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Deep Learning for Heart StrokePrediction-A CNN-LSTMApproach to Automated Diagnosis

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Abstract: Predicting heart stroke is essential for better results and early detection. This project analyzes medical data using deep learning (CNN, LSTM). Prediction are guided by patient characteristics such as age, blood pressure, and ECG readings. The model's accuracy and interpretability are enhanced by feature selection. Metrics including accuracy, recall, F1-score, and ROC-AUC are used for evaluation. It promotes automated, effective diagnosis with an eye toward healthcare innovation.
Keywords: CNN, LSTM, Deep Learning, Heart Stroke Prediction, Medical Data, Healthcare Innovation, and Automated Diagnosis.

I. INTRODUCTION

Since heart stroke is still one of the world's top causes of mortality, better early identification and preventive strategies are required[1]. Traditional diagnostic methods frequently depend on clinical knowledge, which can be laborious and prone to human error [2]. Recent developments in Artificial Intelligence, especially deep learning, have demonstrated great potential to revolutionize medical diagnostics [3]. Increasingly, methods like Long Short-Term Memory (LSTM) Networks and Convolutional Neural Networks (CNNs) are being used to find complex patterns in patient data, improving the accuracy of predictions for a range of medical disorders [4]. Important characteristics for cardiac stroke prognosis include age, blood pressure, cholesterol levels, and electrocardiogram (ECG) results play a critical role in assessing risk levels [5]. Additionally, incorporatingfeature selection techniques helps in enhancing model interpretability by identifying the most influential predictors, thus supporting clinicians in making informed decisions [6]. This study proposes a deep learning-based system that not only automates the prediction of heart stroke but also integrates seamlessly into clinical workflow, aiming to reduce diagnostic delays and support preventive healthcare initiatives [7].

II. LITERATURE REVIEW

Numerous investigations on early diagnostic techniques have been prompted by the fact that heart stroke is still one of the top causes of death [1]. Despite their widespread use, traditional methods are prone to human error and decision-making delays [2]. Cardiovascular disease have been moderately well predicted using machine learning approaches including SVM, decision trees, and random forests [3]. Nevertheless, this models frequently failed to capture the temporal and non-linear patterns found in medical data [4]. High accuracy feature extraction from complicated datasets, such as ECG and imaging data, has been demonstrated by deep learning, and CNNs in particular [5]. Sequential data, including vital signs and medical history, can be effectively analyzed over time by LSTM networks [6]. Disease prediction models have performed better when CNN and LSTM combined [7]. To increase the efficiency and interpretability of the model, feature selection techniques such as PCA and RFE have been used [8]. Numerous studies point to age, blood pressure, cholesterol, and ECG readings as important predictors for stroke [9]. While Kumaret al. demonstrated improved prediction using LSTM on patient time-series data [10]. Smith et al.'s recent work utilizing CNN for stroke classification reached over 90% accuracy [11]. Model dependability is frequently verified using evaluation metrics such as precision, recall, F1-score, and ROC-AUC [12]. Notwithstanding progress, issues including unequal class distribution and opaque model projections still exist [13]. Strong, interpretability, and clinically integrable models are needed to support medical practitioners, according to literature [14]. This objective are met by this study using a hybrid CNN-LSTM system in conjunctions with efficient feature selection [15].

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III. METHODOLOGIES

Using patient medical data, a deep learning-based system for predicting the risk of heart stroke is developed as part of this study's methodology. A thought dataset comprising clinical characteristics like age, gender, blood pressure, cholesterol, heart rate, and electrocardiogram (ECG) readings is first gathered. To ensure consistency and quality throughout the dataset, data preparation is done to manage missing values, standardize numerical data, and encode categorical variables. To find the most significant predictors and improve the model, feature selection methods such as correlation analysis and Recursive Feature Elimination (RFE) are used. Long Short-Term Memory (LSTM) networks and convolution neural networks (CNNs) are combined in this architecture. While the LSTM component records temporal trends in patient history, the CNN component extracts spatial patterns and feature interactions. These are incorporated into a hybrid model, which is then followed by a softmax classifier for risk classification and dense layers. To prevent overfitting and preserve class balance, stratified data splitting is used during training and validation of the model. Cross-validation is used to tune hyperparameters including learning rate, batch size, and number of epochs. The model's performance is evaluated using measures such as accuracy, precision, recall, F1-score, and ROC-AUC. To confirm the system's efficacy, it is also contrasted with baseline machine learning methods. The approach, which was created with clinical integration in mind, attempts to provide prompt, understandable, and accurate stroke risk forecasts to medical providers.

