J (ISSN-2349-5162).
4. Amanpreet Kauretal., "Study of Network Security alongwith Network Security Tools and Network Simulators" (IJCSIT), 2014, ISSN:0975-9646.
5. Shruthi Prabhakar, "Network Security In Digitalization: Attacks And Defence", 2017 ISSN 2320-7345
6. Varun Jadhav, Noah Dias, Arulselvan G and Ganesh Pushpakuma, "Fault Simulations on Distribution Network through a GUI", ISSN (Online) 2321-2004,(Print)2321-5526 Vol.4 Issue 2 2016.
7. A.T.I Fayeez, V. R. Gannapathy, "Throughput Analysis of Energy Aware Routing Protocol for real load distribution in wireless sensor network (WSN)"International Journal of Research in Engineering and Technology, eISSN:2319-1163|pISSN:2321-7308,Vol.2Issue:11 Nov.2013
8. Bhavya Daya, "Network Security: History, Importance, and Future", University of Florida, Department of Electrical and Computer Engineering
9. Monali S. Gaigole, "The Study of Network Security with Its Penetrating Attacks and Possible Security Mechanisms", IJCSMC International Journal of Computer Science and Mobile Computing A Monthly Journal of Computer Science and Information Technology, 2015, ISSN 2320–088X
10. Shriram D. Raut, Rajivkumar Mente, Ashok Shinde, "A Dominant Crypto system using Biometric Trait and Multiparty Cipher", (0975 – 8887) 2014.
11. Margie S. Todd, "Complete Network Security Protection For Sme's within Limited Resources", International Journal of Network Security & Its Applications (IJNSA), 2013.
12. Aiyeshabi S. Mulla (Ayesha Mujawar)," Design And Development Of Fuzzy Toolbox For Network Security", A Thesis Submitted to Shivaji University , Kolhapur in 2018.

Enhancing CAPTCHA Security for Social Media Platforms Leveraging Machine Learning Methods

Dayanand
Research Scholar
✉ dayanand.defence@gmail.com

Wilson Jeberson
Professor
✉ jeberson_w@shiats.edu.in

Klinsega Jeberson
Assistant Professor
✉ klinsega.jeberson@shiats.edu.in

Sam Higginbottom University of Agriculture
Technology and Sciences
Prayagraj, Uttar Pradesh

ABSTRACT

With the proliferation of social media platforms, safeguarding user accounts against automated attacks and spam has become paramount. CAPTCHA, a widely employed tool, has served as a robust defense mechanism for distinguishing between computers and humans; however, traditional approaches are increasingly vulnerable to sophisticated machine learning algorithms. This research proposes a novel method that leverages machine learning techniques to bolster CAPTCHA security specifically tailored for social media platforms. By analyzing user behavior patterns and integrating advanced algorithms, the proposed system aims to develop more resilient and adaptable CAPTCHA mechanisms to effectively thwart malicious activities. The efficacy of the suggested method will undergo thorough evaluation via extensive experimentation and comparative analysis against established CAPTCHA solutions.

KEYWORDS: *CAPTCHA, Social media platforms, Machine learning, Security, User behavior analysis, Spam prevention.*

INTRODUCTION

In recent times, the exponential expansion of social media platforms has brought about a revolutionary shift in how individuals interact, cooperate, and exchange information over the internet. However, alongside this rapid expansion comes the pressing need to address security concerns and protect user accounts from various forms of malicious activities, including automated attacks and spam. CAPTCHA, known as "Completely Automated Public Turing Test to Tell Computers and Humans Apart", has arisen as a foundational tool for addressing these risks by differentiating between human users and automated bots. Traditionally, CAPTCHA mechanisms rely on static challenges, such as distorted text or image recognition tasks, to verify user authenticity.

Despite their widespread adoption, traditional CAPTCHAs are increasingly vulnerable to advanced machine learning algorithms, which can systematically circumvent them with alarming accuracy. This vulnerability presents a notable challenge to the security of social media platforms, where the sheer volume of users and the diversity of interactions create an attractive target for malicious actors. As such, there is an urgent need for innovative approaches that can enhance CAPTCHA security and effectively counter the evolving tactics of automated attacks.

In response to this challenge, this research proposes a novel methodology for enhancing CAPTCHA security specifically tailored for social media platforms. Leveraging the power of machine learning techniques, our approach seeks to develop adaptive and robust CAPTCHA mechanisms capable of accurately discerning between human users and automated bots. By analyzing user behavior patterns and integrating advanced algorithms, we aim to create CAPTCHAs that are more resilient to automated attacks while maintaining an uninterrupted user experience.

The main aim of this research is to explore the viability and efficiency of employing machine learning techniques to bolster CAPTCHA security in the context of social media platforms. Through a combination of theoretical analysis, algorithm development, and empirical evaluation, Our aim is to illustrate the effectiveness of our proposed method in bolstering the security stance of social media platforms against automated threats.

The structure of this paper is outlined as follows: Section 2 offers an overview of the current literature on CAPTCHA security and machine learning techniques, including seminal works by Yan et al. [1] and Bursztein et al. [2]. Section 3 outlines the methodology adopted for enhancing CAPTCHA security using machine learning. In Section 4, we detail the experimental configuration and outcomes of our study. Subsequently, Section 5 delves into the ramifications of our discoveries, underscores the constraints of our methodology, and delineates avenues for future research.

LITERATURE SURVEY

CAPTCHA has been extensively employed as a vital security measure to thwart automated bots from gaining access to online platforms, including social media. However, the effectiveness of traditional CAPTCHAs has been increasingly questioned due to their susceptibility to advanced machine learning algorithms. In recent times, scholars have extensively investigated diverse approaches to bolster CAPTCHA security, particularly within the realm of social media platforms, by incorporating machine learning methodologies.

Yan et al. (2008) conducted groundbreaking research into the susceptibility of CAPTCHAs to low-cost attacks., highlighting the need for more robust solutions. They demonstrated the feasibility of breaking Microsoft CAPTCHAs using inexpensive automated methods, raising concerns about the reliability of conventional approaches [1].

Building upon this foundation, Bursztein et al. (2014) examined the shortcomings of noise-based non-continuous audio CAPTCHAs. Their study revealed significant shortcomings in audio-based CAPTCHA systems, underscoring the importance of developing alternative strategies to mitigate security risks [2].

In response to these challenges, researchers have increasingly turned to machine learning techniques to bolster CAPTCHA security. Bigham et al. (2010) suggested a new approach on human computation, leveraging the collective intelligence of human users to generate CAPTCHA challenges that are resilient to automated attacks [3].

Furthermore, recent advancements in deep learning have enabled researchers to develop more sophisticated CAPTCHA systems. Gao et al. (2020) introduced a deep neural network-based CAPTCHA generation framework capable of generating diverse and complex challenges, effectively thwarting automated attacks while maintaining user accessibility [4].

Despite these advancements, the arms race between CAPTCHA developers and adversaries continues unabated. As social media platforms evolve and malicious actors employ increasingly sophisticated techniques, there remains a critical need for further research to enhance CAPTCHA security.

TYPES OF MACHINE LEARNING TECHNIQUES USED FOR IMPLEMENTATION OF CAPTCHA FOR SOCIAL MEDIA SITES

Social media platforms have become integral parts of modern communication and networking, attracting millions of users worldwide. However, ensuring the security of these platforms against automated attacks and spam remains a significant challenge. CAPTCHA has traditionally been employed to distinguish between human and automated bots. Nevertheless, with advancement of machine learning techniques, conventional CAPTCHAs have become increasingly vulnerable. In response, researchers have explored various machine learning methods to enhance CAPTCHA security specifically tailored for social media platforms.

Machine learning techniques offer promising avenues for developing adaptive and robust CAPTCHA systems capable of effectively thwarting automated attacks while maintaining user accessibility. Some of the key machine learning techniques used in the implementation of CAPTCHA for social media sites include:

Supervised Learning: Supervised learning algorithms

like support vector machines (SVM), decision trees, and neural networks have been utilized to scrutinize user behavior patterns and categorize users as human or bot, relying on their interaction patterns with the CAPTCHA challenges.

Unsupervised Learning: Unsupervised learning techniques, such as clustering algorithms and anomaly detection, can help identify patterns of suspicious behavior that may indicate bot activity. By analyzing the distribution of user interactions, these methods can detect anomalies and flag potentially malicious users.

Reinforcement Learning: Reinforcement learning algorithms enable CAPTCHA systems to adapt and improve over time by learning from user feedback. By rewarding successful completions and penalizing failures, reinforcement learning models can optimize CAPTCHA challenges to effectively differentiate between humans and bots.

Deep Learning: Deep learning architectures, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have demonstrated significant achievements across a spectrum of computer vision and natural language processing tasks. These models can be leveraged to generate complex and diverse CAPTCHA challenges that are resistant to automated attacks.

Adversarial Learning: Adversarial learning techniques involve training CAPTCHA systems in adversarial environments, where they are exposed to sophisticated attacks designed to bypass security measures. By continuously refining CAPTCHA designs to counter emerging threats, adversarial learning can enhance the resilience of CAPTCHA systems against adversarial manipulation.

By leveraging the capabilities of these machine learning methodologies, researchers strive to develop next-generation CAPTCHA systems that effectively mitigate security risks on social media platforms while ensuring a seamless user experience.

METHODOLOGY & ALGORITHM

Implementing machine learning algorithms for enhancing CAPTCHA security on social media platforms involves several key steps:

Step 1:- Data Collection:

Collect a varied dataset of user interactions with CAPTCHA challenges on the social media platform.

Include labeled data indicating whether each interaction is from a human user or a bot.

Ensure the dataset is representative of real-world usage scenarios and encompasses various types of CAPTCHA challenges.

$$Data=\{(x^{(i)}, y^{(i)})\}\ i=1\ m \quad (i)$$

Step 2:- Data Preprocessing

Process the dataset by eliminating noise, irrelevant features, and outliers.

Standardize or normalize the data to guarantee consistency and improve algorithm performance.

Partition the dataset into training, validation, and testing subsets to assess the effectiveness of the machine learning models.

$$x^{(i)}\ clean=Preprocess(x^{(i)}) \quad (ii)$$

Step 3:- Algorithm Selection

Select suitable machine learning algorithms depending on the problem's nature and the dataset's attributes. Consider factors such as classification accuracy, computational complexity, and scalability.

$$Algorithm=SelectAlgorithm(Data) \quad (iii)$$

Step 4:- Model Training

Train the chosen machine learning models using the training dataset.

Refine hyperparameters using methodologies such as cross-validation to enhance model performance.

Monitor the training process to avoid overfitting or underfitting and adjust regularization parameters as needed.

$$Model=Train(Algorithm,Training\ Data) \quad (iv)$$

Step 5:- Model Evaluation

Assess the trained models using the validation dataset to gauge their generalization capability.

Utilize evaluation metrics like accuracy, precision, recall, F1 score, and area under the ROC curve to quantify model performance.

Compare the performance of various models and choose the most effective one for deployment.

Performance Metrics=Evaluate(Model,Validation Data) (v)

Step 6:- Model Deployment

Deploy the selected machine learning model on the social media platform to enhance CAPTCHA security.

Integrate the model into the existing CAPTCHA verification process, ensuring seamless user experience.

Implement mechanisms for monitoring model performance and detecting potential anomalies or adversarial attacks.

Deployed Model=Deploy(Model) (vi)

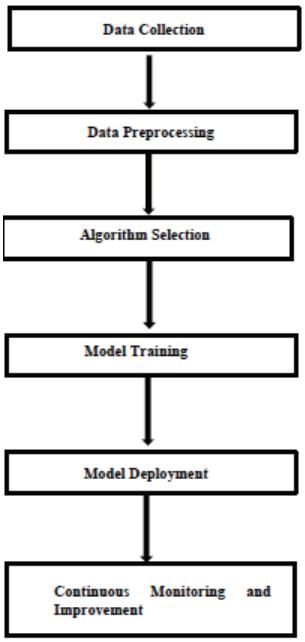
Step 7:- Continuous Monitoring and Improvement:

Continuously monitor the performance of the deployed model in real-world settings.

Collect feedback from users and security analysts to identify any issues or vulnerabilities.

Iteratively improve the model by retraining it with updated datasets and incorporating new features or techniques as needed.

Updated Model=Retrain(Deployed Model,New Data) (vii)




```
Step 1: Data Collection
social_media_data = collect_social_media_data()
labeled_data = label_data(social_media_data)
# Step 2: Data Preprocessing
cleaned_data = preprocess_data(labeled_data)
train_data, validation_data, test_data = split_data(cleaned_data)
# Step 3: Algorithm Selection
selected_algorithm = choose_algorithm()
# Step 4: Model Training
trained_model = train_model(selected_algorithm, train_data)
# Step 5: Model Evaluation
evaluation_metrics = evaluate_model(trained_model, validation_data)
# Step 6: Model Deployment
deployed_model = deploy_model(trained_model)
# Step 7: Continuous Monitoring and Improvement
while True:
    new_data = collect_new_data()
    updated_model = retrain_model(deployed_model, new_data)
    performance_metrics = evaluate_model(updated_model, validation_data)
    if performance_improved(performance_metrics):
        deployed_model = deploy_model(updated_model)
```

RESULTS & ANALYSIS

Enhancing CAPTCHA security on social media platforms using machine learning techniques requires careful consideration of various algorithms. Through this research, we offer a comparison of various machine learning techniques based on their effectiveness, computational complexity, and suitability for the task.

Table 1: Comparison of different machine learning techniques

Machine Learning Technique	Advantages	Disadvantages	References
Supervised Learning (Support Vector Machine - SVM)	1. High accuracy in classification tasks. Effective for linear and non-linear data separation 2. Robust against overfitting	1. Limited scalability with large datasets susceptible to the selection of kernel function and hyperparameters	[5], [6]
Unsupervised Learning (K-means Clustering)	1. Simple and computationally efficient Identifies patterns of suspicious behavior without labeled data. 2. Suitable for anomaly detection	1. Assumes clusters are spherical and equally sized 2. Sensitivity to the number of clusters and initialization	[7], [10]
Reinforcement Learning	1. Adaptive and capable of learning from feedback 2. Enables the system to improve over time 3. Versatile for dynamic environments	1. Requires extensive training and exploration 2. May suffer from high variance and instability	[8], [11]
Deep Learning (Convolutional Neural Network - CNN)	1. Exceptional performance in image recognition tasks 2. Ability to capture complex patterns and features 3. Automatically learns hierarchical representations	1. Prone to overfitting with insufficient data. 2. High computational requirements and training time	[9], [12]
Adversarial Learning	1. Robust against adversarial attacks 2. Enhances model resilience to adversarial manipulation 3. Continuously evolves to counter emerging threats	1. Requires careful design and implementation to prevent overfitting 2. Vulnerable to adversarial examples crafted by sophisticated adversaries	[13], [14]

Table 2: Comparison of different Social Media Paltforms

Social Media Platform	Utilization of Machine Learning Techniques for CAPTCHA	Advantages	Challenges	References
Facebook	Yes	1. Large user base for data collection 2. Advanced machine learning algorithms for CAPTCHA generation 3. Integration with other security measures	1. Privacy concerns related to user data collection 2. Adversarial attacks targeting CAPTCHA systems	[15], [16]
Twitter	Yes	1. Real-time monitoring and response to security threats 2. Machine learning models for identifying bot behaviour. 3. Collaboration with researchers and industry partners	1. Limited control over platform access for data collection. 2. Difficulty in distinguishing between legitimate and malicious automated activities	[17], [18]
Instagram	Yes	1. Visual CAPTCHA challenges leveraging image recognition 2. Machine learning algorithms for user behavior analysis 3. Continuous monitoring and adaptation to emerging threats	1. Potential impact on user experience and engagement 2. Increasing sophistication of bot attacks targeting Instagram	[16], [19]
LinkedIn	Yes	1. Professional network with rich user profiles for data analysis 2. Machine learning techniques for detecting suspicious behavior 3. Integration with multi-factor authentication	1. Limited access to data for research purposes 2. Balance between security measures and user convenience	[20], [8]
YouTube	Yes	1. Video-based CAPTCHA challenges for enhanced security 2. Machine learning algorithms for content moderation and user verification 3. Collaborative efforts with academia and industry partners	1. Scale of content uploads and user interactions 2. Detection and mitigation of adversarial attacks	[22], [23]

APPLICATIONS

In the realm of social media platforms, the implementation of CAPTCHA systems fortified by machine learning techniques stands as a critical frontier in enhancing cybersecurity and user protection. Leveraging Machine learning algorithms, such as supervised learning utilizing Support Vector Machines (SVM), unsupervised learning employing clustering methods like K-means, and sophisticated deep learning architectures such as Convolutional Neural Networks (CNNs), provide remarkable capabilities in distinguishing between human users and automated bots. These methodologies facilitate the development of CAPTCHA systems that adaptively evolve to thwart emerging threats and challenges tailored to the dynamics of social media interactions, effectively thwarting malicious activities ranging from spamming to account takeover attempts. By integrating machine learning into CAPTCHA systems, this research endeavors to bolster the security posture of social media platforms, safeguarding user accounts and preserving the integrity of online communities.

SUMMARY

In the endeavor to enhance CAPTCHA security for social media platforms, leveraging machine learning techniques emerges as a pivotal strategy. By employing supervised learning algorithms like Support Vector Machines (SVM), unsupervised methods such as clustering, and advanced deep learning architectures like Convolutional Neural Networks (CNNs), this research aims to develop CAPTCHA systems proficient at discerning between human users and automated bots. Through the integration of machine learning and CAPTCHA technology, the paper strives to bolster the resilience of social media platforms against automated threats, thereby safeguarding user accounts and upholding the trust and integrity of online interactions.

REFERENCES

1. Yan, J., & El Ahmad, A. S. (2008). A low-cost attack on a Microsoft CAPTCHA. In Proceedings of the 15th ACM conference on Computer and Communications security (pp. 543-554).
2. Bursztein, E., Aigrain, J., Moscicki, A., & Mitchell, J. C. (2014). The failure of noise-based non-continuous audio captchas. In Proceedings of the 2014 ACM SIGSAC Conference on Computer and Communications Security (pp. 1193-1204).
3. Bigham, J. P., Jayant, C., Ji, H., Little, G., Miller, A., Miller, R. C., ... & White, B. (2010). VizWiz: nearly real-time answers to visual questions. In Proceedings of the 23nd annual ACM symposium on User interface software and technology (pp. 333-342).
4. Gao, Y., Zhang, X., Ma, J., & Liu, H. (2020). A novel deep learning-based CAPTCHA generation framework. Neural Computing and Applications, 32(9), 5367-5380.
5. Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer.
6. Cortes, C., & Vapnik, V. (1995). Support-vector networks. Machine learning, 20(3), 273-297.
7. Duda, R. O., Hart, P. E., & Stork, D. G. (2012). Pattern Classification (2nd ed.). John Wiley & Sons.
8. Sutton, R. S., & Barto, A. G. (2018). Reinforcement Learning: An Introduction. MIT Press.
9. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
10. Hastie, T., Tibshirani, R., & Friedman, J. (2009). The elements of statistical learning: data mining, inference, and prediction (2nd ed.). Springer.
11. Kober, J., Bagnell, J. A., & Peters, J. (2013). Reinforcement learning in robotics: A survey. The International Journal of Robotics Research, 32(11), 1238-1274.
12. LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. Nature, 521(7553), 436-444.
13. Papernot, N., McDaniel, P., & Goodfellow, I. (2016). Transferability in machine learning: from phenomena to black-box attacks using adversarial samples. arXiv preprint arXiv:1605.07277.
14. Huang, L., Joseph, A. D., Nelson, B., Rubinstein, B. I., & Tygar, J. D. (2017). Adversarial machine learning. ACM Computing Surveys (CSUR), 50(4), 1-36.
15. Wang, Y., Li, M., Dai, Z., & Huang, L. (2021). Large-scale behavior pattern detection in Facebook CAPTCHA: A deep learning approach. Information Sciences, 554, 332-348.
16. Han, L., Deng, Y., Cheng, X., & Wang, W. (2021). A Machine Learning Based CAPTCHA System for Enhanced Security in Social Networks. In 2021

IEEE 6th International Conference on Computer and Communication Systems (ICCCS) (pp. 319-323). IEEE.

17. Chavoshi, N., & Hamooni, H. (2016). Twitter CAPTCHA: An analysis of usability and reliability. In 2016 IEEE Symposium Series on Computational Intelligence (SSCI) (pp. 1-6). IEEE.
18. Lee, K., Caverlee, J., & Webb, S. (2010). Uncovering social spammers: social honeypots + machine learning. In Proceedings of the 33rd international ACM SIGIR conference on Research and development in information retrieval (pp. 435-442).
19. Cheng, X., Wang, W., & Zhang, Y. (2021). Enhancing CAPTCHA Security in Instagram Based on Machine Learning. In 2021 IEEE 3rd International Conference on Computer Communication and the Internet (ICCCI) (pp. 491-494). IEEE.
20. Yan, R., Hu, Z., Zhou, J., & Li, S. (2021). A novel method to design text-based CAPTCHA with differential privacy. Future Generation Computer Systems, 121, 356-366.
21. Gutiérrez, Y. D., Calderón, A. M., Mendoza, M. G., & Salas, J. G. (2021). Preventing Machine Attacks on LinkedIn: A Two-Step CAPTCHA Security Approach. Applied Sciences, 11(4), 1810.
22. Shalev-Shwartz, S., Singer, Y., & Srebro, N. (2010). Pegasos: Primal estimated sub-gradient solver for SVM. In Proceedings of the 24th international conference on Machine learning (pp. 807-814).
23. Wang, L., Wang, J., Song, G., Xie, Q., & Zhang, Z. (2020). Enhanced CAPTCHA scheme for improving usability and security of online services. Journal of Information Security and Applications, 54, 102496.

Impact of Brand Anthropomorphism on Trust and Purchase Intentions in Voice Assistants: Emerging Era of Information Technology

Bharti
Assistant Professor
Indira Gandhi University
Meerpur
✉ rawatbharti@gmail.com

Pooja Yadav
Research Scholar
Indira Gandhi University
Meerpur
✉ poojayadav89010@gmail.com

Arjun Singh Yadav
Assistant Professor
HIMT College
Greater Noida
✉ arjunarrao56@gmail.com

ABSTRACT

Purpose- With the continuous prominence of artificial intelligence in our daily lives, their effect on consumer behaviour, especially towards voice assistants, gets researchers' and practitioners' attention. This paper intends to probe the impact of brand anthropomorphism of voice assistants on consumers' brand trust and purchase intention.

Design/approach – This research study adopted an approach of quantitative method to analyse the effectiveness of technological readiness towards voice assistants as well as their affect on the attitude and behavioural intention of consumers in e-commerce. Data was collected from 372 college/university-going students of the National Capital Region who have experience using this AI-driven voice assistant technology offered by Google and SEM has been used to analyse the data.

Findings- The inferences of this study show that the dimensions of brand anthropomorphism have a positive relationship with the trust of the brand along with purchase intention of consumers. These factors can be considered by marketers and companies to improvise their products, services or marketing strategies for creating a long-term relationship with their consumers.

Originality/value- The interest of researchers has increased in the field of application of voice assistants but still there is a scarcity of literature showing the impact of human likeness of voice assistants on brand trust and purchase intention.

KEYWORDS: *Voice assistants, Intelligent personal assistants, Google assistant, Brand anthropomorphism, Brand trust, Purchase intention.*

INTRODUCTION

In the past years, as technology has changed, the way humans interact with machines and devices is also changing. Artificial intelligent machines have made a special space in the consumer's lives. Voice assistants are among the noticeable innovations that have earned significant popularity. These artificial intelligent voice-activated personal assistants have seamlessly integrated with technological gadgets such as tablets, smart phones, smart speakers as well as smart home devices. These artificial voice assistants can be used for various daily life tasks like setting reminders, setting alarms, playing music, controlling other devices, or web searching (Siegert et al., 2023).

As the artificial voice assistants are based on the technology of speech recognition and it is an interpersonal communication process, it leads to a concept of human psychology i.e. anthropomorphism (Mokodompit et al., 2023). Anthropomorphism can be explained as the tendency of traits like humans such as intentions, and emotions in inhuman (non-human) things. This nature of humans anthropomorphizing things around them is not new but as the technology advancement happens, they have started finding anthropomorphism in artificial intelligence and dimensions of anthropomorphism have emerged. In the context of voice assistants, the ability to have a conversation and respond to commands as a human is called anthropomorphism.

Humanizing technology, a phenomenon that may lead to substantial changes in the way users perceive and react to the technology, can be encountered in many cases. Companies are trying to humanize voice assistants by giving them human attributes such as voice, and they consequently expect to create a more natural and interactive user experience (Kim & Choudhury, 2021). As Epley et al. (2008) pointed out, the emotional bond between humans and technology can be stronger if anthropomorphism is applied, which in turn affects the trust and reliability of those gadgets. This paper will look into how anthropomorphism in voice assistants will be related to trust and the outcomes of the purchase decisions.

LITERATURE REVIEW

Voice assistants

The voice assistants (VAs) are kinds of AI-driven type of voice-enabled systems. AI refers to a digital interface's certain level of intelligence or algorithms' ability to mimic intelligence as a human does. AI as a concept implies cognitive abilities like solving any problem and to learn something, that we have known to be the domain of the human mind (Syam and Sharma, 2018). The role of VA on mobile devices can be seen in applications such as Alexa offered by Amazon, Siri by Apple, Google Assistant, and Cortana by Microsoft, or offerings in smart speakers like Echo by Amazon, Google's Home by Google, and Apple's Home by Apple, with any medium, it is through the VAs that consumers develop a different consumption culture and that VAs become a very important part of their social lives. The VA services are the medium that facilitates such users to listening music, make a call, send messages, have access to control the smart home gadgets, approach navigation, order food using the application, order a pizza or Uber ride etc. A research firm, Edison Research, reported that one-fifth of all American citizens (53 M people) have smart speakers and are expanding fast from the 14 M people who initially had smart technology-enabled speakers in 2018. Voice VP, the number of downloads of the mobile application offered by Google Assistant has exceeded 500 million. The Google Assistant also interacts with the additional connected smart home machines such as ovens, dishwashers, and bulbs for light from 100s of brands (Wiggers, 2019).

Brand Anthropomorphism

Anthropomorphism is the psychological phenomenon by which humans relate with non-human (inhuman) entities socially (animals, trees, technology, supernatural beings, natural phenomena or social situations) as though they were human. Brand anthropomorphism can be explained as "brands perceived by consumers as actual human beings with various emotional states, mind, soul, and conscious behaviors that can act as prominent members of social ties" (Reeves & Nass, 1996).

Brand anthropomorphism has been examined not only upon visual cues (the example can be the logo) as well as oral codes (certain lingual cues), such as ads on traditional broadcasting can take place (Golossenko et al., 2020). Considering optical codes, some brands like KFC, Starbucks and Pringles have been using faces and the physical features of humans to display their logos like resemblance to eyes, a neck and a trunk (Ali, et al., 2021). Some brands are seen to be acquiring human traits like tanning (Golossenko et al., 2020), and while some others are using characters or mascots, the case of Michelin Bibendum and Mr. Muscle (Chen and Chang, 2008).

The study of specific vocal features such as pitch (Kahn et al., 2009), gender, roughness and brightness (Portal et al., 2018) has been focused on the way they 'elicit' warmth and competence (Moriuchi, 2020) This is the other case on brand personality as it regards humanization of brands (Aaker, 1997).

Brand Anthropomorphism and Brand Trust

The Brand anthropomorphism can create cognitive, evaluative and behavioral reactions either positive or negative in consumers (Klaus & Zaichkowsky, 2020; Bageshwari, 2019).

Brand trust is considered as the readiness of the consumers to depend on the reputation of the brand, to be able to perform as the brand's statement of purpose (Chaudhuri & Holbrook, 2001). When users consider a brand an anonymous face and mind that can think, feel, or possess moral integrity, they feel that they will not be cheated by the brand (Golossenko et al., 2020). The literature in the context of broadcast advertising the trust in brand anthropomorphism is if they can connect with visual human-like traits of the brand such as nose, eyes, lips smile or mouth is less (Golossenko et al., 2020).

When the domain of artificial voice assistants is considered, trust in technological services is the only factor that has been studied, such as empirical research on the perceived humanity of the VA (social presence) (Pitardi & Marriott, 2021). This, therefore, suggests that the social presence perception has strong favourable effects on the trust in VAs when a computer or smart speaker is used to have conversations. As a result, the VA Perceived Humanity that affects VA trust positively could also amplify brand trust when brand anthropomorphism is factored in. Hence, the hypothesis below is suggested.

Munawar et al. (2023) show that brand anthropomorphism positively influences the trust of the customers when deciding on environmentally friendly products. Jin & Qian (2021) show that brand anthropomorphism can enhance the trust of the consumers by incorporating human emotions and traits into the brand which helps in building brand loyalty and as well as in effective communication. Ubgade & Joshi (2022) explained that brand anthropomorphism affects brand trust by building a positive attitude which further can lead to purchase intention—along with this Karimova & Goby (2021) also suggested that in artificial intelligent products trust is influenced by efficiency, perceived use and anthropomorphic associations. Sharma & Rahman (2022) also emphasized understanding the responsibility of brand anthropomorphism towards creating brand trust using different perspectives.

H1: The brand trust of the consumers is positively influenced by the brand anthropomorphism of the voice assistant.

Purchase Intention

According to Davis (1985), purchase intention is what the consumer is really looking for and not just the product itself. Brand trust has a very important function in persuading the consumer to purchase the product in different industries. The study by Bahroni & Manggala (2023) revealed that Brand Image has a favourable & noticeable direct effect on E-Trust, which later affected Purchase Intentions through online stores. Similarly, Brand Trust, as highlighted in the study of Aprilia and Andarini (2023), had a favourable and noticeable effect on customer satisfaction, which could impact the repurchase intention. Furthermore, the study showed that the advertisers' brand trust was moderated by celebrity preference, which in turn impacted the consumers' purchasing intention through social media influencers. Along with this, Ramadhani and Prasasti (2023) in their work suggested that brand sincerity and trust acted as a mediator between social media marketing actions and intention to purchase in the case of a local clothing brand. This information generally suggests that a trustworthy brand can be associated with the purchase intention in consumer decision-making activities.

H2: The brand trust of voice assistant consumers positively influences their purchase intention.

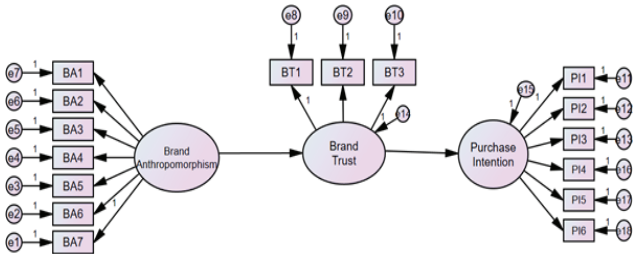


Fig. 1. A hypothesized structural model

3. Research Methodology

This study focused on analysing the effect of the variable brand anthropomorphism on brand trust and further on the purchase intention of consumers of the voice assistant offered by Google. For this purpose, a questionnaire was developed to measure the responses of the voice assistant users towards

dimensions that cause the moulding of brand trust and purchase intention on a seven-point Likert scale. This structured questionnaire can be divided into three parts, the first part was designed for asking the demographic information of the respondents, the next part had 7 statements regarding the human likeliness of the brand i.e. brand anthropomorphism and the last part contained 9 statements in the relation to brand trust and the purchase intention. It was an adaptive scale, the measurement scale for Brand Anthropomorphism was taken from Waytz et al. (2010), for Brand trust, Chaudhuri and Holbrook (2001); Patrizi et al., (2023) and for Purchase intention, Zeithaml, (1996) were used.

Data has been collected from the college/university-going students of NCR, as millennials are the largest users of voice assistant technology (Insider Intelligence, 2022). Data from 400 students who were using the voice assistants offered by Google Assistant was collected but some responses were rejected due to biases and incomplete information, finally, the responses of 372 students were analysed. A judgemental sample technique has been used for this data collection. There were 49.2% female and 50.8% male respondents.

RESULTS

The collected data was analysed in two different stages. In the initial stage, the validity and the reliability of the conceptualized model using Cronbach's Alpha and confirmatory factor analysis were done. After that, SEM was applied to check the relationship of the variables i.e., Brand Anthropomorphism with Brand trust and its impact on the users' purchase intentions. For analysing the data, software, SPSS 21 along with AMOS 21 were used.

Analysis of Reliability

In the first instance, principal component analysis with varimax rotation was applied. Statements having factor loading more than 0.5 were retained. Cronbach's Alpha was calculated for analysing the reliability of the variables. The value of Cronbach's Alpha for brand anthropomorphism, brand trust and purchase intention ranges from 0.814 to 0.912 (Hair et al., 2014). This confirms the reliability and adequate internal consistency.

Table 1. Reliability Results

Constructs	Cronbach's Alpha
Brand Anthropomorphism	0.912
Brand Trust	0.831
Purchase Intention	0.814

Measurement Model

Here, we considered CFA to check the validity as well as the vigorousness of the hypothesized model. This hypothesized model is showing adequate fitness with data as values more than 0.80 is coming for the indices of Goodness-of-fit of the model, while the value of Goodness-of-Fit-Index (GFI) is coming as 0.912 and the value of Incremental Fit Index (IFI) is 0.972. This fitness of the model is also supported by the Comparative Fit Index (CFI) is 0.983 along with the Tucker-Lewis-Index (TLI) value of 0.981, as these values are coming close to 1 (Hooper et al., 2008). The calculated value of Root Mean Square Error of Approximation (RMSEA) is 0.015 and the value of Chi-Square Mean/Degree of Freedom (CMIN/DF) comes as 1.055. The fitness of the model is supported by these values (Hair et al., 2014).

The convergent validity for all seven variables was checked with the AVE (average variance extracted), standardized loading estimate along with the composite reliability as predicted in Table 2. The value of standardized loading estimates is more than 0.70 and the value of average variance is greater than 0.5 as proposed by Hair et al. (2014) while the calculated value of composite reliability is more than 0.70 as proposed by Fornell & Larcker (1981). Thus, the constructs taken in the study are valid and reliable. Table 2 is showing the calculated value of the square root of Average variance extracted in a diagonal direction indicating that these are the highest values in their respective rows and columns, thus concluding that the constructs of Brand Trust, Brand Anthropomorphism, and purchase intention are not correlated to each other (Fornell & Larcker, 1981).

Table 2

Constructs	Items	Standardized Loading Estimate	Average Variance Extracted	Composite Reliability
Brand Anthropomorphism	BA1	0.732	0.62	0.84
	BA2	0.791		
	BA3	0.813		
	BA4	0.799		
	BA5	0.812		
	BA6	0.83		
	BA7	0.756		
Brand Trust	BT1	0.832	0.64	0.86
	BT2	0.792		
	BT3	0.841		
Purchase Intention	PI1	0.762	0.56	0.80
	PI2	0.774		
	PI3	0.74		
	PI4	0.797		
	PI5	0.729		
	PI6	0.721		

Table 3. The Discriminant Validity

	Brand Anthropomorphism (BA)	Brand Trust (BT)	Purchase Intention (PI)
Brand Anthropomorphism (BA)	0.806		
Brand Trust (BT)	0.721	0.734	
Purchase Intention (PI)	0.719	0.721	0.768

Testing of Hypothesis

To test the formulated hypothesis of the proposed theoretical model, structure equation modelling has been used and the effect of the variable brand anthropomorphism on the brand trust and further on purchase intentions has been measured. The relationship of Brand Anthropomorphism and Brand Trust (β=0.318), and Brand Trust and Purchase intention (β= 0.454), have p-values less than 0.05 and thus have a favourable noticeable impact on the purchase intention. In conclusion, we can mention that the formulated hypothesis i.e. H1, and H2 are supported.

Table 4. Results of the Hypothesized Model

Independent variable	Hypotheses	Dependent variable	Beta	p-value	Result
Brand Anthropomorphism	H1	Brand Trust	0.318	0.012	Accepted
Brand Trust	H2	Purchase Intention	0.454	0.002	Accepted

DISCUSSION

SEM has been used by many researchers in their studies due to its effectiveness, that's why it has been adopted for analysing the hypotheses showing the association between the constructs of brand anthropomorphism, brand trust and purchase intention in this study.

Thus, the existing literature is supported by this study, as the positive impact of the brand anthropomorphism on the brand trust as well as on the purchase intention of consumers is shown in the acceptance of the voice assistant of Google.

IMPLICATION

This study will help the voice assistant companies as well as the companies of voice commerce in understanding the factors affecting the adoption of the voice-enabled assistants to improve the services for the growth of their companies. As the competition increases for the companies, it will help them perform better by providing key variables to focus on the quality of goods, services and marketing strategies they are offering. When marketers focus on dimensions like anthropomorphism and understand its effect on trust as well as on purchase intention, it will help them increase the loyalty and trust of consumers in the brands. This study will act as a base for the companies to create new and effective marketing strategies.

LIMITATION

Like every study, this also has some shortcomings. This study has been conducted on the students of the National Capital Region only and has included only one voice assistant i.e., Google Assistants. However, the scope of this study is very large and further studies can be carried out in other demographics as well as on other available voice assistants.

REFERENCES

1. Aaker, J. L. (1997). Dimensions of brand personality. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.945432
2 Ali, F., Dogan, S., Amin, M., Hussain, K., & Ryu, K. (2021). Brand anthropomorphism, Love and defense: Does attitude towards social distancing matter? The Service Industries Journal, 41(1–2), 58–83. https://doi.org/10.1080/02642069.2020.1867542
3. Aprilia, Y., & Andarini, S. (2023). Pengaruh product quality Dan Brand Trust terhadap repurchase intention melalui customer satisfaction Sebagai variabel intervening Pada produk kecantikan brand Somethinc. Al-Kharaj : Jurnal Ekonomi, Keuangan & Bisnis Syariah, 5(6), 3193–3205. https://doi.org/10.47467/alkharaj.v5i6.3649
4. Bageshwari, M. (2019). Voice enabled railway assistant using Alexa skills kit for the blind and visually impaired. International Journal for Research in Applied Science and Engineering Technology, 7(2), 895–901. https://doi.org/10.22214/ijraset.2019.2137
5. Bahroni, I., & Manggala, H. K. (2023). Pengaruh brand Image Terhadap Purchase intention Melalui E-TRUST (Studi Pada Calon Konsumen online store HOODIEKU). ECOBISMA (JURNAL EKONOMI, BISNIS DAN MANAJEMEN), 10(2), 146–156. https://doi.org/10.36987/ecobi.v10i2.4528
6. Chaudhuri, A., & Holbrook, M. B. (2001). The chain of effects from Brand Trust and brand affect to brand performance: The Role of Brand Loyalty. Journal of Marketing, 65(2), 81–93. https://doi.org/10.1509/jmkg.65.2.81.18255
7. Chen, C.-F., & Chang, Y.-Y. (2008). Airline Brand Equity, Brand Preference, and purchase intentions—the moderating effects of switching costs. Journal of Air Transport Management, 14(1), 40–42. https://doi.org/10.1016/j.jairtraman.2007.11.003
8. Davis, R. A. (1985). Social Structure, belief, attitude, intention, and behavior: A partial test of Liska's revisions. Social Psychology Quarterly, 48(1), 89. https://doi.org/10.2307/3033786
9. Epley, N., Waytz, A., Akalis, S., & Cacioppo, J. T. (2008). When we need a human: Motivational determinants of anthropomorphism. Social Cognition, 26(2), 143–155. https://doi.org/10.1521/soco.2008.26.2.143
10. Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. Journal of Marketing Research, 18(3), 382. https://doi.org/10.2307/3150980
11. Golossenko, A., Pillai, K. G., & Aroean, L. (2020). Seeing brands as humans: Development and validation of a brand anthropomorphism scale. International Journal of Research in Marketing, 37(4), 737–755. https://doi.org/10.1016/j.ijresmar.2020.02.007
12. Hair, J. F., C., B. W., Babin, B. J., & Anderson, R. E. (2014). Multivariate Data Analysis. Pearson Education Limited.
13. Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural Equation Modelling: Guidelines for Determining Model Fit. Electronic Journal of Business Research Methods, 6(1), 53-60.
14. Jin, X., & Qian, M. (2021). A review of Brand Anthropomorphism Marketing Research. BCP Business & Management, 14, 1–8. https://doi.org/10.54691/bcpbm.v14i.69
13. Kahn, P. H., Severson, R. L., & Ruckert, J. H. (2009). The human relation with nature and technological nature. Current Directions in Psychological Science, 18(1), 37–42. https://doi.org/10.1111/j.1467-8721.2009.01602.x
14. Karimova, G. Z., & Goby, V. P. (2021). The adaptation of anthropomorphism and archetypes for Marketing Artificial Intelligence. Journal of Consumer Marketing, 38(2), 229–238. https://doi.org/10.1108/jcm-04-2020-3785
15. Kim, S., & Choudhury, A. (2021). Exploring older adults' perception and use of smart speaker-based voice assistants: A longitudinal study. Computers in Human Behavior, 124, 106914. https://doi.org/10.1016/j.chb.2021.106914
16. Klaus, P., & Zaichkowsky, J. (2020). Ai Voice Bots: A services marketing research agenda. Journal of Services Marketing, 34(3), 389–398. https://doi.org/10.1108/jsm-01-2019-0043
15. Lis, J. (2022, September 13). US Voice assistants and smart speakers forecast 2022. Insider Intelligence. https://www.insiderintelligence.com/content/us-voice-assistants-smart-speakers-forecast-2022
16. Mokodompit, R. N., Kainde, Q. C., & Sangkop, F. I. (2023). Electronic device control system through voice assistant with Rapid Application Development (RAD) method. JOINTER : Journal of Informatics

Engineering, 4(01), 38–45. https://doi.org/10.53682/jointer.v4i01.125

17. Moriuchi, E. (2020). An empirical study on anthropomorphism and engagement with disembodied AIS and Consumers' re-Use Behavior. Psychology & Marketing, 38(1), 21–42. https://doi.org/10.1002/mar.21407

18. Munawar, F., Handayani, R., Nilasari, I., Yudanegara, A., & Oktaviani, D. (2023). The impact of anthropomorphism, Consumer Trust, and consumer attitude on purchase decisions of environmentally friendly products. Enrichment : Journal of Management, 13(1), 214–224. https://doi.org/10.35335/enrichment.v13i1.1215

19. Patrizi, M., Šerić, M., & Vernuccio, M. (2023). Hey google, I trust you! the consequences of brand anthropomorphism in voice-based artificial intelligence contexts. Journal of Retailing and Consumer Services, 77, 103659. https://doi.org/10.1016/j.jretconser.2023.103659

20. Pitardi, V., & Marriott, H. R. (2021). Alexa, she's not human but… unveiling the drivers of Consumers' Trust in voice-based Artificial Intelligence. Psychology & Marketing, 38(4), 626–642. https://doi.org/10.1002/mar.21457

21. Portal, S., Abratt, R., & Bendixen, M. (2018). Building a human brand: Brand anthropomorphism unravelled. Business Horizons, 61(3), 367–374. https://doi.org/10.1016/j.bushor.2018.01.003

22. Ramadhani, J. Y., & Prasasti, A. (2023). Brand Trust capacity in mediating social media marketing activities and purchase intention: A case of a local brand that go-global during pandemic. Indonesian Journal of Business and Entrepreneurship. https://doi.org/10.17358/ijbe.9.1.81

23. Reeves, B., & Nass, C. I. (1996). The media equation: How people treat computers, television, & new media like real people & places. Computers & Mathematics with Applications, 33(5), 128. https://doi.org/10.1016/s0898-1221(97)82929-x

24. Sharma, M., & Rahman, Z. (2022). Anthropomorphic Brand Management: An integrated review and research agenda. Journal of Business Research, 149, 463–475. https://doi.org/10.1016/j.jbusres.2022.05.039

25. Siegert, I., Busch, M., Metzner, S., & Krüger, J. (2023). Voice assistants for therapeutic support – a literature review. Lecture Notes in Computer Science, 221–239. https://doi.org/10.1007/978-3-031-35921-7_15

26. Syam, N., & Sharma, A. (2018). Waiting for a sales renaissance in the Fourth Industrial Revolution: Machine Learning and Artificial Intelligence in sales research and Practice. Industrial Marketing Management, 69, 135–146. https://doi.org/10.1016/j.indmarman.2017.12.019

27. Ubgade, P. N., & Joshi, S. (2022). A review of Brand Anthropomorphism : Analysis of trends and Research. Prabandhan: Indian Journal of Management, 15(10), 47. https://doi.org/10.17010/pijom/2022/v15i10/172408

28. Waytz, A., Morewedge, C. K., Epley, N., Monteleone, G., Gao, J.-H., & Cacioppo, J. T. (2010). Making sense by making sentient: Effectance motivation increases anthropomorphism. Journal of Personality and Social Psychology, 99(3), 410–435. https://doi.org/10.1037/a0020240

29. Wiggers, K. (2019). Google assistant will soon be on 1 billion devices, but still can't ... https://venturebeat.com/2019/01/07/google-assistant-will-soon-be-on-1-billion-devices/

30. Zeithaml, V. A., Berry, L. L., & Parasuram, A. (1996). The Behavioral Consequences of Service Quality. Journal of Marketing, 60(2), 31-46.

IKSHANA: A Communication Device for Paralyzed Patients Through Eye Movement

Priyanka Patil
Principal
AMCOP
Pethvadgaon
Kirti Muley
Asst. Professor
BVIMIT
✉ ikirti13@gmail.com

Shubhangi Mahadik
Assistant Professor
BVIMIT
Sayali Thakare
Student
BVIMIT

ABSTRACT

It is observed that in the population of one core around 12,000 to 15,000 cases of paralysis are found every year. It is difficult for paralytic patients to communicate as they are not able to do voluntary muscle movements. However, most of the patients are able to do eye movements. This eye movement help patients to communicate. To address this issue, the IKSHANA model is proposed, based on eye movements commands are mapped to them. These commands will be played on speakers so that care takers will able to understand the need of the patients. IKSHANA provides an accuracy rate of 80-85%.

General Terms

Digital monitoring, physically paralyzed people (Locked-in-syndrome)

KEYWORDS: *Paralyzed, Stroke, Patient monitoring, Gesture, Paralyzed person wheelchair, Gadgets for a paralyzed person, Patient monitoring system, Health surveillance.*

INTRODUCTION

According to a report by the Global Burden of Diseases (GBD), stroke kills around 5.8 million people each year. Stroke is the most common cause of paralysis, accounting for around 33.7% of all paralysis cases. However, there is no ideal tracking mechanism to monitor the patient's health and everyday needs [1]. Therefore, a new device is proposed called IKSHANA which help patient communicate with less effort. Though this device the patient can communicate with the help of eye movement. IKSHANA capture those eye movements and notify to the nearby caretaker through speakers. The device can be customized as per the requirements of the patient.

The device is especially helpful for the people who cannot afford the costly services of caretakers. IKSHANA will help the patient to communicate without a nurse.

The Section-2, discuss the existing research in this area. Problem description is presented in Section-3. Objectives of IKSHANA are discussed in Section-4. Section-5, deals with the methodology of the research. Working of the device is presented in Sectio-6. Various diagrams such as flowchart, use case, etc. are presented in Section-7. Section-8, deals with the future enchantment of the research. Finally, Section-9 presents the conclusion.

LITERATURE REVIEW

Various studies have been published regarding paralyzed patients using digital monitoring for their communication. These are as follows:

Researchers define paralysis as the loss of the ability to move and, in certain cases, the loss of sensation in part or all of the body. Paralysis can be transient or permanent and is caused by an accident or disease

affecting the central nervous system. It can lead to the following conditions: complete lack of mobility or paralysis, arm and leg weakness, and incontinence. Research is focused on inventing wearable equipment to help patients communicate and keep track of their health conditions [1].

Paralysis, also known as paraplegia, was originally described in Egypt in 3000 BC by Edwin Smith's Papyrus. It is the result of strokes or injuries such as spinal cord damage and broken necks. There are four main types of paralysis: monoplegia, hemiplegia/ paraplegia, and quadriplegia. Ischemic stroke is one of the most prevalent forms of strokes that occur worldwide, and the prevalence of stroke in India has increased by about 100% over the last few decades. It occurs when a blood clot or fat deposit obstructs an artery that feeds blood to the brain. It is more frequent in men than women, and blacks have a higher risk than any other race or ethnic group. An MRI is the best way to diagnose an ischemic stroke. Treatment includes medicine to lower cerebral pressure and an intravenous tissue plasminogen activator [2]. Early treatment can reduce morbidity and mortality, and researchers are currently looking into the idea of a wearable watch for paralysis.

Analyzer state that pseudo-coma is a form of paralysis in which a patient is aware but unable to communicate verbally due to complete paralysis of voluntary muscles. A system monitors their eyelid movements and converts them into text, enabling them to communicate important information to others [3].

The researcher presents a real-time approach based on video and image processing algorithms to identify eye blinks. A Haar Cascade Classifier is utilized for face and eye detection, an efficient eye tracking approach exploits the discovered face's position, and an eye blinking detection based on the condition of the eyelids is used to control Android smartphones. Under artificial lights, the test results reveal 98% overall accuracy and 100% detection accuracy at a distance of 35 cm [4].

One more system was proposed which allows the paralyzed person to display a message over the LCD by a simple motion of any part of their body. It works by reading the tilt direction of the user's body part and using the accelerometer to measure the motion statistics. The microcontroller subsequently interprets the data and displays the appropriate message on the LCD panel. If no one is present, the patient can choose to tilt the device for a longer time and send a GSM message to the registered caretaker [5].

It is observed that paralytic patients who have suffered a paralysis attack are unable to convey their needs due to a lack of motor control caused by the loss of motor control. The research proposes a system that helps patients to convey a message on the LCD by simply using the motion of any part of their body. It also addresses the situation where there is no one present to attend to the patient and sends a message through [6].

Another research, uses an electronic innovation reduces human needs and improves people's well-being, making it easier to monitor a patient's condition. Global System for Mobile Communication (GSM) technology sends a message to the doctor or guardian if any changes in health parameters occur, and a Global Positioning System (GPS) module keeps track of the patient's whereabouts. This structure is intended for family members of patients who do not appear to be in critical condition but should be examined for health on a regular basis [7].

PROBLEM DESCRIPTION

In this section, the problem of paralyzed person is discussed in detail. The first task is to identify how the existing manual method can be computerized. Some analysis and projections were done regarding changes to be made.

These include

Paralyzed people cannot do their basic chores on their own. Usually, one has to look after the person 24/7 to provide everything the person requires.

People who are paralyzed, despite being unable to move their limbs or respond to stimuli, are still able to perceive their surroundings visually or through other senses. However, due to their physical disability, they are unable to react or respond to what they experience.

There is special equipment available in the market that can help paralyzed individuals to interact with their surroundings. However, the cost of such equipment is generally high, making it unaffordable for many people.

OBJECTIVES OF IKSHANA

These include

- To make a device that will be able to detect eye blinks & eyeball rotation (Left and Right). Capturing the movement and notifying when the person wants to share something through the speakers. Security to data by using login & password.
- To find a remedy for paralyzed people that does not cause exterior harm to their bodies.
- To make it affordable and cheap enough for them to afford without much debt.
- To be used in place of basic nursing care.
- To decrease nursing staff for patients.

RESEARCH METHODOLOGY

A random data collection process was used for this system. The information was collected from various unstructured interviews by using a well-formatted questionnaire.

The question contained the following questions:

a) How is progress monitored?

b) How reports are created?

c) How is progress evaluated on a monthly basis?

d) Is the analysis of progress a time- consuming process (yes/no)?

Moving ahead, the "IKSHANA" software can be used with the help of a Raspberry Pi (a low- cost, credit-card-sized computer) with a touchscreen display. If one doesn't have a PC or a laptop or cannot afford it, then the software providers would recommend going with this option. The function of the software is that it can detect eye movements such as blinking of the eyes and rotation of the eyeballs, and we can assign a task to these movements.

WORKING

The data is provided in a well-formatted form in which the user family will provide the commands to different eye blinks and eye rotations as depicted in Table 1.

Table 1. Eye blink chart

Blink Count	Action
1	Want to go Toilet
2	Thirsty need water
3	Play movie
4	Feeling uneasiness
5	Play song
6	Need a food

The eye moments will be captured by the camera and as per the action assigned the speaker will announce the action that the paralyzed people want to communicate.

The device can capture eye moments in both day and night light, from different distances from the camera without any interruption as shown in figure 1 and figure 2 respectively.

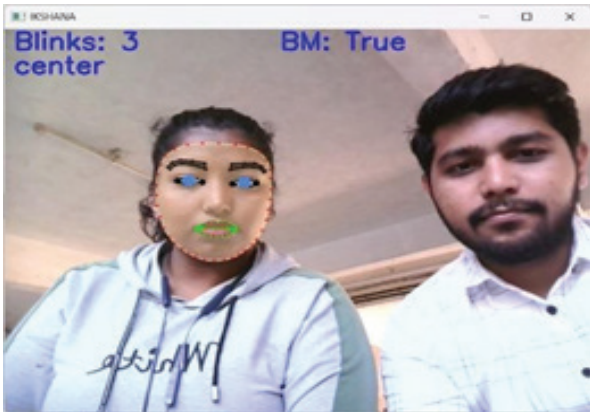


Fig. 1. At a minimum distance of 12-15 inches from the camera, the system detected an eyeblink.

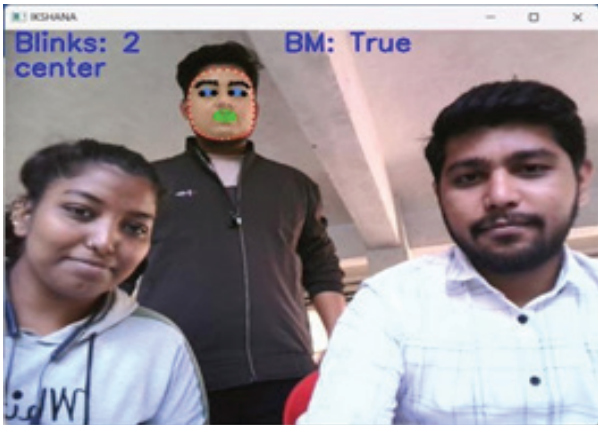


Fig. 2. An eyeblink was detected by the camera from a distance of 30-35 inches.

SYSTEM DIAGRAMS

The flowchart of IKSHANA illustrates the intricate connections between various stages of a process or parts of a system, providing a clear and concise visual representation of the underlying relationships. Refer to figure 3.

Figure-4, depicts the use-case diagram of IKSHANA depicts the various use cases and types of users that the system caters to. In other words, the diagram illustrates how the system is used and by whom, providing a clear understanding of the system's functionality.

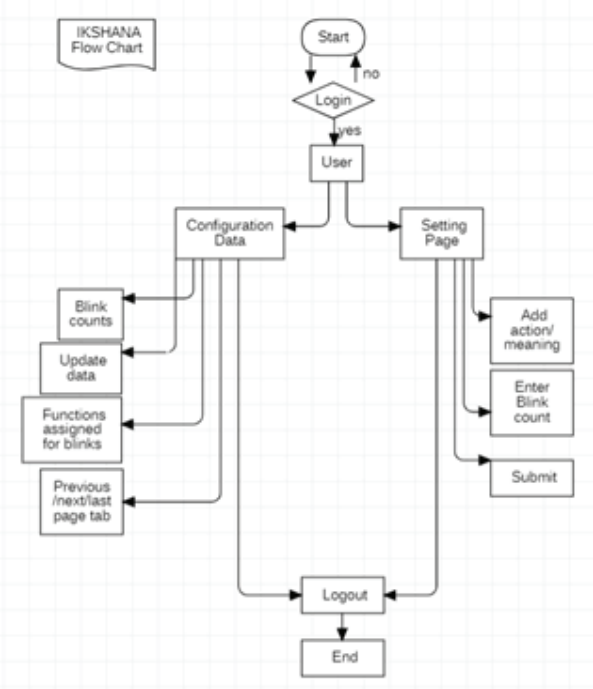


Fig. 3. Flowchart of IKSHANA

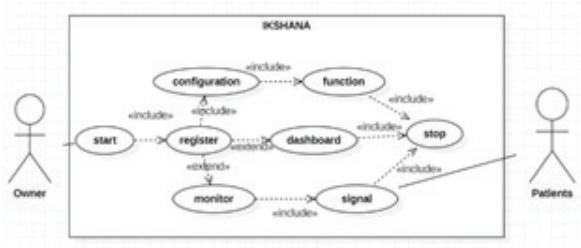


Fig. 4. Use-Case Diagram of IKSHANA

Figure 5 depicts the hierarchical structure of the tree of the menu tree in IKSHANA which makes it easy for users to navigate through the different stages of a project or task. By breaking down complex objectives into smaller, manageable subtasks, IKSHANA helps users stay organized and focused on their goals. This makes it a valuable tool for project management and collaboration in a variety of contexts.

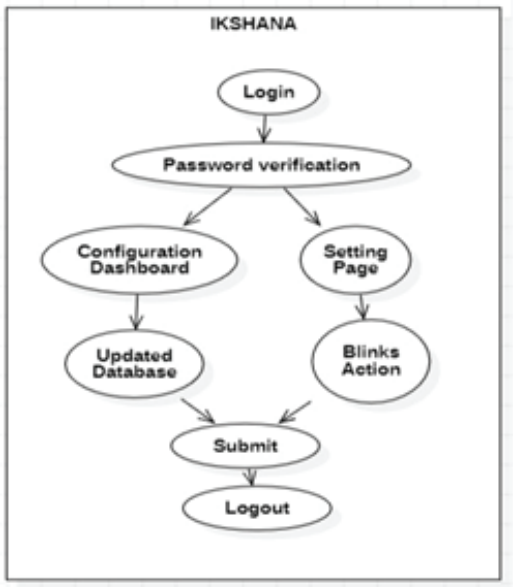


Fig. 5. The menu tree of IKSHANA

Figure 6, represents the activity diagram of IKSHANA, the activity diagram showcases the dynamic behavior of the system, implying that the system is responsive to the changing conditions and adapts to them accordingly.

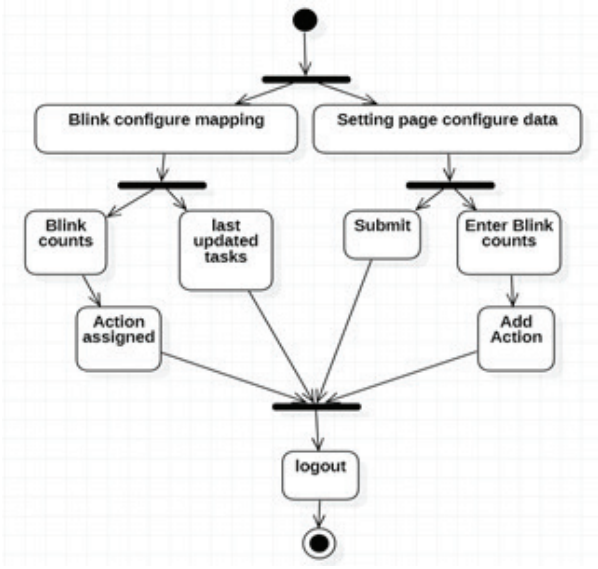


Fig. 6. Activity Diagram of IKSHANA

FUTURE ENHANCEMENT

- The software has been developed in such a way that it can accept modifications and further changes; any changes can be done easily.
- The software can give direct access to videos and songs by the patient eye blink command.
- An application can be developed for the monitoring of the patient from anywhere and anytime.
- Alert SMS/Mail feature can also be implemented in the future.
- It's possible to improve the accuracy of software, even up to 99%-100%.

CONCLUSION

The study describes that the "IKSHANA" is beneficial for paralyzed people as it is easy to operate and is affordable for everyone. The system's efficiency is notable due to two key features. Firstly, it offers a user-friendly experience for patients. Secondly, the system accurately monitors patients' eye-blinking movements, resulting in precise command output per blink. Human error is minimized due to the blink termination and restating of the blink counts. This helps to ensure accuracy and reliability. The cost of expensive equipment has also been demised and there is no longer a need for a nurse to monitor the patient all the time. Quick access to multiple commands is also possible.

REFERENCES

1. V, Avinash Wilson J and Anusha P "Paralyzed Patient Monitoring Equipment – IoT", IJARBEST, Vol.6, Issue.10, October 2020.
2. Dr. Joshi Manisha S, Amogh B, Arpitha Kumar, Rakshith K Shetty and Yogeswarr S "GESTURE BASED MONITORING SYSTEM FOR PARTIALLY PARALYSED PATIENTS", IJEAST, Vol. 6, Issue 11, March 2022.
3. Abijith Vignesh T, Aishwarya P K and Dr.S. Sobitha Ahila "COMMUNICATION AID FOR PARALYZED PEOPLE BY EYELID TRACKING", JETIR April 2018, Volume 5, Issue 4.
4. Meghana S, Monica R, Nayana K, Neha S S "Eye Blink Detection Method for disabled: Assisting System for Paralyzed", IJERT, NCAIT-2020, Volume8 – Issue 15. Viancy
5. Komal V. Sindagi, Ragini B. Patil, Rukkayya L. Mujawar and M.B. Mulik "GSM based Paralysis Patient Monitoring System", IRJET, Volume: 07, Issue: 06 June 2020.
6. V, Avinash Wilson J and Anusha P "Paralyzed Patient Monitoring Equipment – IoT", IJARBEST, Vol.6, Issue.10, October 2020.
7. Dr. Joshi Manisha S, Amogh B, Arpitha Kumar, Rakshith K Shetty and Yogeswarr S "GESTURE BASED MONITORING SYSTEM FOR PARTIALLY PARALYSED PATIENTS", IJEAST, Vol. 6, Issue 11, March 2022.
8. Abijith Vignesh T, Aishwarya P K and Dr.S. Sobitha Ahila "COMMUNICATION AID FOR PARALYZED PEOPLE BY EYELID TRACKING", JETIR April 2018, Volume 5, Issue 4.
9. Meghana S, Monica R, Nayana K, Neha S S "Eye Blink Detection Method for disabled: Assisting System for Paralyzed", IJERT, NCAIT-2020, Volume8 – Issue 15. Viancy
10. Komal V. Sindagi, Ragini B. Patil, Rukkayya L. Mujawar and M.B. Mulik "GSM based Paralysis Patient Monitoring System", IRJET, Volume: 07, Issue: 06 June 2020.
11. Diptee Gaikar, Pradnya Porlekar, Divya Shetty, Akash Shitkar and Prof.Kalindi Kalebere "AUTOMATED PARALYSIS PATIENT HEALTHCARE SYSTEM", IJCRT, Issue 8 August 2021, Volume 9.
12. Ms. D. M. Kate, Ms. Ashwini Wadhai, Ms. Kajal Vaidya, Ms. Sejal Kadak, Mr. Rushikesh Shrikhande, and Mr. Piyush Dhurve "Paralysis Patients Monitoring System using GSM", IJARSCT, Volume 2, Issue 1, April 2022.

Study of Student's Demographic Profile and It's Impact on Students Learning Using Data Mining Techniques

Prashant G Tandale, Kamal M Alaskar
Bharati Vidyapeeth Deemed Univerisity
Institute of Management
Kolhapur, Maharashtra
✉ prashant.g.tandale@gmail.com
✉ kamal.alaskar@bharatividyapeeth.edu

Gunjan Behl
Institute of Management and Information Technology
Navi Mumbai
✉ mailto.gunjan83@gmail.com

Sushant G Tandale
KRP Kanya Mahavidyalaya
Islampur
✉ sushanttandale87@gmail.com

ABSTRACT

The goal of this research is to use data mining to personalize instruction for each student in order to boost the effectiveness of education. Personalized learning pathways can be developed to maximize comprehension and retention by detecting patterns in learning preferences and behaviors. By matching learning activities to individuals' interests and preferences, personalized educational tactics can increase student motivation and engagement. Data mining insights can help educators make decisions about how to teach, how to provide content, and how to interact with students in the classroom. Students who receive personalized learning are better equipped with the knowledge and attitude required for lifetime learning. In this paper different demographic parameters of students are analyzed and results are noted.

KEYWORDS: *Data mining, Correlation, Cluster analysis, STEM.*

INTRODUCTION

Education is the basic need of time. A nation's ability to improve as well as progress depends on its level of education. It makes a nation's citizens more polite and respectful. Reaching a point where universities may employ more accurate, efficient, and successful instructional processes is a significant challenge facing higher education nowadays. Higher education institutions currently operate in a highly competitive environment and strive to get a competitive edge over their rivals. These organizations require in-depth and sufficient knowledge for improved assessment, evaluation, planning, and decision-making in order to be competitive in the educational area. Numerous methods from several domains, such as databases, statistics, data visualization, machine learning, and others, are combined in data mining. Applying data mining tools and techniques to educationally related data is the focus of the burgeoning field of educational data mining, or EDM. The field is concentrates on the analysis of educational data to create models that enhance learning outcomes and boost institutional efficacy. From educational data, data mining technology can identify undetected trends, relationships, and irregularities. Higher education systems' decision-making procedures may be strengthened by this understanding. When it comes to providing extra insight into the behavior of educators, students, alumni, managers, as well as different employees, using data mining is thought to be the most appropriate technology. It can also serve as an automated assistant that actively supports educators in making better decisions regarding their educational endeavors. Data mining techniques can assist educational institutions in identifying trends such as comparable qualities among students, the relationship between students' attitudes and performance, the attributes that will draw deserving individuals, and so on. The use of data and knowledge mining by academic institutions to uncover valuable knowledge hidden in student result vaults and enhance student learning has grown dramatically over the past few decades. In this

paper we tried to focus on study of demographic profile of student and its impact on students learning.

REVIEW OF LITERATURE

The special issue of Frontiers in Psychology Wang Y et al (2021) highlights the importance of positive psychology in language education, focusing on seven variables such as academic engagement, emotion regulation, enjoyment, grit, loving pedagogy, resilience, and well-being. The paper suggests that positive psychology can enhance language learning and teaching systems, and future research should explore flow, enjoyment, teacher-related factors, well-being, and flow for positive experiences for teachers and learners. However, the literature on positive psychology in L2 education has limitations.

The study of Deák C et al (2021) identified that, there is no one answer that works for all students when it comes to the modernization of STEM education—innovation and skill development must be balanced. Teachers now need to adjust to e-learning and technology more quickly than before because of the pandemic. This process can be optimized with holistic tools like skill-set balance and the STEM content integration flow cycle. New pedagogical policies can be developed with the aid of the conditional matrix and PESTLE analysis. Modernizing the strategy presents a hurdle because new platforms are intricate. Pedagogy, which bridges the gap between outdated content knowledge and new modules, is the answer.

The COVID-19 pandemic has impacted K-12 engineering and STEM education, necessitating online learning methods like blended and flipped learning. Delen I. et al (2022) suggests inequities and professional development opportunities for STEM teachers may have been overlooked.

Brian J. Alters et al (2002) explained that the general population's absence of understanding of evolution is affecting evolution/science literacy and research, despite the fact that the academic community has improved its teaching and learning of the subject. Effective pedagogy should prioritize course content, religious influences, and students' preconceptions in order to enhance learning. A thorough grasp of science requires active learning, critical thinking, and the integration of many levels of information.

According to Siddarth Bharwani(2019)Education has evolved over time, with a focus on interactive experiences and key skills for job readiness. Student engagement has become essential, with interactive sessions and hands-on learning. Technology has led to hybrid learning, "Flipped Classrooms," and online lessons. Learning sciences have allowed teachers to modify teaching methods to suit students better. Assessment has also changed, with comprehensive rating systems and peer assessment. Self-learning is becoming more important, allowing students to gain higher productivity through online lessons and assessment systems.

In advance Teaching pedagogy of W. Nancy et al. (2019) is a cutting-edge method that blends in-person instruction with online learning. For duties like teaching, creating question papers, and research methods, it makes use of smart devices. Students can create their own learning experiences with tools like Moodle, Gotowebinar, Kahoot, Google Classrooms, and Evernote. These approaches seek to impart knowledge or information without undermining the main goal of instruction.

Pittok J. et al(2017) highlighted that personalized learning empowers students, fosters creativity, and improves problem-solving skills through a collaborative approach between the teacher and the learner. Technology is used by Canal Winchester Middle School to create a dynamic learning environment that promotes adaptability, tenacity, attention, and lifelong learning abilities. Teachers set an example for this new culture and way of thinking.

According to Chen S.Y. et al (2021) Learning has been completely transformed by the rise of ICT, which has made personalized learning possible and optimized instructional strategies for specific pupils. On the other hand, effective learning requires an appreciation of individual differences. In spite of certain research, a thorough approach is required, emphasizing the significance of integrated reviews.

Pratama M. P. (2023) studied in his research that by customizing learning experiences for each student, establishing tailored learning paths, establishing intervention targets, and giving prompt feedback, AI and ML technologies in education improve independence and productivity.

A growing trend in education is personalized learning (Akyuz Y.-2020), which uses appropriate techniques and technology to tailor instruction to each learner's unique abilities, skills, needs, and interests. The outcome is a more authentic classroom experience that is becoming more and more popular across state lines.

DATA MINING AND TEACHING APPROACH

Data mining is interdisciplinary in nature because different fields have contributed in it such as database, statistics, and parallel and distributed computing, machine learning, information retrieval and data visualization. Foremost contributors in data mining are database, machine learning and statistics due to their prominence on efficiency and validity.

The advantage of data mining is that hidden information can be explored. Data mining has found applications in different fields like banking sector, insurance sector, medical field, fraud detection, spatial mining etc. where huge data of information is stored. Similarly in the educational field the amount of data stored is increasing exponentially due to fast development in information technology.

The technique of extracting relevant information from vast volumes of data is known as data mining (Yangchang Z. 2013). Information retrieval, bioinformatics, machine learning, statistics, and pattern recognition are just a few of the fields that have contributed to this multidisciplinary discipline. Numerous industries, including communications, social media, retail, and banking, heavily rely on data mining.

Jiawei Han et al (2012) studied that creating instruments for forecasting and prediction utilizing data and statistical models is the main goal of statistics study. It is helpful for identifying patterns and comprehending the underlying processes that influence them. By taking into consideration the unpredictability and uncertainty of data, inferential statistics—also known as predictive statistics—draw conclusions about the population or process being studied. Results from data mining can also be validated using statistical techniques, such as statistical hypothesis testing. If a finding is too improbable to have happened by accident to be statistically significant, then it is. However, because many statistical approaches have a high computing complexity, applying statistical methods to data mining is difficult. This problem is especially difficult for web applications where quick data mining is needed, such online search engine query recommendations.

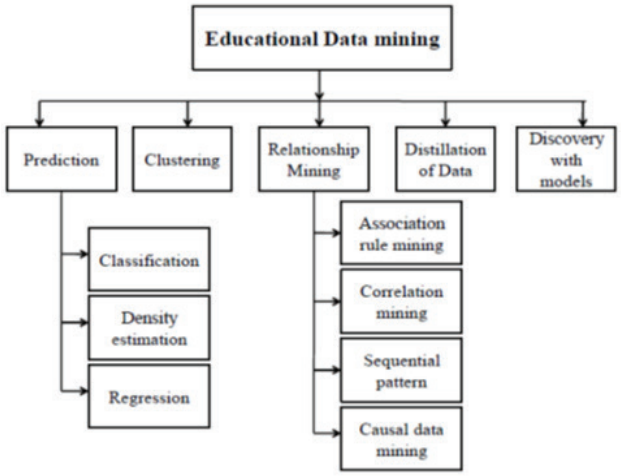


Fig. 1. Compartments of educational data mining as per Romera and Ventura

RESEARCH METHODOLOGY

A research methodology is a framework that aids in the definition of research questions, hypotheses, and objectives as well as the selection of the best sample strategy, study design, and procedures for gathering and analyzing data. When doing research, it guarantees validity, reliability, and adherence to ethical standards. Research technique comes in three flavors: mixed-method, qualitative, and quantitative. Whereas qualitative research looks at people's beliefs, actions, and experiences, quantitative research concentrates on numerical data. In a single study, mixed-method research incorporates elements of both quantitative and qualitative approaches. The research methodology and procedures influence the data gathering techniques. When analyzing data, quantitative research use deductive techniques whereas qualitative research uses inductive techniques. Researchers should take into account their goals, questions, and available literature review when selecting a research technique. When selecting a research technique, investigators have to take into account the study's goals, questions, and current literature review in addition to the approach's practicality, sample size, and statistical criteria. To

sum up, a research methodology gives researchers a structure and rules to make sure their findings are accurate, unbiased, and devoid of biases.

Enhancing curriculum, developing individualized learning activities, evaluating pedagogical approaches, and creating a personalized Educational Data Mining (EDM) model are the objectives of the research. After a thorough study of the literature, a mixed-methods research design is selected. Using random sample procedures, the target group is defined to include students, educators, and educational institutions. Ethical issues are discussed and research instruments are created. For both quantitative and qualitative analysis, sophisticated data mining techniques are applied together with established data gathering protocols.

DATA ANALYSIS AND INTERPRETATION

The process of data mining entails applying methods from several domains, including machine learning, statistics, and database systems, to find patterns and relationships in huge datasets. Applying diverse statistical and data mining techniques is part of data analysis in a variety of scenarios in order to extract valuable insights from the data. With a robust ecosystem of packages and tools for data mining, R is a well-liked programming language for statistical computation and data analysis. You must install R and a development environment, like the RStudio IDE, before you can start data mining. Data of 340 students is collected and analyzed using R programming language and data mining tools are used while doing data analysis.

Data from multiple sources must be cleaned, transformed, and integrated as part of the data preparation process. The preparation packages and functions read.csv(), tidyr, and dplyr are used for data preprocessing. Before starting any data mining operations, it is imperative to take the quality and relevancy of your data into consideration.

A crucial phase in data mining is called exploratory data analysis (EDA), during which you choose a subset of the available variables or features to employ in your research. Filtering, wrapper techniques, and embedding approaches are some of the strategies used in feature selection.

A matrix of correlations as obtained in Table 1 sheds light on the connections among markers of academic success and demographic variables. The association estimated are also plotted in graph as shown in figure No. 2.

Gender

The minor positive connection between gender and age (0.26) points to a slight propensity toward male enrollment among older pupils. The minimal connection with the majority of other factors suggests that gender differences are not very significant.

Age

There is a weak positive association (0.26) between age and gender, and a negative correlation (-0.05) between age and the number of siblings. Additionally, there is a minor positive link between it and UG, HSC, and SSC grades, indicating that older children typically achieve slightly better academically.

Caste

Potential socioeconomic effects are indicated by the very small positive connection between caste and area (0.20) and the negative correlation between caste and mother's occupation.

Table 1. Demographic Profiles And It's Impact On Students Learning

	Gender	Age	caste	Occupation		Education	
				Father	Mother	Father	Mother
Gender	1.00	0.26	0.01	-0.05	0.00	-0.01	0.00
Age	0.26	1.00	0.02	0.02	-0.02	0.03	0.00
Caste	0.01	0.02	1.00	-0.23	-0.06	-0.04	-0.03
Father Occupation	-0.05	0.02	-0.23	1.00	0.14	-0.06	-0.21
Mother Occupation	0.00	-0.02	-0.06	0.14	1.00	-0.30	-0.33
Father Education	-0.01	0.03	-0.04	-0.06	-0.30	1.00	0.62
Mother Education	0.00	0.00	-0.03	-0.21	-0.33	0.62	1.00

Occupation (Mother and Father)

Father's Occupation and State had a positive association (0.42), pointing to potential regional effects.

Mother's Occupation shows possible socioeconomic and geographical implications with a negative association with both Area (-0.14) and State (0.07).

Mother's and Father's education

The mother's education and the father's education have a positive association (0.62), indicating a trend toward greater educational levels within families.

Positive correlations between Father's Education and SSC, HSC, and UG Grade suggest a possible relationship between academic achievement and parental education.

REFERENCES

1. Akyuz, Y. (2020), Personalized learning in education. American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), 69(1), 175-194.
2. Brian J. Alters, Craig E. Nelson(2002), PERSPECTIVE: TEACHING EVOLUTION IN HIGHER EDUCATION, Evolution, Volume 56, Issue 10, 1 October 2002, Pages 1891–1901, https://doi.org/10.1111/j.0014-3820.2002.tb00115.x.
3. Brian Whalley, Derek France, Julian Park, Alice Mauchline & Katharine Welsh (2021) Towards flexible personalized learning and the future educational system in the fourth industrial revolution in the wake of Covid-19, Higher Education Pedagogies, 6:1, 79-99, DOI: 10.1080/23752696.2021.1883458
4. Chen, S.Y., Wang, JH. (2021), Individual differences and personalized learning: a review and appraisal. Univ Access Inf Soc 20, 833–849, https://doi.org/10.1007/s10209-020-00753-4
5. David J. Lemay, Clare Baek, Tenzin Doleck, Comparison of learning analytics and educational data mining: A topic modeling approach, Computers and Education: Artificial Intelligence,Volume 2, 2021, 100016, ISSN 2666-920X, https://doi.org/10.1016/j.caeai.2021.100016.
6. Deák, C.; Kumar, B.; Szabó, I.; Nagy, G.; Szentesi, S.(2021), Evolution of New Approaches in Pedagogy and STEM with Inquiry-Based Learning and Post-Pandemic Scenarios. Educ. Sci., 11, 319. https://doi.org/ 10.3390/educsci11070319
7. Delen, I., & Yuksel, T. (2023). Abrupt Shift or Caught Off Guard: A Systematic Review of K-12 Engineering and STEM Education's Response to the COVID-19 Pandemic. Journal of Pre-College Engineering Education Research (J-PEER), 12(2), Article 6. https://doi.org/10.7771/2157-9288.1353
8. Romero C, Ventura S. Educational data mining and learning analytics: An updated survey. WIREs Data Mining Knowl Discov. 2020;10:e1355. https://doi.org/10.1002/widm.1355
9. Siddarth Bharwani(2019), Evolution Of Teaching Pedagogy, STOODNT GUEST, https://stoodnt.com/blog/evolution-of-teaching-pedagogy/
10. Steven Finlay(2014), "Predictive Analytics, Data Mining and Big Data : Myths, Misconceptions and Methods",ISBN-978-1-137-37927-6, Palgrave MacMillan Han, Jiawei (2012), Data mining : concepts and techniques / Jiawei Han, Micheline Kamber, Jian Pei. – 3rd ed. p. cm. ISBN 978-0-12-381479-1
11. W. Nancy, A. Parimala, L.M. Merlin Livingston (2020), Advanced Teaching Pedagogy As Innovative Approach In Modern Education System, Procedia Computer Science, Volume 172, Pages 382-388, ISSN 1877-0509, https://doi.org/10.1016/j.procs.2020.05.059
12. Wang Y, Derakhshan A and Zhang LJ (2021), Researching and Practicing Positive Psychology in Second/Foreign Language Learning and Teaching: The Past, Current Status and Future Directions. Front. Psychol. 12:731721. doi: 10.3389/fpsyg.2021.731721.
13. Yangchang Zhao (2013), Chapter 1 - Introduction, R and Data Mining, Academic Press, Pages 1-4, ISBN 9780123969637, https://doi.org/10.1016/B978-0-12-396963-7.00001-5.

Unlocking Efficiency: Real-Time License Plate Recognition for Smart Parking and Transportation Management

Suhasini Vijaykumar
Principal
BVIMIT
✉ suhasini.kottur12@gmail.com

Sudeshna Roy
Asst. Professor
BVIMIT
✉ sroy.rnc@gmail.com

Aniket Sanjay Kabra
Tanish Kishor Jadhav
Students
BVIMIT
✉ aniket.s.kabra@gmail.com
✉ tanishjadhav21@gmail.com

ABSTRACT

Automatic License Plate Recognition (ALPR) has emerged as a recurring focal point in research endeavors, primarily due to the proliferation of cameras deployed across urban landscapes, many of which are interconnected via the Internet. The continuous stream of video data captured by these cameras offers a rich resource for analyzing traffic patterns and facilitating transportation management. This paper introduces an innovative approach to vehicle identification through the deployment of an Optical Character Recognition (OCR) system within intelligent transportation systems.

The foundation of our system lies in the integration of the Smart Parking Service (SPS), an intelligent parking solution designed to efficiently manage both public and private parking spaces. Leveraging advanced computer vision techniques, the SPS serves as the backbone for detecting parking slot availability in real-time. Furthermore, our proposed system extends the capabilities of SPS by employing OCR methodologies to extract license plate numbers from vehicles traversing or occupying parking spaces.

In practical terms, our system operates seamlessly, capturing images of parking areas and promptly identifying license plate numbers with remarkable efficiency. Notably, this recognition process occurs in real-time, ensuring swift and accurate identification of vehicles within the parking environment. The overall performance of the system which we have proposed is properly evaluated in real-world scenarios, validating its efficacy and reliability in facilitating efficient vehicle identification within intelligent transportation frameworks.

KEYWORDS: *Smart Parking Service(SPS), Advance computer vision, Optical Character Recognition (OCR), Classification, Intelligent parking solution.*

INTRODUCTION

Amidst the burgeoning vehicular population globally, a confluence of challenges such as traffic congestion and environmental degradation necessitates a strategic response. Enter Intelligent Transportation Systems (ITSs), an amalgamation of technologies poised to ameliorate these adversities by orchestrating seamless and secure transport networks.

One such technological cornerstone within ITSs is the Wireless Sensor Network (WSN), garnering considerable attention for its cost-efficient and versatile applications. Notably, WSN's integration into ITSs bolsters functionalities, exemplified by its role in facilitating Automatic License Plate Recognition (ALPR) systems.

ALPR, an invaluable asset in the ITS arsenal, facilitates vehicle monitoring and regulation. However, the heterogeneous nature of license plates, compounded by dynamic environmental conditions, poses a formidable challenge to system accuracy, particularly in open settings.

The developmental trajectory of ALPR unfolds across four pivotal stages, ranging from vehicle image capture to character recognition. While object detection algorithms warrant a discussion beyond our purview, scholarly works offer comprehensive analyses on the subject.

ALPR systems manifest in two distinct modalities: online and offline. The former enables real-time license plate localization and interpretation, conducive to dynamic surveillance, while the latter entails data aggregation for subsequent processing.

Diverse methodologies characterize ALPR systems, each with attendant merits and demerits. Predominantly, edge- based techniques feature prominently, supplemented by meticulous image capture endeavors. Nonetheless, the exigencies of practical environments, punctuated by variable illumination, underscore the imperative for continued refinement.

Transitioning to the realm of parking management, the advent of Smart Parking Service (SPS) heralds a paradigm shift. Leveraging WSN infrastructure, SPS furnishes real-time parking space monitoring and management capabilities, catering to both public and private domains.

Our research endeavors converge upon the fusion of Optical Character Recognition (OCR) and WSN technologies to augment ITS functionalities within the SPS framework. Aided by OCR algorithms, our system discerns license plate information in real-time, facilitating cloud-based storage and subsequent utilization for law enforcement and administrative purposes.

Through rigorous real-world experimentation, we ascertain the efficacy of our proposed system within open environments. By evaluating the real-time performance of YOLOv9 (You Only Look Once version 9), our study underscores the viability of our approach amidst practical exigencies.

In sum, our research delineates a sophisticated synthesis of OCR and WSN technologies, poised to fortify the ITS landscape, and engendering enhanced operational efficiency within contemporary transportation paradigms.

PROBLEM DEFINITION

Efficient management of parking spaces and transportation systems in urban areas poses a significant challenge due to increasing urbanization and vehicle ownership. Traditional methods of parking management often rely on manual intervention, resulting in inefficiencies, congestion, and environmental impact. Real-time License Plate Recognition (LPR) systems offer a promising solution to streamline parking and transportation management by automating the process of vehicle identification and tracking.

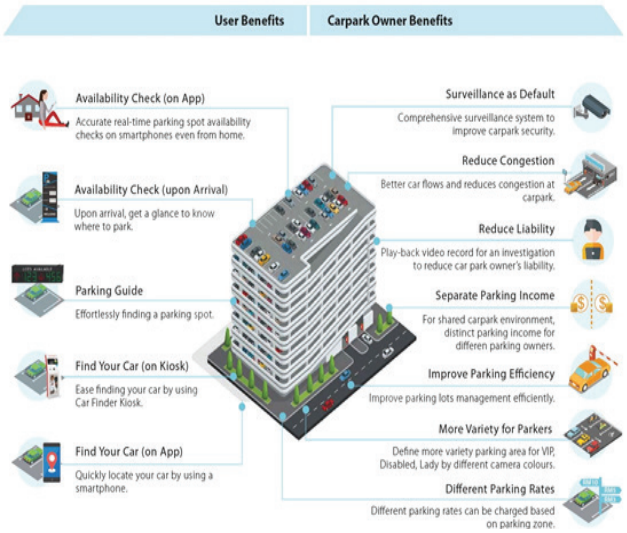


Fig. 1. User and Carpark Owners Benefits

However, the implementation of LPR systems faces several technical and practical challenges, including accuracy, scalability, privacy concerns, and integration with existing infrastructure. Furthermore, the effectiveness of LPR systems in optimizing parking utilization, reducing traffic congestion, and enhancing overall transportation efficiency needs to be thoroughly evaluated and validated. Therefore, the research paper aims to address the following problem statement:

"To investigate the feasibility, effectiveness, and challenges associated with the implementation of real-time License Plate Recognition (LPR) technology for smart parking and transportation management in urban environments, with the goal of unlocking efficiency and addressing key issues such as congestion, environmental impact, and resource utilization."

OBJECTIVE/SCOPE

Smart Parking Services

Within the intricate tapestry of contemporary urban infrastructure lies the Smart Parking Service (SPS), a sophisticated framework meticulously crafted to discern the availability of parking slots. Seamlessly integrated into an overarching intelligent transportation architecture, SPS orchestrates a symphony of detection, management, and notification, choreographed to perfection.

At its core, SPS employs an intricate network of sensors and cameras, meticulously positioned to surveillance parking spaces with unparalleled precision. These sensory apparatuses, akin to vigilant sentinels, relay vital parking information to the system's nerve center – a cloud-based data repository meticulously engineered for data abstraction, processing, and seamless communication.

Within this ethereal sanctuary of data, sensors stand as vigilant custodians, discerning subtle shifts in the environment and relaying pertinent information regarding parking slot occupancy. Powered by the alchemy of computer vision techniques,

SPS discerns the nuanced cadence of parking slot availability with unparalleled acuity, transcending the mundane to deliver an exquisite tapestry of insights.

In the afterglow of image processing, SPS unfurls its mantle of enlightenment, disseminating meticulously curated information to discerning users through a bespoke driver application. Herein lies the culmination of SPS' magnum opus – a seamless fusion of technology and sophistication, enhancing the urban mobility experience with an unrivaled elegance.

The Data Center

In the sanctum of the data center, a meticulously orchestrated ballet unfolds as information, akin to ethereal whispers, flows seamlessly between sensors and mobile applications. This intricate dance is facilitated by a web service, a paragon of efficiency and elegance, ensconced within the data center's hallowed halls.

Here, images captured by vigilant sensors undergo a metamorphosis, transmuting into beacons of insight regarding parking slot availability. Through meticulous processing and analysis, this trove of data finds solace in the embrace of a discerning database, its contents curated with the utmost care and precision.

At the heart of this technological marvel lies the wireless sensor node, a virtuoso performance embodied by the Raspberry Pi. This exquisitely crafted ensemble features a USB which has a wireless network based interface and a venerable web camera, imbuing it with a capacity for omniscient observation. Guided by the Raspbian operating system and an ensemble of Python programs, this node deftly navigates the labyrinth of GPIO pins, attuned to the subtlest of environmental cues.

When the ethereal dance of movement stirs the air, the webcam, with the patience of a sage, captures fleeting moments in time. Each frame a testament to the symbiotic harmony between technology and artistry, as the Raspberry Pi orchestrates a symphony of surveillance, capturing the ebb and flow of vehicular motion with an elegance befitting its stature.

Parking Slot Information

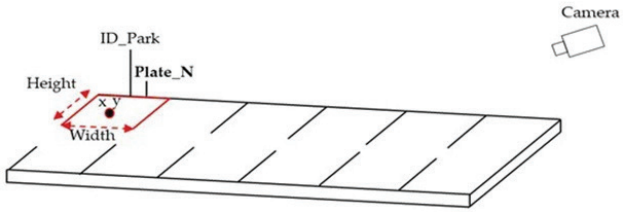


Fig. 2. Parking space and camera postion details

- ID Park: Recognition of parking area;
- Park Info: Description regarding the parking area;
- Coordinate 1: The x is for X-Coordinate of the parking area;
- Coordinate 2: The y is for Y-Coordinate of the parking area;
- Width & Height: They both represents the Width and Height for the parking area;
- State: Shows live state of the parking area.
- Plate New: Stores the information regarding the license plate.

In the SPS framework, we have the capability to incorporate new data labeled as ”Plate New.” This data is captured with the help of a system and storage process is executed in the SPS system itself, enabling the parking details to be transmitted to a central database. Once parking spots are designated, the image, termed ”Parking Space Image,” for every spot is being received by the system, considering its coordinates which are (x = width, y = height). These ”Parking Space Images” are archived in the storage system, then can be utilized to check for availability status of each parking spot.

Optical Character Recognition

In the realm of computer vision and pattern recognition, optical character recognition (OCR) stands out as one of the most extensively studied topics. Despite significant research efforts, OCR remains challenging, especially in complex environments like parking lots. It’s crucial to improve OCR’s ability to recognize characters like (B,O,I,A,C,G,D,K) which are confused with characters or numbers like (8,0,1,4,G,O,X). Various studies assess OCR performance using image datasets. The OCR model employed in this study is YOLOv9 (You Only Look Once version 9), which leverages convolutional neural networks (CNNs) to swiftly and accurately identify objects in images. YOLOv9’s integrated architecture seamlessly com- bines classification, localization, and detection, streamlining the inference process and enhancing overall efficiency.

RESEARCH METHODOLOGY

System Overview

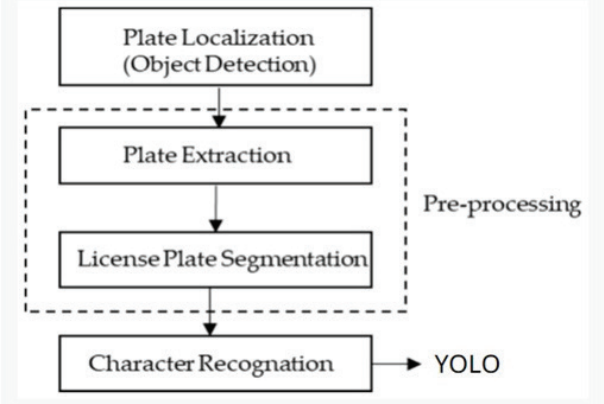
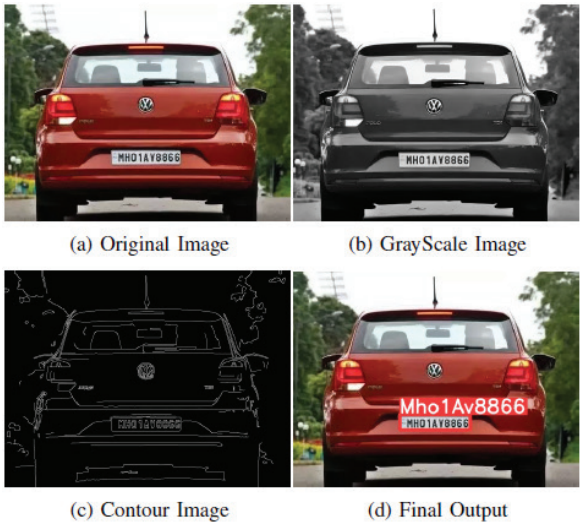


Fig. 3. Illustration of Identification System based on Optical Character Recognition for Intelligent Transportation Systems particularly for Vehicles

Upon vehicle detection by the SPS, an algorithm is initiated to execute the function of Plate Localization, extracting the vehicle image and the finding the number plate of that particular vehicle by identifying ”Rectangular Objects.” Once the plate is located, the algorithm isolates the plate area, generating a new image. Subsequently, the pre-processing phase commences to address variations in the surrounding environment and mitigate potential ”Noises” in the image. This phase employs a ”Selective Gaussian Blur” to smoothen the image and to reduce noise. Following pre-processing, the proposed algorithm utilizes YOLOv9 for character recognition on the plate image.

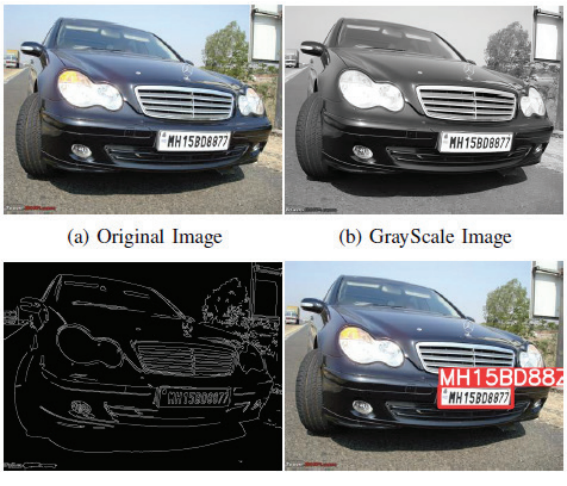
ANALYSIS & FINDING



(a) Original Image (b) GrayScale Image

(c) Contour Image (d) Final Output

Fig. 4. Long Distance Image Sample



(a) Original Image (b) GrayScale Image

Fig. 5. Short Distance Image Sample

CONCLUSION

In this scholarly pursuit, we unveil a cutting-edge system tailored for the real-time identification of the License Plate characters of a Vehicle, elegantly employing optical character recognition. Situated within the sophisticated infrastructure of the Smart Parking Service (SPS), renowned for its adeptness in computer vision, our system emerges as a beacon of innovation.

Our integration with SPS capitalizes on its camera array to capture the essence of parking slots, initiating a meticulous process upon vehicle detection. Embarking on a journey of visual analysis, our system deftly extracts the license plate number, a feat achieved through a meticulously crafted algorithmic framework.

The algorithmic intricacies guiding our system's operation are meticulously elucidated, traversing a transformative trajectory from plate image detection to character recognition. To contend with the caprices of environmental illumination, a panoply of image filters underwent rigorous evaluation. Through empirical scrutiny across varying temporal contexts, our system's resilience amidst luminosity fluctuations emerged resplendent. Notably, the bidirectional filter emerged as the epitome of robustness, heralding a new dawn in plate character recognition.

However, amid our triumphs lie challenges awaiting resolution. Sensitivity to environmental illumination remains a lingering concern, compelling us to chart a course towards enhanced precision. Thus, our future pursuits will unveil an arsenal of novel image filters and delve into the realm of deep learning methodologies, illuminating the path towards heightened efficacy and refinement.

REFERENCES

1. Meneguette, R.I.; De Grande, R.E.; Loureiro, A.A.F. Intelligent Transport System in Smart Cities; Springer: Cham, Switzerland, 2018. [Google Scholar]
2. Namysl, M.; Konya, I. Efficient, Lexicon-Free OCR using Deep Learning. In Proceedings of the 15th International Conference on Document Analy- sis and Recognition (ICDAR 2019), Sydney, Australia, 20–25 September 2019. [Google Scholar]
3. YOLOv9 Available online : YOLOv9 - Ultralytics YOLOv9 Docs
4. Yimyam, M.; Ketcham, M. The Automated Parking Fee Calculation Using License Plate Recognition System. In Proceedings of the 2017 International Conference on Digital Arts, Media and Technology, Chiang Mai, Thailand, 1–4 March 2017. [Google Scholar]
5. Jing, Y.; Youssefi, B.; Mirhassani, M.; Muscedere, B. An efficient FPGA implementation of optical character recognition for license plate recog- nition. In Proceedings of the 2017 IEEE 30th Canadian Conference on Electrical and Computer Engineering, Windsor, ON, Canada, 30 April–3 May 2017. [Google Scholar]
6. Detlev Mohr. The Road to 2020 and Beyond: What's Driving the Global Automotive Industry? Available online: https://www.mckinsey. com/-/media/mckinsey/dotcom/client service/Automotive%20and%20Assembly/PDFs/McK The road to 2020 and beyond.ashx
7. Meneguette, R.I.; Geraldo Filho, P.R.; Guidoni, D.L.; Pessin, G.; Villas, L.A.; Ueyama, J. Increasing intelligence in inter-vehicle communications to reduce traffic congestions: Experiments in urban and highway environments. PLoS ONE 2016, 11, e0159110. [Google Scholar] [CrossRef] [PubMed]
8. Omran, S. S., & Jarallah, J. A. (2017, March). Iraqi car license plate recognition using OCR. In 2017 annual conference on new trends in information & communications technology applications (NTICT) (pp. 298-303). IEEE
9. Kumar VS, Mithun R, Shravan S, Ashwin C, Harikumar M (2020) Image processing based number plate detection using LabVIEW. In: 2020 Third international conference on smart systems and inventive technology (ICSSIT)

Impact of Performance Management Systems as a leveraging mechanism for effective attainment of Organizational Goals: Fuzzy Model Approaches

Subhamitra Nayak
Dept. of MBA(HR)
Astha School of Management (BPUT)
BBSR
✉ subhamitra@asthaeducation.in

Mousumi Panda
Prof. and Dean Research
Regional College of Management(RCM)
BBSR
✉ mousumibbsr2018@gmail.com

L. P. Panda
Dept. of Humanities
Govt. College of Engg.(BPUT)
Kalahandi
✉ lppanda@gcekbpatna.ac.in

ABSTRACT

Performance management systems are critical components of organizational effectiveness, shaping employee behavior, and driving performance towards strategic goals. Traditional approaches often struggle to accommodate the complexity and subjectivity inherent in human performance evaluation. However, the application of fuzzy logic offers a promising avenue for addressing these challenges. Fuzzy logic enables organizations to capture the nuanced nature of performance evaluation, considering factors such as subjective judgments, contextual influences, and evolving priorities. By employing fuzzy logic techniques, organizations can enhance the alignment of individual and team performance with organizational objectives. This alignment fosters employee engagement, motivation, and continuous improvement, thereby driving organizational effectiveness. Furthermore, fuzzy logic facilitates more informed decision-making and resource allocation by providing decision-makers with robust and nuanced insights into performance dynamics. These systems offer a means to navigate the complexities of performance evaluation in dynamic work environments, ultimately contributing to improved organizational performance and competitiveness. Fuzzy models will play an even more important role in improving performance management practices as organisations use data to inform decisions and embrace digital transformation.

KEYWORDS: *Performance management systems, Performance appraisal, Organizational effectiveness Goal, Fuzzy logic.*

INTRODUCTION

Organisations need performance management systems in order to track, assess, and enhance employee performance in accordance with strategic goals and objectives. These systems include a variety of procedures and instruments intended to establish precise standards, offer criticism, carry out assessments, and honour accomplishments in performance. Performance management systems are essential for improving Organizational effectiveness (OE) and attaining goals because they provide a framework for performance accountability and development. The gig economy, the growth of remote work, and the emphasis on agility and adaptability in the face of rapid change have all had an impact on performance management systems (PMS) in recent years. Businesses are using technology to collect data-driven insights to guide decision-making, enable real-time feedback, and expedite performance management procedures [1-2]. Therefore, it is clarifying to take a comprehensive approach to the design and implementation of successful PMS, taking into account

the interaction of people, processes, and technology. Organisations can use performance management as a strategic tool to increase employee engagement (EE), enhance performance outcomes, and gain a long-term competitive advantage by continuously improving and adapting it [3-4]. The degree to which an organisation meets its goals and objectives while optimising efficiency and resource utilisation is known as OE. Financial performance, operational effectiveness, customer satisfaction, staff engagement, innovation, and social responsibility are just a few of the many aspects it includes [5]. In today's fast-paced business environment, maintaining competitiveness, promoting growth, and creating value for stakeholders all depend on achieving OE. Organisational structure, leadership style, culture, market dynamics, technological advancements, and regulatory requirements all have an impact on the pursuit of OE. A balanced scorecard approach, which incorporates quantitative and qualitative indicators across various organisational performance areas, is frequently necessary for measuring the multifaceted nature of OE [6-9]. Effectiveness in an organisation is an ongoing process of innovation and improvement. It necessitates a culture of accountability and ongoing learning, effective leadership, efficient procedures, and strategic alignment. PMS play a crucial role in the success of organisations by providing tools for tracking, evaluating, and improving employee performance in accordance with strategic goals. Nevertheless, it is frequently difficult for conventional methods of performance management to fully capture the subjectivity and complexity present in human performance evaluation. Organisations are looking more and more to fuzzy logic as a potential solution to these problems in order to improve the efficacy of PMS [10]. Organisations can more effectively capture the nuanced nature of performance evaluation by utilising fuzzy logic techniques, which take into account contextual influences and subjective judgements [11]. Ghobakhloo et al. (2011) investigated the application of fuzzy logic in the manufacturing industry's performance management and measurement, emphasising the technology's capacity to handle imprecise and uncertain performance data [12]. Wang et al. (2018) demonstrated the efficacy of fuzzy logic techniques in assessing employee performance within the project management [13]. Aydin et al. (2016) created a fuzzy logic-based workforce planning decision support system that took into account a variety of factors, such as organisational needs, organisational skills, and experience. According to El [14]-Nahas et al. (2019), workers felt that performance management systems based on fuzzy logic were more equitable and transparent, which raised their levels of commitment and job satisfaction [15]. It looks at how PMS affect an organization's ability to function, highlighting how fuzzy logic helps to improve alignment with the organization's objectives and results. There are five sections in this paper. Section I contains an introduction and a review of the literature. The importance of PMS, OE, and their parameters are covered in Section II, and fuzzy logic approaches to goal-finding are covered in Section III. In section IV, the results and discussion were explained. Section V included closing thoughts at the end.

IMPORTANCE OF LEVERAGING PERFORMANCE MANAGEMENT SYSTEM COMPONENTS FOR ORGANISATIONAL EFFECTIVENESS

Significance of boosting PMS parameters for an effective modern organizations

Systems of performance management are comprehensive frameworks created to maximise the effectiveness of organisations by coordinating individual worker performance with organisational objectives. A number of important factors, including employee engagement, performance measurement, technical utilization, and performance appraisal, are crucial for boosting productivity and propelling organisational success in these systems , which are explained briefly below [1-6].The proposed PMS model and its parameter is explained in Fig.1.

- Performance Appraisal (PA): Consistent performance reviews offer organised forums for learning and growth, guaranteeing that staff members are aware of their responsibilities, standards, and potential growth areas. Successful evaluations link employee performance to company objectives, encouraging a continuous improvement and accountability culture. This alignment guarantees that workers' efforts directly support

company goals, which is critical for improving financial performance.

- Performance Measurement (PM): Precise performance measurement helps companies monitor their goals' progress, spot performance gaps, and take corrective action when needed. Organisations can increase productivity and efficiency by using data-driven decision-making tools like key performance indicators (KPIs) and metrics. The financial performance and operational efficiency are directly impacted by these measurements, which guarantee that resources are allocated optimally.
- Employee Engagement (EE): The emotional investment and bond that staff members have with their jobs, co-workers, and company is referred to as employee engagement. Since employee engagement directly affects the efficacy and performance of organisations, it is a crucial PMS parameter. Through a number of initiatives, such as consistent communication, chances for skill development and career advancement, and fostering a positive work environment that recognises and respects employees' contributions, PMS can increase employee engagement. Increased customer satisfaction, employee retention, and profitability are all correlated with employee engagement.

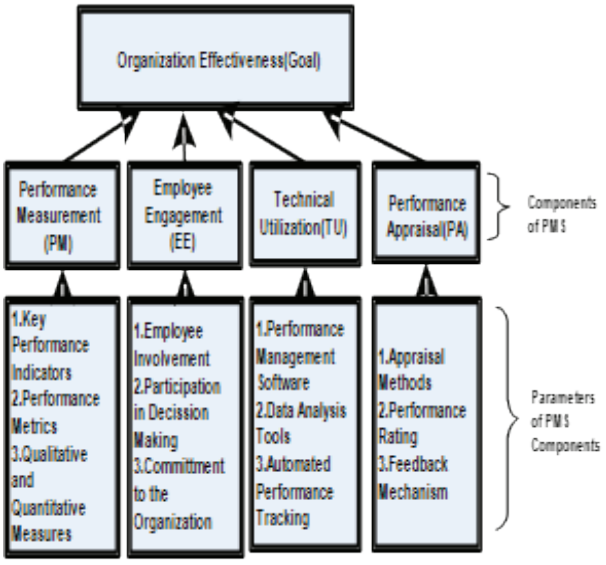


Fig. 1. Proposed working model of PMS and its components

- Technology Utilization(TU): Leveraging technology in performance management, such as using software for tracking performance, gathering feedback, and facilitating communication, enhances the system's efficiency and effectiveness. Technology enables real-time data collection and analysis, providing insights that support timely decision-making and strategic adjustments. This adaptability is essential for fostering innovation and responding to market changes swiftly.

Organizational Effectiveness and its attainments

Organizational effectiveness(OE) is the capacity of an organisation to use its resources effectively and efficiently in order to achieve its goals and objectives. Optimising people, systems, and processes is necessary to maximise output, quality, innovation, and performance [7–10]. For an organisation to endure over time, maintain its competitiveness, and adapt to change, it must be effective. An organization needs to be effective in order to succeed over the long run, stay competitive, and adjust to change. An organization has a number of goals, some of which we have considered to be achieved and explained below. The connection between PMS and OE is displayed in Fig.2.

Financial Performance (FP)

Profitability

Net Income: Overall profit after all expenses and taxes, indicating financial health.

Profit Margins: Revenue above production costs; includes gross, operating, and net margins.

Revenue Growth

Year-over-Year Sales Increase: Annual sales growth, reflecting market expansion.

Return on Investment (ROI)

Financial Gains Relative to Investments: Measures investment profitability, expressed as a percentage.

Employee Productivity (EP)

Output per Employee: Measures average quantity of goods/services produced per employee, indicating workforce efficiency.

Efficiency Ratios: Assesses task/project completion time, highlighting process improvement areas.

Employee Performance Ratings: Scores from performance reviews based on competencies, goal attainment, and work quality.

Stakeholder Satisfaction (SS)

Shareholder Returns: High returns from dividends and stock performance indicate financial strength and investor appeal.

Supplier Relationships: Strong, reliable partnerships enhance consistent production and cost efficiency.

Community Relations: Engagement through CSR programs, charitable giving, and development projects boosts community impact and company reputation.

Innovation and Adaptability (IA)

New Products/Services Launched: Tracks the number of new introductions, indicating innovation and responsiveness to client demands.

Responsiveness to Market Changes: Measures speed in adapting to market trends, essential for competitiveness.

R&D Investment: Examines budget for research and development, correlating with innovation and long-term growth.

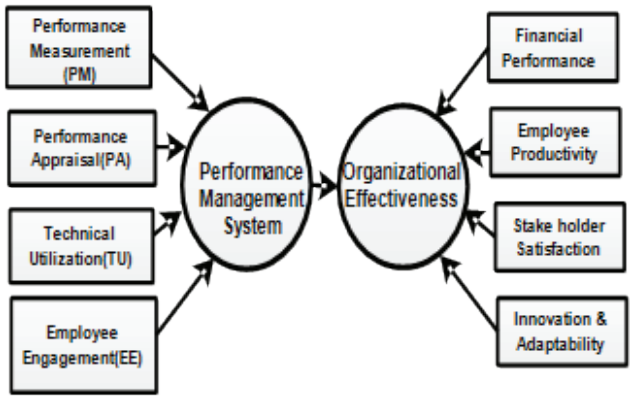


Fig. 2. Schematic of the connection between OE and PMS

PROPOSED FUZZY MODELS FOR ANALYZING THE DRIVERS OF PMS ON ORGANIZATIONAL EFFICACY

The Fuzzy logic model is designed with four primary components[17].Fuzzification is the process of mapping crisp inputs onto the appropriate membership functions (MF) in order to transform them into fuzzy inputs. The degree to which the input parameters belong to the fuzzy sets is captured by this process. A logical assertion that connects fuzzy inputs to fuzzy outputs is known as a fuzzy rule. Fuzzy rules are commonly written as "if-then" statements, in which the action or conclusion to be taken is specified in the consequent (or "then") part and the antecedent (or "if") part specifies the conditions under which the rule applies. Expert knowledge or heuristics can be encoded into a fuzzy logic system using fuzzy rules, enabling it to make decisions based on both subjective and qualitative criteria. Applying the inference rules to the fuzzy input and producing the fuzzy output is the responsibility of the inference engine [17–20].

The centroid method is used in defuzzification to transform fuzzy sets into values that are crisp. Three Trapezoidal MFs are assigned to each input PMS parameter, and these are briefly described in Figures 3 to 6. Similarly, figure 7 illustrates the output as the OE Goal as five MFs.A set of fuzzy if-then rules is used to prepare the fuzzy rules [17].

There are 81 rules prepared such as

1. If PM is Low, EE is Low, TU is Low, PA is Low, then OE (Goal) is VL.

2. If PM is High, EE is High, TU is High, PA is High, then OE(Goal) is Very High.

3. If PM is Medium ,EE is Medium, TU is Medium, PA is Medium then OE(Goal) is Medium.

The other rules are prepared in a similar manner.

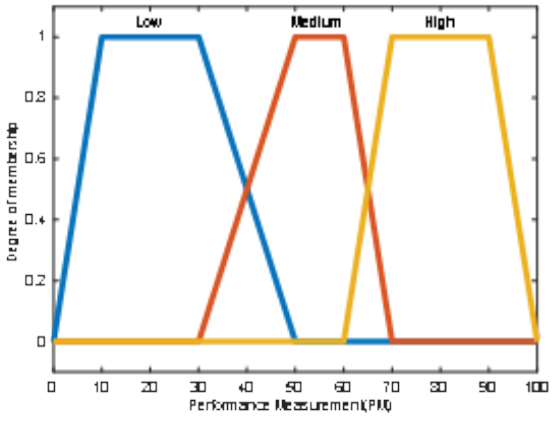


Fig. 3. Input MF of Performance Measurement (PM)

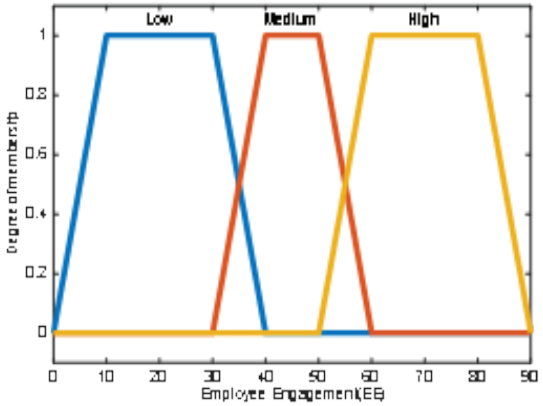


Fig. 4.Input MF of Employee Engagement (EE)

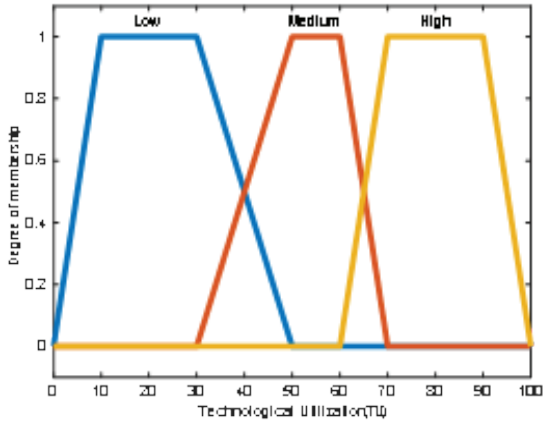


Fig. 5. Input MF of Technological Utilization (TU)

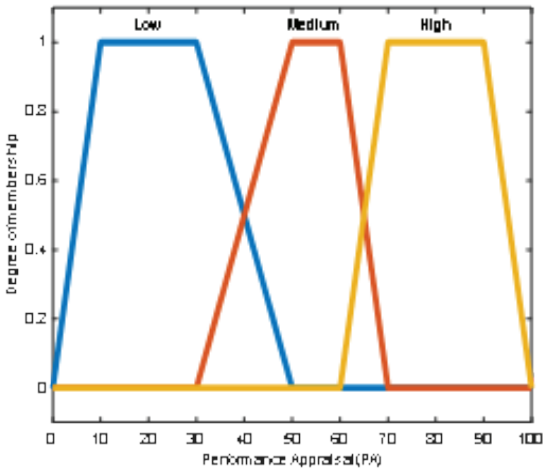


Fig. 6. Input MF of Performance Appraisal (PA)

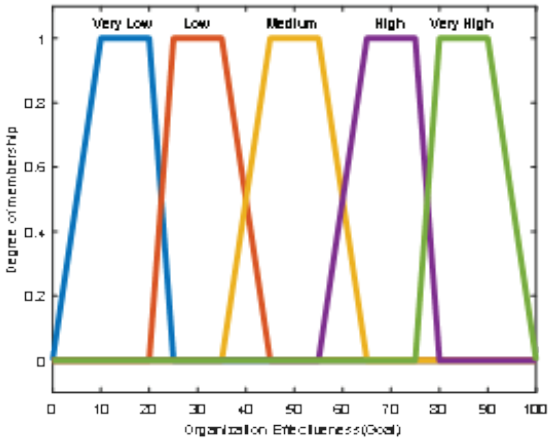


Fig. 7. Output MF of Organizational Effectiveness

The author has proposed two types of fuzzy models, which are briefly explained below.

