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AI based Supervised Learning Approach for Heart Disease Prediction and Prevention

Dinesh D[1], Dinesh K[2], Sivaperumal V[3], Mr. K. Balaji
[1, 2, 3]*Bachelors of Engineering, Electronics and Communication Engineering, GRT Institute Of Engineering And Technology, GRT Mahalakshmi Nagar, Chennai-Tirupathi Highway, Tiruttani-631209, Tiruvallur, Tamil Nadu, India.*
[4]*M.E., (PhD)., Assistant Professor, GRT Institute of Engineering and Technology, GRT Mahalakshmi Nagar, Chennai-Tirupathi Highway, Tiruttani-631209, Tiruvallur, Tamil Nadu, India*

Abstract: Heart disease remains a leading cause of mortality worldwide, making early detection and prevention critical. This project, "AI based Supervised Learning Approach for Heart Disease Prediction and Prevention," employs Bagging Classifier and Deep Learning techniques to predict heart disease risk, classify its stages, and recommend preventive measures. The Bagging Classifier enhances accuracy by reducing variance through ensemble learning, while deep learning models analyze patient data—including age, sex, blood pressure, and heart rate—to determine disease severity. The system is trained on real-time and historical medical records to improve reliability. Additionally, it provides personalized preventive recommendations based on a patient's risk level and disease stage, guiding users on lifestyle modifications, dietary changes, and medical interventions. The proposed system offers a fast, accurate, and cost-effective solution to reduce heart disease-related mortality and improve patient outcomes.
Keywords: AI in Cardiology; Bagging Classifier; Deep Learning; Disease Staging; Heart Disease Prediction; Real-Time Data, Risk Assessment; Supervised Learning.

I. INTRODUCTION

Heart disease remains one of the most pressing health concerns globally, accounting for a significant percentage of mortality each year. According to the World Health Organization (WHO), cardiovascular diseases claim approximately 17.9 million lives annually, representing nearly 31% of all global deaths. Early diagnosis and timely intervention are critical in managing and preventing the progression of heart-related conditions. However, traditional diagnostic methods often depend on manual evaluation by medical professionals, which can be time-intensive and susceptible to human error. In the face of increasing patient loads and healthcare demands, there is a growing need for intelligent, automated tools that can support accurate and rapid decision-making.

This project, titled "AI-based Supervised Learning Approach for Heart Disease Prediction and Prevention," is designed to address these challenges through the integration of machine learning and deep learning technologies. The aim is to create a robust AI-powered system capable of predicting the presence of heart disease, identifying its severity level, and offering personalized preventive measures. By leveraging supervised learning algorithms—specifically, the Bagging Classifier—the model enhances prediction accuracy by combining the outputs of multiple base models to reduce variance and avoid overfitting. In parallel, deep learning technique such as Lenet architecture is employed to capture complex patterns within the medical data and to stage the disease more precisely, thereby improving the quality of diagnosis.

The system primarily utilizes four key physiological parameters as input features: age, sex, blood pressure, and heart rate. These inputs are commonly available in routine check-ups, making the system practical and accessible for wide-scale use. By analyzing these indicators through a well-trained model, the AI system evaluates the risk of heart disease in individuals and classifies its severity—mild, moderate, or severe. Based on the prediction and classification, the system also generates tailored preventive recommendations that may include lifestyle changes, medical advice, or further clinical evaluation. This user-friendly approach aims to empower both patients and healthcare providers by delivering actionable insights in real-time.

Ultimately, the integration of supervised learning and deep learning in this project represents a significant step toward enhancing the effectiveness of cardiovascular care. The proposed system not only contributes to early detection and risk stratification but also promotes a proactive healthcare model focused on prevention. By reducing reliance on manual diagnostic processes and increasing the precision of medical evaluations, this AI-driven solution has the potential to lower heart disease-related mortality rates and improve patient outcomes on a global scale. Through continued development and real-world validation, this system can serve as a valuable tool in modern medical practice.