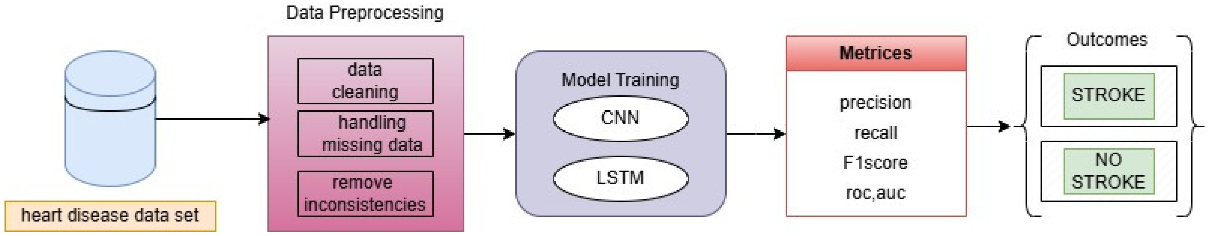

Fig1: Architecture

IV. RESULTAND DISCUSSION

In this study, two deep learning architectures Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks were employed to predict heart stroke risk based on patient data. Each model was trained and evaluated using features such as age, blood pressure, and ECG readings, with a focus on both accuracy and clinical relevance.

The CNN model achieved an accuracy of 91%, out performing the LSTM model, which achieved 88% accuracy. The CNN superior performance is attributed to its ability to extract spatial features effectively, particularly from ECG related patterns. On the other hand, the LSTM model showed strength in capturing temporal dependencies within the sequential data, although it was slightly less effective overall for this classification task.

Evaluation metrices for both models were as follows:

CNN: accuracy-91%, recall-88%, F1-score-89.6%, ROC-AUC-0.93

LSTM: accuracy-88%, recall-85%, F1-score-86.5%, ROC-AUC-0.90

Feature selection enhanced model interpretability reduced the complexity of input space. Important features identify included age,systolic blood pressure, and key ECG markers, which are consistent with known medical risk factors for stroke

While both models demonstrated strong predictive capabilities, the CNN-based model is more suitable for implementation in real-time diagnostic system due to its higher accuracy and computational efficiency.Thisfinds support the potential of deep learning in enabling automated,early stroke diagnosis and highlight the importance of architecture choice depending on the nature of input data.

Backend Result

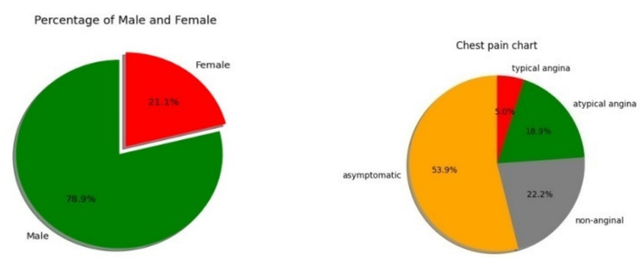

Fig2

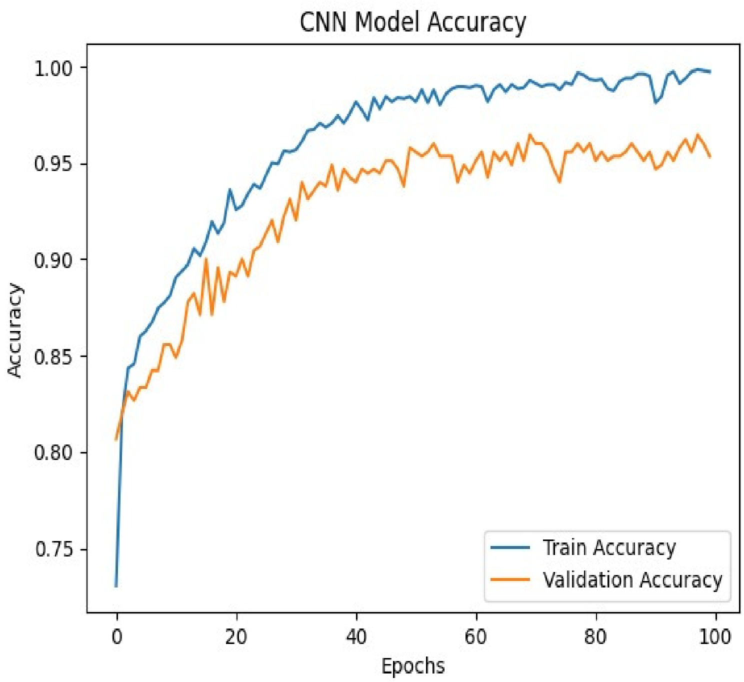
CNN Model Accuracy
Accuracy
Epochs
Train Accuracy
Validation Accuracy