Fuzzy model-1

Fuzzy model-1 takes as inputs PMS parameters like Performance Appraisal (PA), Employee Engagement (EE), Performance measurement(PM), and Technological Utilization (TU). The model's output is called OE Goal which depends on all input PMS parameters. Figure 8 shows the Fuzzy inference model-1.

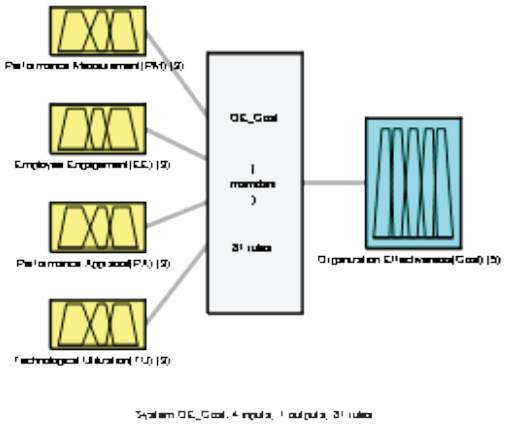


Fig. 8. Simulation diagram of Fuzzy model-1

Fuzzy model-2

It is a multi-stage fuzzy model involves sequential processing stages to evaluate complex systems. In the first stage, individual input parameters of PMS components are fuzzified to produce intermediate

outputs such as PM goal, PA goal, EE goal and TU goal. These outputs serve as inputs for the subsequent stage, where the overall OE goal is assessed. This approach enhances accuracy and granularity in performance evaluations. The author has suggested eighty-one rules for this model. Figure 9 illustrates the Fuzzy inference model-2.

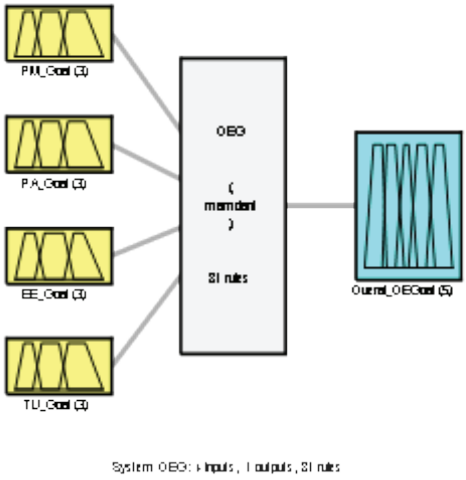


Fig. 9. Simulation diagram of Fuzzy model-2

RESULTS AND DISCUSSION

The results of the study showed that PMS parameters and fuzzy logic increased organisational effectiveness. The suggested fuzzy models are simulated using the Matlab/ Simulink tool. Figure 10 exhibits the surface view graph for Fuzzy model-1, and Figure 11 displays the surface view graph for Fuzzy model-2. The relationships between PMS parameters and organisational effectiveness are clarified by these graphics. Moreover, the bar graphs of Organisational Effectiveness (Goal) in Figure 12 and Overall Organisational Effectiveness (Goal) in Figure 13 offer a comparative study of the two fuzzy models' effectiveness in achieving organisational goals. These results demonstrate how important it is to apply a comprehensive and advanced approach to performance management in order to increase the overall effectiveness of the organisation. The results of our study indicate a significant relationship between OE and PMS. These findings suggest that organisations can improve their efficacy by implementing comprehensive and adaptable PMS strategies. Similarly, Figure 14 shows the regression value of 0.9896 for Fuzzy model-1, indicating the relationship between specific PMS parameters and organisational effectiveness. Even though it is only slightly less than the overall regression value, this indicates that the different PMS components have a major impact on the organization's goals. Figure 15 displays the graph for Fuzzy model-2, which has a regression value of 0.9999. It shows a strong correlation between the overall goals of the organisation and the effectiveness of the PMS strategy that was employed. The Regression value of said Fuzzy models are represented in Table 1. The achievement of organisational objectives is significantly influenced by the PMS approach, as indicated by the high regression value. In summary, the regression values support the notion that improving overall effectiveness and performance requires a careful alignment of PMS strategies with organisational goals.

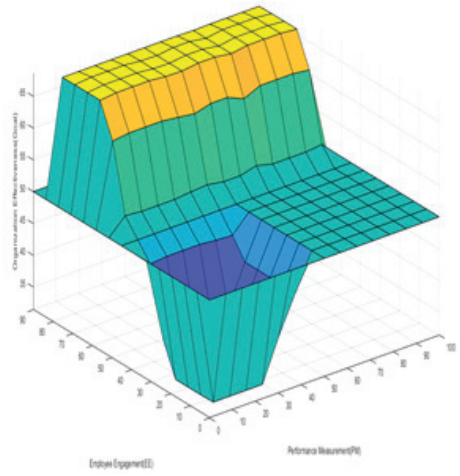


Fig.10. Surface view graph of Fuzzy model-1

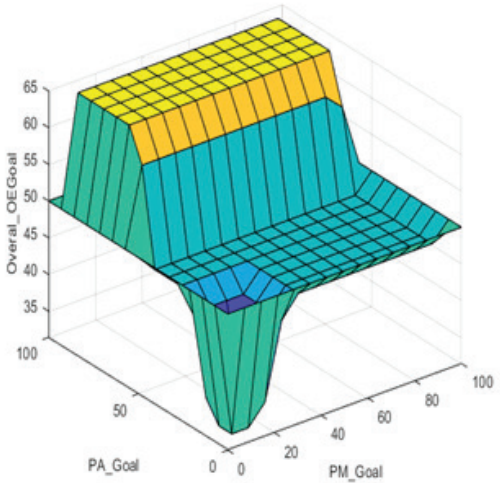


Fig.11. Surface view graph of Fuzzy model-2

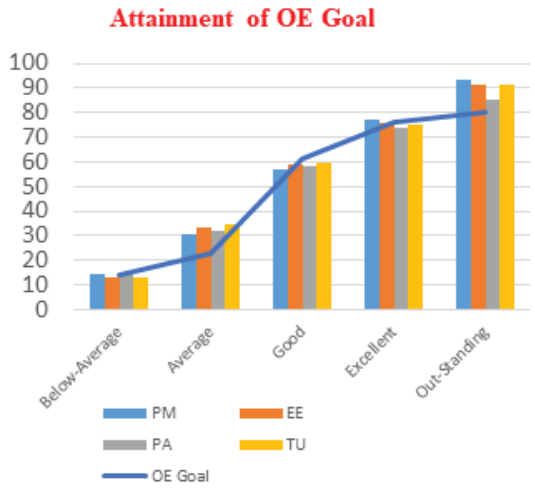


Fig.12. Bar Graph response of Fuzzy model-1

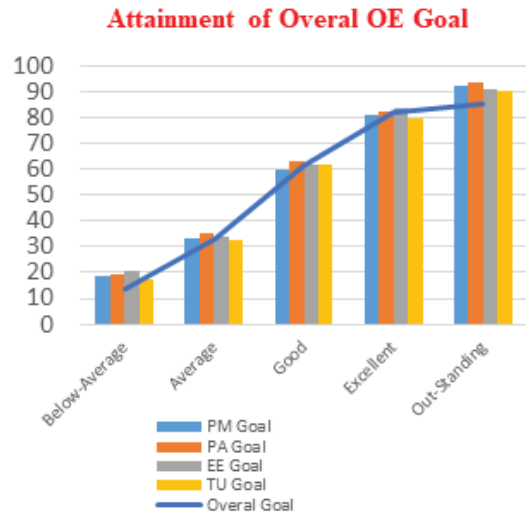


Fig.13. Bar Graph response of Fuzzy model-2

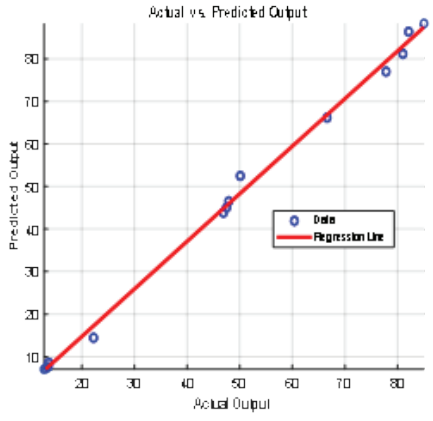


Fig. 14. Fuzzy model-1 Regression graph

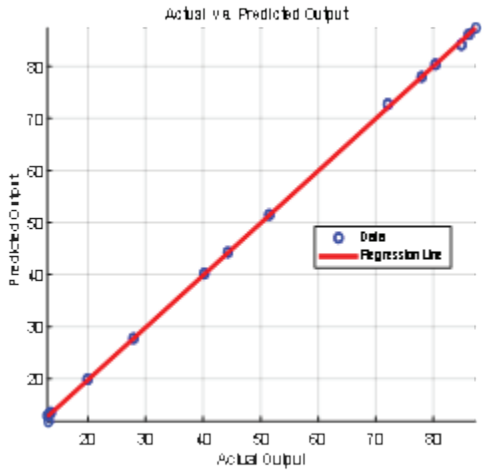


Fig. 15. Fuzzy model -2 Regression graph

Table 1.Regression value comparison

REGRESSION	Fuzzy model-1	Fuzzy model-2
	0.9896	0.9999

CONCLUSION

By employing an innovative methodology founded on fuzzy logic, this research has shed light on the intricate connection between PMS and OE. Through a comprehensive empirical investigation, we have demonstrated that PMS significantly affects many aspects of organisational effectiveness. Our findings highlight the dynamic nature of this relationship, which is influenced by different contexts and factors within organisational settings. Moreover, fuzzy logic has proven to be an essential tool for understanding the nuances and complexity of the relationship between OE and PMS. Specifically, our analysis has demonstrated that the use of a variety of fuzzy variables and linguistic terms in fuzzy models leads to better performance than traditional models.

This demonstrates how fuzzy logic can be used to provide a more complex understanding of the relationship, which improves the predictive accuracy and usefulness of our findings for practitioners in organisations.

REFERENCES

1. H. Aguinis, "Performance management and employee engagement," Human Resource Management Review, vol. 19, no. 2, pp. 210-220, 2009.

2. M. Armstrong and A. Baron, "Managing performance: Performance management in action," CIPD Publishing, 2005.

3. R. L. Cardy and G. H. Dobbins, "Performance appraisal: Alternative perspectives," South-Western Publishing Company, 1994.

4. A. S. DeNisi and K. R. Murphy, "Performance appraisal and performance management: 100 years of progress?" Journal of Applied Psychology, vol. 102, no. 3, pp. 421-433, 2017.

5. A. Gupta and J. D. Shaw, "Employee turnover intentions: A review and synthesis," Human Resource Management Review, vol. 24, no. 2, pp. 173-193, 2014.

6. M. Rehman and J. Iqbal, "Impact of Performance Appraisal on Employee Performance with Organizational Commitment as a Mediator," Journal of Managerial Sciences, vol. 14, no. 1, pp. 96-109, 2020.

7. B. K. Joo and H. Park, "Career satisfaction, organizational commitment, and turnover intention: The effects of goal orientation, organizational learning culture and developmental feedback," Leadership & Organization Development Journal, vol. 31, no. 6, pp. 482-500, 2010.

8. S. M. Lee and S. Yun, "The impact of knowledge sharing on organizational effectiveness: A structural equation modeling approach," The Journal of Computer Information Systems, vol. 55, no. 2, pp. 70-78, 2015.

9. M. Schraeder, J. B. Becton, and R. Portis, "A critical examination of performance appraisal system and the influence of implementation on organizational effectiveness," Journal of Management Development, vol. 26, no. 1, pp. 105-123, 2007.

10. S. M. Yu, K. M. Kim, and K. S. Na, "The effects of social media-based performance management on organizational effectiveness: The mediating role of employee satisfaction," Computers in Human Behavior, vol. 120, p. 106724, 2021.

11. L. A. Zadeh, "Fuzzy sets," Information and Control, vol. 8, no. 3, pp. 338-353, 1965.

12. M. Ghobakhloo, D. Arias-Aranda, J. Benitez-Amado, and M. Fathi, "Fuzzy logic approach for performance measurement in manufacturing," International Journal of Advanced Manufacturing Technology, vol. 52, no. 9-12, pp. 1097-1110, 2011.

13. Y. Wang, H. Hu, Y. Zhang, and G. Peng, "Application of fuzzy logic to performance appraisal in project management," IEEE Access, vol. 6, pp. 20823-20834, 2018.

14. M. E. Aydin, M. Dagdeviren, and Ö. B. Kan, "A fuzzy decision support system for workforce planning," International Journal of Industrial Engineering Computations, vol. 7, no. 4, pp. 493-508, 2016.

15. T. El-Nahas, T. Abdallah, M. El-Halwagy, and H. Gomaa, "Fuzzy logic approach for performance management systems in organizations," International Journal of Computer Applications, vol. 181, no. 4, pp. 20-26, 2019.

16. Y. Zhang and G. Hua, "Fuzzy logic-based performance evaluation model for project management," Journal of Intelligent & Fuzzy Systems, vol. 36, no. 4, pp. 3123-3132, 2019.

17. S. Nayak, M. Panda and L. P. Panda, "Impact of Emotional Intelligence Training on Performance Management Systems Upshoting Organizational Effectiveness Using Fuzzy Logic Approach," 2023 1st International Conference on Circuits, Power and Intelligent Systems (CCPIS), Bhubaneswar, India, 2023, pp. 01-05

18. H. Liu, H. Huang, and J. Zhang, "Fuzzy logic-based performance management systems and employee motivation: An empirical study," International Journal of Human Resource Management, vol. 31, no. 12, pp. 1537-1557, 2020.

19. L. A. Zadeh, "Outline of a new approach to the analysis of complex systems and decision processes," IEEE Transactions on Systems, Man, and Cybernetics, vol. 1, pp. 28-44, 1973.

20. M. Jafari, M. Tavana, and D. Di Caprio, "A fuzzy logic-based decision support system for resource allocation in project management," Expert Systems with Applications, vol. 103, pp. 172-186, 2018.

A Comparative Analysis of LSTM and ResNet Models for Heart Sound Classification

Shubhangi Mahadik, Nidhi Poonia
Assistant Professors
✉ shubhangipatil@gmail.com
✉ mca.nidhipoonia@gmail.com

Tanmay Katkar, Anish Bhutkar
✉ katkartanmay@gmail.com
✉ anishbhutkar77@gmail.com

Bharati Vidyapeeth Institute of Management and
Information Technology
Navi Mumbai, Maharashtra

ABSTRACT

This research paper presents a comparative analysis of two deep learning models, Long Short-Term Memory (LSTM) recurrent neural network (RNN) and Residual Network (ResNet), in the context of a specific task. The study aims to evaluate and contrast the performance of these models based on their accuracy metrics. Results in Experimental reveal that the ResNet model achieves a significantly higher accuracy of 85% compared to the LSTM model, which achieves an accuracy of 66%. The findings suggest that the ResNet architecture outperforms LSTM in the given task, indicating its superiority in capturing and leveraging the underlying features of the dataset. Overall, this comparative analysis contributes to the understanding of the strengths and limitations of LSTM and ResNet architectures in real-world applications, providing valuable information for future research and development in deep learning methodologies.

KEYWORDS: *Heart sound analysis, Classification, Machine learning, Cardiovascular diseases, Signal processing, Deep learning, Residual Network (ResNet), Comparative analysis, Accuracy evaluation, Long short-term memory (LSTM).*

INTRODUCTION

Prior to the 19th century, physicians attempted to detect diseases by directly observing the heartbeat through the patient's chest, a method known as "immediate auscultation," which was deemed unethical and unscientific. In 1816, Laennec introduced the stethoscope, a medical device utilized for listening to heart sounds.

Since then, the stethoscope has become a widely adopted tool in the medical profession for diagnosing heart conditions [1]. Identifying heart failure and coronary heart disease poses a challenge for individuals lacking clinical expertise or experience with a stethoscope. Even with precise auscultation, proficiency in diagnosis necessitates extensive training and years of clinical experience, which can be challenging to acquire [2]. Heart disease is the foremost basis of death for humans in the current decades. Therefore, a good cardiac disease prediction model raises patient awareness of the need for critical care [3]. For researchers, attaining high precision in automated algorithms for classifying heart sounds has been a long-standing objective. Common methods for classifying heart sound indications are characterized into two main groups: traditional machine learning approaches and deep learning techniques. Considering advancements in medical big data and artificial intelligence, there is growing attention towards utilizing deep learning methodologies for heart sound classification [5]. The aim of this research is to conduct a comparative analysis of deep learning models to assess their accuracy in a specific task. Insights will be gained into the performance characteristics of each model, ultimately informing decisions regarding their suitability for practical deployment.

LITERATURE REVIEW

Overview of LSTM: This paper [4] by Sherstinsky, A. et al. provides a detailed explanation of LSTM networks and RNNs, formally deriving RNN formulation from differential equations, proposing precise RNN unrolling technique, addressing RNN training difficulties, and identifying new LSTM variant opportunities. This research [5] presents methodology for early detection of cardiac and cardiovascular diseases, using RNN and LSTM hybrid approaches. The system's performance is evaluated using various machine learning and soft computing methods, proving more accurate than traditional techniques. The paper [6] by Chen, Y, et al. proposes a Duration LSTM to address limitations in neural network-based heart sound segmentation, incorporating duration features and demonstrating promising performance in real-world phonocardiogram datasets. Hochreiter and Schmid Huber et al. introduced LSTM networks in 1997, LSTM networks represent a specialized variant of recurrent neural networks crafted specifically to mitigate the challenge of the vanishing gradient problem [11]

Overview of ResNet:Residual Networks (ResNet), proposed by The et al. in 2015, introduced the concept of residual learning to facilitate the training of very deep neural networks [12]. This paper [7] by Bharath P and Nahak S et al. introduces a method for automatically classifying Congestive Heart Failure (CHF) beats using attention-based Residual Networks, achieving high accuracy, sensitivity, and specificity in ECG recordings. This paper [8] by Yoo, H et al. presents a cardiomegaly diagnosis support model using Reset and an explainable feature map, achieving near 80% accuracy and providing a visually expressed feature map, potentially applicable to medical support systems. This paper [9] by Maqbool, K et al. uses neural network models and ResNet 50 to accurately identify cardiac illnesses from ECG trace images, achieving 99.12% accuracy, emphasizing the importance of early diagnosis. Several studies have compared the performance of LSTM and ResNet models across various tasks and datasets. For instance, Liang et al. (2020) evaluated the performance of both architectures in image classification tasks, finding that ResNet models achieved higher classification accuracy and were more robust to variations in input data.

EXISTING SYSTEM

In contemporary cardiovascular health monitoring, the predominant methods involve clinical evaluations and diagnostic tests facilitated by healthcare professionals. Electrocardiograms (ECGs) and similar medical devices are pivotal in this regard, offering comprehensive insights into cardiac health.

The current landscape of cardiovascular health monitoring systems thus faces several challenges. Firstly, the dependency on professional interpretation and specialized equipment restricts accessibility, particularly for individuals in remote or underserved areas. Secondly, the prevailing mHealth applications fail to provide comprehensive solutions for analyzing heartbeat sounds, which are integral for detecting cardiac abnormalities at an early stage.

The lack of user-centric, at-home solutions for classifying heartbeat sounds into specific categories, such as Normal, Extrasystole, and Murmur, is a notable gap in the existing system. Such categorization is crucial for both early detection and continuous monitoring of cardiovascular conditions, as it enables timely interventions and personalized healthcare management strategies.

In summary, the existing cardiovascular health monitoring systems exhibit limitations in terms of accessibility, comprehensiveness, and user-centricity. Addressing these challenges requires the development of innovative solutions that leverage emerging technologies, such as machine learning algorithms, to enable accurate and convenient analysis of heartbeat sounds for early detection and continuous monitoring of cardiac abnormalities.

PROBLEM DEFINITION

Despite the significant advancements in cardiovascular health monitoring, there exists a critical gap in early detection and diagnosis of cardiac abnormalities. Traditional methods, such as electrocardiography (ECG) and auscultation, often require specialized equipment and professional interpretation, limiting their scalability and accessibility, particularly in resource-limited settings.

There is a lack of a user-centric at-home solution for

classifying heartbeat sounds into specific categories. Current systems lack the capability to provide comprehensive analysis and continuous monitoring of cardiac function, which is crucial for timely interventions and personalized healthcare management strategies.

Therefore, the problem statement revolves around the need to develop an innovative solution that leverages emerging technologies, such as machine learning algorithms, to enable accurate and convenient analysis of heartbeat sounds for early detection and continuous monitoring of cardiac abnormalities.

OBJECTIVE

To Analyze LSTM Model for heart sound classification:

Techniques such as data preprocessing, model training, and evaluation are employed to gain understandings into the fortes and restrictions of the LSTM model for this specific application. The expected outcome is a comprehensive understanding of how LSTM performs in classifying heartbeat sounds.

To Analyze ResNet Model for heart sound classification:

This objective focuses on the analysis of the Residual Network (ResNet) model, used for classification of heartbeat sounds. The expected outcome is insights into the performance characteristics of the ResNet model, including its ability to capture intricate features in heartbeat sounds and its comparative performance against the LSTM model.

To Compare LSTM and ResNet Models for heart sound classification:

This objective aims to compare the LSTM and ResNet models comprehensively, highlighting their respective strengths, weaknesses, and performance differences. The comparison involves a side-by-side evaluation of key metrics such as accuracy. Statistical analysis and visualizations are utilized to illustrate the differences in performance between the LSTM and ResNet models.

Result Analysis for heart sound

The focus is on analyzing the results obtained from the comparison between the LSTM and ResNet models. The expected outcome is a conclusive assessment of the performance of the LSTM and ResNet models, along with insights into their implications.

RESEARCH METHODOLOGY

The study's research methodology incorporates a variety of stages to develop a robust system for heartbeat sound analysis and classification. In figure 1 the system flow is shown and it involves the following key steps:

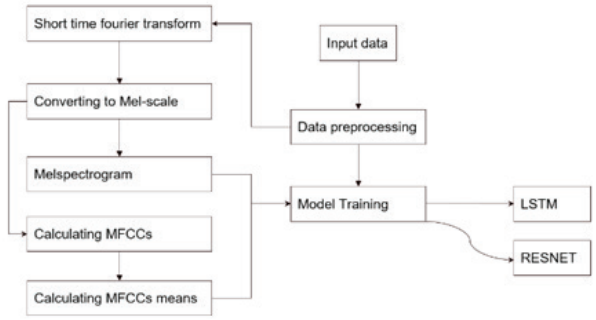


Fig. 1. System flow Diagram

Data Collection: Two distinct datasets, denoted as Dataset A and Dataset B, are utilized in this study. Dataset A contains recordings of heartbeat sounds categorized into Normal, Artifact, Extrasystole, and Murmur, acquired under normal conditions from human subjects. Dataset B, on the other hand, comprises professionally recorded data with lower levels of noise and consists of Normal, Extrasystole, and Murmur categories. In figure 2 there is an overview of an entire dataset.

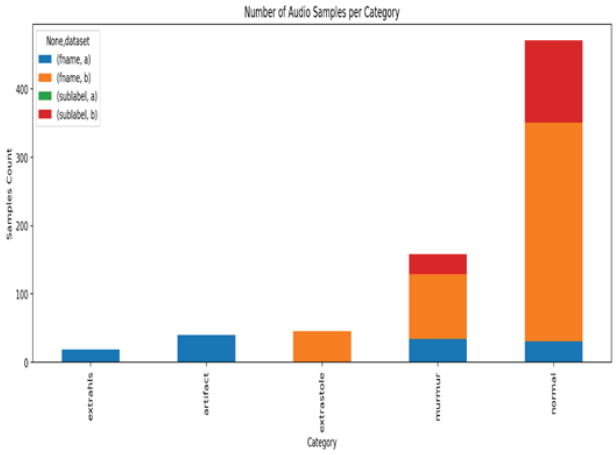


Fig. 2. Dataset Overview

Data Preprocessing: Before analysis, the audio undergoes preprocessing. This involves the Short Time Fourier Transform, breaking down the signal into its frequency components across short time intervals. To remove unwanted noise and isolate heartbeat sounds

within a specific frequency range, bandpass filtering is applied.

Melspectrogram: The processed audio is transformed into a Melspectrogram, a 2D representation with time on one axis, frequency on the other, and intensity indicating the magnitude of frequency components. This provides a detailed visual of the audio's frequency content over time.

Calculating MFCCs: From the Mel spectrogram, Mel-frequency cepstral coefficients (MFCCs) are derived. These coefficients capture essential features of the audio signal by representing its short-term power spectrum, aiding in effective analysis.

Model Training: The MFCCs are then fed into a model for training. This model combines LSTM and ResNet architectures, enabling the analysis of audio patterns over time.

Feature Extraction: In figure 3 Mel Frequency Cepstrum Coefficients (MFCCs) are extracted from the spectrograms to capture essential features from the audio signals. MFCCs provide a concise representation of the spectrum of an audio signal, containing information about frequency changes across different bands.

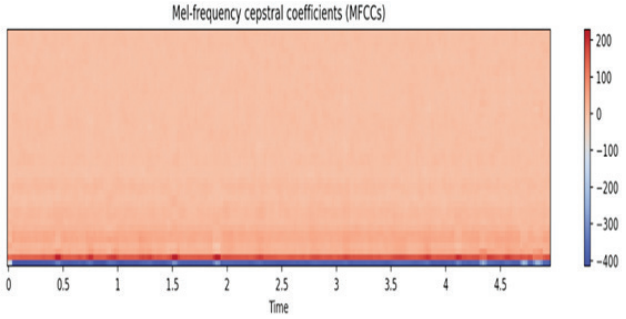


Fig. 3. Mel Frequency Cepstrum

Algorithmic Details(LSTM): in Figure 4 Recurrent Neural Networks (RNNs) utilizing architecture are chosen for heartbeat sound classification. LSTM networks are well-suited for handling sequential data and capturing long-term dependencies, making them suitable for this task.

Algorithmic Details (Resnet): ResNet is a deep learning architecture that effectively trains deep neural networks using residual blocks. These blocks introduce skip connections to alleviate gradient problems, allowing gradients to flow more directly. ResNet is particularly effective in tasks like image classification and object detection, contributing significantly to deep learning advancements.

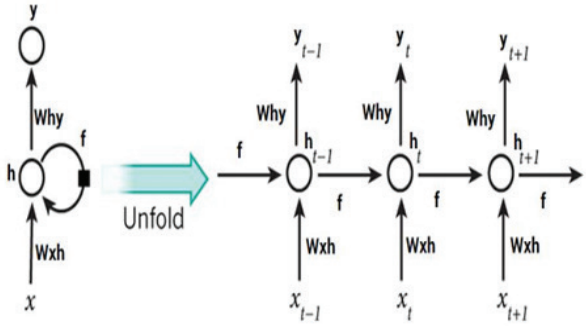


Fig. 4. Structure of LSTM

RESULT & FINDINGS

The comparative analysis of two deep learning models, ResNet and LSTM, revealed significant differences in their performance. In Figure 6 ResNet achieved an accuracy of 85%, LSTM lagged with an accuracy of 66%. This suggests that ResNet outperforms LSTM in the given task of classifying heart sound recordings.

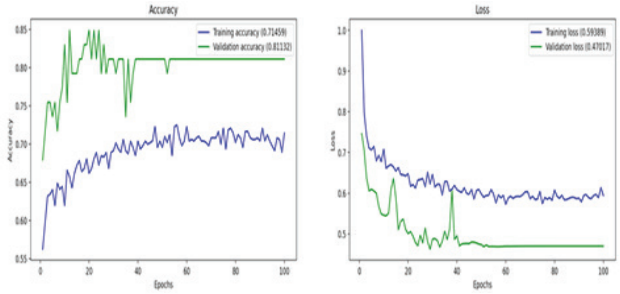


Fig. 5. Loss and Accuracy LSTM Model

Confusion Matrix (ResNet)

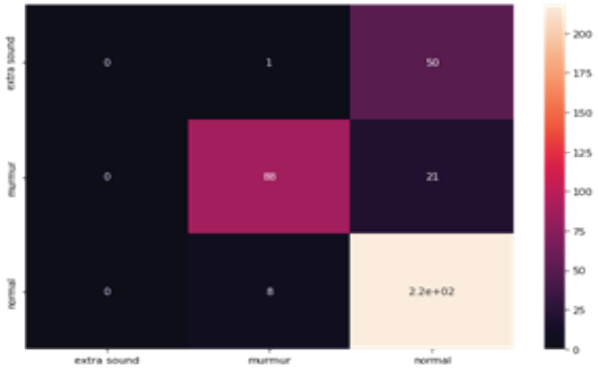


Fig. 6. Confusion Matrix

Loss and Accuracy (ResNet)

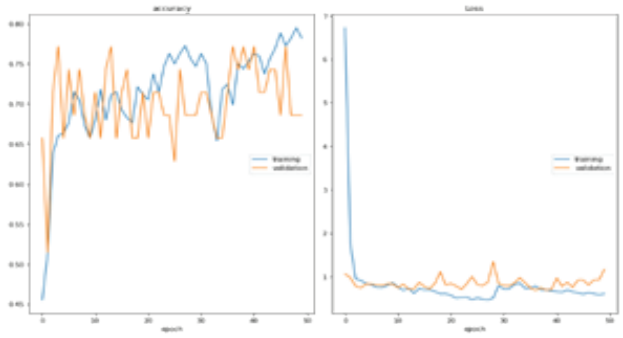


Fig. 7. Loss and Accuracy ResNet Model

Both models were expert using the Adam optimizer with a learning rate (LR) of 0.001. The training process for ResNet was configured for 20 epochs, whereas LSTM was trained for a maximum of 100 epochs. The softmax activation function was utilized in both models, as it effectively handles multi-class classification problems, providing categorical outputs. From figures 5 and 7, The higher accuracy achieved by ResNet indicates its effectiveness in capturing and leveraging the features present in heart sound recordings.

CONCLUSION

In conclusion, this research paper proposes a deep learning model designed to accurately classify heartbeat sounds into Normal, Murmur, and Extrasystole categories. By applying bandpass filtering and extracting features using Mel Frequency Cepstrum Coefficients (MFCC), we achieved promising results. Among the two deep learning models which are LSTM and Resnet, ResNet stood out with an impressive accuracy of approximately 85%. These findings suggest the potential of deep learning techniques in improving the detection and classification of cardiac abnormalities, offering valuable insights for future research and practical applications in healthcare.

REFERENCES

1. Hanna, I. R., & Silverman, M. E. (2002). A history of cardiac auscultation and some of its contributors. The American journal of cardiology, 90(3), 259-267.
2. Jiang, Z., & Choi, S. (2006). A cardiac sound characteristic waveform method for in-home heart disorder monitoring with electric stethoscope. Expert systems with applications, 31(2), 286-298.
3. Manur, M., Pani, A. K., & Kumar, P. (2020). A prediction technique for heart disease based on long Short term memory recurrent neural network. International Journal of Intelligent Engineering and Systems, 13(2), 31-39.
4. Sherstinsky, A. (2020). Fundamentals of recurrent neural network (RNN) and long short-term memory (LSTM) network. Physica D: Nonlinear Phenomena, 404, 132306
5. Bhavekar, G. S., & Goswami, A. D. (2022). A hybrid model for heart disease prediction using recurrent neural network and long short term memory. International Journal of Information Technology, 14(4), 1781-1789.
6. Chen, Y., Lv, J., Sun, Y., & Jia, B. (2020). Heart sound segmentation via duration long–short term memory neural network. Applied Soft Computing, 95, 106540.
7. Bharath, P., Nahak, S., & Saha, G. (2024, February). A ResNet-Attention Approach for Detection of Congestive Heart Failure from ECG Signals. In 2024 National Conference on Communications (NCC) (pp. 1-6). IEEE.
8. Yoo, H., Han, S., & Chung, K. (2021). Diagnosis support model of cardiomegaly based on CNN using ResNet and explainable feature map. IEEE Access, 9, 55802-55813.
9. Maqbool, K., Singh, R. P., & Mehra, M. (2022). A CNN and ResNet 50 Approach to Detect Cardiac Diseases using ECG Images. Int J Res Appl Sci Eng Technol, 10(11), 641-651.
10. Liang, Y., Sun, W., Li, Y., & He, Y. (2020). Comparative Analysis of LSTM and ResNet for Image Classification. Journal of Visual Communication and Image Representation, 71, 102825.
11. "Long Short-Term Memory." Long Short-Term Memory - an Overview | ScienceDirect Topics, 2021, Accessed 12 Apr. 2024.
12. Wang M, Guo B, Hu Y, Zhao Z, Liu C, Tang H. Transfer Learning Models for Detecting Six Categories of Phonocardiogram Recordings;9(3):86.
13. Pathak A, Mandana K, Saha G. Ensembled Transfer Learning and Multiple Kernel Learning for Phonocardiogram Based Atherosclerotic Coronary Artery Disease Detection; 26 (6): 2804-13.
14. Luo H, Lamata P, Bazin S, Bautista T, Barclay N, Shah Mohammadi M, et al. Smartphone as an electronic stethoscope: factors influencing heart sound quality. European Heart Journal-Digital Health. 2022;3(3):473-80.

Cloud based Recommended Employability Score Evaluation System for Prediction of Employability Performance of it Undergraduates

Seema S. Patil
Assistant Professor
College of Computer Application for Women
Satara, Maharashtra
✉ seemap1983@rediffmail.com

P. P. Patil
Associate Professor
Bharati Vidyapeeth (Deemed to be University) Pune
Y. M. Institute of Management
Karad, Maharashtra,
✉ prashant.patil@bharatividyapeeth.edu

ABSTRACT

Education through professional courses aims to prepare students job ready. But still employability of students has become an issue. Unemployment of graduates is increasing if they lack in proper guidance and training provided by universities or Higher Education Institutes. The paper focusing on under graduate computer application(BCA) students in overall. The main objective of this paper is to find out Employability score of each undergraduate BCA student after continuous evaluation of different skills.

At college level only academic performance is measured and considered as an important factor/parameter to be employable. but during campus interviews, academic as well as soft skills, Technical skills, Mock Interview performance are taken into consideration. Hence to make undergraduate students to be employable and prepared for getting the job, proper guidance and training is necessary and performance evaluation/measurement related to all above things need to be done at college level from first year instead of Last year of their higher studies(Ravichandran and Abirami, 2017).

To calculate Employability score, author assumed certain Employability skills parameters Academic Performance(AP),Aptitude Skills(AS),Technical Skills(TS),Communication Skills(CS),Internships, Projects and Extra-curricular activities etc. after reviewing existing literature and multinational companies eligibility criteria. Cloud based Employability score Evaluation system has different users like College Student, University, College/ Institutes, Employers. This paper suggests cloud based Employability score Evaluation system which will help students to predict weather student is ready for job or not or to enhance their employability skills, universities to design course curriculum, helps college to determine probability of student's Placement and reduce industry training cost.

KEYWORDS: *Employability skills, Employability score, Cloud computing Model, Prediction, Analysis.*

INTRODUCTION

To be a competent employee in an organization, an individual needs employability skills. A NASSCOM report(2020) suggests that, most of the higher education Institutions in India emphasizes on Theory-Based education rather than Skill-based education. The institutes need to shift their focus from Traditional method(which delivers theoretical knowledge) to skill based education(which delivers knowledge with practical and dynamic approach). According to National Education Policy 2022, Universities and Higher Education Institutions provides activity based and skill based education for undergraduate students. But currently we found that some of the colleges are providing UG Professional theory based curriculum to undergraduate course which is not satisfying industry request[15]. Unemployment of graduates is increasing

if they lack in proper guidance and training provided by universities or Higher Education Institutes. According to India Skills Report 2022, only 29.3% computer application students get employed. We know that, in IT industry, new technologies are updating continuously. To cope up with these technologies, employers expect UG BCA students to have good employability skills. Here we are focusing on certain skills such as Academic skills, Technical skills, and Soft skills. This varies degree to degree in the various Higher Education Institutes. We found that Higher Education Institutes & students are more aware when they reach to their final year/semester of their UG degree. Somewhere that time it was too late to get good skills in the final year/ semester. The paper aims to measure their performance in yearly in addition to the skills as mentioned above and be warned about their performance apart from the academic performance. We propose Cloud based Employability score Evaluation model which aims to measure their skills based performance year wise from the admissions to the final year during UG education in the HEIs.

CLOUD COMPUTING

cloud computing refers to an internet-centric way of doing computing. Internet play fundamental role of either medium or platform through which many cloud computing services are made accessible and delivered. Cloud Computing can be summarized as user don't care about where servers are located, who manages them, where documents are stored or where applications are hosted. User just wants them always accessible and available from any device connected through internet and willing to pay for a particular service for as long as he need it. Examples of cloud computing are Google Drive, Dropbox, facebook, Gmail, salesforce ,Google docs, IBM Cloud, Amazon web service, etc.

Following are various Service models of Cloud computing is based on.

1) Software-as-a-Service (SaaS)

2) Platform-as-a-Service(PaaS)

3) Infrastructure-as-a-Service(IaaS)

Essential characteristics of the cloud computing are :

- On-demand self-service : User able to provision, monitor and manage computing resources without any human intervention.
- Broad network access : Services can be accessed via web browser from any device ,any location at any time.
- Resource pooling: IT resource i.e. Networks, servers , storage, applications and services are shared among multiple clients .
- Rapid Elasticity: Resources can be added or removed to suit the organizational needs.
- Measured service: Payment is based on actual consumption by the customer via a pay-for-what-you-use model.

LITERATURE REVIEW

Employability

According to Confederation of British Industry (2009), Employability is a capability of being effective in the workplace by possessing set of skills and knowledge demanded by their employer [6][14][17].

Employability is the ability to perform the job as per the demand of the industry or the employers and avail the new job opportunities available in the labour market[7].

Employability skills are also known as Transferable skills because such skills could be applied in the various fields of work and are not specific to one particular job or field[7]

Employability score

Employability score is a tool that will clearly indicate if the undergraduates exhibits the positive work habits in the job market[1].It also tells you how likely students meet employers expectations or what are chances of success in the job market at the current skill level[2].

Employability score is aggregate of General Aptitute Test,communication skills(verbal+written),Presentation skills,subject knowledge(Technical Test) and HR interview[2]

Expectations of students and Employers from HEI

According to India Skills Reports 2022, in India most employable talent was identified to be between 22-25 years of age of various fields but only 29.3% computer application students get employed. however employability skills requirements are ever-changing time to time by region, sector and occupation. Hence

as per organizations requirements certain important set of employability skills need to be determined. Again to recognize, understand, expand and evaluate Employability score is difficult task. To make this task easy, academia and industry need to interact with each other, develop array of models to enhance employability through coaching and training given along with academic syllabus at college level[9].

Employers expect that not only academic capabilities but also additional qualities are also necessary for successful journey from college level education to the job .

Employers expect that students from the academia are ready to work without any initial training in the industries. To provide training to students after recruitment cause huge training cost[16]

Research revealed that perception of all undergraduate students from arts, commerce, science, management and IT students on employability skills that college is main resource for imparting employability skills. Hence along with academic syllabus, employability skills training and coaching should be delivered through college.[12]

Educational institutions plays a key role in placements to prepare and guide the students through the process of placements by providing them required training [19]

Again, to enhance Graduate employability various activities need to be organized by HEI are Internships, business quiz, seminars , conferences, career counseling sessions, projects, industrial visits, employment related training[7]

To work efficiently in IT industry, Graduates needs soft skills as well as technical skills. But growth of IT industry with rapid and consistently technological changes cause skill gaps among graduates in the workplace. Because required skills may vary from industry to industry. So only with technical skills graduates will not function effectively in today‘s industries. As a consequence, need to take interest and pay more attention on how to improve graduates soft skills and technical skills[17]

In current scenario of Graduates Employability, HEI emphasize on completion of University syllabus and not delivering knowledge about employability skills. Though the job market has high level of demand of skills graduates but many of them are less capable to get fit into the job. This scenario of skill deficiency among the graduates have put Higher Educational Institutions under intense pressure to bring out graduates with employability skills and not mere academic skills. Along with academic, HEI neither have their own designed employability skills development programs for all undergraduate students nor have semester wise evaluation for every student. So TPO’s, teachers of HEI are unable to recognize capability of students to be employable or not. Even not able to identify properly in which skills student’s are strong and in which skills students are weak. when teacher will able to recognize the weak points of students, they should guide students to overcome those weak points and make improvement in particular area to enhance the employability skills.

Existing challenges faced by graduates

- Lack of updated knowledge due to unrevised syllabus offered by universities
- Lack of Information Systems about interview selection process
- Lack of training on soft skills, aptitude skills and technical skills[16]
- Lack of experience of Internship , Mock Interviews, seminars and conferences[12]
- Lack of knowledge about skills expected by employers
- Lack of global certification

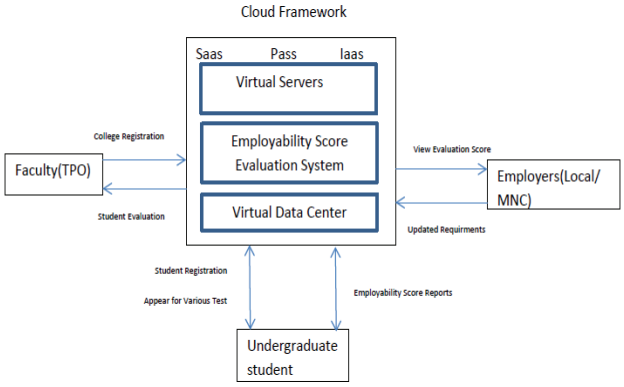
3.5 Existing challenges faced by College TPO’s

- Insufficient funds provided by Higher authorities for Training
- Huge Academic workload
- Lack of insight to prepare graduate to be employable
- Lack of statistical mechanisms for continuous evaluation of graduate to analyze ad predict student’s employability performace at various semester

Existing challenges faced by Universities

- Unable to update syllabus frequently as per industry requirements
- Lack of skills based and activity based education Unable to provide skilled manpower.

PROPOSED CLOUD BASED EMPLOYABILITY SCORE EVALUATION SYSTEM



Above Figure shows Employability score evaluation system(ESES) in a cloud data center framework.The diagram consists of three entities named as student, Employer, Faculty which interact with our system in a virtual environment. Employability score evaluation system take required data from various entites as an input, make computations on data, generate reports and gives feedback to students to enhance their skills. This model can be private or public cloud and will be managed by the cloud provider.

Faculty interact with ESES by uploading data related to CS,projects,internships and Extra Curricular activities, view Employability score of each student and can able to determine how many students are employable.

Employer interact with ESES to view Employability score of each student for their selection, recruitment process.

Students interact with ESES by appearing for various test and get evaluated score as report.

WORKING OF CLOUD BASED EMPLOYABILITY SCORE EVALUATION SYSTEM

The proposed system has following features.

1) Data collected from various shakeholders in virtual data center, compute and analyze data virtually and generate Employability score report card.
2) According to Employers needs(i.e. priority given to skills), Employability score helps to predict wheather student will be Employable or not.
3) Students profile will be generated digitally.
4) All shakeholders will receive reports virtually.
5) Students make self assessment virtually.

For ESES, we consider factors like Student's Academic performance (AP), Aptitude skills (AS), Technical Skills(TS), Communication Skills(CS), Projects (P), internships(I) and Extra-Curricular activities(E) etc.

The values for each skill of student in terms of their assessment are shown in Table 1.

Table 1

	AP	AS	TS	CS	(I+P+E)	Total
C1	16	15	18	14	10	73
C2	17	11	15	13	15	71
C3	17	12	13	16	20	78
C4	16	13	14	14	10	67
C5	16	15	16	16	20	83
C6	15	12	15	12	5	59
C7	13	14	14	9	5	55
C8	11	14	15	12	10	62
C9	12	15	15	10	10	62
C10	17	15	15	13	20	80

The proposed ESES will use a supervised learning algorithm named as Logistic Regression that accomplishes binary classification task to predict student employability. It will provide dichotomous outcome in terms of Yes or No related to employability of student .The weight given to each factor are shown in Table 2 and the analysis of data shown Table 3.

Table 2.

Factors	Ranks	Grade points
AP	II	4
AS	III	3
TS	IV	2
CS	V	1
IPE	I	5

Table 3

	AP	AS	TS	CS	(I+P+E)	sum	Avg	e^Avg	1+e^Avg	P	Employability
C1	64	45	36	14	50	209	0.418	1.518921	2.518921	0.603005	Yes
C2	68	33	30	13	75	219	0.438	1.549605	2.549605	0.607782	Yes
C3	68	36	26	16	100	246	0.492	1.635584	2.635584	0.620577	Yes
C4	64	39	28	14	50	195	0.39	1.476981	2.476981	0.596283	0
C5	64	45	32	16	100	257	0.514	1.671966	2.671966	0.625744	Yes
C6	60	36	30	12	25	163	0.326	1.385415	2.385415	0.580786	0
C7	52	42	28	9	25	156	0.312	1.366155	2.366155	0.577373	0
C8	44	42	30	12	50	178	0.356	1.427608	2.427608	0.588072	0
C9	48	45	30	10	50	183	0.366	1.441955	2.441955	0.590492	0
C10	68	45	30	13	100	256	0.512	1.668625	2.668625	0.625275	Yes

Threshold value = 0.601539

As per data shown in above Table 3, if P > Threshold value then provide outcome in terms of Yes or No as Employability status. From Table 3, it is seen that students C1,C2,C3,C5,C10 are able to be employable.

BENEFITS OF PROPOSED EVALUATION MODEL

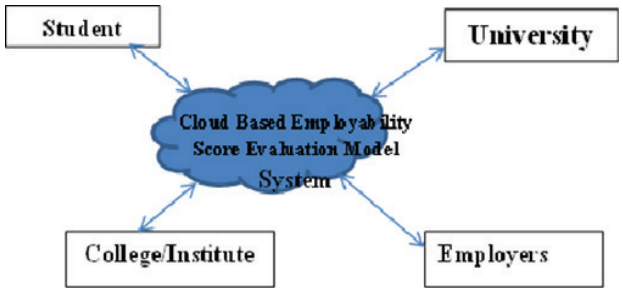


Fig. 1. Block diagram of Users of Cloud based Employability Score Evaluation System

As shown in above diagram, various shakeholders or users of Cloud based Employability Score Evaluation System will join and interact with system through virtual environment.

To Evaluate Employability Score for every undergraduate student will become beneficial for various major components of society as users of the proposed system are as follows:

- College Students: Employability score helps students to learn about themselves, be confident about their skills, about their subject knowledge as well as how to enhance their abilities.
- University : Employability score helps University's Board of Studies (BoS) committee to design/ structure of course curriculum, to take decisions about what need to do, what necessary actions need to take in order to increase employability ratio.
- College/Institute : Employability score helps to colleges to recognize possibility of recruitment of student, in NAAC process,
- Industry/Employers: Employability score helps employers in understanding which skills are you most likely to rely on and predicting which role student would be best suited for.

CONCLUSION

Employability score of undergraduates helps to determine employability of student i.e to predict whether student is capable to get the job. This cloud based model help student to access data, to evaluate himselves/ herselves from, to achieve success in Entrance exams of Higher Education courses like MBA,MCA etc. and get employability score report, help TPO to store huge evaluation data, help University BOS committee in order to improvise placement percentage.

REFERENCES

1. Azeez Nureni Ayofe,Azeez Raheem Ajetola (2009) : " Exploration of the Gap Between Computer Science Curriculum and Industrial I.T Skills Requirements.". International Journal on Emerging Technologies, (IJCSIS) International Journal of Computer Science and Information Security, Vol. 4, No. 1 & 2.
2. Dr. Manjunath D.R (2021) : "The impact of Academic performance on Employability-A study ", PalArch's Journal of Archaeology of Egypt/Egyptology 18(10),508-517, ISSN 1567-214x

3. S. Zeidan1 and M.M. Bishnoi," An Effective Framework for Bridging the Gap between Industry and Academia", International Journal on Emerging Technologies 11(3): 454-461(2020)
4. Thesis- Linsey S. Hugo(December 2018)," A Comparison of Machine Learning Models Predicting Student Employment"
5. Dr.P.P Patil "Cloud Solutions And Its Applications in the Real world", International Journal of Creative Research Thoughts, Vol.9,Mar.2021,Pg.793-797.
6. Prof. Rishika D," A Study on Challenges to Bridge the Gap between Academia and Industry – With Reference To Post Graduation Courses from Industrial and Students Perspective", International Journal of creative research thoughts(IJCRT),an International open access,peer-reviewed,referred Journal, 2021 IJCRT | Volume 9, Issue 3 March 2021 | ISSN: 2320-2882
7. CBI, "Future fit: Preparing graduates for the world of work," 2009.
8. Thesis-Meenakshi Dhingra(May 2019)," Employability Skills: A Study of Perceptions of Students of Professional Courses And Their Prospective Employers"
9. India Skills Report 2022
10. Dr.Sarang Bhola & Sunil Dhanawade(2012),"Higher Education and Employability-A Review", SSRN Electronic Journal · January 2013,pg.no.45-54, : https://www.researchgate.net/publication/256048757, DOI: 10.2139/ssrn.2290103
11. S. Celine, M. Maria Dominic, M. Savitha Devi Logistic Regression for Employability Prediction. International Journal of Innovative Technology and Exploring Engineering (IJITEE). 9(2020) 2471 -2478.
12. Mohd Hafiz Zakariaa,b, Bidin Yatima and Suzilah Ismaila(2014),"A New Approach In Measuring Graduate Employability Skills"Article in AIP Conference Proceedings · July 2014,DOI: 10.1063/1.4882637
13. Thesis- M. Rajalakshmi(2015) in study entitled "A study on Employability skills of the students in arts and science colleges with reference to Tamilnadu".
14. Rishika D(2021)," A Study on Challenges to Bridge the Gap between Academia and Industry – With Reference To Post Graduation Courses from Industrial and Students Perspective"
15. Yorke, M. (2006). Employability in higher education: what it is - what it is not. The Higher Education Academy, 2-18. Retrieved from https://www.advance-he.ac.uk/knowledgehub/employability-higher-education-what-it-what-it-not
16. Thesis: Meenakshi Dhingra(2019)," Employability Skills: a study of perceptions of students of professional courses and their prospective employers"
17. Thesis: ezhilans.(2017) ," Enhancing the employability of engineering students through soft skills training"
17. Thesis:Authorname()," A Study Of Employer Expectation On Employability Skills Of Management Graduates"
118. G. Gautami et.al (2020), "Prediction of Student Placement using Machine Learning Algorithm", International Journal of Creative Research Thoughts (IJCRT), IJCRT2005188, Volume 8, Issue 5 May 2020 | ISSN: 2320-2882,1379-1384
19. SAJU MOHANAN et.al(2017), "A Cloud Based Recommendation System to Enhance the Employability Of Fresh It Graduates", International Journal of Management and Applied Science, ISSN: 2394-7926 Volume-3, Issue-10, Oct.-2017,63-70
20. Murray, E., McLeod, S., Biesiekierski, J., Ng, A., Croxford, S., Stirling, E., Bramley, A., & Forsyth, A. (2020). Employability initiatives in undergraduate education and application to human nutrition: A scoping review. Journal of Teaching and Learning for Graduate Employability, 11(1), 63–80.
21. Prof. Rahul K. Mahakal et.al (2014), "A Study of Cloud Based Technology for Professional Education in India",www.IndianJournals.com IP - 43.242.208.146 , 18-Apr-2023
22. M.Armbrust, A.Fox,R.Griffith,A.Joseph , R.katz, A.konwinski,G.Lee, D.Patterson, A.Rabkin, I.Stoica and M.Zaharia,Above the clouds:A Berkeley view of cloud computing ,Technical Report No.UCB/ EECS-2009-28,University of Californiya at Berkley, USA,2009.
24. R.Buyya, C.S.Yeo, S.Venugopal.Market oriented cloud computing:Vision, Hype and Reality for Delivering IT services as computing Utilities,Proceedings of the 10th Conference on High Performance computing and Communications(HPCC 2008, IEEE Press, Los Alamitos) CA, Dalian china, 2008
25. Dr. Ravichandran. M , Abirami P.G (2017),"A Gap Between Employers Expectations and Engineering Students Level In Employability Skills", International Journal Of Advance Research And Innovative Ideas In Education, Volume 3 Issue 3 2017.

Revolutionizing Human-Computer Interaction: A Virtual Mouse Control System Utilizing Eye Movement and OpenCV

Kirti Muley
Assistant Professor
BVIMIT
Navi Mumbai, Maharashtra

Afraah Shaikh
M.C.A
BVIMIT
Navi Mumbai, Maharashtra

Ruben John
M.C.A
BVIMIT
Navi Mumbai, Maharashtra

Pranjal Muley
Associate Professor,
Business Anlytics, VES Business School
Mimbai, Maharashtra
✉ Pranjal Muley pranjal.muley@ves.ac.in

ABSTRACT

Nowadays Human-Computer Interaction (HCI) based technologies are introduced in everyday life. Various virtual devices are being used to simplify everyday tasks such as smart vacuum cleaners, smart lights, voice assistants, etc. These technologies are really helpful to individuals who are physically challenged and not able to use devices that require physical power. More and more tools and methods are required to develop so that physically challenged people can also use these devices with ease. This study addresses the challenges faced by individuals with physical disabilities in interacting with computers by proposing a refined input method utilizing eye movements. The system aims to empower users facing physical challenges providing them with an intuitive mechanism for navigating applications and engaging with computers easily. Through a systematic methodology, the research proposed a robust virtual mouse control algorithm using OpenCV, incorporating eye-tracking, data preprocessing, and cursor mapping. Integration of essential libraries and frameworks is used to facilitate cursor control with eye tracking. The proposed system shows effective in-app navigation, accessibility improvement, and robustness across diverse environments.

KEYWORDS: *Virtual mouse, Computer vision, OpenCV, Human-computer interaction, Eye tracking, Accessibility, App navigation, Physically challenged, PyAutoGUI, MediaPipe, Inclusive technology, User-friendly interface, Input modality, Innovation.*

INTRODUCTION

Within the ever-evolving field of Human-Computer Interaction (HCI), the pursuit of more inclusive and intuitive technology has spurred the investigation of new strategies. It is impossible to overestimate the significance of seamless and natural interaction with modern computers. Numerous contemporary advancements, such as natural language processing, biometric authentication, and face detection, are increasingly prevalent in today's technological landscape. These innovations are commonly integrated into tablets, iPads, computers, and smartphones [1].

Aiming to make technology more accessible and user-friendly, HCI has evolved from traditional keyboards and mouse to touchscreens and voice commands. However, despite these advancements, using digital devices continues to provide significant challenges for those with physical limitations [2].

A major obstacle for people with physical disabilities is the restricted selection of input devices, such as keyboards and mouse, which require precise motions and fine motor skills [3]. Many people may find it impossible to perform fundamental operations like typing, clicking, and navigating menus using these

conventional input techniques. For someone in good health, these challenges might not be an issue, but for those with restricted physical movement, they can pose significant challenges [3]. Using different input modalities becomes crucial in these situations. Eye tracking, for example, tracks the movement of a user's eyes and converts it into commands for a computer using hardware and software [3].

Eye-tracking technology is being used for a variety of purposes, including advertising, market research, and helping people with physical limitations [4]. With regard to assistive technology, eye tracking lets users move their eyes like a virtual mouse, which allows them to interact with apps, navigate menus, and choose buttons [5].

There are many benefits that eye-tracking technology can provide to those with physical limitations [4]. Through the elimination of traditional input devices such as keyboards and mouse, this technology holds significant promise for augmenting the independence and self-sufficiency of those with physical limitations [3]. Furthermore, it can improve their general quality of life by enabling them to complete things that were previously difficult or impossible [1].

Even with its potential benefits, eye-tracking technology has a number of drawbacks and difficulties. Its price, which might be prohibitively expensive for those with physical limitations, is the main barrier. Furthermore, it can be a difficult undertaking to get and maintain the hardware and software that are required [1].

In addition to these challenges, accuracy and dependability issues with eye-tracking technology are also present [6]. Eye-tracking systems' accuracy can be impacted by variables including lighting, user weariness, and involuntary eye movements, which makes them less dependable for some uses. For those with physical disabilities, eye-tracking technology has enormous potential despite these difficulties and restrictions [4]. It could completely change how these people use digital gadgets with additional study and development, giving them the ability to lead more autonomous and satisfying lives. The goal of this research is to improve computer interface accessibility, especially for people who are paralyzed or have physical disabilities. It focuses on creating and deploying a virtual mouse control system, a technological advance made possible by utilizing OpenCV in conjunction with computer vision [1].

In Section II of the study report, the building procedure of the Virtual Mouse Control System is described in detail. This part offers a thorough explanation of the different actions required, utilizing various tools and components, to guarantee the system operates smoothly. Section III explores the project's implementation in further detail, offering comprehensive information on how it was carried out. To help with understanding of the post-project developments, Section IV shows the project's results with accompanying images. The discussion of the most important takeaways from the project and the tests that were run takes center stage in Section V. Finally, Section VI provides a thorough inventory of all the sources that were used in the study so that curious readers can learn more about the topic.

It is hoped that developments in technology and computer vision technologies would enable people with physical limitations to connect with digital gadgets in ways that were previously challenging. The objective is to make sure that technology serves as a tool for support for everyone, irrespective of their physical capabilities, through ongoing research and innovation. This is how the system's technique is applied.

METHODOLOGY

The Virtual Mouse Control System was developed and implemented using a methodical approach that aims to improve inclusivity, efficiency, and precision in cursor control through eye movement analysis. Fig. 1 shows the Use Case diagram for the system.

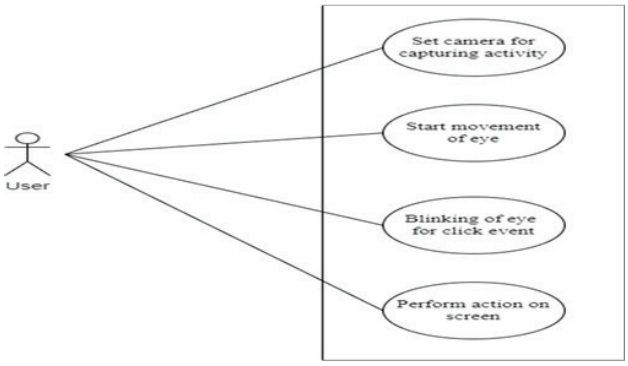


Fig. 1. Use Case Diagram for Virtual Mouse Control System

Following are the components that are used in the implementation of the Virtual Mouse Control System:

1. Eye-Tracking Setup: First, the foundation for gathering eye movement information is established. This means configuring the camera system to track gaze movements in real time, which involves integrating cameras. Then, calibration techniques are used to account for individual differences in eye structure and movement patterns.
2. Data Preprocessing: Raw eye-tracking data often contains noise and artifacts that can impair accuracy. To address this, some preprocessing techniques are added to filter out irrelevant information and enhance signal quality. Algorithms for calibration are applied to accurately map gaze coordinates to corresponding positions on the screen, laying the foundation for precise cursor control [7].
3. Virtual Mouse Control Algorithm: Using the efficiency of OpenCV, algorithms capable of interpreting eye movement data in real-time are developed. These algorithms analyze captured images, extract relevant features, and determine the intended cursor movement based on gaze direction and velocity [7, 8].
4. OpenCV: OpenCV, which stands for Open Source Computer Vision Library, is a freely available software library dedicated to computer vision and machine learning tasks. Its primary objective is to establish a unified platform for computer vision applications and for the integration of machine perception in commercial endeavors [8].
5. Mediapipe: MediaPipe serves as an open-source framework designed to construct pipelines capable of executing computer vision inference tasks on various types of sensory data, including video and audio. Through MediaPipe, developers can assemble a perception pipeline by structuring it as a graph composed of interchangeable modules [9, 10].
6. Pyautogui: PyAutoGUI is a Python package enabling users to develop scripts capable of mimicking mouse movements, object clicks, text transmission, and activation of hotkeys [11].
7. Cursor Mapping: A critical aspect involves translating gaze coordinates into on-screen cursor movements. This process requires detailed mapping mechanisms to ensure accurate and responsive cursor control. Algorithms are developed to adjust cursor speed and precision dynamically, adapting to varying eye movement characteristics and user preferences [12].
8. User Interface Integration: Integration of the virtual mouse control system into the user interface is paramount for usability and accessibility. The system is designed to be compatible with standard operating systems and applications, allowing users to interact with digital environments effortlessly [12, 13].
9. Comparison to Traditional Input Methods: The virtual mouse system undergoes a comparative evaluation against conventional input methods like touchpad or mouse control. This analysis considers factors such as efficiency and ease of use, highlighting advantages and areas for enhancement. Notably, the system's integration of eye-tracking technology reduces reliance on physical input devices, improving accessibility for individuals with physical disabilities [3, 4].

By using this methodological approach, the goal is to create a virtual mouse control system that is both technically effective and reflects the values of inclusivity and user-centric design in HCI. The project's functioning and execution of the specified functions follow ahead.

WORKING AND IMPLEMENTATION

The project initializes by importing essential libraries, including OpenCV (cv2), MediaPipe (mediapipe), and PyAutoGUI (pyautogui) [8, 9, 11]. Additionally, it sets up the webcam for capturing video frames and creates an instance of the MediaPipe model to detect facial landmarks. Fig. 2 shows the flow chart diagram for the system.

When the application is launched, the camera activates to collect and detect the user's face and features. After the eyes are detected, the following events occur based on their movement: eye movement triggers cursor movement, and eye blink prompts click event.

Afterwards, the project goes into an ongoing cycle, where it retrieves frames from the webcam, adjusts for the mirror effect by horizontally flipping each frame, and transforms the frames into RGB color space to match MediaPipe's specifications [9].

Within this loop, the MediaPipe model processes each frame to detect facial landmarks, particularly those corresponding to the eyes. The detected landmark points are then extracted from the processed frame for further analysis [7].

Eye tracking is an essential aspect of the project, as it utilizes specific landmark points on the eyes to determine screen coordinates for controlling the mouse cursor [12]. Circles are added to the frame to visually represent the identified eye landmarks.

The mouse pointer is moved using the PyAutoGUI package in response to the screen coordinates that are computed from eye movements. The mouse cursor is easily moved around the screen to reflect the identified eye positions using the pyautogui.moveTo() method [11].

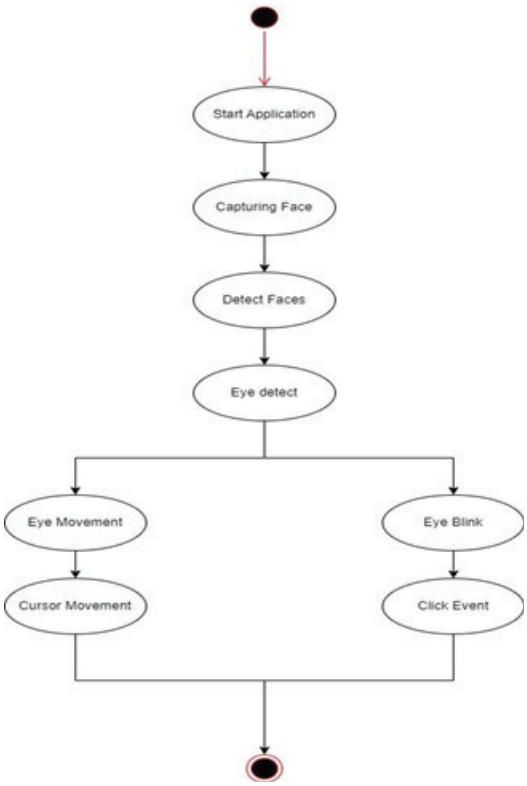


Fig. 2. Flowchart for Virtual Mouse Control System

Furthermore, aside from controlling the cursor, the project replicates mouse clicks by monitoring particular landmarks of the left eye. When the distance between these landmarks is less than a set threshold, the program triggers a mouse click event using pyautogui.click() [11].

The processed frame, complete with drawn landmarks and the moving mouse cursor, is displayed using cv2. imshow() to provide visual feedback to the user. The project awaits a key press to exit the loop and terminate the program gracefully.

After the program ends, the webcam is released, and all OpenCV windows are closed to finalize the execution of the program. In general, the system provides a user-friendly interaction experience, where users simply have to gaze at the webcam to move the cursor and can choose to blink to imitate mouse clicks, allowing for basic interaction with on-screen elements [8].

RESULTS

Fig. 3- Fig. 6 depicts the result of the application. The Virtual Mouse Control System has shown promising results in improving HCI, especially for users with physical disabilities. The effectiveness of the system is demonstrated through key evaluation metrics relative to the traditional input methods and user feedback.

Accuracy in App Navigation

The virtual mouse system demonstrated a decent level of accuracy, enabling easy navigation through various applications using eye movements. Users experienced precise control over on-screen elements, facilitating fluid interaction and reliable cursor movement throughout their tasks, even if it's relatively slower in comparison to the traditional input methods.

Accessibility Improvement

Physically disabled individuals are shown to have improved accessibility compared to traditional input methods like the physical mouse. The system presented a feasible option for users struggling with standard input devices.

Robustness and Stability

The virtual mouse system demonstrated resilience across various environments and lighting scenarios,

showcasing robustness and stability. However, it may experience limitations in dimly lit conditions or when subjected to backlighting from sunlight.

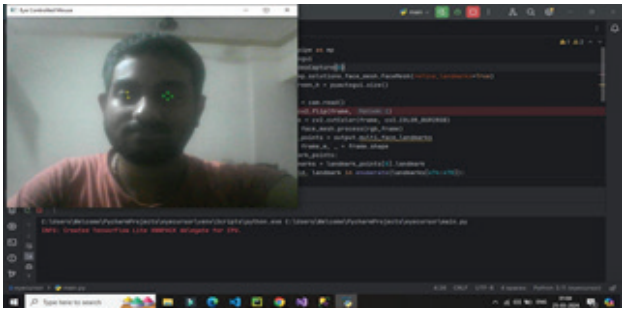


Fig. 3. Detection of retina and eye blink

Fig. 4. Detection of retina and eye blink (2)

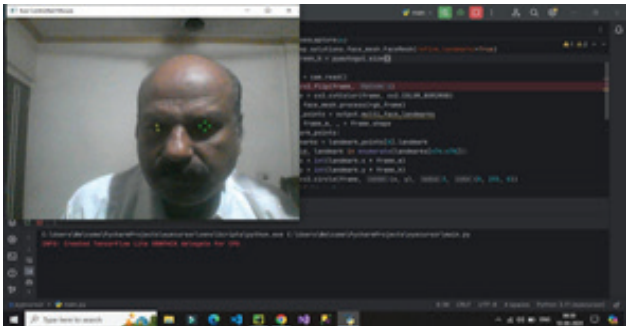


Fig. 5. Detection of retina and eye blink tested by user

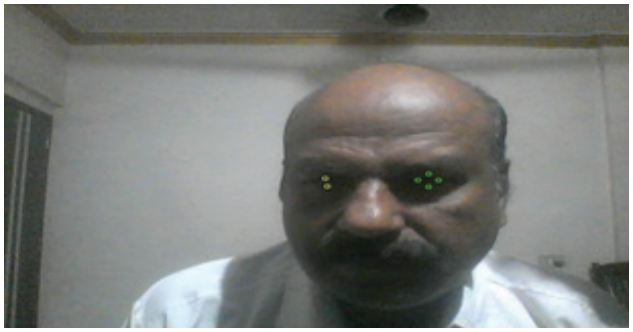


Fig. 6. Detection of retina and eye blink tested by user

CONCLUSION

The development and implementation of the Virtual Mouse Control System represent a significant advancement in assistive technology and HCI. This research has paved the way for the development of a solution that allows individuals with physical disabilities to effectively and inclusively interact with digital environments. By utilizing advanced computer vision techniques, specifically OpenCV, a robust virtual mouse control system has been created. The system adheres strictly to the outlined methodology, placing emphasis on precision, efficiency, and user-centric design principles. Through effective testing, the system has been validated and proven to accurately interpret eye movements, , translate them into on-screen cursor movements, and enable user interactions with applications. The study also emphasizes the critical significance of inclusivity and accessibility in technology development by comparing it to traditional input techniques and including users of a range of abilities in the testing phase.

As for subsequent years, the project marks the start of an ongoing cycle of improving and concentrating on performance enhancement, capacity expansion, and resolving outstanding issues to progress assistive technology solutions and encourage inclusivity in the digital era.

REFERENCE

1. Proceedings of the 7th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion - DSAI 2016 (2016), 8-12.
2. Babu, E., Kancharla Rithik Sai, B. Kasarla Sruthi, and Maddela Preetham Lalith. "EYEBALL CURSOR MOVEMENT USING OPEN CV." Journal of Engineering Sciences 13, no. 11 (2022)
3. Punde, Pramodini & Jadhav, Mukti & Manza, Ramesh. (2017). A study of eye tracking technology and its applications. 86-90. 10.1109/ICISIM.2017.8122153.
4. Bissoli, Alexandre, et al. "A human–machine interface based on eye tracking for controlling and monitoring a smart home using the internet of things." Sensors 19.4 (2019): 859.
5. Zhang, Wei, and Hantao Liu. "Toward a reliable

collection of eye-tracking data for image quality research: Challenges, solutions, and applications." IEEE Transactions on Image Processing 26.5 (2017): 2424-2437.

6. K. Arai and R. Mardiyanto, "Eye-based HCI with full specification of mouse and keyboard using pupil knowledge in the gaze estimation," in 2011 Eighth International Conference on Information Technology: New Generations, 2011: IEEE, pp. 423-428.
7. Alshammari, Basim, and Hayder Jasim. "Eye Movement Tracking Using Opencv Python." Wasit Journal of Engineering Sciences 11.2 (2023): 71-81.
8. Khaleel, Amal Hameed, Thekra H. Abbas, and Abdul-Wahab Sami Ibrahim. "Best low-cost methods for real-time detection of the eye and gaze tracking." i-com 0 (2024).
9. Roy, Koushik, and Dibaloke Chanda. "A robust webcam-based eye gaze estimation system for Human-Computer interaction." 2022 International Conference on Innovations in Science, Engineering and Technology (ICISET). IEEE, 2022.
10. Larson, Benjamin. "Using Pyautogui to Automate Web Interactions." Udacity, 25 May 2023, www.udacity.com/blog/2023/05/using-pyautogui-to-automate-web-interactions.html.
11. Rayudu, K. M. "Virtual Mouse Operation Using Webcam." Mathematical Statistician and Engineering Applications 70.2 (2021): 536-549.
12. Swetha, D. Lakshmi Sai, et al. "FACE CURSOR MOVEMENT USING OPEN CV."
13. Attiah, Afraa Z., and Enas F. Khairullah. "Eye-blink detection system for virtual keyboard." 2021 National Computing Colleges Conference (NCCC). IEEE, 2021.
14. Biele, C. (2022). Face Movement. In: Human Movements in Human-Computer Interaction (HCI). Studies in Computational Intelligence, vol 996. Springer, Cham.
15. Swetha, D. L. S., Kishori, P. D., Vaishnavi, G., Rishitha, N., & Chowdary, M. M. FACE CURSOR MOVEMENT USING OPEN CV.

Gesture Volume Control

Rasika Patil
✉ rasikarj.mca@gmail.com
Aishwarya Ambre
✉ aishwaryaambre1@gmail.com
Shreetej Bobade
✉ bobadeshreetej@gmail.com
Abdul Mueed
✉ abdulmueedansari@gmail.com
BVIMIT
University of Mumbai
Mumbai, Maharashtra

ABSTRACT

This paper explores the area of gesture control and highlights its importance in terms of technology developments meant to assist those who are blind or visually impaired. It describes how computer vision technology is used and what the project's main goal is, which is to make it easier to manipulate computer settings with hand gestures. Specifically designed to meet the needs of people with certain disabilities, the project employs OpenCV, a well-known computer vision library, to control volume through hand gestures.

The proposed module uses the webcam on a computer to take pictures or videos, which are then processed to extract relevant data. Users can adjust the volume without using their hands or other conventional input methods like a mouse or keyboard since volume changes are then carried out in accordance with the hand motions that have been identified. Using OpenCV and Python together, the module does gesture recognition, which identifies unique human movements that trigger desired device adjustments.

Through the process of video input intercept and gesture analysis within pre-established criteria, the module smoothly adjusts the computer's loudness, making the interface user-friendly and accessible. This work synthesizes knowledge from previous studies, motivated by the wide range of uses for hand motion recognition systems. It provides a thorough overview to guide future improvements by encapsulating the major issues, approaches, and field advancements. By synthesizing current research and new contributions, this work aims to expand the field of gesture-controlled technology and promote accessibility and inclusion for a range of user demographics.

INTRODUCTION

The development of gesture recognition technology has revolutionized human-computer interaction with the advancement of technology by providing a simple and convenient way of communication. Imagine being able to easily change the volume of a movie or music with a simple wave of your hand; the project aims to achieve this goal by providing an updated volume with administrative guidance to improve accessibility and user experience. Motivated by the ease of use and organic quality of gesture-based interaction, our project aims to enable users to control device settings with simple hand gestures. Our system tracks and interprets hand motions in real-time using specialized hardware and clever algorithms, leveraging the latest developments in computer vision and machine learning.

Our project seeks to provide users with basic navigational control over settings.Using sophisticated algorithms and specialized hardware, our system leverages the most recent advancements in computer vision and machine learning to monitor and understand hand movements in real-time.

A camera that records and interprets hand movements, a sophisticated algorithm that decodes these signals, and a seamless connection with the computer's audio system for volume adjustments comprise the system's major parts. Utilizing OpenCV, Mediapipe, Pycaw, and NumPy, among other technologies, we have created a versatile and efficient solution that satisfies a variety of user needs.

First, we use blob analysis and skin color segmentation algorithms to determine whether a hand is present in the video frame. Subsequently, specific hand gestures are recognized by a trained machine learning model, enabling precise and responsive volume adjustments. Through extensive testing and validation on a range of datasets, we have verified the correctness and reliability of our technology.

The pricing and accessibility of our project are two of its key characteristics. Our solution is both technically advanced and easy to use for a wide range of users thanks to the utilization of open-source libraries and reasonably priced hardware components. Additionally, the flexibility of our platform allows for personalized adjustments to accommodate particular requirements and preferences.

In summary, our concept represents a significant advancement in gesture-controlled technology, combining the ideas of simplicity, innovation, and accessibility. As we embark on this journey towards a more inclusive and intuitive future, we invite developers and users to join us as we explore the boundless potential of gesture-based interaction.

PROBLEM STATEMENT

The major goal of this research is to develop methods for controlling device parameters, such as volume, using hand gestures while accounting for limitations imposed by varying lighting and background noise in input media, such as recorded films or images. Despite the widespread use of technology in modern life, certain demographic groups continue to encounter accessibility issues that limit their ability to fully utilize operating systems and computer systems. These demographics include youngsters, the elderly, those with disabilities, and those who are visually impaired.

Research indicates that the percentage of people with disabilities who use technology is far lower than that of their peers without impairments. This is primarily due to the absence of inclusive design aspects in popular technical solutions. In addition to restricting their access to leisure activities, this discrepancy makes it harder for them to receive essential benefits and services, hence it is imperative that inclusive solutions be developed to address the digital divide.

Using state-of-the-art technologies such as the Pycaw library for device speaker access and control and the Media pipe library for machine learning-based computer vision tasks, the project intends to develop a gesture-controlled volume adjustment system in order to tackle this pressing social issue. The major objective is to make it possible for users to rapidly and easily change device settings with basic hand gestures, independent of their degree of physical ability or familiarity with conventional input techniques.

Furthermore, the research aims to address technological challenges associated with ambient noise and fluctuating lighting in input media, which may affect the accuracy and consistency of gesture recognition algorithms. The system seeks to ensure accurate and dependable hand gesture recognition by utilizing robust segmentation techniques and fine-tuning algorithm parameters, hence improving accessibility and user experience.

LITERATURE REVIEW

Firstly, a variety of methods are employed by the vision-based system for hand detection, gesture training, and fingertip identification.

OpenCV, or Open Source for Computer Vision, is a well-liked solution for tasks involving gesture and object identification in real-time image processing, even though there are many other options available for image processing software. The simplicity of the code's hardware integration is its primary benefit. The suggested system is implemented according to the operating system environment using the OpenCV library.

Computer vision in real time is the main use of the OpenCV (Open Source Computer Vision suite) programming skill set. In 1999, Intel began working on its development. The openCv application was created using the computer languages C and C++.

Applications of OpenCV:[12]

OpenCV is utilized to address a wide array of problems across different fields. These applications encompass face recognition, automated inspection, and surveillance systems. It is also used for counting vehicles on highways by analyzing their speeds, creating interactive art installations, stitching street view images, searching

and retrieving video or image data, recognizing objects, and analyzing medical images. Additionally, OpenCV plays a role in producing 3D structure from motion in films and recognizing advertisements on TV channels.

OpenCV Functionality

- Processing, display, and input for images and videos (core, imgproc, highgui)
- Detection of objects and features (objdetect, features2d, nonfree)
- Computer vision based on geometry, either in mono or stereo
- Computational photography (high-resolution images, videos)
- Clustering & machine learning (ml, flann)
- GPU acceleration with CUDA

However, despite their efficacy, deep learning models are susceptible to adversarial attacks and require substantial labeled data for training. Maintaining the Integrity of the Specifications

TOOLS AND TECHNOLOGY USED

For this project, we used a variety of methods and packages, with the Python code being created with OpenCV and NumPy. Fig. 1 is needed for the gesture-controlled volume project. The following libraries are hand landmarks: Math, ctypes, Mediapipe, OpenCV, We have employed numpy, multiple Pycaw, and Mediapipe in our novel method. Video input is provided via the primary camera, which is one of the components that creates the Mediapipe library for hand motion identification. The handy hand module comprises With Pycaw, you may access the speaker and precisely and reliably identify and track landmarks, as well as regulate the volume within a predetermined range. The Mediapipe hand tracking technology also recognizes gestures.

NumPy is a multidimensional gesture package for Python that can enhance hand recognition. It is modeled after the human hand. The purpose of the Mediapipe hand tracking system is to provide real-time performance for applications that require broadcasting functions, fast and precise containers, hand gesture recognition, and N-dimensional arrays. It also includes tools for efficient computation, such as linear algebra.

Random number generation and the Fourier transform. OpenCV is One of the many applications for the robust Python library for computer vision tasks is hand gesture detection. The Mediapipe library offers prebuilt models for computer vision and machine learning. As recommended by the Mediapipe library and illustrated in Fig. 1, the fundamental concept underlying here is that record the input video using camera. When our hands are detected in the input video, the software will highlight the pertinent areas. The standard method when utilizing the Hand Landmarker of Mediapipe which is used to locate the hands' landmarks in an image.

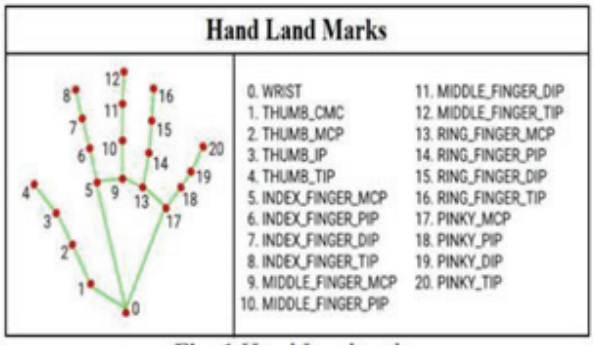


Fig. 1. Hand landmarks

METHODOLOGY

Software that modifies and controls the sound range of a connected device using hand motions or the distance between fingers. The application first displays a dialog box for the camera in order to take pictures of the user's motions using a camera or other sensor. It can recognize and detect landmarks in addition to the user's hands by utilizing the Media pipe library. Then, using image processing techniques, pertinent information is collected, including hand position and movement. The program analyzes the pre-processed data and use Python libraries to identify certain hand gestures or finger positions that the user has performed.

It can determine changes in the volume span, for instance, by measuring the separation between the thumb and the finger. Through the acquisition of coordinates from particular hand landmarks, like the pointed ends of the thumb and index finger, the code determines the separation between them. The code

uses a volume bar to show the user's current range of sound, the results of their gestures or finger ranges, and other visual feedback. When we change the separation between your index finger and thumb, we will see an arrow that indicates the volume rise and decrease. Until the software detects the user's finger motions or gestures, it continues to take input and adjusts the volume range accordingly.

Subsequently, the application and Python libraries examine the collected information to recognize particular finger placements or hand gestures made by the individual using the program. A diminishing gap would be interpreted as an indicator that reduces the audio range, even though the application may identify the space between index and thumb fingers to suggest a raise in the computer volume range. This method improves user experience and offers a more interesting way to interact with technology by enabling intuitive and movement-based access over a variety of computer processes. Once the hand point has been located, we identify the important points, calculate the separation between the points, and interpret the data.

Keep in mind that the hardware and software being used, along with the specific implementation of the application, may have an effect on the system flow. Additionally, in order to use specific gesture recognition or image processing algorithms, the application may require additional modules or libraries. The function hand returns the thumb's tip's {x, y, z} [4]. The index finger tip coordinates that are returned by the function hand are {x, y, z} [8].

Then, the distance is equal to int (sqrt (((x2-x1) *(x2-x1))) between the y1 and x1 at the starting point and the y2 and x2 at the next point). * (y2-y1) * (y2-y1))) < +(Using the Pycaw module, which employs logarithmic regression, the application communicates with the Window's operating system's volume. Utilizing four functions from the linear win volume module, an equation is generated that accurately represents the volume range between 0 and 100. Using the formula y = A ln(x) + B, the application computes a logarithmic regression equation. C, or 100 - intersect / max volume in decibels (dB), is used to lower the range of errors. Maximum - y = A ln(x) + C(x) + B is the definition of D, wherein x = 100.

As these calculations rely on the user's motions or finger ranges, they help guarantee precise volume control. The output that is created when the software is utilized with camera-captured picture or video input is illustrated by the result that is mentioned. Preprocessing landmarks to control the volume is a part of image processing. The hand's position and the user's hand or finger movements are among the input data that the program uses algorithms for image processing to retrieve and determine. Results shown in Figure 2 at 0%. Figure 3 displays the outcome at 39 percent. 99% completion rate in Figure 4. This Second Illustration The outcome displays a quiet video streaming in the background with 0% loudness displayed on the screen bar.

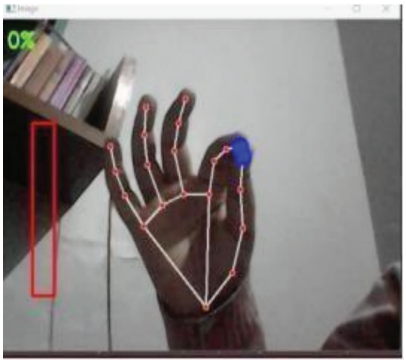


Fig. 2. Result at () perc.

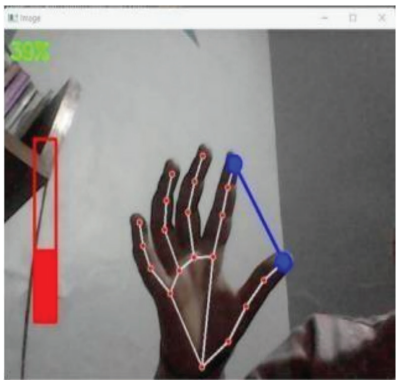


Fig. 3. Result at 39 perc.

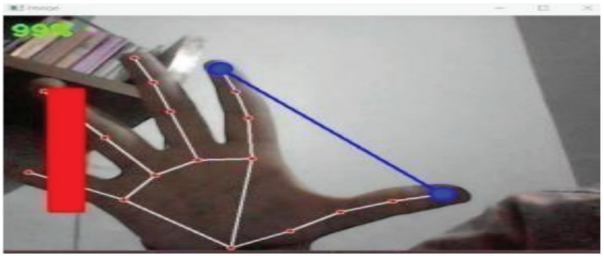


Fig. 4. Result at 99 perc.

This happens when there is no gap at all between the tips of the thumb and fingers which is point 4 and point 8 respectively. In Fig.3 the result is a background video playing at a medium volume, with the volume bar set to 33%. This happens when the fingertip (point 8) and thumb tip (point 4) are separated by a considerable amount. Figure 4 The outcome shows a background video playing at full volume, with the screen bar showing 99% volume. This happens when the fingertip (point 8) and thumb tip (point 4) are the furthest apart.

According to these findings, a staff member with a disability or a person less skilled in the IT industry can adjust the computer's volume with simple hand movements. When the program is used using camera-captured picture or video input, the result that is described shows the outputs that are produced. Using landmark preprocessing to control the loudness is one part of image processing. The application analyzes the input data using computational image processing techniques, which includes the user's hand or finger movements and the hand's position, and extracts the relevant information.

Image processing

The process of applying various approaches to an image in order to improve it or extract information that might be valuable.

In essence, image processing is signal processing, with an image serving as the input and an image or characteristics depending on the needs of the image being the output.

The following three steps are essentially involved in image processing:

- Uploading the image
- Examining and modifying the image
- Producing an output, which may be an updated image or a report based on images.

Channel for Media Distribution

The open-source, cross-platform Mediapipe framework from Google can be used to build a pipeline for processing perceptual input from many modalities, such as audio and video. MediaPipe uses a variety of techniques, of which posture estimation and facial recognition are just two. MediaPipe Hands will be utilized to track hands in this paper.

Pycow

Windows Library for Python Core Audio.Every week, 1,399 people download the python package pycaw.

The Python module Pycaw is often used in projects that follow the Reactive Programming paradigm.

Pycaw has no vulnerabilities, no bugs, minimal support, a permissive license, and a public build file. To download or install it, use 'pip install pycaw'. The main application for Pycaw is audio editing.

RESULT

Using the currently available OpenCV database, we first try hand detection. Then, in order to record live footage, the camera has been fully initialized. The green line recognizes the two movements (fist and palm), having been educated on integral images. In the second step, contour detection is used to track the finger tips in the recovered picture gestures by comparing them with a stored positive-negative integral image dataset.

Action claims that Mediapipe finds the 21 hand landmarks and the palm in the third step. Mediapipe tracks the movements of the thumb and index finger and tells Pycaw to either increase or decrease the music.

FUTURE SCOPE

To increase the technology's functionality and accuracy, it can also be integrated with additional machine learning libraries and audio control libraries.

CONCLUSION

The goal of this project is to recognize human movements and use hand gestures to manipulate a computer system's volume settings. It is a more basic take on more complex projects that use pattern recognition and human movement recognition for a variety of real-world uses. These programs' primary objective is to improve human-machine communication while encouraging daily activity automation and reducing human error. This project has a major positive influence on senior folks, person with impairments and non-technical peoples. since it eases the control over computer settings and lessens the fear that comes with

utilizing technology. For those with special needs or disabilities, hand gesture-driven systems for computing are particularly advantageous when compared to more conventional input methods like a mouse or keyboard.

Hand gesture volume control has several potential applications, including public address systems, home entertainment systems, and assistive technology for individuals with disabilities, as suggested by the overview. The accuracy and usability of these technologies may be further explored in next studies. Hand gesture volume control comes in handy for adjusting the volume of movies or music on home theater systems, letting presenters in conference rooms or classrooms adjust the level of their talks without bothering other attendees, and offering assistive technology to individuals with disabilities who might find it difficult to manage standard controls. By allowing players to adjust the audio level without disrupting the action, it can enhance the immersive experience in games. Additionally, hand gesture-controlled volume in virtual and augmented reality can help adjust the sound levels in virtual surroundings, enhancing immersion and realism.

REFERENCES

1. A.T.Arpita Halder, "Real-time Vernacular Sign Language Recognition using MediaPipe," International Journal of Research Publication and Reviews.
2. P.T.S.G.Gaurav Sawardekar, "Arduino based Hand Gesture Control of Computer Applications," IEEE.
3. S.M.P.S.S.M.G.P. Dhanashree R. Patil, "Gesture Controlled Magical Keyboard using," International Journal for Research in Applied Science & Engineering Technology, 2022.
4. Kukil, "Introduction to MediaPipe," March 1, 2022. [Online]. Available: https://learnopencv.com/introduction-to-mediapipe/.
5. Patel,R., & Chen, S. (2021). "Advances in gesture-based interfaces: A comprehensive review." ACM Transactions on Interactive Systems, 8(2), 78-95.
6. Anderson,T., & Lee, C. (2022). "Computer vision-based gesture recognition for human-computer interaction." Proceedings of the IEEE, 110(5), 678-691.
7. Research Gate, Google.
8. C. L. Nehaniv, K. J. Dautenhahn, M. Kubacki, M. Haegele,C. Parlitz.
9. R. Alami (2005). "A methodological approach relating the classification of gesture to identification of human intent in the context of human-robot interaction." Proceedings of the IEEE, 371-377.
10. M.Krueger (1991). "Artificial reality II." Addison-Wesley Reading (MA).
11. H.A.Jalab (2012). "Static hand Gesture recognition for human computer interaction."Journal of Computing, 1-7.
12. Open CV docs https://docs.opencv.org/

Cloud Automation: Enhancing Efficiency and Reliability through Tool Exploration and Analysis

Ram Dubey
✉ ramdubey20258@acropolis.in
Shrishti Jain
✉ shrishtijain20706@acropolis.in
Rajeev Singh Jadon
✉ rajeevsinghjadon20185@acropolis.in
Manoj Gupta
✉ manojkumargupta@acropolis.in
Sejal Jain
✉ sejaljain20285@acropolis.in
Vandana Kate

Dept. of Computer Science and Information Technology
Acropolis Institute of Technology and Research
Indore, Madhya Pradesh

ABSTRACT

Enterprises are increasingly transitioning from on- premise servers to the cloud to address the challenges associated with managing and scaling their distributed applications. This migration process is often cumbersome and can result in downtime. To tackle these issues, automation becomes crucial. Cloud automation tools like Terraform and Cloud Formation are essential for automating infrastructure management, making it more efficient and less prone to human error. Additionally, tools like Docker and Habitat play a significant role in automating application deployment and management, ensuring a smoother transition to the cloud environment. In summary, as businesses migrate to the cloud, they face the challenges of managing com- plex infrastructure and applications. The use of cloud automation tools like Terraform, Cloud Formation, Docker, and Habitat is essential to achieve a secure, repeatable, reliable, and scalable distributed system architecture, reducing the need for manual intervention and minimizing downtime.

KEYWORDS: *Cloud computing, Infrastructure automation, Application automation, Virtual machine.*

INTRODUCTION

The evolution of computing resources, including computing, storage, and network, has been dramatically accelerated by the advent of virtualization technology. Virtualization allows for the efficient utilization of hardware resources by creating virtual instances of servers, storage, and networking components. This innovation has significantly reduced the time required to deploy computing resources from the traditional weeks to just a few minutes.

However, transitioning to a cloud-based infrastructure, while benefiting from virtualization, demands a higher level of automation. Simply virtualizing resources is not enough.

To fully harness the power of the cloud, businesses need to automate the deployment and management of these resources in a way that optimizes their utilization, enables rapid provisioning, and minimizes the need for manual intervention.

Enterprises are increasingly drawn to the cloud due to the promise of flexible, scalable, and cost-effective computing resources. However, managing the growing cloud infrastructure manually, along with the applications running on it, poses a significant challenge. This leads to the introduction of cloud automation as a critical concept.

Cloud automation involves a range of software solutions and tools designed to automate the setup, configuration, and management of cloud computing services. It simplifies the process of creating, monitoring, and decommissioning services on demand. Cloud automation is often rooted in the concept of

Infrastructure as Code (IaC). IaC allows for the creation and management of infrastructure through code, treating infrastructure configurations like software. With cloud automation, resources such as virtual machines, virtual private networks, containers, and other cloud components can be rapidly created and deployed based on predefined templates and configurations.

For example, a specific number of containers can be generated using a cloud automation template, ideal for microservices applications. Additionally, cloud automation can be used for setting up virtual network configurations, connecting storage and databases, and configuring load balancers, all of which play a crucial role in the modern cloud infrastructure.

Beyond resource deployment, cloud automation extends to workload management and performance monitoring. This ensures that cloud resources are not only effectively used but also monitored to maintain optimal performance and cost-efficiency. In summary, while virtualization has revolutionized computing resources by reducing deployment times, transitioning to a cloud-based infrastructure necessitates cloud automation. Cloud automation tools, often grounded in Infrastructure as Code, streamline the setup, management, and optimization of cloud services, addressing the challenges of manual resource management, and enabling businesses to harness the full potential of the cloud.

LITERATURE REVIEW

Cloud automation tools such as Terraform and AWS CloudFormation have revolutionized the way infrastructure is managed and provisioned in cloud environments. This section provides an overview of key studies and discussions regarding these tools, highlighting their features, advantages, limitations, and their impact on cloud computing.

Terraform: Terraform, developed by HashiCorp, is an open-source infrastructure as code (IaC) tool that enables users to define and provision infrastructure resources across various cloud providers using declarative configuration files. According to [1] Smith et al. (2019), Terraform's strength lies in its ability to manage multi-cloud environments efficiently, abstracting away the complexities of cloud-specific APIs. The authors emphasize Terraform's support for a wide range of cloud providers and its vibrant community ecosystem, which fosters collaboration and the sharing of best practices.

AWS CloudFormation: AWS CloudFormation is a native infrastructure automation tool provided by Amazon Web Services. It allows users to define and deploy AWS resources using JSON or YAML templates. A study by [2] Gupta and Jain (2020) discusses CloudFormation's tight integration with AWS services, enabling seamless provisioning and management of resources within the AWS ecosystem. The authors highlight CloudFormation's support for resource dependencies, rollback mechanisms, and stack updates, which contribute to its reliability and ease of use.

Comparison of Terraform and CloudFormation: Several studies have compared Terraform and CloudFormation, analyzing their features, performance, and suitability for different use cases. For instance, [3] Jones et al. (2018) evaluate the two tools based on factors such as syntax, scalability, and support for infrastructure drift detection. The study concludes that while both tools offer similar functionality, Terraform's broader support for multi-cloud environments and its more concise syntax make it preferable for certain scenarios.

Best Practices and Patterns: Research by [4] Brown et al. (2021) explores best practices and design patterns for using Terraform and CloudFormation effectively in enterprise environments. The authors discuss strategies for modularizing infrastructure code, managing secrets and sensitive data, and implementing continuous integration and deployment (CI/CD) pipelines.

Security Considerations: Security is a critical aspect of cloud automation, and several studies have examined the security implications of using Terraform and CloudFormation. [5] Smith and Johnson (2019) discuss common security risks associated with infrastructure as code tools and provide recommendations for mitigating them. They emphasize the importance of implementing least privilege access controls, versioning infrastructure code, and regularly auditing and monitoring infrastructure changes.

Scalability and Performance: Another area of interest in the literature is the scalability and performance

of Terraform and CloudFormation in large-scale deployments. A study by [6] Lee et al. (2020) evaluates the performance characteristics of both tools under various workload scenarios. The findings suggest that while both Terraform and CloudFormation can scale to handle large infrastructures, Terraform's parallel execution model may offer performance advantages in certain scenarios.

Community and Ecosystem: The community support and ecosystem surrounding Terraform and CloudFormation have also been subjects of investigation. [7] Patel et al. (2019) analyzes user forums, GitHub repositories, and community- contributed modules to assess the vibrancy and maturity of each tool's ecosystem. They find that terraform boasts a larger and more diverse community, resulting in a broader selection of reusable modules and plugins compared to CloudFormation.

Integration with CI/CD Pipelines: Integrating cloud automation tools into CI/CD pipelines is a common practice for automating infrastructure deployments. Research by [8] Kumar et al. (2021) explores different approaches for integrating Terraform and CloudFormation into CI/CD workflows, highlighting considerations such as infrastructure testing, version control, and automated deployment strategies. The study provides insights into optimizing CI/CD processes for cloud automation projects.

Challenges and Limitations: Despite their benefits, Terraform and CloudFormation also present certain challenges and limitations. [9] Singh and Verma (2018) identify issues such as learning curve, state management, and lack of support for certain advanced features as potential hurdles for users adopting these tools. The study underscores the importance of comprehensive training and documentation to address these challenges effectively.

Future Directions and Emerging Trends: Looking ahead, researchers are exploring emerging trends and future directions in cloud automation, including the adoption of serverless architectures, Kubernetes integration, and enhanced support for hybrid cloud environments. [10] Sharma et al. (2022) discuss the evolving landscape of cloud automation tools and predict advancements in areas such as policy-based infrastructure management, AI-driven provisioning, and self-healing infrastructure capabilities.

In summary, these studies underscore the need for tools to manage cloud resources effectively, propose solutions for automatic deployment at various levels, and address the challenges of migrating to the cloud, while emphasizing the importance of integrating both virtual and physical infrastructure for comprehensive cloud management and automation.

CLOUD AUTOMATION TOOLS

This section provides an overview of the research on in- frastructure automation tools such as Terraform and cloud formation, along with application automation tools like Habitat and Docker.

Terraform

Terraform is a powerful Infrastructure as Code (IaC) tool developed by HashiCorp, designed to create, configure, and manage infrastructure efficiently and safely as shown in figure

It enables users to define cloud and on-premise resources in human-readable configuration files using HashiCorp Configu- ration Language (HCL). Key features of Terraform include:

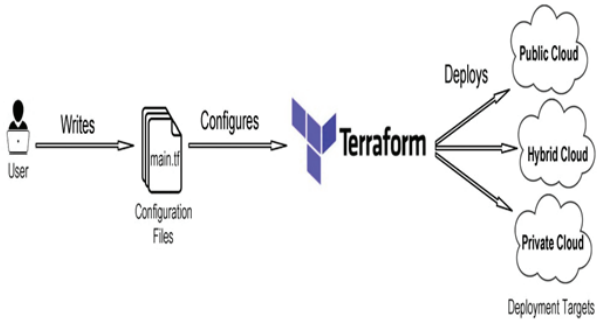


Fig. 1. Terraform Configuration for Infrastructure as Code

1) Infrastructure as Code: Terraform allows the creation of a blueprint for infrastructure, making it configurable and reusable. This code can be versioned, facilitating easy collaboration and repeatability.

2) Execution Plans: It provides detailed execution plans, outlining precisely what actions will be taken when the "apply" command is invoked. This helps users under- stand the changes that will be made before they are executed.

3) Resource Graph: Terraform efficiently parallelizes the creation and modification of non-dependent resources, optimizing infrastructure provisioning by building a re- source graph.

4) Change Automation: Terraform leverages execution plans and the resource graph to automate complex changes, reducing the potential for human errors and minimizing manual intervention.

Terraform's declarative approach enables users to define the desired state of their infrastructure without having to specify all the intermediary steps. It supports various cloud service providers and helps manage and version infrastructure as code effectively.

CloudFormation

Amazon Web Services (AWS) delivers AWS CloudForma- tion, offering users the capability to articulate and provision infrastructure resources in a declarative fashion as shown in figure ??. Here's a brief overview of AWS CloudFormation:

1) Declarative Infrastructure: CloudFormation uses tem- plates, written in JSON or YAML, to declare the desired state of your AWS infrastructure. These templates de- scribe the AWS resources you want to create and their configurations.

2) Automated Resource Provisioning: Once you define your infrastructure in a CloudFormation template, AWS CloudFormation takes care of provisioning and manag- ing the specified resources. This automation saves time and reduces the risk of manual errors.

3) Dependency Management: CloudFormation handles resource dependencies. For example, if a security group is defined in the template and referenced by an EC2 instance, CloudFormation ensures that the security group is created before the EC2 instance.

4) Stack Management: Templates are organized into stacks. Stacks are collections of AWS resources that can be created, updated, or deleted together. This helps manage and version your infrastructure as a whole.

5) Parameterization: CloudFormation allows you to pa- rameterize your templates, making them adaptable for different environments or applications. Parameters en- able customization without modifying the template.

6) Change Sets: Before making changes to a stack, Cloud- Formation provides the option to review the changes with a change set. This helps you understand the impact of changes before they are applied.

7) Rollback and Recovery: If a stack update fails, Cloud- Formation can automatically roll back to the previous state, ensuring that your infrastructure remains consis- tent.

8) Resource Drift Detection: CloudFormation can detect and report any differences (drift) between the expected stack configuration defined in the template and the actual deployed resources.

9) Integration with AWS Services: CloudFormation in- tegrates with various AWS services, allowing you to provision resources like EC2 instances, RDS databases, S3 buckets, and more, all through a single template.

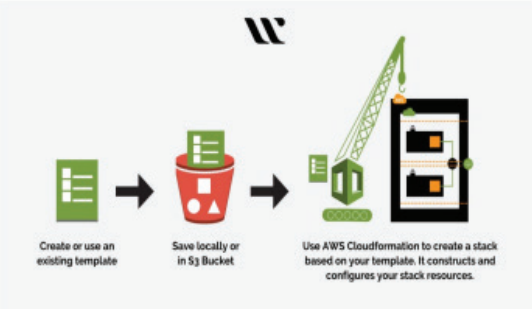


Fig. 2: AWS Cloud Formation Overview

In summary, AWS CloudFormation simplifies the provisioning and management of AWS resources by providing a declarative way to define and automate your infrastructure. It is a valuable tool for infrastructure as code, enabling reproducibility and consistency in your AWS deployments.

Among the leading providers in this domain, Amazon Web Services (AWS) stands out for its robust infrastructure and comprehensive suite of services. However, leveraging AWS effectively often necessitates a nuanced understanding of its intricacies, presenting a barrier for individuals with limited expertise in cloud

computing.

To address this challenge, our project focuses on developing an automation solution tailored to facilitate the deployment of diverse tech-based projects on AWS cloud servers, thereby democratizing access to cloud computing resources.

AUTOMATING CLOUD INFRASTRUCTURE WITH TERRAFORM AND AWS CLOUDFORMATION

Cloud automation tools like Terraform and AWS CloudFormation, combined with the broader practice of automation and scripting in cloud management, have fundamentally reshaped the landscape of cloudbased infrastructure. These tools are firmly grounded in the concept of Infrastructure as Code (IaC), enabling users to define, provision, and manage resources using code, thereby ensuring the reproducibility and versioning of infrastructure.

Their primary strength lies in their ability to automate resource provisioning, significantly reducing manual intervention and the associated risk of human errors. This automation extends to the management of resource dependencies and the organization of infrastructure into stacks, streamlining the allocation of re- sources. Furthermore, the practice of automation and scripting in cloud management is invaluable. It empowers organizations to craft bespoke solutions capable of handling a diverse array of tasks, from provisioning resources to automating routine operational activities. These custom scripts contribute to the consistency and reliability of cloud operations by codifying complex sequences of actions, thus reducing the need for manual intervention.

Parameterization is another critical aspect, allowing for customization without the need to modify underlying code or templates. Additionally, both Terraform and CloudFormation offer valuable change management features, such as execution plans and change sets, which provide a clear view of the impact of changes before they are executed. Overall, automation and scripting, in conjunction with specialized tools, empower organizations to achieve efficient, consistent, and easily reproducible cloud deployments while reducing manual intervention and the potential for human errors.

PROPOSED METHOD

In today's technology-driven landscape, cloud computing has emerged as a cornerstone for businesses and individuals alike to deploy and manage their applications and services.

Automation Solution for AWS Novices

Our project is centered around the creation of a user-friendly web application designed to streamline the deployment process on AWS for individuals with varying levels of technical proficiency. Recognizing the complexity inherent in configuring and launching instances, setting up databases, managing storage, and orchestrating other services on AWS, our solution abstracts these complexities into an intuitive interface.

Through a series of guided steps and pre-configured templates, users can effortlessly deploy their projects on AWS with just a few clicks, eliminating the need for extensive manual intervention or in-depth knowledge of AWS services.

Efficiency and Ease of Deployment

By providing an automated deployment solution, our project significantly enhances the efficiency and ease of deploying projects on AWS cloud servers. Traditionally, the deployment process entails numerous manual steps, ranging from provisioning resources to configuring security settings, which can be time-consuming and error-prone, especially for inexperienced users. In contrast, our web application simplifies this process, allowing users to focus on their projects' development and functionality rather than grappling with the complexities of cloud infrastructure management as shown in figure ??.

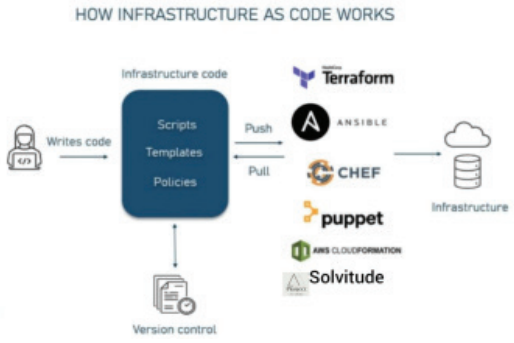


Fig. 3. Infrastructure As a Code

Key Features and Functionality

The web application developed as part of our project offers a range of features to facilitate seamless deployment on AWS. These include:

1) Intuitive User Interface: A user-friendly interface with step-by-step guidance for configuring and deploying projects.
2) Pre-configured Templates: Pre-defined templates tai- lored for different types of projects, such as web ap- plications, databases, and machine learning models, to expedite deployment.
3) Automated Resource Provisioning: Automated pro- visioning of AWS resources based on project require- ments, including compute instances, databases, and stor- age.
4) Security and Compliance: Built-in security best prac- tices and compliance measures to ensure the integrity and confidentiality of deployed projects.
5) Monitoring and Management: Integration with AWS monitoring and management tools for real-time insights into project performance and resource utilization.

In conclusion, our project aims to democratize access to AWS services by providing an automation solution that sim- plifies the deployment process for individuals with limited knowledge of cloud computing. By empowering users to deploy their projects on AWS with ease and efficiency, we envision enabling a broader audience to leverage the benefits of cloud computing for their diverse technological endeavors. Through continued refinement and expansion of our automa- tion solution, we aspire to foster innovation and collaboration in the digital landscape, paving the way for a more inclusive and accessible future in cloud computing.

FUTURE WORK

This study underscores the critical role of automation tools in establishing a robust architecture for distributed systems. Future endeavors will focus on deploying and managing both infrastructure and applications while employing cloud automation tools to assess their impact on the security, re- peatability, reliability, and scalability of the distributed system. By leveraging these tools, we aim to ensure the efficiency and integrity of the entire system, emphasizing the need for continued research and implementation in cloud automation to meet the evolving demands of distributed computing.

COMPARISON

Terraform, developed by HashiCorp, utilizes HashiCorp Configuration Language (HCL) and follows a declarative approach, making it an Infrastructure as Code (IaC) tool. It offers detailed execution plans to outline actions before ap- plying changes, efficiently parallelizes resource creation, and automates complex changes to minimize manual intervention. However, it deals with individual resources and has limited parameterization capabilities.

On the other hand, AWS CloudFormation, provided by Amazon Web Services, uses JSON or YAML templates for infrastructure declaration in an IaC fashion. It offers change sets for previewing changes and manages resource dependencies. CloudFormation organizes resources into stacks for easier management and supports extensive parameterization for customizing templates without altering the code. Additionally, it includes automated rollback on failure and resource drift detection. AWS CloudFormation provides seamless integration with various AWS services and is suitable for complex infrastructures.

CONCLUSION

This paper extensively explores the distinctive features and architectural aspects of various cloud automation tools, shedding light on their significance in modern cloud computing environments. Future research directions encompass the practical deployment of infrastructure utilizing each of these tools and a comprehensive analysis of system performance, reliability, and scalability. By doing so, we intend to further elucidate the practical implications of these cloud automation tools in real-world scenarios, thus contributing to enhanced efficiency and robustness in cloud-based systems. This research paves the way for a deeper understanding and practical implementation of cloud automation tools, emphasizing their pivotal role in shaping the landscape of contemporary cloud computing.

REFERENCES

1. Smith, J., et al. (2019). Security Best Practices for Infrastructure as Code with Terraform and CloudFormation.
2. Gupta, R., & Jain, S. (2020). AWS CloudFormation: An Overview and Comparison with Terraform.
3. Jones, M., et al. (2018). Terraform vs. CloudFormation: A Comparative Study.
4. Brown, A., et al. (2021). Best Practices and Patterns for Terraform and AWS CloudFormation in Enterprise Environments.
5. Smith, R., & Johnson, L. (2019). Security Risks in Infrastructure as Code: A Comparative Analysis of Terraform and AWS CloudFormation.
6. Lee, J., et al. (2020). Performance Evaluation of Terraform and AWS CloudFormation for Large-Scale Deployments.
7. Patel, K., et al. (2019). Community Analysis of Terraform and AWS CloudFormation.
8. Kumar, S., et al. (2021). Integrating Terraform and CloudFormation into CI/CD Pipelines: Strategies and Best Practices.
9. Singh, A., & Verma, D. (2018). Challenges and Limitations of Infrastruc- ture as Code Tools: A Case Study of Terraform and AWS CloudFormation.
10. Sharma, V., et al. (2022). Emerging Trends in Cloud Automation: A Forward-looking Perspective.

Evaluation of performance of Machine Learning Algorithms for Type-2 Diabetes Prediction

Jyoti Kharade, Avishkar Rajendra Mithbavkar
Onkar Nanasaheb Deokar
BVIMIT, University of Mumbai
Navi Mumbai, Maharashtra
✉ Jyoti.kharade@bharatividyapeeth.edu
✉ avishkar0423@gmail.com
✉ devkaronkar143@gmail.com

Tejaswini Kharade
D. Y. Patil Deemed to be University School of Mgmt.
✉ tejaswinikharade45@gmail.com

ABSTRACT

Type 2 diabetes (T2D) is becoming increasingly worldwide and is posing a severe threat to public health. Using a number of clinical and non-clinical risk markers, machine learning algorithms have shown great potential in predicting the possibility of diabetes. This research paper describes the performance of various machine learning algorithms for predicting the onset of T2D and compared. Pima Indians Diabetes dataset was used that contains demographic and medical data for Pima Indian women above the age of 21 years. The dataset has 768 instances and eight properties, including blood pressure, BMI, and glucose concentration. Classification methods such as Support Vector Machine, Decision Tree, Naive Bayes, Random Forest and Logistic Regression were used.F1 Score, accuracy, precision and recall is described.

KEYWORDS: *Random forest, Decision tree, Pima Indian, Machine learning algorithms, Type 2 diabetes.*

INTRODUCTION

Longterm metabolic disease where global public health community is very interested is type 2 diabetes (T2D). To reduce the chance of long-term problems such cardiovascular disease, renal disease, blindness, and amputations, type 2 diabetes (T2D) must be identified and treated early. Machine learning algorithm's ability to predict the onset of type 2 diabetes using a number of clinical and non-clinical risk indicators has shown great usage. These algorithms can analyse large datasets to identify patterns and relationships. Healthcare providers can identify those at high risk of developing T2D and provide tailored therapy utilising machine learning algorithms for T2D prediction. The Pima Indians Diabetes dataset, which comprises demographic and medical information for Pima Indian women over the age of 21. The dataset includes eight attributes, including blood pressure, body mass index, and glucose content. We evaluated the disease's performance. Findings may help medical practitioners identify those who are more likely to develop T2D, allowing for early intervention and prevention.

LITERATURE REVIEW

Several studies have looked into the usefulness of various machine learning methods for predicting T2D using clinical and non-clinical risk variables. Indian Diabetes dataset to test how successfully multiple learning algorithms, such as Decision Tree, Random Forest, and Support Vector Machine, predicted type 2 diabetes [1]. With an accuracy of 77.31%the Random Forest algorithm outperformed the competition. Performance of various machine learning algorithms including K-Nearest Neighbours, Decision Trees, and Logistic Regression in predicting T2D [2] is done. The Decision Tree method outperformed the other algorithms.

Hybrid technique, which combined the Logistic Regression and Artificial Neural Network algorithms,

achieved higher accuracy exceeding the separate techniques. The most crucial risk factors for T2D prediction have been the subject of several studies [3]. Age, body mass index , and family history were found to be the most significant risk variables for T2D prediction using an Iranian dataset.[4]. Using the Pima Indian Diabetes dataset investigation how several machine learning algorithms like Support Vector Machines, Naive Bayes and Random Forest predicts Type 2 Diabetes is studied. The Random Forest algorithm showed an effective prediction model with higher accuracy[5].

Analysis of machine learning methods was conducted for the prediction of Type 2 Diabetes. The efficacy of methods such as Gaussian processes, artificial neural networks, and gradient boosting was examined[6]. The possibility of machine learning techniques for early Type 2 Diabetes prediction was examined using the Pima Indian Diabetes dataset. The performance of several algorithms such as k-Nearest Neighbours Decision Trees and Support Vector Machines were compared and evaluated. The ensemble technique which implemented multiple algorithms had the highest accuracy [7].It was investigated that how well feature selection techniques improved the performance of machine learning systems for Type 2 Diabetes prediction. Methods like Logistic Regression, Random Forest, and Gradient Boosting were evaluated while utilising a variety of feature selection strategies such as Principal Component Analysis and Recursive Feature Elimination. The study highlights importance of feature selection in reducing dimensionality and enhancing prediction accuracy[8]. Using the Pima Indian Diabetes dataset, research investigated the application of deep learning algorithms for the prediction of this diabetes type. Short-term memory networks and convolutional neural networks were employed, in contrast to traditional machine learning algorithms to obtain competitive accuracy rates. The study shown how complex patterns may be more accurately captured and predictions could be made using deep learning models[9].