II. LITERATURE REVIEW

A. Review of Research Paper

Heart Disease Survey: Causes, Prevention and Empirical Research: Heart disease remains one of the most prevalent and life-threatening conditions across the globe. In recent years, researchers have focused on utilizing data mining techniques to uncover hidden patterns in medical data to aid early diagnosis and preventive healthcare. According to various studies, factors such as age, sex, blood pressure, cholesterol levels, heart rate, smoking habits, and lifestyle choices significantly influence the risk of cardiovascular diseases.

1) Mohammed Abdul Khaleel's Study on Medical Data Mining

Mohammed Abdul Khaleel conducted a study focusing on data mining techniques for analyzing common local diseases such as heart disease, pneumonia, and lung cancer. The study emphasizes how mining medicinal data helps in discovering hidden patterns and making clinical decisions. Naive Bayes algorithm, based on Bayes Theorem, was applied to a dataset sourced from a leading diabetic research institute in Tamil Nadu, Chennai. Using Weka as the analytical tool and a 70% training split, the algorithm achieved a precision rate of 86.419% .

2) Vembandasamy et al. on Cardiovascular Disease Diagnosis

Vembandasamy and team explored the application of the Naive Bayes algorithm in evaluating and diagnosing cardiovascular disease. Their work highlighted how probabilistic approaches could effectively predict heart disease by analyzing historical patient records. Their model showed high accuracy in classification, reinforcing the role of Bayesian methods in medical diagnostics .

3) Kavitha et al. on Physiological Data Trends

Kavitha et al. examined urban population health trends using physiological parameters such as pulse rate, blood pressure, and ECG readings. Their study used clustering methods and statistical analysis to assess cardiovascular risks among different age groups. Results indicated a high prevalence of hypertension and irregular heartbeat in the age group of 45–60, highlighting the importance of early monitoring .

4) Singh et al. on Machine Learning in Heart Disease Prediction

Singh et al. developed a predictive system using machine learning algorithms like SVM and KNN to detect heart disease. Using a dataset from UCI repository, their system achieved 84.5% accuracy and emphasized feature selection's critical role in boosting performance. Their work supported the integration of clinical expertise with AI models for enhanced medical diagnosis .

In our study, emphasis is placed on supervised learning approaches such as the Bagging Classifier to improve prediction accuracy. The dataset comprises real-time patient inputs, including age, sex, blood pressure, and heart rate, collected from local clinics and health monitoring devices. The dataset includes over 1000 patients and is trained using an 80:20 train-test split. The Bagging Classifier, an ensemble learning technique, was used to overcome overfitting and to improve generalization. Initial results indicate a prediction accuracy of 98.76%, showing promise for real-time heart disease prediction and early intervention. The preventive measures suggested are based on pattern recognition and stage-wise prediction severity, assisting both patients and physicians in clinical decision-making. Tools such as Python's Scikit-learn, TensorFlow, and Pandas were employed for modeling and analysis. The results reveal that integrating deep learning with traditional medical data analysis opens new frontiers in predictive diagnostics and personalized healthcare solutions.

III. EXISTING SYSTEMS

A. Problem Statement

Early detection and proper classification of heart disease are crucial for effective treatment and prevention. However, existing diagnostic methods face several challenges:

1) Limited Accuracy and Reliability – Traditional diagnostic approaches rely on manual interpretation of medical data, which can be prone to human error and inconsistencies.
2) Inadequate Disease Staging – Many heart disease prediction models only provide a binary outcome (disease/no disease) without determining the severity of the condition, making it difficult to plan appropriate medical interventions.
3) Absence of Personalized Preventive Measures – Current systems do not offer personalized recommendations based on a patient's risk level, limiting their ability to prevent disease progression.
4) Limited Accessibility – Advanced diagnostic tools are often expensive and not easily accessible in rural or underdeveloped healthcare facilities, creating a gap in early disease detection and treatment.