Fig3

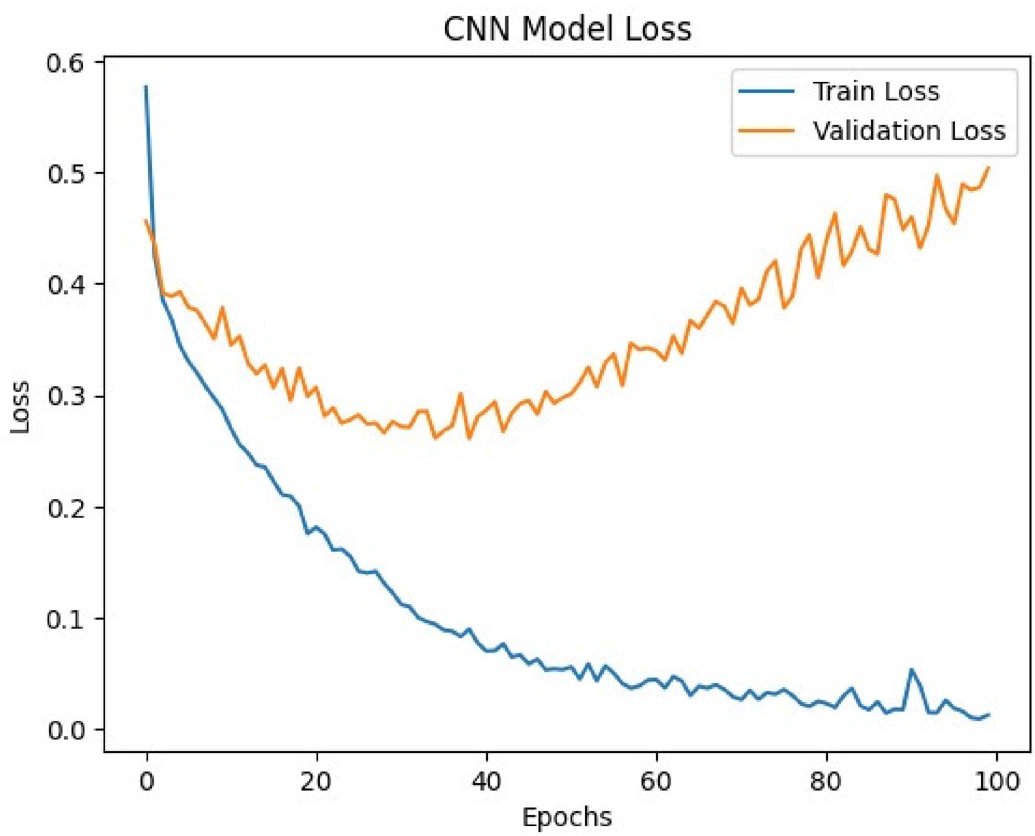
CNN Model Loss
Loss
Epochs
Train Loss
Validation Loss