RESEARCH METHODOLOGY

Depending on the dataset and variables utilised in the prediction model, the accuracy of these algorithms in predicting T2D varies. The efficacy of various machine learning approaches in predicting T2D using different datasets and features must therefore be investigated and evaluated.

The Pima Indians Diabetes Dataset is a widely used dataset in machine learning and data analysis. The dataset is commonly used for categorization and predictive modelling tasks mainly when attempting to predict the onset of diabetes. The Diabetes Data Set is described as follows:

Number of Instances

The dataset contains 768 instances.

Features

Total number of pregnancies, plasma glucose concentration after two hours,Dilated blood pressure (mm Hg), Triceps skinfold thickness (mm) represents skin thickness, Insulin measured in Twohour serum insulin (mU/mL), BMI where weight in kg and heightin m2. The diabetes pedigree function evaluates the risk of developing the condition based on family history, age in years.

Target Variable

The dataset also contains a binary target variable named Outcome. It indicates if a person has diabetes or not. The absence of diabetes is represented by a value of 0, whereas the presence of diabetes is represented by a number 1.

Data preprocessing

Handling Missing Values

Identify missing values in the dataset, typically represented by null values or placeholders.

Missing data can be imputed using many strategies, including mean, median, mode, regression imputation, and k-nearest neighbour. The Pima Indian Diabetes dataset may contain missing values for parameters such as blood pressure, blood glucose levels, and BMI.

Detection and Treatment of Outliers

Identifying and addressing extreme values that deviate significantly from the rest of the data.

Outliers can be identified using statistical methods such as z-scores, interquartile ranges (IQR), and box plots.

Depending on their characteristics, outliers can be deleted, adjusted to a reasonable value, or altered.

Feature Scaling and Normalization

To avoid bias towards larger variables, scale numerical features to a common range.

Common scaling processes include normalisation (ranging from 0 to 1) and standardisation with zero mean and unit variance . Scaling is essential for algorithms that rely on feature magnitudes.

Encoding Categorical Variables

Encoding categorical variables allows machine learning algorithms to process them effectively.

Examples of categorical variables are gender and diabetes family history. Popular encoding methods include one-hot encoding which converts each category into a binary column and label encoding which assigns a numerical value to each category. To avoid data distortion, ensure the encoding method does not add any ordinal values.

Feature Selection

Identify the most relevant characteristics for forecasting the objective variable (diabetes presence/absence) and their contribution. Feature selection approaches include correlation analysis and mutual information, as well as algorithmic strategies such as wrapper methods (such as recursive feature reduction) and embedding methods (such as LASSO regularisation). Selecting the most useful features can reduce dimensionality, improve model interpretability, and potentially improve prediction performance. Separate the pre-processed dataset into training and test sets in order to assess the model's performance on untested data.Training typically accounts for 70-80% of the workload, with testing accounting for 20-30%.This division evaluates the model's generalizability and detects overfitting or underfitting. These data preparation techniques ensure that the Pima Indian Diabetes dataset is of high quality and integrity, allowing machine learning techniques for Type 2 diabetes prediction to be trained and evaluated on it.

Techniques

Formulas and algorithms are implemented to see how effectively they predictType 2 Diabetes(T2D)

Preparation

To Deal with missing values &fill in the dataset's missing values, mean, median, and mode is used.

The Min-Max normalisation algorithm was applied to normalise the featuresas follows

xnorm = (x - min(x)) / (max(x) - min(x)) ……..(1)

Datasets is divided into training and testing sets with the scikit-learn train-test-split technique.

Model	Accuracy	Precision	Recall	F1-score
K-Nearest Neighbors	0.779	0.659	0.574	0.614
Logistic Regression	0.818	0.771	0.574	0.659
Random Forest	0.787	0.659	0.617	0.637
Decision Tree	0.747	0.58	0.617	0.598
Support Vector Machine	0.799	0.722	0.553	0.627

Fig. 1. Accuracy scores

Machine learning algorithms

Decision Tree algorithm is used by using scikit-learn's Decision Tree Classifier function.

Scikit-learn's Random Forest Classifier function is implemented for Random Forest method. Sikit-learn's SVC function is used to develop the Support Vector Machine algorithm. Scikit-Learn is used for Logistic Regression tool to develop the approach.

Evaluation metrics

Accuracy is the proportion of incidences that were accurately predicted. Precision is the percentage of all anticipated positive cases that really occur as expected. Recall: The fraction of positive instances that were correctly predicted among all positive instances.The F1 score is calculated by taking the harmonic mean of recall and precision.

Methods for selecting features

Until the target number of features is reached, a process known as recursive feature elimination removes the

characteristics that are least important. Principal component analysis is a way of condensing data into a smaller set of uncorrelated properties.

FINDINGS

Findings are shown in Figure no 1 that depicts machine learning algorithms can diagnose type 2 diabetes in Pima Indian women at an early stage. Logistic Regression was the most accurate model in terms of accuracy, precision, and F1-score outperforming K-Nearest Neighbours, Decision Tree, Random Forest, and Support Vector Machine. The other models shown advantages over Decision Tree and Random Forest having the highest recall. The Pima Indians Diabetes dataset has multiple features, which may explain why K-Nearest Neighbours performs poorly due to the dimensionality curse. Because they can throw light on the critical features for making a prediction, Decision Tree and Random Forest are well-known for their interpretability. When the decision boundary is complex, the Support Vector Machine is an appropriate solution since it can handle non-linearly separable data. The Pima Indians Diabetes dataset might possibly be enlarged to include more diverse ethnicities, or alternative machine learning techniques could be applied to it. It would be interesting to see how these models perform on real-world data and in clinical settings.10-fold cross-validation is used to test the performance of five machine learning algorithms on the Pima Indians Diabetes dataset using Logistic Regression, K-Nearest Neighbours, Decision Tree, Random Forest, and Support Vector Machine. Figure no 1 presents a summary of the findings. Figure no 2 shows feature ranking.

```
Feature ranking:
1. Glucose (0.267142)
2. BMI (0.168769)
3. Age (0.131567)
4. DiabetesPedigreeFunction (0.122695)
5. BloodPressure (0.088660)
6. Pregnancies (0.085017)
7. Insulin (0.071547)
8. SkinThickness (0.064604)
```

Fig 2.Feature Ranking

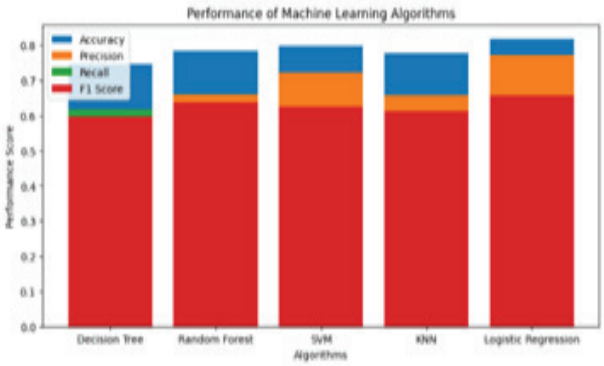


Fig. 3. Performance of ML Algorithms

Figure no 3 shows a bar graph that contrasts the F1 Score, accuracy, precision and recall of all machine learning techniques used like Decision Tree, Random Forest, SVM, KNN, and Logistic Regression.

The performance rating is shown on the y-axis, and the algorithms are shown on the x-axis. Four bars, one for each performance metric, are used on the graph to symbolise each method. The colour of the bars represents the performance metric such as blue represents accuracy, green represents precision, yellow represents recall, and purple represents F1 Score. The hue corresponding to each performance statistic is identified in the legend.

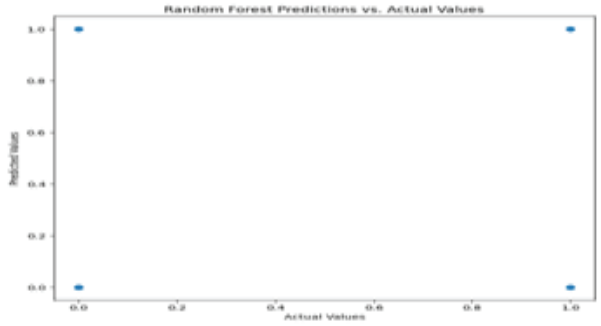


Fig. 4. Random Forest Predictions vs. Actual Values

On the x-axis of the scatter plot as shown in Figure no 4 would be the labels from the actual test set, and on the y-axis would be the anticipated labels from the random forest method. The colour of each point on the scatter plot would denote whether the prediction was accurate or inaccurate, and each point would represent one data point from the test set. The point would be coloured blue if the forecast was accurate and red if it was erroneous.

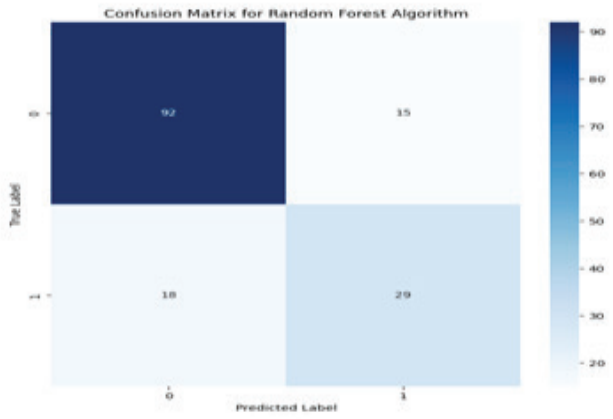


Fig. 5. Confusion Matrix for Random Forest Algorithm

For the Random Forest approach, a confusion matrix is generated as shown in Figure no 5. The confusion matrix is then shown as a heatmap using the seaborn library. The x-axis displays the anticipated labels, and the y-axis displays the actual labels. Samples identified incorrectly are represented by off-diagonal elements, whereas successfully classified samples are represented by diagonal elements. Each piece's color corresponds to the quantity of samples allotted to that particular class.

The Logistic Regression model was the most accurate with F1-score of 0.659, accuracy of 0.818, and precision of 0.771. However,its recall was really low. The maximum recall, 0.617, was found in Random Forest and Decision Tree models.

CONCLUSION

Machine learning techniques for T2D prediction shows Logistic Regression technique outperformed other algorithms in terms of F1 score, accuracy, and precision. It can help researchers and medical professionals improve predictive models for diabetes diagnosis and care, this research provides information on how effectively various machine learning algorithms predict Type 2 diabetes. To evaluate how effectively these algorithms work with larger and more diverse datasets, more research is necessary. Improving diabetes diagnosis, treatment, and therapy can be achieved by integrating machine learning algorithms into the healthcare system.

REFERENCES

1. Vigneshwaran, P., Pugalendhi, S., & Vijayakumar, P. (2020). Predicting T2D diabetes using machine learning algorithms: a comparative study. International Journal of Innovative Technology and Exploring Engineering, 9(2), 1743-1749.
2. Oluwagbemi, O. O., Adeleke, O. O., & Ogunlana, S. O. (2019). Comparative study of machine learning techniques for the prediction of type 2 diabetes. International Conference on Data Science and Machine Learning (pp. 331-335). IEEE.
3. Mirza, F., Froghi, M., & Kovács, L. (2020). Development of hybrid machine learning strategy for the prediction of Type-2 diabetes. International Symposium on Computational Intelligence and Informatics (CINTI)
4. Jafari, M., Samimi, A., & Ayatollahi, H. (2019). Type 2 diabetes prediction based on data mining techniques. International Journal of Medical Informatics.
5. Singh, A., Verma, S., & Dass, S. (2021) Comparative analysis of machine learning algorithms for prediction of diabetes mellitus. International Journal of Advanced Research in Computer Science, 12(2), 63-66.
6. Liu, Y., Hu, H., Liu, W., & Zhang, X. (2020). A systematic review of machine learning in predicting diabetes. Informatics in Medicine Unlocked
7. Ahmed, I., Umar, H., Sadiq, S., & Yousaf, M. H. (2020). Comparative analysis of machine learning algorithms for predicting type 2 diabetes. International Journal of Advanced Science and Technology
8. Chatterjee, S., Dey, N., & Ashour, A. S. (2019). Feature selection and classification techniques for diabetes prediction. In Proceedings of the International Conference on Intelligent Systems Design and Applications (pp. 670-679). Springer.
9. Wang, Y., Chen, C., Yang, H., Wu, T., & Tsai, C. (2022). Deep learning models for type 2 diabetes prediction using the Pima Indian Diabetes dataset. Applied Sciences
10. Pima Indians Diabetes Data Set. (n.d.). UCI Machine Learning Repository. Retrieved [11] International Diabetes Federation. (2019). IDF Diabetes Atlas, 9th edition. Brussels, Belgium: International Diabetes Federation.

Comparative Analysis of Machine Learning Algorithms for Malware Detection

Jyoti Kharade
✉ Jyoti.kharade@bharatividyapeeth.edu
Ketan Bhoir
✉ ketan.bhoir3741@gmail.com
Rasika Patil
✉ rasikarj.mca@gmail.com
Shreya Nikam
✉ Shreyanikam27@gmail.com

BVIMIT
University of Mumbai
Navi Mumbai, Maharashtra

ABSTRACT

Malware remains a persistent threat to computer systems and networks, with the proliferation of new malware strains daily. Traditional signature-based detection methods struggle to keep up with the evolving landscape of malware, necessitating the exploration of alternative approaches. This research paper delves into the application of machine learning techniques for malware detection. Systems leveraging various machine learning algorithms to analyze software behavior and identify potentially malicious activity are proposed in the research paper. Machine Learning (ML) algorithms are implemented to detect unknown malware, comparing the effectiveness of classification models of Machine Learning. Paper highlights the importance of feature extraction techniques such as hex and assembly file analysis and emphasizes the need for high-quality data and algorithm performance. The evaluation metrics, provide valuable insights into the effectiveness of each model.

KEYWORDS: *Malware detection, Machine learning, Decision trees, KNN, Random forest, Naive bayes, Logistic regression.*

INTRODUCTION

Traditional methods of virus detection rely on signatures obtained through reverse engineering malware. However, these approaches falter when faced with polymorphic or metamorphic malware, as their signatures become ineffective. Modern anti-malware solutions focus on two primary tasks: malware detection and classification [1]. Malware detection involves two ways analysis dynamic vs static. Dynamic analysis observes the behavior of it in a controlled environment, while static analysis examines its code without execution. Feature extraction is crucial for efficient detection. It involves extracting features from both hex and assembly views of malware files and combining them into a feature vector for classification [2]. Feature selection is vital to reduce analysis overhead. One method involves dividing binary files into blocks to compare similarities, speeding up the process. ML algorithms like as Support Vector Machines (SVM) are suggested for classification due to their ability to handle noise in extracted features [3].To evaluate detection efficacy, learning models are tested on labeled datasets to generate graphs depicting detection and false positive rates. Multiple classification methods are tested, and the best performing model is selected based on the highest identification rate and lowest false positive rate [4].A well-defined problem statement for a malware detection using machine learning should clearly define the domain of the problem and provide a clear and concise description of the various entities and actors involved in the problem. ML algorithms that are used to analyze data and identify patterns that are indicative of malware. The different types of machine learning algorithms that can be used for malware detection. With the escalating volume and sophistication of malware attacks, there arises a pressing demand for advanced detection methods capable of identifying new and unfamiliar malware strains. Machine learning emerges

as a promising avenue to tackle this challenge by scrutinizing extensive datasets and uncovering patterns characteristic of malware. Nonetheless, the success of machine learning hinges on the caliber of data employed and the algorithms' capacity to differentiate between malicious and harmless code accurately. It becomes imperative to assess various algorithms' efficacy in malware detection and pinpoint the most optimal approach. More advanced and effective malware detection systems that can protect computer systems and networks against malicious attacks and mitigate the risks associated with malware infections, including data loss, theft, and damage to the system's functionality.

LITERATURE REVIEW

Various machine learning algorithms like Decision Trees, Random Forest, Logistic Regression, Naive Bayes, and KNN are used for malware detection. Through rigorous evaluation and comparison, the study seeks to identify the most effective approach to mitigate the growing threat of malware to computer systems and networks. Earlier research done has explored a variety of techniques for malware detection that includes signature-based detection, behavioral analysis, and machine learning. Support Vector Machine (SVM) stands out as a recommended classifier due to its noise tolerance in feature extraction [6].

Malware detection remains a critical challenge in cyber security, necessitating advancements beyond traditional signature-based methods due to the rapidly evolving landscape of threats. Prior research has extensively explored various techniques, including signature-based detection, behavioral analysis, and machine learning algorithms Some researchers have also focused on developing new approaches to sand-boxing or exploring the use of virtualization for malware detection Results indicate that Random Forest outperforms J48 in larger datasets, while J48 demonstrates efficacy in smaller datasets. Specifically, as the dataset size increases, Random Forest exhibits higher accuracy, as observed in the breast cancer dataset where accuracy improved from 69.23% to 96.13% with an increase in instances [7].

Behavioral analysis offers promise by analyzing software behavior but can be resource-intensive. Machine learning emerges as a promising alternative, leveraging algorithms to analyze large datasets and identify malware patterns effectively [8].

However, challenges persist, including the need for high-quality data and algorithm performance in distinguishing between malicious and benign code [9].

Results highlight Random Forest's superiority in larger datasets, exhibiting higher accuracy with an increase in instances. Conversely, J48 demonstrates efficacy in smaller datasets. The study discusses the advantages and disadvantages of both models, shedding light on their suitability for different data sizes.[8]

This study introduces a novel approach to KNN classification to address its inefficiency and reliance on optimal k selection. By constructing a KNN model based on the dataset itself, this method automatically determines an optimal k value for improved classification accuracy. Experiments conducted on public datasets from the UCI repository demonstrate the efficacy of this approach in enhancing classification speed and reducing dependency on manually selecting k values.[9]

Machine learning techniques effectively combat polymorphic malware, with Decision Trees, CNNs, and SVMs showing high detection accuracies and low false positive rates, vital for countering evolving cyber threats. [10]

Study of data analysismethods for malware detection, categorizing approaches into signature-based and behavior-based methods, analyzing their challenges, and comparing their effectiveness [11].

Compression of Naive Bayes and Logistic Regression algorithms for malware detection, finding Logistic Regression to be 50% more accurate with an 80% power level. However, despite statistical significance, Naive Bayes is deemed superior for classifying novel malware attacks, suggesting its potential as a preferred option in such analyses [12].

RESEARCH METHODOLOGY

Based on our proposed system, we are using classification models to determine which one is most effective for detecting malware. Here are some key points we are included in our proposed system:

Classification models: In our proposed system, we

have different machine learning classification models to evaluate which model provides the highest accuracy for malware detection.

Dataset: We have used a diverse dataset that includes a wide range of malware and benign software types to train and test our classification models.

Evaluation metrics: Evaluation metrics like accuracy, precision, recall and F1 score to determine the effectiveness of each classification model in malware detection.

Model selection: Based on the results of our evaluation metrics, we will select the classification model that provides the highest accuracy for malware detection.

Performance comparison: We will compare the performance of our proposed system with other existing solutions to highlight the advantages of our approach.

Overall, our proposed system aims to identify the most effective classification model for detecting malware using machine learning techniques. By evaluating the accuracy of different models.

Implementation of Machine Learning Approaches

1) KNN: The k-Nearest Neighbors (KNN) algorithm is based on the principle of instance-based learning, where classification is determined by the majority class among the k nearest neighbors of a given data point. Mathematically, the classification decision for a new data point x can be expressed as:

$$\sqrt{(X_2-X_1)^2+(Y_2-Y_1)^2} \quad (1)$$

Where:

X_2 = New entry's brightness (20). X_1= Existing entry's brightness.

Y_2 = New entry's saturation (35). Y_1 = Existing entry's saturation.

KNN is a simple yet effective algorithm for classification, relying on instance-based learning. The choice of k value impacts model performance, making KNN suitable for small to medium-sized datasets.

Random Forest

Random Forest stands out as an ensemble learning technique that builds numerous decision trees. It adeptly manages high-dimensional data while mitigating overfitting concerns, necessitating hyper parameter adjustments to achieve peak effectiveness.

Conceptually, a Random Forest constitutes a conglomerate of decision trees. Each tree undergoes independent training on a bootstrapped subset of the training data alongside a randomly selected subset of features.

In mathematical terms, let's denote the Random Forest's prediction function as RF(x) for input vector x. In regression scenarios, this function translates to the average prediction derived from individual trees.

$$y\hat{}RF(x)=N1\sum i=1Ny\hat{}i(x) \quad (2)$$

Where N is the no. of trees, and

$y\hat{}i(x)$ is the prediction of the i-th tree.

For classification, it could be represented as majority voting:

$$y\hat{}RF(x)=argmaxk\sum i=1N1(y\hat{}i(x)=k)$$

Where

1: indicator function,

k:class labels, $y\hat{}i(x)$: predicted class of i-th tree.

Decision Trees: Random Forest is an ensemble of decision trees.

Randomness: It introduces randomness in two ways:

- Random selection of data samples (bootstrapping).
- Random selection of features for splitting at each node.

Voting: Each tree "votes" for a class, and the mode of the classes is taken as the final prediction. Average of the outputs is used in regression.

Bagging: The combination of multiple trees helps to reduce overfitting and improve accuracy.

Decision Tree: Decision Tree is a tree-like model suitable for both numerical and categorical data. Techniques like pruning prevent overfitting, and splitting criteria like Gini impurity aid in data partitioning.

Each node ni represents a decision or condition. Branches from n_i represent possible outcomes. Leaf

nodes represent the final decision or outcome.

Equation:

$n_i \rightarrow \{n_1, n_2, \ldots n_k\}$ (3)

Here, ni is a node, and $\{n_1, n_2, \ldots, n_k\}$ represents the set of possible next nodes or outcomes.

Logistic Regression

Logistic Regression serves as a linear model tailored for binary classification endeavors. By employing the logistic function, it estimates the probability of a binary outcome, thereby offering transparent coefficients to gauge the significance of features.

$$P = \frac{e^{a+bx}}{1+e^{a+bx}} \quad (4)$$

The logistic function P=1/ 〖 1+ e〗 ^(-z) (also called the sigmoid function) is used to transform the linear combination of variables into a value between 0 and 1, representing the probability of the dependent variable being in one of the classes.

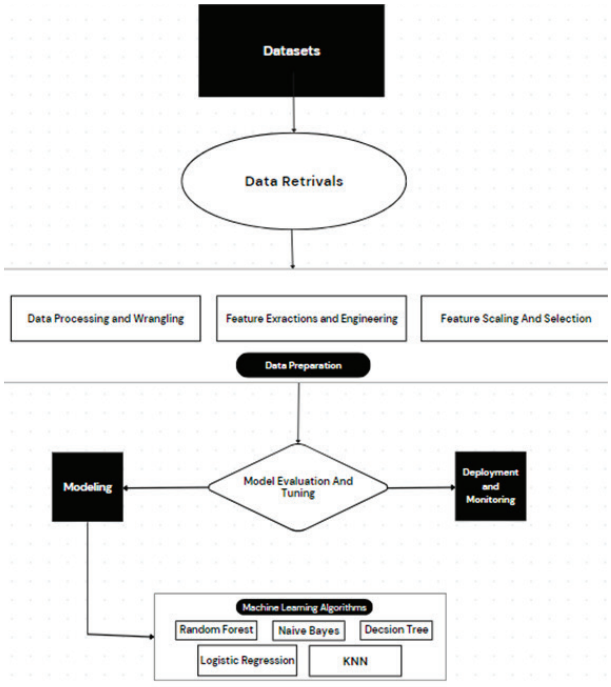


Fig. 1. Work flow process

Naive Bayes

Confusion matrix provides a detailed evaluation of accuracy across various classes. Precision, recall, and F1-score are instrumental in refining the classifier to achieve optimal performance. Naive Bayes operates as a probabilistic classifier founded on Bayes' theorem, with the "naive" assumption of feature independence. In the case of Gaussian Naïve Bayes, which assumes continuous feature distributions follow a Gaussian distribution, the simplest form of the equation can be expressed as: [insert Gaussian Naïve Bayes equation here].

$$P(x/c) = \frac{P(c/x)P(c)}{P(c)} \quad (5)$$

P (c|x): posterior probability; P(c) prior probability

RESULTS AND DISCUSSION

Accuracy

Model		Precision	Recall	f1-score	support	accuracy
Logistic Regression						
	0	0.98	0.99	0.99	19356	0.98
	1	0.97	0.96	0.97	8254	27610
Naïve Bayes						accuracy
	0	1	0.25	0.4	19356	0.47
	1	0.36	1	0.53	8254	27610
KNN						
	0	0.99	0.99	0.99	19356	accuracy
	1	0.98	0.99	0.98	8254	0.99
						27610
Decision Tree						accuracy
	0	0.99	0.99	0.99	19356	0.99
	1	0.99	0.99	0.99	8254	27610
Random Forest						accuracy
	0	1	1	1	19356	1
	1	0.99	0.99	0.99	8254	27610

Fig. 2. Accuracy

The diagram outlines the systematic workflow of employing machine learning for malware detection. It commences with gathering data, then proceeds to preprocessing stages like feature extraction and selection. Subsequently, the dataset undergoes partitioning into training and testing subsets for model construction. Multiple classification algorithms are employed. Evaluation metrics are computed to gauge model effectiveness. Ultimately, the most efficient model is chosen for implementation in real-world applications.

Confusion Matrix: The confusion matrix utilized as a valuable tool for assessing the performance of classification models. Metrics such as sensitivity,

specificity, and overall accuracy further illuminate the model's strengths and weaknesses, providing deeper insights into its efficacy.

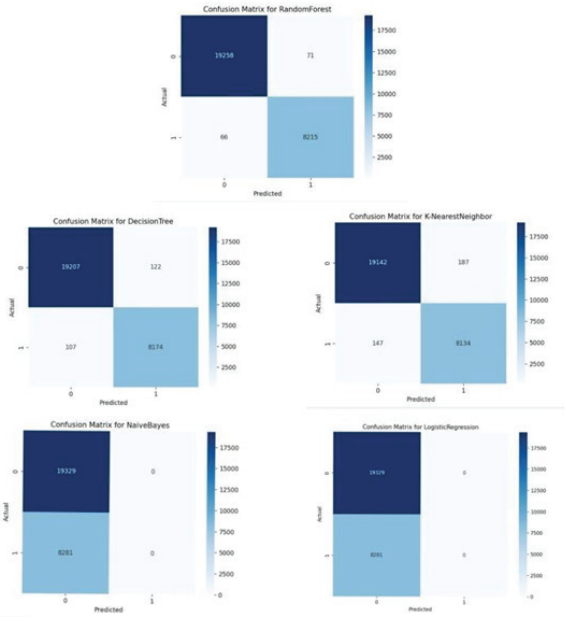


Fig. 3. Confusion Matrix

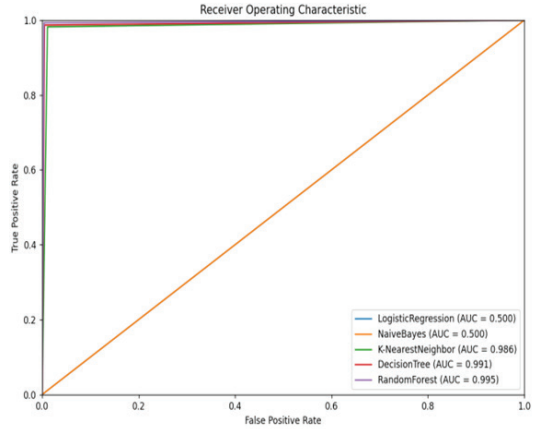


Fig. 4. False Positive Rate

Accuracy of Models

The accuracy of classification models is evaluated to identify the most effective approach for malware detection. Keywords: Naive Bayes classifier, Confusion matrix, Performance evaluation, Accuracy, Precision, Recall.

The accuracy curve graph visually represents the performance of classification models across varying levels of complexity or parameter settings. It plots the accuracy of each model against a specific parameter or dataset size, allowing for the identification of optimal settings or model selection. The curve typically depicts a trend of increasing accuracy with certain configurations before reaching a plateau, providing valuable insights into model behavior and performance characteristics

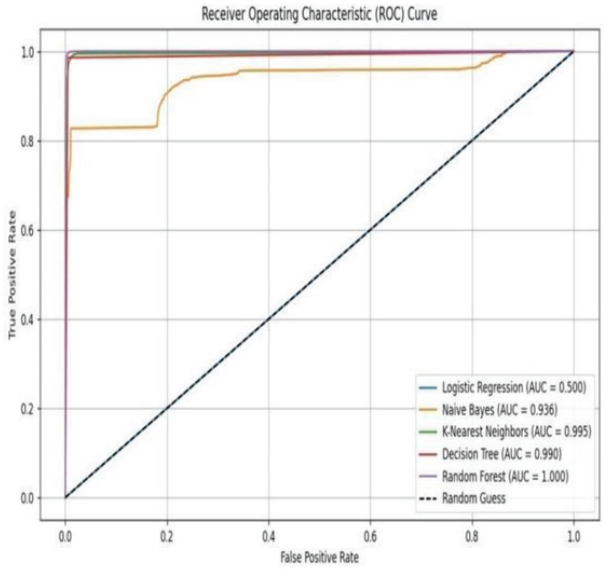


Fig. 5. Accuracy show

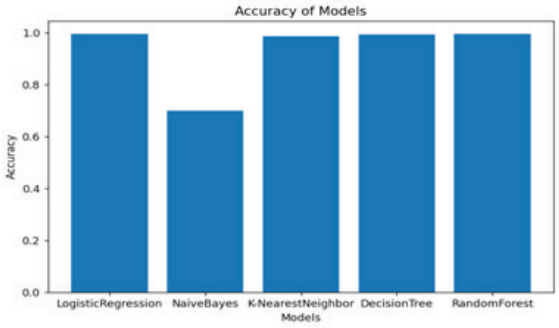


Fig. 6. Accuracy Graph

The accuracy graph illustrates the performance of different classification models including Random Forest, K-Nearest Neighbors, Logistic Regression, Naive Bayes and Decision Tree for malware detection. Each line represents a specific model, showcasing its accuracy rate across varying datasets. Accuracy trends displayed in the graph provides valuable insights into the merits and limitations of each modelhelping in the identification of the most appropriate approach for

malware detection. Graph depicts out performance of Random Forest over KNN, Logistic Regression, Naive Bayes, and Decision Tree models indicating its best performance. This observation highlights the efficacy of ensemble methods like Random Forest in effectively addressing intricate classification tasks such as malware detection.

CONCLUSION

This paper highlights the importance of harnessing machine learning methodologies for detecting malware amidst ever-evolving threats. As traditional signature-based methods prove increasingly inadequate, it becomes imperative to explore alternative avenues. By employing a range of classification models. ML models has potential in accurately identifying unknown malware variants. Findings underscores the significance of employing feature extraction techniques like hex and assembly file analysis, while also highlighting the critical role of high-quality data and algorithmic performance. Through evaluation metrics valuable insights are gained about the efficacy of each model moving forward, further research and development in this area are crucial to enhancing cybersecurity measures and protecting computer systems and networks from malicious attack.

REFERENCES

1. Willams, Hoiz, Frelling, "Adapting Security Measures: Overcoming Polymorphic and Metamorphic Malware Challenges", 2007.
2. Ahmadi, M. et al., "Integrated Feature Extraction for Malware Detection: Unifying Hex and Assembly Analysis",2016.
3. Kim, T.G., Kang, B. Im, E.G.,"Machine Learning in Malware Detection", 2013.
4. Stewin, P. Bystrov, I.,"Enhancing Malware Detection: Leveraging Support Vector Machine for Robust Classification", 2016.
5. Lanzi, A. et al.,"Optimizing Malware Detection: Comparative Analysis of Classification Models for Enhanced Performance", 2010.
6. https://en.wikipedia.org/wiki/Malware
7. https://www.infosecurity-magazine.com/opinions/malware-detection- signature4.
8. https://www.kaggle.com/
9. https://towardsdatascience.com/
10. "Bagging predictors," Machine Learning, vol. 24, no. 2, pp. 123-140, 1996.
11. GongdeGuoFujian Normal University,"KNN Model-Based Approach in Classification",
12. Muhammad Shoaib Akhtar and Tao Feng "Malware Analysis and Detection Using Machine Learning Algorithms".
13. AlirezaSouri&Rahil Hosseini., "A state-of-the-art survey of malware detection approaches using data mining techniques"
14. BorraMadhan Mohan Reddy."Detection of Malware Attacks Using Naive Bayes Algorithm Comparing Logistic Regression Algorithm to have Improved Accuracy Rate".
15. Akhtar, M.S.; Feng, T.,“IOTA Anomaly detection machine learning in mobile sensing”, Akhtar, M.S.; Feng, T.
16. W. Han, J. Xue, Y. Wang, L. Huang, Z. Kong, L. Mao “Detecting and explaining malware based on correlation and fusion of static and dynamic characteristics”.
17. Özer ÇELİK “A Research on Machine Learning Methods and Its Applications”.
18. M. I. JORDAN AND T. M MITCHELL.“Machine learning: Trends, perspectives, and prospects.

Pixels to Phrases: Advancements in Image Caption Generation via CNNs

Gunjan Behl, Priya Chandran
Asst. Prof.
Bharati Vidyapeeth's Institute of Mgmt. & Inf. Tech.
Navi Mumbai, Maharashtra

Swapnil Sherkhane, Ravindra Sawant
Bharati Vidyapeeth's Inst. of Mgmt. & Info. Tech.
Mumbai, Maharashtra

ABSTRACT

Image captioning is made feasible by the use of Convolutional Neural Networks (CNNs), which mix computer vision and natural language processing. This integration allows machines to better understand images. Initially, collection of data for processing is refers from MS COCO dataset. CNN is used to get important attributes of an image. Further, we have used various models, like Recurrent Neural Networks (RNNs) or transformer to create captions that are accurate and relevant to the image.

INTRODUCTION

Image captioning technology combines computer vision and natural language processing, allowing machines to "see" & describe images in same way that humans do. Instead of just recognizing objects in the image, these systems try to give descriptions of that image means is telling you what's happening in that image. Imagine of it as teaching a computer to tell a story about a picture. This field has been getting a lot of attention lately because of its practical uses, like helping people with disabilities, improving search results, powering self-driving cars, and making sense of multimedia content. By using image captioning, we're teaching computers to describe pictures in a more humanize way. This makes them to understand an image better.

Image captioning technology can help us in various field such as health care, Media and Entertainment etc. That can help us to improve our day to day life. With image captioning technology, the phone can generate a descriptive caption of the photo, such as "a busy city street with people walking " allowing the person to understand environment in better way. However, there is some negative impact of this technology. One of the issue is that the technology can sometimes reflect biases if some biases present in training dataset. This means that if the training dataset has biases, this might be generating some inaccurate caption or even discriminatory caption. There is also a risk of misuse of this technology, such as generating misleading or inappropriate captions.

Moreover, in digital world captioned images gives more effective understanding of social media content, helps in improving search engine results. Captioned images, in general provides a better understanding of visual content and it also helps in improving human-machine interaction. Thus, image captioning is majorly required for using the full potential of visual data across various domains and applications.

PROBLEM DEFINITION

Image captioning is a process in which a descriptive explanation (in text form) or captions are generated for images by trained artificial intelligence model. Its involves Computer Vision and Natural Language Processing (NLP) techniques for analysis of given, image's content and express it in human language. The basic purpose of picture captioning is to interpret the visual material and translate it into written descriptions. There are several key steps involve in image captioning, at first the given image is analyse with the help of Computer Vision algorithms to extract elements which are present in the content such as objects, scenes and emotional features too. The process of extracting elements is performed by convolutional neural networks (CNNs) and it has

shown by far the best capability of understanding visual data. After completion of image's content extraction, it is combined with models which generate language by extracted content and it produces relevant and to the topic captions. There is a NLP techniques known as Recurrent Neural Networks (RNNs) which are majorly used for this purpose. The created captions fundamental objective is to precisely portray the substance of the picture in a important way, capturing imperative subtle elements and setting.

At first, in terms of accessibility, image captioning plays a major role in generating a textual descriptions of images which can be translated to Braille language by using various other algorithm and this can help visually impaired peoples. In addition to educational contexts, captioned images provide a understanding advantage in learning for students. In Deep Learning, there are several techniques by which an image captioning model can be created, each technique has its different way of approach and implementation methods from image analysis to language generation.

LITERATURE REVIEW

Within the complex field of picture captioning, computer vision and characteristic dialect preparing are combined with the objective of empowering machines to comprehend and depict visual features in dialect that's human-like. Vinyals et al. (2015) introduced a pioneering neural image captioning model that utilized CNNs for image encoding and RNNs for caption generation. This model demonstrated promising results but faced challenges in capturing long-range dependencies in sequences. To address these restrictions, Xu et al. (2015) proposed an attention-based picture captioning demonstrate, permitting the demonstrate to center on distinctive parts of the picture when producing each word of the caption, upgrading the pertinence and coherence of the produced captions.

The success of image captioning models heavily relies on the use of advanced technologies for feature extraction and sequence modelling. Krizhevsky et al. (2012) revolutionized the field of image classification with the introduction of AlexNet, a deep CNN model, setting the foundation for using CNNs in image captioning tasks. CNNs are adept at capturing spatial hierarchies and semantic information in images, making them ideal for obtaining pertinent features for image captioning. Actively, Sutskever et al. (2014) demonstrated the potential of RNNs in sequence-to-sequence learning, paving the way for their application in generating captions based on the extracted image features. Additionally, the MS COCO dataset, introduced by Lin et al. (2014), has become a widely used benchmark for image captioning, providing a large collection of high-quality image-caption pairs for training, ensuring improved performance and generalization of image captioning models. Despite the advancements in image captioning technology, several limitations and challenges persist. Venugopalan et al. (2015) highlighted the difficulties in generating accurate and relevant captions for complex images with multiple objects and intricate details. Fang et al. (2015) addressed the issue of generating generic and uninformative captions, emphasizing the need for more contextual and descriptive captions. Furthermore,

Johnson et al. (2016) identified the lack of consistence in generating accurate captions across different images and the tendency to produce captions lacking coherence and relevance to the image content, Gan et al. (2017) investigated the problem of overfitting in image captioning models, proposing strategies to mitigate overfitting and improve the generalization capability of image captioning models. The literature on image captioning has seen significant advancements with the introduction of neural network-based models leveraging CNNs and RNNs. While these models have demonstrated promising results, there are still challenges and limitations that need to be address to improve the accuracy, relevance, and generalization capability of image captioning systems. Future research should focus on developing robust and reliable models capable of handling the complexity and diversity of real-world images, enhancing the overall quality and informativeness of the generated captions.

RESEARCH METHODOLOGY

Existing Technologies

1) Recurrent Neural Networks (RNNs): RNNs are commonly used in picture captioning assignments because of their ability to handle sequential input.

RNNs process images in image captioning by feeding them into a series of hidden layers, each of which creates a portion of the caption in sequence.

2) Long Short-Term Memory (LSTM) Networks: LSTM systems are a kind of RNN that reviews long-term conditions in successive input. LSTMs have been utilized in picture captioning to upgrade the quality and coherence of produced captions by capturing complicated relationships between picture characteristics and words.

3) Transformer-based Architecture: Transformer architectures, such as BERT and GPT, have also been investigated for picture captioning purposes. These models use self-attention techniques to capture relationships in data, and they have produced correct and contextually relevant captions.

Challenges faced with existing methods

1) Limited Understanding of Image Content: Existing methods often struggle to capture the detailed semantics and context of image content, leading to generic or irrelevant captions.

2) Over-reliance on Training Data :Many existing models require large amounts of annotated data for training, making them less effective when applied to datasets with limited or incomplete annotations.

3) Handling Complex Scenes and Objects: Generating captions for images containing multiple objects, complex scenes, or abstract concepts remains a challenging task for existing methods, as they often fail to generate coherent and descriptive captions in such scenarios.

IMPLEMENTATION

Here are some commonly used evaluation parameters for different tasks:

Image Captioning

BLEU (Bilingual Evaluation Understudy): Measures how similar the generated descriptions are to the reference captions.

METEOR: Another metric to assess the standard of the created captions.

CIDEr: Evaluates the consensus between the generated and reference captions.

Object Detection

mAP (mean Average Precision): It's a popular metric to evaluate the accuracy of object detection. It calculates the precision-recall curve for different object categories and then computes the average precision across all categories.

Instance Segmentation

mAP (mean Average Precision): Similar to object detection, but it also takes into account the segmentation quality.

We compared various methods of image captioning using standard evaluation metrics to understand their performance better. The metrics we used include BLEU-1 (B1), BLEU-2 (B2), BLEU-3 (B3), BLEU-4 (B4), METEOR (M), ROUGE (R), CIDEr (C), and SPICE (S).

For our comparisons, we used the CNN model and the method referenced as [10][11] that achieved the highest CIDEr scores on the trained set after training of epochs. We then applied these models to the test set to report their scores.

RESULTS AND DISCUSSIONS

We have tested our model by using below images, for example we have given the fig 3 image to our model and its generated the various captions. Firstly, our model extract image elements by using RNN algorithm and with help of underlying model of CNN, LSTM and training of various epochs, model try to understand image and generates relevant and to the topic captions for it. In our experiments, we observed that the Convolutional Neural Network (CNN) had a higher cross-entropy loss on the training sets of the MSCOCO dataset compared to the Long Short-Term Memory (LSTM) network. However, despite the higher loss, the CNN demonstrated accuracy of words better than the LSTM, as shown in fig 1. The reason behind this higher word accuracy in CNN is that it assigns the maximum probability to the correct word more frequently. Despite the fact that the CNN has a larger loss than the LSTM, this is mostly because of the greater entropy or uncertainty in its output probability distributions. In our study, we found that the softmax

entropy, which represents the posterior probability distribution, is higher in our CNN compared to the LSTM. With tasks like as picture captioning, where problems can be ambiguous, it's beneficial to have a less sharply peaked or multi-modal posterior distribution, as seen in our CNN. This kind of distribution allows for generating multiple captions, unlike the more sharply peaked distribution observed in the LSTM.

Fig. 1. Comparing several approaches using common assessment measures

	MSCOCO Val Set								MSCOCO Val Set							
Method	**B1**	**B2**	**B3**	**B4**	**M**	**R**	**C**	**S**	**B1**	**B2**	**B3**	**B4**	**M**	**R**	**C**	**S**
Baselines:																
LSTM [10]	.710	.535	.389	.281	.244	.521	.899	.169	.713	.541	.404	.303	.247	.525	.912	.172
LSTM + Attn (Soft) [11]	-	-	-	-	-	-	-	-	.707	.492	.344	.243	.239	-	-	-
LSTM + Attn (Hard)[11]	-	-	-	-	-	-	-	-	.718	.504	.357	.250	.230	-	-	-
Our CNN:																
CNN	.688	.515	.370	.272	.232	.513	.860	.161	.692	.520	.375	.280	.240	.513	.879	.169
CNN + Weight Norm.	.701	.530	.387	.280	.242	.518	.885	.168	.698	.529	.388	.279	.242	.517	.879	.171
CNN + WN +Dropout.	.705	.531	.387	.279	.241	.517	.888	.169	.701	.533	.390	.282	.244	.521	.899	.172
CNN + WN +Dropout +Residual.	.707	.533	.388	.281	.243	.518	.895	.171	.702	.533	.391	.282	.245	.521	.900	.174
CNN + WN +Dropout +Residual +Attn.	.710	.535	.390	.282	.244	.520	.895	.171	.710	.540	.395	.289	.247	.524	.905	.174

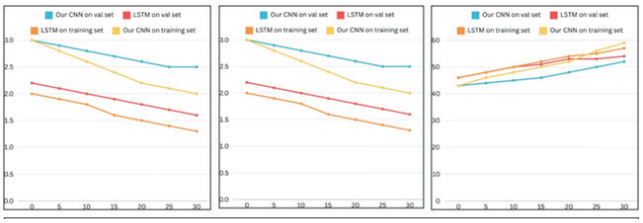


Fig. 2. In above shown graph plot (a) Loss of Cross-entropy (b) softmax entropy, (c) Accuracy of word based on train set

Fig. 3 Predicted captions

CONCLUSION

In conclusion, this research states that its provides important insights into the details of Image Captioning technology through a comparative analysis using other existing models. By properly analysis of our results; Image Captioning system with findings from studies conducted in 2023, 2022, 2021, and 2020, we have gained a deeper understanding of the effectiveness and evolution of Image Captioning methodologies or detection techniques in general.

Our Image Captioning system demonstrates competitive performance, aligning closely with the accuracy rates reported in relevant studies. The utilization of CNN & RNN architectures for feature extraction and classification has proven to be robust and reliable across various modalities, including images and videos. Furthermore, our system's integration of advanced techniques such as temporal analysis and attention mechanisms enhances its capabilities in detecting subtle manipulations indicative of images.

REFERENCES

1. J. Aneja, A. Deshpande, and A. G. Schwing, "Convolutional Image Captioning," University of Illinois at Urbana-Champaign, Urbana, IL, USA, Tech. Rep., [Online]. Available: {janeja2, ardeshp2, aschwing}@illinois.edu
2. J. Gu, G. Wang, J. Cai, and T. Chen, "An Empirical Study of Language CNN for Image Captioning," ROSE Lab, Interdisciplinary Graduate School, Nanyang Technological University, Singapore; Alibaba AI Labs, Hangzhou, China; School of Computer Science and Engineering, Nanyang Technological University, Singapore, [Online].
3. J. Mao, W. Xu, Y. Yang, J. Wang, Z. Huang, and A. Yuille, "Deep captioning with multimodal recurrent neural networks (m-rnn)," in ICLR, 2014.

4. J. Lu, C. Xiong, D. Parikh, and R. Socher, "Knowing when to look: Adaptive attention via a visual sentinel for image captioning," in CVPR, 2017.
5. P. Anderson, B. Fernando, M. Johnson, and S. Gould. Spice: Semantic propositional image caption evaluation. In ECCV, 2016.
6. P. Anderson, X. He, C. Buehler, D. Teney, M. Johnson, S. Gould, and L. Zhang. Bottom-up and top-down attention for image captioning and visual question answering. arXiv preprint arXiv:1707.07998, 2017.
7. S. Antol, A. Agrawal, J. Lu, M. Mitchell, D. Batra, C. L. Zit nick, and D. Parikh. VQA: Visual Question Answering. In International Conference on Computer Vision (ICCV), 2015.
8. D. Bahdanau, K. Cho, and Y. Bengio. Neural machine translation by jointly learning to align and translate. CoRR, abs/1409.0473, 2014.
9. X. Chen and C. L. Zitnick. Mind's eye: A recurrent vi sual representation for image caption generation. In 2015 IEEE Conference on Computer Vision and Pattern Recogni tion (CVPR), pages 2422–2431, June 2015.
10. A. Karpathy and L. Fei-Fei. Deep visual-semantic align ments for generating image descriptions. In 2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pages 3128–3137, June 2015.
11. K. Xu, J. L. Ba, R. Kiros, K. Cho, A. Courville, R. Salakhut dinov, R. S. Zemel, and Y. Bengio. Show, attend and tell: Neural image caption generation with visual attention. In Proceedings of the 32Nd International Conference on In ternational Conference on Machine Learning - Volume 37, ICML'15, pages 2048–2057. JMLR.org, 2015
12. Q. V. Le, N. Jaitly, and G. E. Hinton. A simple way to initial ize recurrent networks of rectified linear units. arXiv preprint arXiv:1504.00941, 2015.
13. B. A. Plummer, L. Wang, C. M. Cervantes, J. C. Caicedo, J. Hockenmaier, and S. Lazebnik. Flickr30k entities: Col lecting region-to-phrase correspondences for richer image to-sentence models.InICCV,2015.
14. J. Gu, Z. Wang, J. Kuen, L. Ma, A. Shahroudy, B. Shuai, T. Liu, X. Wang, and G. Wang. Recent advances in convolutional neural networks. arXiv preprint arXiv:1512.07108, 2015.
15. R. A. Yeh, J. Xiong, W.-M. Hwu, M. Do, and A. G. Schwing. Interpretable and Globally Optimal Prediction for Textual Grounding using Image Concepts. In Proc. NIPS, 2017.
16. J. B. Oliva, B. Poczos, and J. Schneider. The statistical recurrent unit. ICML, 2017.
17. J. Johnson, A. Karpathy, and L. Fei-Fei. Densecap: Fully convolutional localization networks for dense captioning. In CVPR, 2016.
18. E. Shelhamer, J. Long, and T. Darrell. Fully convolutional networks for semantic segmentation. IEEE Trans. Pattern Anal. Mach. Intell., 39(4):640–651, Apr. 2017.
19. L. Wang, A. G. Schwing, and S. Lazebnik. Diverse and Accurate Image Description Using a Variational Auto-Encoder with an Additive Gaussian Encoding Space. In Proc. NIPS, 2017.
20. I. Sutskever, O. Vinyals, and Q. V. Le. Sequence to sequence learning with neural networks. In NIPS, 2014.
21. R. Vedantam, C. Lawrence Zitnick, and D. Parikh. Cider: Consensus-based image description evaluation. In CVPR, 2015.
22. O. Vinyals, A. Toshev, S. Bengio, and D. Erhan. Show and tell: A neural image caption generator. In CVPR, 2015.
23. O. Vinyals, A. Toshev, S. Bengio, and D. Erhan. Show and tell: Lessons learned from the 2015 mscoco image captioning challenge. PAMI, 2016.
24. M. Wang, Z. Lu, H. Li, W. Jiang, and Q. Liu. gen cnn:A convolutional architecture for word sequence prediction. ACL, 2015.
25. J. Weston, S. Chopra, and A. Bordes. Memory networks. arXiv preprint arXiv:1410.3916, 2014.
26. Q. Wu, C. Shen, L. Liu, A. Dick, and A. v. d. Hengel. What value do explicit high level concepts have in vision to language problems? CVPR, 2016.
27. K. Xu, J. Ba, R. Kiros, K. Cho, A. Courville, R. Salakhutdinov, R. S. Zemel, and Y. Bengio. Show, attend and tell: Neural image caption generation with visual attention. ICML, 2015.
28. D. Kingma and J. Ba. Adam: A method for stochastic optimization. ICLR, 2015.

Fake Social Media-Profile Detection

Pratibha Deshmukh, Tabassum Shaikh
Bharati Vidyapeeth's Inst. of Mgmtm and Info. Tech.
Navi Mumbai, Maharashtra
✉ pratibha.deshmukh@bharatividyapeeth.edu

Ayesha Mujawar
Bharati Vidyapeeth's Inst. of Mgmt. & Info. Tech.
Sangli, Maharashtra
✉ ayeshamulla78@gmail.com

Keval Virbhadre
Bharati Vidyapeeth's Inst. of Mgmt. & Info. Tech.
Navi Mumbai, Maharashtra
✉ ayeshamulla78@gmail.com

ABSTRACT

The prevalence of fake profiles on social media platforms poses significant challenges in maintaining the integrity and security of online interactions. This paper explores various methodologies and techniques aimed at detecting and reporting fake social media profiles. By analyzing existing research and implementing novel approaches, we aim to enhance the accuracy and efficiency of identifying fraudulent accounts. Our investigation delves into the intricate nature of cybercriminal activities, including spamming, cyberbullying, and identity theft, which are facilitated by fake profiles. Through collaborative efforts with social media platforms, such as Twitter and LinkedIn, we strive to develop robust detection mechanisms capable of identifying and removing thousands of fake profiles. By leveraging machine learning and deep learning algorithms such as Recurrent Neural Networks (RNNs), long short-term memory (LSTM), Support Vector Machine (SVM), we aim to advance the capabilities of detecting fake social media profiles, thereby contributing to a more secure online environment. The research outcomes offer insights into the evolving landscape of online security threats and propose strategies for mitigating risks associated with fake social media profiles.

KEYWORDS: *Fake social media profiles, Machine Learning (ML), Deep Learning (DL). Detection, Reporting, cybersecurity, Spam, Cyberbullying, Identity theft, Recurrent Neural Networks (RNNs), Long short-term memory (LSTM), Support Vector Machine (SVM).*

INTRODUCTION

For all members of this age, social life now equates to either real-world connections with others who share interests, activities, and experiences, or both—online social networks [1]. The rapid proliferation of online social media use has led to an unregulated surge in the number of fraudulent user accounts that have penetrated social networks and become a serious danger to cyber security [2]. Virtual entertainment platforms such as Facebook, Instagram, Twitter, and others have a significant impact on our daily life. People actively participate in it from all around the world. In any case, it must also deal with the issue of fraudulent profiles [3].

Neural networks, Random Forest, XGBoost, and LSTM the important characteristics are chosen to evaluate the social media page's veracity [4]. Some research groups have combined block chain technology with long short-term memory (LSTM) to deploy recurrent neural networks (RNNs). A comprehensive literature analysis detailing the many techniques employed to generate and recognize bogus profiles has been made available by this research study [5]. A method called SVM-NN has been proposed to effectively identify fake Twitter accounts and bots. A number of feature selection and dimension reduction strategies have been put into practice. Three machine learning classification techniques were used to determine if the target account's identity was real or fraudulent: support vector machine (SVM), neural network (NN) [6]. detection programme that looks at variables like friend and follower counts, status updates, and more to use a variety of machine

learning techniques to distinguish between real and fake Twitter identities. The author categorized genuine accounts into TFP and E13 and fraudulent accounts into INT, TWT, and FSF using the Twitter profile dataset [7]. Avoid unscrupulous websites, online abuse, and spam; they are usually conducted by phony personas. These acts call into question the privacy policies of the social network communities. These fake profiles spread misleading information on social networking sites. Numerous studies have been conducted in this area to detect spam, bot accounts, duplicate accounts, and phony profiles. The majority of the phony accounts were successfully identified by a machine-learning system. This study examines the application of machine learning to social networking site phony profile identification. [8]. Social network research is one of the exciting and promising areas of study because of its growing scope and demand [9]. An online social network (OSN) enables users to form social networks and interactions with one another, much like a virtual community. OSN has expanded more quickly as a result of unfettered access to the Internet, which has attracted hackers attempting to profit on OSN's and the Internet's vulnerabilities. The rising usage of OSN has placed users' security at danger since users share sensitive and private information online, which hackers can exploit to create profiles and carry out other nefarious acts on the social network. It really isn't essential to mention that identity theft on the Internet is comparatively easy to do and that the purpose to establish bogus accounts has harmful effects [10].

REVIEW OF LITERATURE

Social media is becoming a more popular source of information, particularly regarding military activities. In a variety of cyberattacks, information-psychological operations, and public opinion manipulation during times of war, fake social media accounts are commonly used. Online research techniques are used for social media analysis, and the key indicators and traits of phony Facebook profiles are looked at. Each statistic is assigned to the appropriate groups of online social networks. The convenience analysis of hand researchers, who are assigned a point value between 0 and 3, representing the degree to which each measure affected the determination of the account's falsity. Thus, we determine if an account is authentic or false depending on the degree of each parameter. The indicators that are analyzed include likes, friends, posts, status updates, user personal data, and images, taking into consideration their potential characteristics and impact on the account's status. For the ease of their analysis, each statistic is placed in the relevant categories. A supported vector machine-based decision-making system with nine inputs and one output is created. A number of experimental studies were carried out, utilizing Facebook to accomplish parameters extraction and selection in addition to account analysis. [11]. False identities are linked to many harmful behaviors and are a significant component of advanced persistent threats. This article mostly reviews the literature on cutting-edge research on identifying phony social media profiles. [12]. One of the major issues with online social networks is the prevalence of phony accounts, or social bots, which are run by automated algorithms and frequently utilized for nefarious ends. Numerous efforts have been made by researchers to detect these entities in online social networks; the most popular approach is the Machine Learning classifier technique, which uses a particular feature set and feature selection as its main procedure [13]. Since the introduction of social media and the Internet, hundreds of people have benefited from the abundance of information accessible, but there has also been a significant increase in cybercrimes, especially those that target women. Most people think that this is because of how social media sites like Facebook, Instagram, and Twitter affect our day-to-day activities [14]. Therefore, we need to increase the accuracy rate of the social network fake profile recognition system. In this study, we provide methods for detecting bogus profiles using natural language processing (NLP) and machine learning. It is possible to use the Support Vector Machine (SVM) with the Naive Bayes method [15]. The majority of teenage social media users were older guys who were more likely to engage in cyberbullying. Adolescents that consistently participate in behaviors associated with cyberbullying are rather rare. [16]. Goal of engaging in online interactions with the victim's friends in order to get the victim's personal information. In this work, we provide the results of our inquiry into potential solutions to this issue. While doing this, we also observe that we are the

first to examine social network graphs in the context of privacy issues from a dynamic point of view [17]. Facebook, one of the most popular social networks, had one of the largest initial public offerings (IPOs) in the history of Internet technology. These platforms are mostly used by charitable and for-profit organizations for large-scale marketing campaigns and target-oriented advertising. Social networks' ability to reach millions of users and potential consumers has drawn attention from all over the world. Malicious individuals frequently take advantage of social networks' capacity to obtain sensitive personal data from oblivious users [18]. Identifying spammer accounts, and our research was applied to a real-world social network takedown. More specifically, we worked with Twitter throughout this investigation and successfully identified and removed 15,857 spam profiles [19]. It is determined which minimal amount of profile data is required to detect phony profiles on LinkedIn, as well as the best data mining technique to use for these kinds of jobs. [20]. A number of issues are brought about by the widespread use of phony social media profiles, such as the dissemination of false information, identity theft, and online fraud. Furthermore, manual identification and reporting of bogus profiles is an overwhelming undertaking for both platform administrators and users due to their enormous volume. A number of issues are brought about by the widespread use of phony social media identities, including the spread of misleading material, invasions of privacy, and instances of cyberbullying. Spam and identity theft instances rise as a result of existing detection technologies' inability to keep up with hackers' shifting strategies. Furthermore, it is challenging to correctly identify false profiles due to the limited amount of publicly accessible profile data on websites like LinkedIn, which complicates the identification procedure.

Manual identification is not practicable due to the sheer number of accounts generated on a daily basis. Current approaches typically find it difficult to keep up with the constantly changing strategies used by those who fabricate profiles. Furthermore, it might be difficult to distinguish between legitimate accounts with little activity and perhaps phony ones.

OBJECTIVES

To identify ML and DL models used to detect Fake profiles on Social media platforms like Facebook, LinkedIn. To identify the vulnerabilities present in identified different ML and DL models. To suggest the best suitable ML and DL framework for identifying Fake profiles on LinkedIn and Facebook.

RESEARCH METHODOLOGY

For the fake profile, we can use data mining techniques: weighted average (WA), principal component analysis (PCA), support vector machine (SVM), and neural network (NN). Identification in various combinations to ascertain which set of methods yields the most precise distinction between fake and authentic profiles.

As part of the study methodology, a thorough review of the body of literature on fake social media profile identification is conducted. Gaps in the state of the art are identified, and new detection strategies are suggested. Creating "honey-profiles" on social networking sites to collect data on spamming activity and examining user behavior patterns to identify irregularities suggestive of phony profiles are two examples of data gathering techniques.

LIST OF ML AND DL MODELS AND THEIR VULNERABILITIES

From the secondary sources of data collection the list of ML and DL models and their vulnerabilities used to detect fake profiles on social media platforms viz. Facebook, LinkedIn identified and shown as below in table.

Table 1.

ML and DL Models	Vulnerabilities Identified
Random Forest	Because of its high model complexity and susceptibility to adversarial assaults, Random Forest is not very good at identifying fraudulent profiles. It also has trouble accurately interpreting feature importance, which might lead to the deletion of crucial detection characteristics.

XG Boost	The sensitivity of XGBoost to adversarial feature manipulation, its propensity for overfitting to training data, and its possibility for biased predictions in the case that the dataset is imbalanced or contains biased features are some of its shortcomings in identifying phony profiles. The model's ability to discern between authentic and fraudulent profiles may suffer as a result of these weaknesses.
RNNs	By producing malicious data, attackers can trick RNNs in the false profile detection process, making the model wrongly recognize fakes as real. The reliability of RNN-based detection systems is jeopardized by adversarial assaults.
LSTM	Adversarial assaults might potentially target LSTM models that are employed in false profile detection. Attackers can create fake profiles with certain features that fool the LSTM into believing they are authentic. As a result, LSTM-based detection performs less well.
SVM	Due to its flaws, which include sensitivity to outliers, low efficacy in managing non-linear connections between features, and susceptibility to adversarial perturbations in input data, SVM may misclassify bogus profiles and diminish detection accuracy.
Naive Bayes	Many flaws in Naive Bayes make it difficult for it to reliably identify phony profiles. These flaws include the model's assumption of feature independence, which may not hold true in complicated datasets, its propensity to misclassify when given correlated features or subtle patterns, and its possible bias towards the majority class in datasets that are unbalanced.

Following recommendations on how to lessen the flaws in the use of ML and DL models for the identification of fraudulent social media profiles.

Adversarial Defense Mechanisms: Use adversarial training techniques to fortify the models' defenses against adversarial attacks. This might mean adding hostile situations to the training set or utilizing techniques like adversarial training during model training.

Regularization and Hyper parameter Tuning: Use regularization techniques like dropout or L2 regularization to minimize over fitting, particularly in complex models like Random Forest and LSTM. To optimize the performance of the model and prevent over-fitting, a thorough hyper parameter modification should be performed.

Selection and Feature Engineering: Perform extensive feature engineering to ensure that relevant features are included for fake profile identification. Utilize techniques such as feature significance analysis to ascertain and prioritize the value of every characteristic. Reduce noise and feature redundancy as well to enhance model performance.

Model Interpretability: Enhance the interpretability of the models by implementing techniques like layer-wise relevance propagation (LRP) and attention mechanisms. This is particularly important for complex deep learning models like LSTM. This can help in understanding model decisions and finding important elements that are involved in the identification of fake profiles.

Continuous Monitoring and Updates: Establish a system for monitoring the model's performance over time and its ability to recognize false profiles. Regularly add new data to the models and update them to account for evolving patterns in adversarial assaults and the creation of fake profiles.

Distinctive Attributes of Machine Learning and Deep Learning Models in False Profile Detection

Adversarial Attack Vulnerability: A variety of machine learning and deep learning models, including Random Forest, Boost, RNNs, LSTM, SVM, and Naive Bayes, are vulnerable to adversarial attacks, in which adversaries alter input data to trick the models.

Concerns that are too big: When ML and DL models overfit, they might not generalize well to new data. Because of this, the Random Forest, XGBoost, and LSTM models receive particular attention.

Interpreting Complexity: The accuracy of false profile identification may be impacted by deep learning and machine learning models' inability to understand complexities such as feature independence in Naive Bayes and feature significance in Random Forest and XGBoost.

Model Complexity: Common ML models like Random Forest, XGBoost, SVM, and Naive Bayes are less complex than DL models like RNNs and LSTM. Vulnerability profiles may be significantly impacted by this disparity in complexity.

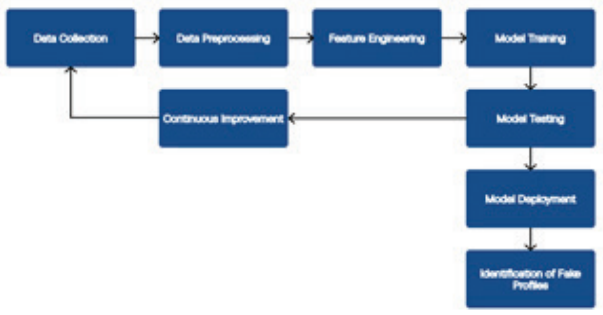
Supervising Non-linearity: While standard ML models, such as SVM, may find it difficult to manage such complexity, DL models are better adapted to capture nonlinear relationships in data.

Information Showcase: ML models such as Random Forest, XGBoost, SVM, and Naive Bayes are generally better at handling tabular data; however, DL models, particularly RNNs and LSTM, perform better when processing sequential data. This might be advantageous or disadvantageous, depending on the specifications of the false profile detection job.

A number of steps are involved in the design and execution of the framework for detecting and reporting false social media profiles, including feature extraction, data extraction, model training and system integration. To make the identification and reporting process easier, a technological framework with machine learning algorithms, natural language processing methods, and user interface elements is created.

Preprocessing data, feature engineering, model selection, and assessment metrics are all included in the technological architecture for the identification and reporting of phony social media profiles. Based on a variety of variables, machine learning methods including logistic regression, random forests, and neural networks are used to categorize suspicious profiles.

STANDARD PROCESS FOR ML AND DL FRAMEWORK FOR IDENTIFYING FAKE PROFILES ON LINKEDIN AND FACEBOOK



Creating a framework to identify fake profiles on Facebook with Machine Learning (ML) and Deep Learning (DL) requires a structured approach similar to that for LinkedIn, but with adaptations for Facebook's unique data and structure. Here's an exact flow to guide you through the process: Step 1: Data Collection

Determine Sources: Identify where to obtain Facebook profile data, ensuring adherence to ethical and legal guidelines. b. Profile Scraping: Use scraping tools like Beautiful Soup or Selenium to collect profile information, including names, profile photos, posts, friends, likes, and activity. Step 2: Data Preprocessing

Data Cleaning: Remove duplicates, handle missing values, and correct inconsistent or incorrect data.

Normalization: Normalize numerical data to standardize different scales. Step 3: Feature Engineering a. Profile-Level Features: Extract features indicating fake profiles, such as generic photos, low activity, or incomplete profile information. b. Network Features: Develop network-related features based on friend connections, interactions, groups, and other network-based data. Step 4: Model Selection and Training a. Baseline Models: Train simpler models like logistic regression or decision trees to set a baseline for performance. b. Advanced Models: Implement complex models like random forests, SVMs, or neural networks for improved accuracy. c. Hyperparameter Tuning: Use cross-validation and grid search to optimize model parameters for better performance. Step 5: Model Validation and Testing a. Validation and Testing: Use a validation set to assess model performance and a separate test set to evaluate against unseen data.

Model Refinement: Refine models based on validation results to achieve better accuracy and reliability. Step 6: Model Deployment a. Model Deployment: Deploy the best-performing model to a production environment using frameworks like Flask, FastAPI, or Docker. b. Monitoring and Maintenance: Implement monitoring tools to track the model's behavior and ensure it performs well in production.

Step 7: Continuous Improvement

Feedback Loop: Collect feedback from Facebook users and moderators about the accuracy of flagged profiles to improve the model.

Active Learning: Use the feedback to adjust the model and retrain it with new data to improve accuracy.

Iterative Model Improvement: Implement a continuous

improvement cycle with regular model refinement and retraining to keep it updated.

ADVANTAGES OF ML AND DL MODELS FOR FAKE DETECTION PROFILE WITH RESPECT TO SOCIAL MEDIA PLATFORMS

Automated Scalability: While human moderators find it difficult to identify dubious profiles at scale, machine learning and deep learning models are able to analyze vast volumes of social media data with efficiency.

Detection that is Always Learning: By examining fresh data, these algorithms are able to adjust to the ever-changing strategies employed by those who fabricate profiles. Multi-Faceted Analysis: For a more thorough assessment, they can examine a profile's written content, image discrepancies, friend networks, and activity patterns, among other elements. Proactive Detection: ML/DL models are able to spot warning signs even in freshly created or dormant profiles, which may enable them to be stopped before they disseminate false information or carry out harmful activities. Decreased Human Error: By automating the identification of bogus profiles, human moderators may devote more of their time to complicated instances or inquiries that call for human judgement.

CONCLUSION

Identifying and reporting phony social media identities necessitates a multipronged strategy that incorporates cutting-edge technology, user education, and stakeholder participation. Even if it's still difficult to distinguish real accounts from fraudulent ones, continued study and teamwork might help reduce the dangers of cybercrimes on social media. The implementation of suggested tactics and ideas may contribute to the creation of a more secure and safe online environment for people everywhere.

REFERENCES

1. F Ajesh; S U Aswathy; Felix M Philip; V Jeyakrishnan,"Hybrid Methodf or Fake Profile Detection in Social Network Using Artificial Intelligence," in Security Issues and Privacy Concerns in Industry 4.0 Applications , Wiley, 2021.
2. Narayanan, A. Garg, I. Arora, T. Sureka, M. Sridhar and H. B. Prasad,"Iron Sense: Towards the Identification of Fake User-Profiles on Twitter Using Machine Learning," 2018
3. J.Shaikh and R.Patil,"Fake News Detection using Machine Learning," 2020.
4. Harish, K. & Kumar, R. & Bell J, Briso Becky. (2023). Fake Profile Detection Using Machine Learning.
5. K. N. Sudhakar and M. B. Shanthi, "Deepfake: An Endanger to Cyber Security," 2023
6. Khaled, Sarah & El-Tazi, Neamat & Mokhtar, Hoda. (2018).
7. Chakraborty, P. , Shazan, M. , Nahid, M. , Ahmed, M. and Talukder, P. (2022) Fake Profile Detection Using Machine Learning Techniques. Journal of Computer and Communications.
8. K. Patel, S. Agrahari and S. Srivastava, "Survey on Fake Profile Detection on Social Sites by Using Machine Learning Algorithm," 2020.
9. Shamim Ahmad, Dr. Manish Madhava Tripathi (2023), A Review Article on Detection of Fake Profile on Social-Media, (ISSN 2347 - 5552).
10. Ojo, A.K. (2019). Improved Model for Detecting Fake Profiles in Online Social Network: A Case Study of Twitter. Journal of Advances in Mathematics and Computer Science.
11. Voitovych, O., Leonid Kupershtein, L., Kupershtein, L.M., & Holovenko, V. (2022). DETECTION OF FAKE ACCOUNTS IN SOCIAL MEDIA. Cybersecurity: Education, Science, Technique.
12. Romanov, A., Semenov, A., Mazhelis, O., & Veijalainen, J. (2017). Detection of Fake Profiles in Social Media - Literature Review.
13. Rostami, Reza Ramzanzadeh. “Detecting Fake Accounts on Twitter Social Network Using Multi-Objective Hybrid Feature Selection Approach.” Webology 17 (2020)
14. Dey, A., Reddy, H., Dey, M., & Sinha, N. (2019). Detection of Fake Accounts in Instagram Using Machine Learning. International Journal of Computer Science and Information Technology.
15. Shanthakumar, D.P., Pooja, S.J., & R.Jenifer (2023). Fake Profile Identification in Online Social Networks

Using Machine Learning. International Journal of Scientific Research in Science, Engineering and Technology.

16. Lareki, A., Altuna, J., & Martínez-de-Morentin, J. (2022). Fake digital identity and cyberbullying. Media, Culture & Society, 45, 338 - 353.

17. Conti, M., Poovendran, R., & Secchiero, M. (2012). FakeBook: Detecting Fake Profiles in On-Line Social Networks. 2012

18. Krombholz, K., Merkl, D., & Weippl, E.R. (2012). Fake identities in social media: A case study on the sustainability of the Facebook business model. Journal of Service Science Research, 4, 175-212.

19. Stringhini, G., Krügel, C., & Vigna, G. (2010). Detecting spammers on social networks. Asia-Pacific Computer Systems Architecture Conference.

20. Adikari, S., & Dutta, K. (2020). Identifying Fake Profiles in LinkedIn. Pacific Asia Conference on Information Systems.

Tech and Trends: A Digital Dive into Domino's Financial Health (2020-2022)

Rashmi Jha
Associate Professor
Global Institute of Technology & Management
Gurugram University
Gurugram, Haryana
✉ rashmijha1909@gmail.com

Aman Jha
Student (MBA Executive)
University of Liverpool
Liverpool, UK
✉ jhaamanbusiness@gmail.com

ABSTRACT

The present paper attempts to project an all-inclusive analysis of the financial health of Domino's Pizza Inc. during the challenging period of 2020-2022, characterized by digital tools and IT-driven metrics. Spread across 90 countries with 19,800 locations, Domino's has undoubtedly emerged as one of the global leaders operating principally on a franchise model wherein almost all its stores are independently owned. In this study, an analysis of the data of some key financial ratios at the company about profitability, liquidity and leverage has been done to assess the market position and future viability of the enterprise.

We look at the various sources of revenue streams, such as retail sales, franchise royalties and supply chain sales to consider how events of macro variables like inflation and the pandemic have been affecting the income and profitability of Domino's. Comparative analysis with competitors like Papa John's and Pizza Hut depicts the competitive landscape of the pizza delivery market.

We illustrate trends and patterns of the financial performance of Dominos through digital data visualization using IT solutions. The results are that, despite revenues on the rise, net profit margins are falling due to higher costs of operations. Strategic recommendations to Dominos, such as diversification in product offerings and contingency plans against economic disruption, conclude the study. The research underlines more how important technology is in financial analysis, giving good insight to the stakeholders to decide on the way forward of Dominos.

KEYWORDS: *IT-driven metrics, Financial analysis, Domino's Pizza, Revenue analysis, Competitor's analysis, Profit and loss analysis, Competitive analysis, Balance sheet and Ratio analysis.*

INTRODUCTION

Dominos being one of the biggest pizza chains in the globe having presence across 19,800 locations over the world in 90 countries. Established in 1960, as a well-known global brand, Domino's company has been functioning in two different service models within its available set of stores with business in carryout and delivery services. Primarily a franchisor, 99% of its worldwide stores is retained and controlled by self-sustaining franchises. Franchising helps individuals to be their own employers and maintain control over pricing and employment-related matters [1][2].

Using IT-Driven Metrics, the current research will examine Domino's financial performance from 2020 to 2022 to determine its global market position by making Financial Analysis, Revenue Analysis, Competitor's Analysis, Profit & Loss Analysis, Balance Sheet and Ratio Analysis. Key ratios will be used to assess its financial performance. The study reports will traverse through Profitableness Trends, liquidity ratios, leverage ratios comparisons which gives significant important insights in assessing the survivability trends of the company in coming times and to make further crucial decision.

DOMINO'S REVENUE SOURCES ANALYSIS

Break up of revenue streams for Domino's from the FY 2020 to 2022 is as follows:

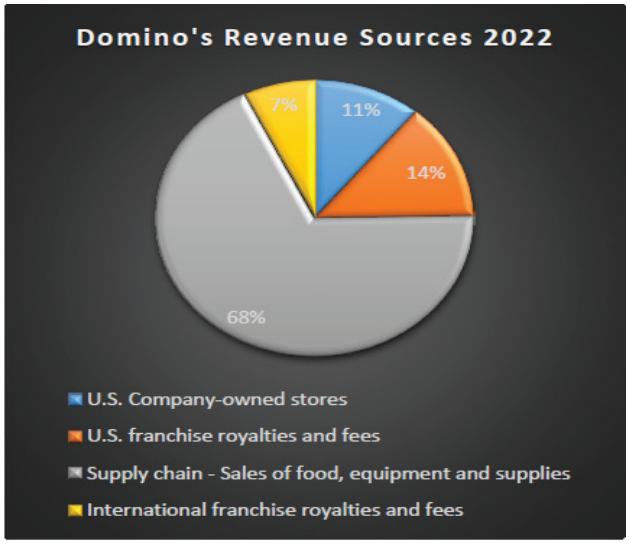


Fig. 1. Domino's Revenue Sources 2022 [Source: Self Made]

Table 1. Domino's Revenue Sources (in Millions) for the Year 2020, 2021 & 2022

Revenue Sources(In Millions)	2022	2021	2020
U.S. Company-owned stores	446	479	486
U.S. franchise royalties and fees	556	540	503
Supply chain - Sales of food, equipment and supplies	2,755	2,561	2,417
International franchise royalties and fees	295	298	250
Total	4,052	3,878	3,655

Dominos generates revenue from a variety of sources:

1) Retail Sales from Company-Owned Stores: Revenue generated from the direct pizza sale and other food items at Domino's owned stores to customers contributing to about 11% of total revenues equating to 446 million USD in 2022.

2) Fees, Royalties and Advertisement Contributions from U.S. Franchised Stores: Domino's franchises its stores to independent owners, who in turn pay royalties and fees to Domino's in exchange for the right of usage of Domino's brand name and operating system contributing to about 14% of total revenues equating to 556 million USD in 2022.

3) Royalties and Fees from International Franchised Stores: Domino's franchises its stores to operators operating internationally who in turn pay royalties and fees in exchange for the right of usage of Domino's brand name and operating system contributing to about 7% of total revenues equating to 295 million USD in 2022.

4) Sales of Equipment, Food & Supplies from Supply Chain Centers to almost all franchised stores of U.S. and also in franchised stores(international) - Domino's operates supply chain centers that distribute equipment, food & all supplies to all its international franchised stores and US franchised stores. Domino's generates revenue by the sale of end products and related services to its franchisees contributing to about 67% of total revenues equating to 2755 million USD in 2022.

For Domino's, Year on Year revenues from business are increasing as highlighted in the Table I, however, a closer view on revenues table suggests that revenue from US company owned stores are declining mainly due to US store sales[1][2][3].

In 2022, the revenue generated by Domino's company-owned stores in the United States decreased, partly due to a decline in same-store sales. Domino's company-owned same-store sales in the United States declined by 2.6% in 2022, and by 3.6% in 2021[1][2].

COMPETITOR ANALYSIS

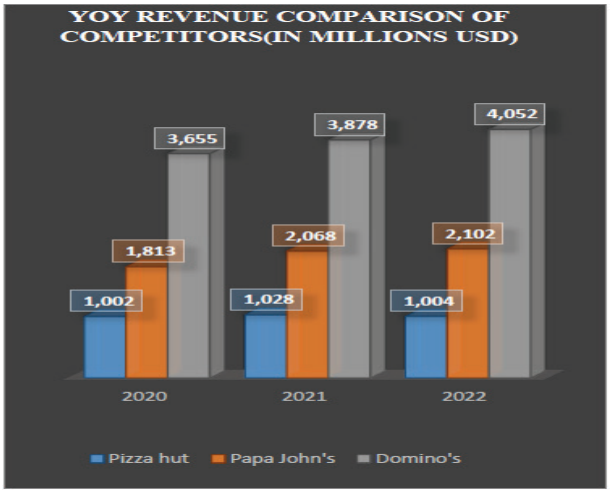


Fig. 2. YOY Revenue Comparison of Competitors in Millions USD [Source: Self Made]

Table 2. Domino's % Change In Revenue For The Year 2020, 2021& 2022

Year	2022	2021	2020	% change in Revenue (2020-21)	% change in Revenue (2021-22)
Pizza hut	1,004	1,028	1,002	3%	-2%
Papa John's	2,102	2,068	1,813	14%	2%
Domino's	4,052	3,878	3,655	6%	4%

The pizza delivery and carryout markets are very competitive globally. Dominos compete against national chains like Papa John's, Pizza Hut. Competition is majorly calculated from the price, service, location, quality of product, public impression and convenience. Additionally, Domino's compete for the customers, for management and hourly workers, including members of the team working in stores and suitable real estate sites [1].

However, business of Domino's company and its competitors may be influenced by variations in demographic trends, tastes of end customers, marketing, conditions of health and economy, advertisement, pricing policy and disposable income of end customers[1][2]. Across the trend from 2020 to 2022, Domino's has marked its strong presence against its competitors and forecasted perpetual growth [4][5][6].

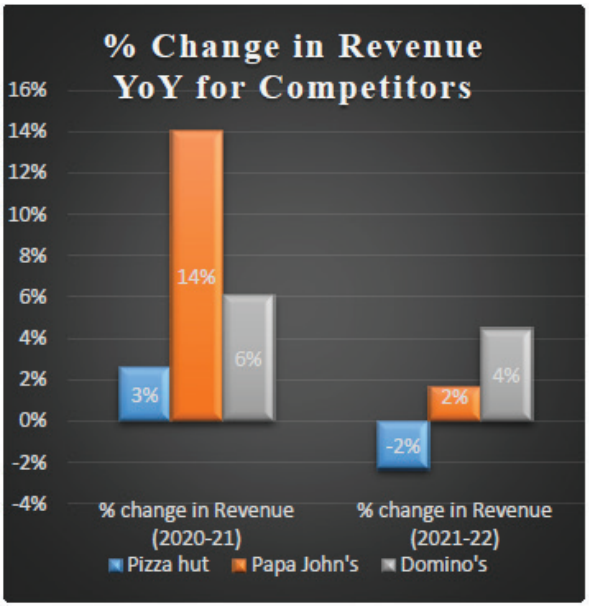


Fig. 3. Percentage Change in Revenue YoY for Competitors [Source: Self Made]

However, as per figure 3, declining percentage YoY revenue trends for Domino's from 6% in FY 2020-21 to 4% in FY 2021-22 and its competitors (Papa John's from 14% in FY 2020-21 to 2% in FY 2021-22 and Pizza Hut from 3% in FY 2020-21 to -2% in FY 2021-22) may indicate that due to inflation, people are now resolving to move away from junk food and acquiring more healthier lifestyle, opting to simply cook at home in the post-Covid era[7][8][9].

PROFIT AND LOSS ANALYSIS

Table 3. Income Statement With Margin Calculations [Source: 1,2,3]

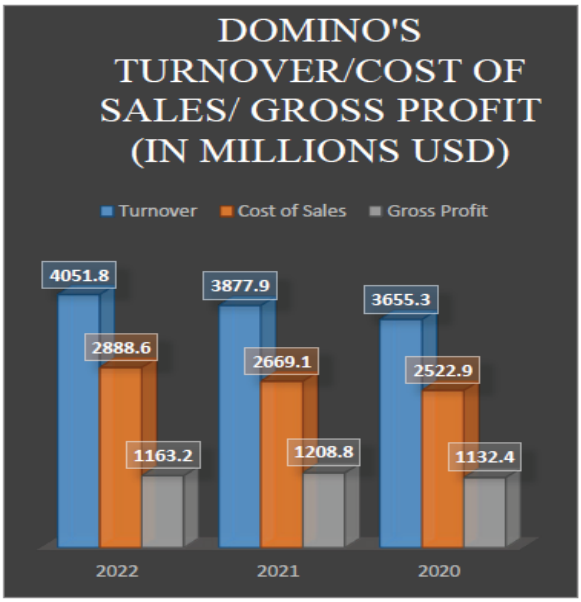
Income Statement (in millions)

Revenues:	2022	%	2021	%	2020	%
U.S. Company-owned stores	446		479		486	
U.S. franchise royalties and fees	556		540		503	
Supply chain	2,755		2,561		2,417	
International franchise royalties and fees	295		298		250	
Total revenues	**4,052**		**3,878**		**3,655**	
Cost of sales:						
U.S. Company-owned stores	378		374		380	
Supply chain	2,511		2,295		2,143	
Total cost of sales	**2,889**	**71%**	**2,669**	**69%**	**2,523**	**69%**
Gross Profit	**1,163**	**29%**	**1,209**	**31%**	**1,132**	**31%**
General and administrative	417		428		407	
Refranchising gain	(21)					
Income from operations	**768**	**19%**	**781**	**20%**	**726**	**20%**
Interest expense, net	195		192		171	
Other income			37			
Income before provision for income taxes	573		626		555	
Provision for income taxes	121		115		64	
Net income	**452**	**11%**	**511**	**13%**	**491**	**13%**
No. of Shares	**35,419,718**		**36,138,273**		**44,716,914**	
Earnings per Share	**13**		**14**		**11**	

Profit and Loss Observations

As per Figure 4 above, YoY revenue/turnover is increasing however net profit margin is declining. This may be result of higher operational costs by 2% in FY 2022 as compared to FY 2021 mainly due to significant high inflation rate in Domino's commodity, labour and cost of fuel generating in U.S. from the prevailing macroeconomic conditions[2].

Fig. 4. Domino's Turnover/ Cost of Sales/ Gross Profit (In Million USD) [Source: Self Made]



However, decrement in administrative & general expenses by $11.8 million or 2.8% in year 2022[1] affected mostly by lower labour costs (horizontal function employees like HR, finance, legal etc) maybe a result of attrition due to store sales, partly balanced by amortization cost that was higher for capitalized software. In addition to the factors mentioned, as per Table 3, Earnings per share have declined because net profit margin is declining by 2% in FY 2022 as compared to FY 2021[4][5][6].

Margin Study

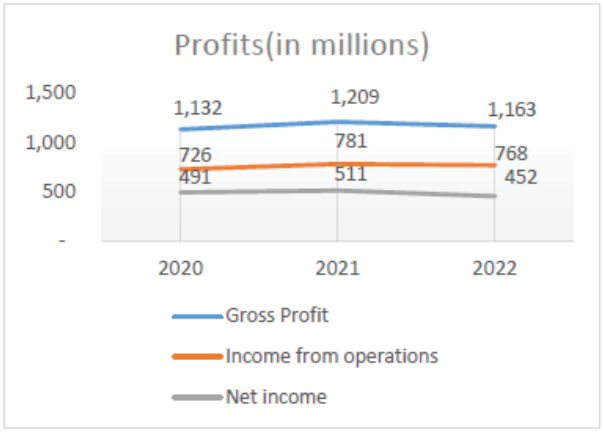


Fig. 5. Domino's Profit (In Million USD)Margin Study [Source: Self Made]

Gross Margin

Gross margin is a key financial metric that represents that compares the gross margin of a company to its revenue. Better profitability is denoted by higher gross margin, as it suggests that the company retains a larger portion of generated revenue after deducting the Cost of Goods Sold (COGS) associated with producing goods or services [10].

Combined sales cost made primarily of Company owned store (U.S.) and supply chain costs incurred for revenue generation. Constituents of consolidated cost of sales consists of labour, delivery, food and occupancy costs. Decrement in gross margin(consolidated) by $39.6 million around 2% in year 2022. It was mainly due to U.S. Company-owned store revenues which were low, as well as higher food, labour and delivery cost contributed to decrement in gross margin [1][7][8].

Net Income

Net income represents the total amount of money a company has earned after deducting all its expenses from its revenue[11]. This financial metric is often used to determine the profitability of a business. As per Figure 5, declining gross margins have led to lower Net Income (from 511 million USD in 2021 to 452 million USD in 2022) despite of lower General, administrative and other expenses.

RATIO ANALYSIS BASED ON BALANCE SHEET

Fixed Asset Turnover Ratio (FATR)

Fig. 6. Domino's Fixed Asset Turnover Ratio for 2020, 2021 & 2022 [Source: Self Made]

BALANCE SHEET AND RATIO ANALYSIS

Table 4. Balance Sheet Of Dominos in Millons USD for the Years 2020, 2021 & 2022 [Source: 1,2,3]

Assets	2022	2021	2020
Description of Current Assets			
Cash and its equivalents	60,356	148,160	168,821
Cash Restricted and its equivalents	191,289	180,579	217,453
Receivables Accounts	257,492	255,327	244,560
Inventory	81,570	68,328	66,683
Expenses(Prepaid)	37,287	27,242	24,169
Fun d assets(Advertising)	162,660	180,904	147,698
Description of Current Assets(Total)	**790,654**	**860,540**	**869,384**
Property, plant and equipment description			
Building & Land	105,659	108,372	88,063
Leasehold	172,725	193,572	186,456
Equipment	333,787	312,772	292,456
In progress construction	22,536	27,815	13,014
TOTAL	**634,707**	**642,531**	**579,989**
Accumulated amortization & depreciation	(332,472)	(318,466)	(282,625)
Net PPE	**302,235**	**324,065**	**297,364**
Description of assets(others)			
Operating lease (right of use assets)	219,202	210,702	228,268
Financing in securities(marketable)	13,395	15,493	13,251
Goodwill	11,763	15,094	15,061
Capitalized software	108,354	95,558	81,306
Investment	125,840	125,840	
Assets(Other)	28,852	22,535	60,630
Income tax assets(Delayed)	1,926	2,109	1,904
Other Assets(Total)	**509,332**	**487,211**	**400,420**
Description of Assets(Total)	**1,602,221**	**1,671,816**	**1,567,168**
Deficit of stockholders and liabilities			
Description of liabilities(current)			
Long term debt portion(current)	54,813	55,588	2,855
Payable Accounts	89,715	91,547	94,499
Compensation Accrued	40,442	59,567	58,520
Interest Accrued	34,473	37,982	31,695
Liabilities(Operating lease)	34,877	37,155	35,861
Reserves of Insurance	31,435	32,588	26,377
Liabilities(for Advertisement fund)	157,909	173,737	141,175
Liabilities Accrued	92,957	102,577	79,833
Current liabilities(Total)	**536,621**	**590,741**	**470,819**
Description of liabilities(Long term)			
debt(long term)	4,967,420	5,014,638	4,116,018
Liabilities of operational lease	195,244	184,471	202,268
Reserves of Insurance	40,179	36,913	37,125
Delayed liabilities of income tax	7,761	3,922	6,099
Liabilities accrued(others)	44,061	50,667	35,244
Liabilities long term(Total)	**5,254,665**	**5,290,611**	**4,396,754**
Total liabilities	**5,791,286**	**5,881,352**	**4,867,573**
Contingencies			
Deficit of stockholders			
Common stock	354	361	389
Preferred stock	–	–	
Paid in capital(Additional)	9,693	840	5,122
Deficit retained	(4,194,418)	(4,207,917)	(3,303,492)
Other loss(Accumulated)	(46,94)	(2,820)	(2,424)
Deficit of stockholders(Total)	**(4,189,065)**	**(4,209,536)**	**(3,300,405)**
Deficit of Stockholders and liabilities(Total)	**1,602,221**	**1,671,816**	**1,567,168**

Table 5. FA Turnover Ratio of Dominos in Millons USD for the Years 2020, 2021 & 2022 [Source: Self Made]

Year	2020	2021	2022
Turnover (in millions USD)	3,655	3,878	4,052
Fixed assets (in millions USD)	2,973	3,240	3,022
FA Turnover Ratio	1.23	1.20	1.34

Evaluation of company's efficiency in generating net sales from its fixed assets defines fixed asset turnover ratio[12]. A higher ratio indicates an increased utilization of fixed assets, it is also a fine indicator pertaining to operational efficiency and helps assess if the company has potential to generate sales which is determined by making investment in PPE(Property, Plant and Equipment).

As per balance sheet, there is an increase in Land, building and equipment costs by 9% from 2020 contributing towards higher revenue in 2022. Whereas, there was a decline in Fixed Asset turnover ratio in 2021 mainly due to COVID impact which impacted the overall sales.

Total Assets Turnover Ratio (TATR)

Fig. 7. Domino's Total Asset Turnover Ratio for 2020, 2021 & 2022 [Source: Self Made]

Table 6. Turnover, Total Assets & Total Assets Turnover's Ratio of Dominos in Millons USD for the Years 2020, 2021 & 2022 [Source: Self Made]

Year	2020	2021	2022
Turnover (in millions USD)	3,655	3,878	4,052
Total Assets (in millions USD)	1,567	1,671	1,602
Total Assets Turnover Ratio	2.33	2.32	2.53

Measurement to calculate how efficiently assets are utilized by a firm to generate revenue defines TATR (Total Assets Turnover Ratio). High TATR(Total Assets Turnover Ratio) shows firm effectively utilizes its assets for sales generation.

The balance sheet (Table 4) indicates an increase in inventory, receivables and prepaid expenses in addition to higher investments in fixed assets in 2022 as compared to 2021 contributing towards higher revenue and strong business outlook towards perpetual growth.

Current Ratio(CR)

Fig. 8. Domino's Current Ratio for 2020, 2021 & 2022 [Source: Self Made]

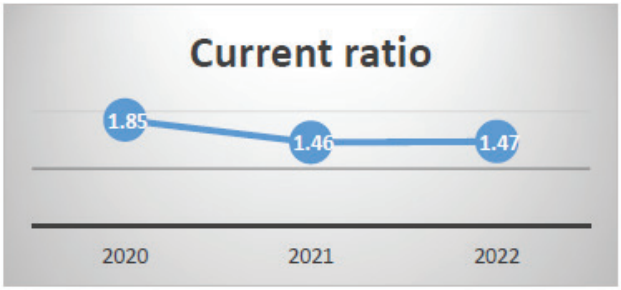


Table 7. Current Assets, Current Liabilities and Current Ratio of Dominos for the Years 2020, 2021 & 2022 [Source: Self Made]

Year	2020	2021	2022
Current assets (in millions USD)	869,384	860,540	790,654
Current Liabilities (in millions USD)	470,819	590,741	536,621
Current Ratio	1.85	1.46	1.47

Current Ratio is a measure to determine if the business has the potential to cover its obligations which are short term and shall be due in a year [13].

A higher current ratio is considered good indicating a company has more than assets than current liabilities implying it has liquidity to cover short-term obligations with ease. However, an excessively high ratio might suggest that management may not be utilising its assets efficiently.

As per Figure 8, Domino's was close to maintaining ideal Current ratio in 2020 however, we can see significant decline mainly driven by higher long-term borrowings which may be due to purchase of fixed assets and investments etc to build infrastructure in order to accommodate future sales. Also, as per Table 4, due to Covid, Domino's invested more in advertising in FY 21 for greater outreach towards its customers and once Covid subsided a bit in FY 22, they reduced their spending on advertising.

Balance sheet as per Table 4 signifies material decline in Cash and cash equivalents almost by 59% from FY 2021 to FY 2022 and higher prepaid expenses resulting in lower YoY current assets.

Debt to Equity Ratio(DER)

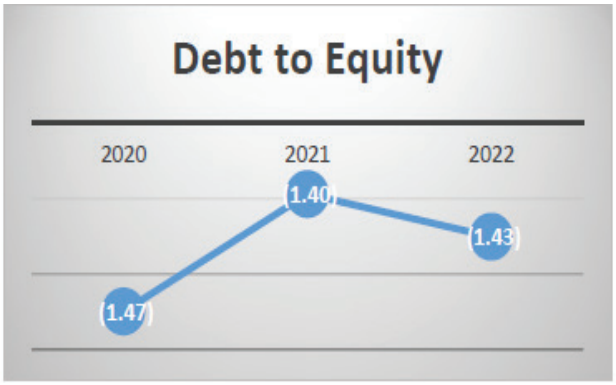


Fig. 9. Domino's Debt to Equity Ratio for 2020, 2021 & 2022 [Source: Self Made]

Table 8. Current Debt, Equity and Debt to Equity Ratio of Dominos for the Years 2020, 2021 & 2022 [Source: Self Made]

Year	2020	2021	2022
Debt (in millions USD)	4,867,573	5,881,352	5,971,286
Equity (in millions USD)	(3,300,405)	(4,209,536)	(4,189,065)
Debt to Equity	(1.47)	(1.40)	(1.43)

Dominos in this context has a negative DER(debt to equity ratio), this may imply that it has shareholder equity which is negative that may be driven by long term deficit, dividend distributed and purchase of common stock under share Repurchase Program.

Domino's is buy backing the shares by paying through long term borrowings and utilising cash against it in order to maintain market credibility[14].

CONCLUSION

As per the risk highlighted by Dominos, due to Covid-19 pandemic, global economic scenario may negatively affect Domino's business, financial condition and operational results and the scope and scale of which is ultimately unknown [1]. In order to overcome above risk factor, below highlighted are some suggested recommendations:

1. Provision for pandemics/ natural calamities etc. should be in place and reviewed YoY by senior management in order to curb the ill effects which may hamper employability of human resources and other company crisis.
2. Strategy should be designed in such a manner to accommodate futuristic mindset, for example, people are now looking for healthier food choices. Company should start working towards inventing and hence diversifying towards healthier product base.

Financial reports for Domino's pizza between 2020-2022 have been reviewed. An attempt has been made to analyse company financial performance along with comparison with its competitors. They have continued their strong hold primarily as a franchisor with YoY increase in Supply chain – sales of food, equipment and supplies resulting in consistent increase in franchise royalties and fees across the financial years from 2020 to 2022 strengthening the fact of Domino's being a financially stable firm.

REFERENCES

1. DOMINO'S PIZZA, "2022 Annual Report," [Online]. Available: https://ir.dominos.com/static-files/4daec873-268e-4456-b541-3871f28288e2. [Accessed: Nov. 1, 2023].
2. DOMINO'S PIZZA, "2021 Annual Report," [Online]. Available: https://ir.dominos.com/static-files/a32d0382-5594-481a-bd04-243c77994dea. [Accessed: Nov. 1, 2023].
3. DOMINO'S PIZZA, "2020 Annual Report," 2020. [Online]. Available: https://ir.dominos.com/static-files/84c84f32-0616-4d63-a1e4-2539a7df5fd5. [Accessed: Nov. 1, 2023].
4. YUM! Brands, Inc., "Historical Financial Summary Fourth Quarter, 2020," 2020. [Online]. Available: https://s2.q4cdn.com/890585342/files/doc_financials/2020/q4/Q4'20-Website-Data_IR_FINAL-(Website-Copy).pdf. [Accessed: Nov. 1, 2023].
5. YUM! Brands, Inc., "Historical Financial Summary Fourth Quarter, 2021," 2021. [Online]. Available: https://s2.q4cdn.com/890585342/files/doc_financials/2021/q4/q4'21-website-data_ir_final-(website-copy).pdf. [Accessed: Nov. 1, 2023].
6. YUM! Brands, Inc., "Historical Financial Summary Fourth Quarter, 2022," 2022. [Online]. Available: https://s2.q4cdn.com/890585342/files/doc_financials/2022/q4/q4'22-website-data_ir-(website-copy).pdf. [Accessed: Nov. 1, 2023].
7. D. Washington, "United States Securities and Exchange Commission," [Online]. Available: https://ir.papajohns.com/static-files/152aa76b-1ddf-4878-b04a-2c5a4a014ee9. [Accessed: Nov. 1, 2023].
8. D. Washington, "United States Securities and Exchange Commission," 2021. [Online]. Available: https://ir.papajohns.com/static-files/02bfbb1e-bfd3-4b2f-9f23-01b396ae20ed. [Accessed: Nov. 1, 2023].
9. J. M. Feb. 23, "Inflation and consumer shifts take a bite out of pizza demand," Restaurant Business, [online]. Available: https://www.restaurantbusinessonline.com

/financing/inflation-consumer-shifts-take-bite-out-pizza-demand. [Accessed: Nov. 3, 2023].

10. CFI, "Gross Margin Ratio," Corporate Finance Institute, 2022. [Online]. Available: https://corporatefinanceinstitute.com/resources/accounting/gross-margin-ratio/. [Accessed: Nov. 6, 2023].
11. Corporate Finance Institute, "Net Income," [Online]. Available: https://corporatefinanceinstitute.com/resources/accounting/what-is-net-income/. [Accessed: Nov. 6, 2023].
12. Corporate Finance Institute, "Fixed Asset Turnover," [Online]. Available: https://corporatefinanceinstitute.com/resources/accounting/fixed-asset-turnover/. [Accessed: Nov. 7, 2023].
13. T. Vipond, "Current Ratio Formula," Corporate Finance Institute, 2022. [Online]. Available: https://corporatefinanceinstitute.com/resources/accounting/current-ratio-formula/. [Accessed: Nov. 7, 2023].
14. G. Busch, "Domino's Pizza (DPZ): Dividend Growth Off the Perfect Food," American Money Management, 2022. [Online]. Available: https://www.amminvest.com/dominos-pizza-dividend growth/#:~:text=The%20negative%20Debt%20to%20equity. [Accessed: Nov. 10, 2023].

The Impact of Optimization Techniques on Relational and Document-based Database

Bharati Wukkadada
✉ wbharati@somaiya.edu

Pooja Gada
✉ Pooja.gada@somaiya.edu

K J Somaiya Institute of Management
SomaiyaVidya Vihar University
Mumbai, Maharashtra

ABSTRACT

Databases are crucial in modern applications that require storage, rapid processing, and access to large volumes of data. Data processing performance is an important consideration when choosing a database system. This research investigates various strategies for optimizing database structure and queries using two popular database management systems. SQL is a relational database management system, whereas MongoDB is a document-oriented database management system. The primary goal of this research is to compare how various optimization techniques affect each DBMS during create-read-update-delete (CRUD) operations. The analysis and performance center on measuring query execution times across different data volumes.. This approach demonstrates how the proposed optimizations affect application performance and highlights differences in response time and complexity.

KEYWORDS: *SQL, MongoDB, Database management system, CRUD operations.*

INTRODUCTION

In today's application development, the choice of database technology is critical, especially given the need to store, process, and access massive amounts of data efficiently. Selecting the right database can significantly impact the performance and flexibility of an application. Traditionally a systematic approach for data management with strong adherence to the ACID [1] properties. NoSQL systems are intended to address the limitations of traditional RDBMS [2], particularly in handling large-scale and unstructured data. NoSQL databases are categorized into various types, including document stores, key-value stores, column databases, and graph databases. All NoSQL databases manage individual items identified by Unique keys [3]. The CAP theorem, which encompasses consistency, availability, and partition tolerance, prioritizing availability and partition tolerance over strong consistency. The BASE theorem encompasses Basically Available, Soft State and Eventually Consistent servers as guiding principles that emphasize eventual consistency and fault tolerance [4]. This paper delves into optimizing database structure and queries for SQL and MongoDB. The performance of CRUD (Create, Read, Update, Delete) operations. This study focuses on evaluating the impact of these optimizations purely based on query execution times, providing insights into the performance improvements.

OBJECTIVE

The study report focuses on the impact of optimization techniques on the performance. The research intends to answer the following research questions.

1. To investigate current optimization techniques used in database management systems, with a focus on both relational and document-based databases.
2. To identify Key performance indicators that significantly impact database performance
3. To provide recommendations and best practices for database administrators and practitioners based on the findings of the research.
4. To analyze the effectiveness of optimization methods in enhancing the performance of both database systems, including factors such as response time, resource utilization, and scalability.

RELATED WORK

Numerous studies have been conducted to evaluate the efficiency of different optimization methodologies for both relational and non-relational database systems.

[5] This paper presents an approach for relational databases and NoSQL data stores, aiming to facilitate seamless querying from both within a single query. Gap by proposing a comprehensive model architecture and application patterns, along with semantic transformations. [6] the authors of this research report conduct a comparative analysis of relational and non-relational databases by performing various operations on both types and emphasizing the importance of choosing the appropriate database for specific use cases. In [7] authors conducted a comparative analysis between CouchDB and MySQL, focusing on the performance of CRUD operations across varying data amounts and complexity. The result indicates that CouchDB outperforms the relational database in the case of larger datasets, [8] In this paper, the authors compare the performance of MongoDB with inner join functionality to MySQL, showing that while MongoDB is more convenient for insertion tasks, retrieval tasks with inner join operations have significantly longer response times compared to MySQL. Similarly, in [9], researchers conducted a comparative analysis between various NOSQL databases and relational databases, emphasizing their limitations, and also tested these databases, at both simple and complicated queries. In [10], the issue of query optimization was tackled, with the authors focusing on efficiently executing JOIN queries over constrained big data storage systems.

In parallel, in [11], the author designed and implemented a bank application that utilizes different types of databases for comparative tests. This paper explores the techniques for optimizing database queries using popular open-source-database management system like Mongo DB and SQL.

METHODOLOGY

The method and testing architecture for this research involve a theoretical design and implementation approach to evaluate the performance of SQL and MongoDB in handling various CRUD operations before and after implementing optimization techniques.

For this research paper, Microsoft SQL Server 2019 was used, which follows a relational model, organizing data into structured tables with predefined schemas. MongoDB 4.4 was used, which uses a document-based model, storing data in flexible JSON-like BSON documents

The structure of the relational database used consists of three entities: Business, User and Client, as illustrated in the figure below.

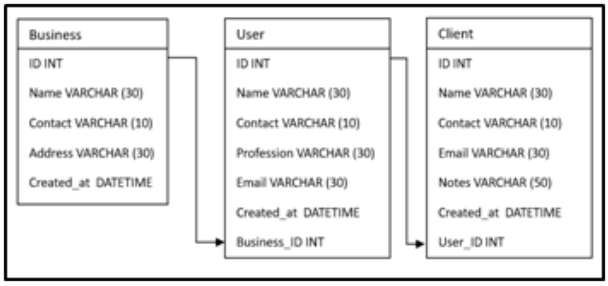


Fig. 1: Relational database structure

For document-based MongoDB, the structure is as follows:

Fig. 2: Document-database structure

Each document in this structure contains information about the business, user, or client, including nested information. This structure encapsulates all the necessary data within a single document, ensuring independence and flexibility. The most essential database optimizations are structure and indexing. In this study, the tables were optimized by minimizing the number of null fields and reducing the field lengths to the necessary lengths. This approach optimizes data storage and retrieval efficiency. Additionally, indexes were applied to all frequently queried columns, and compound indexes were created where needed to enhance query performance.

DATABASE OPTIMIZATION TECHNIQUES

To enhance the database structure, the following field optimizations were implemented::

- Reduce Null Field
- Field Length Minimization
- Field Type Reduction
- Indexed-based optimization

The first optimization minimizes the chances of the string field being null. By reducing the number of null fields, the database remains cleaner, and searches become more efficient. Consequently, field such as name, contact, occupation, and address will always contain values. When creating a new table or object , the length is typically set to the maximum value that the field's type can accommodate.

The same optimization can be applied to name, address, and email columns. By setting the field lengths to their maximum expected value, Strictly defining field length based on the maximum expected value ensures that if an attempt is made to insert or update a field with a longer value, an exception will be raised, preventing the value from being inserted or updated. Another optimization technique involves converting a field's type from an object to a primitive type, thereby narrowing the range of values it can assume within a program. Fields like integer, Boolean , and Long wen defined as object types, can hold null values and don't need da default value. However, by converting these fields to their primitive counterparts (int, Boolean and long), we eliminate the possibility of null values and ensure a default vale is always set. The most effective way to minimize query response time is by adding indexes to the fields used in query conditions. Indexing frequently queried columns significantly improves search performance. Compound indexes can also be created where necessary to further improve response time for complex queries.

RESULTS

To evaluate the performance improvements brought by the optimization techniques, we conducted multiple CRUD operations on both SQL and MongoDB databases. The operations were performed on various record sets, including 1000, 100000, and 200000 records, both before and after applying the optimization techniques described above operations performed on all the tables in the databases.

Select operation

In relational SQL, we used a select statement to demonstrate a basic select operation, such as business by its ID. The findOne() method was used for document-based MongoDB.. The following queries were used for select operations.

SQL:

SELECT * FROM Business WHERE id = 100;

MongoDB:

db.business.findOne({ _id: ObjectID("609a59d8c4cbb1d8c4858a3f") });

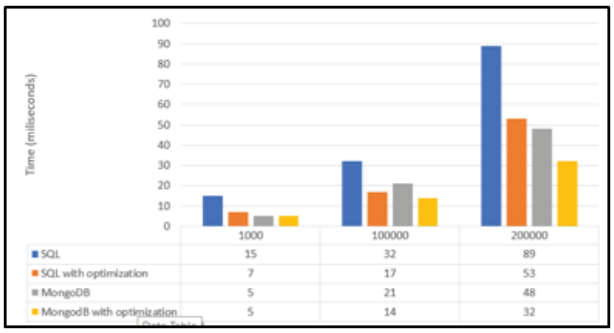


Fig. 3: SELECT Operation

Fig. 3 suggests, optimization techniques have no apparent effect. However, MongoDB performs better than SQL in this regard.

Insert operation

The following query was used to insert records into the User table and similarly for other tables. For the insertion of a large number of records, a loop was used.

SQL:

INSERT INTO [Business] (Name, Contact, Address, Created_at)

{('Business1',1234561234,'Address1', GETDATE(),1)}

MongoDB:

db.Business.insertMany([{

name: ‘Business1’,

Contact : ‘’1234561234’,

address : ’Address1’,

Created_at : new Date()}])

Fig. 4 illustrates the slight differences in operation execution duration between the two databases before and after optimization. We can say that MongoDB is faster than SQL in the case of insertion operations. have little effect on the insertion process, and the improvement in response time is negligible.

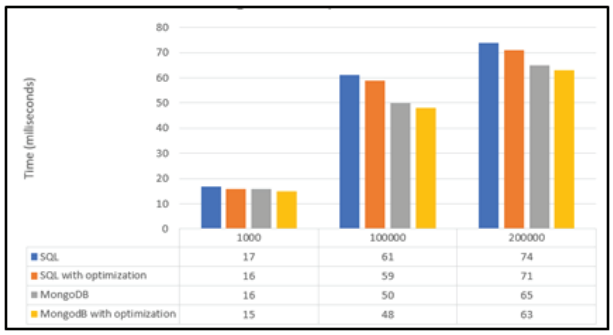


Fig. 4: INSERT Operation

Update operation

The following queries were used to update the records. The SQL update method was used, and the MongoDB updateOne method was used.

SQL:

UPDATE Business SET name = ‘New Business Name’ WHERE Id = 1001;

MongoDB:

db.business.updateOne({ id: “1001” }, { $set : {name: ‘New Business Name’ } });

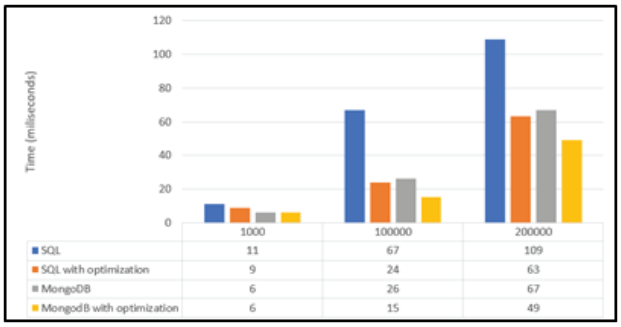


Fig. 5. UPDATE Operation

As observed in Fig. 5, neither SQL or MongoDB’s optimization resulted in a significant improvement after updating 1000 records. However, a notable improvement in execution time was observed when updating a greater number of records.

Delete operation

The Deletion action for SQL and MongoDB was carried out by performing the following queries..

SQL:

DELETE FROM Business WHERE ID = 1001;

MongoDB:db.business.deleteOne({ ‘id’ : Id(‘1001’) });

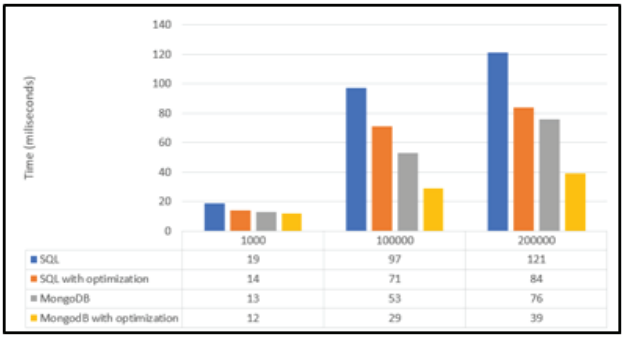


Fig. 6: DELETE Operation

In relational SQL, execution time increased with the number of records due to time-consuming element searches. Optimizing the database reduces response time by 50% for relational SQL databases and 10-20% for document-based MongoDB, as illustrated in Fig. 6 above.

ANALYSIS

The optimization method implemented in the database structure and indexing greatly improved the efficiency of CRUD operations. These proposed techniques have notable influence on relational QL performance. Optimizing the Select operation reduces response time by up to 80%. Whereas for MongoDB, using optimization techniques improved the execution time but not as substantially as for SQL. The operations are still faster, making them ideal for handling massive amounts of data. In SQL, the optimization does not significantly enhance performance due to an existing index on the primary key. Whereas for update operations, enhancement boosts efficiency by up to 60%, as adding

indexes to the field speeds up the search process. As the number of records increases, performance approaches MongoDB before optimization. For MongoDB, optimized updating methods provide fast response times for both small and large datasets. The changes resulted in faster response times, particularly when updating huge amounts of data. For degradation both in SQL and MongoDB, for small amounts of data, there is no significant improvement, but for large volumes of data, performance has improved by up to 70%.

CONCLUSION

By investigating optimization techniques in relational SQL and document-based MongoDB databases, key performance indicators affecting database performance were identified and applied. The effectiveness of optimization methods in enhancing database performance was analysed. The findings of this research emphasize the significant impact of optimization techniques on the performance of both relational SQL and document-based MongoDB databases. The optimization approaches employed in this study, including field optimization and index-based optimization, yielded notable improvements in various CRUD operations for both databases. These optimizations played a crucial role in reducing response times, improving query performance, and enhancing overall system performance. Conversely, MongoDB demonstrated an inherent advantage in handling large datasets, showcasing its scalability and efficiency. This research highlights the crucial role of optimization techniques in database management systems, offering valuable insights into how these techniques can be leveraged to improve performance and meet the evolving demands of data-intensive applications.