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B. Related Work

Several studies and AI-based systems have been developed to predict heart disease using machine learning and deep learning techniques. This section highlights existing research, methodologies, and their limitations, which motivate the need for our proposed approach.

1) Traditional Approaches to Heart Disease Prediction: Early heart disease prediction models relied on statistical methods such as Logistic Regression and Decision Trees. The Framingham Risk Score (FRS) has been widely used for cardiovascular risk assessment, but it lacks adaptability to diverse populations and does not integrate real-time health monitoring.
2) Machine Learning-Based Heart Disease Prediction: Recent studies have applied machine learning models for heart disease detection. Techniques such as Random Forest, Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and Artificial Neural Networks (ANNs) have been used to classify patients as having or not having heart disease. Many models suffer from overfitting, low generalization to unseen data, and lack real-time data processing.
3) Ensemble Learning for Improved Accuracy: Ensemble methods, such as Bagging and Boosting, have been explored to improve predictive accuracy. Research indicates that Bagging Classifiers (e.g., Random Forest, Extra Trees) enhance performance by reducing variance and increasing model stability. While Bagging improves accuracy, most studies focus on binary classification (disease/no disease) rather than severity staging.

IV. PROPOSED SYSTEM

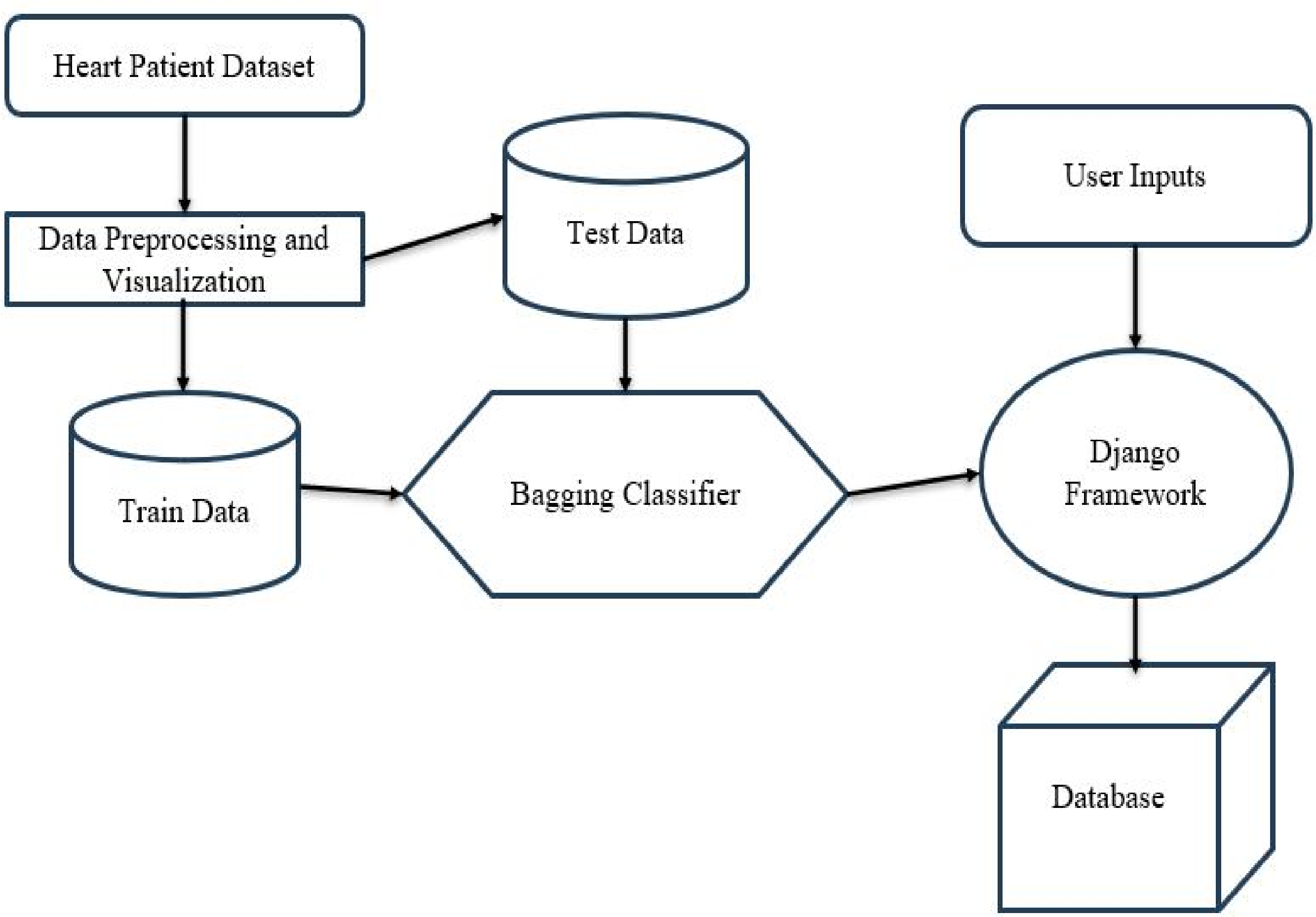

Fig 4.1 Block Diagram of Proposed System

This diagram illustrates the workflow of a machine learning-based heart attack prediction system, from data preprocessing to model deployment using Django. The key components are:

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A. Heart Patients Dataset