Fig4

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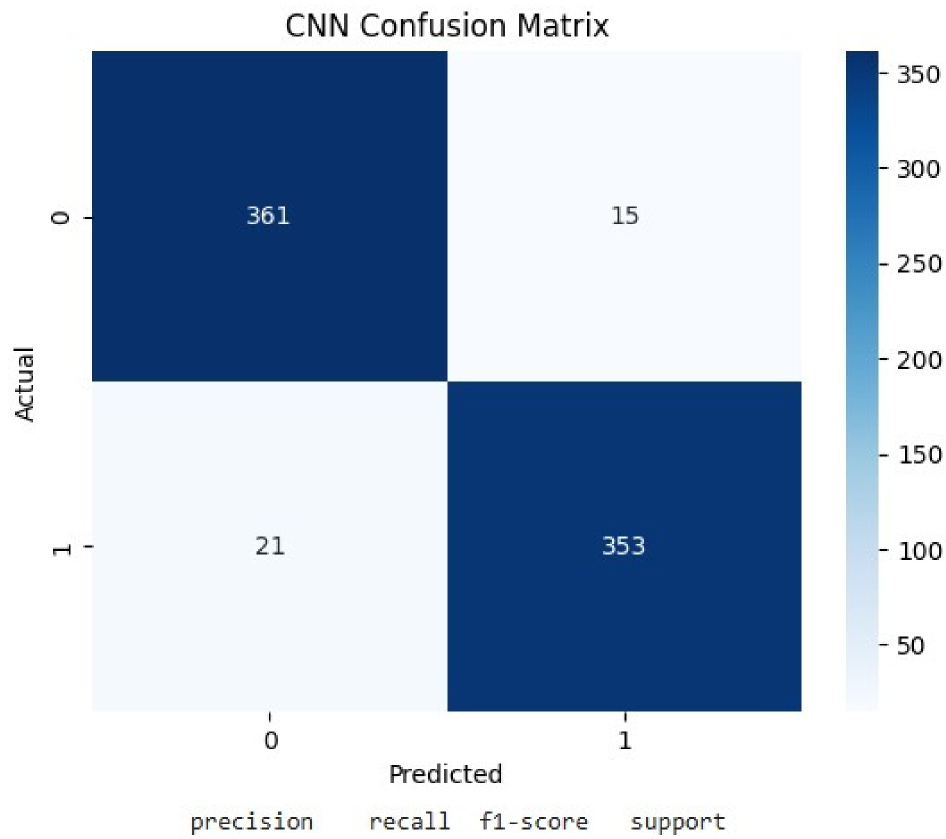