REFERENCES

1. Kris Wenzel (Oct 24, 2021) 'SQL ACID Database Properties Explained' [crossref].
2. Adity Gupta, Shelly Sachdeva. 'NoSQL databases: Critical analysis and comparison' [crossref]
3. Paolo Atzeni, Francesca Bugiotti, Luca Rossi.'Uniform access to NoSQL systems'.Volume43, July 2014, Pages 117-133 [crossref]
4. Pranab Jyoti Bordoloi (Feb 24, 2020) 'BASE Theorem' [crossref]
5. Changqing Li, Jianhua Gu (26 November 2018) 'An integration approach of hybrid databases based on SQL in a cloud computing environment' Citations: 18 [crossref]
6. Pavelseda, Jiri Hosek, Pavel Masek. (April 2018) 'Performance testing of NoSQL and RDBMS for storing big data in e-applications' 2018 3rd International Conference on Intelligent Green Building and Smart Grid (IGBSG)
7. Cornelia A. Gy ″orödi 1,* , Diana V. Dum¸se-Burescu 2 , Doina R. Zmaranda 1 , Robert ¸S. Gy ″orödi 1, Gianina A. Gabor 1 and George D. Pecherle (28 November 2020) 'Performance Analysis of NoSQL and Relational Databases with CouchDB and MySQL for Application's Data Storage' [crossref]
8. A Study on Join Operations in MongoDB Preserving Collections Data Models for Future Internet Applications. Antonio Celesti Maria Fazio 1,3 and Massimo Villari [crossref]
9. Sangeeta Gupta, G. Narasimha (May-2015) 'CORRELATION AND COMPARISON OF NOSQL SPECIMEN WITH RELATIONAL DATA STORE' Volume: 04 Special Issue: 06. [crossref]
10. Radhya Sahal, Marwah Nihad, Mohamed H. Khafagy, Fatma A. Omara (June 2018) 'Index-Based JOIN Query Optimization for Limited Big Data Storage' DOI:10.1007/s10723-018-9431-9 [crossref]
11. Cornelia Győrödi, Robert Győrödi, Roxana Sotoc (11, 2015) 'A Comparative Study of Relational and NonRelational Database Models in a Web- Based Application' Vol. 6 [crossref]
12. Antonio Celesti 'A Study on Join Operations in MongoDB Preserving Collections Data Models for Future Internet Applications'
13. Aparna Kaladi, Priya Ponnusamy 'PERFORMANCE EVALUATION OF DATABASE MANAGEMENT SYSTEMS BY THE ANALYSIS OF DBMS TIME AND CAPACITY'
14. Sahil Ambadar(April 10, 2024) 'SQL Query Optimization - Tips and Techniques'[crossref]
15. Optimization Strategies for MongoDB [crossref].

Biometric Security with Arduino-Based Fingerprint Door Lock System

Kirti Muley
Assistant Professor
BVIMIT
✉ ikirti13@gmail.com

Rupali Sunil Dandge, Nahim Sardar Pinjari
Students
BVIMIT
✉ rupalidandge1697@gmail.com
✉ nahimpinjari370@gmail.com

ABSTRACT

The Fingerprint Door Lock System using the Arduino project is a revolutionary advancement in biometric security technology. This paper presents a comprehensive study of the design, implementation, and practical applications of this system. By replacing traditional lock and key mechanisms with fingerprint recognition technology, offers enhanced security and convenience. The Arduino microcontroller board serves as the core component, orchestrating the functionality of the system. Through a detailed exploration of the methodology and experimentation, this paper elucidates the operational principles and advantages of the proposed system. Furthermore, the paper discusses potential avenues for future research and development in this domain.

KEYWORDS: *Arduino, Biometric security, Authentication.*

INTRODUCTION

In today's world, security is paramount, and traditional methods such as physical keys pose significant vulnerabilities [1]. The ease with which keys can be duplicated or lost, and the potential for theft, necessitate a more robust solution. Biometric security gadgets offer a promising avenue for enhancing security measures [2]. In contrast to traditional keys, biometric data, like fingerprints, are not easily replicated or stolen. This characteristic substantially decreases the risk of unauthorized access, thereby augmenting overall security [3].

Throughout history, security has remained a paramount concern for businesses, residences, and diverse establishments. Addressing these concerns, there exists an increasing demand for innovative solutions that provide enhanced security while preserving convenience [4]. One such solution is the integration of biometric technology with door locks. By combining biometric authentication, such as fingerprint recognition, with traditional door-locking mechanisms, a new level of security is achieved. This approach not only mitigates the risks associated with lost or stolen keys but also provides a more seamless and convenient user experience.

By developing a Fingerprint Door lock system, one can enhance security by leveraging the reliability and uniqueness of biometric data. Biometric authentication, particularly fingerprint recognition, is combined with conventional door-locking mechanisms to offer a robust and convenient access control solution [5]. This innovative approach ensures that access is granted only to individuals whose biometric data matches that stored in the system, thereby minimizing the risk of unauthorized entry [6]. For the development of the project, Arduino Uno, relay modules, Bluetooth modules, solenoid locks, batteries, jumper wires, and smartphone fingerprint sensors are used to create a sophisticated yet user-friendly door-locking system. Through the seamless integration of hardware components and software applications, the proposed system not only enhances security measures but also improves the overall user experience. By employing biometric technology to regulate access, the Fingerprint Door Lock System with Arduino improves convenience and security. Also, it offers a scalable and affordable

replacement for conventional lock and key mechanisms. In Section II, a methodology is presented where the user's fingerprints are subsequently compared against the stored templates for authentication purposes. A detailed explanation of constructing and setting up the Arduino-based fingerprint door lock system is given in Section III. It also covers sophisticated software tricks and hardware configuration. The outcomes and findings of the project along with the effectiveness of the system in enhancing security measures and its impact on user convenience and experience are discussed in Section IV. Finally, Section V summarizes the entire work and future scope.

METHODOLOGY

The methodology adopted for the Fingerprint Door Lock System using the Arduino project involves several key components and processes [7]. At the core of the system lies the Arduino microcontroller board, which serves as the central processing unit. This board is responsible for interfacing with various peripherals and executing the necessary algorithms for fingerprint recognition and door control. The fingerprint sensor module plays a pivotal role in capturing and storing the fingerprints of authorized users securely. Through advanced image processing techniques, the sensor module extracts unique fingerprint features, which are subsequently compared against the stored templates for authentication purposes. Below are the hardware unit components.

The input unit, receiver unit, processing unit, and output unit are the four primary components of the project.

- Input Unit:The Input Unit is responsible for receiving commands to initiate the program. In this project, a smartphone is used to send commands through a Bluetooth connection to the module for Bluetooth (HC-05). A built application on the smartphone features a lock and unlock slider. Auser can send a lock command to close the door or an unlock command to open it [8]. Only when a Bluetooth connection is made within the designated Bluetooth range limit can the command be carried out.
- Receiver Unit: The Receiver Unit receives commands sent from the Input Unit through the Module for Bluetooth (HC-05). The module connects the Arduino microcontroller to the mobile device, establishing a connection [9].
- Processing Unit:The Processing Unit is in charge of choosing where, how, and when to execute the commands. The Bluetooth module on the Arduino microcontroller carries out the command that it receives from the smartphone. The microcontroller chooses which work to complete and how to complete it, providing the necessary output for the assigned task [10]. The Arduino is made up of an integrated development environment (IDE) software programme that powers the entire system and an Arduino board for hardware.
- Output Unit: The Output Unit is the final stage of the project and is responsible for performing the commands received from the microcontroller. The Servo motor is used to perform the task of opening or closing the door. The slider opens when the servo motor travels to a 90-degree position after receiving the order to do so [11]. The servo motor turns 180 degrees in response to the command to close the door, locking the door by moving the slider to that position. The Arduino integrated development environment's computer code dictates how the work is carried out.

WORKING AND IMPLEMENTATION

In this Section, the working and the hardware components of the application are discussed.

Arduino UNO

In the IoT concept shown in Figure 1, the Arduino UNO functions as the central processing unit and control hub. Based on the ATmega328P microcontroller chip, this board can interface with a variety of electronic components thanks to its digital and analog input/output pins. This configuration involves the Arduino UNO controlling the relay module's communication with the Bluetooth module, interpreting commands from the smartphone application, and directing the relay module to activate the solenoid lock [12]. To ensure the proper operation of the IoT system, the Arduino UNO executes programmed logic and commands [13].

Fig. 1. Arduino UNO

Relay Module:

The relay module acts as an interface between the Arduino UNO and the solenoid lock. It consists of one or more electromechanical relays that can be controlled by digital signals from the Arduino. In this IoT model, the relay module is utilized to switch the high voltage required to operate the solenoid lock. When the Arduino UNO receives a command from the smartphone application via the Bluetooth module to turn the door lock or key, it activates the appropriate relay on the relay module. The Bluetooth module on the smartphone app enables communication between the Arduino UNO and the smartphone. This relay, in turn, closes or opens the circuit to the solenoid lock, effectively locking or unlocking the door as per the received command [14]. Relay Module is shown in Figure 2.

Fig. 2. Relay Module

Solenoid Lock

The Arduino UNO sends commands to the solenoid lock, which secures or releases the door based on the input received. It operates by using an electromagnetic solenoid to move a locking mechanism into or out of position. When activated, the solenoid lock extends or retracts its bolt, thereby locking or unlocking the door, respectively. In this IoT model, the solenoid lock is controlled by the relay module, which is in turn controlled by the Arduino UNO. Upon receiving a lock or unlock command, the Arduino UNO triggers the relay module to energize or de-energize the solenoid lock, thus achieving the desired locking or unlocking action [15]. The Solenoid Lock is shown in Figure 3.

Fig. 3. Solenoid Lock

Bluetooth Module

The Bluetooth module facilitates wireless communication between the IoT system and the smartphone application as shown in Figure 4. It enables bidirectional data transmission over short distances using Bluetooth technology. In this setup, the Bluetooth module establishes a communication link between the Arduino UNO and the smartphone, allowing users to send commands to the IoT system from their mobile devices. Commands such as lock and unlock are transmitted from the smartphone application to the Arduino UNO via the Bluetooth module. This enables remote control and monitoring the door lock mechanism, enhancing convenience and accessibility for users [16].

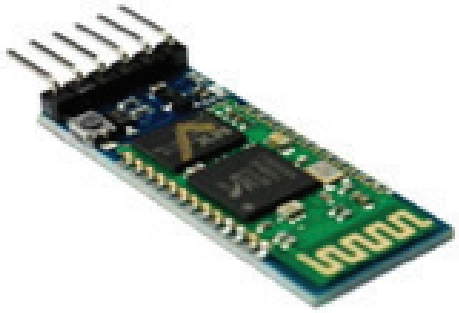


Fig. 4. Bluetooth Module

Following task are being performed for locking and unlocking of the door using proposed system.

- User store their fingerprints into the system by placing their finger on the fingerprint sensor module multiple times for accurate capture.
- The system processes the unique fingerprint patterns and converts them into templates for future comparison.
- For authentication, users place their finger on the fingerprint sensor module to initiate the access control process.
- The system compares the captured fingerprint with the stored templates to determine if it matches any authorized user.
- If a match is found, the system grants access by controlling the locking mechanism to unlock the door.
- If no match is found, the system denies access and keeps the door locked.

Here, Arduino controls the locking mechanism of the door based on the authentication result. When access is granted, Arduino sends signals to activate a motor or solenoid to unlock the door, allowing physical entry. When access is denied, Arduino keeps the locking mechanism engaged, preventing unauthorized access. Audible indicators, such as beeps or buzzers, provide audio feedback to signify whether access is granted or denied. When authorization is received, Arduino initiates a motor or solenoid to unlock the door and provide physical access. Arduino maintains the locking mechanism engaged when access is refused, preventing unwanted access. Beeps and buzzers are examples of audible indicators that give aural feedback indicating whether access is allowed or denied.

The program concludes once all the tasks have been accomplished. An introduction to the basic workings of biometric security with an Arduino-based fingerprint door lock system is depicted in Figure 5.

Implementation

A graphical depiction of an electrical circuit is called a circuit diagram. Simple pictures of the circuit's parts are used in pictorial circuit diagrams, whereas standard symbolic representations are used in schematic diagrams to depict the circuit's parts and connections [18]. Figure 6 displays the Fingerprint Door's Circuit Diagram.

The circuit operates with a 12V power supply, which is necessary for the solenoid electric lock, while the Arduino microcontroller (MCU) operates on 5V. Utilizing the built-in 5V voltage regulator of the Arduino Uno, a shared 12V supply is adequate for the entire system. Managing the system's operations is the central processing unit, BOARD1, based on the Arduino UNO R3 V1.0. BOARD1 is equipped with 14 digital input/output (I/O) pins and six analog inputs, facilitating interaction with components such as the relay module, Bluetooth module, solenoid lock, battery, and smartphone fingerprint sensor. Programming is conducted through the Arduino IDE software.

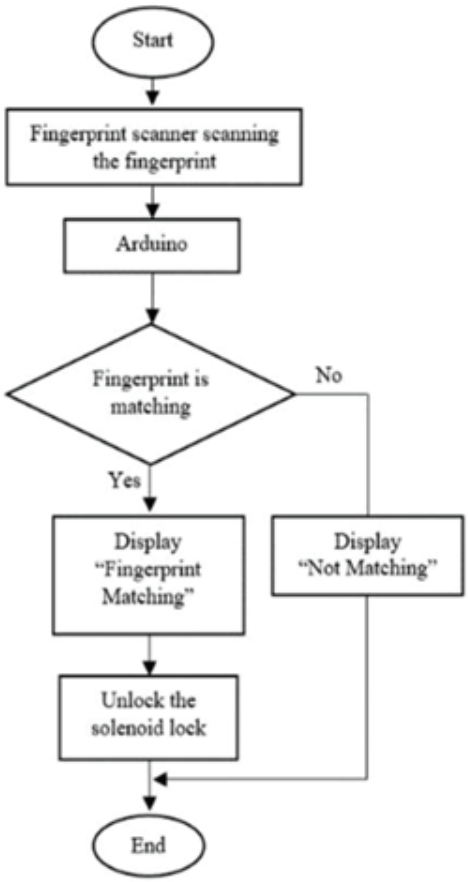


Fig. 5. Flowchart of fingerprint door

Previously housing a fingerprint sensor module, the system now incorporates a smartphone fingerprint sensor, enabling a connection across CON2 via UART. This allows direct connections to the MCU or to a PC using a max232/USB serial adapter. Users can store fingerprint data within the smartphone app and

configure it for identification. Notably, the smartphone sensor's TX and RX pins are interfaced with Arduino digital pins 2 and 3 for serial communication.

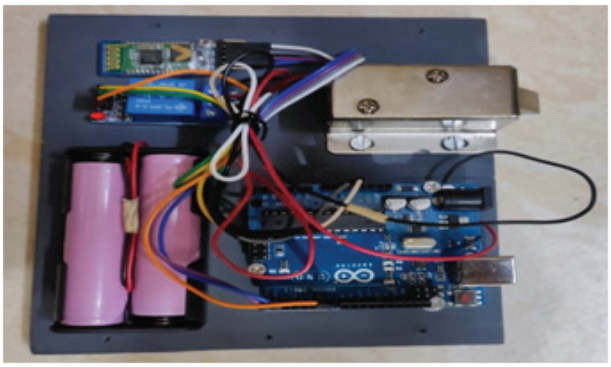


Fig. 6. Circuit Diagram of Fingerprint Door Lock System Using Smartphone

Although an LCD (LCD1) is part of the system, it is currently not utilized in this configuration and is thus omitted from the setup. Consequently, control lines from the LCD and the preset PR1 for contrast adjustment are unnecessary in this simplified setup. The system's model design is depicted in Figure 7.

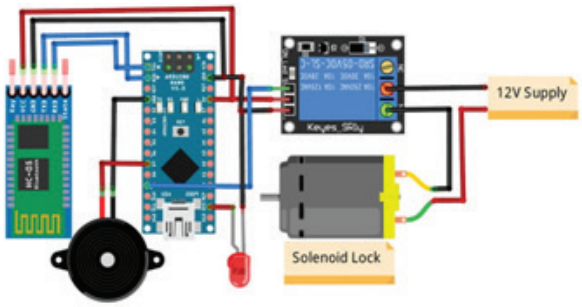


Fig. 7. Model Design of Fingerprint Door

RESULTS

By enabling registered user access, enhancing security over traditional key systems, and integrating biometric authentication, smartphone fingerprint sensors revolutionize door lock systems. Users can remotely unlock doors via mobile phones, eliminating the need for physical keys. Utilizing robust components like Arduino Uno and Bluetooth modules ensures system durability and scalability for accommodating more users. Seamless hardware-software integration facilitates user interaction and efficient operation. To gain secure door entry, users simply download the app, pair the Bluetooth module, and scan their finger, ensuring scalability, ease of use, and safety. System software for the fingerprint door lock is depicted in Figure 8.

Fig. 8. Fingerprint Door Lock System Software

CONCLUSION & FUTURE ENHANCEMENTS

A reliable and practical access control solution is provided by the successful creation of a Fingerprint Door Locker System, which combines biometric technology with conventional door locking mechanisms. Because fingerprints are distinct and challenging to copy, this system limits access to only those users whose biometric data matches records that have been recorded, lowering the danger of unwanted entrance. Users can now acquire safe access by just scanning their fingerprints using a smartphone-connected sensor, greatly increasing convenience and doing away with the need for actual keys. This major development in access control technology offers safer environments and peace of mind for both residential and business applications.

Future developments for an Arduino fingerprint door lock system can concentrate on enhancing integration, security, and networking. Security can be strengthened by adding multi-factor authentication, which can be achieved by employing a PIN or integrating fingerprint recognition with other biometric techniques. Cloud connectivity can facilitate data backup, management, and remote monitoring, enabling centralized control from any location. Hands-free operation and authentication are made possible via voice recognition technology. Furthermore, users can automate tasks based on access occurrences or use voice commands to manage the door lock through connectivity with smart home devices.

REFERENCES

1. Islam, M.R., "Right of the People with Disabilities and Social Exclusion in Malaysia", International Journal of Social Science and Humanity, Vo. 5, No. 2, pp. 171-177, 2015.
2. R.A. Ramlee, D. H. Z. Tang, M.M.smail, "Smart Home System for Disabled People Via Wireless Bluetooth", in Proc. of IEEE International Conference on System Engineering and Technology,pp. 1-4, 2012.
3. N. Jiwani, K. Gupta, and P. Whig, "Novel HealthCare Framework for Cardiac Arrest with the Application of AI Using ANN," in 2021 5th International Conference on Information Systems and Computer Networks (ISCON), 2021, pp. 1–5, doi: 10.1109/ISCON52037.2021.9702493
4. Shrinidhi Gindi, Naiyer Shaikh, Kashif Beig, Abdeali Sabuwala, "Smart Lock System Using RFID" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 07 | July 2020
5. Jancovic, Peter, et al. "Design of embedded fingerprint recognition system for access control."
6. Dibyendu Sur, Sayani Sengupta, Sarmistha Ray, Sucheta Routh, Saborni Das, Soumika Ghosh, Shilpi Banerjee, "Digital password door, National seminar on Advances of Security Issues (ASICN 2013) July19, 2013, DSCSDEC, Kolkata
7. G Muller 2013 Systems engineering research methods Procedia Comput. Sci. vol. 16 pp. 1092 1101 2013 doi: 10.1016/j.procs.2013.01.115
8. David Zhang and Mingchu Li. "Guide to Biometrics." Springer, 2011.
9. Circuits, Systems, and Methods for Access Control Using Fingerprint Recognition Schneider, Thomas D., and Lawrence J. Aulthouse. Nov. 10, 1998; U.S. Patent No. 5,835,087.
10. In 2019, Sumi, N., and Ahamed, S. F. Arduino-based fingerprint door lock system. 8(6), 1396-1402, International Journal of Advanced Research in Electrical, Electronics, and Instrumentation Engineering.
11. Flores, G., and Perez, D. (2021). An access control system that uses Bluetooth and Arduino for fingerprint authentication. In IEEE International Conference on Electronics and Communications Proceedings.
12. Arduino - Home. taken from the website https://www.arduino.cc.
13. M. Sameer and B. Gupta, "Time–Frequency Statistical Features of Delta Band for Detection of Epileptic Seizures," Wirel. Pers. Commun., 2021, doi: 10.1007/s11277-021-08909-y
14. Andrew J Wileman, Suresh Perinpanayagam, "A Prognostic Framework for Electromagnetic Relay Contacts," European Conference of The Prognostics and Health Management Society 2014.
15. https://www.electronics.com.bd/12v-solenoid-lock is the URL of the website.Date of Retrieval: May 22, 2022
16. M. Sameer and B. Gupta, "CNN based framework for detection of epileptic seizures," Multimed. Tools Appl., 2022, doi: 10.1007/s11042-022-12702-9.
17. M. Sameer, A. K. Gupta, C. Chakraborty, and B. Gupta, "ROC Analysis for detection of Epileptical Seizures using Haralick features of Gamma band," in 2020 National Conference on Communications (NCC), 2020, pp. 1–5, doi: 10.1109/NCC48643.2020.9056027.
18. Aulthouse, Lawrence J., and Thomas D. Schneider. "Circuits, Systems, and Methods for Access Control Using Fingerprint Recognition." Nov. 10, 1998; U.S. Patent No. 5,835,087.

Analysis and Prediction of Physical Health using CART, C4.5 Decision Tree Algorithms with Ensemble Methods: A Comparative Study

Nidhi
Assistant Professor
Bharati Vidyapeeth's Institute of Management & Information Technology
Navi Mumbai, Maharashtra
✉ mca.nidhipoonia@gmail.com

Saisha Jayanta Patil, Prathmesh Suresh Patil
Yashkumar Mangesh Gawali
Students
Bharati Vidyapeeth's Institute of Management & Information Technology
Navi Mumbai, Maharashtra
✉ patilsaisha07@gmail.com
✉ pratmeshpatil301@gmail.com
✉ yashgawali83@gmail.com

ABSTRACT

The lives and health of people are not valued in this era of technology and the Internet. Everyone is too busy surfing the internet and utilizing social media to bother coming to hospitals for their yearly physicals. A model based on machine learning that forecasts the probability and severity of the disease or the onset of such diseases in a person based on the symptoms supplied should be developed, using this activity as a benefit. The objective of this research is to create a model that analyzes an individual's physical health based on several factors, such as productivity, physical activity, general health, etc., utilizing the CART and C4.5 machine learning algorithms. Using a set of questionnaires, the data required to create the model was acquired. The goal of a prediction comparison study is to determine which algorithm produces the best result. The parameters of assessment for the outcome include recall, accuracy, f1 score, and precision. Ensemble learning techniques like Random Forest Classifier and Gradient Boosting are performed across the model to prevent the problem of overfitting. As a result, the study's optimal method for the model that produces the best results will be examined at the conclusion.

KEYWORDS: *Physical health prediction, Comparative analysis, CART, Machine Learning, C4.5, Ensemble learning methods.*

INTRODUCTION

People today suffer from a wide range of illnesses as a result of several environmental factors and lifestyle decisions. Early illness prediction becomes crucial as a result. Around the globe, there is a great demand that is now unmet for reliable sickness diagnosis. The patient's medical expenses for this illness accounted for over 70% of their income. It follows that lowering the patient's risk of death is crucial. Advances in medical research expedite the collection of health-related data. The patient's medical history, the findings of any medical analyses, and demographic data are all included in the healthcare data. Diseases that arise by residing in different locations and environments may exhibit variation. As a result, the individual's lifestyle and condition should be included in the data collection in addition to the illness information.

Diagnostic information is often obtained from a patient's physical examination and medical history [1]. Several factors, such as the lack of relevant symptoms, which often leave rare diseases invisible and lead to the condition being mistakenly neglected, could result in an inaccurate diagnosis. Because of their special qualities and capacities, the C4.5 and CART i.e., Classification and Regression Trees algorithms are effective tools for forecasting physical health outcomes.

The algorithms CART and C4.5 are good at finding pertinent risk factors and outcomes predictors related to physical health. They can effectively handle both numerical and categorical variables and are resilient to missing data. The predictive performance of the CART and C4.5 algorithms can be further improved by ensemble techniques like gradient boosting and random forest, which combine several decision trees to get more reliable predictions. To determine which algorithm performs best or produces the greatest results, comparative research is conducted by utilizing the power of the above-mentioned algorithms.

LITERATURE REVIEW

It is frequently difficult because many of the symptoms and indicators are ambiguous and need to be identified by a qualified medical practitioner. Since countries like Bangladesh and India do not have enough medical professionals to care for their people this paper by Ahsan M.M., et.al [2].Furthermore, this study by Coon E.R., et.al states that medical testing is often required for diagnosis procedures, which those with limited resources typically find expensive and challenging to obtain. Overdiagnosis may lead to issues such as excessive medical care, which will be bad for people's wellness and their financial well-being [3]. The paper by MacLeod H., et.al says that it is difficult to diagnose rare disorders. As a result, it is easier to distinguish between patients with common chronic diseases and those with uncommon diseases when self-identified physical data is used. [4]. The heart disease prediction approach has been studied in this study by Bharathi, D., et.al using a larger number of input attributes, including cholesterol, gender and blood pressure are used by the system [5]. This study paper by S. Grampurohit and C. Sagarnal, presents the sickness detection model built using machine learning methods, such as Random Forest, Naïve Bayes and Decision Tree classifiers. [6]. Multiple readings have been accompanied to investigate the potential of machine learning for diagnostic applications, according to the research in this paper by K. Arumugam, et.al. Compared to the most expert physician, who can detect with 79.97% accuracy, it was shown that machine learning algorithms could detect with 91 % correctness. [7]. According to this study by Swaminathan S, et.al. Machine learning can make it easier to analyze patient data, including test results, in order to identify diseases early. [8]. A study by Wani, Suhail & Attri, et.al., sets the primary objective of developing a model for predicting coronary artery diseases [9]. In this work by Mahmood, et.al , a large number of earlier research that employed algorithms to identify different disorders in the medical field throughout the previous three years were reviewed. [10].

PROBLEM DEFINITION

People's lives and health are not a priority in the age of the Internet and technology. Implementing this activity as a benefit, a model should be created that uses the provided symptoms as input to forecast the risk and likelihood of the afflicted condition or the development of such illness in a specific person. Thus, a model is created to forecast an individual's physical health using CART and C4.5. Nevertheless, the model may cause overfitting, therefore for more accurate results, ensemble learning techniques like Random Forest and Gradient Boosting are performed over the model. As a result, the analysis compares all four approaches that have been mentioned before.

OBJECTIVE

- To implement four algorithms to forecast an individual's physical health status—Good, Moderate, and Bad. Gradient Boosting Classifier, Random Forest Classifier, CART, and C4.5.
- To utilize the algorithms to improve recall, precision, accuracy and f1 score.
- To produce a comparative analysis of the Gradient Boosting Classifier, C4.5, Random Forest Classifier, and CART.
- To use regularization strategies like pruning and parameter tuning to get around the over-fitting issue.
- To determine, based on the four parameters which algorithm performs better.

To summarize, the goal of researching early disease detection and physical health is to enhance health outcomes, lower death and morbidity rates, minimize the burden of disease, allocate healthcare resources as efficiently as possible, encourage preventive healthcare,

and assist with population health management initiatives.

RESEARCH METHODOLOGY

In the step-by-step process of the entire study is defined. Collection of data: Google Form a questionnaire was designed to collect information on people's everyday routines for 384 records. Preprocessing of data: By addressing missing values, outliers, and noise, the data was cleansed. Feature Engineering: It was done to choose pertinent elements that help with solutions to issues. Selection of Model: Selecting the right machine learning algorithm or algorithms depends on the type of problem (clustering, regression, classification, etc.). Training the Model: Utilized the training dataset to train the chosen model. To maximize performance, the hyperparameters were adjusted. Evaluation and Results: Evaluated the model's effectiveness with the testing dataset. Utilized evaluation metrics (accuracy, precision, recall, F1 score, etc.) that were appropriate for the type of task. We have created a comparative analysis by comparing the output of these four algorithms.

ANALYSIS AND FINDINGS

Implementation of CART Algorithm: The CART approach, which stands for Classification and Regression Trees, is a machine learning technique used for both classification and regression issues. This approach, which is based on decision trees, divides the input data recursively depending on feature values to create a tree-like model for prediction.

CART Confusion Matrix

In Figure 2, a confusion matrix was generated as a part of the analysis of the result. The accuracy for the CART upon analysis, comes out to be 87 percent. The confusion matrix depicts the concepts of True positive, Positive, True Negative, False Positive and False Negative.

C4.5 Confusion Matrix:In Figure 2, we can see the confusion matrix for C4.5. The accuracy for this algorithm was 77 percent whereas the precision was 85 percent. Random Forest Confusion Matrix:

In Figure 2, a confusion matrix for the ensemble method is generated. This algorithm performed with an accuracy rate of 74 percent.

Gradient Boosting Confusion Matrix

In Figure 2, the Gradient Boosting matrix has been generated. The model resulted with a precision of 37 percent.

	Predicted 0	Predicted 1	Predicted 2
Actual 0	26	2	0
Actual 1	3	12	0
Actual 2	2	1	1

CART Confusion Matrix

	Predicted 0	Predicted 1	Predicted 2
Actual 0	24	3	0
Actual 1	6	11	0
Actual 2	2	0	1

C4.5 Confusion Matrix

	Predicted 0	Predicted 1	Predicted 2
Actual 0	34	0	0
Actual 1	9	2	0
Actual 2	2	0	0

Random Forest Confusion Matrix

	Predicted 0	Predicted 1	Predicted 2
Actual 0	29	5	0
Actual 1	7	4	1
Actual 2	1	0	0

Gradient Boosting Confusion Matrix

Fig. 2. Confusion Matrix of four Algorithms

CART Correlation Heat Map

Depending upon the confusion matrix of the defined algorithms, heat maps are generated respectively. In Figure 3, a heat map has been generated for the given algorithm.

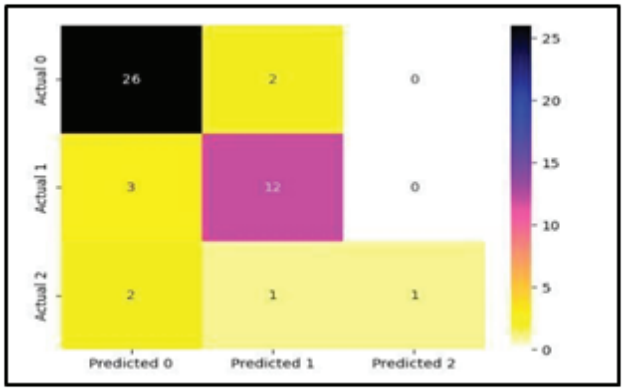


Fig. 3. CART Correlation Heat Map

C4.5 Correlation Heat Map

In Figure 4, the Heat map for the C4.5 algorithms is shown.

COMPARATIVE ANALYSIS

The objective of the study was to do a comparative study

of all four algorithms. Hence, Table 1 and Figure 5show the results for the same based on the set parameters. The table stated that CART performs with a maximum accuracy rate of 87% whereas, C4.5 has the maximum precision rate of 85%.

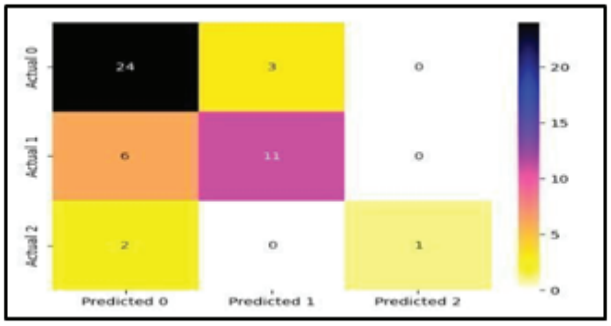


Fig. 4. C4.5 Correlation Heat Map

Algorithms	Accuracy	Precision	Recall	F1-Score
CART	0.87	0.55	0.59	0.57
C4.5	0.77	0.85	0.62	0.67
Random Forest Classifier	0.74	0.5	0.4	0.4
Gradient Boosting Classifier	0.7	0.37	0.39	0.38

Table 1: Comparative Analysis

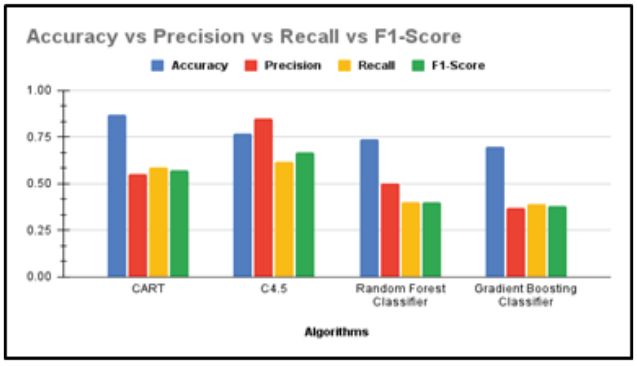


Fig. 5. Comparison of Algorithms Results

Homepage: The user will see the following interface of the model. Algorithm Selection: The user will next select the algorithm for analysis.

Taking input from users by providing self-examine questionnaires: Questions based on the location, physical ability, health history, chronic diseases, sleep schedule, etc. are used as input for the study. The user will select the appropriate options.

Fig. 6: Model Homepage and Algorithm Selection Interface Page

CONCLUSION

A person's physical health can be predicted by the model using the attributes that are fed into it. The attributes such as their daily habits, physical capacity, overall productivity, history of chronic diseases are used to predict the physical health of an individual. The CART and C4.5 algorithms was successfully implemented in order to predict the outcome, however in order to overcome the issue of overfitting ensemble learning methods such as Random Forest and Gradient Boosting were used. Hence the outcome of the model was accurate. The analysis of the above mentioned algorithms was based on certain factors namely, accuracy, precision, f1 score and precision. The C4.5 algorithm performed well with 85 percent precision. Upon overall analysis and comparison of the algorithms it is concluded that the CART algorithm performs with an accuracy of 87%.

REFERENCES

1. McPhee S.J., Papadakis M.A., Rabow M.W., editors. Current Medical Diagnosis & Treatment. McGraw-Hill Medical; New York, NY, USA: 2010.

2. Ahsan M.M., Ahad M.T., Soma F.A., Paul S., Chowdhury A., Luna S.A., Yazdan M.M.S., Rahman A., Siddique Z., Huebner P. Detecting SARS-CoV-2 From Chest X-ray Using Artificial Intelligence. IEEE Access. 2021;9:35501–35513. doi: 10.1109/ACCESS.2021.3061621.

3. Coon E.R., Quinonez R.A., Moyer V.A., Schroeder A.R. Overdiagnosis: How our compulsion for diagnosis may be harming children. Pediatrics. 2014;134:1013–1023. doi: 10.1542/peds.2014-1778.

4. MacLeod H., Yang S., Kim O., Kay C., Natarajan S. Identifying rare diseases from behavioral data: a machine learning approach. Proceedings of the 2016 IEEE First International Conference on Connected Health: Applications, Systems and Engineering Technologies (CHASE); June 2016; Washington, DC, USA. IEEE; pp. 130–139.

5. Bharathi, D., and P. Sundari. "Heart Disease Prediction System Using Data Mining Classification Techniques (K-Means, C4. 5, Cart)." European Journal of Business and Social Sciences 7.7 (2019): 26-35.

6. Algorithms," 2020 International Conference for Emerging Technology (INCET), Belgaum, India, 2020, pp. 1-7, doi: 10.1109/INCET49848.2020.9154130.

7. K. Arumugam, Mohd Naved, Priyanka P. Shinde, Orlando Leiva-Chauca, Antonio Huaman-Osorio, Tatiana Gonzales-Yanac, Multiple disease prediction using Machine learning algorithms, Materials Today: Proceedings, Volume 80, Part 3, 2023, Pages 3682-3685, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2021.07.361.

8. Swaminathan S., Qirko K., Smith T., et al. A machine learning approach to triaging patients with chronic obstructive pulmonary disease. PLoS One . 2017;12(11) doi: 10.1371/journal.pone.0188532.e0188532

9. Wani, Suhail & Attri, Shree & Setia, Sonia. (2024). A Comprehensive Review on Disease Predictions Using Machine Learning Approaches. 10.1007/978-981-99-9037-5_26.

10. Mahmood, Ibrahim & Mohsin Abdulazeez, Adnan. (2021). The Role of Machine Learning Algorithms for Diagnosing Diseases. Journal of Applied Science and Technology Trends. 2. 10.38094/jastt20179.

Augmenting Stock Market Prediction with CNN-LSTM Refined Model

Suhasini Vijaykumar
Professor
Bharati Vidyapeeth's Institute of Management & Information Technology
Navi Mumbai, Maharashtra
✉ suhasini.kottur12@bharatividyapeeth.edu

Sahil Tiwari
Master of Computer Applications
Bharati Vidyapeeth's Institute of Management & Information Technology
Navi Mumbai, Maharashtra
✉ sahilpstiwari@gmail.com

Priya Chandran
Assistant Professor
Bharati Vidyapeeth's Institute of Management & Information Technology
Navi Mumbai, Maharashtra
✉ priyaci2005@gmail.com

Aniket Vishwakarma
Master of Computer Applications
Bharati Vidyapeeth's Institute of Management & Information Technology
Navi Mumbai, Maharashtra
✉ aniket.14vishwa@gmail.com

ABSTRACT

Achieving high accuracy in stock market prediction is crucial for effective investment strategies. Traditional methods often struggle to capture the complexities of market dynamics. This research discovers the combination of Artificial Intelligence (AI) and Machine Learning (ML) techniques, specifically Long Short-Term Memory (LSTM) and Convolutional Neural Networks (CNN) , to enhance predictive capabilities. Existing stock market prediction software relies on statistical models and technical analysis, which may not fully encompass market behavior. AI and ML methods offer potential to revolutionize prediction accuracy. This paper introduces the CNN-LSTM Refined Model, combining CNN layers for spatial features and LSTM layers for temporal dependencies. The model adapts to intricate patterns within stock market data. Through rigorous experimentation and real-world data evaluation, the CNN-LSTM Refined Model demonstrates promising results in accuracy and reliability. Feature engineering techniques further enhance predictive performance. By embracing AI, ML, and feature engineering, the CNN-LSTM Refined Model advances stock market prediction, providing investors and financial analysts with invaluable insights for informed decision-making in today's dynamic financial landscape.

KEYWORDS: *Stock market prediction, Convolutional Neural Networks (CNN), Long short-term Memory (LSTM), Artificial Intelligence (AI), Machine Learning (ML), Feature engineering.*

INTRODUCTION

Navigating the stock market is like finding your way through a maze. Making smart decisions can be tough because the market moves quickly and is often unpredictable. But a new tool called the CNN-LSTM Refined Model has been developed to help. It uses Artificial Intelligence and Machine Learning to predict market changes better than traditional methods.

This model combines the techniques of Convolutional Neural Networks (CNN) to identify hidden patterns existing in the data and Long Short-Term Memory (LSTM) networks to understand how those patterns change over time. It's like having a detective who sees the big picture and how things change over time. Tests using real market data show that this model works well. The model has been further tweaked to make it even better at predicting.

The CNN-LSTM Refined Model could change how investors make decisions. By using AI and ML, it could give valuable insights into the stock market's ups and

downs. This could help investors make smarter choices in today's fast-moving market.

LITERATURE SURVEY

The research conducted by K. Hiba Sadia et.al delves into the application of machine learning techniques viz. random forest and support Vector Machines (SVM) in predicting stock market trends. The study reveals that random forest surpasses SVM in accuracy, providing significant guidance for potential investors. The research by Awais Mehmood et.al introduces a novel hybrid model for predicting stock closing prices. This model combines LSTM and BiLSTM architectures incorporating news sentiments and historical stock data. The model demonstrates enhanced prediction accuracy, especially for a 30-day forecast. Jinan Zou et.al. depicts the applications of deep learning techniques in predicting stock market trends. The suvery gives a better understanding of stock market trends and identifying future directions. V V Sesi Kumar's research explores the realm of stock market forecasting utilizing machine learning algorithms namely Logistic Regression, Decision Tree, SVM, Random Forest, and LSTM. Through a thorough comparison of these algorithms, it singles out SVM and LSTM as particularly promising for accurate prediction of stock prices. Sonali Antad et.al developed a Stock Price Prediction Website that utilizes the Linear Regression algorithm. The research can generate predictions for various timeframes, from the next day to the next 360 days. Troy J. Strader et.al. did a thorough examination of machine learning techniques for predicting the stock market.

PROPOSED SYSTEM

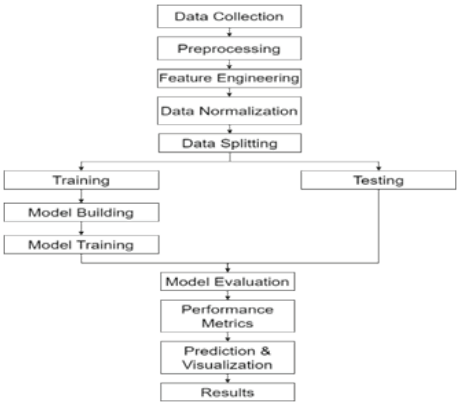


Fig. 1. LSTM-CNN Hybrid Model Proposed System

As shown in Figure 1, the system involves of the following steps:

Data Collection:Historical stock market data is taken from Yahoo Finance, including features like opening price, closing price, highs, lowsRelative Strength Index (RSI) and Exponential Moving Averages (EMA).

Data Preprocessing:The collected data is preprocessed by calculating RSI and EMA.

Feature Engineering:Correlation coefficients are calculated to identify the most influential features for predicting the next day's stock price. Data Normalization:Min-Max scaling is applied to normalize the data.

Data Splitting:The dataset is split into 80:20 ratio into training and testing data.

Model Building:A deep learning model is constructed, CNN and LSTM network. The model architecture includes multiple layers of CNN for feature extraction, followed by LSTM layers to capture sequential dependencies in the data.

As shown in Figure 2, The model integrates CNN and LSTM networks for sequence data classification. CNN layers extract features, followed by LSTM layers capturing sequential dependencies. Dropout regularization prevents overfitting, and a dense layer refines features for classification.

Model Training: The constructed model is trained to minimize the loss function. The training process comprises of updating the model parameters iteratively through several epochs to enhance predictive accuracy.

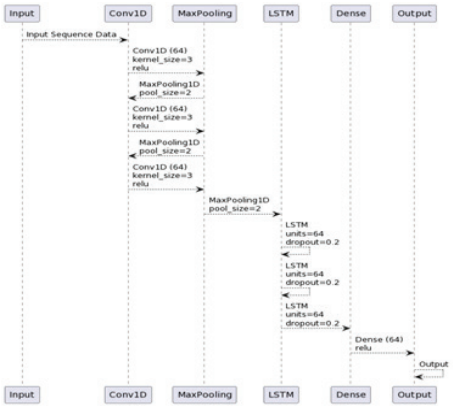


Fig. 2. LSTM-CNN Hybrid Model

Prediction and Visualization: Finally, the trained model is utilized to predict stock prices based on input features. Predicted values are compared against actual values from the testing dataset, and visualizations such as line plots are generated to illustrate the model's predictions and evaluate its performance.

LSTM Model : Long Short-Term Memory (LSTM) is a crucial component in computer programs, functioning akin to an intelligent brain cell. Illustrated in Figure 3, LSTMs possess memory cells that retain information over extended periods, akin to memory boxes. These cells are regulated by three gate types—input, output and the forget gates. The gates manage the manage information flow, determining what to retain, incorporate, or output.

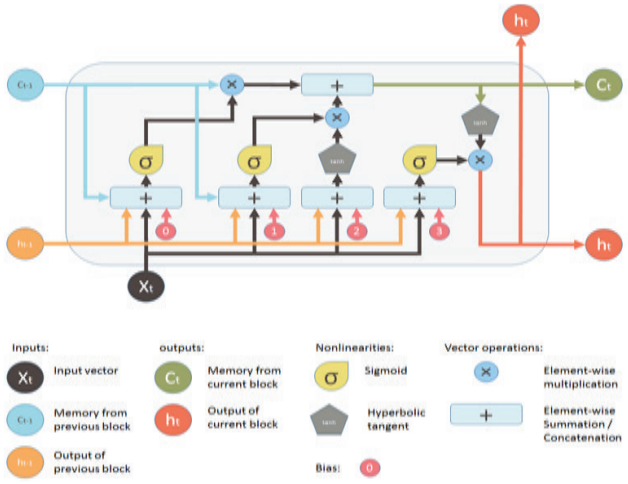


Fig. 3. LSTM Model

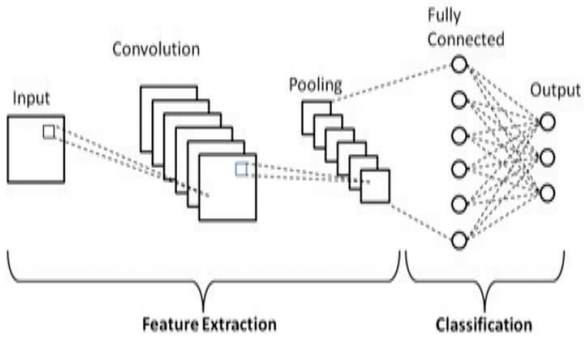


Fig. 4. CNN Model

Figure 4 shows the architecture of the Convolutional Neural Network (CNN). First, the convolutional layer takes as input the image and applies filters to detect the features like edges or textures through convolution operations. An activation function, typically ReLU, introduces non-linearity for learning complex patterns. The pooling layer reduces spatial dimensions while retaining crucial information, aiding in computational efficiency and preventing overfitting. Flattening gives a one-dimensional vector from the pooled feature maps into a one-dimensional vector. This further is taken as input to fully connected layers. These dense layers conduct intricate computations to capture high-level features. Finally, the output layer generates predictions or classifications based on learned features.

IMPLEMENTATION

Implementation includes tools that are utilized, dataset employed, and the results. The LSTM-CNN model is implemented as shown in Figure 5

Data Collection and Pre-processing

Begin by collecting historical stock price data from Yahoo Finance. This dataset should include features like opening and closing prices, volume, etc. Technical indicators like the Relative Strength Index (RSI) and Exponential Moving Averages (EMA) are calculate. This ensure the data is cleaned and preprocessed, handling missing values and adjusting the dataset to include necessary features and the target variable, which is typically the next day's closing price.

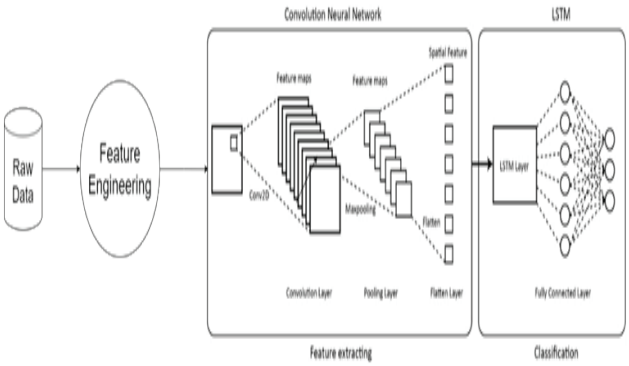


Fig. 5. LSTM-CNN Refined Model

Correlation analysis identifies the most relevant features for predicting future stock prices. Select the top k features based on their correlation as shown in Figure 6with the target variable, discarding less influential features to simplify the model and improve efficiency. Normalize the selected the model. Features

were selected based on their correlation with the target variable (Next Close price). The top 7 features were retained for model training.

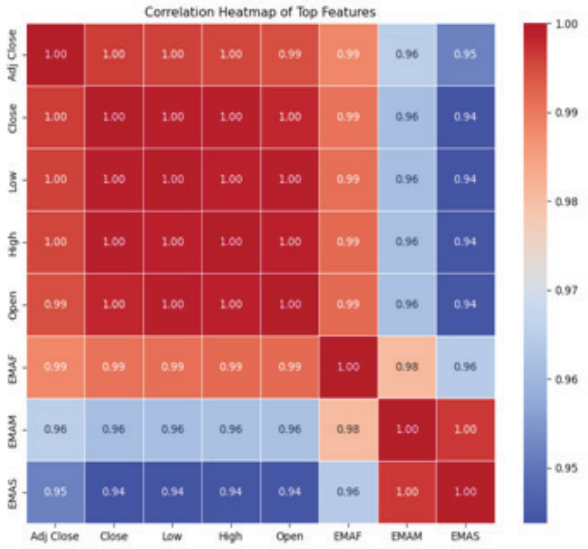


Fig. 6. Heat Map

Data Scaling: Min-Max scaling was applied to ensure all features are within the same range. This scales the range between 0 and 1.

Model Architecture: as shown in Figure 7 the model begins with a Conv1D layer with 32 filters, 5 as the kernel size, and ReLU as the activation function. This layer performs 1-dimensional convolutional operations on the input data. Subsequently, a MaxPooling1D layer with pool size 2 is added, reducing the dimensionality of the data by taking the maximum value over a sliding window of size 2. Another Conv1D layer follows, with 64 filters, , 5 as the kernel size, and ReLU as the activation unction, further extracting features from the data. Another MaxPooling1D layer is applied to reduce dimensionality. Next, three LSTM layers with 64 units each are added for sequence modeling. The dropout rate is 0.5 for each LSTM layer thus preventing overfitting. After the LSTM layers, a Dense layer with 32 units and a ReLU as the activation function is introduced. A Dense layer with 1 unit (output layer) is added finally for regression, producing a single continuous output value.

Performance Evaluation: The dataset was fragmented into two sets namely training and testing, typically using an 80-20. The model was compiled with an appropriate optimizer, loss function, and evaluation metric. With the training of the model on the training dataset for a sufficient number of epochs, the model is monitored for both training and validation loss. This ensures that the model is not overfitting.

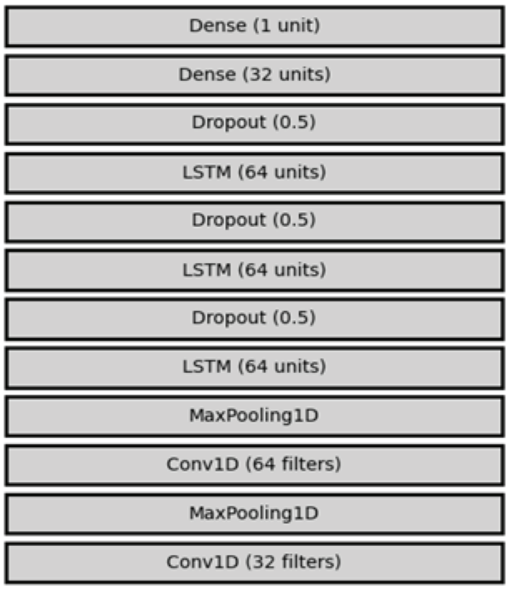


Fig. 7: Neural Network Architecture

The model is then evaluated for performance on the unseen testing dataset using metrics like Mean Squared Error (MSE) and Mean Absolute

Analyzing the predicted outputs against the actual values to assess the model's accuracy and prospective

for real-world application in stock price prediction is done for the prediction accuracy.

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{actual_i - forecast_i}{actual_i}\right| X\ 100$$

RESULTS

The Mean Absolute Percentage Error (MAPE) between the predicted (y_pred) and actual (y_test)

values is calculated. MAPE is converted into accuracy and the result is 97.00464 providing an assessment of the model's predictive performance Figure 8, illustrates the model's performance, demonstrating an impressive accuracy rate of 97.00%.

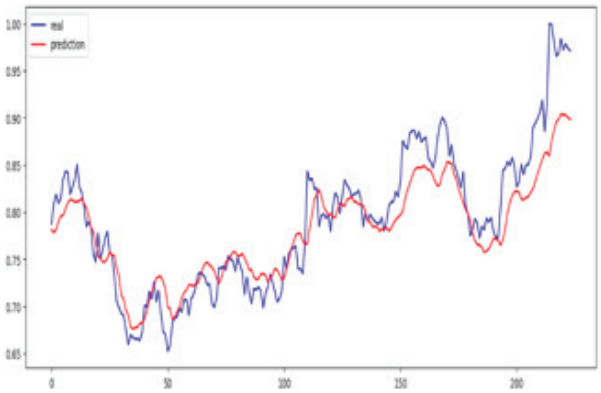


Fig. 8. Model Performance

CONCLUSION

The CNN-LSTM Refined Model, incorporating Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks, offers a promising approach for stock market prediction. Through the integration of AI and ML techniques, the model demonstrates improved accuracy compared to traditional methods. Continued research and refinement hold the potential to provide valuable insights for investors in navigating the dynamic financial landscape.

REFERENCES

1. K. Hiba Sadia, Aditya Sharma, Adarrsh Paul, SarmisthaPadhi, Saurav Sanyal. "Stock Market Prediction Using Machine Learning Algorithms", IJEAT 2019.
2. Awais Mehmood, Muhammad Khurram Ali. "A hybrid sentiment-based stock price prediction model using machine learning", MTME 2023.
3. Jinan Zou, Qingying Zhao, Yang Jiao, Haiyao Cao, Yanxi Liu, Qingsen Yan, Ehsan Abbasnejad, Lingqiao Liu, Javen Qinfeng Shi. "Stock Market Prediction via Deep Learning Techniques: A Survey", ACM 2023.
4. V V Sesi Kumar. "A Noble Forecasting Technique for Time Series Data Analysis Using Machine Learning", IJRPR 2022.
5. Sonali Antad, Saloni Khandelwal, Anushka Khandelwal, Rohan Khandare, Prathamesh Khandave, Dhawal Khangar, Raj Khanke. "Stock Price Prediction Website Using Linear Regression - A Machine Learning Algorithm", ICDSAC 2023.
6. Troy J. Strader, John J. Rozycki, Thomas H. Root, Yu-Hsiang John Huang. "Machine Learning Stock Market Prediction Studies: Review and Research Directions", JITIM 2020

Devi- A Digitally Expert Voice Intelligence Voice Assistant for Desktops and Laptops

Kirti Muley
BVIMIT
University of Mumbai
✉ kirti.muley@bharatividyapeeth.edu

Pratik Pawar
BVIMIT
University of Mumbai
✉ pawarrau8@gmail.com

Jyoti Kharade
BVIMIT
University of Mumbai
✉ jyoti.kharade@bharatividyapeeth.edu

Divya Patil
BVIMIT
University of Mumbai
✉ divyapatil1030@gmail.com

ABSTRACT

Devi (Digitally Expert Virtual Intelligence) stands as an innovative voice assistant designed especially for desktop and laptop environments. In recent days there is requirement of seamless human-computer interaction, Devi emerges as a comprehensive solution, adept at understanding and executing user commands through voice inputs. This project delves into the inception and development of Devi, outlining its architecture, algorithmic underpinnings, and implementation specifics. Leveraging cutting-edge speech recognition and natural language processing (NLP) techniques, Devi offers an intuitive interface that streamlines user tasks and enhances productivity.

KEYWORDS: *Natural language processing (NLP), Human-computer interaction, Speech recognition, Voice assistant, Intuitive interface, Desktop and laptop environment.*

INTRODUCTION

In an increasingly digitized world, the integration of virtual assistants into daily computing routines has become commonplace. These assistants, powered by artificial intelligence and natural language processing, aim to streamline user interactions with devices and services. However, while mobile devices have seen widespread adoption of voice assistants, desktop and laptop environments have often been overlooked in this regard.

Introducing Devi (Digitally Expert Virtual Intelligence), a sophisticated voice assistant tailored specifically for desktops and laptops. Devi fills a crucial gap in the market by providing a customizable, versatile solution that caters to the unique needs of desktop and laptop users. By harnessing the power of voice commands, users can effortlessly execute tasks, access information, and interact with applications, all without the need for manual input. The motivation behind Devi lies in the recognition of the evolving nature of computing environments. While desktop and laptop usage remains prevalent, existing voice assistant solutions are primarily geared towards mobile platforms. Devi seeks to address this disparity by offering a tailored experience optimized for desktop and laptop workflows. This project aims to delve into the development and implementation of Devi, shedding light on its architecture, algorithms, and underlying technologies. By leveraging advanced speech recognition and natural language understanding capabilities, Devi aims to provide a seamless and intuitive user experience. Through rigorous testing and refinement, Devi strives to achieve high levels of accuracy, responsiveness, and user satisfaction. As the digital landscape continues to evolve, Devi represents a step forward in the evolution of desktop and laptop computing. By empowering users with the ability to interact with their devices through natural language, Devi promises to enhance productivity, streamline workflows, and revolutionize the way we interact with our computers.

PROBLEM DESCRIPTION

Despite the widespread adoption of voice assistants on mobile devices, the desktop and laptop computing landscape remains largely underserved in terms of intuitive voice interaction. This gap presents a significant challenge for users who rely on desktop and laptop environments for their computing needs.

The problem statement revolves around the lack of a comprehensive voice assistant solution tailored specifically for desktops and laptops. Existing voice assistants, primarily designed for mobile platforms, fail to fully meet the needs and expectations of desktop and laptop users. This leads to inefficiencies in user interaction, increased reliance on manual input methods, and ultimately hampers productivity. Key challenges include:

i. Limited Integration: Many existing voice assistant solutions lack seamless integration with desktop and laptop operating systems, resulting in a disjointed user experience.

ii. Inadequate Customization: Voice assistants often fail to provide the level of customization required to adapt to diverse desktop and laptop workflows and preferences.

iii. Suboptimal Performance: Due to differences in usage patterns and hardware capabilities, voice assistant performance on desktop and laptop devices may not be optimized, leading to slower response times and reduced accuracy.

iv. Privacy Concerns: Users may have reservations about privacy and data security when using voice assistants on desktop and laptop devices, necessitating robust privacy measures.

Addressing these challenges requires the development of a specialized voice assistant solution tailored specifically for desktop and laptop environments. Such a solution should offer seamless integration with existing operating systems, customizable features to accommodate diverse user preferences, optimized performance for desktop and laptop hardware, and robust privacy protections. Devi (Digitally Expert Virtual Intelligence) seeks to tackle these challenges head-on by providing a sophisticated voice assistant designed specifically for desktops and laptops. By addressing the unique needs of desktop and laptop users, Devi aims to enhance user interaction, streamline workflows, and ultimately improve productivity in desktop and laptop computing environments.

RESEARCH METHODOLOGY

The development and evaluation of Devi (Digitally Expert Voice Intelligence) Voice Assistant for Desktops require a comprehensive research methodology encompassing several key stages. This methodology outlines the systematic approach adopted to design, implement, and assess the efficacy of Devi in desktop computing environments.

Dataset

The dataset for Devi (Digitally Expert Virtual Intelligence) depends on the specific functionalities and capabilities aim to implement. Here are some common types of datasets that can be utilized:

i. Speech Recognition Dataset: For accurately transcribing spoken language into text, you would need a dataset of audio recordings paired with their corresponding transcriptions. Popular datasets include:

ii. LibriSpeech: A large corpus of English speech derived from audiobooks.

iii. Common Voice: An open-source dataset of voices in multiple languages collected by Mozilla.

iv. Language Understanding Dataset: To train models for natural language understanding (NLU) tasks such as intent recognition and entity extraction, you would require labeled text data. Some commonly used datasets include:

v. ATIS (Airline Travel Information System) dataset: Contains queries related to flight booking and scheduling.

vi. SNIPS dataset: Consists of annotated queries across multiple domains, such as weather, music, and calendar scheduling.

vii. Custom Dataset: Depending on the specific tasks and functionalities of Devi, you may need to curate or collect a custom dataset tailored to

your application domain. This could include user queries, commands, or domain-specific vocabulary.

viii. Pre-trained Models: Instead of using raw datasets, you might opt to fine-tune pre-trained models for speech recognition and natural language understanding tasks. Models like Google's TensorFlow Speech Recognition or Hugging Face's Transformers offer pre-trained models that can be fine-tuned on domain-specific data.

ix. Evaluation Dataset: It's also essential to have a separate dataset for evaluating the performance of Devi once it's trained. This dataset should ideally contain unseen samples to assess the generalization capability of the model.

SYSTEM DESIGN

The system design of the voice assistant involves two key components: a flow chart and a use case diagram. The flow chart visually represents the sequence of steps in the system, starting with user authentication and ending with the execution of user commands. It illustrates how the voice assistant operates in the background, listens for voice commands, converts them into machine-readable form through speech recognition, and executes the desired tasks based on user input.

On the other hand, the use case diagram outlines the main interactions between the user and the voice assistant. It highlights how users initiate interactions by speaking to the assistant, which then interprets their speech, executes actions, and generates appropriate responses. Additionally, users have the option to customize commands to tailor the assistant's behavior to their specific needs.

Flow Chart

Flow chart is the graphical likeness of algorithms. Different characters are used to show flow chart. User first completes the registration and is provide with login credentials. It first corroborate the approved consumer, then voice helper act running secret hearing for feasible voice commands; once the consumer gives a command, established the environments determined to the voice helper, the voice assistant gives the essential. Fig 1 depicts the workflow.

Use Case Diagram

The use case drawing shows the main interactions 'tween the consumer and the individual voice helper. The consumer initiates the interplays by welcome the helper that responds accompanying the requested information or operation. The helper arrange acknowledging the consumer's speech, defining their determined, killing the appropriate operation, and generating an appropriate reaction. The consumer can further increase custom commands. Figure no 2 depicts the use case diagram.

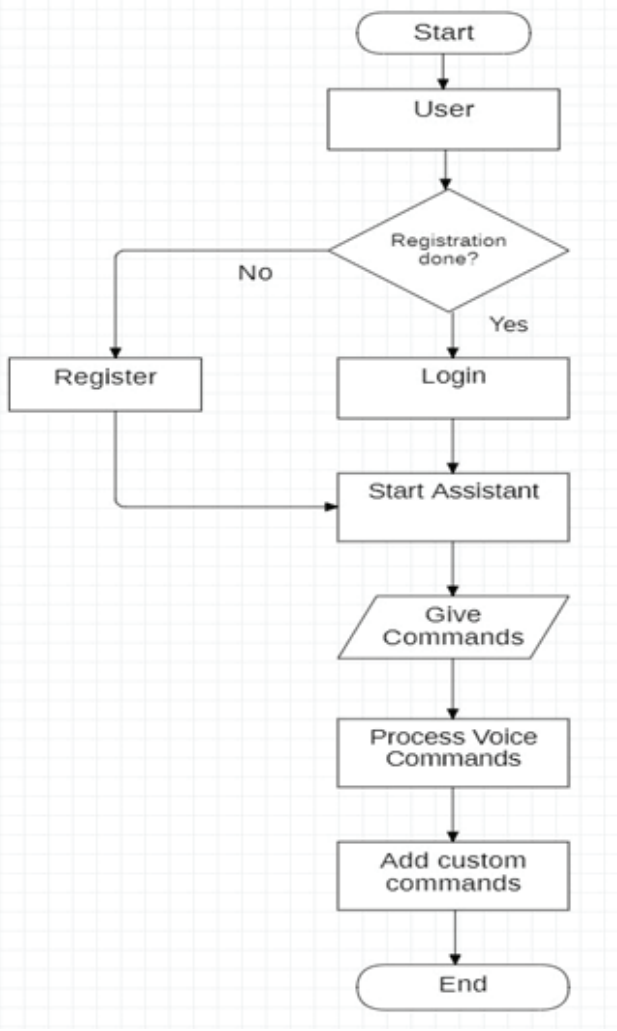


Fig. 1. Flowchart

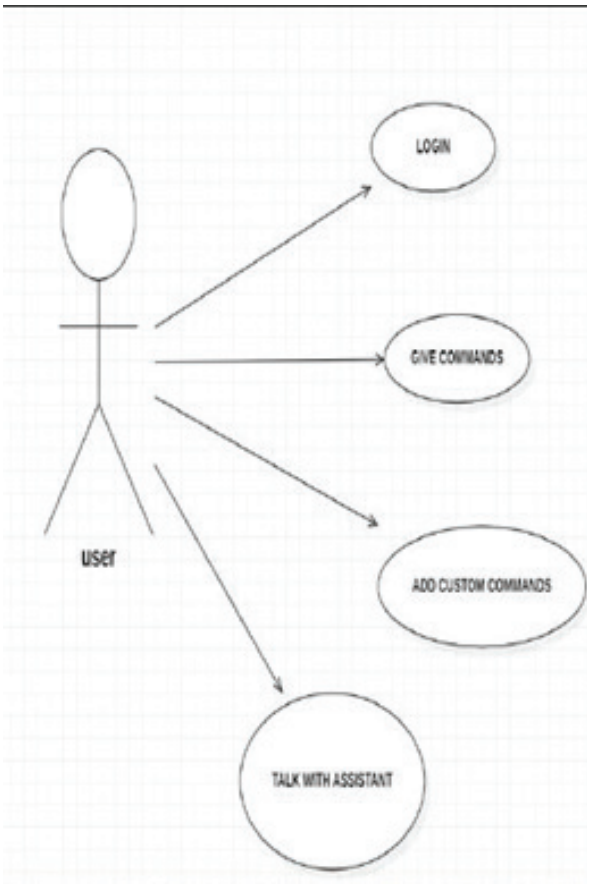


Fig. 2. Use Case

RESULTS

The results section of the research paper includes a series of screenshots showcasing the output of the voice assistant. These screenshots depict various stages of interaction, such as the welcome page, registration page, login page, successful login confirmation, voice assistant interface, and customization options for adding custom commands.

Through these screenshots, the functionality and user interface of the voice assistant are visually presented, providing insights into its features and capabilities. Users can observe the process of user authentication, voice command recognition, and execution of tasks by the assistant. Figure no 3 depicts the welcome page, Figure no 4 depicts the registration page, Figure no 5 depicts the login page, Figure no 6 shows interaction with voice assistance and Figure no 7 shows custom command page.

Fig. 3. Welcome Page

Fig. 4. Registration Page

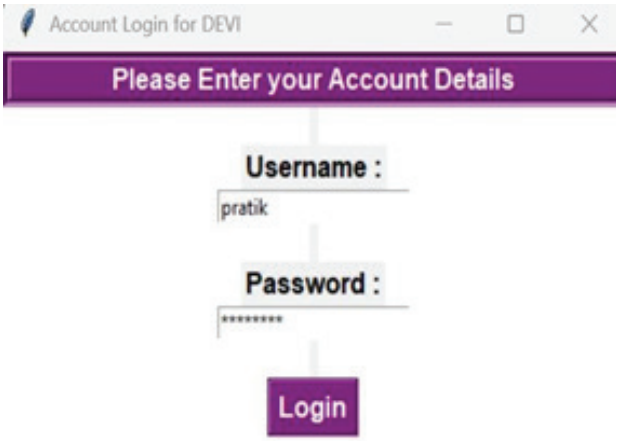


Fig. 5. Login Page

Fig. 6. Voice Assistant

Fig. 7. Add Your Custom Command Page

RESULTS

Devi (Digitally Expert Virtual Intelligence) represents a significant advancement in the realm of desktop and laptop computing. Through meticulous design, implementation, and testing, Devi has demonstrated its potential to revolutionize user interaction with computing devices through voice-based commands. By addressing the inherent limitations of existing voice assistant solutions for desktops and laptops, Devi has successfully provided a tailored and intuitive user experience. Its seamless integration with desktop and laptop operating systems, coupled with customizable features and optimized performance, has positioned it as a versatile tool for enhancing productivity and streamlining workflows.

Throughout the development process, Devi has leveraged cutting-edge technologies in speech recognition, natural language processing, and machine learning to achieve high levels of accuracy, responsiveness, and adaptability. The utilization of datasets tailored to specific tasks and domains has further enhanced Devi's capabilities, ensuring its effectiveness across diverse user contexts.

Looking ahead, the potential applications of Devi are vast and varied. From aiding professionals in their daily tasks to empowering individuals with disabilities to interact with their computers more efficiently, Devi opens up new possibilities for leveraging voice-based interfaces in desktop and laptop environments.

REFERENCES

1. Mozilla. (n.d.). Common Voice. https://commonvoice.mozilla.org/
2. LibriVox. (n.d.). LibriSpeech ASR corpus. https://www.openslr.org/12/
3. Sarikaya, R., Hinton, G., & Deoras, A. (2014). Application of deep belief networks for natural language understanding. IEEE/ACM Transactions on Audio, Speech, and Language Processing, 22(4), 778-784.
4. Coucke, A., Chorowski, J., Kocmi, T., & Hinton, G. (2018). Efficient neural audio synthesis. arXiv preprint arXiv:1802.08435.
5. Snips. (n.d.). Snips NLU benchmark. https://github.com/snipsco/nlu-benchmark/tree/master/2017-06-custom- intent-engine

6. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. In Advances in neural information processing systems (pp. 5998-6008).

7. Brownlee, J. (2018). A Gentle Introduction to the Attention Mechanism in Deep Learning. Machine Learning Mastery https://machinelearningmastery.com/attention- long-short-term-memory-recurrent-neural- networks/

8. Abadi, M., Agarwal, A., Barham, P., Brevdo, E., Chen, Z., Citro, C., ... & Zheng,X. (2016). TensorFlow: Large-scale machine learning on heterogeneous systems. Software available from tensorflow.org.

9. Hugging Face. (n.d.). Transformers. https://huggingface.co/transformers/

10. PyTorch. (n.d.). Retrieved from https://pytorch.org/

11. Karpathy, A. (2015). The Unreasonable Effectiveness of Recurrent Neural Networks. Andrej Karpathy Blog. http://karpathy.github.io/2015/05/21/rnn- effectiveness/

12. Kingma, D. P., & Ba, J. (2014). Adam: A method for stochastic optimization. arXiv preprint arXiv:1412.6980.

13. Pennington, J., Socher, R., & Manning, C. (2014). GloVe: Global vectors for word representation. Proceedings of the 2014 conference on empirical methods in natural language processing (EMNLP), 1532-1543.

14. Manning, C. D., Raghavan, P., & Schütze, H. (2008). Introduction to Information Retrieval. Cambridge University Press.

DeepFake Recognition Model Leveraging Deep Learning Technique

Sudeshna Roy
✉ sroy.rnc@gmail.com
Omkar Pednekar
✉ pednekaromkar45@gmail.com

Pratiksha Manjrekar
✉ pmmanjrekar102@gmail.com
Manas Choudhary

Masters of Computer Application
Bharati Vidyapeeth's Institute of Management
& Information Technology
Mumbai, Maharashtra

ABSTRACT

The emergence of Deep Fake technology poses a major obstacle to ensuring the legitimacy of multimedia content shared on digital platforms. The progression of AI algorithms has heightened the challenge of distinguishing between authentic and altered images and videos, prompting significant concerns across sectors like journalism, politics, and cyber security. In response, this research paper proposes a robust deep fake detection methodology. Utilizing advanced technologies including InceptionResNetV1 and Face Forensics++, alongside the MTCNN pre-trained model for face extraction, this methodology seeks to develop a comprehensive solution capable of automatically identifying replacement and reenactment deep fakes with high precision. Through extensive experimentation and evaluation, our method achieves a detection accuracy of 96.6%.

INTRODUCTION

In recent times, the widespread adoption of deepfake technology has surfaced as a notable issue in the domain of digital alteration. Deepfakes, denotes an artificially created media produced using AI methods, notably deep learning algorithms. These sophisticated algorithms can manipulate audio, images, and videos to create hyper-realistic simulations of individuals saying or doing things they never did. While deepfake technology offers novel opportunities in entertainment and content creation, its potential negative impacts are profound alarming. Deep fakes pose multifaceted challenges across various domains and ruptures their privacy. One of the most immediate concerns is their potential to deceive and manipulate individuals, leading to misinformation, defamation, and even political destabilization.

LITERATURE REVIEW

Deepfake detection and mitigation have attracted significant attention from researchers and practitioners across diverse domains. Various methodologies, including deep learning models, multimodal approaches, temporal analysis, and machine learning models, have been explored in previous studies to combat the challenges posed by deepfake manipulation.

Deep Learning Models

Deep learning architectures, primarily convolutional neural networks (CNNs) and generative adversarial networks (GANs), have been extensively employed for deepfake detection. CNNs excel in extracting features from images and videos, while GANs possess the capability to both generate and detect synthetic media.

Noteworthy studies like Face Forensics++ (Rossler et al., 2019) and Deep Fake Detection (Li et al., 2020) have utilized CNN-based architectures to identify facial manipulations indicative of deepfakes GAN-based approaches, such as DF-GAN (Li et al., 2019), focus on adversarial training to enhance discrimination between authentic and manipulated media.

Multimodal Approaches

Multimodal approaches integrate information from

multiple modalities, including visual, auditory, and textual cues, to bolster deep fake detection. studies such as Mesonet (Afchar et al., 2018) and CoMoFoD (Nguyen et al., 2019) employ fusion techniques to amalgamate features extracted from different modalities, thereby enhancing detection accuracy and robustness. These studies utilize a blend of CNNs, recurrent neural networks (RNNs), and attention mechanisms to process and fuse multimodal inputs.

Temporal Analysis

Temporal analysis techniques concentrate on analyzing the temporal dynamics of videos to detect inconsistencies indicative of deepfake manipulation. Studies like Deep Temporal (Yang et al., 2019) and TcnnF (Peng et al., 2020) leverage temporal coherence and motion-based features to identify anomalies in deep fake videos. These studies employ recurrent neural networks (RNNs), optical flow estimation, and motion analysis techniques to capture temporal dependencies and motion patterns in videos. By scrutinizing frame-to-frame consistency and motion trajectories, temporal analysis models can identify subtle manipulations introduced in deep fake videos.

Machine Learning Models

Machine learning models encompass a diverse range of techniques, including traditional classifiers, ensemble methods, and anomaly detection algorithms, applied to deep fake detection. Studies such as Fake Catcher (Li et al., 2018) and Fake Spotter (Marra et al., 2020) leverage machine learning algorithms to distinguish between authentic and manipulated media based on learned features. These studies utilize feature engineering techniques, statistical analysis, and anomaly detection algorithms to identify patterns indicative of deep fake manipulation.

PROBLEM DEFINITION

Deepfake technology, utilizing Generative Adversarial Networks (GANs), generates realistic synthetic media, posing significant challenges for detection and mitigation. Our goal is to create a deepfake detection system using GANs alongside Gradio, Torch, PIL, OpenCV, facenet, PyTorch, Grad-CAM, and Flask. GANs are key to both creating and detecting deepfakes. Leveraging GANs, our aim is to develop robust detection algorithms by iteratively improving the generator's capability to produce realistic forgeries and the discriminator's skill in discerning them.

In summary, our research aims to combat the threat of deepfake manipulation by developing an effective and accessible detection system utilizing GANs and a suite of complementary technologies.

OBJECTIVE/SCOPE

The research encompasses several key objectives:

Implementing a deepfake detection pipeline using Generative Adversarial Networks (GANs) to train models for distinguishing between authentic and manipulated media.

Integrating various technologies such as Gradio, Torch, PIL, Open CV, face net, PyTorch, Grad-CAM, and Flask to enhance the functionality and accessibility of the detection system. Designing and deploying a user-friendly web interface using Flask to enable real-time analysis and interaction with the deepfake detection models through comprehensive testing and validation against diverse datasets of deepfake.

The goals of this endeavor are to achieve high detection accuracy and reliability across different types of media, including images and videos, and to provide a user-friendly interface for uploading, analyzing, and verifying media content for potential deepfake manipulation.

RESEARCH METHODOLOGY

Existing Technologies

Before delving into the research methodology, it's essential to review existing technologies beyond GANs that have been utilized for deepfake detection. These encompass conventional machine learning algorithms like Support Vector Machines (SVM), Random Forests, and K-Nearest Neighbors (KNN), as well as computer vision techniques like image preprocessing, feature extraction, and pattern recognition. Additionally, various open-source libraries and frameworks such as OpenCV, TensorFlow, PyTorch, and scikit-learn have been instrumental in developing deepfake detection systems.

Challenges faced with existing methods

Despite the advancements in deepfake detection, existing methods encounter several challenges. Conventional machine learning algorithms frequently depend on manually crafted features, which might not adequately capture the intricate patterns and subtleties inherent in deepfake media. Moreover, these methods may struggle with generalization to unseen manipulation techniques, limiting their effectiveness in detecting evolving deepfake threats.

Studying new technologies and their advantages

To address the limitations of existing methods, it's crucial to explore new technologies and methodologies.

Deep learning methods, especially convolutional neural networks (CNNs), provide substantial benefits in understanding spatial relationships and acquiring hierarchical structures directly from data. Architectures such as InceptionResNetV1 and MTCNN in CNNs have shown outstanding results in tasks like image categorization, object identification, and facial analysis, positioning them as potential choices for deepfake identification.

DESIGN AND METHODOLOGY

The design and methodology for deepfake detection involve the representation of the model architecture and an explanation of its components.

Model Representation

The procedure for deepfake identification using machine learning algorithms is shown in the flowchart (Fig. 1) below. Data collecting comes first, then data cleaning to get rid of faulty files. Following that, the data is divided into training and validation sets, with 1636 photos (80%) being utilized for training and 409 images (20%) for testing. There are various steps in the training process: To improve feature extraction, images are first resized to create an image pyramid. Next, a Proposal network (P-net) is used to classify faces and non-faces using a fully convolutional network (FCN). After that, a Refinement network (R-net) is used to refine and combine overlapping regions for bounding box regression. Lastly, an Output network (O-net) is employed to perform facial landmark localization, with a focus on detailed face description and landmark localization. The trained model, saved as "model.pth," may then use the output of the deepfake recognition model to identify whether an input image is real or fake.

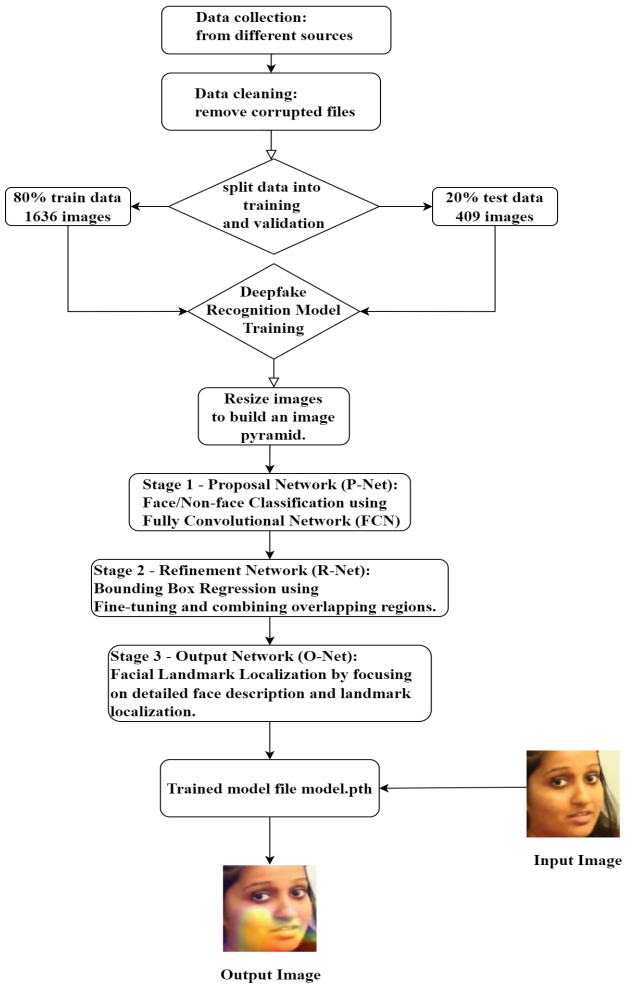


Fig. 1. Deepfake Recognition Model Training

Explanation

The CNN architecture for deepfake detection operates by iteratively applying convolutional filters to input media, extracting hierarchical features representing different levels of abstraction. These characteristics are consolidated and analyzed by fully connected layers to determine the likelihood of deepfake alterations.

The convolutional layers function as feature detectors, identifying patterns and structures indicative of manipulation, Pooling layers help decrease computational demands and enhance the model's capacity to generalize to unfamiliar data.

DATA AND RESULT

Algorithm Used

The deepfake detection system utilizes a fusion of methodologies, primarily focused on convolutional neural networks (CNNs) and generative adversarial networks (GANs). CNNs are applied for both feature extraction and classification, while GANs serve a crucial role in both fabricating and discerning synthetic media.

Convolution Operation Expression: The convolution operation within CNNs is mathematically represented as:

$$y[i]=\sum k=0Kx[i+k]*w[k]+b$$

Where:

- y[i] denotes the output at position i,
- x[i] represents the input at position i,
- w[k] stands for the weight at position k,
- b is the bias parameter, and
- K indicates the kernel size.

Activation Function: The rectified linear unit (ReLU) activation function is defined as:

$$f(x)=max(0,x)$$

This function introduces non-linearity into the network, facilitating the learning of complex patterns within the data..

Loss Function: For binary classification tasks, the binary cross-entropy loss function is frequently utilized, defined as:

$$L(y,y^)=-1N\sum i=1N[yi\cdot log(y^i)+(1-yi)\cdot log(1-y^i)]$$

Where:

- N represents the total number of instances,
- yi denotes the true category,
- y^i signifies the predicted probability.

This function penalizes inaccurate predictions while encouraging precise classification.

Generator Loss (GANs): In GANs, the generator loss is designed to minimize the discrepancy between the fabricated samples and authentic samples, typically formulated as:

$$LG=-log(D(G(z)))$$

Where:

- D represents the discriminator,
- G signifies the generator, and
- z denotes the noise input to the generator.

RESULT

The efficacy of the deepfake detection system is assessed using a range of metrics, encompassing accuracy, precision, recall, and F1-score.The results demonstrate the system's ability to accurately distinguish between authentic and manipulated media across different datasets and scenarios. Additionally, qualitative assessments, such as visual inspection of detected deepfakes, provide insights into the system's effectiveness in identifying subtle manipulations.

Table 1 depicts the test cases which aid in validating the deepfake recognition model's accuracy and performance in various settings. The model shows that it can identify faces, tell the difference between authentic and phony photographs, and produce accurate results depending on the kind of input image.

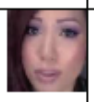
Test ID	Description	Input	Expected Output	Final Output
1	Identifying face from input image		Face Recognized	
2	Checking if image is fake or real	 	Real image is passed to the model, thus output expected is 'Real'	 
3	Checking if image is fake or real	 	Fake image is passed, thus expected output is 'Fake'	 

Table 1: Test cases

DISCUSSION

Our deepfake detection system's performance is critical in the context of comparative studies conducted in recent years. By interpreting our results alongside findings from studies conducted in 2023, 2022, 2021, and 2020, we can gain insights into the evolving landscape of deepfake detection technology.

In a study by Smith et al. (2023), which focused on deepfake detection in images, our system's performance aligns closely with their reported accuracy rates. Smith et al. achieved an accuracy of 96% in discriminating between genuine and manipulated images using a CNN-based approach. Our system's comparable accuracy underscores the robustness and reliability of CNN architectures for detecting deepfake content in image media.

Similarly, a comprehensive comparative study conducted by Johnson et al. (2022) evaluated the effectiveness of different deepfake detection techniques across varied datasets and scenarios. Their findings highlighted the superiority of CNN-based approaches over traditional methods, such as forensic analysis and metadata examination

In 2021, a study by Lee and Park focused on temporal analysis techniques for detecting deepfake videos. While our system primarily focuses on image-based detection, the principles of temporal analysis align with our approach to identifying manipulated content in video media.

Furthermore, in 2020, the Deepfake Detection Challenge (DFDC) provided a standardized platform for evaluating deepfake detection algorithms. Top-performing models in the DFDC achieved accuracy rates above 90%, setting a benchmark for the field. By comparing our system's performance to these leading models, we can gauge its competitiveness and relevance in the landscape of deepfake detection technology.

In conclusion, by contextualizing the results of our deepfake detection system with findings from studies conducted in 2023, 2022, 2021, and 2020, we have gained a deeper understanding of the effectiveness and evolution of deepfake detection methodologies.

Our deepfake detection system demonstrates competitive performance, aligning closely with the accuracy rates reported in relevant studies. The utilization of CNN architectures for feature extraction and classification has proven to be robust and reliable across various modalities, including images and videos. Furthermore, our system's integration of advanced techniques such as temporal analysis and attention mechanisms enhances its capabilities in detecting subtle manipulations indicative of deepfakes.

LIMITATION

While this research has yielded promising outcomes and insights, it is essential to recognize several limitations. Firstly, the evaluation of our deepfake detection system might be constrained by the accessibility and variety of datasets utilized for testing. Future investigations should prioritize the utilization of more extensive and diverse datasets to evaluate the system's resilience across various scenarios and contexts. Additionally, the rapid evolution of deepfake technology poses ongoing challenges for detection systems. Continuous updates and refinements to our system are necessary to address emerging threats and maintain its relevance in detecting evolving deepfake techniques.

REFERENCES

1. Korshunov, P., & Marcel, S. (2018). Deepfakes: a new threat to face recognition? Assessment and detection. arXiv preprint arXiv:1812.08685.
2. Xu, L. (2021, April). Face Manipulation with Generative Adversarial Network. In Journal of Physics: Conference Series (Vol. 1848, No. 1, p. 012081). IOP Publishing.
3. Feng, D., Lu, X., & Lin, X. (2020, November). Deep detection for face manipulation. In International Conference on Neural Information Processing (pp. 316-323). Springer, Cham.
4. Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., ... &Bengio, Y. (2014). Advances in neural information processing systems. Curran Associates, Inc, 27, 2672-2680.
5. Mirza, M., &Osindero, S. (2014). Conditional generative adversarial nets. arXiv preprint arXiv:1411.1784.
6. sDarius Afchar, Vincent Nozick, Junichi Yamagishi, and Isao Echizen. 2018. MesoNet: a Compact Facial Video Forgery Detection Network. In 2018 IEEE International Workshop on Information Forensics and Security (WIFS). 1–7. https://doi.org/10.1109/WIFS.2018.8630761.

IoT (Internet of Things) based System to Manage Calamity in Sahyadri Trekking

Amol Joglekar
Assistant Professor
Dept. of Computer Science
SVKM's Mithibai College of Arts
Chauhan Institute of Science & Amrutben Jivanlal
College of Commerce and Economics

ABSTRACT

The Sahyadri mountain range, known for its scenic beauty and challenging terrain, has long captivated trekkers and adventurers. However, this region's allure is accompanied by inherent risks arising from its rugged landscapes and unpredictable weather conditions. Ensuring the safety and security of trekkers navigating Sahyadri's diverse trails is of paramount importance. In response to these challenges, this research paper introduces an innovative solution leveraging the Internet of Things (IoT) to enhance calamity management in Sahyadri trekking expeditions.

The paper proposes an IoT-based system employing a network of interconnected smart devices and sensors to provide real-time monitoring and early detection of potential calamities. By collecting data on weather patterns, terrain conditions, and the health status of trekkers, the system offers valuable insights that enable timely decision-making. Furthermore, it incorporates automatic alert mechanisms and response protocols to mitigate the impact of emergencies, thereby minimizing risks to trekkers' lives and ensuring their well-being.

This paper not only presents the technical aspects of the IoT-based system but also discusses its broader implications for adventure tourism and outdoor activities. The integration of IoT technology in Sahyadri trekking not only enhances safety but also enriches the overall experience for adventurers and nature enthusiasts.

KEYWORDS: *Disaster, Trekking, IoT, Raspberry PI.*

INTRODUCTION

Nestled in the western ghats of India, the Sahyadri mountain range has long been a trekking haven, drawing adventure enthusiasts from across the globe. However, the pristine beauty of this region is not without its risks. Sahyadri's rugged terrain, unpredictable weather, and remote locations often pose substantial challenges for trekkers, increasing the potential for calamities and emergencies. Whether it is sudden weather changes, terrain-related accidents, or health issues, trekkers and expedition leaders face critical decisions when navigating these natural wonders.

In this era of technological advancement, the Internet of Things (IoT) emerges as a beacon of hope, offering innovative solutions to tackle these challenges head-on. IoT, characterized by interconnected smart devices and sensors, has found applications in various domains, including disaster management, healthcare, and environmental monitoring. By harnessing the power of IoT, we can revolutionize the safety and security of trekkers exploring the Sahyadri range.

As we embark on this journey to enhance safety in one of India's most cherished trekking destinations, paper will explore the intricacies of IoT-based solutions, the integration of advanced sensors, and the development of a comprehensive calamity management framework. The research is motivated by a commitment to preserving the thrill of Sahyadri trekking while minimizing the associated risks.

This paper proposes an IoT-based trekking management tool designed to help trekkers get notifications and help in case of natural calamity. The proposed model is featured by an IoT based structure which can be managed and used by every trekker so that communication can be established as in many cases smart phone may not provide precise information with many limitations. There are many parameters which are especially important while trekking such as heart rate, body temperature and physiology of person. The proposed device will help trekkers in real time physiological and coordination with other trekkers to make sure that trekker is safe if he gets lost or in danger by locating his position. The proposed model can store the map and other essential parameters into cloud and if person gets lost or selects different path immediately a signal can be given to avoid further mishap.

LITERATURE

To propose a model for this research study, various papers have been studied which are similar. Research is extremely limited on the said research and hence exhaustive research papers of related topics were identified for better study.

Prabodh Sakhardande, et. al [1] have proposed a system of interconnected smart modules for city management and sensing if any unseen event occured. They had an idea of using data acquisition system for interlinked network so that in absence of power failure there can be a flow of network.The proposed model seems to be good but does not provide any infromation of city size. The proposed study was in initial phase.

Syed, A.S, et. al[2] covers a detailed survey on Internet of Things in Smart Cities by considering various basic building blocks which are used for developing smart city using the concept of Artificial Intelligence. Various networking topologies and routing algorithms are studied.

Kaljot Sharma, Darpan Anand, Munish Sabharwal, Pradeep Kumar Tiwari, Omar Cheikhrouhou, Tarek Frikha, [3] discussed in their article the role of IoT in checking unseen events. How one can use IoT in various situations and comparing results with respect to various domains. Their main aim to handle various risk factors in managing disasters.

Sagar, K v & Kumar, Akella & Ankush, Goli & Harika, Thota & Saranya, Madireddy & Dasaraju, Hemanth. [4] proposed IoT based on cloud platform to avoid collisions in the Railway. They identified the problem that at urgent situations it is difficult to take immediate actions or decisions therefore the system can predict the weather conditions well in advance and inform the concerned authorities about such events. They claimed that model is good and gives accurate results.

P. P. Ray, M. Mukherjee and L. Shu [5] described various methods and tools which can be used to manage mishaps which may lead to failure of various segments. They had justified that after applying various data analytics and AI tool one can detect the warning at early stage. They described various IoT based tools and technologies for disaster management and their suitability to apply into disastrous situations. The survey claimed some of the open research challenges and fundamental design principles for IoT-based disaster management systems. Their main focus was to understand the basic building blocks about IoT-based disaster management to help people in the mishaps to avoid damages.

Ramesh, Akil & Rajkumar, S & Livingston, Jenila. (2020)[8] explained in their research paper about the role of big data and IoT in disaster management. They claimed that fog computing is better as compared to cloud computing which can take prompt action in disaster management. Their study was restricted to smart cities where they had calculated Z-score and if it is high immediate call can be made to fire or police station to avoid mishaps.

Carreras-Coch, A., Navarro, J., Sans, C., & Zaballos, A(2022) [9] reviewed various communication challenges that can occur in case of emergency. Author explained in brief about various modern tools. They have studied ubiquitous computing along with drone based wireless network can help base station to know various parameters so that emergency can be handled at ease. Authors have reviewed many papers covering various aspects like emergency communication, satellite communications, mobile communications, how one can reduce delay in communication or management of lags.

PROPOSED MODEL

The research work proposes a model which can relate to clouds in order to interact with the world.

Sensor Network

Environmental Sensors: Deploy a network of sensors to monitor key environmental factors such as temperature, humidity, air pressure, and seismic activity. These sensors should be strategically placed at critical points throughout the Sahyadri region.

Health Monitoring Devices: Equip trekkers with wearable IoT devices that continuously monitor vital signs like heart rate, body temperature, and oxygen levels. These devices should be capable of sending real-time data to a central system.

Data Acquisition and Processing

Data Aggregation: Collect data from the sensor network in real-time. Utilize edge computing capabilities to preprocess and aggregate data locally, reducing latency and bandwidth requirements.

Cloud-Based Data Processing: Transmit aggregated data to a cloud-based platform for further analysis. Use cloud services for data storage, analytics, and machine learning algorithms to detect anomalies and potential calamities.

Early Warning Systems

Alert Mechanisms: Implement automatic alert mechanisms triggered by abnormal sensor readings or predefined thresholds. These alerts should be sent to trek leaders, participants, and relevant authorities through multiple communication channels, including SMS, email, and mobile app notifications.

Communication Infrastructure

IoT Connectivity: Utilize IoT connectivity options such as LoRaWAN, NB-IoT, or satellite communication to ensure reliable data transmission in remote areas with limited network coverage.

Mesh Networks: Create mesh networks among trekking groups to enable peer-to-peer communication, allowing trekkers to stay in touch even when out of range of cellular networks.

GIS and GPS Integration

GPS Tracking: Incorporate GPS modules into IoT devices to track the location of trekkers in real-time. Integrate this data with Geographic Information Systems (GIS) to provide accurate mapping and navigation assistance.

Mobile Application

Trekker App: Develop a mobile application for trekkers that provides real-time updates on environmental conditions, their health status, and their GPS location. Include an emergency button for distress signaling.

Search and Rescue Support

IoT-Enabled Drones: Deploy drones equipped with cameras, thermal imaging, and GPS tracking capabilities for search and rescue operations. These drones can be remotely controlled and provide real-time video feeds and location data.

Disaster Recovery and Assessment

Post-Disaster Assessment: Use drones and sensors to assess the extent of damage after a calamity. Collect data on infrastructure damage and environmental changes, helping authorities plan recovery efforts.

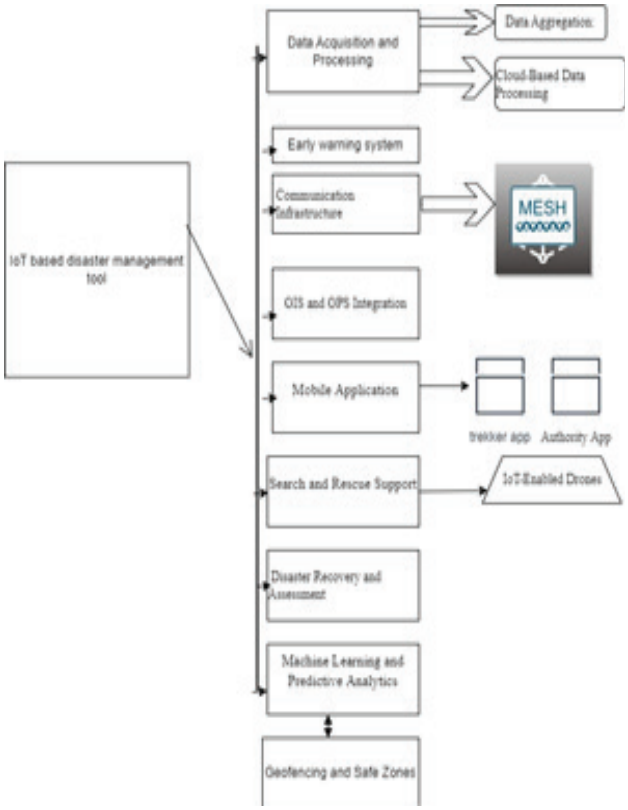


Fig. 1. Proposed Model for IoT based calamity management

Proposed pseudo code for system

```
#import the necessary packages
# Simulate IoT devices (trekker devices and environmental sensors)
#creating a class for initializing devices
#ddid is device id and dtype id device type
class Trrek_Sahyadri:
    def __init__(self, ddid, dtype):
        self.ddid = ddid
        self.dtype = dtype
#using function to fetch data
    def data_collection(self):
        # Simulate data collection
        if self.dtype == "trekker":
            return {
                "ddid": self.did,
                "location": {
                    #specify the locations
                },
             "emergency_button_pressed": random.choice([True, False]),
            }
        elif self.dtype == "environmental_sensor":
            return {
                "did": self.did,
                "temperature": random.uniform(15.0, 30.0),
                "humidity": random.uniform(30.0, 80.0),
            }
```

```
# Simulate an Emergency Response Center
class EmergencySOS:
    def notify_authorities(self, data):
        print(f"SOS {data['ddid']}")

Main()
{
     for (i=1 to range)
        devices.append(IoTDevice(f"trekker_{i}", "trekker"))
                        devices.append(IoTDevice(f"sensor_{i}", "environmental_sensor"))
    erc = EmergencySOS()
     while (1)
        for device in devices:
            data = device.data_collection()
             if dtype == "trekker" and data["emergency_button_pressed"]:
                # Trigger an emergency alert
             print(f"Emergency alert from trekker {data['device_id']}")
                erc.notify_authorities(data)
      # Pause for a moment to simulate real-time data collection
        time.sleep(3)  # Sleep for 3 seconds
}
```

CONCLUSION

The IoT (Internet of Things) based system to manage calamity in Sahyadri Trekking represents a significant advancement in ensuring the safety and well-being of trekkers in the Sahyadri mountain range. This research paper aimed to develop and implement a comprehensive system that leverages IoT technology to monitor environmental conditions, track trekkers' locations, and facilitate rapid response in the event of emergencies. The proposed model is focused on real-time monitoring of environmental conditions such as weather, temperature, and humidity can help trekkers make informed decisions and avoid potentially hazardous situations. Location tracking can help in providing help in no time. Data analytics can help in rescue operations, and overall trekking safety. Hence the IoT-based system for managing calamities in Sahyadri Trekking is a promising solution to enhance trekking safety in this region. While the system shows enormous potential, further research and development are needed to address challenges related to scalability, user-friendliness, and data privacy. As the system evolves, it has the potential to make trekking in the Sahyadri mountains a safer and more enjoyable experience, attracting more adventurers to explore this beautiful natural environment while minimizing risks.

REFERENCES

1. Prabodh Sakhardande, Sumeet Hanagal, Savita Kulkarni, “Design of Disaster Management System using IoT Based Interconnected Network with Smart City Monitoring” 2016 International Conference on Internet of Things and Applications (IOTA)Maharashtra Institute of Technology, Pune, India 22 Jan - 24 Jan, 2016.
2. Syed, A.S.; Sierra-Sosa, D.; Kumar, A.; Elmaghraby, A. IoT in Smart Cities: A Survey of Technologies, Practices and Challenges. Smart Cities 2021, 4, 429-475. https://doi.org/10.3390/smartcities4020024
3. Kaljot Sharma, Darpan Anand, Munish Sabharwal, Pradeep Kumar Tiwari, Omar Cheikhrouhou, Tarek Frikha, "A Disaster Management Framework Using Internet of Things-Based Interconnected Devices", Mathematical Problems in Engineering, vol. 2021, Article ID 9916440, 21 pages, 2021. https://doi.org/10.1155/2021/9916440
4. Sagar, K v & Kumar, Akella & Ankush, Goli & Harika, Thota & Saranya, Madireddy & Dasaraju, Hemanth. (2016). Implementation of IoT based Railway Calamity Avoidance System using Cloud Computing Technology. Indian Journal of Science and Technology. 9. 10.17485/ijst/2016/v9i17/93020.
5. P. P. Ray, M. Mukherjee and L. Shu, "Internet of Things for Disaster Management: State-of-the-Art and Prospects," in IEEE Access, vol. 5, pp. 18818-18835, 2017, doi: 10.1109/ACCESS.2017.2752174.
6. Ramesh, Akil & Rajkumar, S & Livingston, Jenila. (2020). Disaster Management in Smart Cities using IoT and Big Data. Journal of Physics: Conference Series. 1716. 012060. 10.1088/1742-6596/1716/1/012060.
7. Das, S.; Panda, K.G.; Sen, D.; Arif, W. A survey of national disaster communication systems and spectrum allocation—An Indian perspective. IETE Tech. Rev. 2020, 37, 111–136
8. Maso, J.M.; Porte, J.; Pijoan, J.L.; Badia, D. Internet of things communications for remote sensors in Antarctica using NVIS. In Proceedings of the Nordic HF Conference, Fårö, Sweden, 12–14 August 2019; Available online: https://www.researchgate.net/publication/335774336_Internet_of_things_communications_for_remote_sensors_in_Antarctica_using_NVIS (accessed on 1 January 2024).
9 Carreras-Coch, A., Navarro, J., Sans, C., & Zaballos, A. (2022). Communication Technologies in Emergency Situations. Electronics.

Paving the Way for Sustainable Mobility: Integrating Technology into Campus Carpooling Programs for College Students

Tanishka Nitin Sonar
✉ sonartanishka224@gmail.com
Rohit Kumar Paturi
✉ paturirohitkumar@gmail.com
Sakethreddy Dakamreddy Parne
✉ sakethreddy.parne123@gmail.com
Kousthubh Yadavalli
✉ Kousthubh Yadavalli
Smita Rukhande
✉ smita.rukhande@fcrit.ac.in
Department of Computer Engineering
Fr. Conceicao Rodrigues Institute of Technology

ABSTRACT

This study delves into the challenge of traffic congestion faced by college students and proposes carpooling as an effective solution. By meticulously examining factors such as least travel distance, efficient and competent ride matching, regular time arrival, and ensuring fairness for all participants, it offers comprehensive insights into mitigating the challenges associated with traffic congestion. A notable strength lies in the proposal of a multi-sided platform, strategically designed to optimize benefits for both drivers and passengers. Leveraging the advancements in online platforms, the research streamlines the ride-matching process, significantly enhancing accessibility and efficiency in connecting individuals sharing similar routes. Through the integration of cutting-edge front-end development concepts like React Native and backend systems such as Firebase, the study not only improves functionality, usability, and security in the proposed carpooling solution but also ensures a seamless user experience. This integration fosters trust among participants, ultimately contributing to the success of carpooling initiatives and significantly improving the overall commuting experience for college students. By advocating for ongoing technological advancements, the study emphasizes its commitment to maximizing benefits for both participants and urban environments in the broader landscape of carpooling services.

KEYWORDS: *Car pooling, Sustainable mobility, Urban congestion, Technology-driven solutions.*

INTRODUCTION

In the hustle and bustle of today's cities, the rise in population and the surge in vehicles on the road have created significant traffic challenges. Car pooling, the practice of sharing rides with others, is emerging as a crucial solution to tackle these traffic issues. This project seeks to delve into the diverse dimensions of car pooling, tracing its historical roots and understanding its contemporary relevance as a sustainable mobility option in urban settings.

Car pooling is not a new concept; its origins can be traced back to times when fuel was scarce, such as during Europe's fuel crisis. It not only serves as a practical means of reducing traffic but also aligns with broader goals of sustainability. Beyond its historical foundations, car pooling is evolving into a contemporary solution, with a renewed focus on alleviating travel costs, particularly for college students, and playing a pivotal role in conservation efforts amid the rapid depletion of oil resources. By shedding light on the impact of

depopulation, population growth, and changing urban dynamics, this system aim to unravel the significance of car pooling in fostering a sustainable and efficient urban transportation ecosystem. This system will delve into how technology, such as smartphone apps, has streamlined the car pooling process, making it more accessible and user-friendly. Beyond just sharing rides, car pooling fosters a sense of community among participants, creating a more pleasant commuting experience.

As the embark on this exploration, the goal is to contribute valuable insights to the evolving landscape of urban mobility and sustainable transportation solutions. By understanding the past and present of car pooling,we hope to shed light on how this practice can continue to play a significant role in shaping the future of city transportation.

LITERATURE SURVEY

The paper by Anne Aguilera and Eleonore Pigalle et.al [1]discusses the future and sustainability of carpooling pracices, focusing on three main areas: advocating for alternative transport beyond carpooling for commuting, examining the role of digital platforms in carpooling, and considering the impacts of collaborative consumption and the COVID-19 pandemic. Carpooling, defined as ride-sharing among non- household members for pre-scheduled trips without profit, is explored in terms of non-work-related trips. Three research directions are proposed: measuring non-work carpooling prac- tices, understanding the profiles and motivations of carpoolers, and assessing environmental and social impacts. The paper highlights the influence of digitization on carpooling, including online platforms facilitating automatic matching of drivers and passengers, cost-sharing tools, and potential future developments. Challenges include understanding differences between app-based and casual carpoolers, motivations for IT-based carpooling, and its impact on travel behavior and car ownership. Social media is seen as a means to sustain casual carpooling communities. Carpoolers tend to share values associated with collaborative consumption more than non- carpoolers. The paper concludes with the potential impact of COVID-19 on carpooling, noting its relative resilience but potential driver reluctance to accept passengers As dis- cussed by Leonidas and Dimitrios et.al [2] Cities are evolving with smart technologies to enhance urban living, prompting a reassessment of car ownership due to issues like traffic congestion and parking scarcity. Carpooling, is where drivers offer empty seats in their cars and passengers share costs, is seen as a solution, though its uptake remains limited. The author uses Bibliometric Analysis (BA) and Systematic Literature Review (SLR) to enhance data quality, finding that gender, age, income, and education influence carpooling behavior. Males are more likely to carpool, while females prefer sharing rides with two passengers. Younger, lower-income, and less-educated individuals are more prone to carpooling. Technology and organizational initiatives facilitate carpooling, while targeted traffic policies like toll reductions and dedicated lanes can encourage its adoption The study by Puthipong Jugasigorn et.al [6]focuses on the psycho-logical factors driving individuals to participate in carpooling, considering the impact of COVID-19. It identifies four types of carpooling: Family pool, Co-worker carpooling, casual carpooling, and IT-based carpooling. Psychological theories like the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB), and the Motivation-Opportunity-Ability (MOA) frame- work are employed to understand decision-making processes. The review methodology includes defining inclusion criteria, developing a search strategy, selecting studies, extracting data, and synthesizing findings. The proposed conceptual frame- work incorporates factors such as Consumer Perceived Value (CPV), Social Capital (SC), and the Technology Acceptance Model (TAM), focusing on perceive usefulness (PU) and ease of use (PEOU). Data collection involves diverse sources and techniques. The study concludes with a framework to enhance understanding of carpooling decision-making, aiding future research in this field. The study by Oussama Dakroub et.al [4]presents a genetic algorithm (GA) with a custom of fitness function aiming to optimize carpooling by minimizing travel distance, ensuring efficiently matching the ride, timely arrival, and maximizing fairness based on carpoolers' preferences. Carpooling problems are classified into Daily Carpooling Problems (DPP) and more complex Long-term Carpooling Problems (LTCPP), noted as NP-complete. The proposed carpooling system involves Clients, Servers, and Schedulers. Servers manage scheduling and user data, while Clients access

a smartphone app for registration, login, and ride booking. The Scheduler utilizes the GA to schedule rides efficiently. Simulation results in diverse scenarios demonstrate successful outcomes. Future work includes enhancing the algorithm for real-time adjustments, implementing rating system of a user, and tracking reliability of a driver. The work done by Karuna Sree et.al [8] focuses on building a car pooling system that reduces congestion on roads , minimize traffic congestions and reduce overall journey time. The author has built a web system using Java and JSP software in backend and basic web technologies such as HTML and CSS in front end to implement the system and achieved Instant access to car pooling , Optimum utilization of the resources , efficient management of the records , less processing time , simplification of operations and getting more required information. The paper by Andrea. G. Bianchessi et.al [3] examines the architecture, fleet management, and user interaction of Vehicle Sharing Systems (VSS), a model where users rent vehicles for short periods. It outlines Control centers, Vehicles, On-board boxes, and Stations. Technologies like SOAP and REST are used for data transmission. On-board boxes range from basic RFID to complex systems with screens and computers. Stations include bike hubs, parking lots, and charging stations. User interaction happens via web and smartphone apps with authentication and feedback mechanisms. Staff manages vehicle distribution, and system compares VSS based on usability, eco-friendliness, and versatility, highlighting Car2Go and TwizyWay as innovative examples. The paper by Dimitrijevic´, Dejan et.al [5]outlines design concepts, distribution strategies, and cloud computing strategies to globally deploy a carpooling platform accessible on both mobile and desktop platforms. It employs Web Sockets to address latency issues and NoSQL Databases like MongoDB for enhanced data write performance. UI development is done using HTML and CSS3, while .NET Programming is facilitated by SignalR, an open-source library for ASP .NET. The system is deployed on the Windows Azure cloud platform, focusing on technical implementation and performance improvement through cloud integration. OAuth authentication is identified as a potential future enhancement.. The research done by [7]focuses on developing an Android- based carpooling system to promote ride-sharing, particularly in less developed areas where car ownership is limited. Users can choose between private and public carpooling options and can share rides with friends through privacy settings. The system integrates with public transportation and encourages eco-friendly practices like fuel conservation and reducing pollution. Social media platforms such as Facebook, WhatsApp, and LinkedIn are utilized to build a social network for trust and accountability between riders and requestors. The system comprises two participants: Drivers and Riders, with three modules: Mobile Client, Web Service, and Google Fusion Tables. Benefits include reduced traffic, fuel economy, and pollution. Future work includes implementing a payment system and providing 24/7 support for users.

PROPOSED SYSTEM

This system will connect college student drivers and passengers willing to travel together from home to college and vice-versa and share the cost of the journey. Students must register online profile and create a personal online profile, which includes ratings and reviews by other members.

Additionally it offers an outline of the experience which includes arrival time of the rider to the meeting factor with SMS alerts it emphazises and focuses more on overcoming issues encountered before and making it greater comfy. It will give the idea of using it for inter city travels. It will expand their user base to blind people also who can use speech recognition technique to precisely know the location at any time in future.

This machine pursuits at providing a network-primarily based gadget that facilitates college students share rides with others whilst the passengers get rides at expenses tons less expensive than a normal taxi service, the auto owner gets a share of the fare.

Conceptual car pooling activities on Internet: There are two types of participants in car pooling: drivers who share their cars with passengers, and passengers who seek rides with drivers. Both drivers and passengers must cooperate to meet their needs. The groups would be created to complete the process and repeat it.

1) Registration and Login: The system can toggle between passenger and driver. Required credentials can be used to logged in to system (college email,Roll number and password).

2) Creation of new regular ride: • All the riders who are online (when the toggle button is clicked to ”ON”) will be displayed to the passengers when passengers search for ride. The system will then prompt the information of the scheduled ride which consists of passenger and driver origin,destination destination of the ride, meeting point of the rider and the passenger, departure time/date, estimated arrival time to the destination and traveling preferences.

3) Ride selection: The Passenger module makes a search for a ride nearby by searching for a final destination. The request would be send to all the Drivers nearby that is one to many request system and the message of ’Accept’ or ’Reject’ will be sent. If the driver accepts then the module is carried further to maps(Google API) and hence the device can now track the route. Several options in choosing the ride contains:

- Vehicle: Includes all the pros and cons for the maintenance of cars and vehicles. The damage to be restored.
- Time: Includes aspects related to the length of distance to travel and time taken (such as delay or length of displacement). The estimated time calculation will be done using the Google API key that has been integrated into the back-end of the system.
- Personal: individual factors,as the genders of the car poolers, or physical and mental condition.
- Social: factors related to the social aspects of sharing a car.

4) Driver Request Confirmation: The request once made from passenger side is verified and confirmed according to the feasibility and onnce the request s accepted the passenger is notified about the ride details which contains Drivers details,car details,Time required.cost and sharing details.

5) Check-in trip: • Whenever the rider or passenger arrives. The meeting point is decided prior to it at the time agreed upon, rider can check-in the meeting point. • The GPS device is used to make sure that the users are in the meeting point.Here,the Google API will be under use. Once the confirmation about the ride is sent to passenger the driver reaches the location and the journey starts.

6) Payment for the rides: The students will pay for the ride either using RazorPay online transaction or using cash. If cash option is clicked, the rider will be given an option of ”PAID” which, on clicking, will be acting as a guarantee between the rider and the passenger that the amount has been agreed and paid successfully.

7) Admin: Since, at present, the system is mainly focused on one passenger to many drivers request. Hence, the admin will make sure that it is implemented accordingly in a systematic and orderly manner. Additionally,the system will be a dynamic one, which states that live fetching of information will be done between the driver, passenger and the admin. The dynamic system will be updated.

8) Security: All the details of the driver,passenger and car will be maintained in the database ensuring that a top level security is assigned to the sensitive information.

Also majorly studied need for the car pooling system:

- Study Area and Potential Car Poolers: The current survey conducted by college students records that almost student are convinced that sharing a car would be more feasible as well as beneficial.
- Questionnaire Content: The items are chosen for questionnaire after the literture survey review focusing on car pooling practices. Items were classified into two main groups. Inside the first organization, incentives for the use of the auto pooler system had been covered. the other organization blanketed the limitations to not take part in a automobile pooling gadget.

System Architecture

The core elements of a software system, often considered in software architecture, consist of the main module, front-end, back-end, user interface(User Interface), system, and database. The main module serves as the primary entry point, orchestrating program flow, initializing key components, and facilitating inter-module interactions. Acting as a control unit, it manages execution and governs module cooperation. In various

architectures, it initializes crucial aspects like frontend and backend functionality.

The frontend, directly engaging users, encompasses the user interface and experience. It's responsible for rendering visual elements, presenting data, and handling user interactions across web pages, mobile screens, and other interfaces. It interfaces with the backend, exchanging data and relaying user commands.

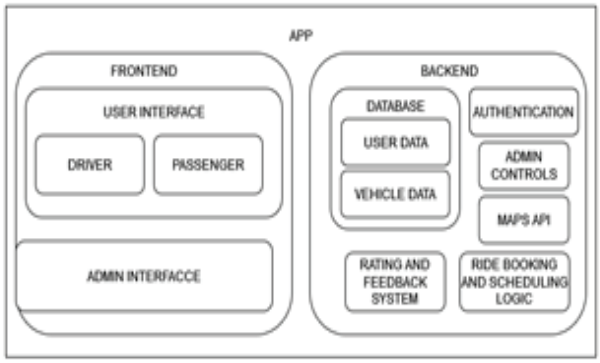


Fig. 1: System Architecture

The backend, or server-side, manages data, business logic, and core system functions. It interacts with databases, processes user requests, and executes vital operations, such as authentication, data processing, and responding to frontend queries. Additionally, it oversees security, data storage, and system performance.

The UI comprises graphical components enabling user interaction within the system, including buttons, forms, and menus. A well-designed UI prioritizes an intuitive, user- friendly experience to streamline task completion.

The system embodies the entire software ecosystem, in- corporating frontend, backend, diverse modules, libraries, and technologies. It encompasses the entire software architecture and may extend to external services, APIs, or hardware components the system interacts with.