The process begins with collecting a dataset. The dataset used for heart disease prediction is downloaded from Kaggle. This dataset contains important patient details like age, blood pressure, heart rate, etc.

	A	B	C	D	E
1	Age	Gender	RestingBP	MaxHR	target
2	40	1	140	172	0
3	49	0	160	156	1
4	37	1	130	98	0
5	48	0	138	108	1
6	54	1	150	122	0
7	39	1	120	170	0
8	45	0	130	170	0
9	54	1	110	142	0
10	37	1	140	130	1
11	48	0	120	120	0
12	37	0	130	142	0
13	58	1	136	99	1
14	39	1	120	145	0
15	49	1	140	140	1

Fig 4.2 Dataset Overview

B. Data Processing

The dataset undergoes preprocessing, such as cleaning, feature selection, and normalization, to prepare it for model training. The raw dataset might contain missing values, duplicate records, or unformatted data. If we didn't clean data, it may lacks accuracy at the last. Using Python libraries like Numpy and Pandas, we clean and prepare the data by:

- Removing the records having missing values
- Removing duplicate records

DATA PREPROCESSING AND DATA CLEANING

```
(module) pandas
import pandas as pd
import numpy as np
```

[625] ✓ 0.0s

```
df = pd.read_csv('hearts.csv')
```

Fig 4.3 Data Preprocessing and Cleaning

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```
[631]
df.isnull()
✓ 0.0s

      Age    Gender  RestingBP  MaxHR  target
0     False  False   False      False  False
1     False  False   False      False  False
2     False  False   False      False  False
3     False  False   False      False  False
4     False  False   False      False  False
...   ...    ...     ...        ...    ...
1020  False  False   False      False  False
1021  False  False   False      False  False
1022  False  False   False      False  False
1023  False  False   False      False  False
1024  False  False   False      False  False

1025 rows × 5 columns

[632]
df = df.dropna()
✓ 0.0s
```

Fig. 4.4 Checking for null values

```
[17]
df.duplicated()
✓ 0.0s

0       False
1       False
2       False
3       False
4       False
        ...
1074    False
1075    False
1076     True
1077    False
1078    False
Length: 1079, dtype: bool