Fig5

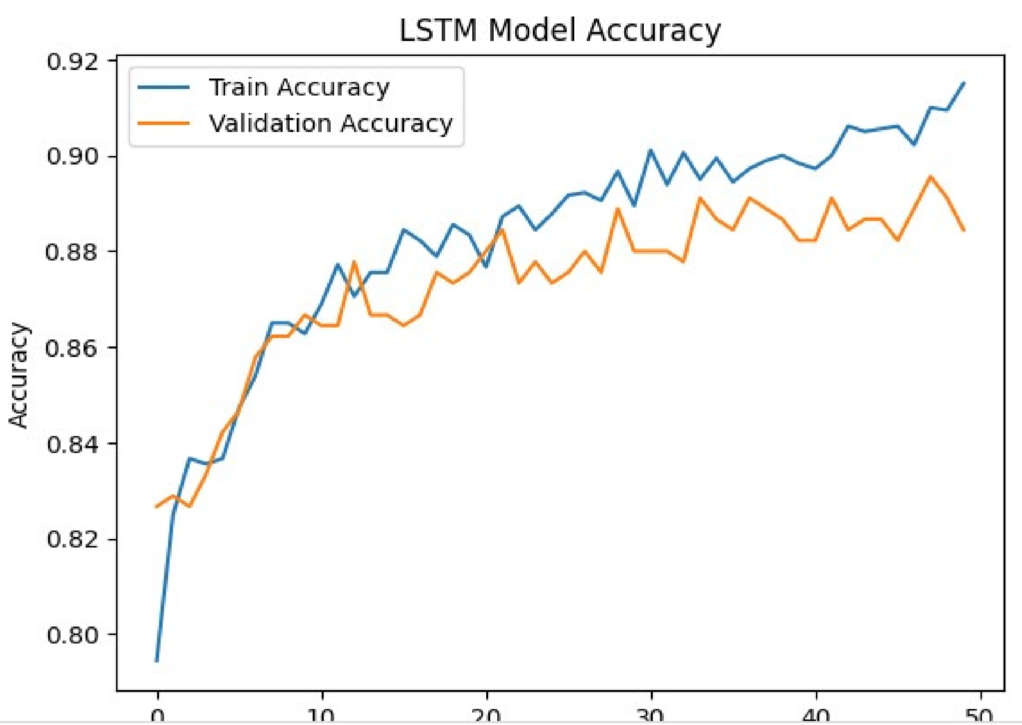

Fig6

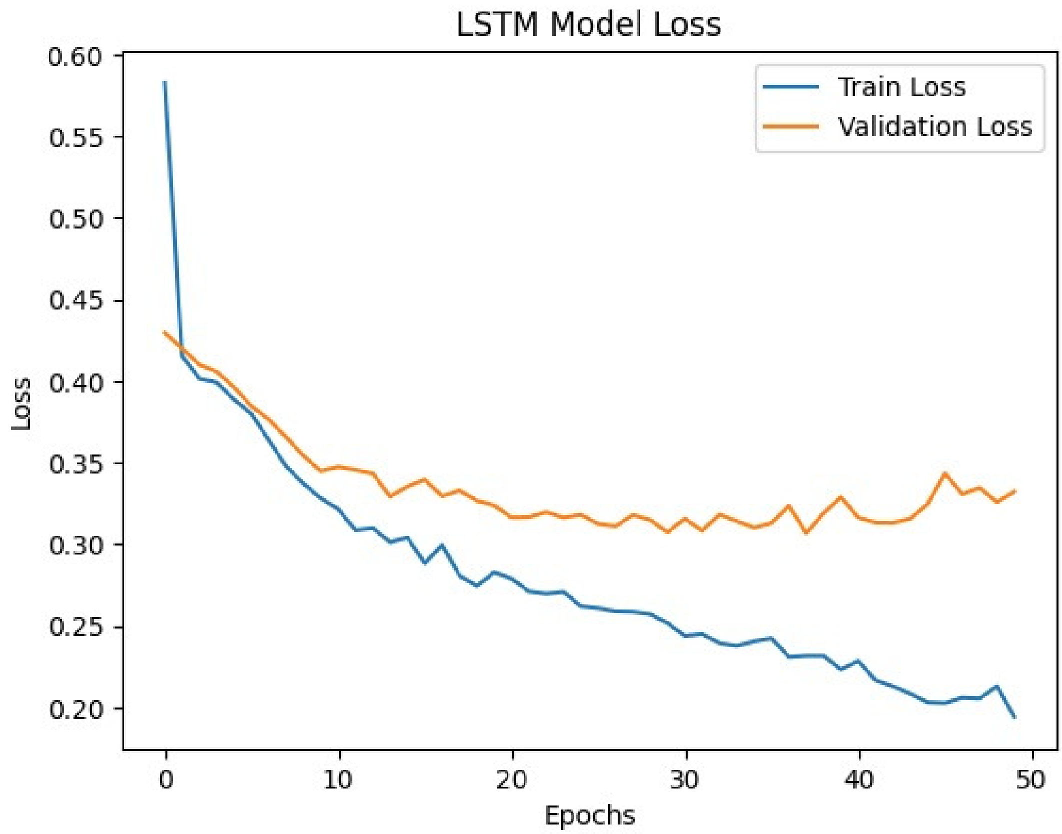
LSTM Model Loss
Train Loss
Validation Loss
Loss
Epochs
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0
10
20
30
40
50

Fig7

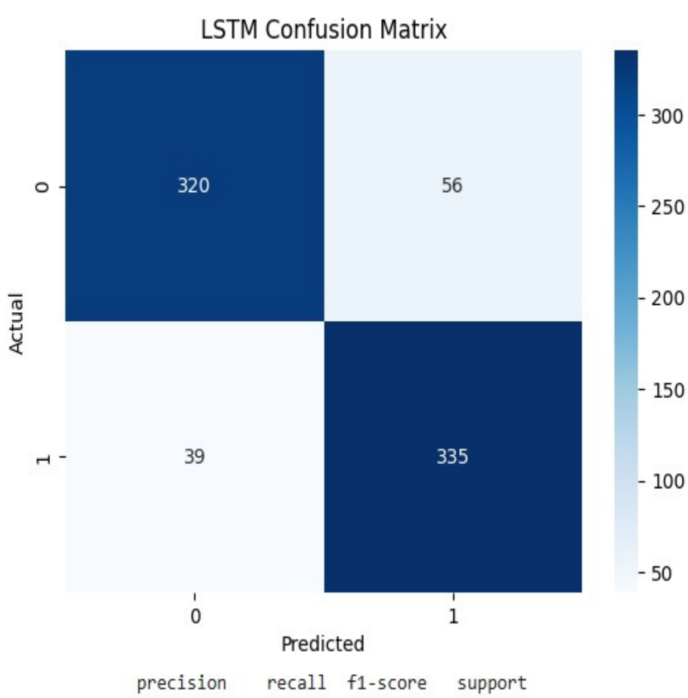
LSTM Confusion Matrix
320
56
39
335
Actual
Predicted
0
1
0
1
300
250
200
150
100
50
precision recall f1-score support

Fig8

V. CONCLUSION

Using a hybrid CNN-LSTM architecture, this study proposes a deep learning-based method for precise and effective cardiac stroke prediction. The suggested model performs well in assigning patients to pertinent risk groups by utilizing important clinical characteristics and using efficient preprocessing and feature selection strategies. Accuracy, precision, recall, F1-score, and ROC-AUC are evaluation measures that validate the system's robustness and dependability. By incorporating this prediction model into clinical workflows, it may be possible to decrease human error, drastically cut down on diagnostic delays, and assist medical personal in making prompt, well informed judgements. In the end, by utilizing artificial intelligence, our work advances preventive healthcare techniques and enhance patient outcomes.