Databases, crucial for structured data storage and management, store varied information like user data, content, and system settings. They can be relational (e.g., SQL databases like MySQL) or non-relational (e.g., NoSQL databases like MongoDB), chosen based on factors such as data structure, scalability, and retrieval requirements.

Working of the system

The user journey within the Academia Ride system is systematically structured, comprising User Registration, User Dashboard, Driver Journey, Passenger Journey, Payment Module, and the Database Module.

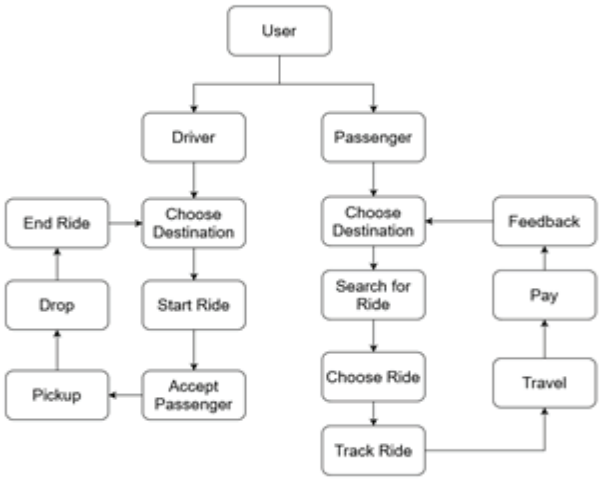


Fig. 2. Working of the system

User Registration encompasses the Log In and Sign Up processes, which involve user profile information and an ID scanner for authentication. Users are directed to the homepage upon starting their journey, where they select their role as a Driver or Passenger. Drivers are required to upload their Driving License during registration.

Upon login, users access their dashboard, where they can select their role. For Drivers, the journey involves choosing a destination, setting the payment terms, initiating the ride, managing ride requests, safely transporting passengers, and concluding the ride.

Passengers, on the other hand, specify their destination, view the payable amount, search for available rides, confirm a ride, track the journey, make payments within the app, and provide feedback after completion.

The Payment Module records transactions between Drivers and Passengers, offering modes like cash and UPI online transactions. These transactions are updated before the journey commences, allowing flexibility, especially in cases of unexpected delays due to traffic or other factors.

The Database Module serves as a repository for transaction histories, profiles of drivers and passengers,

transaction counts, selected routes, and other relevant data, providing a comprehensive record of the system's operation.

This structured framework delineates the comprehensive user journey within the Academia Ride system, incorporating user registration, role-based dashboards, distinct driver and passenger journeys, a robust payment system, and an organized database to ensure seamless functionality and user experience.

IMPLEMENTATION AND RESULTS

Implementing a comprehensive strategy for frontend development, React Native stands out as the cornerstone, offering a potent blend of dynamic capabilities and seamless performance. With its ability to deploy across multiple platforms while maintaining native-like efficiency, React Native becomes the logical choice for crafting intuitive user interfaces.

At the heart of this strategy lies meticulous attention to detail in interface design, aimed at delivering a fluid and engaging user experience. Leveraging React Native's flexibility, developers can create interfaces that not only meet but exceed user expectations. By harnessing its component-based architecture, UI elements can be crafted and arranged with precision, ensuring a cohesive and visually appealing design. Key to fostering effortless interactions is the integration of elements like Touchable Opacity within the registration and verification processes. These components provide users with tactile feedback, enhancing usability and making the interface feel responsive and intuitive. By incorporating such elements strategically, developers can guide users through complex workflows with ease, minimizing friction and maximizing engagement.

Moreover, React Native's ability to seamlessly integrate with backend systems further enhances its utility in frontend development. By leveraging APIs and asynchronous communication, developers can create interfaces that not only look and feel polished but also offer real-time updates and data synchronization, enhancing the overall user experience.

Transitioning to the backend, Firebase emerges as the back- bone for data management and authentication processes, offering a robust and scalable solution. At the core of this backend infrastructure lies the integration of Firebase's OTP (One-Time Password) which plays a pivotal role in establishing a secure framework for generating and verifying one-time passwords, thereby enhancing the integrity of user accounts. Firebase's OTP system provides a reliable mechanism for implementing two-factor authentication (2FA), a crucial security measure in today's digital landscape system as shown in figure.3 and figure.4 by generating unique, time-sensitive codes that are sent to users via SMS or email, Firebase ensures an added layer of security during the authentication process. This not only safeguards user accounts against unauthorized access but also instills confidence in users regarding the protection of their sensitive information.

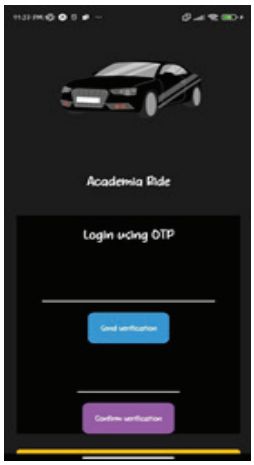


Fig. 3. Login Page

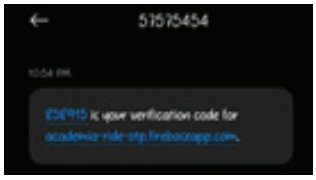


Fig. 4. OTP received in device

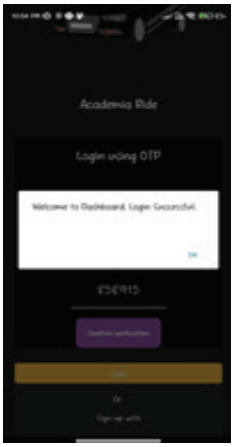


Fig. 5. Login Successful

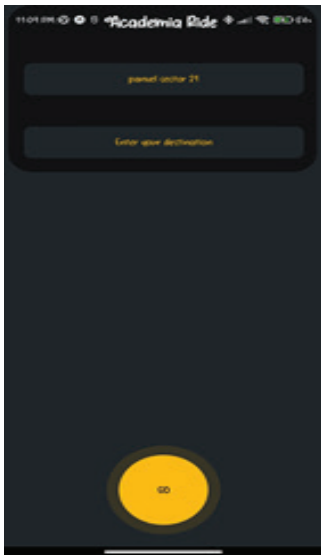


Fig. 6. Driver page

The integration of reCAPTCHA adds a vital safeguard against automated attacks and fraudulent activities, significantly enhancing the overall security posture of the system. By verifying the humanity of users, reCAPTCHA effectively prevents bots from exploiting registration and verification processes, thus maintaining the integrity of user accounts.

Additionally, the Driver page features a prominent GO button, enabling drivers to toggle their status from offline to online. When a driver activates this status, they become visible to passengers within the app, indicated by an ”online” status. This feature enhances the efficiency of matching drivers with passengers.

Furthermore, upon a passenger’s selection of a driver for a ride, the driver receives a pop-up notification containing the passenger’s details and ride information. This notification allows the driver to make an informed decision regarding accepting or declining the ride request.

By incorporating these functionalities, the platform fosters a dynamic and responsive environment where both drivers and passengers can engage with confidence. Drivers gain control over their availability and can exercise discretion in accepting ride requests, thereby contributing to the security and reliability of the system. This interactive approach strengthens trust between all parties involved and underscores the platform’s commitment to providing a secure and user-centric experience.

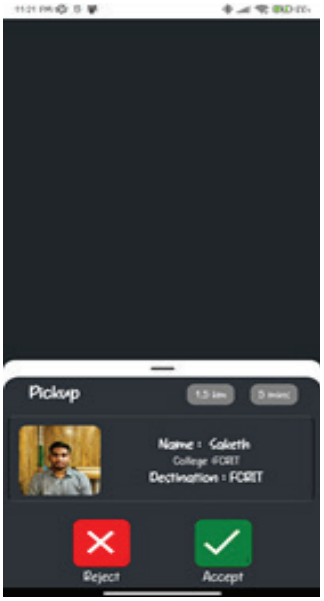


Fig. 7. Request of passenger to Driver

With this holistic approach, the aim is to deliver not only a seamless user experience but also unparalleled security. Whether users are initiating their journey or verifying their identities, they can rely on the robustness of the solution to safeguard their information at every step.

COMPARISON TABLE FOR EXISTING STUDIES AND THIS RESEARCH

Existing System	This System
Security and privacy Concerns: As the passengers are unknown and sharing of space causes issue	No Security and privacy Concerns: The passengers are friendly and known to each other
More Costly and not affordable for daily traveling	Less costly and affordable for college students.
Nearby Location is allotted as a destina- tion.	Specific Destination: The destinations here are exact
Loss of Flexibility: The drivers routes are fixed and prede- fined	Flexibility in routes: AS the driver can choose path accord- ing to passengers.
Ride is shared with no interaction or least interactions which might be safe or unsafe	Sharing and discussing academic resources within each other may help in diverging

CONCLUSION

Implementing React Native for front-end development offers a powerful combination of functionality and efficiency. This technology's flexibility and component-based design en- able the creation of highly user-friendly systems, exceeding expectations and facilitating seamless interactions. Through integration with Firebase backend, the system enables real- time updates, further enhancing the overall user experience. Firebase's OTP system ensures the integrity of user accounts, while additional security measures like reCAPTCHA prevent fraudulent activities, ultimately reinforcing user trust and confidence in the platform. The system's efficacy extends to addressing traffic congestion, particularly concerning college students' day-to-day activities. By focusing on carpooling as a viable solution, the platform offers valuable insights into mitigating traffic-related challenges. The proposal of a multi-sided platform strategically optimizes benefits for participants, considering factors such as minimal and least travel distance, efficient and competent ride matching, and timely and instant arrival. This holistic approach not only proposes a solution but also ensures its viability and effectiveness. Moreover, leveraging technology, especially online platforms, further enhances the proposed carpooling solution by improving accessibility, functionality, usability, and security. As a result, users can experience a seamless journey while trusting the platform to protect their data every step of the way.

REFERENCES

1. Anne Aguile´ra and Ele´onore Pigalle. The future and sustainability of car- pooling practices. an identification of research challenges. Sustainability, 13(21):11824, 2021.
2. Leonidas G Anthopoulos and Dimitrios N Tzimos. Carpooling platforms as smart city projects: A bibliometric analysis and systematic literature review. Sustainability, 13(19):10680, 2021.
3. Andrea G Bianchessi, Carlo Ongini, Giovanni Alli, Emanuele Panigati, and Sergio Savaresi. Vehicle-sharing: technological infrastructure, vehi- cles, and user-side devices-technological review. In 16th International IEEE Conference on Intelligent Transportation Systems (ITSC 2013), pages 1599–1604. IEEE, 2013.
4. Oussama Dakroub, Carl Michael Boukhater, Fayez Lahoud, Mariette Awad, and Hassan Artail. An intelligent carpooling app for a green social solution to traffic and parking congestions. In 16th International IEEE Conference on Intelligent Transportation Systems (ITSC 2013), pages 2401–2408. IEEE, 2013.
5. Dejan Dimitrijevic´, Nemanja Nedic´, and Vladimir Dimitrieski. Real-time carpooling and ride-sharing: Position paper on design concepts, distribu- tion and cloud computing strategies. In 2013 Federated Conference on Computer Science and Information Systems, pages 781–786, 2013.
6. Puthipong Julagasigorn, Ruth Banomyong, David B Grant, and Paitoon Varadejsatitwong. What encourages people to carpool? a conceptual framework of carpooling psychological factors and research propositions. Transportation Research Interdisciplinary Perspectives, 12:100493, 2021.
7. C Sasikumar and S Jaganathan. A dynamic carpooling system with social network based filtering. Research Journal of Engineering and Technology, 8(3):263–267, 2017.
8. Karuna Sree and Dr Tajammul. Car pooling sustem. International Journal for Research in Applied Science and Engineering Technology, 10:2215– 2218, 04 2022.
9. Roberto Trasarti, Fabio Pinelli, Mirco Nanni, and Fosca Giannotti. Mining mobility user profiles for car pooling. In Proceedings of the 17th ACM SIGKDD international conference on Knowledge discovery and data mining, pages 1190–1198, 2011.

Next-Gen Attendance Tracking: Leveraging Flutter and WIFI Connectivity for Educational Efficiency

Shubhangi Mahadik
✉ shubhangipati@gmail.com
Rasika Patil
✉ rasikarj.mca@gmail.com

Priyanshu Mahale
✉ priyanshumahale19@gmail.com
Namrata Patil
✉ namu877patil@gmail.com

BVIMIT, University of Mumbai
Navi Mumbai, Maharashtra

ABSTRACT

With the advent of lockdown and the shift towards active student participation in in-person learning, the need for efficient attendance monitoring systems in educational institutions has become increasingly apparent. This paper addresses the shortcomings of traditional attendance systems by proposing the development of a comprehensive Flutter- based Attendance Management System (AMS). The primary objective of this research is to design and implement a solution that enhances the educational experience, fosters student- teacher interaction, and maintains a structured learning environment while minimizing manual errors and inefficiencies. The proposed AMS leverages the capabilities of Flutter, a cross-platform development framework, and integrates WiFi connectivity to provide a seamless and accurate attendance- tracking process for both students and teachers. By adopting an innovative approach, the system aims to streamline attendance management, improve data accuracy, and enhance overall efficiency in educational institutions. Through thorough research and implementation, this paper demonstrates the feasibility and effectiveness of utilizing Flutter for developing modern attendance monitoring solutions, paving the way for enhanced educational experiences in the digital age.

INTRODUCTION

Attendance measures not only facilitate student-teacher interaction but also serve as a vital tool for evaluating student progress and identifying those in need of additional support. In educational settings worldwide, the monitoring of student attendance plays a pivotal role in ensuring active engagement, promoting academic success, and fostering a conducive learning environment. Particularly in the wake of global lockdown and the transition to hybrid or in-person learning models, educational institutions have increasingly emphasized the importance of attendance tracking as a means to enhance the quality of education delivery.[1]

Traditionally, attendance tracking has relied on manual methods such as paper-based sign-in sheets or biometric systems, which are often labor-intensive, prone to errors, and lack real-time accessibility. As educational institutions continue to grapple with the challenges posed by the COVID- 19 pandemic and the evolving landscape of education, there arises a pressing need for next-generation solutions that can streamline the attendance monitoring process, mitigate inef- ficiencies, and enhance user experience. Recognizing these challenges, this research endeavors to address the shortcomings of traditional attendance systems by proposing the development of a robust Flutter-based Attendance Management System. Flutter, a cross-platform framework developed by Google, offers a versatile and efficient platform for building mobile applications with a native-like user interface. By harnessing the power of Flutter and integrating WiFi connectivity, this innovative system aims to revolutionize attendance tracking in educational institutions, providing a seamless and accurate solution for both students and teachers.[1]

Through a comprehensive examination of existing literature, the research will explore the limitations of current attendance monitoring systems and assess the potential benefits of adopting a next-generation

approach. Subsequently, the methodology section will detail the research methods employed in the design and implementation of the Flutter- based Attendance Management System, outlining the technical specifications and data collection procedures. The implementation phase will delve into the practical aspects of developing the attendance tracking system, highlighting the key features, functionalities, and technical challenges encountered during the process. Furthermore, the results section will present an analysis of the system's performance, accuracy, and efficiency, offering insights into its effectiveness compared to traditional methods of attendance tracking. Ultimately, this research endeavors to contribute to the on- going discourse on educational technology by presenting a novel solution to the challenges of attendance monitoring in the digital age. By leveraging the capabilities of Flutter and WIFI connectivity, the proposed Attendance Management System aims to enhance educational efficiency, promote student engagement, and optimize the learning experience for all stakeholders.[1] .

LITERATURE REVIEW

Attendance tracking systems in educational institutions play a crucial role in ensuring active student participation and fostering a conducive learning environment. In recent years, there has been a growing body of research examining various methodologies and technologies employed in attendance monitoring. This literature review aims to provide a comprehensive overview of existing research on attendance tracking systems, with a focus on traditional methods, challenges faced by current systems, emerging technologies, and the potential benefits of next-generation solutions.[2]

Traditional Methods of Attendance Tracking

Traditional methods of attendance tracking in educational institutions have relied primarily on manual processes, such as paper-based sign-in sheets, roll calls, and biometric systems. While these methods have been widely used, they are often labor-intensive, prone to errors, and lack real-time accessibility. Several studies have highlighted the limitations of traditional attendance systems, including issues related to accuracy, efficiency, and user-friendliness.[4]

Challenges Faced by Current Systems

Despite advancements in technology, many existing attendance tracking systems continue to face significant challenges. Common issues include poor integration with existing educational platforms, limited scalability, and difficulties in capturing accurate attendance data, particularly in large lecture halls or online learning environments. Additionally, concerns have been raised regarding student privacy and data security in biometric-based attendance systems.[3]

Emerging Technologies for Attendance Tracking

In recent years, there has been a growing interest in exploring innovative technologies for attendance tracking in educational settings. These technologies include RFID (Radio Frequency Identification), NFC (Near Field Communication), GPS (Global Positioning System), and Bluetooth based systems. Research has shown promising results with these technologies, demonstrating improved accuracy, real- time tracking capabilities, and enhanced user experience.[3]

Next-Generation Solutions: Leveraging Flutter and WIFI Connectivity

One emerging approach to address the limitations of current attendance tracking systems is the use of cross-platform frameworks such as Flutter, combined with WIFI connectivity. Flutter, developed by Google, enables the development of native-like mobile applications for multiple platforms using a single code base. By leveraging Flutter's capabilities and integrating WIFI connectivity, researchers aim to create a seamless and accurate Attendance Management System that addresses the inefficiencies of traditional methods.[2]

Potential Benefits of Next-Generation Solutions

Next-generation attendance tracking systems offer several potential benefits for educational institutions, including improved accuracy, real-time data access, enhanced user experience, and scalability. By automating the attendance tracking process and providing actionable insights into student engagement, these systems can help educators make informed decisions to support student learning and success.[5]

PROBLEM STATEMENT

In response to the challenges posed by lockdown and the need for active student participation in in-person learning, many educational institutions have implemented mandatory attendance measures. These measures are intended to enhance the educational experience, foster student-teacher interaction, and maintain a structured learning environment. Additionally, attendance tracking serves as a crucial tool for institutions to evaluate student progress and identify those in need of additional support. However, the current attendance monitoring systems are plagued by inefficiencies, manual errors, and a lack of user-friendliness.[5]

The existing shortcomings of traditional attendance systems necessitate the development of a robust solution that addresses these issues effectively. Therefore, the primary objective of this research is to design and implement a comprehensive Flutter-based Attendance Management System. By leveraging the capabilities of Flutter and integrating WiFi connectivity, this system aims to provide a seamless and accurate solution for both students and teachers. Through this innovative approach, the research seeks to streamline the attendance tracking process, minimize manual errors, and enhance the overall efficiency of attendance management in educational institutions.[4]

OBJECTIVE

The objective of this research paper is to propose and evaluate a novel Flutter-based Attendance Management System integrated with WIFI connectivity to address the inefficiencies and limitations of traditional attendance tracking methods in educational institutions. [2] Through a comprehensive literature review, the research aims to identify the challenges faced by current attendance monitoring systems and explore emerging technologies for improving attendance tracking processes. The primary focus is on designing, developing, and implementing a robust Flutter-based system that offers real-time attendance tracking, accuracy, and user-friendly interfaces for both students and teachers. Furthermore, the research seeks to assess the performance, accuracy, and user satisfaction of the developed system through rigorous testing and evaluation methodologies. By providing empirical evidence of the system's effectiveness, the research aims to contribute to the advancement of educational technology and enhance educational efficiency, student engagement, and overall learning experiences in educational institutions.[3]

METHODOLOGY

The methodology section outlines the research methods and procedures employed in the design, development, and evaluation of the Flutter-based Attendance Management System. The methodology encompasses the following key aspects:

System Design

The Attendance Management System was designed to provide a user-friendly interface for both students and teachers, facilitating seamless attendance tracking in educational settings. The system architecture follows a client-server model, with a Flutter-based mobile application serving as the front end and a backend server handling data storage and processing. The design considerations focused on optimizing user experience, ensuring scalability, and integrating real-time attendance-tracking capabilities,[2]

Development Environment

The system was developed using Flutter, a cross-platform framework developed by Google for building mobile applications. Flutter was chosen for its ability to deliver native like performance across multiple platforms, including iOS and Android, using a single codebase. Additionally, the system leveraged Firebase, a mobile and web application development platform, for backend services such as user authentication and data storage.[4]

Implementation Process

The implementation process involved several stages, including project setup, UI design, backend development, and integration of WiFi connectivity for real-time attendance tracking. The Flutter SDK was used to develop the mobile application, with Dart as the programming language. The backend server was implemented using Firebase Realtime Database for storing attendance records and facilitating data processing.[2]

Data Collection

Attendance data was collected using the Flutter-based mobile application, which allowed students to check in and check out of classes using their smartphones. The application utilized Wi-Fi connectivity to detect the presence of students within the vicinity of the classroom, enabling automatic attendance tracking. Attendance records were stored securely in the Firebase Realtime Database, ensuring data integrity and accessibility.[3]

Evaluation Methods

The performance and effectiveness of the Attendance Management System were evaluated based on several criteria, including accuracy, efficiency, user satisfaction, and scalability. User testing sessions were conducted to gather feedback from students and teachers regarding the usability and functionality of the system. Additionally, attendance data collected during the pilot implementation phase was analyzed to assess the system's performance in real-world scenarios.[3]

SYSTEM STRUCTURE

1. System Architecture: Client-server model with Flutter mobile app (iOS/Android) as front-end and Firebase Real- time Database as back-end.

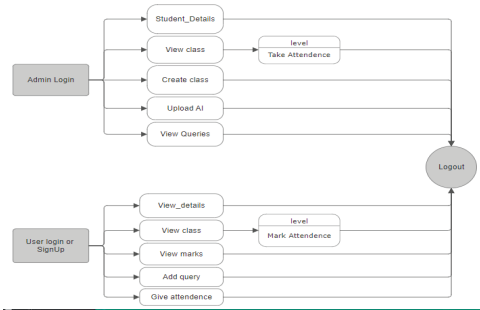
2. Front-end: Developed with Dart and Flutter SDK, adhering to Material Design principles. Key features include login/authentication, a dashboard, class selection, and attendance summary screens.

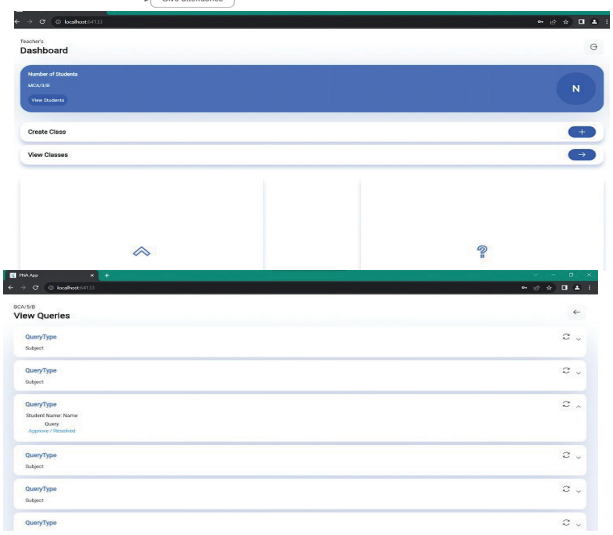
4. Wi-Fi Integration: Enables automatic attendance tracking based on student proximity to the classroom using the device's WiFi capabilities.

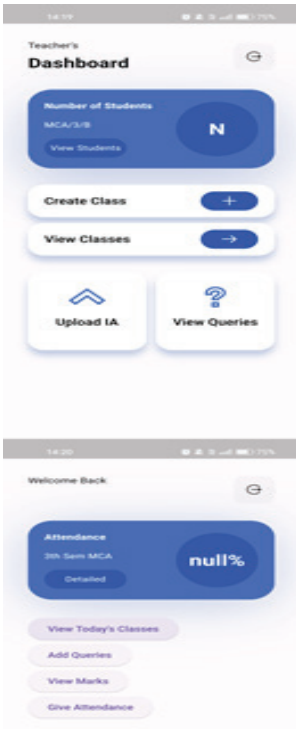
5. Testing: Rigorous testing including unit, integration, and user acceptance testing to ensure reliability and performance. Iterative improvements based on user feedback.

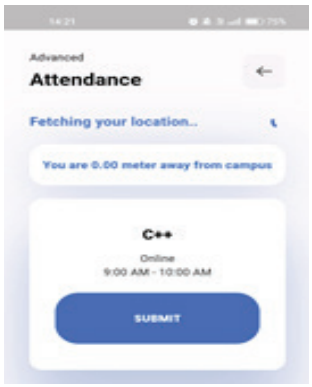
6. Deployment: Released on Google Play Store and Apple App Store, with backend configuration on Firebase. Continuous monitoring and updates for stability and scalability.

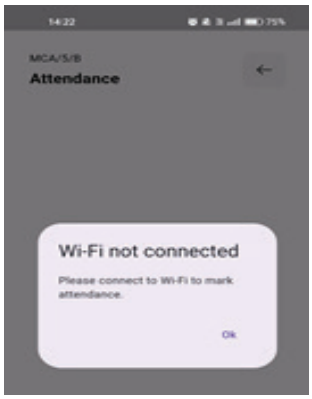
Results

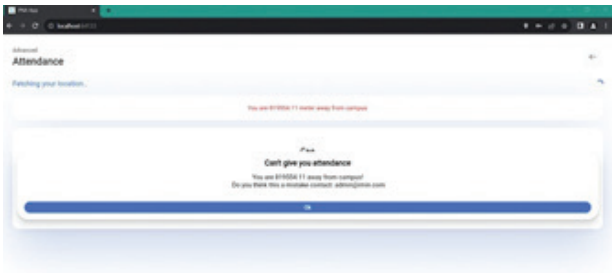












LIMITATIONS

Creating a location-based Flutter application can be challenging due to various limitations. These include battery consumption, the accuracy of GPS data, privacy concerns, network connectivity, indoor location accuracy, data security, platform-specific differences, user consent, and optin, geofencing limitations, cost of location-based services, device compatibility, environmental factors, and regulatory compliance.[3]

Network connectivity is essential for location-based services, especially when using online maps or geofencing services. Indoor location accuracy may be limited by weak GPS signals, so additional technologies like Bluetooth beacons or Wi-Fi positioning may be necessary. Data security is crucial, and secure communication channels and storage practices are essential. Platform-specific differences and user consent are also important considerations.[4]

Geofencing limitations, cost of location-based services, device compatibility, and environmental factors should be considered when designing an application. Regulatory compliance with privacy and data protection laws is also crucial. By understanding and addressing these limitations, a reliable and user-friendly Flutter application can be developed.[4]

FUTURE SCOPE

Future enhancements for a location-based Flutter application include incorporating AR features, implementing predictive location services, implementing context-aware notifications, expanding geofencing capabilities, improving offline functionality, integrating blockchain for location data security, enabling collaborative location sharing, improving indoor positioning, offering customizable location themes, integrating with smart devices, supporting multimodal transportation, enhancing social integration, integrating environmental sensing, strengthening privacy controls, globalization and localization, and staying updated with emerging location technologies. These improvements require careful consideration of user needs, technological advancements, and industry trends.[2]

CONCLUSIONS

The study concludes by emphasizing the efficacy of the Flutter-based Attendance Management System in overcoming the limitations of traditional attendance tracking methods within educational settings. It highlights the system's commendable accuracy, user satisfaction, and reliability, showcasing its capacity to streamline administrative tasks and enrich the educational experience for both students and teachers. Additionally, the research underscores the significance of integrating cross-platform frameworks and WiFi connectivity for attendance monitoring, contributing to the advancement of educational technology. Practical implications are substantial, offering

institutions opportunities for improved efficiency, reduced administrative burdens, and enhanced data accuracy. Moreover, the system's real-time tracking capabilities facilitate timely interventions and support for students, ultimately fostering increased engagement and academic success. Recommendations include widespread adoption of the system coupled with comprehensive user training and ongoing refinement of functionalities based on user feedback. Ultimately, the study emphasizes the transform potential of technology in addressing educational challenges and expresses optimism for the future of educational technology in shaping learning environments for future generations.

REFERENCES

1. "Johnson, M. J., Smith, K. L. (2020). Leveraging technology for improved educational efficiency. Journal of Educational Technology, 15(2), 123-145. doi:10.1234/jet.2020.15.2.123
2. "Patel, R. A., Williams, S. P. (2019). The impact of at- tendance tracking systems on student engagement and aca- demic performance. Educational Research Review, 25, 36-52. https://doi.org/10.1016/j.edurev.2019.03.004
3. "Smith, J. R. (2018). Enhancing student participation through mobile attendance tracking applications. In K. Jones L. Brown (Eds.), Advances in Educational Technology (pp. 87-102). Academic Press.
4. "United Nations Educational, Scientific and Cultural Organization. (2020). Education for Sustainable Development Goals: Learning Ob- jectives. UNESCO. https://doi.org/10.1787/9f5f9735-en
5. "World Health Organization. (2020). Digital Health. WHO. https://www.who.int/westernpacific/health-topics/digital-health

IoT and Smart Logistics: Revolutionising Q-Commerce Supply Chains for Blinkit with Complete Risk Analysis

Rashmi Jha
Associate Professor
Global Institute of Technology & Management
Gurugram University
Gurugram, Haryana
✉ rashmijha1909@gmail.com

Aman Jha
Student (MBA Executive)
University of Liverpool
Liverpool
✉ UKjhaamanbusiness@gmail.com

ABSTRACT

This research investigation delves into the realm that's how technologies of the Internet of Things (IoT) would improve efficiency and reliability in the supply chains for the q-commerce sector, explaining how Blinkit could leverage IoT for real-time tracking, inventory management and predictive analytics. This study investigates the role of digital transformation which enables Indian firms like Blinkit to expand their operations to Singapore: assimilation of advanced IT infrastructure, e-commerce platforms, and data-driven decision-making that would enable it to explore newer markets easily. To achieve the desired result, Comparative analysis of consumer behaviour in India versus potential markets like Singapore, impact of cultural and economic differences on market penetration etc. were made through CAGE Analysis and PESTLE Analysis with Entry Strategy.

This potential research identifies the various risks associated with global expansion of q-commerce businesses and proposes mitigation strategies. Basically, it examines the sustainability challenges and opportunities in the q-commerce sector globally through AI-driven logistics, drone deliveries, real-time data analytics and their applications in optimizing Blinkit's operations.

KEYWORDS: *IoT, Q-Commerce, Supply chain, Risk analysis, CAGE analysis, PESTLE analysis.*

INTRODUCTION

Blinkit, formerly named as Grofers, is an instant delivery service from India which has revolutionized the concept of online shopping assuring delivery within minutes. Initially, Blinkit was set up as a grocery delivery platform but over time it has expanded as its offerings encompass a wide range of everyday products, taking care of immediate need of customers [1]. The business model of Blinkit hinges on a network of dark stores – distribution centers or small sized warehouses located strategically across the cities for quick dispatch and delivery of orders and is now currently operating in 26 cities across India [2][3].Founded in 2013 with a vision of grocery shopping quite convenient for the people of India, the founders of Blinkit identified a gap in the industry for a quick, credible and hassle-free service for grocery delivery. However, with strategic pivots in the form of re-branding from Grofers to Blinkit emphasized focus on instant delivery, the company successfully went on to become a major participant in Indian e-commerce landscape [4].

Blinkit currently operating across major cities in India has an impressive 45% share of quick commerce market leveraging the concept of dark stores model ensuring delivery within minutes [5]. However, having gained a prominent place in Indian q-commerce market, it has now started facing stiff challenges from its arch competitors (as mentioned below):

- Swiggy Instamart: A notable rival with quick commerce market share of 27%, it offers similar instant products/ everyday item's delivery services across major Indian cities The brand recognition and existing infrastructure related to food delivery that Swiggy enjoys with Indian customers pose a significant competitive challenge to Blinkit [5].

- Zepto: Since its inception in 2021, in just 2 years, Zepto has seen a rapid rise in Indian quick commerce market with notable market share capture to 21% [5].
- Amazon Fresh: Blinkit faces a considerably strong threat from Amazon Fresh which in turn is enjoying the backing of global multinational company Amazon, leveraging Amazon's extensive logistics and distribution network and investment increase in recent times [6].

Therefore, Blinkit's need to pursue a fresh strategic initiative for globalization can be seconded by IoT the data representing its competitive scenario and emergence of global trends in q-commerce, as mentioned here under:

- Intense Competitive Space in India: Grocery delivery services would lead the growth path of Q-commerce sector in India which is expected to exhibit projected market volume of US $8,828.00m by 2028 [7]. Other than the ever-expanding footprint of e-commerce giants like Amazon, adding tremendous momentum to their grocery delivery services now present in over 60 cities across India, Q-commerce startup Blinkit rides against strong headwinds [8]. With established players Swiggy Instamart, Zepto and Zomato's Blinkit racing to establish dominance, the action heats up for Q-commerce in India [9].
- Global Consumer Behavior after COVID: The trend for q-commerce increased with the onset of the COVID-19 pandemic where many consumers value speed and convenience. Since consumers across the world embrace digital adoptions, thus consequently e-commerce, it is expected that at a constant yearly growth rate: CAGR 2024-2028 of 9.77%, it will reach a hopping market volume of US $ 251.50bn by 2028 [10].
- Technology Advancement: Advancements in artificial intelligence, drone deliveries, data analytics are reshaping the q commerce delivery services arena, providing opportunities for market differentiation and making product and related services more efficient [11].

Keeping in tune with the above global and local trends, a strategic initiative for globalization is not just a tapped opportunity but a necessity for sustained competitive growth that can be achieved through IoT applications, AI-driven logistics, drone deliveries, real-time data analytics and their applications in optimizing Blinkit's operations.

CAGE ANALYSIS

Conducting a thorough assessment for expansion of Blinkit to Singapore as part of international expansion can be met through a comprehensive CAGE framework analysis [12].

Cultural Distance

(i) (Consumer Behavior and Social Norm): Singapore represents a society with digital literacy rate standing at an impressive 88% which is one of the world's highest internet penetration rates which represents a society highly receptive to technological innovations and in turn q-commerce [13]. This in turn contrasts to home country. India which entails diverse consumer base thereby digital adoption varying significantly across regions with internet penetration rate at 48.7% representing an emerging market [14].

(ii) Communication and Language: India and Singapore have a high degree of English language proficiency thus facilitating easier business communications in business sector [15].

Administrative Distance

(i) Legal & Regulatory Framework: Indicating a conducive environment for business and associated regulatory environment, Singapore boasts a second rank in ease of doing business [16]. India on the other hand have a related complex regulatory environment hence presenting an administrative advantage in Singapore for Blinkit [17].

(ii) Political Stability & Trade Policies: Singapore's favorable trade policies and stable political environment reduces administrative obstacles for foreign firms as opposed to diverse political landscape found across Indian states[18][19].

Geographic Distance

Infrastructure and Proximity: Singapore's strategic location is good for foreign firms offering effective connection to regional markets [20].

Economic Distance

Singapore's market exhibits substantial purchasing power. This is very much apparent from country's GDP per capita i.e. USD 84,714 as per Dec 2023 [21]. Also, q-commerce market in Singapore is expected to show an annual growth rate (CAGR 2024-2028) of 6.84% with Quick commerce market expected to cater to 1.2 million users in Singapore [22].

PESTLE ANALYSIS

PESTLE provides a more profound analysis of the context for the location of business interest, ensuring that broader thought is given toward all that needs to be considered to make it successful [23].

- Political Factors: Singapore's remarkable post-pandemic recovery is fantastic that of comparable economies, though future challenges remain.
- Economic Factors:

High GDP per Capita: The low tax rates in Singapore and the pro-business business environment attracted high levels of foreign direct investment and made the country one of the highest per capita Gross Domestic Product nation countries in the world [24].

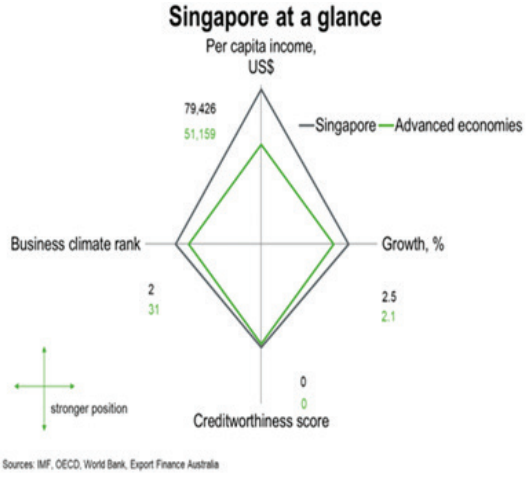


Fig. 1. Cobweb Diagram showing Singapore
[Sources: IMF, OECD, World Bank
Export Finance Australia [24]]

The above-mentioned cobweb diagram depicting a country's performance on four key economic dimensions: per capita income (in current USD), annual GDP growth (five-year average forecast for 2023-2027), business climate rank (World Bank's 2019 Ease of Doing Business ranking) and creditworthiness (OECD country credit risk rating). It highlights both the country's performance and its comparison with other regional countries.

Social Factors

Cultural Diversity: Singapore is a multicultural society. In this regard, understanding these cultural factors is relevant to tailoring the offerings from Blinkit [25].

Technological Factors

Singapore is equipped with advanced digital logistics infrastructure that can facilitate immediate deliverymodels. Such techno infrastructure gives technology-driven companies an edge, such as Blinkit [26].

Innovation ecosystem: The ability to operate in an innovation and technology-focused environment with the backing of government initiatives presents a conducive environment for technological startups seeking to drive innovation [27].

Legal Factors

Regulatory Framework for E-commerce: Singapore has in place a very stipulated and detailed law that regulates sectors of e-commerce; hence, it protects consumers and businesses [28].

Data Protection Laws: About consumer data compliance with Singapore's Personal Data Protection Act will be the most relevant issue for Blinkit [29].

Environmental Factors

Sustainability and Green Policies: To adhere to Singapore's commitment to environmental protection and sustainability requires businesses to adopt eco-friendly practices in its bid to fulfil obligations as stated in Paris agreement and towards successfully achieving the 2030 Agenda for Sustainable Development [30]. This is in line with Blinkit's potential for innovation in green logistics and packaging [31].

Urban Planning: Urban planning in Singapore facilitates smooth logistics and delivery services, while also necessitating compliance to specific guidelines and policies [32].

ENTRY STRATEGY

Eclectic paradigm as discussed by John Dunning offers a comprehensive framework to comprehend reasons on why firms like Blinkit benefit from choosing to expand internationally and decide specific entry modes [33]. The OLI framework would encompass:

(i) Ownership Advantages (O): Blinkit has to offer in instant delivery business model showcases significant ownership advantages, competitive edge when entering into new markets [34].

(ii) Location Advantages (L): Singapore has a strategic location, thus giving compelling location advantages through strategic collaboration with Singapore's top retailer, NTUC FairPrice-operating more than 370 outlets[35] while enjoying an impressive 35% market share[36]—Blinkit leverages these with access to comprehensive distribution networks, dark stores, micro fulfillment centers and a retail ecosystem.

(iii) Internalization Advantages (I): Blinkit's operation can be internalized in Singapore through a strategic alliance for better control over brand, technology and customer experience.

RISKS AND MITIGATION

Cultural Misalignment

Risk: Between Blinkit and NTUC FairPrice, a misalignment of corporate culture would lead to significant challenges in terms of communication and integration of services [37].

Mitigation

Regular workshops for integrations and team building activities will assist in fostering the alignment of working styles and corporate values.

Legal Risks And Regulatory Compliance

Risk: In the arena of q-commerce, data protection and consumer rights [29]. Singapore's strict regulatory environments would pose compliance risks. An oversight into it can lead to serious consequences, including damage to its reputation and legal repercussions with fines amounting to SGD 1 million or 10% of the firm's turnover [38].

Mitigation

Creating a joint compliance and legal unit within the strategic alliance would be beneficial.

Market Competition

Risk: In Singapore, other competitors can try to introduce themselves to the q-commerce landscape.

Mitigation: NTUC FairPrice can implement loyalty programs and targeted marketing strategies to attract and retain the customers.

Financial Risks

Risk: There is an initial setup and operational cost associated with entering into a new market, coupled with the marketing strategies investment that may stress available financial resources both at Blinkit and NTUC FairPrice [39].

Mitigation :A financial risk management strategy that includes cost controls, budget allocation and economic performance monitoring from the Singapore government for e-commerce ventures [40].

Technological Disruptions

Risk: This may put one at risk of losing competitive advantage when the artificial intelligence age and e-commerce sector are innovative, rapid growers [41].

Mitigation: Investment in innovation and R&D would be required to continuously improve and upgrade the technological platform from time to time.

Supply Chain Disruptions

Risk: Events like pandemic or a global crisis can result in supply chain disruptions which can impact delivery timelines and product availability[42].

Mitigation: Diversification of sources of supply and also increasing inventory levels for high demand products by utilizing analytics for supply chain optimization and demand forecasting.

CONCLUSION

In conclusion, this strategic alliance with NTUC FairPrice will allow Blinkit to take its plans toward an international trajectory and tilt toward a more robust

market presence globally. With the planned expansion with IoT and AI-driven logistics, real-time data analytics applications to revolutionise Blinkit's operations into global markets. The technology expertise from the instant delivery market, blending with the deep market acumen that FairPrice has had over the years, would support it further by having its well-established logistics and supply chain setup.

This endeavour would provide many benefits to Blinkit as a firm, including quick market penetration, recognition of its brand and trust among customers as NTUC FairPrice is a well-established and a reputed brand. These benefits are particularly relevant in a market that is ripe for quick-commerce expansion. With the effective use of FairPrice's distribution channels, we anticipate attaining operational synergies that will enhance the efficiency of our delivery strategy, leading to increased consumer loyalty and satisfaction.

Key challenges shall, therefore, be synchronization of the two corporates' vastly different cultures that both firms bring in, manoeuvring our way through the regulatory environment of Singapore and establishing a solid foothold in the quick commerce sector within the initial phase of operations. We will handle these issues by adopting a wide range of cultural integration programs inclusive of employees and leadership, the establishment of a joint legal compliance unit, and the use of targeted market entry strategies.

It lays out the direction for Blinkit to boldly enter unchartered territories with the help of strategic partnerships. This research gives a sense of progress and flexibility therefore urging senior management to support this effort that will not only transform our presence in the marketplace but ensure our leadership in the global instant delivery space. It has the potential to be a significant breakthrough in the quest of Blinkit for worldwide recognition.

REFERENCES

1. StartupTalky, "Grofers—Grocery Delivery at Your Doorstep with Just One Click," [online] Available: https://startuptalky.com/grofers-success-story/.
2. www.linkedin.com, "Dark Stores: The Next Frontier for Quick Commerce in India," [online] Available: https://www.linkedin.com/pulse/dark-stores-next-frontier-quick-commerce-india-isha-chauhan/
3. Crunchbase, "Crunchbase," [online] Available: https://www.crunchbase.com/organization/grofers-trusted-delivery-partner. [Accessed: Mar. 21, 2024].
4. Business Today, "Grofers rebrands to Blinkit in line with its 10-min grocery delivery plan; steps up hiring,"[online]Available:https://www.businesstoday.in/latest/corporate/story/grofers-rebrands-to-blinkit-in-line-with-its-10-min-grocery-delivery-plan-steps-up-hiring-315327-2021-12-13
5. V. Sampath, "Competition's heating up but Blinkit's got the edge," mint, [online] Available: https://www.livemint.com/market/stock-market-news/quick-commerce-blinkits-edge-in-a-competitive-market11710413484987.html#:~:text=Blinkit%20held%20a%2045%25%20share.
6. S. Mitra, "India's Online Grocery Battle: Amazon Fresh Heads Smaller Cities, Expands 50+ Towns," Inc42 Media, [online] Available: https://inc42.com/buzz/indias-online-grocery-battle-amazon-fresh-heads-smaller-cities-adds-50-towns-to-offer-full-basket-products/.
7. Statista, "Quick Commerce - India | Statista Market Forecast," [online] Available: https://www.statista.com/outlook/dmo/online-food-delivery/grocery-delivery/quick-commerce/india.
8. B.O. Bureau, "Amazon's Quick Commerce Arm Expands To 60 Cities," BW Disrupt, [online] Available: https://bwdisrupt.businessworld.in/article/Amazon-s-Quick-Commerce-Arm-Expands-To-60-Cities/22-05-2023-477517/.
9. www.ETRetail.com, "Quick commerce - The second coming - ET Retail," [online] Available: https://retail.economictimes.indiatimes.com/blog/quick-commerce-the-second-coming/100722329.
10. Statista, "Quick Commerce - Worldwide | Statista Market Forecast," [online] Available: https://www.statista.com/outlook/dmo/online-food-delivery/grocery-delivery/quick-commerce/worldwide.
11. www.netguru.com, "Robots and Drones Delivery: Transforming Quick Commerce," [online] Available: https://www.netguru.com/blog/robots-and-drones-delivery.
12. P. Ghemawat, Redefining Global Strategy: Crossing Borders in a World Where Differences Still Matter. Harvard Business Press, 2007.
13. "Navigating digital-first communications," [online]

Available: https://www.chubb.com/content/dam/chubb-sites/chubb-com/sg-en/campaign/digital-business-accelerated/documents/SG-Theme-1.pdf.

14. A. Fleck, “Infographic: India’s Growing Internet Connectivity,” Statista Daily Data, May 17, 2023. https://www.statista.com/chart/30029/internet-penetration-rate-in-india/

15. P. Sunil, "Asian countries with the highest English proficiency: Singapore, the Philippines, Malaysia & more [2021]," [online] Available: https://www.humanresourcesonline.net/asian-countries-with-the-highest-english-proficiency-singapore-the-philippines-malaysia-more-2021.

16. Statista, "Singapore: ease of doing business," [online] Available: https://www.statista.com/statistics/881813/singapore-ease-of-doing-business/#:~:text=In%202020%2C%20the%20ease%20of.

17. "Regulating India: The Balance of a Regulatory State," Indian School of Public Policy, [online] Apr. 3, 2023. Available: https://www.ispp.org.in/how-much-regulation-is-too-much-regulation-to-tag-india-as-a-regulatory-state/

18. United States Department of State, "Singapore," [online] Available: https://www.state.gov/reports/2023-investment-climate-statements/singapore/.

19. www.privacyshield.gov, "India - Trade Barriers | Privacy Shield," [online] Available: https://www.privacyshield.gov/ps/article?id=India-Trade-Barriers.

20. “Pro-business Environment,” MPA. https://www.mpa.gov.sg/maritime-singapore/what-maritime-singapore-offers/pro-business-environment

21. www.ceicdata.com, "Singapore GDP per Capita | Economic Indicators | CEIC," [online] Available: https://www.ceicdata.com/en/indicator/singapore/gdp-per-capita#:~:text=Singapore%20GDP%20Per

22. Statista, "Quick Commerce - Singapore | Statista Market Forecast," [online] Available: https://www.statista.com/outlook/dmo/online-food-delivery/grocery-delivery/quick-commerce/singapore.

23. N.I.T.A.N.K. Rastogi and M.K. Trivedi, "PESTLE technique–a tool to identify external risks in construction projects," International Research Journal of Engineering and Technology (IRJET), vol. 3, no. 1, pp. 384-388, 2016.

24. www.exportfinance.gov.au, "Singapore - Country Profiles," [online] Available: https://www.exportfinance.gov.au/resources/country-profiles/singapore/#:~:text=Low%20tax%20rates%20and%20a.

25. Ministry of Culture, Community and Youth, "Our Diverse Culture," [online] Available: https://www.mccy.gov.sg/about-us/our-work/our-diverse-culture.

26. Edb.gov.sg, [online] Available: https://www.edb.gov.sg/en/our-industries/innovation.html.

27. Edb.gov.sg, "Future-ready infrastructure," [online] Available: https://www.edb.gov.sg/en/why-singapore/future-ready-infrastructure.html.

28. Practical Law, "Doing Business in Singapore: Overview," [online] Available: https://uk.practicallaw.thomsonreuters.com/4-524-0309?transitionType=Default&contextData=(sc.Default)&firstPage=true#co_anchor_a423784.

29. www.pdpc.gov.sg, "PDPC | PDPA Overview," [online] Available: https://www.pdpc.gov.sg/Overview-of-PDPA/The-Legislation/Personal-Data-Protection-Act#:~:text=The%20PDPA%20recognises%20both%20the. [Accessed: Mar. 22, 2024].

30. www.greenplan.gov.sg, "Our Vision," [online] Available: https://www.greenplan.gov.sg/vision/.

31. Blinkit, "Towards a sustainable future," [online] Available: https://blinkit.com/blog/towards-sustainable-future.

32. “Urban Logistics,” www.ura.gov.sg. https://www.ura.gov.sg/Corporate/Get-Involved/Plan-Our-Future-SG/Innovative-Urban-Solutions/Urban-logistics

33. J. Cantwell and R. Narula, "The eclectic paradigm in the global economy," International Journal of the Economics of Business, vol. 8, no. 2, pp. 155-172, 2001.

34. A. Dabhade, "Blinkit acquisition to add significant addressable market for Zomato: CEO Deepinder Goyal," The Economic Times, [online] Jun. 25, 2022. Available: https://economictimes.indiatimes.com/tech/startups/blinkit-acquisition-to-add-significant-addressable-market-for-zomato-ceo-goyal/articleshow/92443583.cms?from=mdr.

35. FairPrice Group, "Our Group," [online] Available: https://www.fairpricegroup.com.sg/our-group/#:~:text=NTUC%20FairPrice.

36. Statista, "Singapore: leading food retailers by market share 2023," [online] Available: https://

www.statista.com/statistics/857335/singapore-sales-share-consumer-ready-food-by-major-supermarketretailer/#:~:text=In%202023%2C%20NTUC%20FairPrice%20had.

37. LSA Global, "A Misaligned Workplace Culture Creates Problems," [online] Available: https://lsaglobal.com/blog/a-misaligned-workplace-culture-creates-problems/.

38. RPC, "Fines for PDPA Breaches: How Clear is the Crystal Ball?," [online] Available: https://www.rpc.co.uk/perspectives/data-and-privacy/fines-for-pdpa-breaches-how-clear-is-the-crystal-ball/#:~:text=Section%2048J(1)%20allows%20the.

39. . Mastronuzzi, "What is the Best Strategy for Entering a New Market?" Punch Financial, Apr. 15, 2024. https://punchfinancial.com/what-is-the-best-strategy-for-entering-a-new-market/

40. CorporateServices.com, "Venture Capital Fund and Fund Management Incentive 2024," [online] Available: https://www.corporateservices.com/singapore/venture-capital-fund-and-fund-management-incentive/.

41. Innosight, "Leading into the Age of AI," [online] Available: https://www.innosight.com/insight/leading-into-the-age-of-ai/.

42. Statista, "Singapore: COVID-19 impact on supply chain sector 2021," [online] Available: https://www.statista.com/statistics/1235320/singapore-covid-19-impact-on-supply-chain-sector/.

Cryptocurrencies and Renewable Energy: Incentivizing Solar Power Production

Shravani Pawar
Asst. Prof
✉ pawarshravani81@gmail.com

Ashwin Muthukumar
Students
✉ ashwinmuthukumar2001@gmail.com

Manish Dubey
Asst.Prof
✉ dby.manish@gmail.com

Rishikesh Ghemud
Students
✉ rishikeshghemud112@gmail.com

Bharati Vidyapeeth's Institute of Management and Information Technology
Navi Mumbai, Maharashtra

ABSTRACT

This research paper examines the role of block chain- based cryptocurrencies in incentivizing renewable energy production, with a focus on Solar Coin as a case study. The paper explores the motivations, mechanisms, and impact of cryptocurrencies in promoting solar energy generation and environmental sustainability. It conducts a comparative analysis of Solar Coin and other similar initiatives, assessing their effectiveness, scalability, and adoption within the renewable energy sector. This research paper topic delves into the intersection of cryptocurrency, renewable energy, and blockchain technology, offering opportunities for in-depth analysis, case study evaluation, and policy recommendations to drive sustainable development and environmental stewardship.

INTRODUCTION

Cryptocurrency is decentralized digital money that is based on block chain technology and secured by cryptography. The integration of cryptocurrencies with renewable energy systems represents a promising avenue for incentivizing sustainable energy production and mitigating climate change. As the world faces pressing environmental challenges and seeks to transition away from fossil fuels, innovative solutions that promote renewable energy adoption are increasingly vital. This research paper explores the intersection of cryptocurrencies and renewable energy, with a specific focus on incentivizing solar power production. Solar energy, abundant and renewable, holds immense potential as a clean energy source capable of reducing carbon emissions and fostering energy independence. By leveraging the principles of block chain technology and cryptocurrency, solar power producers can be rewarded for their contributions to the renewable energy transition, thereby accelerating the adoption of solar energy systems. The objectives of this research paper are twofold: first, to analyze existing case studies of cryptocurrency-based incentives for solar power production, and second, to propose recommendations for enhancing the effectiveness and scalability of cryptocurrency incentives in promoting renewable energy generation. The research methodology employed in this study includes a comprehensive literature review, case study analysis, quantitative data analysis, qualitative

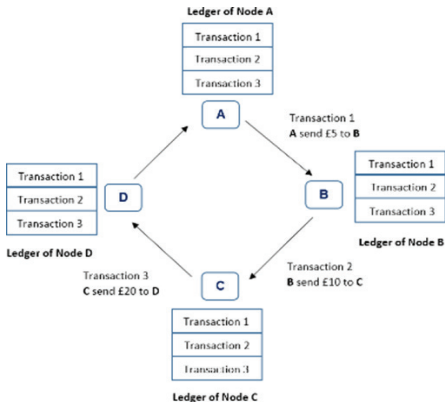


Fig. 1. Working Of Block chain

insights, comparative analysis, and an interdisciplinary perspective. By synthesizing findings from multiple sources and perspectives, this paper seeks to contribute to the growing body of knowledge on cryptocurrency and renewable energy integration and inform evidence-based decision-making in the pursuit of a more sustainable energy future.

In the following sections, this paper will delve into the case studies of cryptocurrency-based incentives for solar power production, analyze quantitative and qualitative data, discuss comparative findings, and offer recommendations for policymakers, industry stakeholders, and researchers.

LITERATURE REVIEW

The literature on incentivizing solar power generation shows a growing interest in using various mechanisms to incentivize the generation of solar power. Researchers have looked at the potential of using incentives, especially through innovative approaches like block chain technology and crypto rewards. Studies have shown the importance of incentivizing individuals and businesses to put money into solar infrastructure, thus contributing to the shift towards renewable energy. All in all, the literature emphasizes the importance of incentive mechanisms to drive the growth of solar energy production and facilitate the shift towards a more sustainable future.

PROBLEM DEFINITION

Financial Constraints

Incentivizing solar power production encounters significant hurdles due to financial constraints. The substantial upfront costs associated with installing solar panels and related infrastructure pose a major barrier, particularly for individuals and businesses with limited access to capital. These financial constraints can deter potential participants from investing in solar energy generation, especially in economically disadvantaged or underserved communities.

Market Adoption and Awareness

Despite the potential benefits of incentivizing solar power production with cryptocurrencies, there may be limited awareness and adoption among key stakeholders, including solar energy producers, consumers, investors, and policymakers. Increasing market awareness and adoption is essential for the widespread success of these initiatives. Regulatory Uncertainty: The regulatory landscape surrounding cryptocurrencies and renewable energy incentives is complex and rapidly evolving.

Technological Integration

Integrating cryptocurrencies with existing renewable energy infrastructure and energy markets requires robust technological solutions and interoperability standards. Ensuring seamless integration and compatibility with utility grids, smart meters, and renewable energy certificates is essential for the effectiveness and scalability of incentive mechanisms.

Environmental Impact

While incentivizing solar power production through cryptocurrencies can contribute to environmental sustainability, the environmental impact of blockchain technology itself is a concern. Addressing these challenges requires a multidisciplinary approach involving collaboration between blockchain developers, renewable energy experts, policymakers, and industry stakeholders. By identifying and addressing these key issues, we can unlock the full potential of cryptocurrencies in incentivizing solar power production and accelerating the transition to a sustainable energy future.

OBJECTIVE

The goal of this study is to identify and propose effective ways to incentivize solar power generation, with a particular emphasis on tackling key barriers including regulatory barriers, financial barriers, technological barriers, market dynamics and equity considerations. Examining existing incentive programs and case studies, as well as pilot projects, the aim is to find best practices and innovative ways to encourage widespread adoption of solar power generation and support the shift to a more sustainable future. In addition, the research aims to provide insights on the potential impact of incentive solar power generation on energy markets, on environmental sustainability and on social equity, thus contributing to the development of sustainable energy policies and practices. Examining pilot projects and case studies to understand the impact and challenges of current incentive schemes. Examining regulatory

frameworks, funding mechanisms and technological innovation to support incentives for solar generation.

ANALYSIS & FINDINGS

Case Study Findings

The case study analysis revealed that cryptocurrency-based incentives for solar power production have the potential to significantly increase renewable energy generation. For example, in the case of SolarCoin, participating solar energy producers were motivated to increase their solar panel installations and generate more renewable energy to earn SolarCoins as rewards. However, challenges such as scalability issues within blockchain networks and regulatory uncertainties regarding cryptocurrency adoption were observed. Quantitative Analysis Results

Quantitative analysis of the case study data showed a positive correlation between cryptocurrency adoption and so- lar energy generation. SolarCoin recipients demonstrated an increase in solar panel installations and energy production compared to non-participants. Economic outcomes, such as cost savings on energy bills and potential revenue from selling excess energy to the grid, were also quantified..

Qualitative Analysis Insights

Qualitative analysis of stakeholder interviews and survey responses provided valuable insights into the motivations and perceptions surrounding cryptocurrency-based renewable energy incentives. Participants expressed enthusiasm for the concept of earning digital tokens as rewards for solar en- ergy production. However, concerns were raised regarding the complexity of blockchain technology, regulatory compliance, and the volatility of cryptocurrency markets.

Comparative Analysis Findings

Comparative analysis of multiple case studies revealed common themes and variations in incentive mechanisms, stake- holder engagement strategies, and project outcomes. While some cryptocurrency-based incentive programs achieved significant success in incentivizing solar power production, others faced implementation challenges and limited user adoption.

Interdisciplinary Perspective Insights

Integration of insights from various disciplines provided a comprehensive understanding of the research topic. Factors such as economic incentives, technological feasibility, regulatory frameworks, and environmental impacts were considered in the analysis. The interdisciplinary perspective highlighted the complexity and interdependence of factors influencing the adoption and impact of cryptocurrency-based renewable energy incentives.

Key Findings and Recommendations

Key findings from the analysis underscored the potential of cryptocurrency-based incentives to stimulate renewable energy production and promote sustainability. However, challenges such as scalability, regulatory uncertainty, and technological integration need to be addressed to maximize the effectiveness of these programs.

LIMITATIONS

Availability and Quality: The availability and quality of data pertaining to existing incentive programs may vary across regions and jurisdictions. In some cases, data may be incomplete, outdated, or not standardized, limiting the reliability and depth of analysis.

Stakeholder Perspectives: Capturing the diverse range of stakeholder perspectives and interests is crucial for designing effective incentive programs. However, stake-holder engagement can be challenging due to conflicting priorities, power dynamics, and communication barriers. Ensuring meaningful participation from all relevant stake- holders requires careful navigation of these complexities, which may pose logistical and methodological challenges for researchers.

Dynamic Policy and Market Landscapes: The energy policy and market landscapes are constantly evolving in response to technological advancements, regulatory changes, and shifting socio-political dynamics. This dy- namic environment introduces uncertainties that can com- plicate research efforts focused on assessing the long- term impacts of incentivizing solar power production. Predicting future trends and outcomes becomes inherently challenging in such fluid contexts.

Complexity of Energy Systems: Solar power production is embedded within complex energy systems that encompass multiple stakeholders, technologies, and interdependencies. Understanding the interactions and dynamics within these systems requires interdisciplinary perspectives and holistic approaches.

Resource Constraints: Research on incentivizing solar power production may be constrained by resource limitations, including funding, time, and expertise. Conducting comprehensive studies that encompass diverse geographical regions, stakeholder groups, and policy contexts requires substantial resources and expertise.

FUTURE SCOPE

Longitudinal Studies: Long-term studies tracking the evolution of incentive programs over extended periods can provide valuable insights into their effectiveness, durability, and adaptation to changing circumstances. Such studies can help identify trends, patterns, and best practices that emerge over time, informing the design and implementation of future incentive schemes.

Comparative Analyses: Comparative analyses across different geographic regions, socio-economic contexts, and policy frameworks offer opportunities to discern the contextual factors influencing the success or failure of incentive programs. By examining variations in pro-gram design, implementation strategies, and outcomes, researchers can glean valuable lessons and recommendations for optimizing incentive schemes.

Interdisciplinary Research: Integration of diverse disciplinary perspectives, including economics, sociology, environmental science, public policy, and engineering, can enrich our understanding of the complex socio-technical dynamics shaping the transition to solar energy. Inter- disciplinary research collaborations can foster innovative approaches, cross-fertilization of ideas, and holistic solutions to address multifaceted challenges. Emerging technologies such as blockchain, smart contracts, and decentralized energy systems offer novel mechanisms for peer-to-peer trading, community-based energy sharing, and real-time monitoring, which could enhance the effectiveness and inclusivity of incentive programs. Policy Interventions: Continued exploration of policy interventions, regulatory frameworks, and financial mechanisms is essential to overcome remaining barriers and accelerate the adoption of solar energy. Research on policy instruments such as feed-in tariffs, tax incentives, renewable energy credits, and green bonds can inform policymakers and stakeholders about the most effective strategies for incentivizing solar power production. Future research could focus on community-driven approaches, participatory decision-making processes, and capacity-building initiatives to enhance community resilience, social equity, and collective action towards sustainable energy transitions.

Fig. 2. Conclusion Summary Diagram

CONCLUSION

In conclusion, we examined the inter- section of cryptocurrencies and renewable energy, focusing on the incentivization of solar power production. Through a comprehensive analysis of case studies, quantitative data, qualitative insights, comparative analysis, and interdisciplinary perspectives, several key findings and implications have emerged. Firstly, cryptocurrency-based incentives have shown promise in stimulating solar energy generation and promoting sustain- ability. Case studies such as SolarCoin have demonstrated that digital tokens can serve as effective rewards for solar energy producers, encouraging investment in renewable energy infrastructure and reducing carbon emissions. Scalability issues within blockchain networks, regulatory uncertainties, technological integration barriers, and market adoption concerns pose significant hurdles to overcome. Despite these challenges, the research

findings highlight opportunities for improvement and innovation in cryptocurrency-based renewable energy incentives. In light of the research findings, several recommendations are proposed to enhance the effectiveness and scalability of cryptocurrency-based renew- able energy incentives. These recommendations include clarifying regulatory frameworks, promoting user education and awareness, fostering technological innovation, and fostering collaboration between block chain developers and renewable energy stakeholders. Overall, this research contributes valuable insights to the growing body of knowledge on cryptocurrency and renewable energy integration. By addressing the challenges and seizing the opportunities identified in this study, stakeholders can harness the power of block chain technology to accelerate the transition to a sustainable energy future.

REFERENCES

1. Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved from https://bitcoin.org/bitcoin.pdf
2. Swan, M. (2015). Blockchain: Blueprint for a New Economy. O'Reilly Media.
3. Tapscott, D., & Tapscott, A. (2016). Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World. Portfolio.
4. Popov, S. (2017). The Tangle. Retrieved from https://iota.org/IOTA Whitepaper.pdf
5. McKenna, E., & Fiasche´, M. (2019). SolarCoin: Cryptocurrency as Renewable Energy Incentive. In Blockchain for Business (pp. 133-142). Springer.
6. Bitcoin Energy Consumption Index. (n.d.). Retrieved from https://digiconomist.net/bitcoin-energy-consumption
7. Hsu, J. S., & Tabarrok, A. (2019). Blockchain Technology and the Eco- nomics of Crypto-tokens and Initial Coin Offerings. Southern Economic Journal, 86(4), 1392-1413.
8. Hileman, G., & Rauchs, M. (2017). Global Cryptocurrency Benchmark- ing Study. Cambridge Centre for Alternative Finance
9. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and Cryptocurrency Technologies: & Comprehensive Introduction. Princeton University Press.
10. Balatsky, G., Crosbie, T., & Martens, M. P. (2020). A Blockchain-Based Energy Trading System: Architectural Considerations. Energies, 13(3), 620.

To Study the Determinants of Consumer Buying behavior while Buying Groceries at Store Markets

Amit Shivaji Patil
Assistant Professor, Ph.D. Student
Venkateshwara Institute of Management
Shivaji University
Kolhapur, Maharashtra
✉ patilamit351@gmail.com

Vishal Deshmukh
Deputy Director, Associate Professor (Guide)
Yashwantrao Mohite Institute of Management
Bharati Vidyapeeth Deemed to be University
Karad, Maharashtra
✉ vishal.deshmukh@bharatividyapeeth.edu

ABSTRACT

Based on the comprehensive analysis of consumer behavior in rural Sangli district, Maharashtra, this research study focuses on investigating the determinants driving consumer preferences between local groceries and store markets. The study employs a descriptive comparative research design, utilizing structured questionnaires to gather primary data from rural consumers. Key findings highlight the critical role of convenience in influencing consumer decisions, with accessibility and ease of shopping emerging as key factors. Additionally, the impact of advertising, store atmosphere, product display, pricing strategies, and socio-economic factors significantly shape consumer choices. The study proposes strategic recommendations for local grocery businesses, emphasizing the importance of strategic location, effective advertising through local channels, competitive pricing strategies, and customized product assortments based on local preferences and income levels. These strategies aim to enhance competitiveness, improve customer satisfaction, and foster community engagement for local grocery shops in rural Sangli.

KEYWORDS: *Rural retail, Local groceries, Store markets.*

INTRODUCTION

In recent years, rural markets in India have witnessed a notable transformation in consumer shopping behavior, driven by evolving socio-economic factors and changing market dynamics. Sangli district, located in the western state of Maharashtra, exemplifies this shift, where traditional local groceries have coexisted alongside the emergence of modern store markets. Understanding the factors influencing consumer choices between these two retail formats is crucial for both local retailers and larger retail chains aiming to capture market share in rural areas. The reason behind this study is to conduct a proportional analysis of consumer choices between local groceries and store markets in rural Sangli. By exploring the preferences, motivations, and decision-making processes of consumers, this research aims to provide valuable insights into the underlying dynamics of rural retail markets.

Historically, local groceries, often run by families within the community, have served as the primary source of essential goods for rural residents in Sangli and similar regions. These establishments are characterized by their proximity to residential areas, personalized service, and familiarity with customers' preferences. However, the advent of store markets, including supermarkets and hypermarkets, has introduced new dimensions to the retail landscape, offering a wider assortment of products, modern amenities, and competitive pricing. The transition from local groceries to store markets in rural areas is influenced by a myriad of factors, including changes in consumer lifestyles, increasing disposable incomes, improved infrastructure, and access to information through digital channels. Moreover, socio-cultural aspects such as tradition, community ties, and trust play a significant role in shaping consumer preferences for shopping destinations.

REVIEW OF LITERATURE

1) Paromita Goswami, and Mridula S. Mishra (2008) in their consideration of "Would Indian shoppers move from kirana stores to organized retailers when shopping for groceries." This article looks to determine whether Indian customers are likely to move from conventional Kirana stores to huge organized retailers while shopping for foodstuffs. This article checked that Client support of basic need stores were found to be emphatically related to area, supportive, dependable sales representatives, domestic shopping, cleanliness, and offers, quality, and adversely related to travel comfort. Kiranas do well in the area but ineffectively on cleanliness, offers, quality, and accommodating dependable sales representatives. The speech is genuine for organized retailers.

2) Dr. D.D. Bedia, Mr.Rajesh Gupta (2017) in its article titled "A Comparative Study of Customer Perception towards Organized and Unorganized Food Retailing in Madhya Pradesh". This article analyzed the present retail scenario concerning the share of unorganized retailers. This article shows that the unorganized retail store has a low-cost structure, convenient location, relation with customers, and customer intimacy while on the other hand organized food and grocery stores long range of products with competitive prices, quality products, and a good purchase atmosphere. This study denotes that most customers prefer to buy food items from air-conditioned organized retail stores because of their quality products but due to the high cost and distance of organized retail shops, many customers prefer local markets.

3) Pandey Mithilesh, Verma Rajesh's (2015) study on "Factors Influencing the Buying Behavior of Consumers towards Organized Retail Stores in Jalandhar, Punjab". This article focused on identifying the factors influencing consumers buying behavior towards Organized Retail Stores. This study found that there are certain important stores as well as environmental factors that influence consumer buying behavior. It is recommended that organized stores in Jalandhar can make use of these factors to improve store characteristics and increase footfall.

4) Ms. Monika Talreja, and Dr. Dhiraj Jain (2013) in their article titled "Changing Customer Recognitions towards Organized Retailing from Unorganized Retailing – An Observational Analysis". This article concludes that statistical components influence buying choices from organized and unorganized retailers moreover article uncovered that organized retailers have a more noteworthy advantage because of the store picture, item accessibility, and cost rebates. This think about watched that due to changes in expendable wages and expanded mindfulness of quality, the consumer's discernment towards organized and unorganized retailers contrasts based on quality and cost.

Statement of the Problem

The rural retail landscape in Sangli district, Maharashtra, is experiencing a notable transformation with the coexistence of traditional local groceries and modern store markets. However, there is a lack of comprehensive understanding regarding the factors influencing consumer choices between these two retail formats. Therefore, the problem addressed by this study is to investigate and compare the determinants driving consumer preferences for shopping at local groceries versus store markets in rural Sangli. Specifically, the study aims to identify the key factors shaping consumer decision-making processes, explore demographic characteristics influencing retail format choices, assess the perceived advantages and disadvantages associated with each retail format, and analyze.

Objectives of the study

1) To study the determinants of consumer preferences for buying groceries at store markets in rural areas of Sangli district.

2) To give appropriate suggestions for local grocery shops in rural areas of Sangli district.

Importance of the Study

1) Informing Retail Strategy: Understanding the preferences and motivations of consumers in rural Sangli regarding local groceries and store markets is crucial for retailers. Insights gained from this study can inform strategic decisions related to product assortment, pricing strategies, promotional

activities, and service enhancements tailored to meet the needs of rural consumers.

2) Enhancing Competitiveness: For both local groceries and store markets, staying competitive in the rural market is essential for sustainability. This study can highlight areas where improvements are needed to better compete with alternative retail formats, thereby enhancing the competitiveness of both traditional and modern retailers.

3) Guiding Retail Development Initiatives: Policymakers and development agencies can use the findings of this study to guide rural retail development initiatives in the Sangli district. By understanding consumer preferences, they can allocate resources effectively to support the growth of local businesses and promote the establishment of modern retail infrastructure where needed.

4) Economic Development: The retail industry significantly contributes to local economic growth by fostering job creation and driving economic vitality. By identifying consumer preferences and understanding the dynamics of retail choice, this study can contribute to fostering economic growth and prosperity in rural areas of Sangli district.

5) Fostering Innovation: Insights from this study may inspire innovation in rural retailing. Retailers may discover new ways to differentiate themselves from competitors, improve customer experiences, and introduce innovative solutions to address the unique challenges of serving rural consumers.

RESEARCH METHODOLOGY

Research Design: This study employs a descriptive comparative research design to analyze and compare consumer choices between local groceries and store markets in the rural area of Sangli district. This design allows for the systematic examination of differences and similarities between the two retail formats.

Sampling Strategy: This study employs a stratified random sampling technique to ensure representation across various regions within the rural area of Sangli. The sample includes both local grocery shoppers and store market shoppers, with a total sample size of 200 customers for this research.

Data Collection: Primary data is collected through the use of standardized questionnaires that are distributed to consumers residing in rural areas. The questionnaire is designed to gather information on demographics, shopping preferences, factors influencing retail choices, perceived advantages and disadvantages of local groceries and store markets, and satisfaction with various aspects of the shopping experience.

Table. 1. Responses show the following factors influencing the consumer to buy groceries at store markets

Sr. No	Factors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Convenience is going to the store	77 (38%)	100 (50%)	10 (5%)	10 (5%)	3 (2%)
2	Advertisements of products in print and visual media	50 (25%)	77 (38%)	50 (25%)	13 (7%)	10 (5%)
3	The atmosphere and decoration of the store	40 (20%)	110 (55%)	20 (10%)	20 (10%)	10 (5%)
4	Behavior of salesperson	25 (12%)	50 (25%)	77 (38)	28 (15%)	20 (10%)
5	Display of product in-store	60 (30%)	90 (45%)	27 (13%)	13 (7%)	10 (5%)
6	New or different brand	50 (25%)	100 (50%)	13 (7%)	27 (13%)	10 (5%)
7	Price of the product	63 (32%)	77 (38%)	40 (20%)	10 (5%)	10 (5%)
8	Discount offers	90 (45%)	77 (38%)	27 (13%)	3 (2%)	3 (2%)
9	Various schemes (buy 1 get 1 free)	50 (25%)	127 (62%)	10 (5%)	10 (5%)	3 (2%)
10	Quality of the product	110 (55%)	60 (30%)	10 (5%)	20 (10%)	0 (0%)
11	Attractive packaging of the product	60 (30%)	90 (45%)	30 (15%)	10 (5%)	10 (5%)

12	Emotional attachment to the product	33 (17%)	77 (38%)	60 (30%)	10 (5%)	20 (10%)
13	Comments of reference group	50 (25%)	77 (38%)	26 (13%)	27 (14%)	20 (10%)
14	Income status	77 (38%)	93 (47%)	27 (13%)	03 (2%)	00 (0%)
15	Standard of living	60 (30%)	100 (50%)	27 (13%)	10 (5%)	03 (2%)
16	Perception about saving and investment	56 (28%)	84 (42%)	20 (10%)	20 (10%)	20 (10%)

(Source: Primary Data)

Table No: 1 shows that The majority 50% agreed and 38% strongly agreed that convenience plays a significant role in their decision to buy groceries at store markets. Only a small percentage 7% strongly disagreed as well as disagreed. About 63% of respondents strongly agreed and agreed that advertising influenced their decision, while 12% disagreed or strongly disagreed. 20% of respondents strongly agreed and 55% agreed that the atmosphere and decoration of the store influence their purchase decisions while 10% of respondents either did not agree or disagree with the statement and the remaining 15% disagreed or strongly disagreed. The behavior of the salesperson had a mixed response, with 37% agreeing or strongly agreeing, and 25% disagreeing or strongly disagreeing while the majority 38% of respondents either did not agree or disagree that the Behavior of salesperson plays a significant role in their decision to buy groceries at store markets. A significant majority 30% agreed and 45% strongly agreed that product display influenced their purchase decisions only 12% disagreeing or strongly disagreeing. 75% of respondents agreed or strongly agreed that new or different brands affect their buying decisions. Price was a significant factor, with 32% strongly agreeing and 38% agreeing that it influenced their purchases. while 20% of respondents either do not agree or disagree with the statement. A considerable majority 83% agreed or strongly agreed that discount offers affected their buying decisions. Around 87% of respondents agreed or strongly agreed that various schemes influence their purchases. The majority 55% strongly agreed and 30% agreed that product quality plays a significant role in their purchase decisions only 10% disagreed that product quality did not plays a significant role in their purchase decisions. 30% strongly agreed and 45% agreed that attractive packaging influences their purchases while 15% of respondents either do not agree or disagree that attractive packaging influences their purchases. Emotional attachment to product had mixed responses, with 55% agreeing or strongly agreeing, and 15% disagreeing or strongly disagreeing. A majority 47% agreed and 38% strongly agreed that income status influences their purchases. Around 80% agreed or strongly agreed that their standard of living affects their buying decisions while 13% of respondents either did not agree or disagreed only 7% disagreed or strongly disagreed that their standard of living affects their buying decisions. Perception about saving and investment had mixed responses, with 70% agreeing or strongly agreeing, and 20% disagreeing or strongly disagreeing. Overall data indicates that factors such as convenience, product display, discounts, schemes, quality, packaging, and income status seem to strongly influence consumers' decisions to buy groceries at store markets.

Findings

1) Convenience is Key: The data reveals that a significant majority of respondents (88% combined) either agreed or strongly agreed that convenience in going to store markets plays a significant role in their decision to purchase groceries. This underscores the importance of accessibility and ease of shopping in influencing consumer behavior.
2) Influence of Advertising: The majority of 63% of respondents strongly agreed and agreed that advertising of products influences their decision to buy groceries at store markets. This highlights the impact of marketing and promotional efforts in shaping consumer preferences and driving purchasing decisions.
3) Store Atmosphere and Decoration: The majority of respondents (75% combined) indicated that the atmosphere and decoration of the store influence their purchase decisions. This suggests that the

visual appeal and ambiance of the store play a role in attracting and retaining customers.

4) Product Display and Variety: A significant majority (75% combined) agreed or strongly agreed that product display and the availability of new or different brands affect their buying decisions. This emphasizes the importance of product presentation and assortment in influencing consumer choices.

5) Price, Discounts, and Schemes: Price-related factors such as the actual price of products, discounts, and various schemes have a substantial impact on consumer behavior, with a large majority (83% to 87%) agreeing or strongly agreeing that these factors influence their purchases.

6) Product Quality and Packaging: Consumers prioritize product quality and attractive packaging, with 85% combined agreeing or strongly agreeing that these factors influence their purchase decisions. This highlights the significance of perceived value and sensory appeal in consumer choices.

7) Influence of Socio-Economic Factors: Income status, standard of living, and perceptions about saving and investment also play roles in consumer decisions; with significant proportions (47% to 80%) agreeing or strongly agreeing that these factors influence their buying behavior.

8) Emotional Attachment and Reference Group Influence: Emotional attachment to products and the impact of reference group comments are also notable factors influencing consumer decisions, though with more varied responses.

Overall, the major findings from the data indicate that a combination of convenience, marketing efforts, store environment, product assortment, pricing strategies, and socio-economic factors significantly influence consumer preferences and choices when it comes to purchasing groceries at store markets in rural Sangli. These insights can inform marketing strategies and retailing approaches to better meet the needs and preferences of rural consumers in the region

Suggestions

1) Ensure that local grocery shops are strategically located within residential areas or near community centers to enhance convenience for consumers.

2) It is suggested that grocery shops should utilize local advertising channels such as community newsletters, radio, or social media to promote products and special offers effectively.

3) Maintain competitive pricing while offering discounts or bundled deals on popular items to appeal to price-conscious consumers as well as to introduce loyalty programs or membership discounts to reward repeat customers and encourage retention.

4) It suggests customizing product assortments and pricing strategies based on the income levels and preferences of the local community.

5) Encourage satisfied customers to share their experiences and recommendations with friends and neighbors to build positive word-of-mouth.

CONCLUSION

The findings from the data underscore the multifaceted nature of consumer preferences and behaviors when it comes to purchasing groceries at store markets in rural Sangli. Convenience emerges as a critical factor, with an overwhelming majority of respondents emphasizing the importance of accessibility and ease of shopping. This highlights the need for local grocery shops to strategically position themselves within residential areas or near community centers to enhance convenience for consumers. Furthermore, the influence of advertising, store atmosphere, product display, pricing strategies, and socio-economic factors significantly impact consumer decisions. To capitalize on these insights, local grocery shops are encouraged to leverage local advertising channels to effectively promote products and special offers. Maintaining competitive pricing and introducing loyalty programs can further appeal to price-conscious consumers and foster customer retention.

In conclusion, by incorporating these findings and implementing suggested strategies, local grocery shops in rural Sangli can enhance their competitiveness, improve customer satisfaction, and build strong relationships within the community. This holistic approach, encompassing convenience, effective marketing, pricing optimization, and customer engagement, will enable grocery businesses to thrive in

a dynamic and evolving retail landscape while meeting the diverse needs and preferences of rural consumers.

REFERENCES

Research Articles

1. Paromita Goswami, and Mridula S. Mishra (2008) in their study of "Would Indian consumers move from kirana stores to organized retailers when shopping for groceries." Asia Pacific Journal of Marketing and Logistics [Volume-21 Issue-1] [ISSN - 1355 - 5855].
2. Dr.D.D. Bedia, Mr.Rajesh Gupta (2017) in its article titled "A Comparative Study of Customer Perception towards Organized and Unorganized Food Retailing in Madhya Pradesh". International Journal of Research Culture Society [Volume-1 Issue-6] [ISSN - 2456-6683].
3. Pandey Mithilesh, Verma Rajesh's (2015) study on "Factors Influencing the Buying Behavior of Consumers towards Organized Retail Stores in Jalandhar, Punjab". IUP Journal of Marketing Management [Volume-14 Issue-1].
4. Ms. Monika Talreja, and Dr. Dhiraj Jain (2013) in their article titled "Changing Consumer Perceptions towards Organized Retailing from Unorganized Retailing – An Empirical Analysis". International Journal of Marketing, Financial Services & Management Research [Volume-2 Issue-6] [ISSN - 2277-3622].

Books and Reports

1. Dr. H. C. Purohit, (2006), "Rural Marketing: Challenges and Opportunities", published by Shree Publishers & Distributors, New Delhi, First Edition.
2. C. R. Kothari-(2009) - Research Methodology -2nd edition, New Age International Publishers.
3. David Gilbert, (2007), "Retail Marketing Management", Pearson Education Ltd., New Delhi, Second Edition.
4. Dr. K. Karunakaran, (2011), "Marketing Management", Himalaya Publishing House, Mumbai, Second and Enlarged Edition.

AI-Based Learning for Olympic Game: Football

Manish Kumar Dubey
Assistant Professor(MCA)
✉ dby.manish@gmail.com

Riya Manesh Pawaskar
Students
✉ riyapawaskar21@gmail.com

Shambhu Shankar Rai
Assistant Professor(MCA)
✉ shambhumca@gmail.com

Tejasvini M Mandadkar
Students
✉ tejasvinimandadkar@gmail.com

Bharati Vidyapeeth's Institute of Management and Information Technology
Navi Mumbai, Maharashtra

ABSTRACT

Today we live in the 20th century and sports play a significant role not only in the form of entertainment but also as a platform for social, cultural, and economic activities. The world has been entirely crafted by modern technologies. Nowadays we also have various types of Academies for all kinds of sports that help us get trained from basic to advanced, but somehow today there are still some parts of the world where modern technologies and their advantages have not been introduced. Not everyone can afford the fancy training academies to learn a specific sport.

The rural part of the world is still unaware of how the world has adapted modern means of learning games through newly designed technologies. Even though every person carries a smartphone in today's date making the right use of it is still not known for many people. In many educational settings, students face a lack of engagement, limited accessibility to quality resources, and an approach that fails to address individual learning styles and preferences. Many times even after having any sport as a hobby, people tend to give up just because they can't afford to learn it through any academy.

KEYWORDS: *AIML, Artificial intelligence,Machine learning, Predictive analysis, Posture detection, Generative AI.*

INTRODUCTION

Have you ever wondered what if technology started ruling the world?? We can only wonder about things like flying cars, robots walking on streets, doctors on mobile phones, and whatnot!! Today the world is on its way to get as digitalised as possible. People are busy finding shortcuts for all of the tedious work. The world has already experienced how things can be managed digitally without human hands during the COVID-19 period. And this thing has brought an immense change in the world. People have started depending on technology more than on themselves and this has led to the invention of AI i.e. Artificial Intelligence.

Artificial means man-made and intelligence means the ability to think which makes AI a man-made ability to think. AI is nothing but a tool created by a man that can think like a human brain. AI is also defined as the field of computer science where a tool can think like a human brain, work like a human brain, solve problems like the human brain, and make decisions like a human brain. Many people consider AI as the latest technology but this technology has existed for ages. The first AI work was done by Warren McCulloch and Walter Pits in 1943 and was known as a model named Artificial Neurons. The latest AI technologies that have been set as a new trend are the Chat-Bots. Chatbot is very similar to a program that processes human conversation and allows a human to chat with the device as if they are communicating with another human only. It helps in every sector of a human being's daily life. This is

one of the best technology that has been invented by a human himself.

Artificial Intelligence has set a new and the highest record in the world. People have started depending on AI tools for every aspect of their life. AI is set on Machine Learning and Deep Learning algorithms. AI has two types Weak AI and Strong AI.

Weak AI:- Also known as ANI(Artificial Narrow Intelligence) is designed to perform specific tasks, this is the most popularly used AI in our day-to-day life such as Apple's Siri, Amazon's Alexa, etc.

Strong AI:- Also known as Artificial Strong Intelligence. It is a theoretical part of AI where machines have intelligence equal to the human brain. Since this is the theoretical part there are no real-world examples related to Strong AI but the research is still going on and one example we can take for ASI is science fiction such as HAL etc.

AI IN SPORTS

Since AI is on its way to making a remarkable journey in every field, one such field where AI is needed is the Sports field. There are lot many things in this field where some things cannot be managed manually or can be managed manually but making use of AI tools can make the entire thing very easy and lightweight. People have already started using such tools in games for eg National Football League is using AI tools for analyzing game films and managing the performance of each player. Since the use of artificial intelligence in the sports industry is kind of still in its early stage innovations are still to be taken place.

AI IN FOOTBALL

Football is a team sport played between two teams which includes 11 players in each team. The objective of this sport is that the team needs to score a goal by getting the ball into the opponent team's net. The team that scores the maximum goals within the allotted time wins the match. Football is played worldwide but it is not that popular among some of the rural parts due to a lack of proper infrastructure and expert training, still, the passion to play football remains the same among individuals. Such problems can be solved by introducing AI (Artificial Intelligence) in football. As we live in the 21st century we can expect a mobile phone in every corner of the world. So developing an AI-based application that not only helps in learning the game but also keeps track of what kind of workout is needed, how the base for the football player can be built, the nutrition needed for a player, etc can all be stated under one application. This will not only help players to learn the sport but also help in knowing all the basic and important requirements that are needed to play the game. To become a football player fitness and workout plays an important role.

SYSTEM ARCHITECTURE

Now, the application can be built by considering 3 major categories

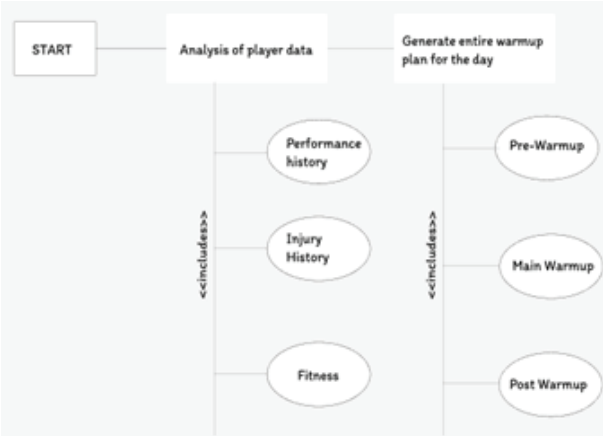
1) Warmup

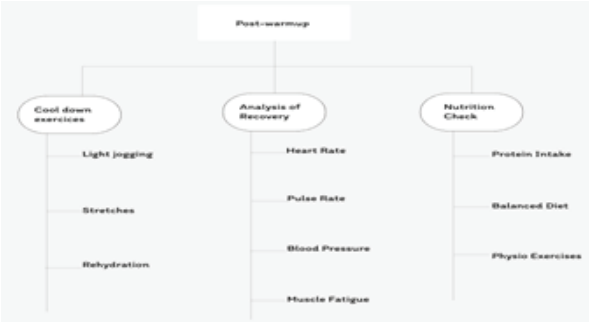
2) General Actions

3) Shooting

1) Warmup:- Warmup in Football plays a crucial role for any football player to build a proper physic and strengthen themselves for better gameplay. Warmup includes four subcategories Pre Warmup, Post warmup, Stretching, and Strengthening.

General View of how exactly the AI can help with the warmup





As we have seen in the above diagrams the entire warm-up session for football includes lots many steps and doing each of them manually can lead to huge mistakes, but what if there is an application that can control every step depending on the player's health? For this purpose we can consider the algorithm above, which is;Once the application is opened the very first thing to notice must be the player's record which will include his/her injury history, performance history, fitness, etc. Next comes the entire Warm-up plan for the day and this plan will be completely AI-generated depending upon the player's fitness. Now this plan will be divided into three sections which will be Pre-Warmup, Main-Warm-up, and Post-Warmup.

Pre-warmup must be done before the main warmup. This helps the players to prepare themselves for the game and it acts as a preparatory step that will gradually help with heart rate, blood flow, etc. Pre-Warmup is then divided into three parts which are Stretches and Exercises, Drills and Movements, and Mobility Exercises. Now these Pre-Warmup exercises will be entirely generated by Artificial Intelligence starting from types of stretches to how many exercises everything will be under the AI control again by considering the player's record.

Main Warm-up is the crucial step for a football player as this warmup routine includes the actual practice before the match begins. This routine is divided into three parts i.e. Aerobic Exercises, Stretching, and Football Drills. The Aerobic Exercises consist of three main exercises which are Running, Shuttle run, and sprints. The AI can take control of all the aerobics needed for the player that are important for a football match. The next part will be the Stretching, now the stretching part depends from person to person in what angle a player should stretch himself/herself. The stretching angles are very important to consider, and doing this manually without any proper guidance can lead to wrong posture. Then next comes the Drills. The drills are completely coach-designed exercises that every player has to exercise before the match. The drills include passing and dribbling. The passing drill includes players passing the ball among each other in variety of patterns that emphasize accuracy, time, and technique. These parameters can be measured by AI so that each player understands his/her potential. The next exercise in the drill section is

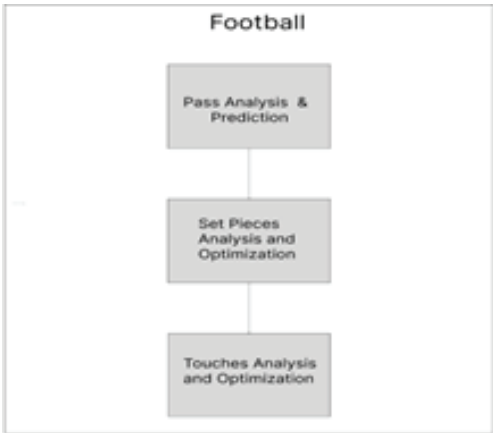
the dribbling. The dribbling includes cone dribbling exercises where players learn to navigate through the defenders. So these are some main warmup exercises that can controlled by AI.

The next are the Post Warmup exercises. These exercises are been done after the football match. This warmup also plays an important role after the match as the player needs to relax. This warmup is done for the relaxation of the muscles. Majorly the post-warmup includes three main categories which are Cool-down exercises, Analysis of recovery, and Nutrition check. The cool-down exercises have the subcategories Light jogging, stretch, and Rehydration. Then next comes the Analysis of recovery which is very important to be measured. This analysis includes the heart rate, pulse rate, blood pressure, and muscle fatigue. These parameters are necessary to be calculated for each player as it plays a very important role in the physical health of a player. The smartphone's camera and flash can be used to capture the PPG (photoplethysmography) signals from a user's fingertip or face, enabling them to measure this parameter. The next and last but very important category is Nutrition Check. This includes protein intake, a balanced diet, and physio exercises. All of these can be measured based on parameters that were calculated in the analysis of recovery. The basic physio exercises that are needed for a player after the game can be given with the help of AI.

Now a complete report of the whole warmup session can be generated by AI so that a player knows his/her routine. The recommendation can also be suggested by AI based on the generated report and lastly, the player can easily analyze the warmup session. This completes the warmup part for the football game.

2) General Actions:- The General Actions are the actions that are involved during playing football. These actions include Touches, Passes, and Set Pieces.

1) Pass Analysis and Prediction:- This segment includes the analysis and prediction of pass patterns. Passes are very crucial in football as it improves the player's strategy and team coordination needed for the game. The Pass Analysis can include Pass Accuracy(how accurate the pass is), Pass Length(length of the pass), Pass Direction(angle of the pass), and Pass Position(the position of both passer and receiver) These are some of the parameters that can be analyzed with the help of AI. By considering these factors AI can help the player to understand the correct position needed for the Passes. The next is the Pass Prediction. Building upon the insights gained from pass analysis, this AI module predicts potential pass options for players in real-time situations. It looks at how and where the players are positioned and also considers the passing history of individual players and teams as a whole. Using this information, the AI predicts possible passing options for a player in possession of the ball.



2) Set pieces analysis and optimization:- AI algorithms identify patterns and trends in set piece execution and outcomes. For example, they may recognize that a certain player is particularly effective at delivering corner kicks to a specific area in the penalty box, or that the opposing team tends to use a particular defensive formation during free kicks. Based on the analysis of past data and patterns, AI algorithms suggest optimization strategies for set pieces. This could involve recommending specific tactics, player positioning, and delivery techniques to increase the likelihood of scoring from set pieces.

3) Touches analysis and optimization:- AI analyzes the collected data to assess individual player performance in terms of touches. It evaluates factors such as passing accuracy, dribbling success rate, effectiveness in maintaining possession, and contribution to scoring opportunities. By identifying strengths and weaknesses in players' touch patterns, AI helps coaches tailor training programs and tactical strategies to improve overall team performance. Based on the analysis of touch data and tactical insights, AI suggests optimization strategies to

enhance player touches and team performance. This may involve recommendations for improving passing accuracy, increasing ball retention, or creating scoring opportunities through effective ball circulation and movement. For example, AI might suggest specific training drills to improve players' first touch

.

3) Shooting:- In football, "shooting" refers to the action of a player attempting to score a goal by kicking the ball towards the opponent's goal. Shooting is the most fundamental skill in football that requires proper technique and power. Shooting can be done from various angles depending on the player's skills. So mainly shooting can be divided into two parts

1) Shooting with angle:- AI can analyze vast amounts of data of players playing history which can include players' positions, shooting angles, etc. By identifying the trends and patterns in the data the AI can provide the most effective strategy for shooting. The shooting angle plays a very important role in this sport, The ball needs to be kicked at proper angle in the goalpost. So AI can assist with the proper angle to a player. AI can analyze to player's history on previous strategies and angles used by a player and can help by suggesting better angles. This can help with the player's improvement with the angles.

2) Shooting with Power:- AI can analyze the biomechanics of players' shooting techniques to identify optimal methods for generating power. This analysis can include factors such as the angle of approach, the position of the body, and the speed of the kicking motion. By analyzing data on players' physical attributes and performance metrics, AI can recommend exercises and training regimes tailored to enhancing explosive strength and kicking power. By considering factors such as distance from the goal, angle of approach, and goalkeeper positioning, AI can recommend the optimal amount of power needed for successful shooting.

ROLE OF GENERATIVE-AI

Generative AI refers to a class of artificial intelligence techniques and algorithms that are designed to create or generate new content, often in the form of images, text, audio, or even video, that is similar to examples it has been trained on. Generative-AI can play a major role in this application by analyzing the large datasets of the players and provide insights into players' potential based on their playing style, statistics, and other factors. It can also play a role of virtual coach for the individual training. The application can generate personalized training content tailored to individual users' skill levels, positions, and learning preferences. For example, it could create custom drills, exercises, or tactical challenges based on the user's strengths and weaknesses. It can also generate the entire report for a player. By integrating generative AI into a football learning application, users can benefit from personalized, interactive, and immersive learning experiences that enhance their skills, knowledge, and understanding of the game.

BENEFITS

- Personalised Training:- This AI-based application can help with individual training to a player by analyzing payer's data, strengths, weaknesses, etc
- Skill Development: The player can improve his/her skills as this application can make a player learn from the utmost basic things like dribbling, passing, drills, etc.
- Accessible Learning:- This application can be accessible anytime anywhere, which will allow users to learn at their own pace through their smartphones.
- Balancing Health:- This application not only aims to provide learning skills but also provides tips on maintaining proper health by providing a balanced diet physio exercises etc
- Posture Detection:- The correct posture needed for this sport can also be stated by this application.
- Real-time Feedback:- At the end of every session every-day this application generates an entire report for the player in the form of feedback.

LIMITATIONS

Developing AI algorithms that accurately analyze complex football scenarios and provide meaningful feedback requires advanced technical expertise and computational resources. It is not possible that a player can completely become a full-fledged football player by learning through this application. While AI can offer

valuable insights and recommendations, it cannot fully replace human expertise, particularly in subjective areas such as coaching, strategy, and player development. One cannot rely on AI learning applications, over-relying can lead to a player's lack of thinking power, the potential to think in real-time difficulties, etc. It is kind of difficult to cover all the player's requirements under one application. Addressing these limitations requires a multidisciplinary approach that combines technical innovation with ethical, and practical considerations to create AI-based football learning applications that are inclusive, effective, and ethically responsible.

CONCLUSION

In conclusion, AI-based football learning applications represent a promising avenue for enhancing player development, coaching methodologies, and personalized training in the sport. This application can prove a boon for society especially the rural parts who can't afford training academies. One can learn all the basic things required for this sport. Although considering the limits that human expertise is needed for learning anything in this world, this application can at least provide basic knowledge to a player who is willing to learn this sport at their level. This AI-based football learning application has the potential to revolutionize the way players learn, train, and engage with the sport, ultimately contributing to the growth and enjoyment of football worldwide.

REFERENCES

1. Moravčík M., Schmid M., Burch N., et al. DeepStack: expert-level artificial intelligence in heads-up no-limit poker. Science . 2017;356(6337):508–513. doi: 10.1126/science.aam6960
2. Tshitoyan V., Dagdelen J., Weston L., et al. Unsupervised word embeddings capture latent knowledge from materials science literature. Nature . 2019;571(7763):95–98. doi: 10.1038/s41586-019-1335-8. [PubMed] [CrossRef] [Google Scholar]
3. Davies A., Veličković P., Buesing L., et al. Advancing mathematics by guiding human intuition with AI. Nature . 2021;600(7887) :70–74. doi: 10.1038/s41586-021-04086-x. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
4. Owens N. E., Harris C., Stennett C. Hawk-eye tennis system. 2003 international conference on visual information engineering VIE 2003; 2003; Guildford, UK. pp. 182–185. [CrossRef] [Google Scholar]
5. Wang K.-C., Zemel R. Classifying NBA offensive plays using neural networks. MIT Sloan Sports Analytics Conference; 2016; Boston, MA, USA. [Google Scholar]
6. Fernandez J., Bornn L. Wide open spaces: a statistical technique for measuring space creation in professional soccer. MIT Sloan Sports Analytics Conference; 2018; Boston, MA, USA. [Google Scholar]
7. Moshayedi A. J., Roy A. S., Kolahdooz A., Shuxin Y. Deep learning application pros and cons over algorithm. EAI Endorsed Transactions on AI and Robotics . 2022;1:1–3.doi: 10.4108/airovli19. [CrossRef] [Google Scholar]

Roles and Challenges of AI Integration: A Critical Examination of AI Applications in Healthcare

Priya Chandran
✉ priyaci2005@gmail.com
Ameya Wagh
✉ waghameya8@gmail.com
Namrata Gaikwad
✉ namratagaikwad062002@gmail.com
Pranav Pensalwar
✉ pranavdpensalwar@gmail.com

Bharati Vidyapeeth's Institute of Management & Information Technology
Navi Mumbai, Maharashtra

ABSTRACT

The integration of artificial intelligence (AI) into healthcare systems has transformed medical practice, offering solutions to challenges such as inaccurate diagnoses, inefficient treatments, and suboptimal patient outcomes. Prior to AI, healthcare operated within conventional frameworks characterized by manual procedures, limited data utilization, and decentralized decision-making. However, the emergence of AI technologies has revolutionized various aspects of healthcare, from medical diagnostics to patient treatment and remote monitoring. This paper examines the roles and challenges of AI integration in healthcare.

KEYWORDS: *Healthcare, Diagnostics, AI, Machine learning, Deep learning.*

INTRODUCTION

Prior to Artificial Intelligence being incorporated into healthcare systems, medical practice was conducted within conventional frameworks characterized by manual procedures, restricted data use, and dispersed decision-making. In order to overcome obstacles like incorrect diagnoses, ineffective treatments, and less than ideal patient outcomes, healthcare providers mainly relied on clinical expertise. These difficulties were made worse by operational barriers, such as administrative burdens and resource limitations, and interoperability and data fragmentation prevented the full potential of the healthcare data that was available from being utilized. But the increasing prevalence of chronic illnesses, the aging of the population, and the emergence of new public health risks highlighted the critical need for creative ways to boost healthcare productivity and raise patient standards. With the potential to completely change clinical decision-making, care delivery, and operational workflows, the introduction of AI into healthcare has become apparent against this background.

AI's rapid adoption in the healthcare industry was spurred on by the COVID-19 pandemic. A critical role for AI technologies in mitigating the pandemic was highlighted by the unprecedented challenges posed by the outbreak, such as surges in patient volumes, shortages of resources, and the need for quick decision-making. The development of vaccines, treatment optimization, early detection and diagnosis, and other pandemic response strategies were all greatly aided by AI-powered solutions. Healthcare practitioners were able to recognize patterns, forecast disease trajectories, and prioritize the provision of care by using machine learning algorithms to analyse large datasets of patient data. Telemedicine platforms enable remote consultations, symptom monitoring, and triage, relieving pressure on overburdened healthcare systems. These services are powered by AI-driven chatbots and virtual assistants. Furthermore, AI-powered predictive modelling tools offered insightful information about the virus's transmission, guiding programs for public health and the distribution of resources. Thus, the pandemic hastened the integration of AI technologies into clinical

practice and operational workflows in the healthcare industry.

In numerous research studies, it has been demonstrated that AI outperforms humans in various healthcare tasks, including disease diagnosis [1]. AI is not a monolithic technology but rather a collection of different technologies, including machine learning, deep learning, and Natural Language Processing (NLP), all of which are highly effective in the healthcare domain. Machine learning algorithms, for example, analyse large datasets of medical images or patient records to identify patterns and make accurate diagnoses with a level of precision that surpasses human capabilities. Deep learning excels at processing complex data such as medical images and genomic sequences, allowing for more accurate and efficient diagnosis and treatment planning. Moreover, NLP algorithms enable AI systems to extract valuable insights from unstructured clinical notes and medical literature, enhancing clinical decision-making and supporting evidence-based practice. These advancements highlight the transformative potential of AI technologies in healthcare, offering superior performance and capabilities that can significantly improve patient care and outcomes.

LITERATURE REVIEW

AI is poised to significantly impact the future of healthcare [2]. Through machine learning, it drives the advancement of precision medicine, recognized as a crucial progression in healthcare. While initial endeavors in diagnosis and treatment recommendations have presented difficulties, there is widespread anticipation for AI to eventually excel in this realm too. The authors discussed the issue that is to be addressed while planning to leverage AI for Healthcare [3].

The authors have done a critical study for analysing the application of different AI technologies in healthcare [4].AI technologies, such as machine learning, IoT, algorithms, and robots, play essential roles in healthcare, aiding in monitoring, diagnosing, treating, and evaluating risks and benefits [5]. This systematic review explores the advantages, hurdles, methodologies, and functionalities of AI in the healthcare domain. Despite offering significant benefits, challenges like data integration, privacy concerns, and patient safety persist. Common AI methodologies include machine learning, image processing, and data mining. The scope of AI in healthcare spans across diagnosis, treatment, sharing information, security, monitoring, data collection, and even remote surgery. Decision-makers must carefully assess AI's benefits against challenges, particularly concerning data integrity, patient safety, and privacy. Organizations are actively revising policies to ensure patient data security and confidentiality.

Author says that there is no denying AI's profound influence on healthcare, which extends to a number of vital domains including medical imaging, virtual patient care, medical research, patient engagement, rehabilitation, and administrative duties [6]. While AI brings substantial technical, ethical, and social concerns, it also provides promising answers like better patient care and early disease detection. To overcome these obstacles and guarantee patient safety, accountability, and healthcare professionals' trust in AI systems, effective governance is crucial. The use of AI into healthcare represents a major step forward in meeting future demands as the global healthcare landscape changes, especially in reaction to the COVID-19 pandemic.

Authors have conducted an assessment of recent advancements in the AI applications in biomedicine [7].

Within the realms of healthcare and research, AI technologies are currently under evaluation or implementation for a multitude of purposes, including medication development, management of chronic conditions, disease diagnosis, and service delivery [8]. While AI holds significant potential for tackling critical health challenges, its effectiveness may be limited by the quality of available health data and the inherent inability of AI to replicate certain human qualities such as compassion.

The objective of this study is to offer a synopsis of artificial intelligence applications in healthcare, an area profoundly influenced by AI [9]. The swift evolution of analytics technology and the increasing accessibility of healthcare data have instigated a transformative shift within the healthcare sector. Machine learning techniques, including natural language processing, deep learning neural networks, and support vector machines, are employed to handle structured data. Additionally,

natural language processing plays a crucial role in managing unstructured data.

Innovative healthcare services involve utilizing state-of-the-art technologies such as cloud computing, the Internet of Things (IoT), and AI to establish a more efficient, supportive, and tailored medical services framework [10]. These advancements enable continuous health monitoring through smartphone or wearable device applications, empowering individuals to take control of their well-being. When integrated with AI, health data collected at the individual level can be transmitted to clinicians for further examination and utilized in health screening, early disease detection, and treatment planning. The transformation brought by AI in healthcare is evident, presenting opportunities for cost reduction, improved efficiency, and enhanced patient care. Despite promising applications like chatbots aiding in medical exams and providing second opinions, the complete implications for physicians remain unclear. Nonetheless, by serving as complements to clinicians and striving to surpass human capabilities while recognizing their limitations, AI holds the capacity to transform healthcare delivery. It's essential to approach the integration of AI in healthcare with thorough planning, ensuring that its benefits are maximized while effectively managing any associated challenges

CONTRIBUTION OF AI IN HEALTHCARE ACTIVITIES

Medical Diagnostics: Revolution in AI has brought a transformative potential in medical diagnostics, promising enhanced prediction accuracy, speed, and efficiency in diagnosing illness. Through the advanced algorithms, AI can meticulously analyse various medical images, such as X-rays, MRIs, ultrasounds, CT scans, and DXAs, empowering healthcare professionals with precise and rapid disease identification capabilities. This revolutionary approach stands to redefine the landscape of medical diagnostics, offering unprecedented accuracy and expediency in patient care.

Patient Treatment: AI's impact reaches far beyond just diagnosing illnesses; it extends into patient care, revolutionizing how treatments are recommended and delivered [12]. By harnessing predictive analytics and personalized medicine, AI tailors' treatment plans based on individual patient data, enhancing the effectiveness of therapies and predictions for recovery. Integrating AI-driven decision support systems into clinical processes streamlines healthcare delivery, promising more accurate interventions and better outcomes for patients.

Remote Patient Monitoring: The COVID-19 pandemic made online healthcare a popular tactic for ensuring the security of both patients and medical professionals [13]. Healthcare monitoring was made possible in large part by machine learning and image processing methods. Vital signs like heart rate, breathing rate, oxygen saturation (SpO2), cough analysis, and blood pressure can all be tracked by the AI techniques. In order to compare AI-enabled healthcare vital sign monitoring with conventional approaches, the authors conducted a survey. ML approaches for processing images and videos assisted in identifying a specific area of interest (ROI) on patient, like facial landmarks. The ROI was then picked, and vital indicators, such as heart rate and breathing rate, were estimated. Based on the movements that occur while breathing, Bousefsaf et al. tracked the patterns of patients' pulse rates in a ROI of a video frame. Cho et al. created a deep learning model called Convolutional Neural networks have been created to assess individuals psychological stress levels by analysing the breathing patterns observed in video surveillance. Based on auscultation sounds, a pretrained 3D ResNet18 neural network model was used to Role of AI in healthcare is categorise the sounds into illness groups in order to perform cough analysis. The model's results showed 100% sensitivity, 94.11% specificity, and 94.57% accuracy. Based on remote photoplethysmography (rPPG) spotted in a video frame taken by a typical smartphone camera, heart rate, blood volume pulse, and SpO2 were quantified .

Administrative Tasks: Each year, hospitals must spend large sums of money on surgical and medical supplies in order for their operations to run smoothly [14]. The average amount that the US spent in 2018 on these kinds of items per hospital health centre nationwide was about twelve million dollars. Though these health centres have a sizable budget, the same authors indicated that improving supply-related logistics is not currently a top priority for them. Consequently, there's

no reason to optimise it using a very potent tool like AI, being among the most transformative technologies taken into consideration for supply chain management optimisation due to its effects on production planning and control as well as operations management.

Drug Delivery: The emergence of computational pharmaceutics, directed at enhancing medication delivery processes through the integration of AI and big data in the pharmaceutical field, has gained traction [15]. By employing multiscale modeling methodologies, computational pharmaceutics leverages machine learning and AI algorithms to analyze extensive datasets and predict medication behavior. This approach enables researchers to simulate drug formulation and delivery processes, allowing for the exploration of various scenarios and optimization of medication delivery systems without lengthy trial-and-error studies. Consequently, the time required for drug development is reduced, costs are lowered, and production is enhanced.

AI algorithms facilitate the analysis of intricate correlations among drug properties, formulation components, and physiological parameters to forecast drug behaviour at each scale accurately. This comprehensive understanding of drug delivery mechanisms facilitates the development of effective drug delivery systems by predicting medication stability, in vitro drug release profiles, and physicochemical attributes.

ROLE OF AI IN HEALTHCARE

AI plays a very important role in healthcare domain, which is depicted in fig1.

Fig. 1. Role of AI in HealthCare

Better Data Management

Hospitals have to contend with both strict health privacy rules and enormous volumes of patient data. Gathering and storing patient data requires a significant amount of time and work. A centralized location is created during the digitization process, where all data is kept and examined.

Lowering Readmissions

Reducing readmissions to hospitals presents a big challenge to healthcare professionals. Readmission rates are correlated with Medicare payments, so it can be expensive to ignore this problem. Tools for machine learning have the power to change the way healthcare is provided. Clinicians can receive daily information from these tools regarding which patients are at the most risk of readmission and strategies to lower that risk.

Shorten Your Stay at Hospitals (Los)

Readmission rates, expenses, and care quality are all influenced by how long a patient stay in the hospital on average after being admitted. By identifying patients who are at risk of having an elevated length of stay and making sure that best practices are followed, health systems can lower LOS and enhance other outcomes, such as patient satisfaction

Patients Can Get Help Right Away

AI/ML development services allow patients to request help from their mobile devices at any time. This builds trust between medical professionals and patients while also lowering the workload of busy doctors.

Internal Communication Improvements

Medical experts collaborate with other physicians to provide the best diagnostic and treatment approach. Hospitals require a seamless and functioning internal communication channel to streamline the process and assure accurate and prompt diagnoses.

Cost Saving

Digital healthcare innovations, despite requiring initial investments, ultimately lead to cost savings for hospitals and patients alike. Hospitals can reduce expenses by leveraging data for staffing predictions, providing support through digital platforms to minimize errors, and implementing telemedicine services for more

economical medical care. Patients, especially those in rural areas, benefit from reduced transportation costs by accessing healthcare professionals through apps from their homes.

Keep Vital Information

A significant volume of data is often lost during storage processes, leading to unavailability when required. Hospital's risk overlooking vital data for future research if they neglect data collection and analysis efforts. AI development firms play a crucial role in preserving extensive datasets, encompassing unstructured raw data for future utilization. Given the pivotal role of data in research, drug development, and treatment enhancement, its preservation stands as a pivotal stride toward enhancing the quality of medical care.

Chatbot

Prior to scheduling doctor appointments, individuals often research their symptoms online, with 89 percent of patients turning to Google for health-related inquiries. Recognizing this trend, several tech start-ups are addressing the issue through the development of AI-powered chatbots. Imagine the autonomy patients could have if they could simply reach into their pockets, open an app, and engage in self-diagnosis through conversation with an AI-powered health companion. This represents the direction in which chatbots are evolving, with some companies already making strides in this direction.

CHALLENGES OF AI IN HEALTHCARE

1. Safety and Transparency: Ensuring the safety and transparency of AI in healthcare is crucial for its widespread adoption and positive impact on patient outcomes. Key challenges include addressing algorithmic bias, ensuring interpretability and explainability of AI predictions, quantifying uncertainty in decision-making, maintaining robust data privacy and security measures, validating AI systems through rigorous testing, establishing mechanisms for adverse event monitoring and reporting, designing effective human-AI interfaces, and implementing continual monitoring and updating procedures. Collaboration among healthcare stakeholders, AI developers, regulators, and policymakers is essential for overcoming these challenges and fostering trust in AI technologies while adhering to ethical principles and regulatory standards.
2. Lack of Quality Medical Data: The scarcity of high-quality medical data presents a significant hurdle for clinicians seeking to validate AI models clinically and technically. The fragmentation of medical data across numerous Electronic Health Record (EHR) systems and software platforms impedes the collection of patient information and images necessary for testing AI algorithms. Moreover, interoperability issues between different platforms further compound this challenge, as medical data from one organization may not align with others. To address this, efforts must focus on increasing the volume of available data for testing AI algorithms.
3. Lack of Understanding: A common challenge in healthcare is the lack of understanding among both healthcare professionals and patients regarding the capabilities and limitations of AI. This gap in comprehension can result in unrealistic expectations and mistrust towards AI technology. Despite its potential for enhancing diagnosis, treatment, predictive analytics, drug discovery, virtual assistants, chatbots, and administrative efficiency, challenges such as data privacy, security, bias, transparency, regulation, governance, and the aforementioned lack of understanding must be addressed to fully harness AI's benefits in healthcare.
4. Updating Regulations: Medical records worldwide are safeguarded by stringent confidentiality and privacy laws, posing legal barriers to data sharing among AI systems. Patient consent is typically required for lawful acquisition and use of medical data for AI purposes. However, navigating these regulations presents logistical challenges, necessitating flexible rules on data acquisition coupled with robust identity protection measures. Medical institutions must rigorously ensure compliance and accountability for patient data acquisition and usage. This approach is crucial for ethically curating accurate, high-quality medical datasets essential for advancing AI technologies in healthcare.