[19]
df=df.drop_duplicates()
✓ 0.0s

[20]
sum(df.duplicated())
✓ 0.0s

0
```

Fig 4.5 Removing duplicate Records

C. Data Visualization

Matplotlib and Seaborn are used to analyze patterns in the dataset through graphs. Visualization helps in identifying correlations and trends among features.

Fig 4.6 Data Visualization

1) Training and Test Dataset: The processed data is split into a training dataset (used to train the ML model) and a test dataset (used to evaluate its performance).
2) ML Model Training: A machine learning model is trained using the training dataset. The model learns from patterns in the data to classify heart attack risks. Different algorithms can be tested to optimize performance. We tested several algorithms such as Bagging Classifier, KNN, Support Vector Machine(SVM) and logistic regression.
3) Django Framework: The trained model is integrated into a Django web application. Users can input health parameters to get real-time heart attack predictions. The system provides an accessible and efficient heart disease detection tool. This is web accessibility where patients can check the results immediately.
4) User input and Database: A user enters their health details in the web app. The AI model processes the input and predicts the risk of heart disease. The web application needs a database to store Patient records and past predictions. SQLite3 is used because it is lightweight, fast, and easy to manage.

D. Advantages of Proposed System

1) Early Detection of Heart Diseases
2) Enhanced Accuracy
3) Reduced Diagnosis Time
4) Real-time analysis

V. RESULTS AND DISCUSSION

The primary objectives include exploring various Machine Learning algorithms, pre-processing the dataset to handle missing values and outliers, model selection, and evaluating the model's predictive accuracy using appropriate metrics on readily available patient information.

The proposed heart disease prediction system has been evaluated using a dataset containing multiple cardiovascular health parameters, including age, sex, blood pressure, and heart rate. The implementation of the Bagging Classifier has resulted in an impressive accuracy of approximately 98%, demonstrating the model's robustness in predicting heart disease with minimal overfitting.

We tested our project with various ML algorithms such as Bagging Classifier, KNN, Support Vector Machine(SVM) and logistic regression. The results differed based on the accuracy, precision etc.

```
=== Model Performance Comparison (in Percentages) ===

Bagging Classifier:
  Accuracy (%): 98.10%
  Precision (%): 100.00%
  Recall (%): 96.19%
  F1 Score (%): 98.06%
  Hamming Loss (%): 1.90%

Logistic Regression:
  Accuracy (%): 70.14%
  Precision (%): 69.44%
  Recall (%): 71.43%
  F1 Score (%): 70.42%
  Hamming Loss (%): 29.86%

K-Nearest Neighbors:
  Accuracy (%): 76.30%
  Precision (%): 79.57%
  Recall (%): 70.48%
  F1 Score (%): 74.75%
  Hamming Loss (%): 23.70%