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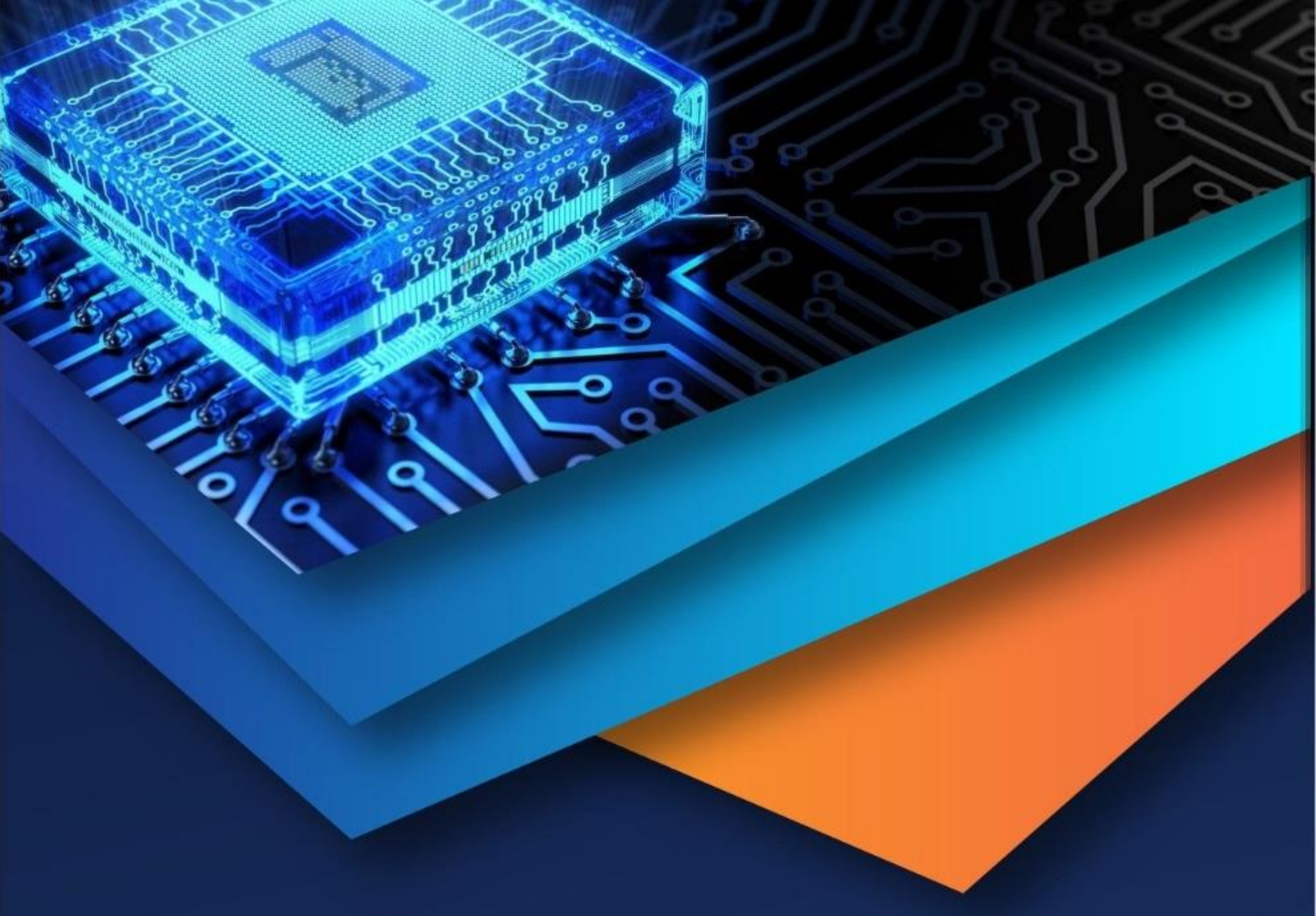

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