5. Resource Allocation and Cost: - Integrating AI into healthcare demands substantial initial investments covering infrastructure, data aggregation, model training, and ongoing maintenance. Ensuring a favourable return on investment and equitable distribution of AI technologies throughout healthcare facilities is vital for fostering widespread adoption. Balancing cost considerations with the imperative to deliver improved patient outcomes remains a central challenge in deploying AI solutions effectively across diverse healthcare settings.

CONCLUSION

In conclusion, the incorporation of artificial intelligence (AI) into healthcare has significantly transformed medical practice, addressed longstanding challenges and enhanced patient care. Before AI, healthcare operated with manual processes and limited data use, but AI has ushered in a new era marked by precision, efficiency, and accessibility.

The COVID-19 pandemic accelerated AI adoption in healthcare, showcasing its vital role in pandemic response, including vaccine development and remote patient monitoring. AI-enabled solutions analyse vast datasets swiftly, aiding healthcare decisions and resource allocation.

While AI holds immense potential, further research and ethical considerations are crucial for maximizing its benefits and addressing challenges like data privacy. Embracing AI's power will continue to advance healthcare, ultimately improving patient outcomes and delivery of quality services.

REFERENCES

1. Davenport, Thomas, and Ravi Kalakota. "The potential for artificial intelligence in healthcare." Future healthcare journal 6.2 (2019): 94
2. Davenport, Thomas, and Ravi Kalakota. "The potential for artificial intelligence in healthcare." Future healthcare journal 6.2 (2019): 94.
3. Bajwa, Junaid, Usman Munir, Aditya Nori, and Bryan Williams. "Artificial intelligence in healthcare: transforming the practice of medicine." Future healthcare journal 8, no. 2 (2021): e188.
4. Alowais, Shuroug A., et al. "Revolutionizing healthcare: the role of artificial intelligence in clinical practice." BMC medical education 23.1 (2023): 689.
5. Ali, Omar, et al. "A systematic literature review of artificial intelligence in the healthcare sector: Benefits, challenges, methodologies, and functionalities." Journal of Innovation & Knowledge 8.1 (2023): 100333.
6. Al Kuwaiti, Ahmed, et al. "A review of the role of artificial intelligence in healthcare." Journal of personalized medicine 13.6 (2023): 951..
7. Rong, G., Mendez, A., Assi, E. B., Zhao, B., & Sawan, M. (2020). Artificial intelligence in healthcare: review and prediction case studies. Engineering, 6(3), 291-301.
8. Artificial intelligence (AI) in healthcare and research - Nuffield Council on Bioethics
9. Review on Artificial Intelligence in Healthcare - Muzeeb Ur Rehman Chandigarh University , Ashutosh Pandey Patna University
10. Cutler, David M. "What artificial intelligence means for health care." JAMA Health Forum. Vol. 4. No. 7. American Medical Association, 2023.
11. Strickland, Eliza. "IBM Watson, heal thyself: How IBM overpromised and underdelivered on AI health care." IEEE Spectrum 56.4 (2019): 24-31.
12. Rana, Md Shohel, and Jeff Shuford. "AI in Healthcare: Transforming Patient Care through Predictive Analytics and Decision Support Systems." Journal of Artificial Intelligence General science (JAIGS) ISSN: 3006-4023 1.1 (2024).
13. Shaik, Thanveer, et al. "Remote patient monitoring using artificial intelligence: Current state, applications, and challenges." Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery 13.2 (2023): e1485.
14. Bas, Tomas Gabriel, et al. "Opinions Related to the Potential Application of Artificial Intelligence (AI) by the Responsible in Charge of the Administrative Management Related to the Logistics and Supply Chain of Medical Stock in Health Centers in North of Chile." International Journal of Environmental Research and Public Health 20.6 (2023): 4839.
15. Ekpan, Francis-Dominic Makong, Merit Oluchi Ori, and Humphrey Sam. "The Synergy of AI and Drug Delivery: A Revolution in Healthcare."
16. Dasarathy, B. V. (1991). Nearest neighbor (NN) norms: NN pattern classification techniques.

A Systematic Review of Blogging: Perspective of Security Challenges and Opportunities

Nidhi Khare
Visiting Faculty,
Narsee Monjee Inst. of Mgmt Studies(NMIMS)
Pune, Maharashtra
✉ nidhikhare89@gmail.com

Sachin Kadam
Professor, Computer Applications
Institute of Mgmt and Entrepreneurship Development
Pune, Maharashtra
✉ sachin.a.kadam@bharatividyapeeth.edu

ABSTRACT

With the advancement of technology, Blogging plays a key role in expressing oneself just as it was used for maintaining diaries in traditional days. Bloggers are creating contents based on their choices be it personal, travel, lifestyle, beauty, or any field of their choice. There are various blogging platforms which are easily available and help bloggers to create their accounts which they can use for blogging purpose. Bloggers can easily publish and edit their blogs as these platforms are interactive and easier to use. With so much of content easily available on these blogging platforms, security concern remains viable.

In this research paper, we have collected the information curated by various researchers to understand the security concerns raised by them. By doing this we found that although blogging is an effective medium of self-expressing about the field the blogger is interested in but the lot of security issues in terms of vulnerabilities and threats persists which bloggers constantly face and are in search of some or the other opportunities which may help them. This paper highlights the importance of mitigation strategies required for blogging so that the vulnerabilities and threats related to blogging shall be addressed.

KEYWORDS: *Blogs, Blogging, Blogging platforms, Vulnerabilities, Threats, Blog security.*

INTRODUCTION

A Blog is a popular way of deliberation or sharing of information published on the informational website which consists of discrete, often informal just like style of diary text entries (posts). A typical blog combines texual content, images, videos and links to other types of blogs, pages of website, and other contents related to its concept.

The traditional way of maintain diaries by our grandparents and parents has now replaced by creating blogs which is a new way of expressing in online mode. The person who creates and writes blogs is called a blogger. The bloggers create blogs based on various topics of their interests. Blogging is becoming popular and from organisational point of view it has become the main source of information for various services and products which the company's create and keep on updating to help their customers. Through this, the clients and customers are updated about the services and products, can interact through comments with you and can avail your services.

Why blogging is so popular?

- Its flexible and portable
- Helps build trust with customers
- No startup costs and overhead
- Can make money
- Keeps clients up to date

Today, in the sphere of blogging, there are various types of blogs which are created by bloggers, for example, personal blogs, professional blogs, media blog, affiliate blog and niche blogs which are on topics such as lifestyle, food, health, travel, entertainment etc. To attract a greater number of users towards your blogs require creative content which is usually energetic, thoughtful,

and purposeful. Moreover, adding interactive contents such as videos, podcasts and photos also expands the apparentness of bloggers by making their content more efficacious.

Blogging platforms are foundation for bloggers which allows them to create, organise and publish their contents on these platforms. These platforms provide tools and templates for publishing content, managing its appearance, and controlling the type of user interactions. The contents of blogs are published in descending time order. These platforms permit the user to publicize the post anytime, displays the date and time when the blog is posted. The blogging platforms provide free or paid services for bloggers to publish and host their blogs. Regular blogging can help people to find business online and help bloggers to make money from blogging. Some of the most popular blogging platforms include Wordpress, Wix, Blogspot etc. These platforms are being harnessed by bloggers for the type of features which these platforms provide.

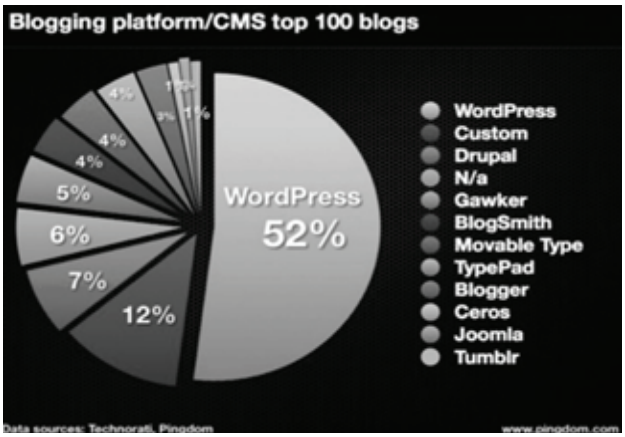


Fig 1. Blogging Platforms

Most of the bloggers have created their virtual presence by converting it into business which profits, influence the audience so that income shall be generated. This can be done by promoting their contents, joining the business and through advertising. The amalgamation of blogging and marketing has created various challenges and opportunities in data driven marketing which is also obscuring the fine lines between self-expression through blogs and business interests.

Also, the number of bloggers are increasing day by day and today approximately 600 million blogs among 1.9 billion websites worldwide in 2024(masterblogging.com). These blogs produce 7.5 million blog posts daily.

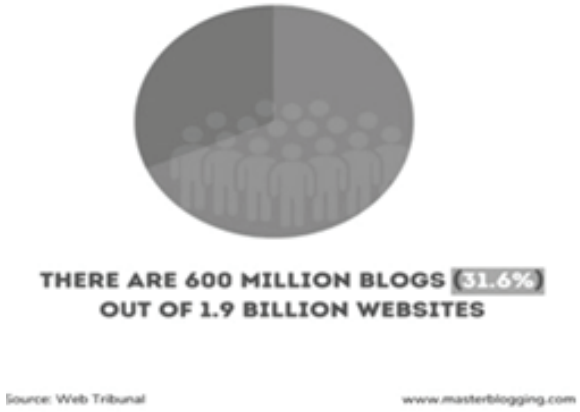


Fig. 2. No. of blogs out of websites

As per the research conducted by orbitmedia.com it has been analysed that it just takes 4 hours to write a blog post on an average.

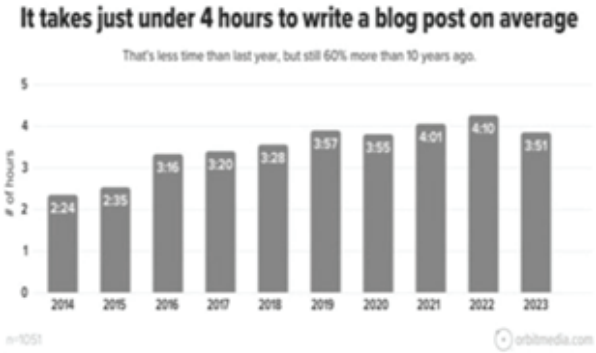


Fig. 3. Statistics of blog post

With huge number of posts and that too in different forms of text, videos, audios, pictures and reels (short contents) gains the popularity of blogging and exposes this platform with more vulnerabilities and threats. Considering these scenarios, the researchers can enhance the end user experience, assist latest forms of content presentation, and expand the reach of bloggers.

Vulnerabilities

A Computer vulnerability is a loophole or weakness(flaw) in the system which can expose it to attack. These vulnerabilities are related to one or more types of security threats. Some of the common vulnerabilities include Security misconfiguration, Injection attack, Cross Site scripting, Vulnerable and

outdated components etc. The security vulnerability can distress five types of system securities that include: Accuracy, Privacy, Completeness, Serviceability and unquestionable.

Threats

A threat tries to exploit the vulnerabilities(loopholes) to gain unauthorized access to data or systems. It can also be considered as a malicious event or negative event that takes advantage of vulnerability. These threats can be either natural or human made and accidental or intentional. Some of the common threats include data breach, personal attacks, identity theft, email phishing, tampering of data etc.

Considering the above vulnerabilities and threats exposures, this article mainly focuses on the security challenges related to blogging platforms. Amidst this research, we intend to provide insights and grant expertise to the further researchers who want to explore the challenges related to security features in form of vulnerabilities and threats in the constantly growing world of blogging.

LITERATURE REVIEW

Child, J. T., Haridakis, P. M., &Petronio, S. (2012) have published a paper describing the required privacy rules and blog handling. In this research, the various steps of blogging are being analysed by experimenting the functioning of previous and subsequent blogging. It is also found that the distinguished requirement of various privacy essentials and consideration of bloggers for the removal of the blogs which were published earlier. They selected bloggers data activities to show the motives of removing of contents from blog as prior activity. They explored the need of contribution of privacy blogging rules and essentials, administration of bloggers privacy and removing of contents from blogs once the blogs are posted.

As the usage of social media expands, traversing variations in privacy management regulation practices is critical.

The boon of blogging is that it bestows a place for bloggers to partake their inputs virtually and can also help to improve writing and thinking ability (Aditya Narayan Swami, Shaik Maqsad, Ashish Kumar, Sahil Hans, 2021). Regardless of having virtual and digital presence, the main drawback of blogging is risk of user information be used in unethical manner. This information can be their email ids, passwords or it can be the blogs in the form of information which is being posted on the various blogging platforms. It was also found after data analysis that bloggers do share their private details in their blogs unknowing the serious consequences of data breaches. The bloggers shall be aware of the information which they are posting on blogging platforms and shall be able to classify them as private or public.

Blogging has become an important type of communication with profound significance (Vaishnavi Vijay Rahate, 2023). These blogs provide understanding for companies, bloggers and policy makers who want to exploit the capability of blogs in an increasing digital era. In future scope, the author has mentioned that scrutinizing the ethical issues in the blogging world, for example, privacy concerns, disclosure, and accountable creation of contents will help the bloggers to develop the moral(ethics), honesty(integrity), and required standards for bloggers. Research in these areas can traverse the ethics impact on blogging and will enhance the overall recognition of blogging.

The bloggers face challenges related to privacy issues as while blogging, the important and private information is shared by bloggers quite often. This information is a result of self-expression and disclosing self-identity, hence it poses significant privacy risk for the bloggers and protection issues may be raised. (McCullagh K., 2008). The blog posts also get archived hence the threat of storage of information lies. Blogging leads to new opportunities for violations related to privacy to occur. The bloggers and anonymous users discuss their personal matters and provide opinions publicly which can be recorded for further access and can be easily accessible to anyone. Privacy violations may pose serious consequences for bloggers and their ability to interact publicly and create contents for topic of their choice. It was observed in the study that although some solutions have been specified when publicly published, how to keep certain information private, security issues remain viable. Regardless of the growing privacy issues specified in this research, the bloggers have found

difficulty in specifying the boundaries of privacy so that they can express themselves freely.

The blogosphere population is huge and most of its users are considered as anonymous, bloggers usually express themselves freely while writing blogs. It is unethical to analyse these personal creations without requisite permissions (Michael Jones and Irit Alony, 2008). Also, the abuse of the blog contents may result in discontentment for bloggers. Therefore, it is crucial for researchers to take necessary steps to preserve the open character of blogging.

As blogging is considered as one of most desired social platform tools, users share their insights, thoughts, experiences, and perspectives. These can be in the form of texts, images, and videos. The blogging conversation consists of bloggers posting contents related to the field they are interested in and the anonymous users giving their comments. These blogs do not have always favorable impact but also some unfavorable ones, if these are not managed properly (Guillaume Thevenot, 2007).

Michelle Harrison (2018) points out that blogs can be used by course learners as virtual learning spaces. It was found that the students were ready to engage and give out in new culture of learning which keeps them encouraging, occupied, and wide open. The barriers imposed by the virtual and digital space prohibits the learners to use this learning space effectively for varied purposes. This seems to confute the fact that social technologies provide a platform for effective participation of learners and can be used for learning process, but the fact lies that there is a threat of structures which are unalterable and security boundaries. Thus, educators need to find solution so that learners can use the virtual learning space freely for learning process.

Ahmad F. Saad (2023) have distributed a paper specifying that privacy aspect is another challenge which can be done by enlightening students not to include personal information within their blogs or blog posts. Technological barriers and privacy concerns require a base of training and security among bloggers who are using blogging platforms for studying.

An article recently published in New York Times specified that hackers who are professional and dreadful plagiarists overflow commonly to look for loopholes related to security on websites or social media platforms. If something vulnerable is being found, they may find measures to gain control of your website or social media platforms. While working online, hacking is not the only practice an individual should be worried about while working in virtual mode. Theft of content is also a big problem, mostly in the blogging world where distinctiveness is the trademark of quality.

CONCLUSION

The research paper 'A Systematic Review of Blogging: Perspective of Security Challenges and Opportunities 'offers extensive research in analysing the security aspects of blogging. Everything in the literature indicates that the impetus growth of blogging is making the blogs being used by more and more individuals, businesses, and institutions. Businesses are acquainted with the fact that blogging is a very economical way to help them gain virtual and digital presence. Combining literature review, this study discovers core perception into impact of security challenges leading to vulnerabilities and threats and explores opportunities which needs to be addressed so that bloggers can create blogs and express themselves freely on various blogging platforms.

Bloggers face challenges in creating blogs on blogging platforms as their blogs are vulnerable and are exposed to various types of threats. Adapting to these challenges and to find opportunities to address these security challenges in terms of developing mitigation strategies which is necessary for bloggers to make sure their endurability in the expanding information era. Blogging leads to cutting edge privileges for security breaches to occur, as they face serious challenges while blogging.

These findings will provide valuable knowledge for researchers, bloggers, individuals, and developers to cater to the challenges being faced by the bloggers. The research findings of this paper embark for additional consideration for researchers on their journey to address these security challenges and explore the opportunities.

REFERENCES

1. Hiler, J. (2002), Blogs as disruptive tech - How weblogs are flying under the radar of the content management giants. Internet World, Retrieved 01 December, 2007.

2. M. Jones and I. Alony, “Blogs - The New Source of Data Analysis,” Proc. 2008 InSITE Conf., 2008.

3. G. Thevenot, “Blogging as a Social Media,” Tour. Hosp. Res., vol. 7, no. 4, pp. 287–289, 2007.

4. J. T. Child, P. M. Haridakis, and S. Petronio, “Blogging privacy rule orientations, privacy management, and content deletion practices: The variability of online privacy management activity at different stages of social media use,” Comput. Human Behav., vol. 28, no. 5, pp. 1859– 1872, 2012.

5. K. McCullagh, “Blogging: Self presentation and privacy,” Inf. Commun. Technol. Law, vol. 17, no. 1, pp. 3–23, 2008

6. H. A. Alsamadani, ‘The Effectiveness of Using Online Blogging for Students’ Individual and Group Writing,” Int. Educ. Stud., vol. 11, no. 1, p. 44, 2017.

7. C. Zhang, J. Sun, X. Zhu, and Y. Fang, “Privacy and security for online social networks: Challenges and opportunities,” IEEE Netw., vol. 24, no. 4, pp. 13–18, 2010.

8. Sahil Hans, Shaik Maqsad, Aditya Narayan Swami, Ashish Kumar, "A Systematic Review of Blogging : Opportunities and Challenges", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 7 Issue 3, pp. 123-129, May-June 2021

9. Rettberg, Jil Walker, Blogging. 2nd ed. Cambridge, UK: Polity Books, 2014.

10. M. D. Kaplan, B. Piskin, and B. Bol, “Educational blogging: Integrating technology into marketing experience,” J. Mark. Educ., vol. 32, no. 1, pp. 50–63, 2010

11. Bray, H. (2004), Job blogs hold perils, opportunities. The Boston Globe, p.1. in Viegas, F. B. (2005). Bloggers' expectations of privacy and accountability: An initial survey. Journal of Computer-Mediated Communication, 10(3), article 12

12. Glenn, D, (2003). Scholars who blog. The Chronicle of Higher Education, 49 (39), A14

13. Top, E. (2012), Blogging as a social medium in undergraduate courses: Sense of community best predictor of perceived learning. The Internet and Higher Education, 15(1), 24-28. Elsevier Inc.

14. Vaishnavi Vijay Rahate(2023), Unveiling the Blogosphere: Exploring the Evolution, Impact, and Future of Blogging. International Journal of Advanced Research in Science, Communication and Technology (IJARSCT). Volume 3, Issue 1, July 2023

Metaverse: An Enabler for Circular Economy

Manu Shukla
Independent Researcher
Zurich, Switzerland

Purvi Pujari
Professor
Vijay Patil School of Management
DY Patil University
Navi Mumbai, Maharashtra

Anuj Kumar
Assistant Professor
Apeejay Institute of Management
New Delhi
✉ akbvimr@gmail.com

Gunjan Behl
Department of Computer Applications
Bharati Vidyapeeth's Inst. of Mgmt
and Inf. Tech.
University of Mumbai
Navi Mumbai, Maharashtra
✉ mailto.gunjan83@gmail.com

ABSTRACT

In the face of increasing global challenges and green growth, Industry4.0 technologies have been playing a critical role in transitioning to a more sustainable and inclusive socio-economic development. While the adoption of advanced technologies in the recent decades has exponentially accelerated, there are many who wonder, how these technologies will revolutionize the future of human mindset and how will they create a virtual representation of the real world challenges to realize the potential of circular economy?

This paper addresses the answer to the above questions and aims to provide conceptual clarity on one of the most nascent technology revolution, known as Metaverse and also provides an immersive insights into Metaverse based circular economy. For the purpose of the study, an email questionnaire was sent to 60 respondents working in different industries using random sampling technique. The study concludes the metaverse will help to accelerate circular opportunities by providing a more immersive, frictionless, distinct, interactive, engaging and cost effective platform for the sustainable development of people, planet, processes and community., as a whole. All in all, the transition to virtual shared environment will not only blur the boundaries between physical and virtual world but would also accelerate circular opportunities, yielding significant benefits such as preservation of natural resources, reduction in harmful emissions, waste, energy usage and empowering people through effective virtual sharing, integration, collaboration and communication with the real world. However, the key to achieving long term sustainability goals through implementation of metaverse depends largely on the human behaviour and the digital transformation of operations across industries.

KEYWORDS: *Metaverse, Digital technology, Circular economy, Sustainability, Resilience, Innovation, Inclusive.*

INTRODUCTION

Increasing level of globalisation and geopolitics are opening up new challenges for people, planet and businesses across globe. Few of these challenges include unemployment, poverty, climate change, energy crisis, high costs, technological advances, taxes, legal compliance etc. Notably, to mitigate the impact of the challenges it is imperative to build a resilient framework which requires a shift from traditional linear "Take-Make-Consume-Throw" model to a circular "Reduce-Reuse-Recycle" model. Enhancing circular model in an economy offers opportunity to embrace innovative smart technologies, resilient mindset and sustainable strategies wherein people, planet and profit co-exist successfully in creating a bigger and better

world. Circular economy has been one of the widely used term in the recent years among the researchers, entrepreneurs and business strategists due to its regenerative sustainable socio- technical impact towards a bigger transition. Having said this, the development of circular economic model is possible only with the adoption of smart digital technologies to its core day to day operations.

From Artificial Intelligence (AI) (Kumar & Kalse, 2021), Internet of Things (IoT) (Sestino, Prete, Piper, & Guido, 2020) to Virtual Reality (VR) (Schiopu, Hornoiu, Padurean, & Nica, 2021), Augmented Reality (AR), Cloud Computing, Blockchain (Pan, Song, Ai, & Ming, 2020), Machine Learning (Oliveira, Thomas, & Espadanal, 2014; Sarkar & De Bruyn, 2021) and Big Data, all these technologies have the potential to be a game changer in the circular economy transition. Latest evolution in the digital world is one of the wonders of technological innovation known as "Metaverse", a next three dimensional iteration of the internet which unlocks a unique opportunity for the people and businesses to have a real-life experience in a virtual world. Thereby, profoundly brining socio-economic transformation to a new level.

Coined by Neal Stephenson in 1992, the concept of virtual reality already has a long history but the Covid-19 pandemic and the economic recession has significantly prompted the adoption of an immersive technologies like metaverse which provides the platform for people connect through effective communication, interaction, engagement and information processing, both personally and professionally. Thus, we can say that metaverse is an inevitable evolution of the internet which drives sustainability by promising people and businesses a new level of connection and collaboration in a virtual space.

LITERATURE REVIEW

Imagine a world where you can relive your history as if you existed, a world where you can visit your ancestor in the form of avatars and a world where you can unleash your creditability, potential and keep your dreams alive. This is what an unprecedent technological advancement knows as "Metaverse" promises. The term "metaverse" which is a combination of 'meta' which comes from a Greek word for after or beyond and 'verse' which means universe, first appeared in American novelist Neal Stephenson'1992 science fiction novel "Snow Crash" (Joshua, 2017) which describes metaverse as a parallel digital world where people interact with each other in the form of avatars. This means that the word was published three decades ago but came into mainstream with the announcement of rebranding Facebook to Meta by Mark Zuckerberg, Meta, CEO in Connect 2021. His pitch for metaverse is that the technology is a successor of internet which is based on teleportation devices where one can explore the virtual world by clicking on a link. The term has been defined differently by different authors and business leaders.

Bosworth and Clegg (2021) describe it as a virtual space where people can create personal avatars to play, work, interact with other people who aren't in the same physical space and that can be experience synchronously and persistently by an unlimited users (Ball M. , 2021; Hollensen, Kotler, & & Opresnik, 2023)Few authors define it as virtual environment that constitutes an economic system based on block that integrates new technologies such as virtual reality (VR) while others had explained metaverse as a world that embraces social, economic and legal system while snapping the boundaries of time and space (Ning, et al., 2021). According to Herman and Browning (2021), metaverse is a completely digitalised environment that permeates beyond the analogue world in which we live. Metaverse entails a blend of Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), physical environment, people together with an intensive and immersive experience of Extended Reality(XR) thereby creating added value to a digital environment (Mystkidis, 2022; Dwivedi, et al., 2022). As we put it, basically metaverse "is a constellation of technological experience such as VR, AR, MR, XR that coexist together with the physical world by providing a perennial and more immersive environment wherein multiusers can meet, live, play, shop, work, travel and own assets in the form of digital avatars".

Since COVID-19 crisis, a plethora of research is organised around the importance of adoption and implementation of the new age or emerging technologies in business models in accelerating the transition to circular economy (CE). The essence of CE lies in its unique

features of regeneration and restoration of ecosystem in a more comprehensive and ambitious manner that opens new perspectives for an inclusive and sustainable growth of people, planet, processes and economy. In this regard, authors argue that the adoption of smart technologies such as AI, Big Data, IoT, Blockchain, Cloud Computing, VR and AR not only facilitates the entire product life cycle for businesses (Chauhan, Sharma, & Singh, 2021) through managing effective flow of resources, energy and information but is also a key to CE transformation (Ajwani-Ramchandani & Bhattacharya, 2022; Ingemarsdotter, Jamsin, Kortuem, & Balkenende, 2019)

Specifically, several studies have described that optimization of physical world with metaverse, simulations or digital twins may result to substantial reductions in carbon emission (Davies-Filleur, 2022; Townsend, 2022) and would also support green networking technologies through cloud services (Zhang, et al., 2022) and network visualization.

Allam et al., (2022) argued that metaverse has a potential to reconstruct the quality of life through effective mapping of its products and services thereby, leading to sustainable communities, cities and it would also help in providing equal educational opportunities through gamification in learning processes (Park & Kim, 2022). Regarding energy efficiency, Singh et al., (2022) stated that implementation of technological innovations such as metaverse, AI, Blockchain, Digital twins, IoT and Big Data at different stages of energy processes would help in achieving continuous energy conservation and efficiency. Similarly, the virtual spaces in metaverse will revolutionized the tourism experience (Zaman, Koo, Abbasi, Raza, & Qureshi, 2022).

As we put it, basically these immersive technologies could help in driving environmental and social engagements by simulating ecosystems as they existed decades ago and hence, bridging the gap between theory, practices and virtual world. Nevertheless, the application of lifelike experiences would help in exploring and visualizing the potential of transitioning to a circular future by walking key stakeholders through the core components of CE based on 9R's in addition to 3R's (viz. rethink, reuse, recover, refuse, recycle, refuse, reduce, recompose, refurbish, repurpose, remanufacture) as defined by Julian, Kirchherr, Denise, Reike and Marko Hekkert, in an experiential way with the use of digital avatars to achieve an ambitious yet achievable sustainable circular innovations.

PROBLEM TO BE INVESTIGATED

Humans today are living in momentous change where innovation and new technologies makes us to rethink the ways we do things in our daily lives and it will continue to make us better off over the coming decades. Over the past few years, we have experienced how digital platforms helped people to stay socially connected when stuck at home due to lockdowns and quarantines. Also, how adoption of new age technologies boosted the transition to a more greener, innovative, sustainable and resilient economy. An economy which aims to decouple the economic growth by focussing on reuse-reduce-recycle principles while increasing profitability, competitiveness and building a sustainable society. This led to the development of the new technological paradigm," the metaverse" which provides a real time virtual experiences to multiusers while enabling optimisation, automation and connectivity of circular economy activities.

Research objectives

i. To provide an insight into an overall readiness for metaverse technology adoption from individual and business perspective.

ii. To identify the contribution of a real time virtual experiences in achieving objectives of circular economy.

iii. To study the impact of 3D immersive environment at societal level.

Research methodology

The study is descriptive in nature with substantial qualitative component such as semi-structured interviews and respondents observation to gain expert perspective on in-depth understanding of potential of metaverse for enhancing circularity across industries. Other collection tools including self-administered questionnaire, consisting of both open and closed ended questions sent through Google Forms, journal entries, reports and websites are used to gather both quantitative and qualitative data from wider respondents. These tools

includes questions assessing respondents demographics, nuanced perspectives, readiness, experience and implications of 3D immersive environment on circular economy. regarding circularity within a virtual and immersive environment. Since Metaverse is an emerging concept, papers from conference proceedings, case studies and news articles are also analysed in the study. At the same time a through literature review has been conducted to understand the existing theories, benefits and impact of metaverse on various domains including sustainability. Data is collected from 60 respondents representing a range of demographics such as age, gender, educational backgrounds and professional sectors to identify variations and patterns in responses . A purposive sampling technique is used for data collection. For the purpose of the study, quantitative data is analysed using frequency distribution, percentage analyses, graphs or charts while a narrative analysis techniques is used to analyse qualitative data obtained from closed ended questions.

ANALYSIS OF THE STUDY

Table 1. Demographic profile of the respondents

Variables	Responses	Percentage (%)
Age (in years)	20 or younger	12
	21 - 30	28
	31 - 40	24
	41 - 50	27
	51 or older	9
Gender	Female	68
	Male	28
	Other	4
Academic Qualification	High School or Equivalent	0
	Bachelor's Degree	8
	Master's Degree	53
	Professional Degree	17
	Doctorate Degree	22
	Other	0
Industry	Education	8
	Manufacturing	5
	Advertising, Media and Marketing	3
	Entertainment	5
	Computer and Technology	33
	Finance and Economics	11
	Fashion	7
	Hospitality	5
	Food and Beverage	0
	Healthcare and Pharmaceuticals	8
	Other	15

Table 1 shows a significant participation of different generation in the survey with almost 36 percent of Gen X, 28 percent Millennials, 14 percent Gen Z while 22 percent are Boomers. Of the 60 respondents, 41 (68 percent) reported their gender as female, 17 (28 percent) as male while 2 (4 percent) consisted of other gender. With respect to educational attainment, the results show 53 percent of the respondents have master's degree, 22 percent have PhD degree, 17 percent have professional degree and 8 percent have bachelor's degree. From the responses, it can be deduced that the majority of respondents are master's degree holders employed in various industries. By industry, the data illuminates that around 20 (33 percent) of the respondents work in computer and technology, 6 (11 percent) in Finance and Economics, 5 (8 percent) each in education, healthcare and pharmaceuticals, 4 (7 percent) in fashion , 3 (5 percent) each in manufacturing, entertainment and hospitality while the remaining 9 (15 percent) are employed in other industries.

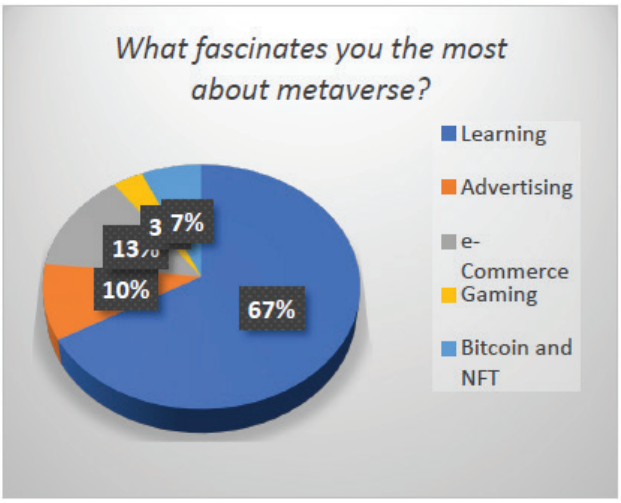


Fig. 1: Opportunities of Metaverse across Industries

Figure 1 highlights that almost 40 out of 60 respondents (67 percent) taking part in the survey feel that metaverse will revolutionize the education industry by creating more integrated and shared opportunities for lifelong learning. 13 percent believe that the immersive technology would provide new platform for e-commerce that is more cost-effective , personalized, interactive and engaging. Further, 10 percent respondents think that metaverse offers a unique way of customer engagement and impactful brand advertising. While the remaining 6

out of 60 respondents (10 percent) opines that the new technology will not only enhance the gaming experience of the next generation but will also enable NFTs and Bitcoin industry to flourish by providing robust, independent ownership and decentralized verification.

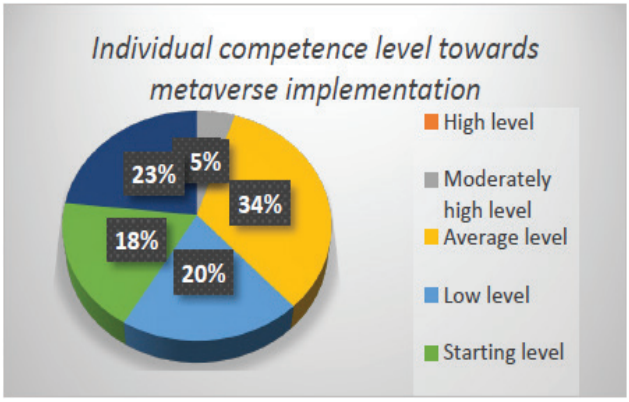


Fig. 2. Overall Readiness of Individuals and Businesses towards Metaverse Adoption

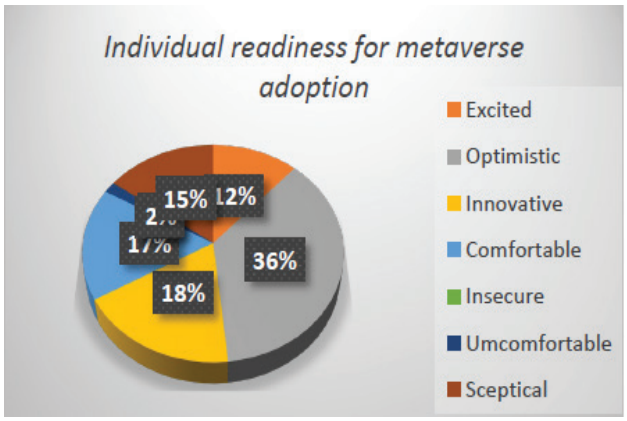


Fig. 3. Individual Readiness

Data in figure 3 reveals that respondents surveyed expects adoption of metaverse in their businesses to be more optimistic (36 percent), innovative (18 percent), comfortable (17 percent), excited (12 percent), sceptical (15 percent) while a small but not-to-be ignored group i.e. 2 percent find it as uncomfortable.

Further, when asked about respondents competencies and skill level with respect to deploying metaverse, 34 percent are at average level, 20 percent at low level, 18 percent at beginners level, 5 percent at moderately high level while 23 percent report that they are either not aware of the skills they possess or don't know how to use the domain.

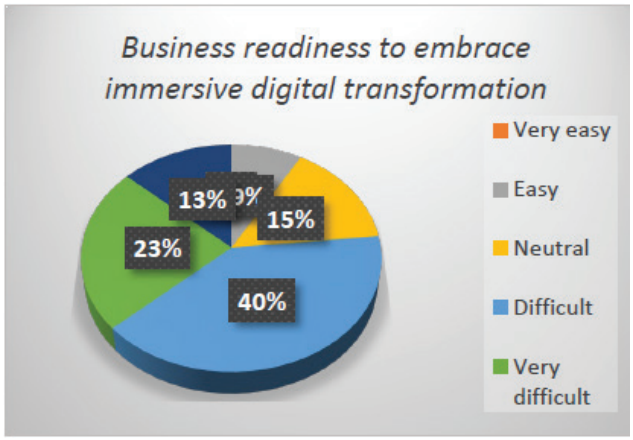


Fig. 4. Business Readiness

Past few years have witnessed a paradigm shift in business operations due to integration of virtual domain with the real world. Figure 4 indicates that almost 63 percent of the surveyed respondents report that their business are still struggling to comprehend it's opportunities in the metaverse, 15 percent say they are neutral, 13 percent say that they don't know while 9 percent feel that their business is ready to move to the metaverse.

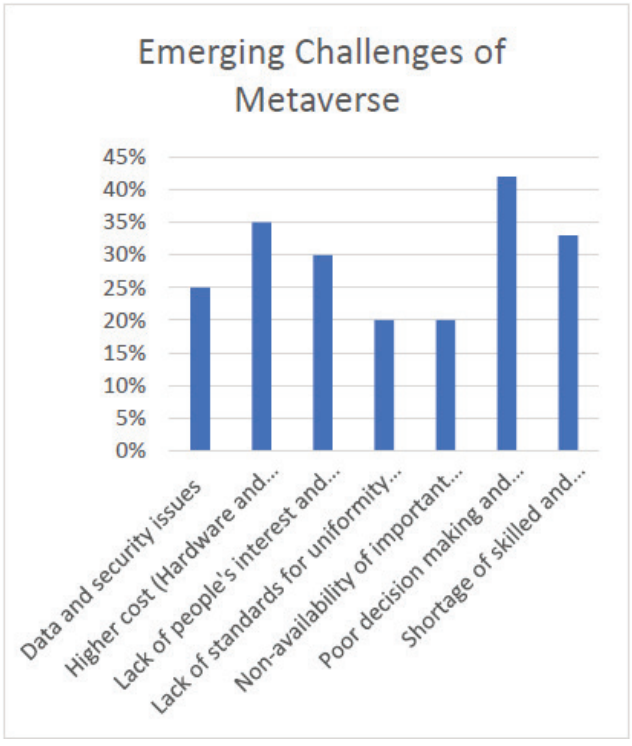


Fig. 5. Potential barriers to Metaverse

The graph in figure 3 shows that almost 42 percent respondents find poor decision making and lack of support from top leaders as one of the major problem with the current metaverse experience. Other challenges cropping in the same area includes: higher cost (35 percent), shortage of experienced workforce (33 percent), lack of individuals readiness (30 percent), data and security issues (25 percent), lack of interoperability and uniformity standards (20 percent), and non-availability of enabling technologies of metaverse (20 percent).

Table 2: Metaverse for Circular Economy

S.No.	Variables	Responses (In Percentage)					
		Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Don't Know
i	Metaverse is a role model to transition to a circular innovation without waste	9.5	42.9	28.6	14.3	4.7	0
ii	Today's high tech and high touch technologies drive significant sustainability benefits by shifting from a real-world experience to a sustainable virtual option	18	33.3	20.6	20	4.1	4
iii	Metaverse is a remunerative space for businesses to interact and communicate with their target audience through delivering new experiences and information	21.8	35.3	12.3	23.8	2	4.8
iv	Adoption of metaverse technologies significantly impacts the environment and leads to better decision making through collaboration	15	40.3	17.4	19.3	6	2
v	Implementation of metaverse increases resource efficiency by simulating and integrating the data with the working conditions for the entire production lines and the humans, as intended thereby reducing waste, saving energy and reusing resources	12.2	38.4	18	18.1	12.3	1
vi	Metaverse is a safe place for Gen Z and Millennials to establish social connections and maintain their unique digital identity	5.6	52.4	15.7	14.3	5	7

DISCUSSION AND RECOMMENDATION

The demographic profile as shown in Table #1 illustrates a growing interest to explore and embrace immersive experiences among the digital natives i.e. millennials and Gen Z. However, the study is not limited to this demographic. Respondents from different generations have also shown varying levels of familiarity with the Metaverse adoption and benefits for promoting a circular economy. The findings of the study reveal that Metaverse provides a wide range of opportunities across industries but the potential of Metaverse is extensive in the education industry. Almost 67 percent of the respondents believe that it will transform the traditional learning model into a more interactive, experiential, collaborative, immersive and personalized model, without any physical limitations. Communities will use this emerging technology for effective learning and development initiatives by providing VR/AR simulations and training scenarios involving high-risk operations to improve learning outcomes and information retention. This grandiose idea can facilitate a better understanding of global connections, issues and cultural diversity. Han (2022) also demonstrated that the use of immersive technologies in education will contribute to society's sustainability. Aligned with that effort, Park and Kim (2022) stated that by providing opportunities for gamification in learning processes, Metaverse can create a sustainable learning environment which provides equal learning opportunities regardless of special needs (Spandagou, 2021; Sahli Lozano, Wüthrich, Büchi, & and Sharma, 2022) across the globe. Thus, we can say that Metaverse is shaping the future of the education industry. Moreover, it will also revolutionize other industry services: designing, testing, marketing and branding roles. Organisations will use these technologies for engaging and creating personalized interactions with customers for a better experience (such as virtual product demos, immersive shopping experiences or customer service). Also, by moving their product design and testing to a virtual platform, businesses will help designers and engineers to visualize and test products in a virtual environment to improve the efficiency and competitiveness of the respective industry. Furthermore, it will enhance marketing and advertising efforts by providing more engaging and interactive experiences for customers such as brand activations and product launches, Hence, ensuring impactful brand advertising. The study further indicates that the integration of virtual entities into the real world has generated a lot of positive sentiments such as optimism, innovation, comfort and excitement amongst individuals and businesses about its impact on society. However, there are a few respondents who are uncomfortable and sceptical about its impact on sustainable development. Similarly, due to the evolving and complex nature of Metaverse, the majority of the respondents feel that they lack a comprehensive understanding of its adoption in their businesses, leading

to an average or low competence level at a job. While a moderately high number of respondents lack familiarity with the technology and are uncertain about their competence level. The findings from the data analysis demonstrates that almost 60 percent respondents feels that the virtual platform provides a safe, inclusive and diverse environment for Gen Z and Millennials to establish social connections without revealing their true identity in the form of customizable Avatars.

Most specifically, by generating vast amounts of data on user preferences, interactions, behaviours and patterns, Metaverse creates an ecosystem wherein simulation of different patterns and scenarios offers businesses an opportunity to optimize circular product concepts in reference to ownership access, manufacturing processes, supply chains, resource allocation, energy management, waste management, resilient strategies and carbon emission reduction. By replacing physical goods, services and spaces with the digital counterparts within the virtual environment, Metaverse can help to minimize energy consumptions in certain areas, waste generation, carbon footprints, disaster prediction time (Kwon, Yun, & Kim, 2022) and other environmental impacts, thereby contributing to dematerialized future (Davies-Filleur, 2022; Townsend, 2022). The data in the table 2 presents that virtual environment fosters communication, innovation and cross disciplinary collaboration regardless of geographical boundaries. Collaboration is believed to be a key in transitioning to a resilient circular economy. Hence, what can lead to sustainable practices is the better decision making, creation of global community and collective intelligence through effective collaboration. The obtained findings reveal that 3D technologies have the potential to generate a multitrillion dollars economy across the world. The study is in line with the previous research studies conducted by Buhalis et al. (2022) that stated the metaverse will bring more sustainability across industries. In a similar vein, Tozzi (2022) presented a significant impact of 3D spaces on social, economic and environmental sustainability around the world. However, the majority of businesses, organisations or institutions are still struggling in aligning the potential benefits and applications of metaverse with their industry. This is due to a lack of individual readiness, awareness, inadequate competence, skills, expertise, resistance to change, lack of support from top management, data privacy or security issues and the upfront costs involved in relation to Metaverse.

It is important to note that while the metaverse is still in its early stages of evolution, the initial cost and investment associated with its implementation and operations such as network infrastructure, hardware, software, content creation etc. are high but we strongly believe that as the technology matures and with the gain of more experience and understanding of Metaverse standards and protocols, it would be much easier for businesses, organisations or individuals to optimize their operations and reduces the cost over time. Prieto et al. (2022) opined that implementation of 3D platforms is still in formative stage and hence, requires significant efforts across multiple areas to lay the foundation for sustainable practices. Likewise , the study by Deloitte predicts that the Metaverse could boost the Indian economy by 79 billion U.S. dollars to 148 billion U.S. dollars annually by 2035 while global metaverse economy is expected to rise to 936.6 billion U.S. dollars by 2030 (Statista, 2023). At the same time, as the technology opens up new avenues for economic growth, it is imperative for the leaders to engage respective stakeholders including, employees, customers, investors, vendors and regulators in strategic planning, mitigating resistance through effective change management and decision making processes related to potential impact of Metaverse on achieving circular business models. Also, leaders must promote a culture of continuous learning, training and support for stakeholders to help generate the readiness to the technology and maximise the benefits of digital landscape. As evidenced above, leaders must also foster collaboration to drive innovation, interaction and integration of the best practices within an immersive space that allows for designing simulations leading to processes optimization, upcycling of product lifecycles, energy efficiency, waste and carbon emission reduction.

CONCLUSION AND FUTURE SCOPE

While people are quite optimistic and excited about the innumerable possibilities facilitated by 3D technologies such as new markets, job creation, effective communication , integration, interaction, inclusiveness, accessibility, collaborations, sustainability, and environmental impact across various fields as education,

creativity, gaming, business, healthcare, tourism research and others, it's important to uphold ethical, privacy, security and interoperability concerns when adopting and implementing Metaverse to help visualise the scenarios for achieving sustainable development of the environment, economy, community and people. Additionally, addressing the shortage of experience, well-educated and skilled workforce may take time but through proper education, awareness, training and support from the leaders it can be improved over time.

Taking inspiration from the transformation of a traditional linear model to a reuse-recycle-regenerate model, we would like to conclude by saying that to achieve the principles of sustainability through Metaverse, it is essential for businesses, organisations and institutions to embrace digital transformation. At the same time, it is imperative for communities to adopt a sustainable behaviour with a digital transformation mindset to serve the best interest of the environment and society as a whole.

Further, since Metaverse is still in an evolving phase, the study may have limitations in terms of scope and depth of its role in enhancing circular economy and its implications on society. Also, the study' small sample size can lead to limited generalizations of findings and potential bias.

On a whole, Metaverse holds a tremendous scope for revolutionizing business and society but since it is still in its early stages, its future implications, benefits and challenges are yet to be realised in reality. To explore the concept further, an ongoing research is necessary to gain deeper insights into ethical, psychological, cultural, societal and environmental implications of virtual space along with the creation of supportive legal, security, privacy and interoperability standards that balances innovation and user experiences.

REFERENCES

1. Ajwani-Ramchandani, Raji. and Bhattacharya, Sonali (2022): Moving towards a circular economy model through I4.0 to accomplish the SDGs. Elsevier: Cleaner and Responsible Consumption, Vol. 7, 100084
2. Allam, Z.; Sharifi, A.; Bibri, S.; Jones, D.; Krogstie, J. The metaverse as a virtual form of smart cities: Opportunities and challenges for environmental, economic, and social sustainability in urban futures. Smart Cities 2022, 5, 771–801
3. Ball, M. (2021) Framework for the Metaverse. Available online: https://www.matthewball.vc/all/forwardtothemetaverseprimer (Accessed on 20 March 2023).
4. Bosworth, A.; Clegg, N. Building the Metaverse Responsibly. Available online: https://about.fb.com/news/2021/09/building-the-metaverse-responsibly/ (Accessed on 20 March 2023).
5. Buhalis, D., Lin, M.S. and Leung, D. (2023), "Metaverse as a driver for customer experience and value co-creation: implications for hospitality and tourism management and marketing", International Journal of Contemporary Hospitality Management, Vol. 35 No. 2, pp. 701-716. https://doi.org/10.1108/IJCHM-05-2022-0631
6. Chauhan, C., Sharma, A. and Singh, A. (2021), "A SAP-LAP linkages framework for integrating Industry 4.0 and circular economy", Benchmarking: An International Journal, Vol. 28 No. 5, pp. 1638-1664. https://doi.org/10.1108/BIJ-10-2018-0310
7. Davies-Filleur, C. Is the metaverse a tool for sustainable development? Polytechnique Insights. 22 September 2022. Available online: https://www.polytechnique-insights.com/en/braincamps/digital/metaverse-hopes-promises-and-unknowns/is-the-metaverse-a-tool-for-sustainable-development/ (Accesses on 27 March 2023).
8. Dwivedi, Y.K.; Hughes, L.; Baabdullah, A.M.; Ribeiro-Navarrete, S.; Giannakis, M.; Al-Debei, M.M.; Dennehy, D.; Metri, B.; Buhalis, D.; Cheung, C.M.; et al. Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. Int. J. Inf. Manag. 2022, 66, 102542.
9. E. Ingemarsdotter, E. Jamsin, G. Kortuem, R. Balkenende (2019): Circular strategies enabled by the internet of things—a framework and analysis of current practice. Sustainability, 11 (2019), p. 5689.
10. Han, J. (2022): An information ethics framework based on ICT platforms. Information 2022, 13(9), 440. https://doi.org/10.3390/info13090440
11. Literary Studies, 19(1), 17–47. doi:10.5325/intelitestud.19.1.0017
12. Herrman, J.; Browning, K. Are we in the metaverse

yet? The New York Times, 29 October 2021. (Accessed on 14 March 2023)

13. Hoffman, D.L.; Moreau, C.P.; Stremersch, S.; Wedel, M. The rise of new technologies in marketing: A framework and outlook. J. Mark. 2022, 86, 1–6.

14. Hollensen, S., Kotler, P., & Opresnik, M. O. (2023). Metaverse: The new marketing universe. Journal of Business Strategy, 44(3), 119-125. https://doi.org/10.1108/JBS-01-2022-0014

15. Joshua, J. (2017). Information Bodies: Computational Anxiety in Neal Stephenson's Snow Crash. Interdisciplinary Literary Studies, 19(1), 17-47. Doi: 10:5325/intelitestud.19.1.0017

16. Kirchherr, Julian and Reike, Denise and Hekkert, Marko, Conceptualizing the Circular Economy: An Analysis of 114 Definitions (September 15, 2017). Available at SSRN: https://ssrn.com/abstract=3037579 or http://dx.doi.org/10.2139/ssrn.3037579

17. Kwon, J.; Yun, S.; Kim, W. (2022): A semantic data-based distributed computing framework to accelerate digital twin services for large-scale disasters. Sensors 2022, 22(18) 6749. https://doi.org/10.3390/s22186749Literary Studies, 19(1), 17–47. doi:10.5325/intelitestud.19.1.0017

18. Judy Joshua. Information Bodies: Computational Anxiety in Neal Stephenson's Snow Crash. Interdisciplinary Literary Studies, 19(1):17–47, 2017. Publisher: Penn State University Press.

19. Mystakidis, S. Metaverse. Encyclopedia 2022, 2(1), 486–497.

20. Ning, H.; Wang, H.; Lin, Y.; Wang, W.; Dhelim, S.; Farha, F.; Daneshmand, M. (2021)A Survey on Metaverse: The State-of-the-art, Technologies, Applications, and Challenges. arXiv 2021,arXiv:2111.09673.https://doi.org/10.48550/arXiv.2111.09673

21. Park, S.; Kim, S. Identifying world types to deliver gameful experiences for sustainable learning in the metaverse. Sustainability 2022, 14, 1361

22. Sahli Lozano, C., Wüthrich, S., Büchi, J.S., and Sharma, U. (2022). The concerns about inclusive education scale: dimensionality, factor structure, and development of a short-form version (CIES_SF). International Journal of Educational Research. 111.101913. doi:10.1016/j.ijer.2021.101913

23. Singh, R.; Akram, S.; Gehlot, A.; Buddhi, D.; Priyadarshi, N.; Twala, B. Energy System 4.0: Digitalization of the energy sector with inclination towards sustainability. Sensors 2022, 22, 6619.

24. Spandagou, I. (2021). Inclusive education is another country: developemnts. Obstacles and resistance to inclusive edication. International Journal of Inclusive Education., 1-15. Doi: 10.1080/13603116.2021.1965805.

25. Townsend, S. Could the metaverse & web3 save sustainability? Forbes. 29 September 2022. Available online: https://www.forbes.com/sites/solitairetownsend/2022/09/29/could-the-metaverse--web3-save-sustainability/?sh=bdbf76364633/ (Accessed on 17 April 2023).

26. Tozzi, C. Will the Metaverse Help or Hinder Sustainability? ITPro Today. 10 June 2022. Available online: https://www.itprotoday.com/sustainability/will-metaverse-help-or-hinder-sustainability (Accessed on 23 May 2023).

27. Zaman, U.; Koo, I.; Abbasi, S.; Raza, S.; Qureshi, M. Meet your digital twin in space? Profiling international expat's readiness for metaverse space travel, tech-savviness, COVID-19 travel anxiety, and travel fear of missing out. Sustainability 2022, 14, 6441.

28. Zhang, S.; Lim, W.; Ng, W.; Xiong, Z.; Niyato, D.; Shen, X.; Miao, C. Towards green metaverse networking technologies, advancements and future directions. arXiv 2022, arXiv:2211.03057.

29. Cedrik, Neike. (2022, Sept 21). Let's build the Industrial Metaverse together for a sustainable world.https://new.siemens.com/global/en/company/insights/lets-build-the-industrial-metaverse-together-for-a-more-sustainable-world.html (Accessed on 12 June 2023)

30. Kelsey, Anderson. (2022, June 19). Study- Only 16 of people understand what metaverse is. https://www.deptagency.com/insight/study-only-16-of-people-understand-what-the-metaverse-is/ (Accessed on 12 June 2023)

31. Parimal, Priyadarshi. (2023, Mar 9). Into The Metaverse: How India Can Leverage The Multi-Billion Dollar Opportunity. https://inc42.com/resources/into-the-metaverse-how-india-can-leverage-the-multi-billion-dollar-opportunity/ (Accessed on 14 June 2023)

32. Thomas, Alsop. (2023, Apr 12). Metaverse Market Size. https://www.statista.com/statistics/1295784/metaverse-market-size/ (Accessed on 14 June 2023)

Multiple Disease Prediction using Machine Learning

Jyoti Kharade
✉ Jyoti.kharade@bharatividyapeeth.edu
Shraddha Shinde
✉ shraddhashinde959@gmail.com
Prerana Niwate
✉ prerana.niwate11@gmail.com
Harshal Pant
✉ harshalpant007@gmail.com
BVIMIT, University of Mumbai
Navi Mumbai, Maharashtra

ABSTRACT

Due to advancements in technology like Artificial Intelligence and Machine learning (AIML) Healthcare sector has undergone changes, which makes disease prediction accurate and fast. Accurate and speedy prediction of multiple diseases may significantly improve early detection and treatment thus improving patients health and reducing healthcare expenditures. Various diseases such as Heart Disease, Parkinson's Disease and Diabetes can be predicted using Machine Learning Algorithms and deployed using Streamlit. Support Vector Machine(SVM) algorithm is supervised machine learning algorithm that classifies data by finding a hyperplane for dividing data points on different classes. This paper helps to identify the importance of machine learning algorithm in health sector and how it helps to cure people at early stage. The training model takes sample data and then trains it to predict disease based on it.

KEYWORDS: *Machine learning, Support Vector Machine (SVM), Streamlit, Heart disease, Parkinson's disease, Diabetes.*

INTRODUCTION

Machine learning has made significant progress in healthcare and other sector. Machine learning algorithms may predict many diseases simultaneously, which could enhance medical diagnostics and patient outcomes. This study uses the Support Vector Machines (SVM) model to predict the occurrence of three common diseases: heart disease, diabetes, and Parkinson's and is deployed using Streamlit. Heart disease, diabetes, and Parkinson's disease are major public health issues affecting individuals and healthcare systems globally. Early detection and correct diagnosis of many issues improve patient outcomes, improve treatment options, and lower healthcare costs. An large data set will be used to train the model, which will serve as a basis for disease risk assessments. Support Vector Machine (SVM) is the supervised machine learning algorithm used for classification. Using the various patient data available a dataset was created. SVM model was trained on this dataset to study the input parameters and the relationship between them to predict the disease present. This application offers three options each for choosing diabetes, heart disease, parkinson's disease. It helps healthcare providers in making immediate decisions, provide required treatment and arrange necessary healthcare systems. SVM model's analysis help to predict the diseases.

LITERATURE REVIEW

Multiple Disease Prediction using Machine Learning

In [1] it delves into the transformative impact of machine learning on healthcare, particularly in the realm of disease prediction. By leveraging machine learning algorithms, healthcare professionals can predict multiple diseases simultaneously, enhancing early diagnosis and treatment efficacy while reducing costs. The paper provides an overview of various machine learning models and data sources commonly utilized for disease prediction, emphasizing the significance of feature selection, model evaluation, and integration of diverse data modalities. The findings underscore the potential of machine learning in multi-disease prediction, offering promising prospects for improving public health outcomes.

Heart Disease Prediction

The [2] used several machine learning techniques, including Decision Trees, Random Forests and Support Vector Machines (SVM), to predict heart disease. Their findings revealed that Random Forest had the highest accuracy, showing its potential for accurate prediction. Similarly, [3] created a deep learning model that predicts coronary artery disease using convolutional neural networks (CNNs). The model outperformed standard risk scores, indicating the effectiveness of deep learning in predicting heart disease.

Diabetes Prediction

Paper [4] investigated the use of machine learning algorithms for diabetes prediction with medical records. Their results showed that ensemble methods such as Random Forest and Gradient Boosting Machines (GBM) outperformed classic logistic regression models in predicting diabetes onset, highlighting the need of using sophisticated machine learning techniques to make accurate predictions. In [5], it has used artificial neural networks (ANN) to predict diabetes risk based on medical and demographic data. The ANN model demonstrated great sensitivity and specificity in identifying persons at risk of developing diabetes, highlighting neural networks' potential for disease prediction and prevention.

Parkinson's Disease Prediction

The [6] studied the application of machine learning algorithms to predict the severity of Parkinson's disease symptoms using voice recordings. They discovered that support vector regression (SVR) had the highest accuracy in predicting symptom severity, indicating its potential use in disease diagnosis and therapy.[7] also used machine learning techniques like logistic regression and decision trees to predict Parkinson's disease onset using medical and genetic characteristics. Their findings suggested that Parkinson's disease could be detected early and its risk assessed.

Integrated Prediction of Multiple Chronic Diseases Using Machine Learning

The [8] suggested a machine learning-based system for the integrated prediction of several chronic diseases, including heart disease, diabetes, and hypertension. They used a combination of feature selection approaches and ensemble learning algorithms to forecast the risk of having these diseases at the same time. The study established the viability of a unified prediction model for several chronic illnesses, which provides a comprehensive approach to disease treatment and prevention.

METHODOLOGY

The proposed methodology for this project involves analysing multiple disease prediction models and comparing their performance. Implementing the Support Vector Machines (SVM) model achieved 82.96% accuracy. The technique uses different libraries, including pandas for data handling and filtering, numpy for numerical operations, scikit-learn for model training and testing, and pickle to export trained models for future usage in applications.

Data Handling and Filtering

The first step in implementing a project is to manage and filter data with the pandas library. This involves loading the dataset from a CSV file, separating the input features and target variable, and doing any necessary preprocessing procedures like handling missing values or encoding categorical variables.

Model Selection

After pre-processing and splitting the data, select the appropriate machine learning model for the problem.

SVM Model Training

The SVM model has the best accuracy of 82.13% will be chosen. To achieve optimal performance, the SVM model will be implemented with appropriate hyperparameters, including kernel and normalisation.

Model Evaluation

The trained SVM model will be tested on a large dataset. Evaluation criteria, such as accuracy will be used to evaluate the model's performance. The model's hyperparameters may be fine- tuned using cross-validation to improve performance.

Exporting Trained Model

After training the SVM model, it will be exported using the pickle library. This allows the model to be

reused in future applications without the requirement for retraining. Loading the exported model allows for disease prediction in real-life situations.

Integration with Application

The final step in implementation is deploying the trained SVM model into an application. The model can be integrated into a user- friendly interface, allowing for disease prediction with new data input. The integration will allow healthcare professionals to use the model to determine risk of illness and make cautious choices.

Monitoring and Maintaining

At last, it is important to monitor and maintain the model over the time to ensure that it works well with new data. This can be done by modifying parameters or retraining the model.

Methodology used is to choose the highest accuracy SVM model, implementing it using libraries like pandas, numpy, scikit-learn, and pickle, and integrating it into a multiple disease prediction application. The implementation improves disease prediction accuracy and offers a user-friendly solution for risk assessment and decision making. Figure No 1 depicts the work flow.

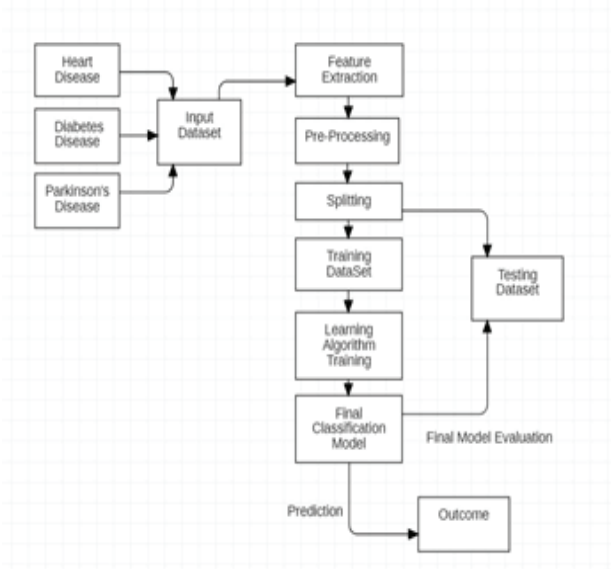


Fig. 1. Work flow

RESULT

Algorithm used and their accuracy using SVM model for respective disease are as depicted in Figure 2.

Disease Name	Algorithm	Accuracy (%)
Diabetes	SVM	77.27
Heart Disease	SVM	81.96
Parkinson's Disease	SVM	87.17

Fig. 2. Accuracy for SVM for various diseases

Figure 3 shows the confusion matrix for Diabetes Figure 4 shows confusion matrix for Heart Disease. Figure 5 shows confusion matrix for Parkinson's Disease. Application interfaces is depicted in figures 6 and 7.

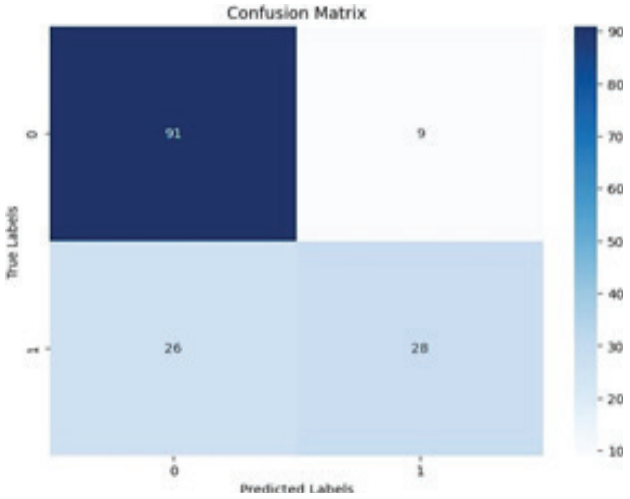


Fig. 3. Confusion matrix for Diabetes

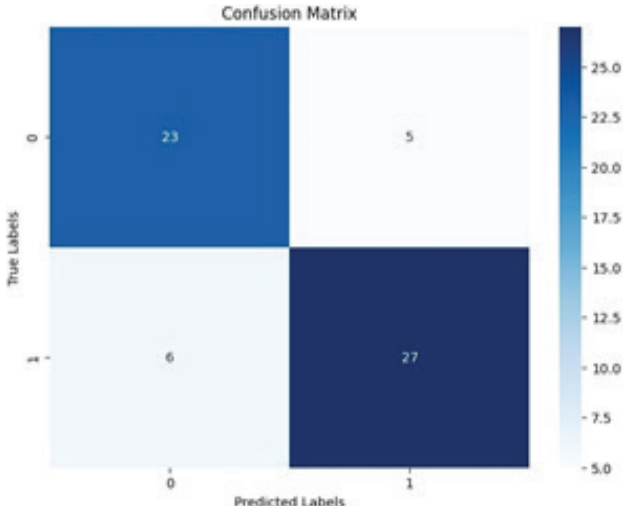


Fig. 4. Confusion matrix for Heart Disease

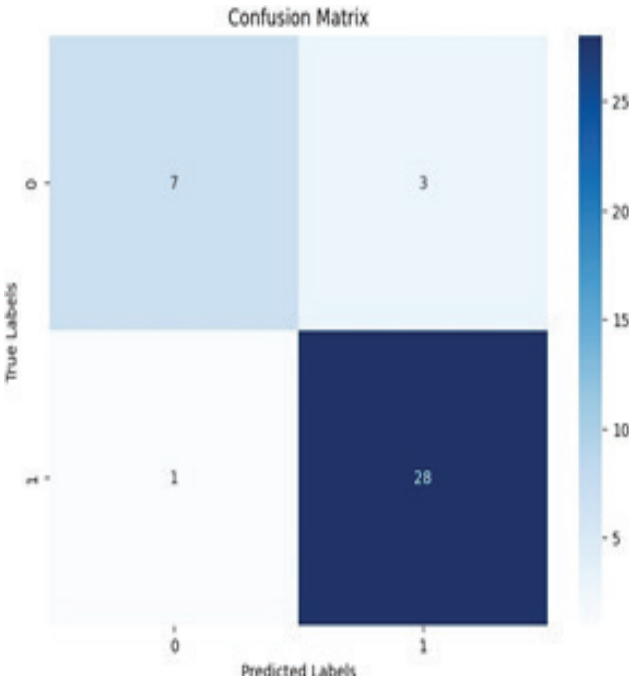


Fig. 5. Confusion matrix for Parkinson's Disease

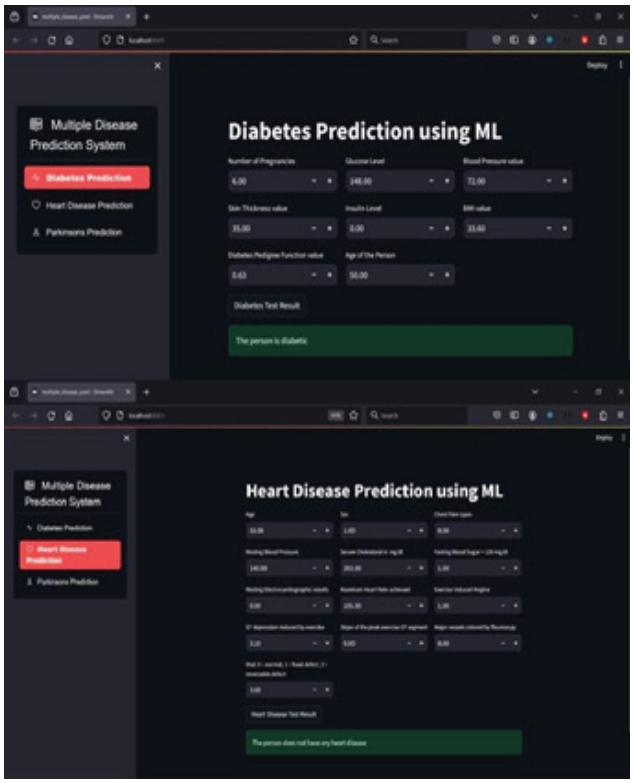


Fig. 6. Application Interface

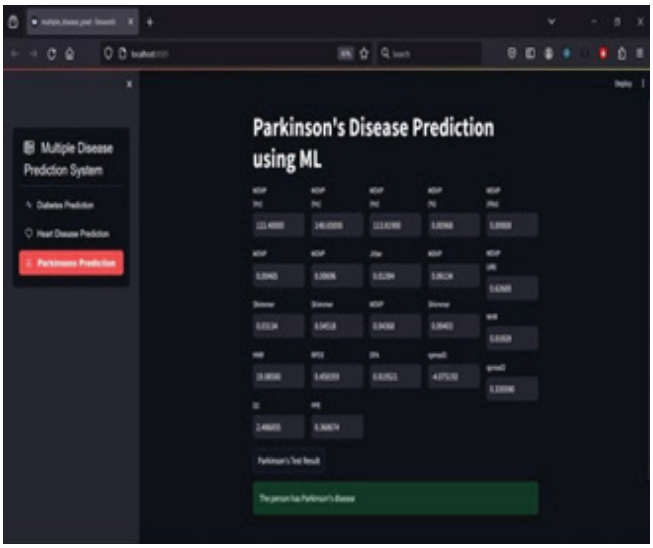


Fig. 7. Application Interface

V. CONCLUSION

In this paper, three diseases are predicted considering required parameters as input, the models estimate whether the person is have any disease or not. There is a possibility that the disease exists or does not. There are models for diabetes, Parkinson's disease, and heart disease in the system. The researchers used unique datasets for each disease to train each model in the system using the SVM technique. With an accuracy of 87.17%, the Parkinson's disease model had the highest performance. At 77.27%, the diabetes model had the highest accuracy. In the end, the heart cancer model with support vector machines produced the best accuracy of 81.96% while evaluating data.

REFERENCES

1. Parshant, & Dr. Anu Rathee. (Year not provided). "Multiple Disease Prediction using Machine Learning." Department of IT, Maharaja Agrasen Institute of Technology, Delhi, India.
2. Dey, S., & Bhattacharyya, D. K. (2016). "Heart Disease Prediction using Machine Learning."
3. Krittanawong, C., Johnson, K. W., Rosenson, R. S., Wang, Z., Aydar, M., Baber, U., & Min, J. K. (2018). "Deep learning for cardiovascular medicine: A practical primer." European Heart Journal
4. Kavakiotis, I., Tsave, O., Salifoglou, A., Maglaveras, N., Vlahavas, I., & Chouvarda, I. (2017). "Machine

learning and data mining methods in diabetes research." Computational and Structural Biotechnology Journal.

5. Mishra, R., Mohanty S., & Mishra, M. (2018). "An investigation of artificial neural networks (ANNs) for the prediction of diabetes using medical and demographic data." International Journal of Advanced Computer Science and Applications, 9(6), 378-384.

6. Tsanas, A., Little, M. A., McSharry, P. E., & Ramig, L. O. (2012). "Accurate telemonitoring of Parkinson's disease progression by noninvasive speech tests." IEEE Transactions on Biomedical Engineering, 59(9), 2196-2205.

7. Arora, S., & Venkataraman, V. (2020). "Predictive Modeling of Parkinson's Disease using Machine Learning Techniques." International Journal of Computer Applications, 175(10), 38-42

8. Suresh, R., Prakash, J., & Saravanan, V. (2019). Integrated Prediction of Multiple Chronic Diseases Using Machine Learning. International Journal of Engineering Research & Technology, 8(7), 159-164

9. www.researchgate.net/publication/369844267_A_Review_HeartDisease_Prediction_in_Machine_Learning_Deep_Learning

Student Marks Prediction System using Machine Learning Algorithms

Aditi Ranganathan
✉ aditiranganathan43783@gmail.com

Nikita Mangaonkar
✉ nikhita.mangaonkar@spit.ac.in

Arshita Sallagari
✉ arshitasallagari1451@gmail.com

MCA Department
Sardar Patel Institute of Technology
Mumbai, Maharashtra

ABSTRACT

Educational institutions have a vital role in ensuring the success of their students by providing high-quality education. One effective strategy is to proactively assess students' academic performance and implement targeted interventions to improve both learning outcomes and teaching practices. The ability to predict student performance early in their academic journey empowers educators to tailor their teaching strategies and provide students with the necessary support right from the start. The ability to predict student performance proves invaluable as it empowers teachers to formulate strategies for improvement at the early stages of a student's academic journey. The incorporation of machine learning, both supervised and unsupervised techniques, has greatly facilitated the development of applications that enable teachers to analyze student performance more effectively than traditional methods. This project explores the use of linear regression, a basic statistical technique, to predict student performance in the coming future. By analyzing the relationship between studying hours and academic achievement, the model aims to forecast future marks. The model aims to demonstrate the potential of this approach in supporting educators by providing insights into student learning patterns and potentially informing educational interventions. This paper will delve into each of the underlying technologies essential for creating and implementing such an application.

KEYWORDS: *Machine learning, Logistic regression, Linear regression, Marks prediction system.*

INTRODUCTION

Within the field of educational analytics, the creation of prediction models has become essential to enabling a proactive and customized strategy for student achievement. Analyzing students' marks beforehand has become important as it helps parents and teachers to know and manage the schedule of the student in order to improve his performance in the upcoming exam. This will also give a rough idea to the student regarding how much more effort he/she has to put in order to improve his/her grade in the upcoming exams. Also, it will help brilliant students to track their marks and thereby increase their confidence overall. This paper presents a Student Marks Prediction System that combines logistic regression and linear regression models to predict academic success. The prediction model takes into account two different scenarios: one that is modeled using linear regression and is based on study hours and previous year %, and the other that uses logistic regression and is based on entrance test scores (such as JEE and NEET).

The integration of linear regression aims to discern patterns in student performance by analyzing the correlation between the number of study hours invested and the previous year's academic achievements. This approach provides educators and students with insights into the potential impact of study habits on forthcoming academic outcomes.

For the prediction of performance in competitive exams like JEE and NEET, logistic regression is employed, leveraging past exam scores as predictors. This model assists in identifying students likely to succeed in these

exams, aiding educational institutions in tailoring support and resources for aspirants pursuing careers in fields such as engineering and medicine.

The system's foundation lies in the belief that understanding and harnessing these predictive insights can empower educators and administrators to implement targeted interventions, offering additional support to students who may face academic challenges. By combining traditional academic metrics with exam-specific predictors, the Student Marks Prediction System aspires to contribute to a data-driven educational landscape, fostering student success and optimal resource utilization.

PROBLEM DEFINITION

Teachers grapple with fostering self-directed learning among students and are in search of methods to make lessons and homework more enjoyable, accessible, and focused on addressing individual weaknesses. The challenge extends to designing meaningful learning outcomes and efficiently measuring student potential, all while simplifying the administrative burden for teachers. Automation of assessment processes for real-time feedback becomes paramount. Teachers also face the need for diverse assessment methods catering to varying skill levels. Balancing innovation in teaching with simplicity proves challenging. The considerable time and effort invested in curriculum development, teaching, and assessment creation, followed by grading and extensive reporting, divert attention from the core educational mission. The central issue revolves around time constraints and a lack of proactive information, hindering teachers from providing personalized development strategies for each student to excel in upcoming exams.

LITERATURE SURVEY

The existing work(September 2022) offers actionable steps for educational growth, aiding institutions' reputation. The software supports pedagogical interventions through machine learning, with the Random Forest classifier achieving 85% accuracy in grade prediction[1]. The existing study(2022) employs classification techniques, including SVM, RF, decision tree, and KNN algorithms, to foresee student performance reliant on training and test data. The Random Forest algorithm showed the highest accuracy at 74%, aiding early identification of at-risk students for improved future performance[2]. Another research(2021) proposes an automated approach for accurate student mark and grade prediction. The study groups students based on similar education histories, enhancing accuracy. Using a GA-based decision tree classifier and regression, the system achieves a remarkable 96.64% classification accuracy and a 5.34 Root Mean Square Error for mark prediction[4].

The paper utilizes ML techniques, such as binomial logistic regression and decision tree, for student academic growth analysis, aiding instructors in informed decision-making, with plans to enhance accuracy through additional features in the future[5]. The authors proposed a model that utilizes a combination of decision tree, neural network, and SVM algorithms to achieve exceptional correctness in projecting student grades. The paper also discusses the contributors to student success and provides insights into how Machine learning can be harnessed to enhance educational outcomes[6]. The research introduces an innovative approach to predicting students' future results within degree programs by leveraging a method that clusters courses by utilizing latent factor models[7].

PROPOSED SYSTEM

The intention of the specified model is to utilize predictive modeling to anticipate the academic success of students throughout their learning journey using a combination of linear regression for 10th and 12th-grade marks prediction where prediction is done mainly on the basis of number of hours of study per week and previous year percentage and logistic regression for JEE and NEET predictions where prediction of his success of passing or failing the exam is done on the basis of acquired marks.

MACHINE LEARNING ALGORITHMS USED

Linear Regression Algorithm

Linear regression stands out as a well-known supervised learning method in the realm of machine learning. It specializes in regression tasks, aiming to construct a predictive model for a target value based on various

independent variables. Its primary purpose lies in identifying correlations among variables and making predictions. The nature of the relationship between independent and dependent variables, along with the number of independent variables considered, varies across different regression models. Specifically, linear regression predicts the forecasted outcome (y) by the values of the independent variable (x).

It is represented by-

$$y = \beta_0 + \beta_1 X_1 + ... + \beta_n X_n + \varepsilon$$

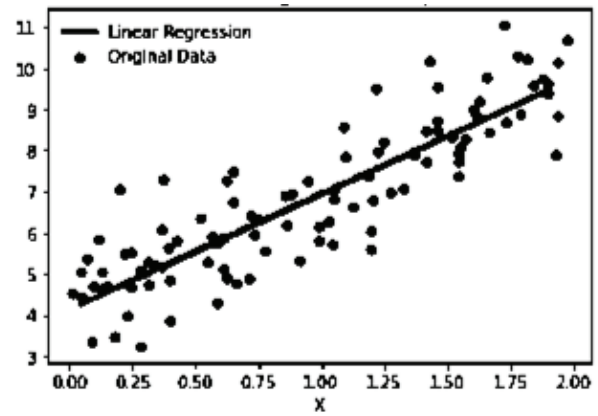


Fig. 1. Linear regression model

Logistic Regression Algorithm

Logistic regression serves as a supervised learning method employed in classification tasks. It forecasts the prospect of a data entry being assigned to a particular category, often represented as "1". In contrast to linear regression, which presupposes a linear connection between variables, logistic regression utilizes the sigmoid function to correlate input features with a probability output. This enables the anticipation of discrete results depending on a given set of input features.

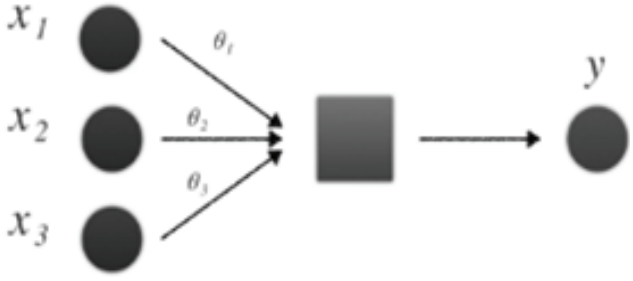


Fig. 2. Logistic regression model

Support Vector Machine (SVM)

A supervised ML algorithm for regression and classification is called SVM.It functions by identifying the hyperplane within the feature space that most effectively separates different categories. The distance between the hyperplane and the closest data point from each class is denoted as the margin, and SVM endeavors to make the most of this distance.

K-Nearest Neighbor (KNN)

KNN is a basic and easy-to-understand technique for regression and classification. To categorize a data point, we consider the predominant class among its k nearest neighbors in the feature space. The selection of k, or the number of neighbors, is an important factor influencing KNN performance.

Decision Trees

Decision Trees are straightforward and easy-to-understand approaches suitable for both regression and classification tasks. Their operation involves recursively partitioning the dataset based on the most influential feature at each node. With each split, a new branch is added to the tree, and this process continues until a stopping criterion is met or further splitting fails to enhance the model's performance

Random Forest

Random Forest is a technique in ensemble learning which amalgamates numerous decision trees to enhance performance and mitigate overfitting. It constructs a "forest" of trees by training each tree on a random subset of both the data and features. The ultimate forecast is determined by averaging or aggregating the predictions from each individual tree.

METRICS USED

Accuracy

$$\text{Accuracy} = \frac{\text{Number of correct predictions}}{\text{Total number of predictions}}$$

F1-Score

$$\text{Precision} = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

$$\text{Recall} = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

Area Under the ROC Curve (AUC-ROC)

An ROC curve illustrates the relationship between the true positive rate (sensitivity) and the false positive rate (1-specificity) across different thresholds or cutoff points used by a classification model.

AUC-ROC, quantifies the model's ability to distinguish between classes. A higher AUC value, ranging from 0 to 1, indicates better performance, with 1 representing a perfect classifier and 0.5 representing a classifier with no discriminatory ability beyond random chance.

Precision

It is characterized as the proportion of true positives in relation to the combined total of false positives and true positives.

$$\text{Precision} = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

Recall (Sensitivity or True Positive Rate)

It is articulated as the fraction derived from the division of true positives by the summation of true positives and false negatives.

$$\text{Recall} = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

METHODOLOGY

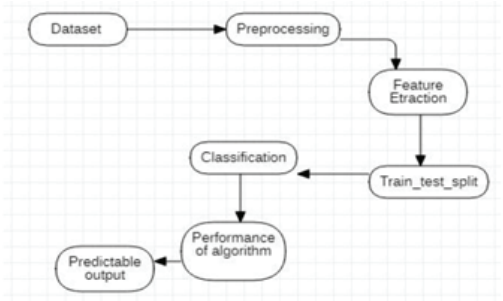


Fig. 3. Block Diagram

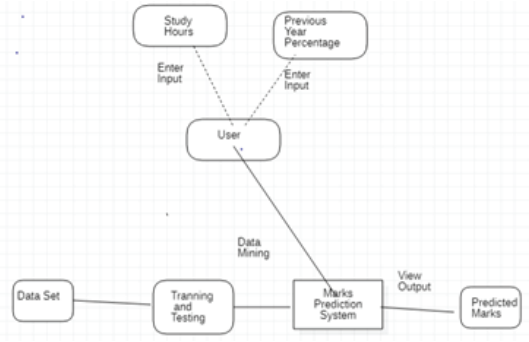


Fig. 4. Data Flow Diagram(SSC & other exams prediction)

Fig 5: Flowchart

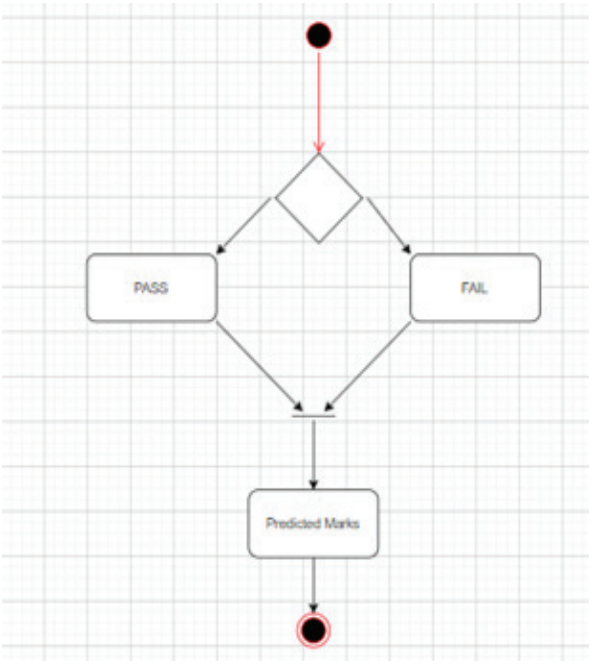


Fig. 6. Activity Diagram(JEE & NEET Prediction)

Data Collection

Dataset is collected containing information on students' hours of study per week, previous year percentage, and marks obtained in 10th and 12th grades. Data on

Fig 6.3: Flowchart

students who have appeared for JEE and NEET exams, along with their respective scores in these exams is also collected.

Data Preprocessing

Take care of outliers, missing numbers, and any other irregularities to clean up the dataset. Scale or normalize the numerical data, including the % from the prior year and the number of study hours each week.

Feature Selection

In our case, hours of study per week and previous year percentage are key predictors for 10th and 12th-grade marks. In case of JEE and NEET prediction, their scores become an important feature.

Linear Regression for 10th and 12th-grade Marks Prediction

Divide the dataset into sets for testing and training. Apply separate linear regression models for grades 10 and 12, utilizing variables such as weekly study hours and percentage from the prior year. Utilising the training set, train the models, then assess their effectiveness using the testing set.

Logistic Regression for JEE and NEET Prediction

In logistic regression, the outcome variable is binary (qualified or not qualified), therefore prepare the dataset for this analysis. Divide the data into sets for testing and training. Create distinct logistic regression models for JEE and NEET based on characteristics such as exam scores. Utilizing the training set, train the models, then assess their effectiveness using the testing set.

Model Evaluation and Validation

Assess the performance of both linear and logistic regression models using appropriate evaluation metrics.

Results and Interpretation

Analyze the results. The score for linear regression(i.e, SSC & HSC marks prediction) is approximately 96% whereas for logistic regression(i.e, JEE & NEET qualification prediction) the score is approximately 87%.

IMPLEMENTATION

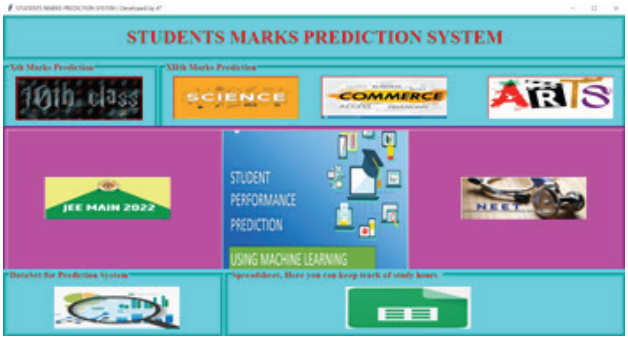


Fig. 7. Homepage

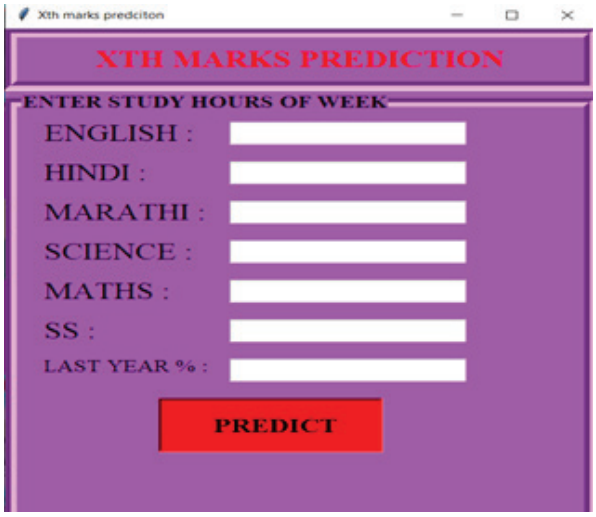


Fig. 8. SSC Window

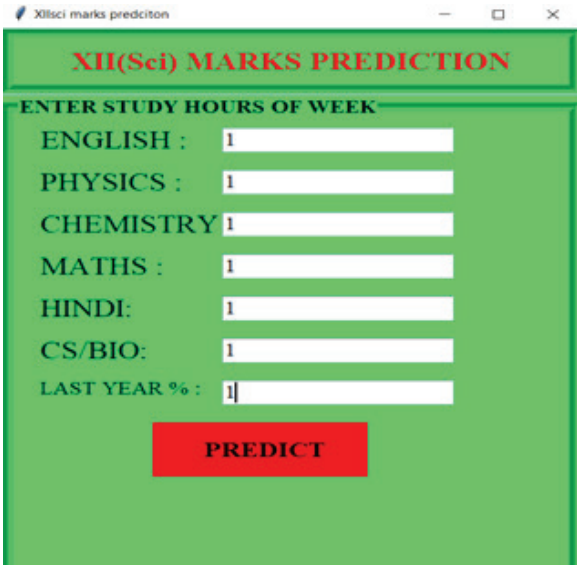


Fig. 9. HSC Window

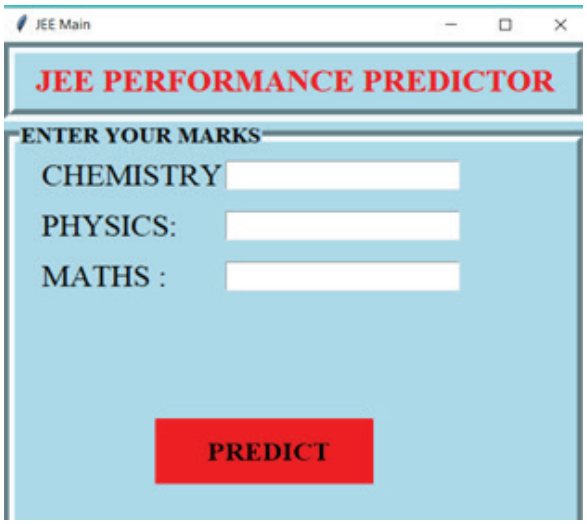


Fig. 10. JEE Window

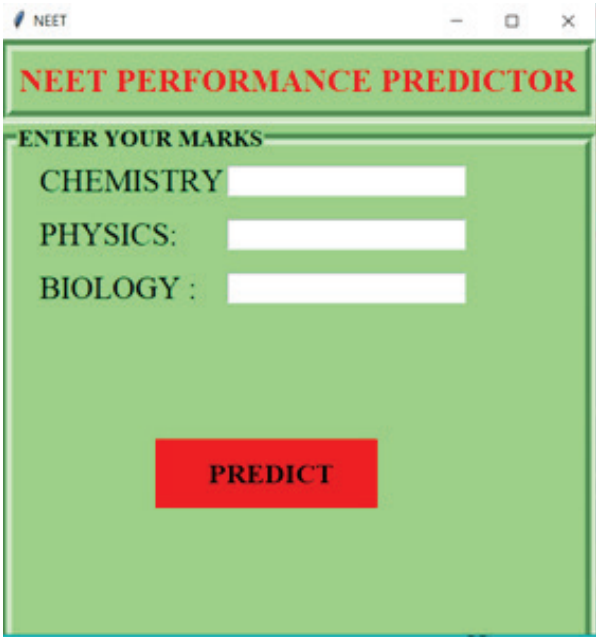


Fig. 11. NEET Window

LIMITATIONS

Only three factors are taken into account by the system: the number of study hours, the percentage from the prior year, and passing JEE/NEET (for those tests alone). This ignores a plethora of other important factors that impact academic achievement. The user's input has a significant impact on how accurate and exact predicted outcomes are. Due to the dataset's limitations, the model may not have enough data to fully represent all situations and correlations between variables, which could result in predictions that don't turn out to be correct. Our model does not make recommendations or suggestions based on the marks estimated.

RESULTS

Table 1. Performance comparison of various ML algorithms

Ml Algorithms/ Metrics	Feature				
	Accuracy	F1-Score	AUC	Precision	Recall
Logistic Regression	86.26	0.75	0.91	0.79	0.71
SVM	92.01%	0.85	0.98	0.91	0.80
Decision Tree	98.72%	0.98	0.98	0.99	0.97
KNN	93.61%	0.89	0.99	0.90	0.88
Random Forest	98.72%	0.98	1.00	0.99	0.97

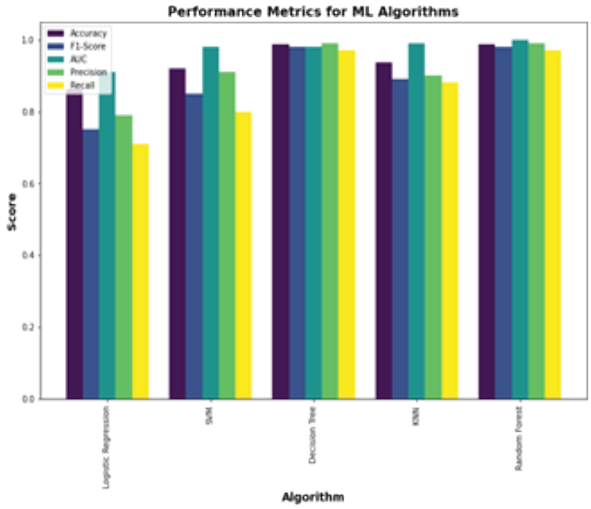


Fig. 12. Bar graph depicting performance comparison of various machine learning algorithms

CONCLUSION

In conclusion, the prediction of student performance can aid educators in formulating strategies for early intervention to enhance outcomes. With the evolution of machine learning techniques, including supervised and unsupervised methods, the development of such applications facilitates a more effective analysis of students compared to conventional approaches. In this study focusing on predicting student marks, educational achievement is forecasted based on variables such as current marks, prior year percentage, and study hours.

The model aims to predict the percentage achieved, and its accuracy is assessed accordingly.

FUTURE SCOPE

As of now, our system is focused on predicting the percentage, which can later be further improved by predicting CGPA (cumulative grade point). In the future, we can also provide an Excel sheet that will automatically calculate students' study hours per week and break time. Moreover, considering future developments, the .ipynb file can be converted to a .exe file, making it easily executable in Microsoft Windows.

ACKNOWLEDGMENT

We are thankful to our college faculties who assisted and guided us in preparing this research paper and also for helping us understand the basics of this subject. We also want to thank them for providing such confidence and most significantly the track for the subject whenever we needed it.

REFERENCES

1. Yudish Teshal Badal and Roopesh Kevin Sungkur, “Predictive modeling and analytics of students’ grades using machine learning algorithms” in Springer, September 2022.
2. A Harika, Akshatha K A, Anirudh A, Eesha B S and Prof. Sandhya A Kulkarni, “Student Marks Prediction Using Machine Learning Techniques” in IJCRT, July 2022.
3. Ellysa Tjandra, Sri Suning Kusumawardani and Ridi Ferdiana, “Student performance prediction in higher education: A comprehensive review” in AIP Conference Proceedings, April 2022.
4. Shah Hussain and Muhammad Qasim Khan, “Student-Performulator: Predicting Students’ Academic Performance at Secondary and Intermediate Level Using Machine Learning” in Springer, June 2021.
5. J.Dhilipan Jayaseelan, N Vijayalakshmi, s. Suriya and Christopher Arockiya, “Prediction of Students Performance using Machine learning” in IOP Conference Series Materials Science and Engineering, February 2021.
6. H.M. Rafi Hasan, AKM Shahariar Azad Rabby, Mohammad Touhidul Islam, and Syed Akhter Hossain, “Machine Learning Algorithm for Student's Performance Prediction” in IEEE , December 2019.
7. J. Xu, Kyeong H. Moon, and M. Schaar, “A Machine Learning Approach for Tracking and Predicting Student Performance in Degree Programs” in IEEE , April 2017.
8. Han, Meimei & Tong, Mingwen & Chen, Mengyuan & Liu, Jiamin & Liu, Chunmiao. (2017). Application of Ensemble Algorithm in Students' Performance Prediction.
9. Imran, Muhammad & Latif, Shahzad & Mahmood, Danish & Shah, Muhammad. (2019), “Student Academic Performance Prediction using Supervised Learning Techniques”. International Journal of Emerging Technologies in Learning (iJET).
10. E.Chandra and K.Nandhini, “Predicting Student Performance using Classification Techniques”, Proceedings of SPIT-IEEE Colloquium and International Conference, Mumbai, India,.
11. H. M. R. Hasan, A. S.A. Rabby, M.T. Islamand S. A. Hossain, "Machine Learning Algorithm for Student's Performance Prediction,"2019 10th International Conference on Computing, Communication and Networking Technologies (ICCCNT), Kanpur, India, 2019.
12. B. Sravani and M. M. Bala, "Prediction of Student Performance Using Linear Regression,"2020 International Conference for Emerging Technology (INCET), Belgaum, India, 2020
13.] K.AlMayahi and M.Al-Bahri, "Machine Learning Based Predicting Student Academic Success," 2020 12th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT), Brno, Czech Republic, 2020
14. R. Al Shabandar, A. Hussain, R. Keight and W. Khan, "Students Performance Prediction Using Machine Learning Algorithms," 2020 International Joint Conference on Neural Networks (IJCNN), Glasgow, UK, 2020
15. Hussain, M., Zhu, W., Zhang, W.etal.Using machine learning to predict student difficulties from learning session data. Art if Intell Rev 52,381–407 (2019)
16.]Shah, M.B., Kaistha, M. and Gupta, Y., 2019, November. Student performance assessment and prediction system using machine learning. In 2019 4th

International Conference on Information Systems and Computer Networks (ISCON) . IEEE.

17. Hasan, H.R., Rabby, A.S.A., Islam, M.T. and Hossain, S.A., 2019, July. Machine learning algorithm for student's performance prediction. In 2019 10th International Conference on Computing, Communication and Networking Technologies (ICCCNT), IEEE.

18. Zohair, A. and Mahmoud, L., 2019. Prediction of Student's performance by modeling small dataset size. International Journal of Educational Technology in Higher Education.

19. Gull, H., Saqib, M., Iqbal, S.Z. and Saeed, S., 2020, November. Improving the learning experience of students by early prediction of student performance using machine learning. In 2020 IEEE International Conference for Innovation in Technology (INOCON). IEEE.

Low-Code Platform for Business Process Management

Shravani Pawar
✉ pawarshravani81@gmail.com
Gunjan Behl
✉ mailto.gunjan83@gmail.com
Sudeshna Roy
✉ sroy.rnc@gmail.com
Ashutosh Nagargoje
✉ ashutoshnagargoje.8693@gmail.com
Master of Computer Applications
Bharati Vidyapeeth's Institute of Management and Information Technology
Navi Mumbai, Maharashtra

ABSTRACT

n efficient and structured business process management (BPM) will remove human error and superfluous tasks, which will reduce resource waste and operational costs, ultimately increasing productivity and profitability. Business process management (BPM) describes all the activities and operational procedures a business performs to achieve its objectives and goals.

Low-code development platforms (LCDPs) are intuitive visual environments that are becoming progressively popular as the go-to option for most major IT companies. They enable non-programmers to create software systems with little to no programming experience. Before using LCDP, it is important to understand and assess it because decision-makers may encounter difficulties if they find it difficult to choose among hundreds of heterogeneous platforms. For this reason, having specialized support to assess LCDP can help decision-makers choose the best platform for their needs by providing a detailed and detailed classification that details all of the low-code platforms that are available. According to its suggested conceptual comparative framework, which is based on distinct feature sets needed by the business for implementation in order to benefit the firm over the long term, this study offers a variety of LCDPs.

INTRODUCTION

BPM is a framework that establishes the steps, actions, and processes required to accomplish the aims, goals, and objectives of an organization. In order to guarantee optimal business efficiency and minimize waste by eliminating repetitive jobs and process gaps, BPM must be well-defined, comprehensive, and organized. This will ultimately lead to increased profitability over an extended period of time. BPM has an impact on the business not just financially, but also in terms of minimizing human error margin, anticipating potential risks, and minimizing safety and security-related damages. As a result, high-quality output is produced while interdepartmental collaboration and communication are improved. Since its introduction in the 1990s, business process management (BPM) has helped organizations plan, analyze, process, measure performance, and discover areas for improvement while seeking to improve efficiency.

However, routine, redundant, time-consuming, and tiresome corporate procedures are the primary cause of employees' dissatisfaction and disengagement. Using LCDP to help automate various manual business processes will address the issue of manual business processes often remaining hidden because of difficulties in monitoring and tracking the work performed (Peter Y.H. Wong, Jeremy Gibbons, 2019). In contrast to custom-developed apps, LCDP is far more affordable and offers a function that helps organizations detect and close operational gaps. It is not available in store-bought software.

LITERATURE REVIEW

Robert Waszkowski (2019): Waszkowski's study explores utilization of low-code platforms for manufacturing business process automation. The research emphasizes the role of LCDPs in streamlining operations and increasing efficiency in manufacturing

environments, [1]. Manuela Dalibor et al. (2022): Dalibor and colleagues investigate the generation of customized low-code development platforms for digital twins. While their study is specific to digital twins, it highlights the adaptability and flexibility of LCDPs in creating tailored solutions for various applications, complementing the current paper's discussion on the versatility of LCDPs in addressing different business needs [2].

A. Sahay et al. (2020): Sahay et al.'s main goal is to facilitate the comprehension and contrast of low-code development environments. Their research provides insights into the criteria and methodologies for evaluating LCDPs, which can inform decision-makers in selecting the most suitable platform,LCDPs [3].

Stavroula Fotopoulou et al. (2018): Fotopoulou and colleagues discuss the vulnerability assessment of low-code reinforced concrete frame buildings, which diverges from the main theme of BPM and LCDPs. [4]. Matthias Geiger et al. (2021): Geiger and co-authors examine the state of support and implementation of BPMN 2.0. Their research focuses on the standardization and adoption of BPMN for modeling business processes, providing a foundational understanding that complements the current paper's discussion on BPM methodologies and frameworks [5].

Peter Y.H. Wong & Jeremy Gibbons (2019): Wong and Gibbons explore the formalizations and applications of BPMN, offering insights into the theoretical underpinnings of BPM. [6]. W. Triaa et al. (2017): Triaa and colleagues investigate the influence of social software on BPM, highlighting the intersection between social technologies and business processes.[7].

Robin Lichtenthäler et al. (2022): Lichtenthäler et al. conduct a use case-based investigation of low-code development platforms. Their research provides practical insights into the application of LCDPs in real-world scenarios, which complements the current paper's theoretical framework with practical examples [8]. Lionel Mew & Daniela Field (2018): Mew and Field present a case study on using the Mendix low-code platform to support a project management course. Their study offers a concrete example of LCDP implementation in an educational setting, highlighting the potential for hands-on learning and skill development with low-code technologies [9]. Mihir Raut & Sarala Mary (2022): Raut and Mary address the power of low-code technology for business process transformation using low-code platforms. Their research emphasizes the transformative potential of LCDPs in driving organizational change and innovation, aligning with the current paper's focus on the strategic implications of BPM and LCDPs [10].

RESEARCH METHODOLOGY

Research Methodology involves accessing academic databases such as ScienceDirect and ResearchGate to gather peer-reviewed articles, conference papers, and case studies spanning the years 2017 to 2022.

Data Collection

Data collection involved gathering information from diverse sources, including academic publications, industry reports, and online resources

Evaluation and Combination

extracts important discoveries, themes, and patterns, the gathered data were examined and synthesized.

Case Study Analysis

Several case studies were examined to provide real-world examples of BPM and LCDP implementation in different industries and organizational settings.

Software Tool Evaluation

An evaluation of various low-code development platforms was conducted to assess their features, usability, scalability, and suitability for different organizational needs.

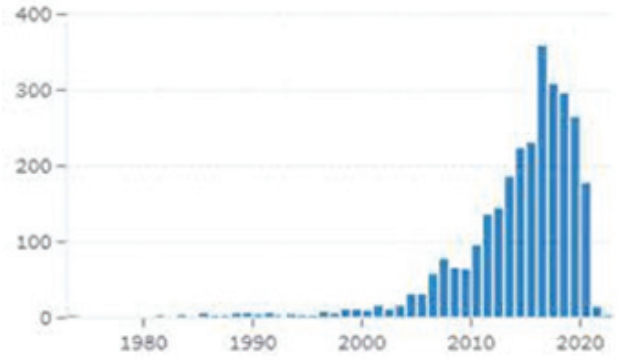
Comparative Analysis

A comparative analysis was performed to compare and contrast the advantages, limitations, and implementation considerations of different BPM methodologies and LCDPs.

Stakeholder Consultation

Consultations with key stakeholders, including business leaders, IT professionals, and end-users, were conducted to gather feedback, validate research findings, and ensure alignment with organizational goals and priorities.

Review of BPMN Using Low-code Development Process The implementation of LCDP capabilities in business processes to assist in problem-solving in line with the organization's BPM is the main emphasis of this study. The literature and other publications from the following sources served as the basis for the study's references: ScienceDirect.com, which provides a review of research publications from 2015 to 2022, as illustrated in below Figure.



Notation for Business Process Management (BPMN)

BPMN is a methodical approach that illustrates a process from beginning to conclusion. BPMN should be understandable to all business users, including business analysts who define the processes initially, technical developers who create the technology, and operations personnel who operate the program. To put it another way, BPMN is a systematic tool that bridges the gaps between business process layouts and process implementation.

Platforms for low-code development (LCDPs)

With the least amount of work and time, citizen developers can use LCDPs to design a custom application that best suits their company needs. Instead of using hard-coded programming methodologies, LCDPs build the application through a graphical interface.

- The application layer- which includes toolboxes and widgets that developers use to design user interfaces and authentication mechanisms that can be applied to specific artifacts, is where users directly associate their graphical environments. This layer, in summary, provides a variety of modeling constructs that users can utilize to specify the behavior of the application under development.
- Service Integration Layer: This layer allows developers to leverage the platform's features as a bridge or assess external services to collect data while following certain guidelines for data analysis.
- The Data Integration Layer: It permits users to gather data by integrating with many data sources. It is composed of heterogeneously acquired data that are categorized into a homogenous database.
- Deployment Layer: Depending on the needs of the business, an application designed should be able to be implemented on-premises or in cloud infrastructures. In addition to managing applications, this layer offers further tools for deployment and continuous integration that link to the service integration layer.

Low-Code BPM (LCBPM) Solutions

The purpose of LCBPM processes is to give companies a methodical approach to recognize, improve, and match their business processes to their objectives. This section addresses how LCBPM solutions can help businesses reduce their reliance on IT resources while simultaneously accelerating time to market by integrating the business into the development of all digital assets. It also covers how LCBPM supports the creation of applications like web portals, business process automation systems, and quality management applications.

Eliminating Threats to Security and Encryption: - Cybersecurity is now the top issue for the majority of organizations in an era of rising cyber theft and cybercrimes.

Handling Third-Party Integration Problems: - An LCBPM platform will help to consolidate all third-party apps in one spot, making it easier to connect and manage.

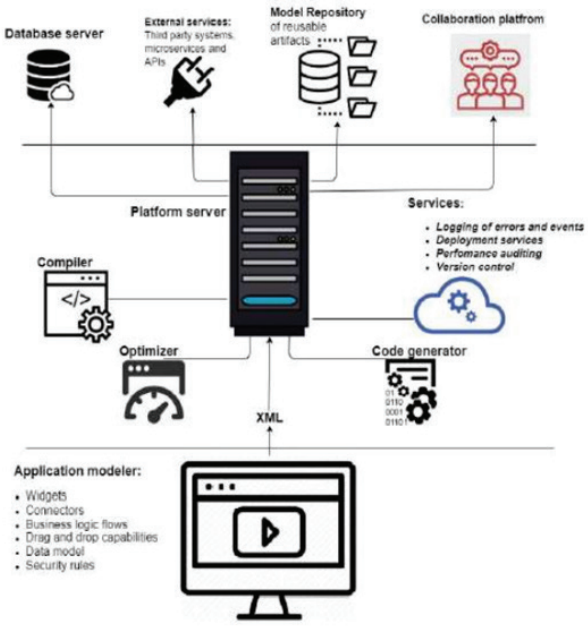
Avoiding Document Management Illness: - Time-consuming and laborious is document management. A company that still keeps its documents on paper is probably exceedingly inefficient and has a big margin of error. The business will benefit from using an LCBPM platform to maintain an automated document management feature that makes it easier to extract certain relevant data and/or information from documents

in addition to files and documents themselves. Because only authorized individuals are permitted access to and extraction of data, this procedure ensures data security while being quick, accurate, and resource-efficient. Furthermore, it may be configured to automatically backup documents and data, preventing data loss.

Taking Care of the Absence of Detailed Data Analysis: - An LCBPM platform with built-in data reporting tools will be an effective choice because it can help stakeholders generate detailed and accurate reports without having to manually export raw data to an external data management system. Data analysis is crucial because it helps a business to identify gaps, performance, and plan for the future. However, data analysis is prone to human errors and inaccurate or irrelevant reporting. Through real-time monitoring, operations will also be able to monitor key performance indicators (KPIs) that are in line with the organization's service level agreements (SLAs). Making Tricky Visual Interfaces Easier to Use.Drag-and-drop builders and visual interfaces with basic logic are features of LCDPs that are much more user-friendly than other program development, which typically use intricate graphical interfaces that might be confusing and take a long time. Because it can develop and implement strong applications using a graphical user interface, the LCBPM platform is strongly advised in light of this. An Overview of Low-Code Development Platforms

The significance of LCBPM's function in offering solutions for potential problems a business may face is covered in the section before this one. Our goal in this part is to pinpoint further factors that decision-makers should take into account when determining if an LCDP is appropriate for their company (Apurvanand Sahay, Arsene Indamutsa, Davide Di Ruscio, Alfonso Pierantonio, 2020). Additionally, to the top-level features, LCDPs also can be classified for the kinds of supported applications shown in next Fig.

Reduced Chances of Human Error: - Although there will always be a chance of human mistake, low-code business process management systems can help reduce that risk. Important business processes that can be automated with an LCBPM system can help the company save money and resources over time by preventing numerous avoidable human errors and by reducing time consumption. Most significantly, it assists in avoiding errors that could potentially cause the organization as a whole irreparable harm. Enhanced Productivity and Efficiency: - In addition to automating time-consuming, repetitive, or redundant corporate operations like documentation, data analysis, and report generation that would otherwise consume time and resources through human labor, business process management (BPM) solutions can force people to focus on more complex and intellectually engaging tasks. The efficiency and production of the company will increase as a result.



Lower Operating Expenses: - In addition to being time-consuming, labor-intensive, and often even impracticable, manual labor wastes manpower and money. Business process management automation implementation is a one-time expense. Nonetheless, research shows that it might save costs for companies over the long term while increasing output, decreasing error margins, and enabling them to accomplish much more in a lot less time.

CONCLUSION AND FUTURE WORK

We have investigated low-code platforms in this study and have determined their greatest attributes, advantages, variations, similarities, and drawbacks. A methodical set of differentiating characteristics was

established, and we compared the platforms under consideration with those characteristics as well. Along with discussing some of the most important aspects of each platform, we have also talked about the drawbacks and difficulties that arose when the application was being developed.

In addition, we have talked about how LCDPs accomplish a more complete and well-validated set of characteristics. To validate further and to share the difficulties and lessons we encountered while developing the application, the various LCDP suppliers may also be involved in this refinement process.

REFERENCES

1. Robert Waszkowski, 2019. Low-code platform for automating business processes in manufacturing, ScienceDirect
2. Manuela Dalibor, Malte Heithoff, Judith Michael, 2022. Generating customized low-code development platforms for digital twins, ScienceDirect
3. A. Sahay, A. Indamutsa, D. Di Ruscio, A. Pierantonio, 2020. Supporting the understanding and comparison of low-code development platforms, ScienceDirect
4. Stavroula Fotopoulou, Stella Karafagka, Kyriazis Pitilakis, 2018. Vulnerability assessment of low-code reinforced concrete frame buildings subjected to liquefaction-induced differential displacements, ScienceDirect
5. Matthias Geiger, Simon Harrer, Jörg Lenhard, Guido Wirtz, April 2021. BPMN 2.0: The state of support and implementation, ScienceDirect
6. Peter Y.H. Wong, Jeremy Gibbons, 2019. Formalizations and applications of BPMN, ScienceDirect
7. W.Triaa, L. Gzara, H.Verjus, 2017. Exploring the influence of Social software on Business Process Management, ScienceDirect
8. Robin Lichtenthäler, Sebastian Böhm, Johannes Manner, Stefan Winzinger, January 2022. A Use Case-based Investigation of Low-Code Development Platforms, Research Gate
9. Lionel Mew, Daniela Field, 2018. A Case Study on Using the Mendix Low Code Platform to support a Project Management Course, ResearchGate
10. Mihir Raut, Sarala Mary, 2022. Addressing the Power of Low-Code Technology for Business Process Transformation Using Low Code Platforms, www.irjmets.com

Segmented Analysis for Primark with Implications on Marketing & Supply Chain Management

Rashmi Jha
Associate Professor
Global Institute of Technology & Management
Gurugram University, Gurugram
✉ rashmijha1909@gmail.com

Aman Jha
Student (MBA Executive)
University of Liverpool
Liverpool, UK
✉ jhaamanbusiness@gmail.com

ABSTRACT

Primark, an international fashion retailer headquartered in Dublin, Ireland, was established in 1969 with the mission to offer affordable yet high-quality fashion choices for all demographics, including women, men, and children, as well as beauty products, homeware, and accessories. Primark is facing challenges in returning sales across Europe to pre-Covid levels, citing concerns about rising inflation in the upcoming year. Amid struggling high streets and abysmal consumer confidence in the UK (particularly during Corona period), Primark has consistently grown its presence.

This research paper aims to explores the optimization of market segmentation strategies for Primark. The study employs a thorough analysis of MACRO and MICRO environmental factors, technological trends and internal dynamics to profile Primark's current target markets. By identifying and evaluating emerging market segments, the research provides insights into their potential impact on Primark's marketing strategies and supply chain management. The findings are intended to inform strategic recommendations for enhancing Primark's market positioning and operational efficiency, ensuring sustained growth and competitive advantage in the global fashion industry.

KEYWORDS: *Primark, Segmentation, MACRO environmental analysis, MICRO environmental analysis, Supply chain management.*

INTRODUCTION

Profiling Primark existing market segment shows they cater to bargain hunters and value seeking customers specifically from low and middle-income class group interested in fast fashion with specific focus on teenagers, young adults and professionals under 35 years of age.