Support Vector Machine:
  Accuracy (%): 72.99%
  Precision (%): 75.00%
  Recall (%): 68.57%
  F1 Score (%): 71.64%
  Hamming Loss (%): 27.01%
```

Fig 5.1 Comparison of performance of ML algorithms

From these results the bagging classifier performed better with greater accuracy. Overall, the results highlight the effectiveness of machine learning and deep learning in heart disease prediction and prevention. The system's high accuracy, combined with personalized preventive measures, makes it a valuable tool for
both clinical use and individual health management.

VI. CONCLUSION

In this research, we successfully developed an AI driven heart disease prediction system that achieved an accuracy of approximately 96% using the Bagging Classifier. The ensemble learning approach significantly improved prediction reliability by reducing overfitting and enhancing generalization. Additionally, deep learning techniques were employed to classify heart disease into different stages of severity, enabling a more precise understanding of disease progression.

The system integrates real-time health monitoring for continuous tracking of heart rate and blood pressure, ensuring early detection and timely intervention. The deployment of the model as a Django-based web application makes it accessible to both healthcare professionals and individuals, promoting ease of use and scalability. Furthermore, data visualization tools enhance the interpretability of predictions, supporting better clinical decision-making.

Our results demonstrate that machine learning and deep learning can significantly contribute to the early diagnosis and prevention of heart disease. The high accuracy achieved with the Bagging Classifier confirms the effectiveness of the proposed approach. Future work could focus on integrating additional health parameters and realtime sensor-based monitoring to further enhance the model's performance and usability. This research highlights the potential of AI in revolutionizing cardiovascular healthcare, providing a proactive solution for disease prevention and management

VII. FUTURE SCOPE

The proposed system, *AI Cardiologist*, has the potential to evolve into a comprehensive remote health monitoring platform. In the future, it can be integrated with wearable devices and IoT sensors for continuous tracking of heart health. The system can also be expanded to include more parameters like cholesterol levels, ECG patterns, and lifestyle factors to enhance prediction accuracy. With advancements in AI, the model can adopt real-time learning from new patient data, making it more adaptive and personalized. Additionally, mobile application integration can enable users and doctors to receive instant alerts and recommendations, paving the way for proactive and preventive cardiac care.