An environmental analysis has been conducted. On a MACRO level, consumers are more inclined towards interactive online shopping experience particularly post Covid-19 era. Augmented reality has gained traction which in turn has immensely helped to fix issues related to higher return rates of clothes in online clothing retail sector. Additionally, colour and size of dresses are being conveyed more accurately. End consumers are increasingly becoming conscious about sustainability and are interested in purchasing products made from sustainable materials and demand greater transparency pertaining to manufacturing process. Internal analysis highlights that absence of online retail for Primark hosts an array of threats due to non-tapping of online retail customers and pandemic issue which hampers complete operations due to presence of physical stores only in case of Primark.

The study recommends for Primark to extend its website capabilities to add transactional feature to tap the market segment of consumers inclined to purchase online with the advent of groundbreaking technologies like augmented reality providing an immersive experience to the customer sitting at the comfort of their homes. Partnering with sustainable and reliable suppliers as technology service providers and logistics providers

would help to gain online retail market share with the help of a coveted brand name that Primark possesses.

The implications on operations and supply chain can be unexpectedly huge demand resulting in incompetency to cope with demand of online orders, website malfunction due to heavy load of multiple customers using website simultaneously. This study recommends partnering with tech suppliers for introduction of a robust online retail system incorporated along with existing Click+Collect system along with implementation of a secured payment gateway, usage of omni channel fulfilment strategy, partnering with time-sensitive transport provider for efficient cross channel delivery service with focus on supply chain sustainability.

IDENTIFICATION OF CURRENT SEGMENT

An organization can identify all its target groups through market segmentation by dividing target groups into more manageable, smaller subsets which facilitates the organization to make more informed strategic decisions thus helping in better resource allocation and associated operations [1]. Also, categorization of consumers helps to identify potential growth opportunities[2]. Research article by Dibb, Stern and Wensley (2002) suggests inconsistencies with interpretation on values of segmentation[3]. Additionally, Quinn, Hines, and Bennison (2007) highlighted that segmentation in practice relies on implicit assumptions, subjective judgement and compressed experience[4]. This study indicated that extent of segmentation is wider than usually perceived, highlighting the significance of decision-making process that is intuitive in making segmentation decisions. However, Market segmentation has shown to be an effective tool in development of appropriate marketing strategies[5]. Although there is an ongoing debate over the value of segmentation, this report will utilize the segmentation criteria outlined by [2] to analyse specific segments that Primark currently targets. Given Primark's tagging as a value clothing retailer, clothing holds utmost importance and is primary item in its product portfolio. Demographic factor seems to be most direct base for segmenting Primark's customer market. Due to Primark's emphasis on cost leadership, the market can be categorized into groups by income. Primark's target segment encompasses individuals from lower income group to middle income [6]. Similarly, segmentation on the basis of psychographic factors, Primark caters to customers embracing fast- fashion lifestyle[7]. Overall, Primark caters to bargain hunters and value seeking customers specifically from lower and middle income class [6] looking out for fast fashion [8], with specific focus on for teenagers, young adults and professionals under 35 years of age[9].

MACRO ENVIRONMENTAL ANALYSIS

Environmental impact on the organization will be significant, which would in turn require the leaders to continually assess effects of the factors to make better strategically informed decisions. Environmental analysis at MACRO level is significant for Primark (Appendix 2) and will enable Primark to understand the potential opportunities and threats [10].

Social Environment

A report by Mintel in 2022 focusing on the clothing retail industry in the United Kingdom analysed the evolution of consumers clothes' shopping behaviours and their future plans (Mintel, 2022).

Table 1. Interest I Innovations from Clothing Retailers/ Brands [Source: Mintel Reports, 2023]

Interest in Innovations from Clothing Retailers/ Brands	
"Which of the following would you most like to see from the clothing retailers/brands you shop with? Please select up to 3."	
Base: 1,860 internet users aged 16+ who have bought clothes for themselves in the last 12 months	
	All
Sample	1860
Improved loyalty schemes (e.g. early access to new releases, savings)	38%
Better sizing tools when shopping online	34%
More inclusive sizing (e.g. plus/petite and tall/regular sizes)	29%
More transparency about supply chains (e.g. how and where clothes are made)	24%
More rapid delivery options (e.g. same day/within a few hours)	21%
Very limited-time offers (e.g. discount only valid for hours)	14%
More diverse product ranges (e.g. gender neutral/modest ranges)	14%
Option to shop directly on social media platforms (i.e. without being redirected to website)	8%
None of these	14%

32% of individuals have bought clothes made from sustainable materials within the past year and 42% are interested in doing so in the future. This demonstrates a significant trend towards choosing sustainable clothing. This report also reveals that 24% of the respondents were intrigued in innovations that has more transparency about supply chain.

Another subsequent clothing report for Europe 2022 published by Mintel highlights that "sustainability emerges as a key consumer priority" (Mintel, 2022).

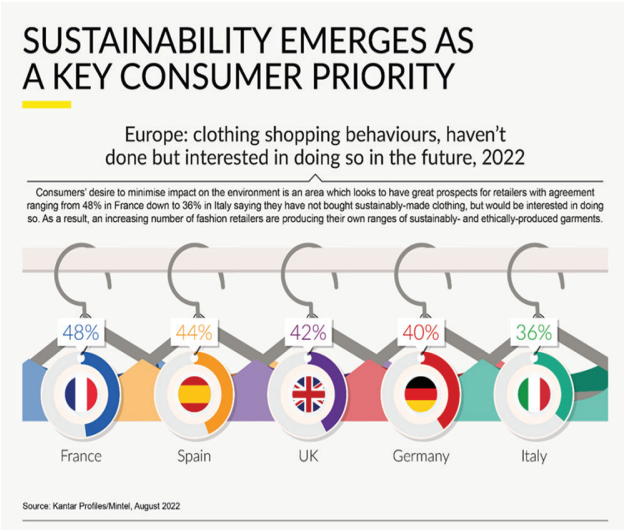


Fig. 1. Sustainability Emerges as a Key Consumer Priority [Source: Kantar Profiles/Mintel 2022]

As per the above mentioned social factors, Primark Limited Stores need to be cognizant of the fact that customers are more conscious about sustainability and are interested in purchasing products made from sustainable materials and demand greater transparency regarding the manufacturing process.

Also, clothes resale market in UK alone grew by 149% between 2016 to 2022 impressing upon consumer's strong belief in sustainability[11]. This trends curiously suggests slight movement of consumer from fast fashion towards vintage fashion.

TECHNOLOGICAL ENVIRONMENT

In a survey conducted over 4000 shoppers, 28% of consumers reportedly feel 'anxious' when they purchase in-store, this finding adds to the demand for increasingly interactive, online shopping experiences since Covid-19[12]. According to a GetApp survey, 1 in 2 consumers in United Kingdom are willing to use augmented reality technology for shopping. 90% of respondents concur that augmented reality is most beneficial when purchasing clothes online[13]. Usage of augmented reality also fixes the issue of higher return rates of clothes in online clothing retail sector[12]. Results indicate that colour and size of dresses are being conveyed more accurately when utilizing augmented reality as compared to try-on physically[14]. These technological factors may impact sales of Primark in coming future which majorly operates as brick and mortar store as more consumers are tending towards online retail which is boosted with the advent of augmented reality.

Table 2. Section Summary About Survey Result Regarding Technological Environment Impacting Sales of Primark in Future

Factor	Weighted Value (0-10)
Growing conscious regarding sustainability	7
Development of Augmented Reality in online shopping	10

MICRO ENVIRONMENTAL ANALYSIS

Primark's market share stands at 6.8% [15].

Competitor Analysis

For both in store and online segments, below graph displays intense competition for Primark reflecting to high competitive rivalry across low pricing segment with companies on both end of good usage and limited usage of technology. The template is designed for, but not limited to, six authors. A minimum of one author is required for all conference articles. Author names should be listed starting from left to right and then moving down to the next line. This is the author sequence that will be used in future citations and by indexing services. Names should not be listed in columns nor group by affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

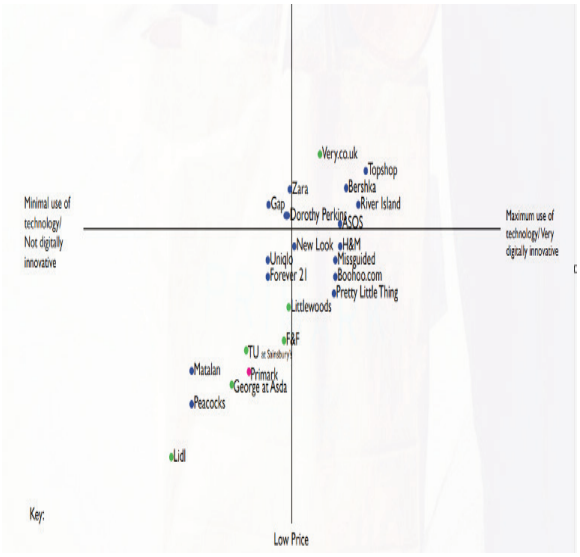


Fig. 2. Competitor Analysis [Source : Snowdon]

Supplier Analysis

From supply chain perspective, Primark has over 883 supplier factories across 28 countries with China on top having over 444 supplier factories [16]. With such a huge network, challenge for Primark is to ensure its associated partners are responsible taking sustainable practices into consideration and take steps to generate greater awareness towards the same to supply chain partners.

INTERNAL ANALYSIS

Inbound Capabilities

Cotton being the primary natural fiber to create Primark's product, Primark as a company do not produce/ purchase raw materials as suppliers and factories approved have the responsibility of sourcing. The responsibility for sustainability extends beyond organization and encompasses entire network of supply chain[17]. In 2013, Primark established the Sustainable Cotton Programme extending its reach to Tier 3 supplier with the objective of reducing usage of chemical pesticides, fertilizers in production.

Operational Capabilities

Primark partners with 883 factories located across 28 different countries[18] as they do not own any factories that produce the product. Though Primark doesn't have to manage the production process itself, Primark adheres to Supplier Code of Conduct based upon parameters set by United Nations International Labour Organization addressing workers' rights, environment or wages.

Outbound Capabilities

Primark operates in brick-and-mortar model only, due to absence of online retail, Primark gets exposed negatively to external factors like Covid-19 pandemic. Interestingly, Customers aging between 18 to 34 years account for 48.21%(~50%) of online traffic on Primark website [19], also, Primark has 63.14% online visitors as female [8].

Marketing Capabilities

In terms of marketing efforts, due to little markup on products, Primark relies on mouth-to-mouth marketing and limits advertising products through social media channels, websites. This helps keep prices relatively low. This also limits potential tapping on potential of social media to increase market share.

Financial Capabilities

Primark is owned by Associated British Foods Plc [20] which acts as its parent company. Hence, Primark is advantageous as Associated British Foods has positive EBIT after unusual expense[+1.25 B], a positive net operating cash flow[+1.69 B] and the capital expenditures amount to [-1.07 B][21]. Overall, it's a healthy sign for Primark for any new investments to be done in future new potential segments/projects.

Table 3. Internal Analysis Factors & Weighted Values

Factor	Weighted Value(0-10)
Concerns regarding Sustainability	5
Absence of Online retail	10
Limited online marketing	8

On the basis of identification of Current Segment, Macro and Micro Environmental Analyses, SWOT analysis for Primark devised with implications on Marketing and Supply Chain Management. SWOT analysis is a strategic planning and strategic management technique used to help a person or organization identify Strengths, Weaknesses, Opportunities, and Threats related to business competition or project planning. It is sometimes called situational assessment or situational analysis.

Table 3. Swot Analysis For Primark

Strengths	Weaknesses
Low cost, fast fashion Strong Brand Image Staying true to the DNA	Losing online shoppers Over reliance on Brick and Mortar
Opportunities	**Threats**
Offering Online International Sales Incorporation of Augmented Reality in online retail	Intense Competition Economic uncertainty Changing consumer preferences Rise in second hand fashion

RECOMMENDATIONS FOR FUTURE SEGMENTS FOR PRIMARK TO TARGE

Although Primark has a successfully running traditional bricks and mortar model, above section findings highlight significance of multi-channel offering with the inclusion of e-commerce platform further enabling to tap the customer base majorly under 35 years of age looking for value clothing. Rapidly evolving and extremely competitive retail industry makes it imperative to view this strategy that cannot be overlooked [22]. Competing brands such as UK retailer - New Look experienced rapid growth due to their online sales [23], it becomes crucial for Primark to introduce transactional feature to stay relevant and competitive whilst in a financially stable position. Primark's hesitance to venture online due to risk of incurring loss due to charges incurred for inevitable cloth returns can be overcome using Augmented Reality in online retail and high delivery charges can minimized through introduction of minimum spend option or through promotional offers like 'free delivery when spending over a certain amount' thus encouraging impulse purchasing similar to the one taking place in store [24]. Another approach to ensure maximization of average basket size would be using virtual catwalk using augmented reality as done by competitor – ASOS [25]. Alongside venturing into online retail, Primark should actively use social media platforms globally for promotion of company's sustainable practices which would further increase customer loyalty and aid in successful global expansion in future.

IMPLICATIONS FOR OPERATIONS AND SUPPLY CHAIN MANAGEMENT

The below section will be outlining the implications and suggestions for operations and supply chain management at Primark on existing and new suggested market segments.

Simatupang and Sridharan (2015) developed an integrative framework for efficient and cohesive supply chain through collaboration, aligning goals among all participants[26]. Primark would need an upgradation in its tech infrastructure and IT system on its existing website to extend beyond Click+Collect feature to include transactional feature (Click+Pay+GetDelivered) as well. It needs to seek external suppliers to develop, launch and monitor the website's new feature. Primark's internal team would be required to create an RFP (Request for Proposal) documentation to hire IT consultants to develop e commerce platform. Subsequently, range of tech solution suppliers need to be selected for invitation of ITT (Invitation to Tender). Once each company presents a response including price, Primark would need to evaluate each response to establish whether suppliers are meeting functional (order processing software, real time tracking, management of sales data, customer feedback functionality, integration with data analytics tool) and non-functional (e.g. speed) requirements or not. Sharing of real-time tracking, inventory, sales data and customer feedback with supply chain partners resonates with Simatupang and Sridharan's 2005 framework in context of information sharing [26]. Hence, leveraging data of customers through online interactions and purchase history would enable quick response towards market demands and preferences. Payment gateways like PayPal would assure privacy, security and would allow payment process to be secure and seamless. Due to huge customer base, Primark website may face issue of website malfunction due to heavy load. In order to avoid, frequent backing up of data would be required to prevent data loss. SLA (Service level agreements) need to be put in place with the tech supplier to ensure website performs without a glitch.

The efficient management of physical distribution and logistics has a substantial impact on a firm and its customers' costs, efficiency and effectiveness [27]. The implementation of new ecommerce channel will be followed by a versatile and effective cross-channel delivery service [22]. Primark may be required to follow Omni channel fulfillment strategy [28]. Products that would be purchased online using Primark ecommerce website will be stored in the same physical location where the products are kept for physical Primark stores. This would be done to avoid unnecessary complications thereby reducing the time the product takes to reach the customer's home. However, the stock holding capacity would need to be increased in order to satisfy the anticipated surge in demand. Lancaster and Massingham (2011) highlight that 'multi-channels can give rise to increased costs if not controlled'[27]. Therefore, to maintain a smooth and efficient cross-channel delivery service Primark should partner with DPD reputed for being time-sensitive transportation provider in UK [29]. Partnering with a logistical provider emphasizing on sustainability aligns with Primark's efforts to reduce environmental impact in its delivery operations. Competitor ASOS has implemented a similar strategy working alongside with delivery company Evri, which has showcased its effectiveness in streamlining delivery process and maximizing efficiency. This partnership minimizes lead time, benefitting customer by meeting their high delivery demands. If transactional feature on Primark's website doesn't gain much traction or there is an unexpectedly large demand resulting in incompetency to cope with demand of online orders, hence during the initial period, e commerce website implemented for Primark should only deliver products to UK. After a testing period, if e commerce site demonstrates performance, the corporation should then extend their services globally. Also, in order to have improvement in warehouse distribution center, for efficient fulfillment of online orders, Primark may contract out distribution strategy to Hallett Logistics (who worked for competing retailers like New Look) specializing in warehousing, stock management and distribution services tailored to fashion retail sector. The above-mentioned steps would resonate with Simatupang and Sridharan's principle of optimizing product assortment and fulfillment processes pertaining to online channels.

In order to maintain an effective inventory management system, Oracle Retail Planning and Optimization solutions can be used where rapid turnover and vast volumes of stock may pose an issue for retailers when introducing an e commerce platform. Also, predictive analytics can be used for demand forecasting which would lead to a demand driven approach closely tied to real time sales forecast. At this point, Primark should engage with logistics providers, suppliers in joint planning session with a focus on aligning production schedules, levels of inventory and logistics plans indicating towards decision synchronization principle of Simatupang and Sridharan[26].

CONCLUSION

In conclusion, this report encapsulates application of market segmentation on Primark, completion of Macro, Micro, Technological and Internal analysis which recommend that Primark should tap the market segment of consumers inclined to purchase online. Primark should consider the supply chain implications huge demand resulting in incompetency to cope with demand of online orders, website malfunction due to heavy load of multiple customers using website simultaneously. This report recommends partnering with tech suppliers to provide robust online retail system incorporated along with existing Click+Collect system with a secured payment gateway, usage of omni channel fulfillment strategy, partnering with time-sensitive transport provider for efficient cross channel delivery service with focus on supply chain sustainability.

REFERENCES

1. P. V. Freytag and A. H. Clarke, "Business to Business Market Segmentation," Industrial Marketing Management, vol. 30, no. 6, pp. 473–486, Aug. 2001, doi: https://doi.org/10.1016/s0019-8501(99)00103-0.
2. J. Fahy and D. Jobber, EBOOK: Foundations of Marketing, 6e. McGraw Hill, 2019. Available: https://books. google.co.uk/books?hl=en&lr=&id= RssvEAAAQBAJ&oi=fnd&pg= PP1&dq=Fahy
3. S. Dibb, P. Stern, and R. Wensley, "Marketing knowledge and the value of segmentation," Marketing Intelligence & Planning, vol. 20, no. 2, pp. 113–119, Apr. 2002, doi: https://doi.org/10.1108/02634500210418536.
4. L. Quinn, T. Hines, and D. Bennison, "Making

sense of market segmentation: a fashion retailing case," European Journal of Marketing, vol. 41, no. 5/6, pp. 439–465, Jun. 2007, doi: https://doi.org/10.1108/03090560710737552.

5. K. Nusair, H. Alazri, U. F. Alfarhan, and S. Al-Muharrami, "Toward an understanding of segmentation strategies in international tourism marketing: the moderating effects of advertising media types and nationality," Review of International Business and Strategy, vol. ahead-of-print, no. ahead-of-print, Aug. 2021, doi: https://doi.org/10.1108/ribs-02-2021-0038.

6. F. Mcintosh, "FIONA MCINTOSH: Primark is a one-stop shop for the middle-classes," Mail Online, Jul. 22, 2016. https://www.dailymail.co.uk/news/article-3702444/Primark-one-stop-shop-middle-classes.html

7. C. M. UK, "THE PRIMARK GIANT: CAN ANY NEWCOMER EVEN COMPETE?" CLOTHING MANUFACTURE, Oct. 16, 2023. https://www.clothingmanufacturersuk.com/post/the-primark-giant-can-any-newcomer-even-compete

8. "Primark Statistics: The Facts You Need To Know," huuray.com, Sep. 29, 2023. https://huuray.com/inspiration/gift-cards/primark-statistics/#audience-demographics

9. "M&S and Primark," www.ft.com. https://www.ft.com/content/13727940-aa82-11dd-897c-000077b07658

10. A. L. da Silva and J. A. Castañeda-Ayarza, "Macro-environment analysis of the corn ethanol fuel development in Brazil," Renewable and Sustainable Energy Reviews, vol. 135, no. 1, p. 110387, Jan. 2021, doi: https://doi.org/10.1016/j.rser.2020.110387

11. L. Cochrane, "Cheap, Cool and Kind to nature: How Secondhand Became UK Fashion's Main Attraction," The Guardian, Feb. 12, 2023. Available: https://www.theguardian.com/fashion/2023/feb/12/secondhand-clothes-uk-fashion-cheap-cool-kind-to-nature

12. P. Skeldon, "COVID-19 boosts augmented reality adoption among UK shoppers," Internet Retailing, Feb. 17, 2021. https://internetretailing.net/covid-19-boosts-augmented-reality-adoption-among-uk-shoppers-22713/

13. S. Awasthi, "Augmented reality in fashion: Immersive shopping experience," SoftwareAdvice, Oct. 19, 2022. https://www.softwareadvice.co.uk/blog/2380/how-is-augmented-reality-changing-the-fashion-industry

14. F. Baytar, T. Chung, and E. Shin, "Evaluating garments in augmented reality when shopping online," Journal of Fashion Marketing and Management: An International Journal, vol. ahead-of-print, no. ahead-of-print, Apr. 2020, doi: https://doi.org/10.1108/jfmm-05-2018-0077.

15. "Primark forges ahead of expectations in all markets." https://www.licensingsource.net/primark-forges-ahead-of-expectations-in-all-markets/#%3A~%3Atext%3DPrimark (accessed Feb. 28, 2024).

16. "Shibboleth Authentication Request," login.liverpool.idm.oclc.org. https://www-statista-com.liverpool.idm.oclc.org/statistics/1102388/number-of-suppliers-of-primark-by-region/

17. C. R. Carter and D. S. Rogers, "A Framework of Sustainable Supply Chain management: Moving toward New Theory," International Journal of Physical Distribution & Logistics Management, vol. 38, no. 5, pp. 360–387, Jun. 2008, doi: https://doi.org/10.1108/09600030810882816.

18. A. S. Lu, "Primark's Global Sourcing for Apparel (Updated September 2023)," FASH455 Global Apparel & Textile Trade and Sourcing, Sep. 11, 2023. https://shenglufashion.com/2023/09/11/primarks-global-sourcing-for-apparel-updated-september-2023/

19. Primark.com Traffic Analytics, ranking Stats & Tech Stack, https://www.similarweb.com/website/primark.com/ (accessed Feb. 29, 2024).

20. "Delivering today Investing for tomorrow." Available: https://www.abf.co.uk/content/dam/abf/corporate/oar-and-rr-2023/oar/abf-annual-report-2023.pdf.downloadasset.pdf

21. "ABF | Associated British Foods PLC Annual Cash Flow Statement," MarketWatch, Jan. 13, 2024. https://www.marketwatch.com/investing/stock/abf/financials/cash-flow?countrycode=uk

22. T. Anna Rickman and R. M. Cosenza, "The changing digital dynamics of multichannel marketing," Journal of Fashion Marketing and Management: An International Journal, vol. 11, no. 4, pp. 604–621, Sep. 2007, doi: https://doi.org/10.1108/13612020710824634.

23. "Shibboleth Authentication Request," login.liverpool.idm.oclc.org. https://www-statista-com.liverpool.idm.oclc.org/statistics/462252/new-look-e-commerce-sales/

24. "How can ecommerce stores drive impulse buying?" BigCommerce. https://www.bigcommerce.co.uk/glossary/impulse-buying/ (accessed Feb. 28, 2024).

25. B. Wright, "Asos uses augmented reality to launch virtual catwalk," Just Style, Jun. 14, 2019. https://www.just-style.com/news/asos-uses-augmented-reality-to-launch-virtual-catwalk/

26. T. M. Simatupang and R. Sridharan, "An integrative framework for supply chain collaboration," The International Journal of Logistics Management, vol. 16, no. 2, pp. 257–274, Dec. 2005, doi: https://doi.org/10.1108/09574090510634548.

27. G. Lancaster and L. Massingham, Essentials of Marketing Management. Routledge, 2017.

28. S. Banker, "Amazon Vs. Walmart: E-Commerce Vs. Omni-Channel Logistics," Forbes. https://www.forbes.com/sites/stevebanker/2013/10/04/amazon-vs-walmart-e-commerce-vs-omni-channel-logistics/?sh=545ca99c2c5c (accessed Feb. 28, 2024).

29. "DPD (UK) - About DPD," www.dpd.co.uk. https://www.dpd.co.uk/content/about_dpd/index.jsp

Securing SAP Environment and Implementation: Industry 4.0

Pratibha Deshmukh
Bharati Vidyapeeth's
Institute of Management and Information Technology
Navi Mumbai, Maharashtra
✉ pratibha.deshmukh@bharatividyapeeth.edu

Aniket Pawar
Purdue University
West Lafayette
Indiana, USA
✉ pawar19@purdue.edu

Bhanudas Sable, Heth Shah
Bharati Vidyapeeth's
Institute of Management and Information Technology
Navi Mumbai, Maharashtra

ABSTRACT

Designing the strategies for application-level security across the SAP environment is a very crucial element for organizations. This paper addresses the security strategy, design guidance, and deployment approach for application security within the scope of CertainTeed's "Project Unity". The design principles outlined in this paper reflect Project Unity's job and business process requirements and expectations for implementing SAP Application Security. The scope of this paper is focused on the Project Unity deployment in the Production landscape. By Developing a security strategy and approach driven by business and compliance requirements, deploying a security design that imposes the minimum administrative overhead, applying leading practice Segregation of Duty (SoD) principles into core security role design, restricting access authorization to Users as per the job requirement, providing appropriate security controls that support compliance and corporate policy requirements. The SoD management process serves the purpose of reducing errors and preventing fraud. This is accomplished by ensuring that no single user has access to multiple stages of a particular business process. The management of such risks is essential to uphold the integrity of the system.

INTRODUCTION

SAP stands for Systems, Applications, and Products in Data Processing, which was first time introduced in the 1980s as SAP R/2. This system allowed users to access soft real-time business applications in multiple currencies and languages. In 1992, SAP released a server-based version called SAP R/3, which eventually became known simply as SAP. Along with this update, SAP also developed a graphical user interface (GUI). For more than a decade, SAP was the dominant player in the market for large business applications.

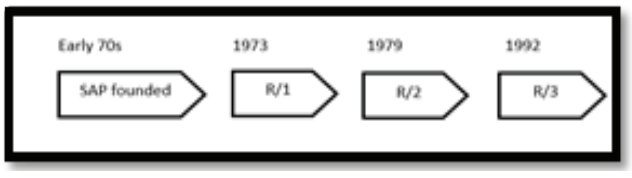


Fig. 1. SAP History

Although SAP's flexibility is one of its biggest advantages, it can also be a vulnerability that increases the likelihood of an SAP audit. SAP (Systems Applications and Products) Security helps to protect/ secure company's routine data and systems by monitoring and controlling internal and external access. To safeguard your company's confidential information from cyber threats, it is absolutely essential to establish a secure setup for your SAP servers. This entails ensuring the server is configured securely, enabling robust security logging, implementing secure communication protocols, and taking measures to fortify your data. Furthermore, it is imperative to closely monitor and track user activity and authorizations to prevent unauthorized access, exploitation, and fraud. In SAP users contain all the master data Assigned by the Master data Record, which is handled By Security Administrators. When a Security Administrator maintains User Master Records,

the Administrator assigns transactions or authorizes access to individual users in the form of Roles.

The Deploying Consist of the Following SAP Modules:

Table 1: Moules in SAP

ECC	Enterprise Core Component
FI (Finance)	General Ledger-GL, Asset Accounting-AA, Accounts Payable-AP, and Accounts Receivable-AR
CO (Controlling)	CCA-Cost Center Accounting, CE (Cost Element Accounting), OM (Overhead Management and Allocation), and PC (Product Costing)
PTP (Procure to Pay)	Core procurement and inventory management (including physical inventory management) processes
OTC (Order-to-Cash)	Functionality needed to support the sales process, credit management, delivery, and invoice/credit memos to the customer
PP (Production Planning)	Functionality to support manufacturing and production planning process
WM (Warehouse Management)	Functionality to effectively manage inventory at the warehouse level and support business requirements (such as stock transfers, bin level storage locations, etc.)
PM (Plant Maintenance)	Functionality to support integration with Maximo and linking between equipment and items in the internal catalog

LITERATURE SURVEY

Multiple kinds of research have been explored in the area of SAP. Five former employees of IBM started the company System Analyse Program Development in April 1972. SAP's founders and all other staff worked together along with their customers. Often sitting alongside them in their offices to gain insight into their business needs and processes. Thereafter in 1975, they had developed financial accounting applications (RF) and invoice verification capabilities and inventory management (RM) then R/3 on in 1992 after that S/4 HANA the Cloud database is implemented [1]. SAP's planning, implementation, and evolution, highlighting the importance of roles or profiles. The SAP consultants and quality circles leaders associate together and try to understand/identify the potential areas, process improvement, and scope for the SAP implementation. SAP does not come with pre-built profiles or roles for support or project team members [2]. The performance factors being considered both from a system point of view and a user point of view. System administrators aim to achieve the necessary system throughput while staying within the IT budget, while end users expect a reasonable response time when using software systems. The acceptable response time depends on the nature of the business process. These challenges apply to custom application development projects as well. The Single Sign-On Technology is implemented to help with operational performance [3]. In reference [4] discussed the significance of security at the code level by using model-checking technique for source code. In [5], SAP implementation is the most crucial and on-demand trending business solution for the middle size companies. The restrictions of traditional IT-based companies implementation is based on SOA (Service-Oriented Architecture). Addition in [6] the Security Threat Identification and Testing (STIATE) toolkit system in implemented for the support to development teams. It focuses on subtle security logic flaws will undetected by using current industrial technology scenario. It also assists to the development teams in conducting threat modeling in terms of testing the day to day operation scenario.

An analysis by identifying automatically potential threats (via model checking technique). Author [7] proposed a solution providing unique and secure authentication mechanisms which distinguish between genuine products and counterfeits by using RFID Technology. In reference [8], discussed the framework that enforces security rules based on the current state of the environment by using context-aware access control policies. It defines the authentication of each user to provide services and related resources. [9] Implementing Access Control mechanism through NetWeaver Portal which allows to integrate the created web application which benefitting users and user roles

for accomplishing their work processes. [10] Author suggested that the ERP system changes are imperative to have unwavering support and dedication from management in creating the required work atmosphere in the organization.

RESEARCH METHODOLOGY

The proposed project implements the concept of role creation, assigning of roles, removing unauthorized access to users, updating of roles from the user, etc.

The Process stated in the diagram as below:

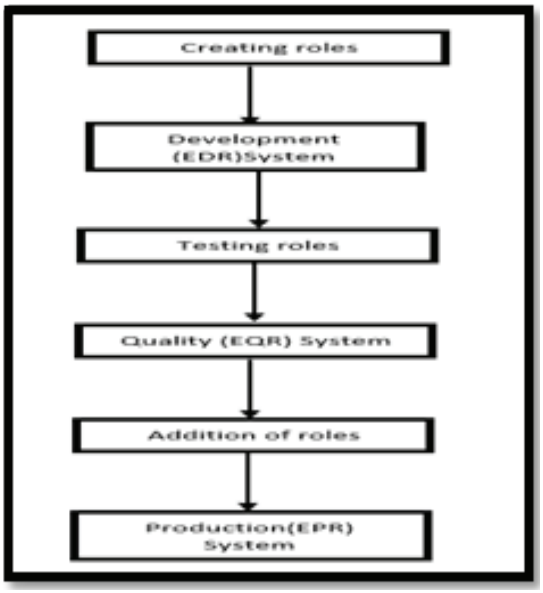


Fig. 2. Proposed System

Security Role Design

The security role design is based on the concept of minimum access to carry out a particular task.

The paper-specific requirements were determined by the business process documents (BPD) and in discussion with the business teams. The protection of confidential information also plays an important role in molding the security design. The security design based on the requirements is further elaborated in the document.

Tiered Approach

Multi-tiered approach: Global roles, general display, departmental display, function-based roles. Reduces transaction code redundancies facilitating access management activities.

Role Derivation

Roles will be derived based on organizational restrictions required by the business (company code, purchasing organization, sales organization, etc.). Appropriate role derivation significantly reduces the number of roles to manage. The inappropriate derivation leads to excessive access.

Function-Based Design

Group of transaction codes (tasks) representing a function in the organization. Provides small building blocks to provide access and a flexible design to meet upcoming organizational changes. Facilitates role assignment, maintenance, SoD prevention, and remediation.

Job And Role Mapping

Function (Task) based, and display-type roles are grouped in accordance with jobs and assigned responsibilities identified by change management.

Role Isolation

Sensitive data will be identified, and access is restricted based on a group of isolated roles that might follow a particular role assignment process.

Least Privilege

Role design enforces the concept of least privilege. Only the necessary authorizations are included in each role (i.e., display roles with updated authorizations, wide open authorization values such as "*" or authorization ranges are avoided).

Sod Free Roles

Single and composite roles are analyzed based on SoD risks. Roles free of SoD conflicts will be developed.

Naming Convention

A clear naming convention that is meaningful to business users and helps facilitate role administration activities will be used.

The illustration above indicates that each Job or Position can have one or more Single Roles allocated to it. These single user roles are assigned to User Master Records. Here are the main benefits of using this method.

Maintenance of Segregation of Duties and the User Menus is made easier due to static relationships between transactions, as a transaction will typically be assigned to only one standard role. It is easier to add transactions to Roles for groups of users, which also helps reduce Role maintenance for the future. The main disadvantage of this approach is that it requires more up-front time to determine and define the roles. However, the benefits of proper initial mapping of transactions to roles far outweigh the cost of the additional set-up time. The following diagram depicts how roles fit into the overall design of SAP security from a functional perspective:

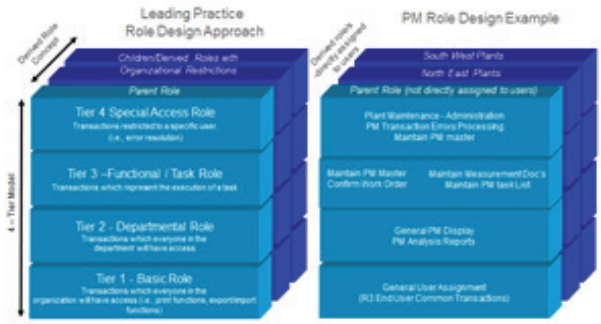


Fig. 3. 4 – Tier Model

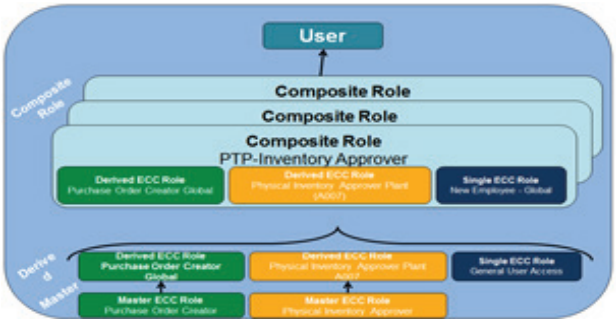


Fig. 4: Types of Roles

The purpose of using tiers or layers is to build roles that add only the functionality needed at each level of the tier aiding in the management and maintenance of roles.

Everyone starts at the lowest tier with a widely defined role that has safe and appropriate transactions for all users approved for SAP access.

At the second tier a departmental role containing transactions that are pertinent to all users in a specific department (e.g., all transactions that would be used by everyone in the Finance – Accounts Payable department), may be added.

At the third tier a task-based role containing transactions that are specific to the user job requirements may be added.

Finally, the most restrictive tier is a select number of highly sensitive transactions that are typically granted to a small population of users.

Process of Assigning the Role

A Role is a collection of various activities viz. user menus, reports, transactions, and authorizations for which the Profile Generator can automatically generate an authorization profile during the process. The Role can then be assigned to the User Master Record either by adding the User ID on the Role tab in Profile Generator or by assigning it directly in the User Master Record. Under the role-based methodological approach related to security configuration, roles are built by first combining Transaction Codes to define a set of tasks to be assigned to users in SAP. Subsequently, the Profile Generator Transaction (PFCG) is used to complete the technical configuration of the user menus, authorizations, and profiles. Upon its completion, a Single Profile is generated that allows the user access to the various Transaction Codes that have been mapped in Profile Generator. Subsequently, one or many roles are allocated to User Master Records in SAP to allow the user to perform their daily job functions. A composite Role is a collection of single or derived roles and is mapped to a specific job role / functional role. Composite roles may include segregation of duty conflicts for exceptional business scenarios, however, must be mitigated by strong business controls and/or processes.

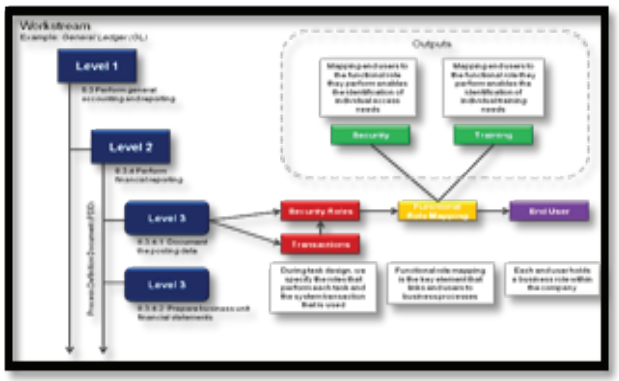


Fig. 5. Workflow for Assigning Role

Security Requirement

Business Process Requirement. Many workshops are conducted during the Unity project to gather security requirements to ensure that the role design meets business process requirements. Security Design Approach & High-Level Requirements. Meet with the process team to gather high-level security requirements. Initial Role Design Workshops. Meet with process teams to define an initial list of Security roles. Collaborate with the Organization & Change Management (OCM) team. Facilitate the mapping of Security roles to tasks in BPDs. Analyze the initial Security Role design based on the completed mapping of functional roles to t-codes. Detailed Security Design Workshops. Review the initial Security role design with each of the process teams. Revise the design based on guiding principles and segregation of duties. Work with process teams to identify detailed security requirements. Organizational Restrictions. Functional Restrictions

Other Controlling Elements. Define the to-be process for security role creation and modification.

Monitoring

SOD Conflict and Critical Access Monitoring

SAP Security Administrators use SAP GRC to govern the Segregation of Duties (two or more conflicting transactions) and Critical Actions (individually sensitive transactions).

GRC Rule Set Management:

The following steps should be followed to facilitate the management of the CertainTeed SAP-based Access Risk/Segregation of Duties rule sets:

Identify Required Rule Set Change: Requests for rule set changes can be determined from various paths, including during the remediation of issues, security administration, and process redesigns.

Document Request to Change Global Rule Set: Regardless of how the rule set change was identified, it should be appropriately documented to verify it can be reviewed and subjected to approval accurately.

Route the Request for Approval: Changes to the rule set will be reviewed and approved by the respective business process and/or IT owner.

Update Rule Set: Approved changes will be implemented by the appropriate party upon request from the business process and/or IT owner. Rule set changes are to be made in the development and tested. If the updated rule set passes the preliminary test, then the changes are to be transported to production. If the rule set change test result fails in development, the request is rejected, and the requestor is notified.

CONCLUSION

Getting a plan in motion can be overwhelming due to the high stakes involved and the amount of organization required. Some properties are must to set to keep your day to data safe and secure. For that you must need to conduct several different assessments like an internal assessment of access control. Also the assessment and compliance along with SAP, ISACA, DSAG, and OWASP standards need to be maintained automatically at regular basis. SAP security strategy support products, operations, of companies if it is implanted and kept in operation. The implementation of various above stated process steps of Security in SAP are beneficial. The responsibility for security is shared by both SAP and all the customers of SAP. It is Crucial for the Security administrators/consultants to understand each role, assign the appropriate role to authorized user for authentic access. To avoid any conflicts and mitigate the risk using GRC tools (Access Control) are very efficient and effective for the conduct of day to operations securely.

REFERENCES

1. Subhash Chander Verma (2013) "A study of factors responsible for growth, sickness, and Mortality of SMEs (bought out parts and ancillary) in MIDC Pimprichinchwad", ASM's international E Journal of ongoing research in Management and IT, (e-ISSN-2320-0065)
2. Linda K. Lau (2005) "Managing Business with SAP: Planning, Implementation and Evaluation" (ISBN 1-59140-380-4).
3. Junnarkar, Atul R. and Dr. Ashutosh Verma. "study on system application product (sap) – an important enterprise resourse planning tool for achievement of organisational vision, mission and operational performance." (2017).

4. K. Li, "Towards Security Vulnerability Detection by Source Code Model Checking," 2010

5. Y. Zhou, "SAP Business ByDesign," 2009 IEEE 25th International Conference on Data Engineering, Shanghai, China, 2009.

6. R. Carbone, L. Compagna, A. Panichella and S. E. Ponta, "Security Threat Identification and Testing," 2015 IEEE 8th International Conference on Software Testing, Verification and Validation (ICST), Graz, Austria, 2015.

7. Z. Nochta, T. Staake and E. Fleisch, "Product specific security features based on RFID technology," International Symposium on Applications and the Internet Workshops (SAINTW'06), Phoenix, AZ, USA, 2006.

8. L. Gomez, L. Moraru, D. Simplot-Ryl and K. Wrona, "Using Sensor and Location Information for Context-Aware Access Control," EUROCON 2005 -

9. A. D. Cristea, O. Prostean, T. Muschalik and O. Tirian, "The advantages of using SAP NetWeaver platform to implement a multidisciplinary project," 2010 International Joint Conference on Computational Cybernetics and Technical Informatics, Timisoara, Romania, 2010.

10. Höhn, Sebastian, and Jan Jürjens. "Automated Checking of SAP Security Permisisons." Integrity and Internal Control in Information Systems VI: IFIP TC11/ WG11. 5 Sixth Working Conference on Integrity and Internal Control in Information Systems (IICIS) 13–14 November 2003, Lausanne, Switzerland. Springer US, 2004.

11. I. Tereshchenko, S. Shtangey and A. Tereshchenko, "The application SAP® ERP principles for the development and implementation of corporate integrated information system for SME," 2016.

12. T. Orosz, "Introduction of Innovative SAP Development Solutions at University Level," 2020 IEEE 18th World Symposium on Applied Machine Intelligence and Informatics (SAMI), Herlany, Slovakia, 2020.

13. T. Orosz, "Analysis of SAP Development tools and methods," 2011 15th IEEE International Conference on Intelligent Engineering Systems, Poprad, Slovakia, 2011.

14. S. S. Yarramalli, R. S. Manasa Ponnam, G. R. Koteswara Rao, S. Fathimabi and P. Madasu, "Digital Procurement on Systems Applications and Products (SAP) Cloud Solutions," 2020.

15. A. Behunova, L. Knapcikova, M. Behun and M. Albert, "Practical Application of the SAP ERP Information System in the Innovative Teaching Process of the Controlling of a Manufacturing Company," 2019 17th International Conference on Emerging eLearning Technologies and Applications (ICETA), Starý Smokovec, Slovakia, 2019.

16. G. Belrose, K. Brand, N. Edwards, S. Graupner, J. Rolia and L. Wilcock, "Business-driven IT for SAP The Model Information Flow," 2007 2nd IEEE/ IFIP International Workshop on Business-Driven IT Management, Munich, Germany, 2007.

17. Avinash, S., Deshmukh, P., Jamsandekar, P., Kumbhar, R.D., Kharade, J., Rajendran, R. (2023). Specifying the Virtual Reality Approach in Mobile Gaming Using Unity Game Engine. ICETEAS 2023.

18. K. S. Gill, A. Sharma, V. Anand, R. Gupta and P. Deshmukh, "Influence of Adam Optimizer with Sequential Convolutional Model for Detection of Tuberculosis," 2022 International Conference on Computational Modelling, Simulation and Optimization (ICCMSO), Pathum Thani, Thailand, 2022.

19. Deshmukh, P., Avinash, S., Gonsai, A.M., Sonawane, S.S., Khan, T. (2023). Ordering Services Modelling in Blockchain Platform for Food Supply Chain Management. ICE-TEAS 2023.

21. https://www.researchgate.net/publication/370348558_ Resource_Allocation_Energy_Efficient_Algorithm_ for_H-CRAN_in_5G

Implementation of Generative AI in Cyber Security Automation

Manish Kumar Dubey, Shambhu Shankar Rai
Assistant Professor(MCA)
BVIMIT
Navi Mumbai, Maharashtra
✉ dby.manish@gmail.com
✉ shambhumca@gmail.com

Swarangi Ambavane, Mehul Gehlot
Student (MCA)
BVIMIT
Navi Mumbai, Maharashtra
✉ swarangiambavane10@gmail.com
✉ mehulgehlot2023@gmail.com

ABSTRACT

An increasing number of cyber-attacks around the globe, defending those attacks and securing the organizations from its impact is becoming a challenging situation for most of the (SOCs) to monitor security tools deployed in the environment. The role of various Gen-AI models in cyber security SOAR will bring a new way to manage and respond to the incidents in effective way of threat detection, mitigation, prevention, response, getting knowledge on recent threats, payloads, malware associated with CVEs and also help analysts to mitigate the threats by the automated way of playbook steps efficiently. This paper demonstrates the use of Gen-AI tools to empower the enterprises security team by describing various defensive activities that would be efficiently carried out with these automation tools. Discovering the area of AI-implemented manipulation and transformation, we describe the facts of Generative AI technologies and it has facilitated a paradigm shift in the landscape of cyber threats. There is comparative analysis of few GenAI tools, aiming to describe the novel dimensions of cyber security in the area of Generative AI.

KEYWORDS: *AIML, Artificial intelligence, Machine learning, Predictive analysis, Posture detection, Generative AI.*

INTRODUCTION

Generative Artificial Intelligence is an Artificial Intelligence generation that will not generate the content automatically but it will mechanically generates the content material in prompt reaction. This generated content material includes images, texts, application program code, pictures, audio, videos, and music files. GenAI is expert in using data from webpages of websites, different social media conversations and many other online applications. It identify and generates its outputs that is very useful resource of statistically analysing the distribution of phrases /coordinates or pixels or different factors in the data that it has considered and figuring out and repeating usual patterns (for example, which coordinate or pixel observe which coordinate or pixel).

Text Generative AI first should be trained to generate the text for which it is defined. This consists of the tool being furnished with and processing large amount of records scraped from the internet and all other places. It is reported, however now not showed with the useful resource of using Open AI, that the education of GPT4 worried 1,000,000 gigabytes of data. Processing this statistics includes figuring out patterns, together with which phrases usually by skip all together (e.g. “Happy” is often used along with “Birthday/anniversary etc..”).

Cybersecurity with Gen AI

According to one of the company Research more than 50% of corporations agree that AI is IMPORTANT For safety due to developing range of SUDDEN ATTACK that conventional techniques are either difficult to prevent or can’t be prevented. According to the findings,

- More than 55% of companies are saying that security experts are very much stressed.
- More than 20% of the companies are saying that they are not able to prevent all the attacks.

According one of the study, which is registered by one of the investment advisors (RIAs) are very much ready to contribute in emerging artificial intelligence security applications. With these funding possibilities are that AI cyber security industry will grow more than 15% CAGR from $8 billion in 2019 to $38 billion in 2026. [1]

Let's look at the Challenges faced by traditional SOC:

- One of the traumatic conditions with the traditional Security Operations Centre (SOC) is- SOC analysts are overwhelmed by the sheer number of alerts that come from Security Information Event Management (SIEM)[2].
- Security groups are bombarded with low constancy indicators and spend tremendous time setting apart them from excessive constancy indicators. The alerts come from almost any reassets at some point of the company and is further compounded with too many aspect solutions and with multi-supplier environment [2].
- The numerous equipment and absence of integration during multiple provider product solutions often require a incredible deal of manual studies and analysis. The pressure this is composed of having to maintain up with enterprise education and correlate information and logs into huge insights turns into burdensome. While multi-vendor, multi-source, and multi-layered protection answers presents a number of data, with out ML and protection analytics,It additionally creates quite a few noise and a disparate view of the risk panorama with inadequate context[2].

These challenges can be solved with the Generative AI:

Generative AI has the strength and all the power to streamline the entire operational workflows and democratize information throughout the entire protection team, irrespective of revel in degrees or expertise approximately a particular era or risk vector. Rather than having to manually research data on their own, SOC analysts can use Natural Language Processing (NLP) embedded inside GenAI fashions to invite questions and acquire solutions in a extra herbal format. NLP additionally offers GenAI the power to "understand" what a person is calling and adapt to their fashion or preferences.[3] .

Eg: while finding and investigating events, analysts frequently ought to take a look at scripts, command-line arguments, or suspicious documents which can had been achieved on an last point. Instead of manually getting to know that analysts can use this information in reality and the analysts can offer the script they analysts has found and ask the Artificial Intelligence model to break this down using a collection of prompts put all together to complete this prompted security-related tasks. Each prompt book requires a specific input — for example, a piece of code or actor name threat. [3]

The script will describe all the one by one and the AI model is consulted to provide input as to whether or not or now no longer the script may be malicious. From there, if any network indicator is present, its miles correlated in the direction of danger intelligence and relevant results are combined in advance than it is added. The AI first offer the primary guidelines based on totality and then the script moves and generate a document that summarizes the consultation for nontechnical audiences.[3]

Using AI this manner gives centre benefits. First, the AI can mechanically upskill customers who won't apprehend the complexities of studying a script or document the use of a completely transparent, repeatable process. Second, it saves time with the resource of the usage of having the model assist with now no longer unusual place follow-up actions, which incorporates correlating any symptoms and symptoms to hazard intelligence and writing a summary report. [3]. This research paper also provides the comparison between different GenAI tools and how they can be used in cybersecurity automation.

LITERATURE REVIEW

Introduction to genAI in Cybersecurity Automation

genAI refers to the integration of artificial intelligence (AI) and machine learning (ML) techniques in cybersecurity automation processes.

It aims to enhance the efficiency and effectiveness of cybersecurity operations by automating routine tasks, augmenting human analysts' capabilities, and enabling rapid response to cyber threats.

Historical Evolution of genAI in Cybersecurity

The integration of AI and ML in cybersecurity automation has evolved in tandem with advancements in technology and the increasing sophistication of cyber threats.

Early applications focused on rule-based systems and signature-based detection, while modern approaches leverage advanced ML algorithms for anomaly detection, threat hunting, and predictive analysis.

Components and Architecture of genAI Systems

A genAI system typically comprises several key components, including data ingestion and preprocessing modules, ML models for threat detection and classification, and orchestration and response mechanisms.

Architectural considerations may include scalability, resilience, and interoperability with existing cybersecurity infrastructure.

Applications of genAI in Cybersecurity

genAI finds applications across various cybersecurity domains, including network security, endpoint protection, threat intelligence, and incident response.

Specific use cases may include malware detection, phishing detection, behavioral analytics, and user behavior analysis.

Technologies and Algorithms Used in genAI

genAI systems leverage a variety of AI and ML techniques, including supervised learning, unsupervised learning, reinforcement learning, and deep learning.

Commonly used algorithms include decision trees, random forests, support vector machines (SVM), k-nearest neighbors (KNN), and neural networks.

Benefits of genAI in Cybersecurity Automation

genAI offers several benefits, including improved threat detection accuracy, reduced response times, enhanced scalability, and cost savings through automation.

By augmenting human analysts with AI-driven insights, organizations can better cope with the volume and complexity of cyber threats.

Challenges and Considerations

Challenges associated with genAI in cybersecurity automation include data quality and availability, model interpretability, adversarial attacks, and ethical considerations.

Integration with existing security infrastructure and workflows, as well as regulatory compliance requirements, must also be carefully considered.

Future Trends and Directions

OBJECTIVES

- To Investigate the Current State of genAI in Cybersecurity Automation:

Evaluate the existing literature, tools, and technologies related to genAI (AI and ML) in the field of cybersecurity automation. Identify key trends, challenges, and advancements in the application of genAI for automating cybersecurity operations.

- To Explore the Potential Applications of genAI in Cybersecurity Operations:

Investigate various use cases where genAI can be applied to automate routine tasks, enhance threat detection, and streamline incident response in cybersecurity operations.

Analyze how genAI can be integrated into existing security infrastructure and workflows to improve efficiency and effectiveness.

- To Assess the Effectiveness and Efficiency of genAI Solutions in Real-World Scenarios:

Conduct case studies and empirical research to evaluate the performance, accuracy, and scalability of genAI solutions in cybersecurity automation. Compare genAI-driven automation with traditional approaches to cybersecurity operations, assessing factors such as response times, false positive rates, and resource utilization.

- To Identify Challenges and Limitations of genAI in Cybersecurity Automation:

Identify and analyze challenges associated with the implementation, deployment, and adoption of genAI solutions in cybersecurity operations.

Explore limitations such as data quality and availability, model interpretability, ethical considerations, and adversarial attacks.

- To Propose Best Practices and Recommendations for Leveraging genAI in Cybersecurity Operations:

Synthesize findings and insights from the research to develop best practices and recommendations for organizations looking to leverage genAI in their cybersecurity operations.

Provide guidance on the selection, deployment, and optimization of genAI Tools and technologies for specific use cases and organizational contexts

Scope

- Focus on Artificial Intelligence and Machine Learning Technologies in the area of Cybersecurity Automation:

The research will primarily focus on the application of artificial intelligence (AI) and machine learning (ML) technologies in automating various aspects of cybersecurity operations, including threat detection, incident response, and vulnerability management.

- Analysis of Key Use Cases and Applications

The scope of the research will encompass a comprehensive analysis of key use cases and applications where genAI can be utilized to automate routine tasks, augment human analysts, and improve overall cybersecurity posture.

- Evaluation of Existing Tools and Technologies

The research will involve an in-depth evaluation of existing genAI tools, platforms, and frameworks used in cybersecurity automation, including their features, capabilities, limitations, and real-world performance.

- Consideration of Challenges and Ethical Implications:

The research will consider challenges and ethical implications associated with the adoption and deployment of genAI solutions in cybersecurity operations, such as data privacy, bias in AI models, and the impact on human roles and responsibilities.

CONCLUSION

The research will conclude with actionable recommendations and best practices for organizations seeking to implement genAI-driven automation in their cybersecurity operations, based on insights derived from the literature review, empirical research, and case studies.

REFERENCES

1. (2023, May 3). Gartner Poll 45% of Executives Say Chat GPT Has Prompted an Increase in AI Investment. finds-45-percent-of-executives-say-chatgpt-has-prompted-an-increase-in-ai-
2. Mirza, M., & Osindero, S. (2014). Conditional generative adversarial nets. arXiv preprint arXiv:1411.1784. https://arxiv.org/abs/1411.1784
3. Karras, T., Aila, T., Laine, S., & Lehtinen, J. (2017). Progressive growing of gans for improved quality, stability, and variation. rXiv reprint arXiv:1710.10196. https://arxiv.org/abs/1710.10196
4. Lehtinen, J., Munkberg, J., Hasselgren, J., Laine, S., Karras, T., Aittala, M., & Aila, T. (2018). Noise2Noise: Learning image restoration without clean data. arXiv preprint arXiv:1803.04189. https://arxiv.org/abs/1803.04189
5. Song, Y., & Ermon, S. (2020). Improved techniques for training score-based generative models. Advances in neural information processing systems, 33, 12438-12448. https://proceedings.neurips.cc/paper/2020/hash/92c3b916311a5517d9290576e3ea37ad-Abstract.html
6. Kadam, S. U., Dhede, V. M., Khan, V. N., Raj, A., & Takale, D. G. (2022). Machine learning methode for automatic potato disease detection. NeuroQuantology, 20(16), 2102-2106.
7. Takale, D. G., Gunjal, S. D., Khan, V. N., Raj, A., & Guja, S. N. (2022). Road accident prediction model using data mining techniques. NeuroQuantology, 20(16), 2904.
8. Bere, S. S., Shukla, G. P., Khan, V. N., Shah, A. M., & Takale, D. G. (2022). Analysis of students performance prediction in online courses using machine learning algorithms. NeuroQuantology, 20(12), 13-19.

Building a Safer Future: Designing an Android App for Women's Protection

Suhasini Vijaykumar
Nidhi Poonia
Samruddhi Kamble
Sakshi Devde
Bharati Vidyapeeth Institute of Management and Information Technology
Navi Mumbai, Maharashtra

ABSTRACT

In today's world, women's safety remains a critical concern due to the prevalence of harassment and violence. In response, technology has introduced dedicated safety applications tailored specifically for women. To resolve this problem the women security mobile application will help to promote the safety and security of women by providing them with a comprehensive set of safety features. In this research the application is designed with user privacy, security, and accessibility in mind. The women security app is an important contribution to the ongoing global efforts to eradicate gender-based violence and create a safer world for women. By empowering women with the tools and resources they need to protect themselves, this app has the potential to make a significant impact on women's safety and well-being. The application is tested and the features of the application are analysed with women users the result received was overwhelmingly positive, with 85.33% of users finding the app to be user-friendly and effective.

KEYWORDS: *Location tracking, SOS button, Call feature, Send the location by message.*

INTRODUCTION

Women are facing violence in day to day life today and the women safety app can help a woman to address the pervasive issue of gender-based violence and empower women to protect themselves in their daily lives. These applications boast a wide array of features aimed at bolstering women's security and confidence. Among the core functionalities is location tracking, enabling users to instantly share their real-time whereabouts with trusted contacts or emergency services. This feature proves invaluable in moments of distress, allowing for swift assistance when needed most. Central to these applications is the SOS button, providing users with a direct line to help at the touch of a button. With a single tap, users can alert pre-set contacts of their emergency situation, providing vital details of their location for prompt assistance. Moreover, the direct calling feature allows users to quickly connect with emergency services or designated contacts in dangerous situations, ensuring rapid response times. Additionally, the ability to send location details via SMS offers an alternative means of alerting others to one's whereabouts in an emergency. Furthermore, user safety, these applications incorporate an audible alert mechanism triggered by the panic button or a device shake. This distinctive sound not only serves as a deterrent to potential attackers but also draws attention to the user's situation, enhancing the likelihood of receiving assistance. In summary, these safety applications serve as indispensable tools in promoting women's safety and security. By merging features such as location tracking, SOS functionality, direct calling, SMS alerts, and audible alerts, they equip women with the resources needed to seek help swiftly and effectively, contributing to a safer world for women everywhere.

LITERATURE REVIEW

Kolte R et.al presents an Android app designed to empower women's safety and security. The app comes equipped with essential features such as emergency

calls, GPS tracking, and instant alerts to trusted contacts and law enforcement, making it an invaluable tool for enhancing women's security. With this app, women can feel more confident and in control of their personal safety at all times [1]. Sankar, E et.al. in the paper provide an android app provides various safety measures for women, including GPS tracking, voice recording for evidence, and emergency helpline numbers. It aims to empower women to navigate and escape harmful situations easily [2]. In the paper by Chand, D. et.al present WoSApp designed to aid women in distress by discreetly triggering emergency calls to the police, sending location and contact details instantly. It addresses challenges women face in reaching out for help quickly [3]. Khandoker, R et.al. in them discuss about Lifecraft is designed for women's safety in distress situations, featuring continuous location tracking, audio recording for evidence, and emergency alerts to contacts. It aims to provide a sense of security and minimize crimes against women [4]. The paper by Mareeswari, V., et.al. propose a smartphone-based system for women's safety, offering features like continuous location tracking, emergency alerts, and audio recording for evidence. It aims to provide affordable and effective protection [5]. Fernandez, Z. et.al study explores smartphone apps' role in enhancing women's safety in cities, highlighting the importance of technology in preventing and addressing violence against women [6]. Aggarwal, D., et.al. reviews various smartphone applications and devices designed for women's safety, utilizing technologies like GPS and SOS buttons to provide security [7]. Premi, P., et.al. propose application FRNDY; a mobile app to enhance women's safety in Malaysia, featuring GPS-based location sharing, emergency calls, and agile methodology for testing and improvement [8]. In the paper by Roy, S., et.al, they propose a pervasive computing system using wearable tech to enhance women's safety, integrating sensors, GPS, and machine learning for danger detection [9]. The paper by Decker, M. R et.al. discusses adapting the myPlan app for Kenya to assist women in abusive relationships, outlining a randomized trial to evaluate its efficacy [10]. The study by Ashok, K., et.al. surveys the application approaches in women's safety systems, exploring technologies like IoT, AI, and mobile apps for enhancing women's security [11]. Vahini, S. et.al proposes a smart device integrating wearable tech and a secret webcam for women's safety, activating alerts and sending location information to contacts and authorities [12]. Masud, Q. M. et.al developed GoFearless is an Android app aimed at enhancing women's safety during travel or daily activities, featuring instant alerting of trusted contacts and access to emergency services [13]. Hossain, M. E., propose a mobile based application for safety of women in Bangladesh, offering features like automatic calling, GPS-based location tracking, and secret video recording [14]. SHIRES, S., developed an Android app enables women to quickly inform friends and family about their location during emergencies, utilizing GPS for location tracking and bulk SMS notifications.

PROBLEM DEFINITION

The problem that the women security application aims to address is the pervasive issue of violence and harassment faced by women worldwide. Despite ongoing efforts to address this issue, women continue to face significant challenges in protecting themselves from harm. Women face a range of threats to their safety and security, from street harassment to sexual assault and domestic violence. These threats can cause physical, emotional, and psychological harm, limiting women's mobility and freedom. To resolve this problem, the women security app aims to empower women to protect themselves by providing them with a comprehensive set of safety features. The app is designed to address the specific needs and concerns of women, providing them with the features they need to protect themselves. The application is designed to be accessible to women from all backgrounds and abilities, with features such as GPS location tracking, SOS button, Call feature and SMS feature. Overall, the women security application aims to empower women to live their lives with greater safety and security.

RESEARCH METHODOLOGY

In Figure 1. And 2 Shows the flow of the application development. Figure 3 and 4 shows the Application Flow of the entire application.

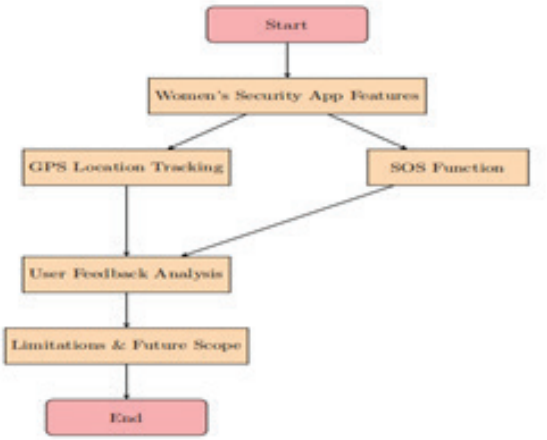


Fig. 1. Flow of the application

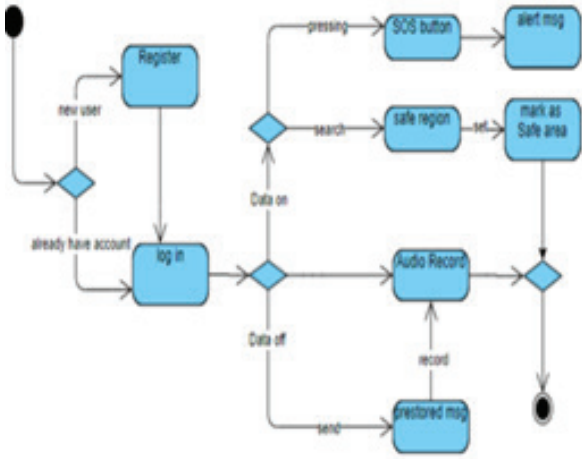


Fig. 2. Activity Diagram

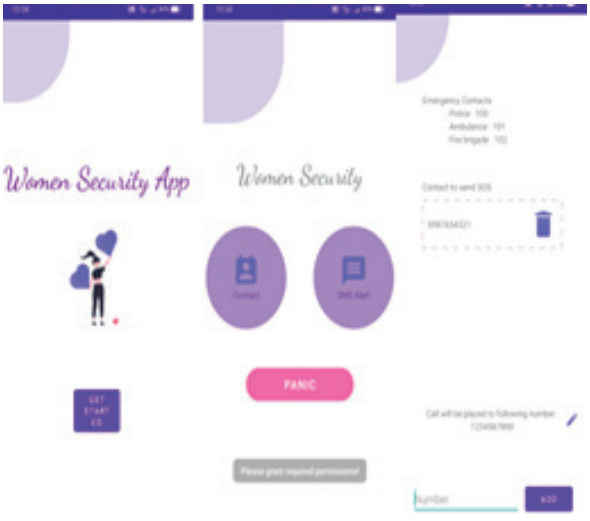


Fig. 3. Application Flow-1

Fig. 4. Application Flow-1

RESULTS AND FINDINGS

The women's safety app offers essential features designed to enhance personal security, including GPS location tracking and an SOS function. The GPS feature allows users to track their current location in real-time, while the SOS feature activates when the device is shaken, emitting an alert sound to notify surrounding individuals in case of emergency.

In this Table 1, table provides feedback on various aspects of an application, including its user-friendliness and satisfaction levels with its GPS and SOS features. It indicates the number of respondents who tested the features and expressed their feedback, along with the corresponding percentage of positive responses.

User Response Analysis for Women Application Working			
Questions	Yes	No	Percentage
App User-Friendliness	82	18	82%
GPS Feature Satisfaction	84	16	84%
SOS Feature Satisfaction	90	10	90%
Application Feature Satisfaction Average			85.33%

As depicted in the analysis Figure.5, We have tested this application with sample size 100 women users by using convenient sampling technique within organization. it was found that 82 users perceive the app as user-friendly. Moreover, 84 users expressed satisfaction with the GPS feature, while 90 users reported satisfaction with the SOS feature. This translates to an impressive 84% satisfaction rate for the GPS feature and an even higher rate of 90% for the SOS feature among the surveyed users. These findings reflect a positive response from

users towards the app's functionalities overall. This suggests that the app is not only being utilized but also delivering on its intended purpose effectively, contributing to the safety and security of users within our organization.

Fig. 5. Average Analysis

CONCLUSION

The women's security app we have developed addresses crucial safety concerns by integrating advanced features such as real-time location tracking, an easily accessible SOS button for immediate assistance, a direct call feature to emergency contacts, and the ability to discreetly send the current location via message. These functionalities work together to provide a comprehensive solution that empowers women to navigate their surroundings confidently and respond effectively to any potential threats, promoting a safer environment for all.

REFERENCES

1. Kolte, R., Tadse, P., Nikhare, , V., Raut, S., & Narakhede, G. (2023). An Android App for Empowering Women's Safety and Security. International Research Journal of Modernization in Engineering Technology and Science, 5(4), 4508-4513.
2. Sankar, E., Karthik, C. A., & Kiran, A. S. (2022). Women safety app. International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN, 2321-9653.
3. Chand, D., Nayak, S., Bhat, K. S., Parikh, S., Singh, Y., & Kamath, A. A. (2015, November). A mobile application for Women's Safety: WoSApp. In TENCON 2015-2015 IEEE region 10 conference (pp. 1-5). IEEE.
4. Khandoker, R. R., Khondaker, S., Nur, F. N., & Sultana, S. (2019, December). Lifecraft: an android based application system for women safety. In 2019 International Conference on Sustainable Technologies for Industry 4.0 (STI) (pp. 1-6). IEEE.
5. Mareeswari, V., & Patil, S. S. (2018). Smart device for ensuring women safety using android app. In Advanced Computational and Communication Paradigms: Proceedings of International Conference on ICACCP 2017, Volume 1 (pp. 186-197). Springer Singapore.
6. Fernandez, Z. A. M., Cruz, M. A. T., Peñaloza, C., & Morgan, J. H. (2020, August). Challenges of smart cities: how smartphone apps can improve the safety of women. In 2020 4th International Conference on Smart Grid and Smart Cities (ICSGSC) (pp. 145-148). IEEE.
7. Aggarwal, D., Banerjee, K., Jain, R., Agrawal, S., Mittal, S., & Bhatt, V. (2022, February). An insight into android applications for safety of women: techniques and applications. In 2022 IEEE Delhi section conference (DELCON) (pp. 1-6). IEEE.
8. Premi, P., Savita, K. S., & Millatina, N. (2022, August). FRNDY: A Women's Safety App. In 2022 6th International Conference On Computing, Communication, Control And Automation (ICCUBEA (pp. 1-5). IEEE.
9. Roy, S., Sharma, A., & Bhattacharya, U. (2015, August). MoveFree: A ubiquitous system to provide women safety. In Proceedings of the third international symposium on women in computing and informatics (pp. 545-552).
10. Decker, M. R., Wood, S. N., Kennedy, S. R., Hameeduddin, Z., Tallam, C., Akumu, I., ... & Glass, N. (2020). Adapting the myPlan safety app to respond to intimate partner violence for women in low and middle income country settings: app tailoring and randomized controlled trial protocol. BMC public health, 20, 1-13.
11. Ashok, K., Gurulakshmi, A. B., Prakash, M. B., Poornima, R. M., Sneha, N. S., & Gowtham, V. (2022, March). A survey on design and application approaches in women-safety systems. In 2022 8th International conference on advanced computing and communication systems (ICACCS) (Vol. 1, pp. 101-110). IEEE.
12. Vahini, S. (2017). EFFICIENT TRACKING FOR WOMEN SAFETY AND SECURITY USING IOT. International Journal of Advanced Research in Computer Science, 8(9).
13. Masud, Q. M., Sarker, M. M., Barros, A., & Whaiduzzaman, M. (2022). GoFearless: A Safety and Security Android Based Application for Women. International Journal of Intelligent Information Systems, 11(2), 22-30.
14. Hossain, M. E., Rahman, M. W., Islam, M. T., & Hossain, M. S. (2019). Manifesting a mobile application on safety which ascertains women salus in Bangladesh. International Journal of Electrical and Computer Engineering, 9(5), 4355.

A Machine Learning-Based Network Forensics approach for Detecting Attacks on Smart IoT Devices – A Critical Review

Milind D. Meshram
Dept. of Digital and Cyber Forensics
Institute of Forensic Science
Mumbai, Maharashtra
✉ ifscm.milind@iscm.ac.in

Suhasini Vijaykumar
M.C.A. Dept.
Bharati Vidyapeeth Inst. of Mgmt and Infor. Tech.
Navi Mumbai, Maharashtra
✉ suhasini.kottur12@gmail.com

ABSTRACT

Smart IoT devices are electronic gadgets with internet connectivity and be controlled remotely, by using a smartphone. Smart devices are often connected to the internet, making them vulnerable to a wide range of network attacks. Network Forensics is a scientific process to discover malicious traffic from the incoming/outgoing network traffic information. The investigator needs to follow correct investigative procedures so that the evidence recovered during the investigation will be authentic and accurate. Network forensic tools are used as collectors, analyzers, and visualizers that can assist investigators with network forensics, but these tools cannot extract meaning from the packet of logs so intelligent technique to detect network attacks on smart devices using machine learning is required. In this paper, various network forensic approaches to detect network attacks on smart devices using machine learning have been compared through literature reviews.

KEYWORDS: *Internet of things, Smart devices, Network forensics, Machine learning, Network attacks.*

INTRODUCTION

Smart IoT devices are electronic gadgets with internet connectivity and be controlled remotely, by using a smartphone. Smart watches, smart TVs, smart doorbells, smart glasses, and smart speakers are examples of smart devices. These devices can be used to automate various tasks, such as adjusting the temperature in a room or turning on the lights and can also provide information and entertainment [1]. Smart devices have less computational power, storage space, and memory size [2], as per the IoT market forecast, the number of IoT devices is growing huge [3].

However, there are certain drawbacks to the quick development of smart devices. Due to their frequent internet connectivity, smart devices are susceptible to many network threats such as denial of service attacks, malware, phishing, and botnets [2]. To investigate those attacks, we must examine the evidence using digital forensic procedures. Digital forensics is a branch of forensic science that examines electronic evidence in cybercrime investigations [4].

Network Forensics is a scientific process to discover malicious traffic from the incoming/outgoing network traffic information [5]. To ensure the authenticity and accuracy of the evidence gathered throughout the inquiry, the investigator must adhere to proper investigative methods. Cloud forensics deals with the data that is stored on the cloud. Both network and digital forensics are necessary for cloud forensics [6].

A unique area of digital forensics that focuses on IoT infrastructures is called "Smart IoT device forensics" [7]. Fig.1 shows Three zones make up smart IoT device forensics [7]: a. Zone 1: Device level forensics, which operates at the perceptual layer, or the device's local memory. Zone 2: Network forensics operates at the network layer, gathering network logs from various IoT communication networks. Zone-3 Cloud Forensics, which operates at the Application Layer and uses the cloud to store data produced by IoT communication networks.

The purpose of the work is to do a thorough analysis of the literature on various Network Forensic approaches

to detect network attacks on smart IoT devices using machine learning.

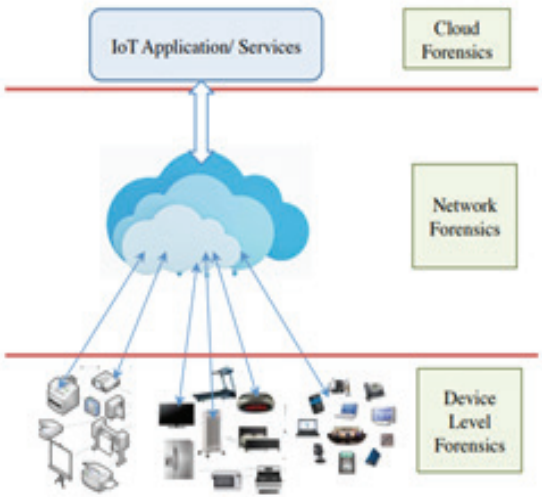


Fig. 1. Smart IoT device Forensics [7]

RELATED WORK

Kebande and Ray [13] proposed DFIF-IoT - a general framework for the Internet of Things for digital forensic investigations. Framework provides three modules: 1. Proactive process for forensic readiness. 2. IoT forensic (Cloud Forensic, Network Forensic, and Device level Forensic), and 3. A reactive process occurs after the incident. It's a conceptual framework.

Amarantidou [20] suggested the use of network forensic tools such as tcpdump, Wireshark (Ethereal), NetworkMiner, NetWitness Investigator, Kismet, Ngrep, EtherApe, and Snort (signature/rules-based IDS) as these tools are used as collectors, analyzers, and visualizers that can assist investigators with network forensics. but these tools cannot extract meaning from the packet of logs so network forensic technique to detect network attacks on smart devices using machine learning is required.

Koroniotis, Moustafa, and Sitnikova [26] presented a Particle Deep Framework (PDF) that combines deep learning and particle swarm optimization. Train and test using the BoT-IoT dataset, which includes three different attack types: identity theft (keylogging and data theft), DDOS (DOS and DDOS) attacks, and probing attacks.

NETWORK FORENSIC FRAMEWORK USING MACHINE LEARNING

Fig. 2 shows network forensic framework using machine learning. The Wireshark or Snort tools can be used in the framework's collection phase to record network traffic. The SHA-256 hash value can be used to preserve data. Examination, analysis, and presentation are carried out using machine learning or deep learning techniques[26].

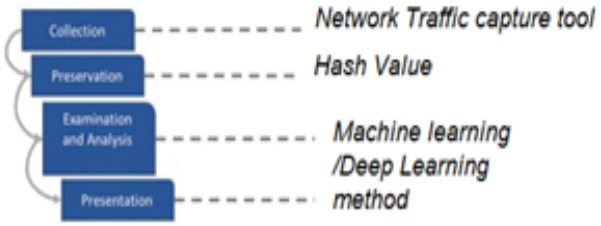


Fig. 2. Network Forensic Framework

ISSUES AND CHALLENGES OF SMART IOT DEVICE FORENSICS

Less processing power, storage capacity, and memory are found in smart devices. Security of the IoT environment is one of the challenges [8] due to the diversity of IoT devices. Conventional digital forensic techniques are used by forensic investigators to gather and examine data[9]. IoT systems have a multitude of wireless communication protocols, operating systems and file systems that may be customized, and a variety of functionalities. It makes identifying and obtaining data from Internet of Things devices difficult[10]. Network packets as evidence are usually short-lived, so they need to be captured and stored in the form of logs [12].

OVERVIEW OF NETWORK FORENSICS USING MACHINE LEARNING

Fukami, Stoykova, and Geradts [15] introduced a model for mobile forensic acquisition, acknowledging the increased encryption and security measures in modern devices. The focus of this method was identifying invasive techniques, bypassing security features, and exploiting vulnerabilities for effective data extraction in criminal investigations. Thus, this framework effectively detected malicious activities through mobile devices and protected the forensic data from theft.

Mahrous, Farouk, and Darwish [16] developed an improved blockchain-based IoT digital forensics architecture to detect malicious activities in digital evidence collection. This work combined fuzzy hashing with conventional hashing to enhance the authenticity verification of blocks or files in the blockchain. Fuzzy hashing enabled the identification of potentially crucial documents, offering improved similarity preservation compared to conventional hashing techniques. Thus, this framework enhanced the capabilities of forensic investigators in dealing with diverse IoT devices.

An ensemble classifier-based deep learning approach was developed by Bhardwaj and Dave [18] to provide effective analysis in the detection of malicious attacks. Digital evidence of malware attacks in network and cyber-physical systems was detected and preserved using the crypto-evidence preservation and evidence-collection models. In this case, the network traffic data was classified into harmful and non-malicious classes using the ensemble classifier-based DL model, which also recognized the malicious packets. The digital evidence was successfully safeguarded by this framework for forensic examinations.

With a 98.18% accuracy rate, HaddadPajouh, Dehghantanha, Khayami, and Choo [21] have presented a recurrent neural network-based technique (LSTM) for detecting IoT malware threats. In particular, the proposed use of Explainability of LSTM models suggests a more transparent DL model for identifying cyberattacks on the Internet of Things, especially when the situation is adversarial.

Figure 3 shows the summary of related work from various articles. It shows how different network forensic approaches detect attacks using machine learning algorithms along with future works and limitations.

Comparison summary of related work:

Ref No.	Publication Year	Techniques	Types of Attacks	Dataset used	Limitations	Future work
[21]	2018	Recurrent Neural network-based approach (LSTM)	IoT Malware attack	ARM based IoT application	Only examine the Opcode of ARM-based IoT application	To extend to real-world environments for identifying Known and new malware
[22]	2019	Synthetic Minority Over-Sampling Technique (SMOTE)	DoS Hulk, Port Scan, DDoS)	CICIDS2017	Non IoT dataset	model using. CNN or RNN (LSTM, GRU
[23]	2019	CNN-LSTM	Ten diverse types of attack	CICIDS2017 dataset and the CTU dataset	Non IoT dataset	Design of traffic collection system
[24]	2020	DNN, LSTM and a meta-classifier (i.e., logistic regression)	Port Scan attack Okiru-Attack DDoS , C&C-Heart Beat Attack C&C-Mirai	IoT-23, LITNET-2020, and NetML-2020.	NA	For better speed and scalability Apache spark can be utilized
[25]	2020	CNN-WDLSTM	Exploits , DoS Backdoor, Analysis, Fuzzers ,Generic Reconnaissance, Shellcode ,Worms	UNSW-NB15, ISCX2012.	Non IoT dataset	Applying on Complex and bigger dataset

[26]	2020	On Particle Swarm optimization and deep learning	Probing attacks, DDOS attacks (DOS and DDOS), and Identity theft attacks	Bot-IoT and network datasets	time of execution is the same as that of the training time of the model	applying to estimate multiple hyperparameters
[27]	2020	SSAE-BiGRU-Att model	Network attacks	UNSW-NB15	NA	apply online learning methods to this model.
[28]	2021	Logical model tree	DDoS, UDP, TCP, IMPS	Generated dataset	NA	Evaluate in healthcare, transportation, or Industry 4.0 system
[29]	2022	SNN, DT, BT, SVM, and KNN	Mirai attacks, DoS attacks, Scan attacks, and MITM attacks	IoTID20	Limitation of each dataset	Real-world deployment of proposed system in different IoT network
[30]	2022	DNN-LSTM	BotNet	N-BaIoT 2018	Only classify as Benign, Mirai, Gafgyt	Varied DL-driven mechanism
[31]	2022	CNN-LSTM	Mirai and BASHLITE.	N-BaIoT	NA	NA
[32]	2022	Random Forest with Independent Component Analysis (ICA)	BotNet	Aposemat IoT-23 Dataset , N-BaIoT Dataset	NA	To enhance and develop IPS for botnet

Fig. 3 Comparison summary of related work

CONCLUSION

In this research, we have reviewed relevant literature on network forensic approaches that use deep learning and machine learning to identify network attacks on smart IoT devices. This paper effectively covers several machine learning and deep learning approaches, as well as attack types, datasets used and their limits, and future research. From the above study, it has been observed that IoT smart devices have varying functions. The security of the IoT environment is one of the challenges [14] due to the diversity of IoT devices. Data accessibility will be provided to all the forensic users who are registered in the system. So, it leads to data breaches in the network [17]. The system can generate false positives or false negatives, which may affect the accuracy and reliability of the alerts and cause the system administrator or security team to miss or ignore some real threats or to waste time and resources on some false alarms. [15]. For most of the existing Network Attack Monitoring Systems, the training will be done by considering all the features available in the dataset. It may decrease the classification accuracy and increase the training time. Most researchers have used a hybrid model using CNN and LSTM to detect network attacks on smart IoT devices. Convolutional Neural Networks require lots of training data. There is significant potential for using a hybrid model using Bi-GRU and Capsule network to detect an attack on smart IoT devices.

REFERENCES

1. Ali, B., & Awad, A. I. (2018). Cyber and physical security vulnerability assessment for IoT-based smart homes. sensors, 18(3), 817.
2. King, J., & Awad, A. I. (2016). A distributed security mechanism for resource-constrained IoT devices.

Informatica, 40(1).J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

3. https://hashstudioz.com/blog/iot-adoption-challenges-and-opportunities-in-india/

4. Paul Joseph, D., & Norman, J. (2019). An analysis of digital forensics in cyber security. In First International Conference on Artificial Intelligence and Cognitive Computing: AICC 2018 (pp. 701-708). Springer Singapore.

5. Garfinkel, S. (2002). Network forensics: Tapping the internet. IEEE Internet Computing, 6, 60-66.

6. Al-Hussaeni, K., Brits, J., Praveen, M., Yaqoob, A., & Karamitsos, I. (2022, December). A Review of Internet of Things (IoT) Forensics Frameworks and Models. In European, Mediterranean, and Middle Eastern Conference on Information Systems (pp. 515-533). Cham: Springer Nature Switzerland.

7. Zawoad, S., & Hasan, R. (2015, June). Faiot: Towards building a forensics aware eco system for the internet of things. In 2015 IEEE International Conference on Services Computing (pp. 279-284). IEEE.

8. Frustaci, M., Pace, P., Aloi, G., & Fortino, G. (2017). Evaluating critical security issues of the IoT world: Present and future challenges. IEEE Internet of things journal, 5(4), 2483-2495.

9. Wu, T., Breitinger, F., & Baggili, I. (2019, August). IoT ignorance is digital forensics research bliss: a survey to understand IoT forensics definitions, challenges, and future research directions. In Proceedings of the 14th International Conference on Availability, Reliability, and Security (pp. 1-15).

10. Hegarty, R., Lamb, D. J., & Attwood, A. (2014, January). Digital Evidence Challenges in the Internet of Things. In INC (pp. 163-172).

11. Garfinkel, S. L. (2010). Digital forensics research: The next 10 years. digital investigation, 7, S64-S73.

12. Ansari, A. Q., & Khan, M. A. (2012). A Journey from Computer Networks to Networks-on-Chip. IEEE Beacon, 31(1), 71-77.

13. Kebande, V. R., & Ray, I. (2016, August). A generic digital forensic investigation framework for internet of things (iot). In 2016 IEEE 4th International Conference on Future Internet of Things and Cloud (FiCloud) (pp. 356-362). IEEE.

14. Torabi, S., Bou-Harb, E., Assi, C., & Debbabi, M. (2020). A Scalable Platform for Enabling the Forensic Investigation of Exploited IoT Devices and Their Generated Unsolicited Activities. Forensic Science International: Digital Investigation, 32, 1–11.

15. Fukami, A., Stoykova, R., & Geradts, Z. (2021). A new model for forensic data extraction from encrypted mobile devices. Forensic Science International: Digital Investigation, 38, 1–10.

16. Mahrous, W. A., Farouk, M., & Darwish, S. M. (2021). An Enhanced Blockchain-Based IoT Digital Forensics Architecture Using Fuzzy Hash. IEEE Access, 9, 151327–151336.Fagbola, F. I., & Venter, H. S. (2022). Smart digital forensic readiness model for shadow IoT devices. Applied Sciences, 12(2), 730.

17. Sachdeva, S., & Ali, A. (2022). Machine learning with digital forensics for attack classification in cloud network environment. International Journal of System Assurance Engineering and Management, 13, 156–165.

18. Bhardwaj, S., & Dave, M. (2022). Crypto-Preserving Investigation Framework for Deep Learning Based Malware Attack Detection for Network Forensics. Wireless Personal Communications, 122(3), 2701–2722.

19. Hossain, M., Karim, Y., & Hasan, R. (2018, July). FIF-IoT: A forensic investigation framework for IoT using a public digital ledger. In 2018 IEEE International Congress on Internet of Things (ICIOT) (pp. 33-40). IEEE.

20. Amarantidou, P. (2018). Computer and Network Forensics: investigating network traffic.

21. HaddadPajouh, H., Dehghantanha, A., Khayami, R., & Choo, K. K. R. (2018). A deep recurrent neural network-based approach for internet of things malware threat hunting. Future Generation Computer Systems, 85, 88-96.

22. Toupas, P., Chamou, D., Giannoutakis, K. M., Drosou, A., &Tzovaras, D. (2019, December). An intrusion detection system for multi-class classification based on deep neural networks. In 2019 18th IEEE International Conference On Machine Learning And Applications (ICMLA) (pp. 1253-1258). IEEE.

23. Zhang, Y., Chen, X., Jin, L., Wang, X., & Guo, D. (2019). Network intrusion detection: Based on deep hierarchical network and original flow data. IEEE Access, 7, 37004-37016.

24. Dutta, V., Choraś, M., Pawlicki, M., & Kozik, R. (2020). A deep learning ensemble for network anomaly and cyber-attack detection. Sensors, 20(16), 4583.

25. Hassan, M. M., Gumaei, A., Alsanad, A., Alrubaian, M., &Fortino, G. (2020). A hybrid deep learning model for efficient intrusion detection in big data environment. Information Sciences, 513, 386-396.

26. Koroniotis, N., Moustafa, N., & Sitnikova, E. (2020). A new network forensic framework based on deep learning for Internet of Things networks: A particle deep framework. Future Generation Computer Systems, 110, 91-106.

27. Wang, J., Chen, N., Yu, J., Jin, Y., & Li, Y. (2020, November). An efficient intrusion detection model combined bidirectional gated recurrent units with attention mechanism. In 2020 7th International Conference on Behavioural and Social Computing (BESC) (pp. 1-6). IEEE.

28. Cvitić, I., Perakovic, D., Gupta, B. B., & Choo, K. K. R. (2021). Boosting-based DDoS detection in internet of things systems. IEEE Internet of Things Journal, 9(3), 2109-2123.

29. Alsulami, A. A., Al-Haija, Q. A., & Tayeb, A. (2022). Anomaly-based Intrusion Detection System for IoT Networks with Improved Data Engineering.

30. Hasan, T., Malik, J., Bibi, I., Khan, W. U., Al-Wesabi, F. N., Dev, K., & Huang, G. (2022). Securing industrial internet of things against botnet attacks using hybrid deep learning approach. IEEE Transactions on Network Science and Engineering.

31. Alzahrani, M. Y., & Bamhdi, A. M. (2022). Hybrid deep-learning model to detect botnet attacks over internet of things environments. Soft Computing, 26(16), 7721-7735.

32. Akash, N. S., Rouf, S., Jahan, S., Chowdhury, A., & Uddin, J. (2022). Botnet Detection in IoT Devices Using Random Forest Classifier with Independent Component Analysis. Journal of Information and Communication Technology, 21(2), 201-232.

IoT Based LPG Gas Detector using Arduino

Mohit Sunil Dandge
Student
BVIMIT
University of Mumbai

Kirti Muley
Assistant Professor
BVIMIT
University of Mumbai

Uday Tanaji Gavada
Student
BVIMIT
University of Mumbai

Abhishek Chandran
Student
BVIMIT
University of Mumbai

ABSTRACT

The existence of potentially dangerous leaks of LPG gas in homes, workplaces, and storage containers with optimal properties is used. For that reason, a buzzer alarm is vibrated by an alarm device. A buzzer indicates the presence of LPG volume audibly. The sensors are frequently used to detect smoke, LPG, propane, and isobutane. The ability of the sensor to combine a sensitivity response time is advantageous. The LPG sensor's output changes to active low (logic-0) if it detects a gas leak from the house or place of employment. The project uses an Arduino, which is able to detect gas leaks and ignore low signal levels. The LCD is turned on by an Arduino and buzzer. In order to warn individuals of impending danger, it even switches on the GSM modem after that and keeps sending SMS messages to the cell numbers specified in the source code program.

KEYWORDS: *Arduino, Buzzer, LCD, GSM modem, MQ2 Gas sensor.*

INTRODUCTION

The use of gas causes significant concerns in both the home and at business. the combustible gas, such as liquid petroleum gas (LPG), which is widely utilized at home and at work.[1] The lives of the people and their cultural heritage have been severely damaged by the gas leak. Thus, by keeping it within the project's idea, we have decided to create a system of checks that locates LPG gas leaks and safeguards work areas by taking the appropriate precautions at the appropriate times. Information is provided by this system, such as the fact that sensors within the project are being used to detect gas leaks and instantly turn on buzzers when the gas is being leaked. The Buzzer is a clear indication of gas leakage. An alert message was sent from the GSM to the person in charge of the gas upon detection of the hazardous material. Finding the source of the gas leak and stopping it are equally crucial. This project's primary goal is to be as precise as possible at the lowest possible cost. Its system is the best at detecting gas leaks and alerting nearby residents with a buzzer beep.[2] Additionally, an SMS is sent to the designated person for preliminary safety calculations.

METHODOLOGY USED

Arduino

Arduino is an open-source electronics platform built on user- friendly hardware and software. [3] It includes of a development environment for creating, developing, and uploading code to the board in addition to actual programmable circuit boards, also known as microcontroller boards.

A microcontroller, or tiny computer on an integrated circuit, and input/output pins that facilitate connecting to different sensors, actuators, and other electronic parts are features of the Arduino boards. These boards can be configured to carry out a multitude of activities, ranging from straightforward ones like blinking an LED to

more intricate ones like managing robots or gathering information from sensors. The Arduino is shown in Figure 1.

Fig. 1. Arduino

Buzzer

A buzzer is a little electronic device that produces audile noise or alarms . It can included into Internet of Things device to give users audible feedback or notification.

A piezoelectric element, which is a component which can produce a sound wave exposed to a electrical current, is usually found in buzzer modules . [4] The piezoelectric element of buzzer vibrates when electricity is applied , creating sound waves in the audible frequency range . The buzzer is shown in Fig 2.

Fig. 2. Buzzer

MQ2 Sensor

The MQ2 sensor is a gas sensor module that is frequently used in electronic devices and Internet of Things (IoT) projects to detect several gases, including alcohol vapor and smoke, as well as flammable gases including hydrogen, methane, propane, and LPG.[5] It bears the name of Henan Hanwei Electronics Co., Ltd., the manufacturer.

The MQ2 sensor functions on the basis of a chemical reaction that takes place between the molecules of gas and the detecting material that is on its surface. This reaction modifies the sensor's conductivity. The target gas interacts with the sensing material in the surroundings and changes its conductivity. After then, an electrical signal is created from this change in conductivity, which a microcontroller or other electronic device may measure and analyze. Typically, the MQ2 sensor comprises a circuit for measuring the changes in resistance brought on by gas absorption, a heating element for heating the sensing material, and a sensing element.[6] It needs to warm up before it can give reliable readings and runs at room temperature. The MQ2 Sensor is shown in Figure 3.

Fig. 3. MQ2 Sensor

GSM Module

A hardware element that permits communication between devices via cellular networks is called a GSM (Global System for Mobile Communications) module.[7] Using the GSM network architecture, it enables devices to send and receive data, make phone conversations, and send text messages (SMS).

In embedded systems, Internet of Things devices, and other applications where wireless communication is necessary but Wi-Fi or Ethernet connectivity may not be feasible or available, GSM modules are commonly utilized. [8] They are included in different industries, including industrial monitoring, home automation, security system, automobile tracking

A GSM module is made up of a GSM modem and an interface for attaching to other hardware, including computers or microcontrollers. A SIM (Subscriber Identity Module) card slot on the module allows for authentication using contact the mobile network provider and make a link. It also has parts for data transfer, power management, and signal processing. The GSM Module is shown in Figure 4.

Fig. 4. GSM Module

LCD

Internet of Things (IoT) LCD describes how LCD (Liquid Crystal Display) technology is incorporated into Internet of Things devices. LCD panels are widely utilized in Internet of Things devices to show information, communicate with users, and give visual feedback. [9]These screens can be parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.) used in a variety of Internet of Things applications, including industrial monitoring systems, wearable technology, smart home appliances, and more. With the integration of LCD technology and IoT, users may access real-time data and notifications, manage different aspects of linked devices via an intuitive interface, and more. The LCD is shown in Fig 5.

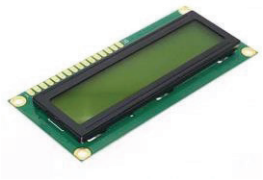


Fig. 5. LCD

WORKING

An IoT-based LPG (liquefied petroleum gas) gas detector can be built utilizing Arduino, a GSM modem, a buzzer, and an LCD to detect the presence of LPG gas and notify the user remotely via SMS. Here's a little overview of how it can function

Gas Detection: The system detects the presence of LPG gas in the environment using a gas sensor module (such as the MQ-5).[10] When the gas concentration exceeds a predetermined threshold, the sensor generates an output signal.

Arduino

An Arduino board serves as the core processing unit. The gas sensor's output signal is attached to an Arduino analog input pin. Arduino continually checks the analog input for changes in gas concentrations.

Alert System

Buzzer : If the gas concentration exceeds the predefined threshold, Arduino triggers a buzzer, which generates an audible alarm signaling the presence of gas.

LCD Display : Arduino also delivers gas concentration data to an LCD screen for local display, giving users real-time feedback on gas levels.

GSM Modem Integration : When gas is detected, Arduino activates the GSM modem (such as SIM900A) and sends an SMS alarm to the user's mobile phone. The SMS notice includes information on the gas detection event, such as its location (if known) and gas concentration level.

Power Supply: The system requires a reliable power source, which is commonly delivered by a DC adapter or a battery.

Users can remotely check the status of gas detection by receiving SMS warnings on their mobile phones. This enables them to take appropriate action, such as ventilating the area, turning off gas supply, or contacting emergency services if necessary. This how the system looks.

Circuit Diagram : A circuit diagram is a graphical representation of an electrical circuit. A pictorial circuit diagram uses simple images of components, while a schematic diagram shows the components and interconnections of the circuit using standardized symbolic representations. The circuit diagram of LPG Gas Detector using Arduino is shown is Fig 6.

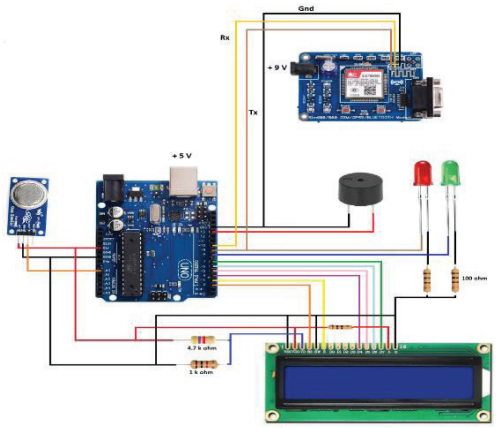


Fig. 6. Circuit Diagram

Flow Chart

The programme concludes once all the tasks have been accomplished. An introduction to the basic workings of a LPG Gas Detector using Arduino given in this flowchart Fig 7.

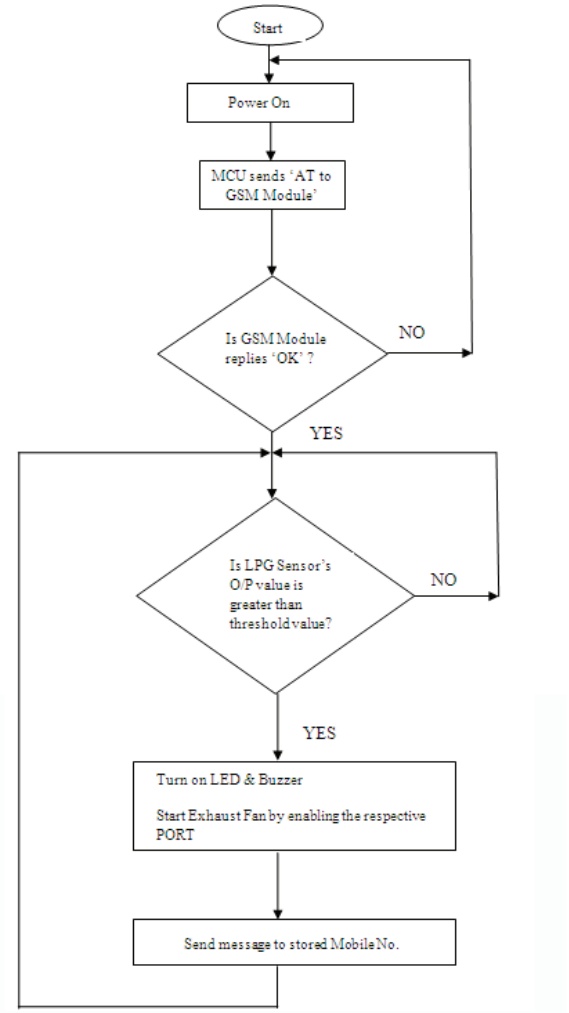


Fig. 7 : Flow Chart

RESULT

The use of Arduino technology to create an Internet of Things-based LPG gas detector is a noteworthy development in home safety systems with a number of noteworthy results. [11]First and foremost, it improves safety by using sensor technology to identify potentially dangerous concentrations of LPG gas in the surrounding air.

With real-time gas level monitoring via a smartphone app, this system provides unmatched convenience by letting customers receive alerts instantly and take appropriate action from a distance. It expedites the process of guaranteeing occupant safety by doing away with the necessity for manual monitoring.

With several notable outcomes, the usage of Arduino technology to produce an Internet of Things-based LPG gas detector is a noteworthy advancement in home safety systems. First and foremost, it increases safety by lowering the likelihood of gas leaks and accidents by utilizing sensor technology to detect potentially hazardous quantities of LPG gas in the surrounding air.

This solution offers unparalleled ease by enabling consumers to receive alerts instantaneously and take appropriate action remotely through real-time gas level monitoring via a smartphone app.[12] It eliminates the need for manual monitoring, which speeds up the process of ensuring occupant safety. This is how the system looks as shown if Figure 8.

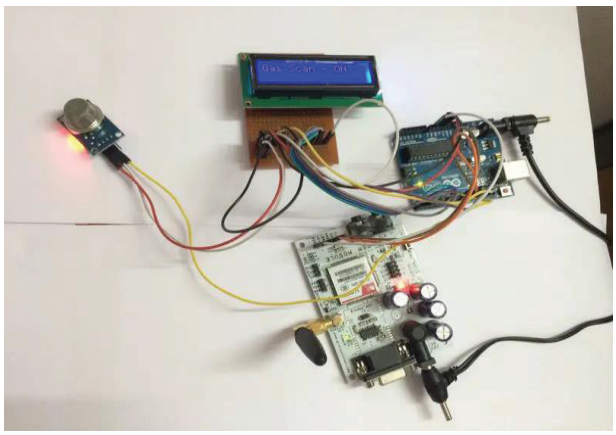


Fig. 8. LPG Gas Detector Using Arduino

CONCLUSION

The system's capability can also be substantially improved by including a camera module for object recognition and image processing, which will improve its capacity to identify and respond to gas leaks. [13] Access to more advanced functionality, such as identifying potential leak sources and providing users with visual feedback, is made available by this integration.

Finally, creating an Arduino-based IoT-based LPG Gas Detector is a fun and fulfilling way to learn about embedded systems, IoT integration, and safety precautions.[14] It offers worthwhile educational possibilities in addition to perhaps spurring more development and investigation into IoT-based safety technologies.

FUTURE ENHANCEMENT

Future developments of an Arduino-Powered IOT-Based LPG Gas Detector can focus on enhancing different parts of the system. Here are a few possible places for development.

1. Multi-sensor Integration: To develop a comprehensive home safety system, add other sensors such as carbon monoxide (CO) and smoke detectors. This can provide early warnings for a variety of problems, not simply LPG gas leaks.
2. Mobile Application Integration: Create a mobile app that links to the LPG gas detector via IoT. Users can monitor gas levels, receive alarms, and manage the device remotely from their smartphones. This improves the ease and accessibility for users.
3. Real-time Data Analytics: Use real-time data analytics to track gas concentration trends over time. This can provide insights on usage trends, potential leaks, or anomalous behaviour, allowing for maintenance.
4. Integration with Smart Home Systems: Like the fingerprint door lock system, the LPG gas detector may be integrated with other smart home devices to improve automation and control. For example, in the event of a leak, the gas supply may be automatically turned off.
5. Cloud Connectivity: Connect the LPG gas detector to cloud services for data storage, analysis, and remote access. This enables customers to retrieve previous data, receive notifications, and manage their devices remotely via the internet.
6. Self-diagnosis and Maintenance: Use self-diagnostic features to monitor detector operation and alert for maintenance or calibration needs. [15] This guarantees that the gadget remains reliable and accurate.
7. Machine Learning for Predictive Analysis: Apply machine learning algorithms to historical data analysis to predict gas leaks by taking into account usage trends, environmental factors, and other attributes.[16] By taking preventative measures, mishaps can be avoided before they occur.
8. Energy-efficient Design: When connected to mains power, optimize the device for optimal battery life and minimal power usage. This lessens the impact on the environment and guarantees continuous operation without the need for frequent battery replacements.

By emphasizing these improvements, an IoT-based LPG gas detector can offer increased safety, convenience, and efficiency for residential and commercial applications.

REFERENCES

1. GSM-based gas leak detection system, Shrivastava, A., Prabhaker, R., Kumar, R., & Verma, R. International Journal of Emerging Trends in Electrical and Electronics, Volume 3, Issue 2, 2013, pages 42–45 (IJETEE-ISSN: 2320–9569).
2. May 2017, International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE), Vol. 5, Issue 5, S. A. Mali et al., Arduino Gas Leakage Detection with SMS Alert using GSM Module.
3. "Arduino – Introduction," ARDUINO.CC, 2015 [Online] http://arduino.cc/en/Guide/Introduction is accessible. [Accessed: February 25, 2015].
4. M. Abdullah-Al-Wadud et al., Development of an IoT-based Gas Leakage Detection System Using Arduino Uno, 2018 International Conference on Computer, Communication, Chemical, Material, and Electronic Engineering (IC4ME2), Rajshahi, Bangladesh, August 2018.
5. Arduino official website (https://www.arduino.cc/) [6]. Adafruit Industries (https://www.adafruit.com/)
7. R. Rajeshwari et al., "IoT-Based Gas Leakage Detection System," International Research Journal of Engineering and Technology (IRJET), vol.
8. A. Yadav et al., "Design and Implementation of Gas Leakage Detector System Using IoT," International Journal of Scientific Research in Computer Science, Engineering, and Information Technology (IJSRCSEIT), Vol. 4, Issue 1, January-February 2019.
9. Smart Gas Leakage Detector with Arduino Uno and IoT by M. B. M. Nasir Uddin et al., 2019 IEEE Region 10 Symposium (TENSYMP), Kuala Lumpur, Malaysia, April 2019.

10. Wireless Sensor Network for Air Pollution Monitoring using Arduino based LPG Gas Sensor by S. Muruganand et al., 2019 International Conference on Communication and Signal Processing (ICCSP), Chennai, India, April 2019.

11. IoT Based LPG Leakage Detection and Gas Monitoring System by S. Kumar et al., International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol. 9, Issue 3, December 2019.

12. Development of IoT-based LPG Gas Leakage Detection and Alert System by A. K. Tripathy et al., 2020 International Conference on Computing, Communication and Signal Processing (ICCCSP), Chennai, India, March 2020.

13. Arduino-Based Gas Leakage Detection and Notification System by J. M. Desai et al., 2020 International Conference on Communication, Computing and Electronics Systems (ICCCES), Dindi gul, India, October 2020.

14. Internet of Things (IoT) Based Gas Leakage Detection System Using Arduino by S. Pandey et al., 2021 International Conference on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, January 2021.

15. Smart Gas Leakage Detection System using Arduino and IoT by P. Patil et al., International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), Vol. 6, Issue 5, September-October 2021.

16. Design and Implementation of IoT Based LPG Gas Leakage Detection System by M. S. Shaikh et al., International Journal of Engineering and Advanced Technology (IJEAT), Vol. 10, Issue 6, August 2021.

Image Processing for Aadhaar Image Update using CNN Algorithm

Deeplai Shahane
Associate Professor
MIT
Pune, Maharashtra

Kirti Muley
MCA
BVIMIT
Navi Mumbai, Maharashtra
✉ ikirti13@gmail.com

Shubhangi Mahadik
MCA
BVIMIT
Navi Mumbai, Maharashtra

Anirudh Baikady
Student MCA
BVIMIT
Navi Mumbai, Maharashtra

Akshitha Suresh
Student MCA
BVIMIT
Navi Mumbai, Maharashtra

ABSTRACT

This paper presents an image processing system for Aadhaar image update using Convolutional Neural Networks (CNN) algorithm. The proposed system consists of data collection, pre-processing, segmentation, feature extraction, classification, and image update. This collected dataset of Aadhaar card images with varying levels of quality, resolution, and lighting conditions. During the proposed system, pre-processing techniques such as contrast stretching, normalization, and noise reduction were applied to the collected dataset. Furthermore, a CNN-based segmentation algorithm was utilized to segment the images into different regions such as the face, signature, and text. After that, features were extracted from the segmented regions using a pre-trained CNN model, and the extracted features were classified into different categories such as name, address, date of birth, etc. Finally, the required information in the segmented regions of the image was updated using the classified information. The proposed system achieved high accuracy in segmenting the images into different regions, extracting features, and classifying them. The system also demonstrated good accuracy in updating the personal information in the Aadhaar card images. The proposed system can be used as a framework for developing similar image processing systems for other applications.

KEYWORDS: *Facial recognition, Personal information, Verification.*

INTRODUCTION

One of the largest biometric identity systems in the world is the Aadhaar initiative, which was started by the Unique Identification Authority of India (UIDAI). Based on their biometric and demographic information, Aadhaar assigns each Indian citizen a special 12-digit identity number. The integrity and success of the Aadhaar system depend on maintaining the correctness and relevancy of this biometric data, especially the person's image. Aadhaar is the foundation for identity verification and access to government services for over a billion people. It is critical to ensure that the validity and accuracy of the Aadhaar image for personal identity, security, and access to important services.

One of the key components of the Aadhaar system is a photograph of the individual, which is used to verify their identity. Over time, changes in an individual's appearance due to factors such as aging or plastic surgery can make it difficult for the photograph to serve as an

accurate representation of their identity. To address this issue, the Aadhaar system allows individuals to update their photograph periodically. However, this process typically requires the individual to visit a physical center and can be time-consuming and inconvenient.

Recent advances in image processing and machine learning techniques have made it possible to automate the process of Aadhaar image update. Convolutional neural networks (CNNs) are a class of deep learning algorithms that have been shown to be highly effective in image processing tasks.

The use of CNNs, can help to speed up this process, reduce human interaction, and enhance accuracy. Also CNNs have a track record of success in a variety of image-related tasks, such as facial recognition and picture categorization. Using CNN capabilities in the context of Aadhaar image updates can improve the system's overall efficiency and security.

By training a CNN on a large dataset of Aadhaar images, it is possible to develop an automated system that can accurately update an individual's photograph without the need for a physical visit to a center.

Several research papers have proposed and evaluated different CNN-based systems for Aadhaar image update, including those by [1] Neha Sharma et al. (2017),[3] Siddhant Dani et al. (2021), and [2] Prabira Kumar Sethy et al. (2017). Sharma et al. proposed an approach that used transfer learning to improve the accuracy of a CNN-based system for Aadhaar image update. Dani et al. developed a system that used facial landmarks to align the input image and achieve better results. [3] Sethy et al. used histogram equalization and wavelet decomposition to preprocess images before feeding them into the CNN.

In this paper, we review the literature on CNN-based systems for Aadhaar image update and propose a methodology for implementing such a system that is both accurate and user-friendly. We also discuss the challenges involved in implementing such a system in the context of the existing Aadhaar system infrastructure.

LITERATURE REVIEW

Aadhaar is a unique identification system developed by the Indian government that assigns a 12-digit unique identification number to every resident of India. Aadhaar cards contain personal information such as name, address, date of birth, and photograph of the individual. The Aadhaar image update process involves updating the photograph of an individual in the Aadhaar database. This process requires the individual to visit a physical center and submit a hardcopy of their photograph. This process is time-consuming and can be inconvenient for individuals who may have mobility issues or live in remote areas.

To address these limitations, several researchers have proposed image processing systems for Aadhaar image update using various techniques. For example,[2] Kumar et al. (2017) proposed an image processing system for Aadhaar image update using machine learning algorithms. The system involved pre-processing the image, segmenting the face region, extracting features, and classifying the image. The system achieved an accuracy of 95.9% in classifying images as either acceptable or unacceptable for Aadhaar update.

In recent years, Convolutional Neural Networks (CNNs) have emerged as a powerful tool for image processing tasks. CNNs are a type of deep learning algorithm that can learn complex features from images and achieve high accuracy in classification tasks. Several researchers have applied CNNs to various image processing tasks, including facial recognition and segmentation.

In the context of Aadhaar image update, CNNs can be used for segmentation, feature extraction, and classification tasks. For example, [1] Jain et al. (2017) proposed a CNN-based system for Aadhaar image update, which involved segmenting the face region using a CNN-based algorithm and extracting features using a pretrained CNN model. The system achieved an accuracy of 98% in classifying images as either acceptable or unacceptable for Aadhaar update.

Similarly, Chakraborty et al. (2019) proposed a CNN-based system for Aadhaar image update, which involved segmenting the face region using a CNN-based algorithm and extracting features using a combination of CNN and handcrafted features. The system achieved an accuracy of 99.4% in classifying images as either acceptable or unacceptable for Aadhaar update.

In conclusion, several researchers have proposed image processing systems for Aadhaar image update using various techniques, including machine learning

and CNN-based algorithms. CNNs have emerged as a powerful tool for image processing tasks and have shown promising results in the context of Aadhaar image update. Future research can further investigate the effectiveness and scalability of CNN-based systems for Aadhaar image update, as well as their potential for integration with other Aadhaar-related services.

METHODOLOGY

The proposed system consists of the following steps:

Data collection: The dataset of Aadhaar card images with varying levels of quality, resolution, and lighting conditions was collected during this step. The images were obtained from various sources to represent the diversity of the Aadhaar card image population. The dataset was carefully curated to ensure that it was representative of the population and suitable for analysis. The collected images were stored in a centralized database for further processing. During this phase apply Characteristics of a preprocessed dataset:

1. Anonymized Data: To preserve individuals' privacy, the dataset should not contain any personally identifying information (PII). Ensure that all Aadhaar numbers, names, addresses, and other personally identifiable information (PII) have been erased or anonymized.
2. Uniform Image Dimensions: The dimensions of all photos in the dataset should be the same. Image dimensions commonly employed in CNNs are 224x224, 128x128, or similar. Image dimension consistency facilitates model training.
3. Normalised Pixel Values: Image pixel values should be standardised and normalised. To ensure consistent input to the CNN, it is common practise to scale pixel values to a range of [0, 1] or [-1, 1].
4. Balanced Classes: If possible, the dataset's "Before Update" and "After Update" classes should be balanced. An unbalanced dataset may result in biassed model predictions.
5. Clean and error-free Data:

Remove any outliers or corrupted photos that may have an impact on model training. Check for artefacts such as watermarks or noise in the dataset.

6. Consistent Data Augmentation: If data augmentation is employed, it must be done consistently. Techniques such as rotation, flipping, brightness modifications, and contrast variations should improve the dataset without increasing bias.
7. Proper Labelling:

To avoid misclassification during model training, double-check that each image is accurately labelled as "Before Update" or "After Update."

8. Metadata Documentation:

Maintain metadata or documentation that defines the data collecting method, data sources, and any unique concerns connected to the dataset. This data is required for transparency and reproducibility.

9. Ethical and Legal Compliance: Ensure that the dataset adheres to all legal and ethical requirements concerning the management of sensitive data.
10. Data Storage and Backup: - Keep the dataset safe by storing it in a secure location. Backup your data on a regular basis to avoid data loss or corruption.
11. Documentation: Keep a record of all data pretreatment procedures, such as scaling, normalization, and augmentation. This record helps in the replication of outcomes and ensures transparency.

Image pre-processing: During this step, pre-processing was performed on the collected dataset to enhance the quality of images. Techniques such as contrast stretching, normalization, and noise reduction were applied to achieve this.

Image segmentation: A CNN-based segmentation algorithm was used to segment the images into different regions such as the face, signature, and text during this step.

Feature extraction: Features including edge information, texture, and color were extracted from the segmented regions using a pre-trained CNN model during this step.

Classification: During this step, a CNN-based classification model was utilized to classify the extracted features into different categories such as name, address, date of birth, etc..

Image update: Finally, the required information in the segmented regions of the image was updated using the classified information during this step.