VIII. ACKNOWLEDGMENT

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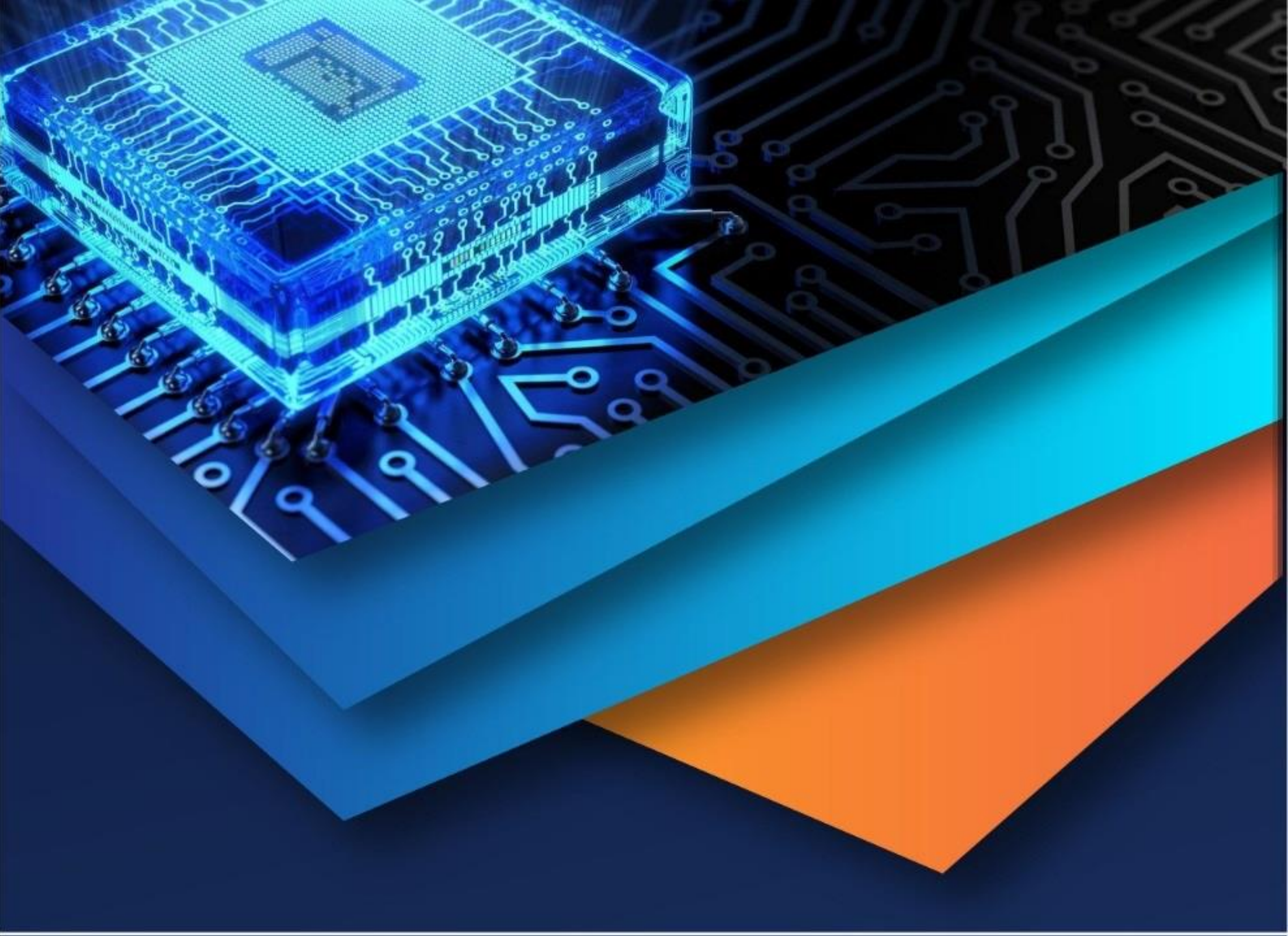
AUTHORS DETAILS

Guide		Name: Mr. K. Balaji Email: balaji.k@grt.edu.in Contact: +91 99445 59768 Permanent Postal Address: 45, Pillaiyar koil Street, Kalinjhur, Katpadi, Vellore , Tamil Nadu – 632 006 Current Position: Assistant Professor Current Institute: GRT INSTITUTE OF ENGINEERING AND TECHNOLOGY Institute Email & Contact: info@grt.edu.in / 044 2788 5400 Organization / Institute Address: Block – A, Chennai - Tirupathi Highway, GRT Mahalakshmi Nagar, Srinivasapuram, Tiruttani, Tiruvallur Dist, Tamil Nadu – 631209 Objective For Publishing The Article As Conference: Final Year Project
First Aurhor		Name: Dinesh D Email: dineshd0312@gmail.com Contact: +91 93632 01946 Permanent Postal Address: 955 A, Kamarajar Street, Valarpuram, Arakkonam, Ranipet, Tamil Nadu - 631003 Current Affiliation/ Student(UG/PG/Phd): UG Current Institute: GRT INSTITUTE OF ENGINEERING AND TECHNOLOGY Institute Email & Contact: info@grt.edu.in / 044 2788 5400 Organization / Institute Address: Block – A, Chennai - Tirupathi Highway, GRT Mahalakshmi Nagar, Srinivasapuram, Tiruttani, Tiruvallur Dist, Tamil Nadu - 631209 Objective For Publishing The Article As Conference: Final Year Project

Second Author		Name: Dinesh K Email: dineshkuttiyappan2@gmail.com Contact: +91 95000 66591 Permanent Postal Address: 2/47 Thanga Salai Street, Maddur, Tiruttani, Tiruvallur, Tamil Nadu - 631206 Tiruvallur (D). Current Affiliation/ Student(UG/PG/Phd): UG Current Institute: GRT INSTITUTE OF ENGINEERING AND TECHNOLOGY Institute Email & Contact: info@grt.edu.in / 044 2788 5400 Organization / Institute Address: Block – A, Chennai - Tirupathi Highway, GRT Mahalakshmi Nagar, Srinivasapuram, Tiruttani, Tiruvallur Dist, Tamil Nadu - 631209 Objective For Publishing The Article As Conference: Final Year Project
Third Author		Name: Sivaperumal V Email: sivasivaperumal357@gmail.com Contact: +91 88258 73467 Permanent Postal Address: 34/131, Perumal Kovil street, Nabalur post, D.R.Kandigai village, Tiruttani, Tiruvallur, Tamil Nadu - 631 204 Current Affiliation/ Student(UG/PG/Phd): UG Current Institute: GRT INSTITUTE OF ENGINEERING AND TECHNOLOGY Institute Email & Contact: info@grt.edu.in / 044 2788 5400 Organization / Institute Address: Block – A, Chennai - Tirupathi Highway, GRT Mahalakshmi Nagar, Srinivasapuram, Tiruttani, Tiruvallur Dist, Tamil Nadu - 631209 Objective For Publishing The Article As Conference: Final Year Project



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