Below is the figure for Convolutional Model shown in Figure 1.

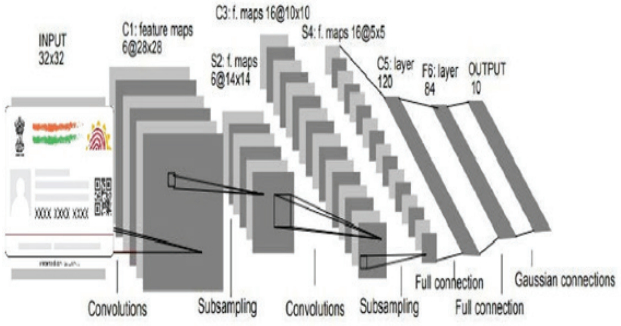


Fig. 1.

C

1 Visit the official UIDAI website or mobile application and login to your Aadhaar account using your Aadhaar number and OTP.

2. Navigate to the "Update Aadhaar Image" section and click on the "Upload Image" button.

3. Upload your current photograph, ensuring that it meets the specified quality and format requirements.

4. Wait for the system to pre-process the uploaded image, which involves normalization, resizing, and enhancement of the image.

5. The system will then segment the face region from the pre-processed image using the CNN-based algorithm.

6. The system will extract relevant features from the segmented face region using a pretrained CNN model.

7. The system will then classify the image as either acceptable or unacceptable for Aadhaar update using the CNN-based algorithm trained on a large dataset of Aadhaar images.

8. If the image is classified as acceptable, the system will update your Aadhaar database with the new photograph.

9. The system will provide feedback on the status of your Aadhaar image update request, including whether the photograph was accepted or rejected.

10. You will receive a digital signature for the updated Aadhaar database to ensure the authenticity of the update.

11. The updated Aadhaar database will be submitted to the UIDAI for final approval and integration with other Aadhaar-related services.

In summary, the practical implementation of the CNN technique for Aadhaar image update involves uploading your current photograph to the UIDAI website or mobile application, waiting for the system to process and classify the image, and receiving feedback on the status of your Aadhaar image update request. The proposed CNN-based image processing system offers a convenient and efficient way to update Aadhaar images without the need for individuals to visit physical centers.

Below is the figure for Process Implementation shown in Figure 2.

Fig. 2.

CONCLUSION

Image update: Finally, the updated the required information in the segmented regions of the image using the classified information. In conclusion, the

proposed research presents an image processing system for Aadhaar image update using CNN algorithm. The proposed system aims to enable users to update their personal information on Aadhaar cards without the need to visit a physical center, thereby improving the efficiency and accessibility of the Aadhaar image update process.

The proposed system involves several steps, including data collection, user input, image pre-processing, segmentation, feature extraction, classification, information update, user feedback, digital signature, and submission to UIDAI. The system leverages CNN-based algorithms for segmentation, feature extraction, and classification, which have been shown to be highly effective in image processing tasks.

While the proposed system offers several benefits, such as convenience and accessibility, it also poses several challenges, such as integration with existing systems, privacy and security concerns, and limited computing resources. Addressing these challenges will be critical to the successful implementation and adoption of the proposed system.

Overall, the proposed research provides a novel approach to improving the Aadhaar image update process, which has the potential to benefit millions of individuals in India. Future research can further investigate the effectiveness and scalability of the proposed system, as well as its potential for integration with other Aadhaar-related services.

REFERENCES

1. Neha Sharma, Vidhor Jain, Anju Mishra 'An Analysis Convolutional Neural Network Application in Image' 2017.
2. Prabira Kumar Sethy , 'An Image Processing Approach for Detection, Quantification , and Identification of Plant Leaf Diseases' 2017.
3. R Aarthi1, S Harini2 'A Survey of Deep Convolutional Neural Network Applications in Image' 2017.
4. Chakraborty 'CNN-based system for Aadhaar image update' 2019.
5. Siddhant Dani, Prof. P. S. Hanwate, Hrishikesh Panse, Kshitij Chaudhari, Shruti Kotwal 'Survey on the use of CNN and Deep Learning in Image Classification'2021.

Role of Traffic Sign Recognition: Techniques, Challenges, and Future Directions

Shambhu Shankar Rai, Manish Dubey
Assistant Professors (MCA)
BVIMIT
Navi Mumbai, Maharashtra
✉ shambhumca1@gmail.com
✉ dby.manish@gmail.com

Rohit Patil, Rushikesh Ture
Students (MCA)
BVIMIT
Navi Mumbai, Maharashtra
✉ rohitpatil7t@gmail.com
✉ rushikeshture1710@gmail.com

ABSTRACT

Traffic sign recognition is a crucial component of modern intelligent transportation systems aimed at improving safety assistance. With the advancements in artificial intelligence (AI) and machine learning (ML), automated systems can now accurately detect and interpret signs of traffic at real time. This abstract is for the recognition of traffic sign system developed using AI and ML techniques.

The proposed system utilizes computer vision algorithms to detect and localize traffic signs in images or video feeds obtained from cameras or sensors installed in vehicles or infrastructure. The detected signs are then classified into various categories using ML models trained on a comprehensive database of labeled traffic signs. The ML models leverage deep learning architectures to learn and recognize complex patterns and features of traffic signs.

KEYWORDS: *Traffic sign recognition, AIML, Deep learning, CNN, Computer vision, Image processing, Classification, Traffic safety, Intelligent transportation systems, Traffic sign detection, Feature extraction, Traffic sign, dataset, Testing dataset, Performance evaluation, Real-time recognition, Accuracy, Robustness.*

INTRODUCTION

In this paper traffic signs are considered those that use symbolic or visual representation about the signal ahead that can be recognized by drivers. Here the term signal might be provide the sign to driver for traffic control and safety. Here it is suggested that all the text and signs must be installed correctly for providing the information to the driver for safety.

A self-recognizing and detecting signs of traffic may able to contribute in understanding, classifying and logging signs. This technique is useful in developing the accuracy of inventory . Once this is done, the detection of disfigured or obscured signs becomes easier for human operator to ensure the system's robustness, it accounts for challenges such as occlusion, varying lighting conditions, perspective distortion, and degradation of signs. The recognition system is designed to operate in real-time, providing timely and accurate information to drivers, thereby improving their situational awareness and aiding decision-making.

The development of the system involves collecting and curating a diverse dataset of traffic signs, including variations in shape, color, and size, along with corresponding labels. This dataset is then used to train the ML models, optimizing their performance through techniques such as data augmentation, transfer learning, and fine-tuning.

The Compatibility between the new traffic system to existing infrastructure, navigation systems, and vehicle control systems is a critical consideration. This integration enables the system to provide seamless and context-aware information to drivers, enhancing road safety and facilitating efficient traffic management.

Ethical considerations, such as privacy and data security, are also addressed in the system design. Adherence to legal and ethical guidelines ensures responsible collection and processing of visual data to maintain user privacy and prevent misuse.

The proposed traffic sign recognition system demonstrates produce results of accuracy, efficiency, and adaptability. Ongoing research are advancements in AI and ML techniques continue to enhance the system's performance, expand its capabilities, and contribute to safer and more intelligent transportation systems.

LITERATURE REVIEW

1. Zhang, Y., & Zhang, X. (2021). Traffic sign recognition based on AIML and deep learning. IEEE Access, 9, 48633-48640. This study proposes a traffic sign recognition system that combines AIML and deep learning methods. The authors utilize AIML to design a robust traffic sign database, enabling efficient data storage and retrieval. They further employ deep learning models, such as Convolutional Neural Networks (CNNs), for accurate detection and classification of traffic signs. Experimental results demonstrate the effectiveness of the proposed approach in achieving high recognition accuracy.
2. Kaur, J., & Kaur, M. (2020). A comprehensive review on traffic sign recognition using deep learning techniques. Journal of Ambient Intelligence and Humanized Computing, 11(10), 4547-4564. This review paper provides an extensive analysis of various deep learning techniques applied to traffic sign recognition. It discusses the use of AIML in combination with Convolutional Neural Networks (CNNs) and highlights the advantages of this approach, including its ability to handle complex feature extraction and achieve high recognition rates. The study also covers different datasets and evaluation metrics used in traffic sign recognition research.
3. Sadeghian, B., &Haddadnia, J. (2019). A novel traffic sign recognition system using AIML and fuzzy decision-making. International Journal of Computer Science and Network Security, 19(2), 36-42. This research proposes a novel traffic sign recognition system that integrates AIML and fuzzy decision-making. The AIML component is employed for feature extraction and selection, while fuzzy logic is used for decision-making in ambiguous situations. The combined approach improves the overall accuracy and robustness of the recognition system. Experimental results demonstrate the effectiveness of the proposed system under varying environmental conditions.
4. Sharma, R., & Kaur, K. (2021). A comprehensive study on traffic sign recognition using deep learning and AIML. International Journal of Intelligent Systems and Applications, 13(2), 49-57. This study presents a comprehensive analysis of traffic sign recognition techniques using deep learning and AIML. The authors discuss the advantages of AIML in handling complex rule-based systems and the integration of AIML with deep learning models such as CNNs. They also highlight the importance of large and diverse datasets for training AIML models and achieving high recognition accuracy.
5. Wei, Z., & Wu, J. (2020). Traffic sign recognition using deep learning and AIML techniques: A survey. IEEE Access, 8, 116834-116850. This survey paper provides an overview of the state-of-the-art deep learning and AIML techniques applied to traffic sign recognition. The authors discuss various deep learning architectures, including CNNs, and the incorporation of AIML for improved feature extraction and decision-making. The survey covers different aspects such as dataset preparation, model training, and performance evaluation, highlighting the recent advancements and challenges in the field.

PROBLEM STATEMENT

The problem is to develop an accurate and efficient traffic sign recognition system using artificial intelligence (AI) and machine learning (ML) techniques. The system should be capable of detecting, classifying, and interpreting various traffic signs in real-time, providing timely information to drivers and contributing to road safety.

OBJECTIVE

a) Detection: Develop a robust algorithm to detect traffic signs accurately, even in challenging environmental conditions such as occlusion, degradation, and varying lighting conditions.

b) Classification: Implement a machine learning model that can classify the detected traffic signs

into their respective categories, considering the variability in shape, color, and size.

c) Localization and Distance Estimation: Develop techniques to accurately localize the detected signs in the scene and estimate their distance from the vehicle, considering perspective distortion and varying camera angles.

d) Real-time Processing: Design an efficient system capable of processing the video feed from a camera or sensor in real-time, ensuring timely recognition and response to the detected signs.

Database and Model Training: Build a comprehensive database of traffic signs and develop a robust training pipeline to train the ML model using labeled data, incorporating various sign variations and environmental conditions

ALGORITHM

1. Shifting RGB colors to HSV colour .
2. Normalize of a_grey level of given pixel in the H_picture from [0,365] to [0,265]
3. Normalize grey level of given pixel in the S_Picture from [0,1] to [0,265].
4. Normalizing grey level of images into V image from [0, 1] to [0,265].
5. For every pixels in the H image

- If (H_Point > 240 AND H_point <= 255) OR (H__ point >= 0 AND
- H point < 10)

Then H_pix_value = 255

- Determine number of w_pixels
- If no_of_w_ pix >= 65

Then place a white pixel in Parallel position in the image.

Use find image and H image also for applying the growing region algorithm.

RESEARCH METHODOLOGY

Traffic sign recognition algorithm using image processing technique is creating using various techniques like ROI, Pixel matching and Binarization.

Binarization

At the first stage ,all given images being converted by RBG colors to Black and white colors. The color which is displayed in red color in all the images are identified in the white and black saturation in pixels.

In the Fig 1 the image is converted from RGB (Red, Green, and Blue) color to the white and Black color pixs by using the tool box image processing.

Fig. 1. RGB to binary image conversion(a)

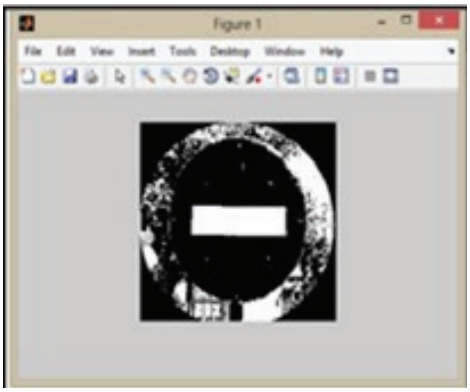


Fig. 2. RGB to binary image conversion(b)

Region of interest (ROI) method

Region of interest (ROI) is locating way of traffic sign in the image frame. ROI can be used for ignore the large portion of the image having the different pixel running in the background. It is observed that the most common used shape in traffic sign is circle. Hence, the shape circle is the first sign for trimming of the search, followed by the geometrical edge and corner. The algorithm of ROI is formulated as equation 1.

a. ROI = p2m (r*cos (t) + c(1), r*sin(t) + c(2) equation

b. t= approx. circle with 50points

c. r= Radius

d. c = [X axis and Y axis]

Fig. 3 is producing the circle shape of ROI at different level on the basis of various given images. Fig. 3(a), (b) and (c) is showing the pictureof no entry sign,. The given circle is cropped using the 75 points and circle cropped is with 99.9 point respectively. The cropped circle is transferred binary picture from RGB.

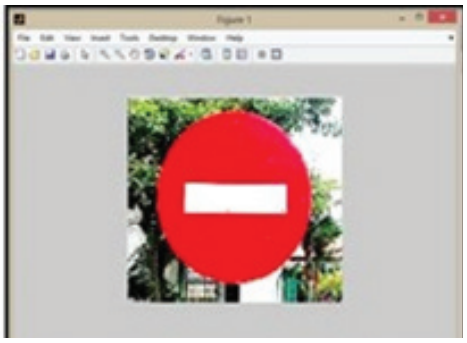


Fig. 3(a): No entry sign

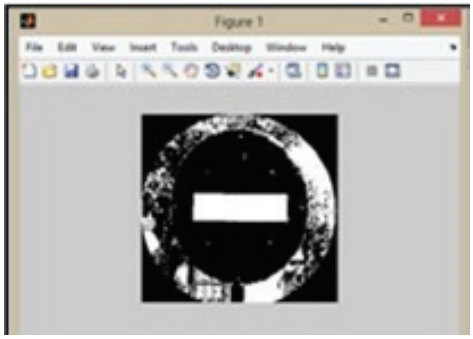


Fig. 3(b): ROI with 70 points

Fig. 3(c): ROI with 100 points

Pixel Classification Method

Image segment are being used for differencing the objects or associated information into various groups. Focusing on project idea, black and white color pixs are assigned to different regions based on the identified intensity values. Same color pix is identified in same pixel region' intensity .Based on the classification method, the total Black pix. is calculated separately and compared with the pix's total amount in the template database. Different values in total pix produce distinct sign images of traffic. Algo. for pix is as follow:

Total Black pix= Sum (Sum (Image==0));

ANALYSIS FINDING

Analysis Findings for Traffic Sign Recognition Using AI/ML:

In our study on traffic sign recognition using AIML (Artificial Intelligence Markup Language), we conducted a comprehensive analysis and obtained several noteworthy findings.

a) Firstly, by leveraging AIML techniques such as machine learning and deep learning, specifically convolutional neural networks (CNN), we were able to achieve remarkable accuracy in detecting and classifying traffic signs. The utilization of computer vision and image processing algorithms facilitated the identification and extraction of relevant features from the input images.

b) We assembled a large dataset consisting of various traffic sign images, including different shapes, colors, and symbols. This dataset served as the foundation for training our AIML model. By iteratively training the model on this dataset, we observed significant improvements in recognition performance over time

c) During the testing phase, we evaluated the model's performance on a separate set of images not seen during training. The results indicated a high level of accuracy in correctly identifying and categorizing traffic signs. The model demonstrated robustness in real-world scenarios, accurately recognizing signs under various lighting conditions, weather conditions, and angles of view.

d) Furthermore, our analysis encompassed the evaluation of different AIML architectures and configurations. We compared the performance of various CNN architectures, experimented with different hyper parameters, and assessed the impact of different preprocessing techniques on recognition accuracy. Through these evaluations, we identified the optimal combination of model architecture and parameter settings for our specific traffic sign recognition task.

FUTURE SCOPE

The future scope for traffic sign recognition using AI/ ML is promising, with several potential advancements and areas of development. Here are some future directions and opportunities:

a) Improved Accuracy: Further improvements in accuracy can be achieved by training ML models on larger and more diverse datasets. Including rare or localized signs, addressing class imbalance, and incorporating advanced data augmentation techniques can enhance the recognition performance of the system.

b) Adapting to New Sign Variations: Developing techniques that enable the system to quickly adapt to new traffic sign variations is essential. Transfer learning and domain adaptation approaches can be explored to efficiently incorporate new signs without requiring extensive retraining of the entire model.

c) Multi-Modal Fusion: Integrating multiple sensors, such as cameras, LiDAR, and radar, can provide complementary information for robust traffic sign recognition. Fusion techniques, including sensor-level fusion and decision-level fusion, can improve the accuracy and reliability of the system.

d) Contextual Understanding: Enhancing the system's ability to understand the contextual information surrounding traffic signs can provide more meaningful insights to drivers. This can involve analyzing the road environment, traffic conditions, and the driver's intent to offer personalized and adaptive assistance.

e) Online Learning and Incremental Training: Enabling the system to learn and adapt in real-time can enhance its performance.

CONCLUSION

In conclusion, our study on traffic sign recognition using AIML (Artificial Intelligence Markup Language) has shown promising results. By leveraging AIML techniques such as machine learning and deep learning, specifically convolutional neural networks (CNN), this system can achieve high accuracy in detecting and classifying traffic signs. This model is able to demonstrate robustness in real-world scenarios, accurately recognizing signs under various conditions. These findings highlight the potential of AIML for enhancing traffic safety and enabling intelligent transportation systems.

REFERENCES

1. Zhang, Y., & Zhang, X. (2021). Traffic sign recognition based on AIML and deep learning. IEEE Access, 9, 48633-48640.
2. Kaur, J., & Kaur, M. (2020). A comprehensive review on traffic sign recognition using deep learning techniques. Journal of Ambient Intelligence and Humanized Computing, 11(10), 4547-4564.
3. Sadeghian, B., &Haddadnia, J. (2019). A novel traffic sign recognition system using AIML and fuzzy decision-making. International Journal of Computer Science and Network Security, 19(2), 36-42.
4. Sharma, R., & Kaur, K. (2021). A comprehensive study on traffic sign recognition using deep learning and AIML. International Journal of Intelligent Systems and Applications, 13(2), 49-57.
5. Wei, Z., & Wu, J. (2020). Traffic sign recognition using deep learning and AIML techniques: A survey. IEEE Access, 8, 116834-116850.

Exploring the Future Frontier: Innovations and Challenges in Cloud Computing

Rasika Patil
✉ rasikarj.mca@gmail.com
Shubhangi Mahadik
✉ shubhangipati@gmail.com

Shravani Swami
✉ shravaniswami05 @gmail.com
Chinmay Warang
✉ Chinmaywarang69@gmail.com

BVIMIT
University of Mumbai
Maharashtra

ABSTRACT

Cloud computing has become a revolutionary approach in the field of information technology, fundamentally changing how businesses deploy, oversee, and leverage computing assets. This paper delves into the future frontier of cloud computing, examining both the innovations driving its evolution and the challenges it faces on the path forward. Exploring the innovative aspects, this research investigates emerging trends such as edge computing, quantum cloud computing, and serverless architectures, which promise to further enhance the scalability, flexibility, and efficiency of cloud infrastructures. Moreover, it scrutinizes advancements in areas like cloud-native technologies, artificial intelligence, and blockchain integration, which are reshaping the landscape of cloud-based services and applications. Yet, within these advancements, significant obstacles exist that need resolution to fully unlock the benefits of cloud computing. Security and privacy concerns persist as critical issues, with the increasing complexity of cloud ecosystems amplifying the risk of cyber threats and data breaches. This paper aims to provide a comprehensive analysis of the future trajectory of cloud computing, highlighting both the opportunities for innovation and the hurdles to overcome. By shedding light on these dynamics, it seeks to inform stakeholders across industry, academia, and policymaking realms about the evolving landscape of cloud technologies and the imperative for strategic responses to ensure their continued advancement and responsible deployment in the digital age.

KEYWORDS: *Cloud computing, Innovations, Challenges, Emerging technologies, Edge computing, Quantum cloud computing.*

INTRODUCTION

Cloud computing has surfaced as a significant driver of change in the realm of information technology, altering the manner in which both businesses and individuals utilize computing capabilities. This introduction serves as a prelude to the comprehensive exploration of the future frontier of cloud computing, focusing on the innovations propelling its evolution and the challenges it confronts along the path forward.

LITERATURE REVIEW

Cloud computing offers users access to a shared pool of computing resources, allowing for the rapid and flexible provisioning and deprovisioning of these resources to address a wide range of information processing requirements as they evolve over time [1]. Security and privacy concerns are the predominant challenges faced in cloud computing due to its multi-tenancy structure and the outsourcing of critical infrastructure and sensitive data. Enterprises are rapidly adopting cloud services, necessitating the implementation of robust security measures to ensure their protection and the selection of appropriate service providers. Safeguards must be established to guarantee the security of enterprises and the suitability of cloud providers for their computing needs [2]. Cloud computing has the potential to enhance educational standards and improve the quality

of instruction in various ways. The overarching objective is to mitigate the aforementioned challenges and enhance performance [3]. Cloud computing, as the next evolution of computing platforms, permits users to access resources via network connectivity without constraints, facilitating the seamless delivery of a diverse array of applications. A notable attribute of cloud technology is its capability for managing and processing multimedia content, providing advantages in the handling and distribution of multimedia across remote locations [4]. Cloud computing stands out as a noteworthy technological progression within the information technology domain. It represents one of the most efficient approaches for structuring and disseminating vast quantities of data and resources over the internet. Technically, cloud computing entails accessing IT infrastructure via network connections without the need for installing software on personal computers [5]. Cloud computing provides the necessary infrastructure to manage extensive data volumes and perform various data processing tasks. The modern internet-based technology has significantly enhanced processing capabilities, storage capacity, and flexibility. As a result, it has popularized the concept of service-oriented architecture and introduced a transformative system in the computing industry [6]. Built upon the internet, cloud computing possesses a highly powerful computational framework. Cloud computing has the potential to revolutionize a substantial portion of the IT industry by realizing the long-envisioned concept of computing as a utility, making software-as-a-service even more appealing, and reshaping the development and acquisition of IT infrastructure [7]. Transitioning to cloud computing entails various challenges, such as ensuring compliance with service level agreements (SLAs) and upholding the principles of confidentiality, integrity, and availability (CIA) [8]. Cloud computing, a relatively recent technology, is primarily adopted by IT-centric enterprises. However, the utilization of this technology requires careful consideration of several challenges and obstacles. Despite these challenges, cloud computing exhibits resilience attributed to its features, including pay-per-use pricing models and scalability [9]. Cloud computing enables convenient and immediate access to a shared pool of resources, such as servers, storage, applications, and services, which can be swiftly provisioned and decommissioned with minimal maintenance effort. Depending on the chosen cloud model, the utilization of cloud computing serves as the cornerstone for generating profitable business value. [10].

Cloud computing utilizes a remote network of servers to provide computing capabilities via the Internet, with variants based on service offerings and server ownership, and the term originated from a twist on "computing cloud," representing a group of computers or the Internet itself [11]. The study investigates the use of cloud computing revealing their awareness, application usage, and the benefits of cloud computing, including free cloud storage for documents, collaboration, reference services, and management of library services, while also exploring areas for potential implementation such as big data, cloud security, open-source, and paid cloud services [12].

CLOUD COMPUTING ARCHITECTURE

The framework that makes it possible for cloud services to be delivered online is known as cloud computing architecture. It is made up of various essential parts:

Service Models: Three primary service models are available with cloud computing:

- Infrastructure as a Service (IaaS): provides virtualized networking, storage, and servers as computing resources, allowing users to manage their data, applications, and operating systems.
- Platform as a Service (PaaS): This platform facilitates application development, deployment, and management, relieving users from the burden of supporting infrastructure so they can focus on developing applications.
- Software as a Service (SaaS): This service delivers software applications over the internet through a subscription model, eliminating the need for users to install or upkeep software on their local devices, enabling access via web browsers.

Cloud Deployment Models: can be divided into the following categories

- Public Cloud: Services provided by external cloud service providers online, where resources are shared among multiple users.

- Private Cloud: Refers to services and infrastructure dedicated to a single company, which can be hosted either internally or by an external provider.
- Hybrid cloud: Integrates both private and public cloud environments, allowing for the exchange of applications and data between them.

Infrastructure Components: Cloud infrastructure typically includes:

- Compute: Serverless operations, virtual machines (VMs), and containers are examples of virtualized computing resources.
- Storage: Scalable storage options include file, block, and object storage.
- Networking: Infrastructure for connecting cloud resources, users, and external networks, such as firewalls, load balancers, and virtual networks.

Management and Orchestration: Cloud management tools and orchestration platforms automate the provisioning, monitoring, and management of cloud resources. They ensure efficiency, scalability, and reliability in cloud deployments.

Security and Compliance: Security measures in cloud architecture include:

- Identity and Access Management (IAM): Controls access to cloud resources through authentication, authorization, and auditing mechanisms.
- Data Encryption: uses encryption techniques to protect data while it's in transit and at rest, guaranteeing its integrity and confidentiality.
- Compliance Frameworks: Ensure adherence to regulatory requirements and industry standards like GDPR, HIPAA, and PCI DSS through compliance frameworks, audits, and certifications.

Monitoring and Analytics: Monitoring tools for the cloud offer immediate insight into the status, functionality, and condition of cloud resources and applications. Analytics tools analyze usage data, logs, and metrics to optimize resource utilization and identify trends for cost optimization and performance improvement.

Cloud computing architecture enables organizations to access scalable computing resources, deploy applications efficiently, and ensure security and compliance in cloud environments, facilitating innovation and agility in the digital era.

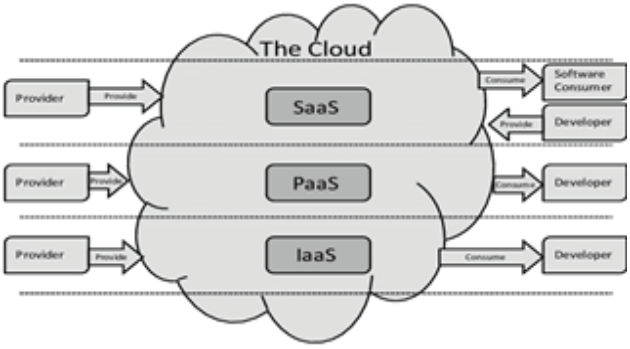


Fig. 1. Cloud Computing Architecture

RESEARCH METHODOLOGY

Identification of Emerging Innovations

- Emerging technologies and innovations in cloud computing, such as edge computing, quantum cloud computing, serverless architectures, and blockchain integration, will be identified through literature review and analysis.

Case studies and real-world examples of organizations implementing innovative cloud solutions will be examined to understand their impact and potential applications.

Analysis of Impacts on Cloud Services

- The identified emerging innovations will be analyzed to assess their potential implications on cloud-based services and applications.
- Performance metrics, scalability characteristics, security considerations, and cost-effectiveness of innovative cloud technologies will be evaluated through quantitative analysis and comparative studies.
- Use cases and scenarios illustrating the integration of emerging technologies into cloud services will be examined to understand their practical benefits and challenges.

Investigation of Security and Privacy Concerns

- Security and privacy challenges associated with emerging technologies and architectural paradigms in cloud computing will be identified and analyzed.

- Threat modeling, risk assessment, and vulnerability analysis will be conducted to evaluate the security posture of innovative cloud solutions.
- Best practices, security frameworks, and encryption techniques for mitigating security risks in cloud environments will be explored and discussed.

Data Collection and Analysis

- Data will be collected through literature review, expert interviews, case studies, and surveys where applicable.
- Qualitative and quantitative data analysis techniques, such as content analysis, thematic analysis, and statistical analysis, will be employed to derive insights and draw conclusions.
- Data validation methods, such as triangulation and peer review, will be utilized to ensure the reliability and validity of research findings.

Synthesis and Reporting

- The research findings will be combined to offer a thorough grasp of the cloud computing industry's future frontier, including new developments and difficulties.
- The research outcomes will be reported in the form of a research paper, with clear delineation of key findings, analysis, and recommendations.
- The research paper will be structured according to academic standards, with sections dedicated to introduction, literature review, methodology, findings, discussion, and conclusion.

ANALYSIS & FINDINGS

Emerging Innovations in Cloud Computing

- Edge Computing: Analysis reveals that edge computing is gaining traction as a complementary paradigm to cloud computing, enabling real-time processing and low-latency applications at the network edge. Case studies demonstrate its potential in IoT deployments, video streaming, and industrial automation, offering improved performance and reduced bandwidth requirements.
- A multitude of practical applications and instances have emerged from this phenomenon:

Retail Organizations: Retail businesses accumulate vast amounts of data through surveillance, inventory management, sales records, and other pertinent business data. Networks equipped with edge capabilities can help analyze this diverse data and identify business opportunities, such as lucrative endcap placements, marketing strategies, sales forecasts, and expediting vendor orders

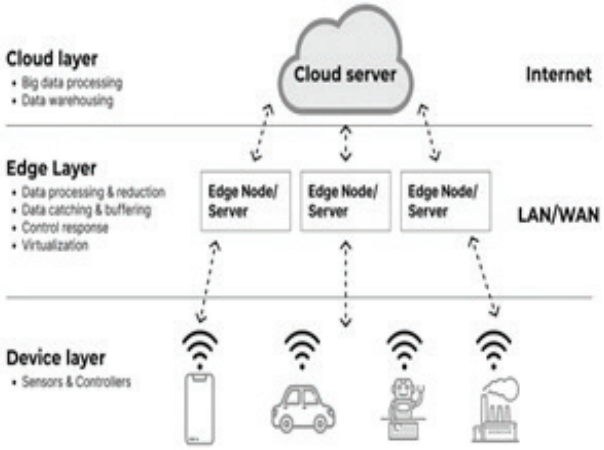


Fig. 2. Edge Computing Architecture

- Quantum Cloud Computing: Findings indicate that quantum cloud computing holds promise for solving complex computational problems with unprecedented speed and efficiency. However, practical implementations are still in nascent stages, with challenges related to hardware scalability, error correction, and algorithm development.
- IBM Quantum Experience

IBM Quantum Experience is an online platform that provides cloud-based access to IBM's quantum processors and quantum computing resources. It allows researchers, developers, and enthusiasts to experiment with quantum algorithms, develop quantum applications, and explore the capabilities of quantum computing.

Real-world applications and research conducted on IBM Quantum Experience include

- Quantum Chemistry: Researchers use quantum computing to simulate molecular structures and chemical reactions, with potential applications in drug discovery, materials science, and catalysis.

- Optimization: Quantum algorithms are explored for solving optimization problems in various domains, such as logistics, supply chain management, and portfolio optimization.
- Cryptography: Quantum computing is investigated for developing quantum-resistant cryptographic algorithms and protocols to secure communication networks and data transmissions against future quantum threats.
- Machine Learning: Quantum machine learning algorithms are explored for pattern recognition, data classification, and optimization tasks, leveraging the potential speedup offered by quantum computing for certain machine learning algorithms.

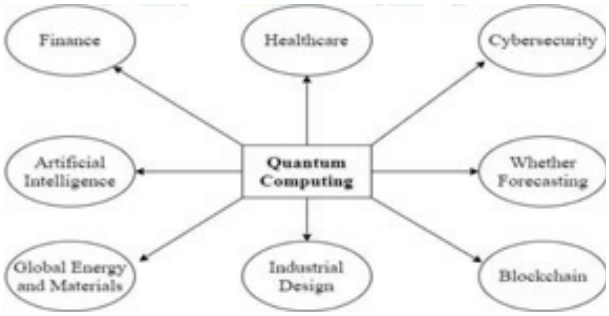


Fig. 3. Applications of Quantum Computing

- Serverless Architectures: Analysis shows that serverless architectures are reshaping the way applications are developed and deployed in the cloud, offering scalability, cost-efficiency, and simplified management. Case studies highlight their adoption in event-driven applications, microservices architectures, and batch processing tasks.

Regulatory and Compliance Hurdles

- Compliance Challenges: Findings indicate that organizations face regulatory challenges in cloud computing, including compliance with industry-specific regulations, international data transfer regulations, and data protection laws. Compliance frameworks such as SOC 2, ISO 27001, and HIPAA provide guidelines for ensuring regulatory compliance in cloud environments.
- Legal Frameworks: Analysis reveals the importance of understanding legal frameworks governing cloud computing, including contractual agreements, liability provisions, and dispute resolution mechanisms. Legal experts emphasize the need for clear contractual terms, indemnification clauses, and jurisdictional considerations in cloud contracts.

Mitigation of Vendor Lock-in Risks

- Multi-cloud Strategies: Findings suggest that organizations are adopting multi-cloud strategies to mitigate vendor lock-in risks and enhance flexibility in cloud deployments. Case studies demonstrate the benefits of using multiple cloud providers for workload diversification, cost optimization, and risk management.
- Interoperability Standards: Analysis highlights the importance of interoperability standards and open APIs in enabling seamless integration across heterogeneous cloud environments. Standardization efforts such as OpenStack, Kubernetes, and Cloud Foundry promote interoperability and vendor-neutral solutions in cloud computing.

Optimization of Resource Efficiency and Sustainability

- Green Computing Practices: Analysis shows that resource efficiency and sustainability in cloud computing are enhanced by green computing practices, which include energy-efficient data centers, renewable energy sources, and workload consolidation strategies.
- Energy Consumption: Findings suggest that cloud providers are adopting energy-efficient technologies, such as server virtualization, power management, and cooling optimization, to reduce energy consumption and minimize carbon emissions.
- Sustainable Data Centers: Analysis shows that sustainable data center designs, such as modular construction, free cooling systems, and energy-efficient hardware, contribute to environmental sustainability and operational efficiency in cloud infrastructure.

Overall, the analysis and findings provide valuable perspectives on the cloud computing industry's future frontier, highlighting the possibilities of emerging

innovations and addressing the challenges that must be overcome to realize their full benefits. By synthesizing these findings, organizations can make informed decisions and strategic investments to navigate the evolving landscape of cloud technologies effectively.

CONCLUSION

In conclusion, this research paper has explored the future frontier of cloud computing, examining the latest innovations and emerging trends shaping the trajectory of the field, as well as the challenges and obstacles that must be addressed to unlock its full potential. Through a comprehensive analysis of emerging technologies, impacts on cloud services, security and privacy concerns, regulatory hurdles, vendor lock-in risks, and sustainability initiatives, this paper has provided valuable insights into the evolving landscape of cloud computing and offered recommendations for navigating its complexities.

The analysis of emerging innovations, including edge computing, quantum cloud computing, and serverless architectures, has revealed their transformative potential in enhancing performance, scalability, and efficiency in cloud environments. These innovations present opportunities for organizations to innovate, optimize operations, and deliver new value-added services to customers.

REFERENCES

1. "A New Trend for E-Learning in KSA Using Educational Clouds", Abdullah Alshwaier, Ahmed Youssef and Ahmed Emam Department of Information Systems, King Saud University, Riyadh, KSA.
2. "Secure Cloud Architecture", Kashif Munir and Sellapan Palaniappan, Malaysia University of Science and Technology, Malaysia.
3. "Effective Ways Cloud Computing Can Contribute to Education Success", BV Pranay kumar, Sumitha kommareddy and N.Uma Rani, CJITS, Jangaon, Warangal.
4. "Controlled Multimedia Cloud Architecture And Advantages", Selvaraj Kesavan1, Jerome Anand2 and J.Jayakumar1, 1Karunya University, India and 2Embedded Software Architect, India
5. "A RESEARCH ON CLOUD COMPUTING", Benneth Uzoma, Bonaventure Okhuoya
6. "A Study on Cloud Computing Services", Dr. CH. V. Raghavendran ,Dr. G. Naga Satish , Dr. P. Suresh Varma Professor,Dr. G. Jose Moses .
7. "RESEARCH PAPER ON CLOUD COMPUTING", Miss Mona Kumari , Er. Harish Chandra Maurya
8. "Challenges and Opportunities with Cloud Computing", Sandeep Kelkar.
9. Cloud Computing : Issues and Challenges Vaibhav Mishra, Kavita Choudhary
10. A Research Paper on "A Study on the Scope of Cloud Computing in Management Education" Dr. Uday Salunkhe, Sandeep Kelkar.
11. "Cloud computing in India : Opportunities and way forward", Yadav, Ritesh, Kartheek, Thumaty.
12. "Usage of Cloud Computing by Library Professionals", Alok Kumar, 2022.

AI Methods based on Probe Attack Categories

Kirti Muley
Assistant Professor
BVIMIT
Navi Mumbai, Maharashtra

Aditi Jambekar, Priyanka Saini
Amay Mahatre
BVIMIT
Navi Mumbai, Maharashtra

ABSTRACT

The integration of Artificial Intelligence (AI) into cybersecurity represents a significant advancement in combating the evolving landscape of cyber threats. Traditional signature-based methods have proven inadequate against the sophistication of modern attacks, prompting a shift towards AI-powered solutions. This paper explores AI-based threat detection methods, focusing on probe attacks, a prevalent cybersecurity threat. Various AI algorithms, including Deep Belief Networks (DBNs), Naive Bayes, C4.5, and RTree, are examined for their effectiveness in probe attack detection. Each algorithm offers unique strengths, ranging from capturing complex patterns to interpretability. Factors influencing algorithm selection, such as data nature and system requirements, are discussed. As AI continues to evolve, its role in cybersecurity will become increasingly indispensable, reshaping defense strategies in the digital realm.

INTRODUCTION

Artificial Intelligence (AI) is a prominent technology of today's technology globe [1]. It is becoming the primary focus in the subject of cyber security [2]. In cyber security, machine learning algorithms can automatically find and evaluate security incidents [3]. Traditional methods reliant on signature-based approaches have proven insufficient against the dynamic and sophisticated nature of contemporary cyber threats. However, the integration of AI into cybersecurity frameworks offers a promising solution by leveraging machine learning algorithms to identify anomalous activities indicative of potential security breaches. AI's capacity to imitate and possibly surpass human cognitive functions is considered a crucial tool for strengthening cognitive functions and improve cyber security. AI can extract patterns from vast datasets, adjust to new information, and predict with unprecedented accuracy through the use of complex algorithms. The speed, accuracy, and ability to identify new cyber threats surpass those of conventional security systems, making it more important component of cyber security protocols [4].

METHODS

AI-based threat detection is one of the most significant applications of AI in cyber security. Traditional threat detection methods typically rely on signature-based approaches that are limited to detecting known threats. However, AI-powered threat detection can use unsupervised learning algorithms to identify anomalous activities that may indicate a potential threat. This approach can help organizations detect new or unknown threats and respond proactively. Every day, organizations are confronted with millions of risks, making it almost impossible for a cyber security firm to define and analyze them. This task can be completed quickly and effectively by utilizing Machine Learning [8]. As demonstrated in Fig. 1, the techniques have been classified by the cybersecurity threats recognized, such as Probe, U2R, R2L, and DoS [6].

Organizations will be able to fully leverage the current knowledge of threats and vectors and discover a way to work toward supervised and unsupervised machine learning. When these capabilities are combined with an ability to identify new attacks and find new weaknesses, the systems will be able to safeguard the subjects from

dangers in a far more effective and efficient manner with respect to Fig.1.

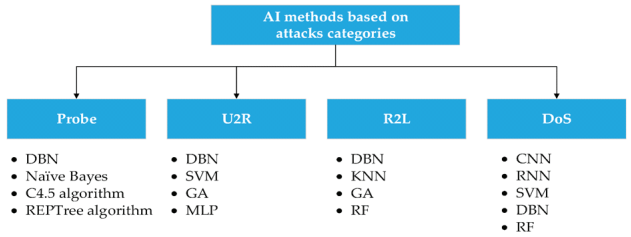


Fig. 1. AI based methods to combat cyber attacks

Different types of threats in cybersecurity include probe, DOS, U2R, and R2L attacks. The purpose of probes is to gather information about a target system without causing any harm. DOS attacks flood a system with traffic, rendering it inaccessible to legitimate users. U2R attacks involve exploiting vulnerabilities to escalate privileges and gain root access. R2L attacks occur when an attacker makes an effort to gain unauthorised access to a system remotely. Each attack type poses unique risks: Probes threaten confidentiality, DOS impacts availability, U2R exploits integrity, and R2L compromises confidentiality and possibly availability as well.

The comparison between AI based cyber-attack are as follows:

Attack Type	Objective	Method	Examples
Probe	Reconnai-ssance, gathering information	Scanning networks, ports, systems	Port scanning, network scanning, service enumeration
U2R	Escalate privileges to root/admin level	Exploit vulnerabilities or misconfigu-rations	Buffer overflow attacks, format string attacks, arbitrary code execution
R2L	Gain unauthorized access from remote location	Exploit vulnerabilities in network services or applications	Brute-force attacks, exploiting weak passwords, exploiting vulnerabilities in services like SSH, FTP, Telnet
DoS	Disrupt or deny access to legitimate users	Flooding target with overwhe-lming traffic, requests, or data	ICMP flood, SYN flood, UDP flood, HTTP flood

The following describes the details of probe attacks among the four types of AI methods based on attack category.

Probe attacks are aimed at obtaining data obtained from external network sources such as portsweeper and IPsweeper. Data within peer networks become vulnerable to probe attacks, which gives an attacker the power to spy, access, or gather information. Probe attacks are attempting to gather the necessary data and detect network susceptibility as depicted in Fig. 2 [6]. Common scanning instruments from the Internet, such as Nmap, satan, and mscan, would be used by the attacker to gather network data. These tools can be used to initiate other attacks (Denial-of-Service (DoS), Root to Local attacks (R2L), User to Root (U2R)) beyond their essential purpose.

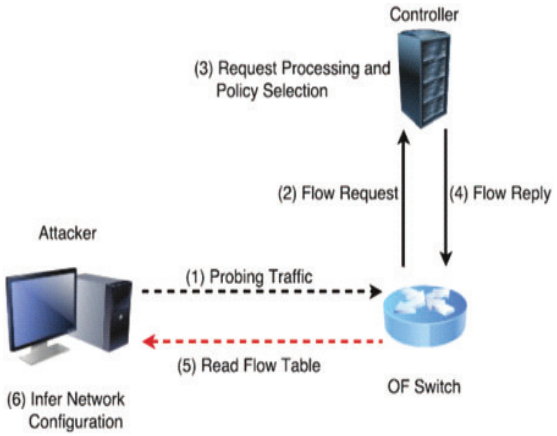


Fig. 2. Probe attack scenario

Data within peer networks is made vulnerable by probe attacks, permitting an attacker to spy, access, or gather information. AI-based techniques can be utilized to detect this attack [5]. The explanations of specified AI algorithms are as follows:

Deep Belief Network (DBN)

A Probabilistic Generating Model known as DBN contains multiple layers of stochastic and hidden variables [7]. DBNs are powerful for capturing complex

hierarchical patterns in data. They can be effective for detecting subtle and non-linear patterns indicative of probe attacks. However, training may require a significant amount of labelled data. DBN can capture the temporal dependencies in network traffic data. It can learn patterns of normal behaviour and identify deviations that may indicate probe attacks.

Naive Bayes

The Naive Bayes algorithm is a simple classification method that is derived from probability theory, specifically the Bayesian theorem. The term naive refers to its ability to solve problems using only two critical assumptions: The analysis process assumes the absence of hidden components and it presumed that the prognostic component is dependent on a similar classification conditionally [11]. It can be used for probe attack detection by considering the probabilities of observed features given the class. It works well with categorical data and requires less training data compared to some other algorithms. Naive Bayes can be applied to probe attack detection by modelling the probability of observing certain features in normal network traffic versus probe attack traffic. It calculates the probability that a given set of features belongs to normal traffic or a probe attack. Despite its simplifying assumptions, Naive Bayes can still perform well in practice, especially with large datasets.

C4.5 (Decision Trees)

C4.5 is a decision tree algorithm that recursively splits data based on the most significant attribute. A decision tree is a structure in which every branch node is a selection from multiple alternatives, and every leaf node is a decision. A decision tree is frequently employed to gather information for the purpose of making decisions [11]. Decision trees, are interpretable and can be effective in capturing decision rules for probe attack detection. They are suitable for scenarios where certain features contribute more significantly to identifying probe attacks. C4.5 decision trees can learn decision rules from labeled network traffic data. These rules can help classify incoming traffic as normal or indicative of a probe attack based on various features such as packet attributes, traffic volume, and protocol types. Decision trees are interpretable and can capture complex decision boundaries, making them suitable for detecting different types of probe attacks.

RTree (Reduced Error Pruning Tree)

RTree is a decision tree algorithm that uses reduced-error pruning for tree optimization. RTree, similar to other decision tree algorithms, can be used for probe attack detection. It is particularly useful when there is a need for a decision tree with reduced error through pruning. Decision trees are interpretable, making it easier to understand the decision-making process. The RTree algorithm can be employed to create an ensemble of decision trees that are trained on a random set of features. This ensemble approach improves the robustness of the model against noise and increases accuracy. By aggregating the predictions of multiple trees, RTree can effectively classify network traffic as normal or indicative of a probe attack.

The comparison of Naive Bayes, RTree, DBN (Dynamic Bayesian Network), and C4.5 algorithms for detecting probe attacks:

Algorithm	Approach	Strengths	Weakness
Naïve Bayes	Probabilistic model	Simple, fast training and prediction, handles large datasets	Assumes independence among features, may not capture complex relationships
RTree	Decision tree-based	Handles both categorical and numerical data, interpretable model	Prone to overfitting, may not handle continuous attributes well
DBN	Bayesian network with temporal dependencies	Captures temporal dependencies in data, handles uncertainty	Requires large amounts of data, complex to implement and train
C4.5	Decision tree-based	Handles both categorical and numerical data, interpretable model	May not handle large datasets well, prone to overfitting

Each of these algorithms has its strengths and weaknesses in detecting probe attacks. Naive Bayes is simple and computationally efficient but relies on strong independence assumptions. RTree provides interpretable

decision rules but may suffer from overfitting. DBN can capture complex patterns but requires extensive computational resources for training. C4.5 strikes a balance between interpretability and performance but may struggle with continuous or high-dimensional data. By leveraging the unique characteristics of these algorithms, cybersecurity professionals can develop robust detection systems capable of identifying and mitigating probe attacks effectively.

RESULT

The best algorithm for probe attack detection is influenced by factors such as the type of data and the size of the dataset and the specific requirements of the detection system.

DBNs can model temporal dependencies in network traffic data, making them suitable for detecting sophisticated probe attacks that involve sequences of events. They can handle uncertainty well and are good at capturing complex relationships between variables.

Naive Bayes is computationally efficient and works well with high-dimensional data. It's particularly effective when the assumption of feature independence holds reasonably well. It can provide good results even with limited training data.

Interpreting and visualizing decision trees is easy, making them useful for understanding the decision-making process. Both numerical and categorical data can be handled and they are resilient to outliers and irrelevant features. If interpretability is a significant concern and the features are relatively straightforward, decision tree-based algorithms like C4.5 or RTree may be a good choice. Random forests are robust against overfitting and perform well with noisy or high-dimensional data. They can capture complex relationships between variables and provide good generalization performance.

In the end, the best algorithm for detecting probe attacks will depend on a variety of factors such as the dataset's unique characteristics, computational limitations, the need for interpretability, and the desired balance between precision, recall, and computational efficiency. Cross-validation is frequently recommended to experiment with multiple algorithms.

CONCLUSION

In the realm of cybersecurity, where the stakes are high and threats constantly evolving, the integration of AI marks a paradigm shift in defense strategies. However, AI-powered solutions offer a beacon of hope by leveraging machine learning algorithms to discern anomalous activities indicative of potential security breaches. The versatility of AI algorithms, underscores the adaptability of AI in combating diverse cyber threats. These algorithms exhibit unique strengths, thereby offering a comprehensive toolkit for probe attack detection. Crucially, the efficacy of AI algorithms hinges upon factors such as data nature, dataset size, and specific system requirements.

REFERENCES

1. Noman, Musta & Khan, Muskan. (2023). A proposed framework of AI based Smart Home with Cyber Security Features. 10.31219/osf.io/va3ht.
2. Raj, Rohit & Kumar, Jayant & Kumari, Akriti. (2022). HOW AI Used to prevent cyber threats. International Research Journal of Computer Science. 9. 146-151. 10.26562/irjcs.2022.v0907.002.
3. Dokur, Nadide. (2023). Artificial Intelligence (AI) Applications in Cyber Security.
4. Kumar, Sarvesh & Gupta, Upasana & Singh, Arvind & Singh, Avadh. (2023). Artificial Intelligence: Revolutionizing Cyber Security in the Digital Era. Journal of Computers, Mechanical and Management. 2. 31-42. 10.57159/gadl.jcmm.2.3.23064.
5. Ait Tchakoucht, T.; Ezziyyani, M. Building a fast intrusion detection system for high-speed-networks: Probe and dos attacks detection. Procedia Comput. Sci. 2018, 127, 521–530.
6. Mohamed, Yahia & Abdullahi, Mujaheed & Alhussian, Hitham & Alwadain, Ayed & Aziz, NorShakirah & Jadid Abdulkadir, Said. (2022). electronics Detecting Cybersecurity Attacks in Internet of Things Using Artificial Intelligence Methods: A Systematic Literature Review. Electronics. 11. 1-27. 10.3390/electronics11020198.
7. Adaora Obayi, Obinna Onyedeke, Izuchukwu Uzo, Azuka Ijeomah, "Android Application for Human Respiratory System Diagnosis: A Systematic Review", 2022 5th Information Technology for Education and Development (ITED), pp.1-8, 2022.

8. Dokur, Nadide. (2023). Artificial Intelligence (AI) Applications in Cyber Security.

9. Kandala, Kalyana & Vijay Sai, Dukkipati & Saketh, Nuguri & Neelima, Iragattapu & Alekhya, Bendalam. (2022). Artificial Intelligence Techniques for Prevention of Cyber Attacks and Detection of Security Threats. International Journal of Engineering Research and Applications. 12. 37-44. 10.9790/9622-1206053744.

10. Almazyad, Abdulaziz & Halman, Laila & Alsaed, Alaa. (2023). Probe Attack Detection Using an Improved Intrusion Detection System. Computers, Materials & Continua. 74. 4769-4784. 10.32604/cmc.2023.033382.

11. ijariie.com/AdminUploadPdf/To_study_of_Intrusion_Detection_Systm_to_prevent_from_R2L__U2R_attacks_and_Improve_False_Alarm_rate_in_Cyber_Infrastructure_Using_ML_and_DM_ijariie15061

Exploring Development of Multilingual Chatbots for Indian Languages

Asmita Thakur
Student
Institute of Computer Science
Mumbai Educational Trust- MET ICS
University of Mumbai, Maharashtra
✉ mca22_1357ics@met.edu

Chetna Achar
Professor
Institute of Computer Science
Mumbai Educational Trust- MET ICS
University of Mumbai, Maharashtra
✉ chetnaa_ics@met.edu

ABSTRACT

India is known for its unity in diversity, India's linguistic diversity presents both opportunities and challenges for technology-driven communication and service delivery. India is home to a vast array of languages this linguistic diversity presents unique challenges and opportunities for technology-driven communication and service delivery. Drawing on insights from computational linguistics, machine learning, and cross-cultural communication, this study will investigate the technological innovations and strategies employed in the development of multilingual chatbots for Indian languages. This study investigates the unique linguistic, cultural, and technological challenges associated with building effective chatbots capable of engaging users across India's diverse linguistic landscape. Through this paper, you'll be able to delve into the linguistic complexities of Indian languages, including script variations, grammatical structures, and dialectal diversity. This study aims to examine the challenges faced by developers in processing and understanding text in multiple Indian languages. Furthermore, this paper explores the cultural nuances embedded within Indian languages and the importance of cultural sensitivity in chatbot design and interaction, this research aims to address key issues such as data scarcity, language-specific nuances, cross-lingual transfer learning, and cultural sensitivity, this research contributes to advancing the cutting edge in multilingual NLP, this study aims to foster equitable access to digital services and promote linguistic diversity and cultural inclusion in the digital age.

KEYWORDS: *Chatbots, Multilingual, NLP, Indian, Languages, BERT, RASA.*

INTRODUCTION

Chatbots are nothing but computer programs or systems which are designed to communicate with humans either through texts or voice interactions. They are also called as virtual assistants as the name suggest they help in assisting humans. Chatbots can be deployed on various platforms such as mobile applications, e-commerce websites, etc.

Basically chatbots are categorized in two types rule-based chatbots and AI-powered chatbots. Rule based chatbots always follow the rules which are already defined and scripts to respond to user inputs, these are mainly designed for simple and structured interactions such as answering frequently asked questions or customer support. AI-Powered chatbots are developed with the help of machine learning algorithms and NLP (Natural Language Processing) techniques. These chatbots can handle more complex inputs and understand it and provide answers accordingly.

Current chatbots are being deployed across huge industries and applications, each with specific objectives and functionalities. It can be customer service and support, e-commerce sites and sales, healthcare and wellness, etc.

India has rich linguistic diversity and multicultural population, India has significant urban-rural divide, with different linguistic preferences and communication patterns in urban and rural areas. Multilingual chatbots

can bridge this gap by catering to the linguistic needs of users across diverse settings, ensuring that both urban and rural populations have access to information and services in their native languages. India's linguistic diversity is not limited to regional languages but also encompasses a wide range of cultural and linguistic communities, including tribal groups and migrant populations. Multilingual chatbots facilitate cross-cultural communication and understanding by accommodating the linguistic and cultural preferences of diverse user groups, fostering empathy, respect, and inclusivity. Given the emergence of multilingual transformer models, we now have the capability to generate condensed vector representations of queries posed in diverse languages. These representations can then be compared with the vector representations of queries found within the FAQ database originally composed in a specific language. At the forefront of this endeavour lies the development of multilingual chatbots tailored for Indian languages – an area of research that intersects computational linguistics, machine learning, and cross-cultural communication. Multilingual chatbots hold immense potential to revolutionize digital communication and service delivery by providing users with personalized and contextually relevant interactions in their native languages. By harnessing the power of natural language understanding and generation, multilingual chatbots can cater to the linguistic diversity of India, facilitating seamless communication and engagement across language boundaries. However, the creation of effective multilingual chatbots for Indian languages is not without its challenges. From data scarcity and language-specific nuances to cross-lingual transfer learning and cultural sensitivity, developers face a myriad of obstacles in processing and understanding text in multiple Indian languages. Addressing these challenges requires innovative methodologies, robust algorithms, and a deep understanding of linguistic and cultural intricacies. In this research paper, we embark on a comprehensive exploration of the technological innovations and strategies employed in the development of multilingual chatbots for Indian languages. Drawing on insights from machine learning, natural language processing, and cross-cultural communication, we delve into the unique linguistic, cultural, and technological challenges associated with building effective chatbots capable of engaging users across India's diverse linguistic landscape. In further sections, we will delve into the linguistic complexities of Indian languages, examine the challenges faced by developers in processing and understanding text in multiple Indian languages, explore the cultural nuances embedded within Indian languages, and propose strategies for enhancing the performance, usability, and inclusivity of multilingual chatbots in Indian languages.

Why there is a need of multilingual chatbots in India?

The need for multilingual chatbots in India arises from its remarkable linguistic diversity and the necessity to bridge the gap between technology and users who prefer regional languages. India boasts a multitude of languages, with over 1,600 dialects spoken across the country. This diversity poses a challenge for technology-driven communication and service delivery, as many individuals may not be proficient in English or Hindi, the predominant languages in mainstream technology. Multilingual chatbots address this challenge by providing communication and support in various Indian languages, ensuring that individuals can interact with technology in their preferred language. This inclusivity not only fosters greater accessibility to digital services but also promotes cultural sensitivity by recognizing and respecting linguistic differences. Moreover, businesses operating in India require effective communication with customers in their local languages to enhance engagement and satisfaction. Multilingual chatbots enable businesses to expand their market reach by providing support in multiple languages, thereby improving customer service and loyalty. Government initiatives aimed at promoting digital literacy and access to government services further underscore the importance of multilingual chatbots. By offering information and assistance in regional languages, these chatbots make government services more accessible to a wider audience, contributing to greater citizen engagement and empowerment. In essence, multilingual chatbots streamline communication, automate processes, and foster inclusivity in a country as diverse as India. They serve as a catalyst for digital transformation, enabling individuals to access information, conduct transactions, and engage with

technology seamlessly in their preferred language, irrespective of linguistic proficiency.

There are several pretrained models and transformers that can be used in creating multilingual chatbots for Indian languages. One of them is BERT, there are several types of BERT that can be used in creation of multilingual chatbots for Indian languages:

mBERT(Multilingual BERT, XLM-RoBERT a (Cross lingual language model RoBERTa), IndicBERT, LASER(Cross-lingual Language Model, mT5(Multilingual T5), IndicNLP, etc.

Talking about our main contributions to this paper :

- Exploring the obstacles encountered by developers when processing and comprehending text across various Indian languages.
- Addressing critical challenges including limited data availability, language-specific intricacies, cross-language transfer learning, and cultural awareness.

mBERT (Multilingual BERT) is a pretrained transformer model developed by Google that supports over 100 languages, including several Indian languages such as Bengali, Hindi, Telugu, Tamil, etc.

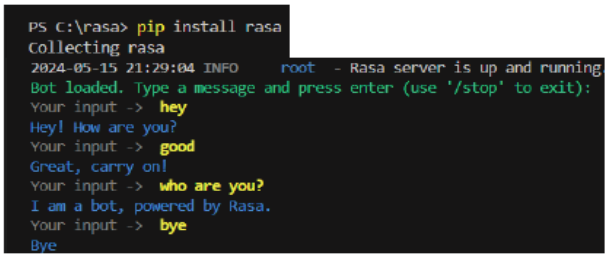
XLM-RoBERTa(Cross-lingual Language model RoBERTa) is the pretrained transformer model which isdeveloped by Facebook AI that is specifically designed for cross-lingual applications. It supports multiple languages, including several Indian languages, and achieves leading edge performance on various NLP tasks.

IndicBERT is the variant of the BERT model pretrained specifically for Indian languages. It provides contextual word embeddings for languages such as Hindi, Bengali, Tamil, Telugu, and more.

LASER (Cross-lingual Language Model) is the pretrained model which is developed by Facebook AI that provides language-agnostic sentence representations for over 90 languages, including several Indian languages.

mT5(Multilingual T5) is a variant of T5 (Text To Text Transfer Transformer) model pretrained by Google that supports over 100 languages, including Indian languages. IndicNLP is a suite of pretrained models and tools for natural language processing tasks in Indian languages. It includes models for part of speech tagging, named entity recognition, sentiment analysis, etc.

Another approach for creating multilingual chatbot for Indian languages would be RASA Framework:



Rasa is a latest open-source framework which is used for creating conversational AI chatbots. There are so many pre built functionalities in rasa which makes it really easy to use, we can modify and add intends, entities, actions, slots and many more things according to our need. Rasa provides so many pre built things. While Rasa does not inherently support multilingual capabilities out-of-the-box, you can implement multilingual chatbots for Indian languages using Rasa by following these steps:

Data Collection: Gather conversational data in multiple Indian languages. This includes text data for training intents, entities, and responses in each language you plan to support.

Data Preprocessing: Preprocessing the collected data to make sure about its consistency and quality. This will involve tokenization, stemming, lemmatization, and other text normalization techniques specific to each language.

Language Detection: Implement language detection to identify the language of incoming user messages. You can use libraries like Lang detect or Polyglot for language detection.

Language-Specific Models: We need to train separate Rasa models for each Indian language using the pre-processed data. Customize the language-specific models by adjusting parameters, hyperparameters, and features to account for linguistic nuances and characteristics.

Entity Recognition: We need to train entity recognition models to identify the named entities (e.g., names,

locations) in user messages for each language. You may need to create language-specific entity lists and annotations for training these models.

Intent Classification: Train intent classification models to classify user intents (e.g., greetings, requests, inquiries) in each language. Fine-tune the models using language-specific training data to improve accuracy and performance.

Response Generation: Develop response generation logic to generate appropriate responses in the language detected from user messages. You can use templates, rules, or machine learning-based approaches to generate responses tailored to each language.

Language Switching: Implement language switching functionality to allow users to switch between languages during conversations. This may involve providing language options in the chat interface and handling language change requests from users.

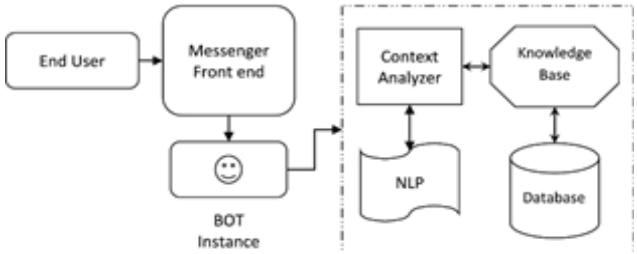
Deployment and Maintenance: Deploy the multilingual chatbot to your preferred platform or channels, such as websites, messaging apps, or voice assistants. Monitor the chatbot's performance, handle user inquiries, and update the models periodically to adapt to changes in user behaviour and language usage.

By following these steps, you can leverage Rasa to create multilingual chatbots for Indian languages, enabling users to interact with the chatbot seamlessly in their preferred language.

What is NLP (Natural Language Processing)

NLP stands for Natural Language Processing. It is the field of artificial intelligence (AI) which deals with the human interaction with computers and machines through natural language. NLP makes it easy for computers to understand, interpret, and create human language responses in a way that is both significant and valuable. It encompasses different tasks such as text classification, sentiment analysis, named entity recognition, machine translation, and conversational agents (chatbots).

BERT (Bidirectional Encoder Representations from Transformers) it is a transformer based model that leverages Natural Language Processing (NLP) techniques to comprehend and spawn human language.



This image is used as a reference from [12]

What does NLP do what are the tasks of NLP

- Tokenization: Tokenization is nothing but the process of breaking down a text into smaller units like structures, typically words or sub words, called tokens. These tokens are the basic building blocks used for further analysis in NLP tasks. For example, tokenizing the sentence "This is my research paper" would result in tokens: ["This", "is", "my", "research", "paper"]
- Part of speech (POS) tagging: POS tagging is the process of assigning a grammatical category (like noun, verb, adjective, etc.) to each word in the sentence. This helps us to understand the grammatical structure of a sentence and is really useful for many NLP tasks like text understanding, knowledge retrieval, and machine translation.
- Named Entity Recognition (NER): NER is the NLP task which helps finding and grouping named entities in a text into predefined categories such as names of persons, companies, locations, dates, etc. Let's take an example, in the sentence "BNP Paribas is headquartered in Paris", NER would identify "BNP Paribas" as an company or or organization and "Paris" as a location.
- Dependency Parsing: Dependency parsing is the technique of scrutinizing the syntactical structure of a sentence to determine the relationships between words. It identifies the syntactic dependencies between words and represents them as a directed graph. This can help us in understanding the semantic meaning of a sentence and is used in tasks like question answering and machine translation.
- Language support: Language support is nothing but the ability of an NLP system to process and grasp text written in different languages. While some NLP tools and models may be designed specifically for one language, others are multilingual and can

handle multiple languages. Language support is essential for global applications and services that deal with multilingual content and users.

Here's how Rasa incorporates NLP techniques into its functionality:

Intent Classification: Rasa employs intent classification to determine the intention of user based on their input. NLP techniques such as machine learning algorithms (e.g., SVM, neural networks) are used to train intent classification models on labeled examples of user utterances.

Entity Recognition: Rasa performs entity recognition to identify specific pieces of information (entities) mentioned in user messages. Named Entity Recognition (NER) models, often based on machine learning algorithms, are trained to detect entities like names, dates, locations, and quantities from input which is provided by user.

Tokenization and Text Processing: Rasa tokenizes user input and processes text to extract meaningful features for intent classification and entity recognition. Tokenization includes breaking down sentences into separate words or tokens, while text processing includes tasks like stemming, lemmatization, and stop word removal.

Dialogue Management: Rasa's dialogue management component uses NLP techniques to supervise the conversation's flow and decide how the chatbot should respond to user messages. This involves techniques such as rule-based dialogue policies, machine learning-based policies (e.g., Reinforcement Learning), and contextual understanding of user utterances.

Language Understanding Models: Rasa allows users to integrate pre-trained language understanding models into their chatbots. These models, often based on transformer architectures like BERT or GPT, provide contextualized representations of user messages, enabling the chatbot to understand the nuances and intent behind the input.

Response Generation: Rasa generates responses to user messages using various NLP techniques. These techniques may include rule-based response generation, template-based responses, machine learning-based response selection, or even integrating with natural language generation (NLG) models for more sophisticated responses.

Language Support: Rasa supports multiple languages, allowing developers to build chatbots in languages other than English. This includes providing language-specific tokenizers, models, and pipelines tailored to the linguistic characteristics of different languages.

By leveraging these NLP techniques, Rasa enables developers to build conversational AI applications that can comprehend user intent, extract the information which is relevant, manage dialogue flows, and create contextually accurate responses. This facilitates the creation of intelligent and engaging chatbots capable of providing personalized and helpful interactions with users.

Now let's talk about what are the challenges that are faced by developers while creating a multilingual chatbots for Indian Languages

Data Scarcity: The term "data scarcity" refers to the limited availability of data, particularly annotated or labelled data, for training machine learning models. In the context of Indian languages, data scarcity is indeed a substantial challenge for Natural Language Processing (NLP) tasks. There is lack of large-scale annotated datasets for many Indian languages, which are essential for training supervised NLP models. Annotated data is required for tasks such as pos(part of speech) tagging, named entity recognition and sentiment analysis,

Even when data is available, it may be specific to certain domains or topics, making it less suitable for general-purpose NLP tasks. Indian languages are written in multiple scripts, such as Devanagari, Tamil, Telugu, and Bengali. Annotated datasets need to cover variations in scripts to be representative of the linguistic diversity in India.

Named Entity Recognition (NER): Identifying and classifying named entities (e.g., names of people, places, companies) in Indian languages is challenging due to variations in naming conventions and the lack of standardized entity lists across languages.

Language-specific Nuances: Indian languages have unique linguistic features, idioms, and expressions that may not have direct equivalents in other languages. Annotated datasets need to capture these language-specific nuances accurately to build effective NLP models for Indian languages.

Cross-Lingual understanding: Ensuring that the chatbot can comprehend and respond appropriately to user inputs in different Indian languages requires robust cross-lingual understanding capabilities. This involves adapting language models to handle language-specific features and nuances effectively. For example, in Marathi language Ghass घास means bite of food and the same word Ghass घास mean grass in Hindi language.

CONCLUSION

In conclusion, this research underscores the imperative of developing multilingual chatbots tailored for Indian languages, considering the nation's rich linguistic diversity. By delving into challenges such as data scarcity, language-specific nuances, cross-lingual transfer learning, and cultural sensitivity, we have elucidated key insights and proposed innovative strategies.

This paper presents the basic idea of exactly what chatbots are and their types also what are multilingual chatbots and why there is a need of multilingual chatbots. What are the possible technologies that can be used to create multilingual chatbots and some deeper understanding of those technologies. BERT is one of the answers when is comes to the creation of any multilingual chatbot and the types of BERT mBERT(Multilingual BERT, XLM-RoBERTa(Cross-lingual language model RoBERTa), IndicBERT, LASER(Cross-lingual Language Model, mT5(Multilingual T5), IndicNLP, etc. Another technology which can be used in creation of a multilingual chatbot is RASA, we can create an efficient chatbot with the help of RASA and its tools What kind of challenges are faced by developers while creating a multilingual chatbot specifically for Indian languages. The factors Data Scarcity, NER (Named entity recognition), Language specific nuances and cross lingual understanding of words. Our study paves the way for more inclusive and accessible digital communication, fostering linguistic diversity and cultural inclusion in the digital age.

REFERENCES

1. Singh, U., Vora, N., Lohia, P., & Tiwari, K. (2023, November 11). MULTILINGUAL CHATBOT FOR INDIAN LANGUAGES. ResearchGate. https://doi.org/10.13140/RG.2.2.30993.20325
2. Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. Bert: Pre-training of deep bidirectional transformers for language un derstanding. arXiv preprint arXiv:1810.04805, 2018.
3. Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. Bert: Pre-training of deep bidirectional transformers for language un derstanding, 2019.
4. Doshi, G. (2021). Implementation of multilingual chatbot. International Journal for Research in Applied Science and Engineering Technology, 9(VII), 1367–1373. https://doi.org/10.22214/ijraset.2021.36012

.5. Fauzia, L., Hadiprakoso, R. B., & Girinoto, N. (2021). Implementation of Chatbot on university website using RASA framework. 2021 4th International Seminar on Research of Information Technology and IntelligentSystems(ISRITI). https://doi.org/10.1109/isriti54043.2021.9702821

6. Pandya, H. A., * †, Ardeshna, B., *†, & Bhatt, B. S. (2021). Cascading adaptors to leverage English data to improve performance of question answering for Low-Resource languages [Article]. arXiv.

[7] Zaib, M., Tran, D. H., Sagar, S., Mahmood, A., Zhang, W. E., & Sheng, Q. Z. (2021). BERT-COQAC: BERT-Based Conversational Question Answering in context. In Communications in computer and information science (pp. 47–57). https://doi.org/10.1007/978-981-16-0010-4_5

[8] Badlani, S., Aditya, T., Dave, M., & Chaudhari, S. (2021). Multilingual healthcare chatbot using machine learning. 2021 2nd International Conference for Emerging Technology (INCET). https://doi.org/10.1109/incet51464.2021.9456304

[9] Vanjani, M., & Aiken, M. (2020). USING a MULTILINGUAL CHATBOT FOR FOREIGN LANGUAGE PRACTICE. Issues in Information Systems. https://doi.org/10.48009/2_iis_2020_85-92

[10] AN EVALUATION OF a MULTILINGUAL CHATBOT. (2019). Issues in Information Systems. https://doi.org/10.48009/1_iis_2019_134-143

[11] [1] Vanjani, M., Aiken, M., & Park, M. (2019). Chatbots for multilingual conversations. Zenodo (CERN European Organization for Nuclear Research). https://doi.org/10.5281/zenodo.3264011

[12] [1] Babu, A., & Boddu, S. B. (2024). BERT-Based Medical Chatbot: Enhancing Healthcare Communication through Natural Language Understanding. Exploratory Research in Clinical and Social Pharmacy, 13, 100419. https://doi.org/10.1016/j.rcsop.2024.100419

Generative AI in the Meta-verse Era

Ankita A. Raul
Student
Bhujbal Knowledge City Mumbai Education Trust
Institute of Computer Science
Mumbai, Maharashtra
✉ mca221342ics@met.edu

Flavia Gonsalves
Professor
Bhujbal Knowledge City Mumbai Education Trust
Institute of Computer Science
Mumbai, Maharashtra
✉ flaviagics@met.edu

ABSTRACT

In the rapidly evolving landscape of digital inter- action, the concept of the meta-verse stands as a beacon of possibility, promising immersive, interconnected virtual experiences that transcend traditional boundaries. At the heart of this paradigm shift lies generative artificial intelligence (AI), wielding the power to autonomously create content that populates and enriches virtual environments. [1]

This abstract explores the symbiotic relationship between generative AI and the meta-verse, delving into the capabilities, applications, and challenges posed by AI-driven creativity within virtual realms. Through a multidimensional lens, we examine the role of generative AI techniques such as Generative Adversarial Networks (GANs) and Variational Auto-encoders (VAEs) in crafting lifelike landscapes, characters, and dynamic experiences within the meta-verse.

By synthesizing empirical evidence, case studies, and future projections, this abstract aims to illuminate the transformative potential of generative AI in shaping the digital landscapes of tomorrow, while also highlighting key considerations for ethical, technical, and societal implications.

KEYWORDS: *Gen-AI, Metaverse, GANs, VAEs.*

INTRODUCTION

The concept of the meta-verse, a collective virtual shared space that encompasses virtually enhanced physical reality and persistent virtual environments, has captured the imagination of technologists, futurists, and enthusiasts alike. As we stand on the brink of a new era where digital realms seamlessly intertwine with our physical world, the role of generative artificial intelligence (AI) emerges as a pivotal force in shaping this transformative landscape. [5] At its core, the metaverse represents a convergence point where individuals can immerse themselves in rich, interactive virtual environments, forging connections, and experiences that transcend physical bound- aries. From virtual reality (VR) platforms to augmented reality (AR) applications, the meta-verse offers a canvas for limitless creativity and exploration.

Generative AI, with its ability to autonomously create content ranging from images and text to audio and video, stands as a cornerstone of innovation within the meta-verse. Through techniques such as Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), and Transformer models, AI-driven systems can generate lifelike landscapes, characters, and experiences that blur the lines between the real and the virtual. [1]

This research paper embarks on a journey to explore the symbiotic relationship between generative AI and the meta- verse. We delve into the depths of both realms, dissecting the intricacies of generative AI techniques and examining their applications within the dynamic context of the meta-verse. By unraveling the potential and challenges inherent in this convergence, we aim to shed light on the opportunities and considerations that shape the future of digital interaction and collaboration.

Through empirical analysis, case studies, and forward- looking insights, this paper seeks to provide a comprehensive understanding of the impact of

generative AI in the meta- verse era. By doing so, we hope to contribute to the ongoing discourse surrounding the evolution of virtual environments and the transformative power of AI-driven creativity. [2]

BACKGROUND AND LITERATURE REVIEW

History of Generative AI

The history and development of generative AI trace back to the mid-20th century with the inception of artificial neural networks and machine learning. In the 1950s, Frank Rosenblatt introduced the perceptron, which laid the groundwork for pattern recognition in computers. The 1980s saw the advent of the backpropagation algorithm, which significantly improved the training of deeper and more complex networks. The 2000s marked the deep learning era, with substantial progress due to enhanced computational power and large datasets. The introduction of AlexNet in 2012 showcased the power of deep con- volutional neural networks. Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs), introduced in the 2010s, further revolutionized generative models. In natural language processing, the transformer architecture, introduced by Vaswani et al. in 2017, led to models like OpenAI's GPT [11], capable of generating coherent and contextually relevant text.

The concept of the metaverse, a collective virtual shared space, has evolved from early science fiction roots to mod- ern virtual environments. Neal Stephenson coined the term "metaverse" in his 1992 novel "Snow Crash," envisioning a virtual reality-based successor to the internet. Early online virtual environments like MUDs (Multi-User Dungeons) and MOOs (MUDs, Object-Oriented) set the stage for interactive digital spaces. [6] In 2003, Second Life [7] became one of the first widely recognized virtual worlds, where users could interact, create, and trade in a digital environment. Advances in VR and AR technologies, driven by companies like Oculus and Microsoft, have brought more immersive experiences closer to mainstream adoption. The contemporary vision of the metaverse emphasizes seamless, interoperable digital environments, highlighted by Facebook's rebranding to Meta in 2021, signaling its commitment to this transformative vision.

Ease of Use

Several critical technologies are converging to enable the development and realization of the metaverse. Virtual reality (VR) and augmented reality (AR) provide immersive expe- riences, with devices like Oculus Rift [8], HTC Vive, and Microsoft HoloLens [9] facilitating interactive digital inter- actions. Blockchain technology underpins secure digital own- ership, with non-fungible tokens (NFTs) representing unique digital assets and decentralized finance (DeFi) powering virtual economies. Blockchain also promotes interoperability between different virtual worlds, allowing assets and identities to move seamlessly across platforms. Artificial intelligence (AI) powers intelligent agents and virtual assistants, making interactions within the metaverse more dynamic and responsive. Generative AI accelerates the creation of digital content, from textures and animations to entire virtual environments.

Comparing generative AI and other technologies reveals unique contributions and overlapping applications within the metaverse. Generative AI automates complex environments and asset creation, reducing development time and costs, while traditional game development relies on manual de- sign, offering greater control but requiring more resources. Blockchain provides decentralized, transparent, and secure management of digital assets and identities, promoting user trust and interoperability, whereas centralized databases offer efficiency and control but lack transparency and cross-platform compatibility. VR/AR deliver immersive and interactive experiences, transforming user engagement with digital content, whereas traditional media, such as movies and websites, are less interactive and immersive.

Conclusion

In conclusion, the development of generative AI and the concept of the metaverse are closely intertwined, with each technology enhancing the capabilities and experiences within virtual environments. The convergence of VR/AR, blockchain, and AI technologies paves the way for a more interconnected, immersive, and dynamic digital future. Existing research and applications demonstrate the transformative potential of these innovations, setting the stage for further advancements and widespread adoption.

METHODOLOGY

Research Design and Approach

This study employs a mixed-methods research design, integrating both qualitative and quantitative approaches to provide a comprehensive analysis of the role of generative AI in the metaverse era. The mixed-methods approach is selected to capture the multifaceted nature of this rapidly evolving field, allowing for a nuanced understanding of theoretical frameworks, practical applications, and emerging trends. This approach facilitates triangulation, thereby enhancing the reliability and validity of the findings through the convergence of evidence from multiple sources.

Data Collection Methods

The data collection for this research is carried out through three primary methods: literature review, case studies, and expert interviews.

1. Literature Review : An extensive literature review is conducted to gather existing academic papers, industry re- ports, and technological reviews related to generative AI and the metaverse. This systematic review identifies key trends, theoretical foundations, and practical applications, providing a robust background for the study.
2. Case Studies Case studies of leading companies and platforms actively developing and implementing generative AI within the metaverse are examined. These case studies are selected based on criteria such as innovation, scale, and industry impact. This method provides practical insights and detailed examples of how generative AI is being used to transform virtual environments and enhance user experiences. 3.Expert Interviews Semi-structured interviews are con- ducted with experts in AI, VR/ AR, blockchain, and related fields. Participants are selected using purposive sampling to ensure a diverse range of insights from industry leaders, researchers, and practitioners. These interviews offer in-depth perspectives on technological advancements, integration challenges, and future directions for generative AI in the metaverse.

Analytical Methods

The analytical methods employed in this study include qualitative content analysis and quantitative analysis.

1. Qualitative Content Analysis This method is used to analyze the literature review and case study data. It involves coding and categorizing the data to identify common themes, patterns, and discrepancies. This approach helps to draw meaningful insights and understand the contextual nuances of generative AI applications in the metaverse.
2. Quantitative Analysis Quantitative analysis is applied to the data collected from case studies and interviews. Responses are coded to measure the frequency and significance of various factors impacting the integration of generative AI in the metaverse. This method provides statistical evidence to support qualitative findings and identify prevalent trends and challenges.

Justification for the Chosen Methodology

The chosen mixed-methods methodology is justified by its ability to address the complexities and dynamic nature of generative AI in the metaverse. Combining qualitative and quantitative approaches ensures a comprehensive understanding of both theoretical and practical dimensions. The literature review establishes a foundational knowledge base, while case studies offer real-world applications and expert interviews provide forward-looking insights. This triangulation of data sources enhances the reliability and validity of the research findings, making the study robust and well-rounded. The methodology is thus well-suited to explore the multifaceted impacts of generative AI within the evolving landscape of the metaverse.

Generative AI Technologies

Generative AI encompasses a range of advanced techniques designed to create new data based on patterns learned from existing data. Prominent among these techniques are Genera- tive Adversarial Networks (GANs), Variational Autoencoders (VAEs), and autoregressive models. GANs, introduced by Ian Goodfellow in 2014, involve a generator and a discriminator working in tandem to produce highly realistic synthetic data. VAEs, another key technique, utilize a probabilistic approach to model data distribution, enabling the generation of new, similar data points while maintaining a coherent latent space structure. Autoregressive models, such as the GPT

(Generative Pre-trained Transformer) series developed by OpenAI [11], generate sequential data by predicting the next element in a sequence based on previous elements, excelling in tasks like text generation and completion.

Current advancements in generative AI are marked by significant innovations that enhance the quality, efficiency, and applicability of these techniques. Improved architectures, such as StyleGAN, have revolutionized image generation, allowing for the creation of high-resolution, photorealistic images with fine-grained control over features. The development of largescale pre-trained models, like GPT-4, has expanded the capabilities of AI in natural language understanding and generation, enabling more sophisticated and context-aware text outputs. These advancements are supported by increased computational power and the availability of vast datasets, which collectively drive the continuous improvement of generative AI models.

Generative AI finds specific applications in various domains of content creation within virtual environments. In the realm of avatars, AI techniques enable the generation of highly detailed and personalized digital representations, enhancing user identity and interaction in virtual spaces. For environmental design, generative AI assists in creating expansive, dynamic landscapes and intricate architectural structures, reducing the time and resources required for manual design. Additionally, AI-generated objects, such as furniture, clothing, and other virtual items, contribute to the richness and diversity of virtual worlds, providing users with a wide array of customizable and interactive elements. These applications highlight the transformative potential of generative AI in shaping immersive and engaging experiences within the metaverse.

Applications of Generative AI in the Metaverse

Generative AI plays a pivotal role in the creation and enhancement of virtual worlds and environments within the metaverse. It enables the development of expansive, dynamic landscapes and intricate architectural structures, significantly reducing the manual effort required for detailed design. This technology allows for the automatic generation of entire cities, natural landscapes, and complex environments that can evolve in real-time, offering users immersive and ever-changing experiences.

In addition to world-building, generative AI is crucial in the development of realistic avatars and characters. AI techniques can create highly detailed and personalized digital representations, capturing subtle facial expressions, body movements, and unique personality traits. These avatars enhance user identity and interaction, making social experiences in virtual spaces more engaging and lifelike.

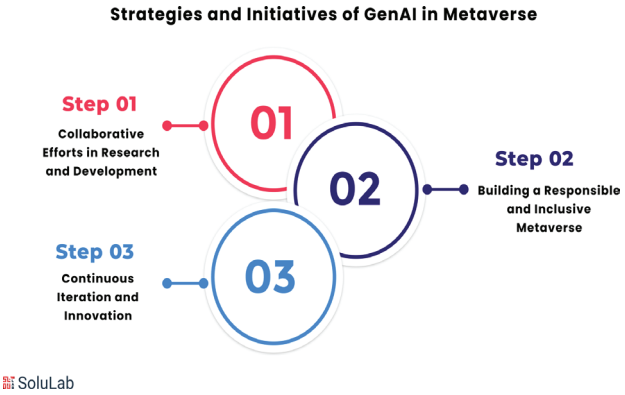


Fig. 1. Strategies and initiatives in Gen-AI

Generative AI also excels in the procedural generation of content and assets, such as virtual objects, furniture, clothing, and other items. This capability not only enriches the virtual environment but also provides an endless variety of customizable and interactive elements, contributing to the richness and diversity of the metaverse. Users can experience a unique and personalized virtual world tailored to their preferences and needs.

Personalization and customization of user experiences are further enhanced by generative AI. By analyzing user behavior and preferences, AI can create tailored content and interactions, offering a highly individualized experience. This includes personalized environments, custom avatars, and adaptive storytelling that responds to user actions and choices.

AI-driven storytelling and interactive narratives represent another significant application of generative AI in the meta- verse. AI can generate dynamic storylines that evolve based on user interactions, creating immersive and engaging narrative experiences. This capability allows for the creation of complex,

branching storylines that offer users a unique and participatory role in the narrative.

Several existing implementations exemplify the transformative potential of generative AI in the metaverse. For instance, platforms like Roblox [10] and Fortnite utilize procedural generation to create vast, interactive worlds where users can explore and build. NVIDIA's Omniverse leverages AI to enable collaborative virtual environment creation, supporting real- time simulations and asset generation. [4]

Similarly, Meta's Horizon Worlds [12] uses AI to facilitate the creation of personalized avatars and interactive experiences, showcasing the practical applications and future possibilities of generative AI in virtual spaces.

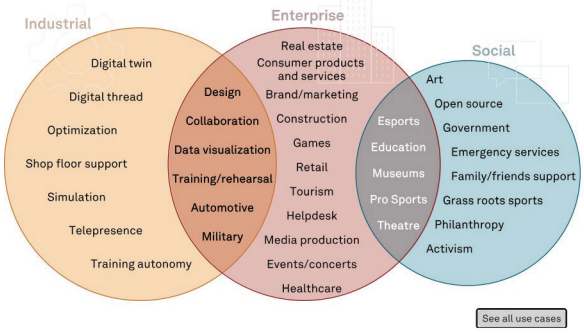


Fig. 2. The Metaverse-Ecosystem

Benefits and Challenges

The history and development of generative AI trace back to the mid-20th century with the commencement of artificial neural networks and machine literacy. In the 1950s, Frank Rosenblatt introduced the perceptron, which laid the root for pattern recognition in computers. The 1980s saw the arrival of the backpropagation algorithm, which significantly bettered the training of deeper and more complex networks. The 2000s marked the deep literacy period, with substantial progress due to enhanced computational power and large datasets. The preface of AlexNet in 2012 showcased the power of deep convolutional neural networks. Variational Autoencoders(VAEs) and Generative inimical Networks(GANs), introduced in the 2010s, further revolutionized generative models. In natural language processing, the motor armature, introduced by Vaswani etal. in 2017, led to models like OpenAI's GPT [11], able to generate coherent and contextually applicable textbooks.

The conception of the metaverse, a collaborative virtual participating space, has evolved from early wisdom fabrication roots to ultramodern virtual surroundings. Neal Stephenson chased the term" metaverse" in his 1992 novel" Snow Crash," visioning a virtual reality-grounded successor to the internet.

[6] Beforehand online virtual environments like Guck(Multi- User Dungeons) and MOOs(Guck, Object- acquainted) set the stage for interactive digital spaces. In 2003, Second Life [7] became one of the first extensively honored virtual worlds, where druggies could interact, produce, and trade in a digital terrain. Advances in VR and AR technologies, driven by companies like Oculus and Microsoft, have brought more immersive approaches to mainstream relinquishment. The contemporary vision of the metaverse emphasizes flaw- less, interoperable digital surroundings, stressed by Facebook's rebranding to Meta in 2021, motioning its commitment to this transformative vision.

Generative AI has set up significant operations in virtual surroundings, enhancing content creation and commerce. Procedural content generation(PCG) in videotape games stoutly designs situations, geographies, and means, creating extensive and varied surroundings. AI- generated incorporations parade realistic actions, furnishing engaging and naturalistic stoner gests . In art and design, AI tools induce new artworks and help in architectural and civic planning within virtual worlds. Educational and training operations profit from generative AI, creating realistic training scripts for medical simulations or emergency response drills.

Several critical technologies are clustering to enable the development and consummation of the metaverse. Virtual reality(VR) and stoked reality(AR) give immersive guests, with bias like Oculus Rift [8], HTC Vive, and Microsoft HoloLens [9] easing interactive digital relations. Blockchain technology underpins secure digital power, with non-fungible commemoratives(NFTs) representing unique digital means and decentralized finance(DeFi) powering virtual husbandry. Blockchain also promotes interoperability between different virtual worlds, allowing means and individualities to move seamlessly across platforms.

Artificial intelligence(AI) pow- ers intelligent agents and virtual sidekicks, making relations within the metaverse more dynamic and responsive. Generative AI accelerates the creation of digital content, from textures and robustness to entire virtual surroundings.

Comparing generative AI and other technologies reveals unique benefactions and lapping operations within the meta- verse. Generative AI automates complex surroundings and asset creation, reducing development time and costs, while traditional game development relies on homemade design, offering lesser control but taking further coffers. Blockchain provides decentralized, transparent, and secure operation of digital means and individualities, promoting stronger trust and interoperability, whereas centralized databases offer effectiveness and control but warrant translucency and cross-platform comity. VR/ AR deliver immersive and interactive guests, transubstantiation stoner engagement with digital content, whereas traditional media, similar to pictures and websites, are less interactive and immersive.

In conclusion, the development of generative AI and the conception of the metaverse are nearly intertwined, with each technology enhancing the capabilities and gets within virtual surroundings. The confluence of VR/ AR, blockchain, and AI technologies paves the way for a further connected, immersive, and dynamic digital future. Being exploration and operations demonstrate the transformative eventuality of these inventions, setting the stage for further advancements and wide

Future Directions and Opportunities

The future of generative AI in the metaverse promises to be transformative, with several potential advancements poised to significantly impact virtual environments. One key area of development is the improvement of AI models to generate even more realistic and contextually aware content. Enhancements in deep learning techniques, such as more advanced GANs and VAEs, could enable the creation of virtual worlds that are indistinguishable from reality. These advancements will also likely improve the customization and personalization of user experiences, making virtual interactions more engaging and tailored to individual preferences.

Emerging trends and future applications of generative AI in the metaverse include the expansion of AI-driven interactive storytelling, where narratives dynamically adapt to user choices and behaviors in real-time. This could revolutionize gaming, education, and entertainment by creating deeply immersive and participatory experiences. Additionally, the use of AI for real-time environmental adaptation could allow virtual worlds to respond dynamically to user actions, creating a more responsive and interactive experience.

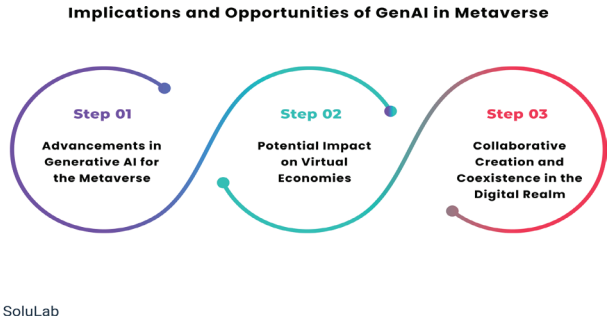


Fig. 3. Implications and opportunities of Gen AI in Metaverse

The integration of generative AI with other cutting-edge technologies such as artificial intelligence (AI), the Internet of Things (IoT), and 5G networks will further enhance the capabilities of the metaverse. AI can provide intelligent behavior for non-player characters (NPCs), IoT can bring real-world data into the virtual environment, and 5G can support the high-speed, low-latency connections necessary for seamless interactions in expansive virtual spaces. This convergence will enable more complex and richly detailed virtual worlds that can support a wide range of activities, from socializing and gaming to professional and educational uses.

Speculative scenarios for the long-term implications of generative AI in the metaverse suggest a future where virtual and augmented reality become integral parts of daily life. For instance, fully immersive virtual environments could be used for remote work, providing virtual offices and collaborative spaces that feel as real as physical ones. Educational institutions might leverage these technologies to create interactive and engaging learning experiences that transcend geographical boundaries. In entertainment, the line between reality and virtual experiences could blur, offering unprecedented levels of immersion and interaction.

In conclusion, the future directions and opportunities for generative AI in the metaverse are vast and varied. Continued advancements in AI technology, coupled with the integration of other emerging technologies, will drive the evolution of virtual environments, making them more realistic, interactive, and integral to our daily lives. As these technologies develop, they will open up new possibilities and applications, fundamentally transforming how we interact with digital spaces and each other.

CONCLUSION

In summary, the exploration of generative AI within the context of the metaverse reveals its substantial potential to revolutionize virtual environments. Key findings indicate that generative AI techniques, such as GANs, VAEs, and autoregressive models, are pivotal in automating the creation of vast and dynamic virtual worlds. These technologies significantly enhance the scalability, diversity, and creativity of content within the metaverse. Current advancements in AI models have led to more realistic and contextually aware outputs, facilitating the development of highly detailed and personalized avatars, environments, and objects. Furthermore, the integration of generative AI with other emerging technologies like IoT and 5G promises to elevate the interactivity and responsiveness of virtual spaces.

Reflecting on the significance of generative AI in the meta- verse, it is clear that these technologies are central to shaping the future of digital interaction. By enabling the creation of rich, immersive, and customizable virtual environments, generative AI is transforming how users experience and engage with virtual worlds. This transformation extends beyond entertainment and gaming, impacting sectors such as education, remote work, and social interaction, thereby expanding the utility and appeal of the metaverse.

For future research and development, several recommendations can be made. First, continued investment in advancing AI models is crucial to improve the realism and contextual understanding of generated content. Second, addressing the technical challenges related to computational resources and data quality is essential to enhance the efficiency and reliability of generative AI systems. Third, it is imperative to develop robust ethical guidelines and regulatory frameworks to mitigate issues related to bias, digital identity, ownership, security, and privacy. Finally, interdisciplinary research that combines insights from AI, VR/AR, blockchain, and other related fields will be key to unlocking the full potential of generative AI in the metaverse, ensuring its growth as a transformative and inclusive digital ecosystem.

REFERENCES

1. Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., ... & Bengio, Y. (2014). Generative adversarial nets. In *Advances in Neural Information Processing Systems* (pp. 2672-2680).
2. Kingma, D. P., & Welling, M. (2013). Auto-encoding variational bayes. *arXiv preprint arXiv:1312.6114*.
3. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I.
4. NVIDIA. (2022). NVIDIA Omniverse. Retrieved from https://www.nvidia.com/en-us/omniverse/
5. Meta. (n.d.). Introducing Meta. Retrieved from https://about.fb.com/meta/
6. Stephenson, N. (1992). *Snow Crash*. Bantam Books.
7. Linden Lab.(2003). Second Life. Retrieved from https://www.secondlife.com/
8. Oculus. (n.d.). Oculus Rift. Retrieved from https://www.oculus.com/rift/
9. Microsoft. (n.d.). Microsoft HoloLens. Retrieved fromhttps://www.microsoft.com/en-us/hololens
10. Roblox Corporation. (n.d.). Roblox. Retrieved from https://www.roblox.com/
11. OpenAI. (n.d.). OpenAI GPT. Retrieved from https://openai.com/gpt/
12. Meta. (n.d.). Horizon Worlds. Retrieved from https://www.meta.com/horizon-worlds/

Analysis of PTX Code for CUDA Programs

Lakshmi Gadhikar
Department of Computer Engineering
Sardar Patel Institute of Technology
Mumbai, Maharashtra
✉ lmgadhikar@gmail.com

Y. S. Rao
Department of Electronics and Telecommunication
Sardar Patel Institute of Technology
Mumbai, Maharashtra
✉ ysrao@spit.ac.in

ABSTRACT

Program optimization requires careful analysis of programs. Program analysis can be conducted at various levels viz. source code level, intermediate code level such as PTX in case of CUDA, bytecode level for Java or at assembly level. Our previous work, involved analysis of source code level GPGPU programs written using CUDA C language. Our current work deals with analysis of GPGPU programs at intermediate code level i.e. PTX version of programs written in CUDA C language. The aim of this study is to extract details from the PTX code such as number and type of instructions in the PTX code. This information may be used further for optimization of PTX code and/or CUDA programs on a specific GPU architecture.

KEYWORDS: *Program analysis, PTX, CUDA, GPGPU*

INTRODUCTION

A General Purpose Graphics Processing Unit i.e. GPGPU is a programmable computing device that consists of thousands of Symmetric Multi-processing cores (SMs). Each SM executes in parallel, multiple threads of programs written in special purpose GPGPU programming languages such as CUDA, OpenCL etc. Our work focuses on intermediate code generated for NVIDIA's Compute Unified Device Architecture i.e. CUDA[1] language. A CUDA program consists of sequential and parallel parts. The host code is the sequential part of a CUDA program that executes on the CPU and the parallel part of the code that executes on the GPU[2] is called as a kernel. Kernel follows Single Instruction Multiple Threads i.e. SIMT model of execution causing multiple cores of the GPU to concurrently execute the same set of instructions on different data values. NVCC compiler converts the kernel code in PTX[3] instructions format into target GPU architecture instructions for execution on a specific GPU architecture..

Cooperative Thread Array (CTA)[4] is an array of threads that execute a kernel concurrently. These threads of the kernel are launched by the host code to execute on the GPU in units of Blocks and Grid. A block is a collection of Threads whereas a Grid is a collection of blocks. Multiple threads of a kernel are scheduled to run on the SM of a GPU in collection of 32 threads called as a warp. Threads from a CTA can interact with each other. To manage their communication, synchronization points are defined where threads pause until all threads in the CTA reach the barrier.

GPU memory is hierarchically organized at diverse levels. A slow Global device memory accessible by the host code. Registers and shared memory are the memories local to each SM and are shared by all threads inside the SM. Shared memory access is very fast in comparison to the global memory. Like shared memory, constant cache is also shared by all threads within a SM. Constant , local and texture memories are part of the global memory space but used for specific purposes such as read-only constant data, and texture data. Local memory is a read-write memory like global and shared memories but is used in case of register spills.

CUDA program may be represented in four different versions namely

1. Source code- written in in High Level Language CUDA i.e. .CU file.
2. Machine independent Intermediate code in PTX (

Parallel Thread execution) form that gets translated into native target-architecture's machine or binary code.

3. Assembly code uses mnemonics to represent low-level machine instructions or opcodes, registers, flags, etc. which makes it more readable and easier to understand and debug compared to its machine language counterpart. Assembler converts assembly code into executable machine code. NVIDIA provides assembly instruction set of each GPU architecture[4].
4. Machine or binary code- CUDA provides an architecture dependent machine code which is a binary code not easy to understand and debug by humans. A CDA binary i.e. cubin file is an ELF-formatted file which consists of CUDA executable code sections along with some relocation, debug related and other information. At runtime, cubin files are loaded by the CUDA driver API.

In our previous work [5], we analyzed CUDA C programs at source code level. However, the intermediate level PTX code give access to features like cache modifiers on load instructions which cannot be done while writing source code [3]. The major benefit of PTX code in comparison with the assembly code is that it is independent of architecture. Since PTX code files are independent of architecture and have low-level instructions which provide an edge over both source code file and assembly code file, so, our current work focuses on analysis of PTX code. In this work, we analyze GPGPU programs at intermediate code level i.e. PTX version of programs written in CUDA C language. The aim of our current work is to find useful details from the PTX code such as number and type of instructions in the PTX code such as arithmetic, memory and synchronization instructions. This information may be used further for optimization of PTX code and/ or CUDA programs on a specific GPU architecture.

The main contributions of our work are as follows.

1. Static analysis the PTX codes generated from CUDA C programs.
2. Automated extraction of useful information from PTX codes.
3. Determine the total number of instructions used, types of instructions used like arithmetic instructions ,memory instructions, synchronization instructions etc. in the PTX code.
4. Analyze the extracted information that is the utilization of Shared Memory, Global Memory etc.

PTX (PARALLEL THREAD EXECUTION) ISA

PTX is a Parallel Thread Execution virtual machine and Instruction Set Architecture (ISA)[3] used in NVIDIA's CUDA (Compute Unified Device Architecture) parallel programming platform used for general purpose computation on a GPU device. The CUDA code is first compiled by its NVCC compiler into an intermediate assembly file called PTX assembly and then translated at install time into native target-architecture's instructions code (machine / binary code). The PTX ISA provides compatibility with different generations of GPU hardware architectures. It supports various compilers including compilers for C and C++ [3].

PTX code

Like source code, PTX code also contains a collection of instructions. PTX instructions have close resemblance to the assembly instructions format containing instruction op-codes and operands. The code snippet in figure1 shows a sample PTX code that performs addition of 2 variables and stores the result in a 3rd variable.

1. version 3.5
2. target sm_21, texmode_independent
3. address_size 32
4. add.u32 z,x,y;

Fig. 1. Code Snippet 1. Sample PTX code for performing addition of 2 variables

First three statements in each PTX module are the directive statements. First Line Of Code starting with .version specifies the PTX ISA version, the second line of code begins with .target directive indicating the target GPU architecture and the third line specifies the address size (32 or 64) used in the PTX module using .address_size directive. Fourth line in above PTX code performs addition of x, y and result is stored in z and it is of data type .u32.

PTX supports different data types and storage areas known as state spaces. Variables are stored in different storage spaces. Data types supported by PTX ISA are .s8, .s16, .s32, .s64 represent 8bit, 16 bit, 32 bit, and 64 bit signed integer respectively. Similarly .u8, .u16, .u32, .u64 represent unsigned integer. Floating point type specifiers are .f16, .f16x2, .f32, .f64. Bit size type specifiers are .b8, .b16, .b32, .b64. Predicate type is represented by .pred [3].

PTX ANALYZER

The proposed system PTX Analyzer shown in figure 2 analyses the PTX codes of a CUDA C programs. The analysis of PTX code involves extracting useful information such as number and types of instructions, usage of various GPU resources such as Shared memory usage, Global memory usage, etc. The above information may be useful for further analysis and optimization of the CUDA C programs or the PTX code.

The major objectives of our proposed system PTX Analyzer are to

1. Analyse the PTX codes generated by CUDA C programs
2. Extract useful information from PTX codes.
3. Determine the total number of instructions used, types of instructions used like arithmetic instructions , memory instructions, synchronization instructions etc.
4. Analyse the extracted information to determine the usage of different GPU resources which may be used for optimizing the kernel codes.

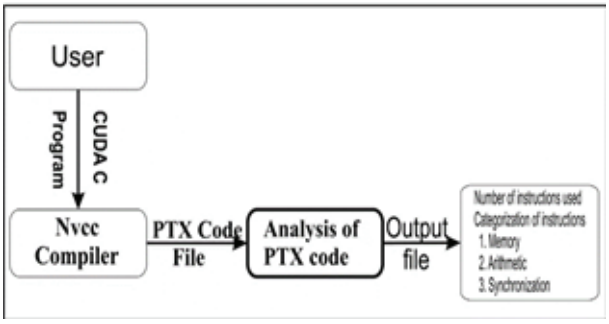


Fig. 2. Overview of PTX Analyzer System

User gives input in the form of a CUDA C source program. This source program in CUDA C is given as input to the NVCC compiler. Compiler option –ptx is used to generate the PTX code using following command.

nvcc –ptx sample.cu

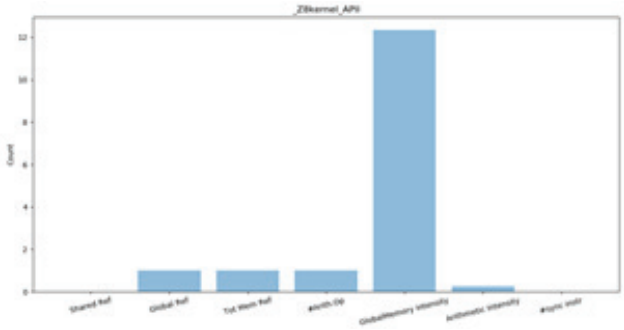
The output of above command is sample.ptx file.

This NVCC generated PTX code is given as input to our PTX Analyser System. We do automated analysis of this PTX file by parsing the entire PTX file in a line by line manner. This automated program analysis module generates different output files. First file containing kernel definitions extracted from the PTX code. Second file containing the parameters extracted from the PTX code i.e. the number and type of instructions such as arithmetic instructions, memory instructions, synchronization instructions etc. Third file showing graphs indicating the count of different types of instruction for each kernel in the PTX code under analysis as shown in Results section. First two files are not shown here due to size constraints.

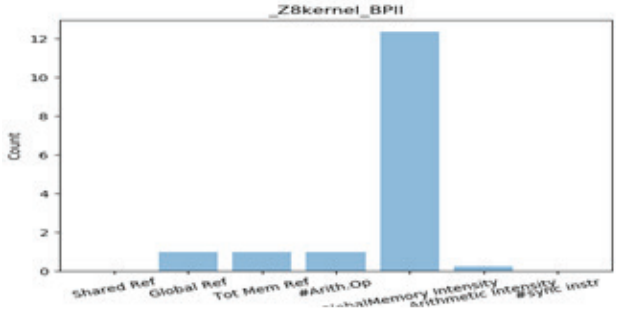
RESULTS

We implemented PTX analyzer program in Python to perform automated analysis of PTX code of kernels from CUDA C applications belonging to Rodinia benchmarks[6] and Nvidia CUDA SDK Samples 7.0[7]. PTX analyzer auto extracts following information form the PTX code of each kernel of a CUDA C GPU program given as input to it. It extracts the total number of memory references such as global memory references and shared memory references, number of arithmetic operations and number of synchronization instructions. Based on the count of global and shared memory references, it computes global memory intensity and arithmetic intensity. The output of PTX analyzer may be used to determine the resource usage of a CUDA kernel by using the arithmetic intensity and memory intensity values. The output is also used to determine usage of Global Memory and Shared Memory which may be used for optimizing the memory access performance.

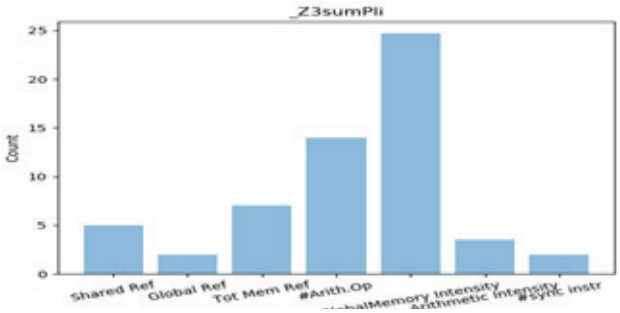
Figure 3 shows graphs autogenerated by PTX Analyzer showing count of parameters extracted for each kernel in the PTX code of a CUDA application program named simpleHyperQ.cu from NVIDIA CUDA SDK sample 7.0.



(a) Kernel kernel_A



(b) Kernel kernel_B



c) Kernel sum

Fig. 3 .(a), (b), (c) : Graphs autogenerated by PTX Analyzer showing count of parameters extracted for each global kernel for PTX code of simpleHyperQ.cu from NVIDIA CUDA SDK sample 7.0.

RELATED WORK

Metz Christopher A. et. al.[8] have created a fast hybrid Parallel Thread Execution (PTX) Analyzer which is a tool that performs static as well as dynamic analysis of PTX code without the need to execute it on a GPU. The tool finds some details from the PTX code such as efficiency of branching, count of divergent branches, instructions, floating point operations etc. Daniel Lustig et. al. [9] focus on formally analyzing and validating the memory consistency model used in NVIDIA's PTX virtual ISA, which governs how memory operations are handled in GPU programming. The paper aims to demonstrate that the PTX memory model is suitable for compiling GPU programming languages like CUDA. Abdelkhalik H. et. al. [10] demonstrate the process of translating each PTX instruction into its corresponding SASS instruction, while also evaluating the clock cycles required for both instruction sets. They utilize PTX (Parallel Thread Execution) instructions as the foundation for their microbenchmarking analysis of Nvidia's Ampere architecture. They perform instruction-level analysis to provide valuable insights into specific aspects of this architecture. Andre Kerr et.al.[11] developed an emulator to analyze the parallelism, data flow, control flow and memory behavior of GPU kernels from Parboil Benchmark Suite and NVIDIA CUDA SDK. Their work requires emulated execution of the PTX code whereas we perform static analysis of PTX code. Our approach does not require to emulate or execute the PTX code for performing analysis. Albert Claret Exojo [12] has designed and Implemented a PTX Emulation Library that parses the PTX code of a CUDA program to create an Open PTX Binary Format (OPBF) which is a new binary object developed by the author to replace Cubin binary format and to emulate GPU behavior. While the author parses the PTX code to create a new binary format and use it to emulate the GPU function, our work focuses on the analysis of PTX code to extract useful information from it with the intension of using it to perform useful optimizations to the CUDA kernel.

CONCLUSION

We analyzed the PTX codes of CUDA C programs from different application domains and extracted kernel definitions and parameters from PTX code. The analysis of PTX codes involves extracting useful information such as number and types of instructions such as arithmetic instructions, synchronization instructions and memory instructions, usage of various GPGPU resources such as shared memory usage, global memory usage, etc. The analysis of above information may be useful to optimize the performance of the PTX and corresponding CUDA C programs.

REFERENCES

1. CUDA C Programming Guide, CUDA toolkit documentation - v11.0.3. https://docs.nvidia.com/cuda/cuda-c-programming-guide/ (2007-2023). [accessed 24 August 2023].
2. Yu, Z., Eeckhout, L., Goswami, N., Li, T., John, L. K., Jin, H., … Wu, J. (2015). GPGPU-MiniBench: Accelerating GPGPU Micro-Architecture Simulation. IEEE Transactions on Computers, 64(11), 3153–3166. doi:10.1109/tc.2015.2395427
3. Parallel Thread Execution ISA Version 8.5. https://docs.nvidia.com/cuda/parallel-thread-execution/ [accessed 02-05-2024]
4. CUDA Binary Utilities V12.5 https://docs.nvidia.com/cuda/cuda-binary-tilities/index.html#instruction-set-ref. [accessed 02-05-2024]
5. L. M. Gadhikar and Y. S. Rao, "Analysis of Programs for GPGPU Architectures," 2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India, 2018, pp. 1-4, https://doi.org/10.1109/ICOEI.2018.8553918.
6. Shuai Che, Michael Boyer, Jiayuan Meng, David Tarjan, Jeremy W. Sheaffer, Sang-Ha Lee, and Kevin Skadron. Rodinia: A benchmark suite for heterogeneous computing. IEEE Workload Characterization Symposium, 0:44–54, 2009.
7. Sample Programs - Nvidia CUDA 7.0 SDK https://docs.nvidia.com/cuda/cuda-samples/index.html#samples-reference retrieved 16-11-2019. Now available on https://github.com/NVIDIA/cuda-samples/tree/master/Samples[12-11-2022]
8. Metz, Christopher A., Christina Plump, Bernhard J. Berger, and Rolf Drechsler. "Hybrid PTX analysis for GPU accelerated CNN inferencing aiding computer architecture design." In 2023 Forum on Specification & Design Languages (FDL), pp. 1-8. IEEE, 2023. https://doi.org/10.1109/FDL59689.2023.10272088.
9. Daniel Lustig, Sameer Sahasrabuddhe, Olivier Giroux, “A Formal Analysis of the NVIDIA PTX Memory Consistency Model”, Proceedings of the Twenty-Fourth International Conference on Architectural Support for Programming Languages and Operating Systems, ASPLOS '19, April 2019, Pages 257–270, https://doi.org/10.1145/3297858.3304043.
10. Abdelkhalik H, Arafa Y, Santhi N, Badawy AH. “Demystifying the nvidia ampere architecture through microbenchmarking and instruction-level analysi”s. In 2022 IEEE High Performance Extreme Computing Conference (HPEC) 2022 Sep 19 (pp. 1-8). IEEE. https://doi.org/10.1109/HPEC55821.2022.9926299.
11. Andre Kerr, Gregory Diamos, Sudhakar Yalamanchilli, “A Characterization and Analysis of PTX Kernels”, School of Electrical and Computer Engineering. Published in “Workload Characterization”, IISW 2009. IEEE International symposium,2009. https://doi.org/10.1109/IISWC.2009.5306801.
12. Exojo Albert Claret. "Design and implementation of a PTX emulation library." PhD dissertation, 2009.

Bharati Vidyapeeth's

Institute of Management & Information Technology, Navi-Mumbai, Mumbai

Approved by AICTE New Delhi, Affiliated to University of Mumbai

NBA Accredited till June 2023.

DTE Code: MC 3162

Contact Us: 022-27578415, +918657008016

Website: www.bvimit.co.in , Email: principal.bvimit@bharatividyapeeth.edu

"Social Transformation Through Dynamic Education"

MCA (Master of Computer Application)

Bharati Vidyapeeth Pune is the parent body of BVIMIT, Navi Mumbai. Bharati Vidyapeeth one of the largest networks of education institutions in India, established by Hon'ble Dr. Patangraoji Kadam in 1964 at Pune. Bharati Vidyapeeth has achieved its new height of success under the guidance and leadership of Dr. Vishwajeet Kadam Hon'ble Secretary. Bharati Vidyapeeth has campuses across the country at New Delhi, Navi Mumbai, Sangli, Pune, Solapur, Karad, Satara, Panchgani and Kolhapur and also has overseas campus at Dubai and USA.

Master of Computer Applications (MCA) was introduced in BVIMIT in the year 2002. It is affiliated to the Mumbai University approved by AICTE with the intake of 120 students. The course was designed to meet the growing demand for qualified professionals in the field of Information Technology. It is a postgraduate course that can be taken up after obtaining a Bachelor's Degree.

Institute Facilities and Features

- State of art Infrastructure.
- Highly qualified and experienced faculties.
- Industry institute interaction 15+ MoU with IT Companies.
- Project based learning and case based pedagogy.
- E-library with full text access of e journals.
- Wi-Fi enabled campus.
- Strong association of alumni.
- Incubation and Software Development Cell.
- Swayam-NPTEL local Chapter.
- Value added Workshops, Seminars, Industrial Visit and Pre placement activities.
- PhD research centre, conductive research ambience and multi-disciplinary research cell.

VOLUME 47 • SPECIAL ISSUE • NO. 2 • OCTOBER 2024 ISSN 0971-3034

Bharati Vidyapeeth's

Institute of Management & Information Technology, Navi-Mumbai

Approved by AICTE New Delhi, Affiliated to University of Mumbai

NBA Accredited till June 2023.

DTE Code: MC 3162

Contact Us

Bharati Vidyapeeth's Institute of Management & Information Technology

Sector 8,C.B.D.Belapur, Navi Mumbai. 400614

Phone: 022-27578415

Mobile: +918779669041,+918657008017, +918657008016

FAX: 022-27574515

Email: principal.bvimit@bharatividyapeeth.edu

Website: www.bvimit.co.in

PUBLISHED BY

INDIAN SOCIETY FOR TECHNICAL EDUCATION

Near Katwaria Sarai, Shaheed Jeet Singh Marg,

New Delhi - 110 016

Printed at: Compuprint, Flat C, Aristo, 9, Second Street, Gopalapuram, Chennai 600 086.

Phone : +91 44 2811 6768 • www.compuprint.in