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HEART ATTACK RISK PREDICTION SYSTEM USING CNN-LSTM

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Abstract: Heart Attack is one of the leading causes of mortality worldwide and poses a significant challenge to modern healthcare systems. Early detection and accurate prediction of heart disease can help reduce complications, improve treatment outcomes, and save lives. With the rapid growth of medical data and advancements in artificial intelligence, machine learning and deep learning techniques have become effective tools for disease prediction. This paper presents a hybrid CNN-LSTM based Heart Attack Risk Prediction System that utilizes Convolutional Neural Networks (CNN) and a hybrid CNN-LSTM model for predicting the presence of heart disease. The dataset is pre-processed using data cleaning, normalization, scaling, and feature selection techniques to improve data quality and model performance. The proposed system is developed with a user-friendly interface that enables efficient data input and prediction analysis. Experimental results show that the hybrid CNN-LSTM model outperforms individual models by effectively learning feature relationships and dependencies among clinical attributes. The CNN model achieved an accuracy of 93.12%, whereas the CNN-LSTM model achieved a superior accuracy of 98.47%. The results demonstrate the effectiveness of the proposed approach in providing accurate and reliable heart disease prediction. The developed system can assist healthcare professionals in early diagnosis and decision-making, thereby contributing to improved patient care and preventive healthcare.

Keywords: Heart Disease Prediction, Deep Learning, CNN-LSTM, Machine Learning, Healthcare Analytics.

I. INTRODUCTION

Heart Attack is one of the leading causes of death worldwide, making early diagnosis and prediction essential for improving patient outcomes. Traditional diagnostic methods rely on clinical expertise, medical tests, and patient history, which can be time-consuming and may not always provide accurate results. With the increasing availability of healthcare data, intelligent prediction systems have become an important tool for supporting medical decision-making.

Machine Learning and Deep Learning techniques have shown significant potential in predicting heart disease by analysing clinical attributes such as age, blood pressure, cholesterol level, and chest pain type. Deep learning techniques such as Convolutional Neural Networks (CNN) and hybrid CNN-LSTM architectures can identify hidden patterns within medical datasets and improve prediction accuracy. However, individual models may not effectively capture all complex relationships present in healthcare data.

This paper presents a CNN-LSTM based Heart Attack Risk Prediction System. The dataset is pre-processed using normalization, scaling, and feature selection techniques to improve model performance. Experimental results show that the CNN-LSTM model achieves an accuracy of 98.47%, outperforming individual models and providing a reliable solution for early heart disease prediction and preventive healthcare.

II. OBJECTIVES

The primary objective of this study is to develop an accurate and reliable Heart Attack Risk Prediction System using machine learning and deep learning techniques. The system aims to analyse patient health data and predict the presence of heart disease at an early stage, thereby supporting healthcare professionals in making informed decisions. To achieve this, the study implements and compares CNN and hybrid CNN-LSTM models. The dataset is pre-processed using normalization, scaling, and feature selection techniques to improve prediction performance and reduce data complexity. The proposed system also focuses on providing a user-friendly interface for efficient data input and prediction analysis. Ultimately, the research seeks to enhance prediction accuracy, support early diagnosis, and contribute to improved patient care and preventive healthcare.

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III. LITERATURE REVIEW

Traditional machine learning algorithms such as Logistic Regression, SVM, KNN, Naïve Bayes, and Random Forest have been widely used for heart disease prediction. Studies by Ahmad et al. (2023) and Singh et al. (2024) reported accuracies ranging from 91% to 95%, demonstrating the effectiveness of these models for disease classification.

Several researchers improved prediction performance through feature engineering and optimization techniques. Bouqentar et al. (2024) applied feature selection methods, while Chandrasekhar et al. (2023) used GridSearch-CV to optimize XGBoost and AdaBoost models, achieving accuracies up to 95%. Teja et al. (2025) implemented automated machine learning pipelines for model selection and diagnosis.

Ensemble learning approaches have also shown promising results. Tiwari et al. (2022) proposed a stacked ensemble model combining Extra Trees, Random Forest, and XGBoost, while Uddin et al. (2023) and Bharti et al. (2021) employed ensemble-based classifiers to improve prediction accuracy and model stability.

Recent studies focused on interpretability and real-world applications. El-Sofany et al. (2024) integrated Explainable AI techniques with machine learning and achieved 97.57% accuracy, whereas Alshraideh et al. (2024) evaluated machine learning models on hospital datasets and reported reliable prediction performance.

Deep learning and hybrid models have gained significant attention for heart disease prediction. Al-Alshaikh et al. (2024) utilized CNN-based ensemble models for feature extraction, while other studies highlighted the advantages of combining multiple learning approaches. Motivated by these findings, the proposed work adopts a hybrid CNN-LSTM model to improve prediction accuracy and provide a reliable heart disease prediction system.

IV. EXISTING SYSTEM

Existing heart disease prediction systems mainly rely on traditional diagnostic methods and machine learning algorithms such as Logistic Regression, Decision Trees, Support Vector Machines (SVM), K-Nearest Neighbour (KNN), and Random Forest. These approaches use patient medical data to predict the presence of heart disease and have shown moderate to good prediction accuracy.

Although these models improve diagnosis compared to manual analysis, they often struggle to capture complex and nonlinear relationships among clinical features. Many existing systems also depend on single-model approaches, which may limit prediction accuracy and generalization across different datasets. In addition, inadequate preprocessing and feature selection can negatively affect model performance.

Furthermore, several existing systems lack user-friendly interfaces and advanced deep learning capabilities. Traditional machine learning models may not effectively capture complex relationships and dependencies among clinical attributes. Therefore, there is a need for a more accurate and intelligent prediction system that combines advanced deep learning techniques with effective data preprocessing for improved heart disease prediction.

V. PROPOSED SYSTEM

The proposed Heart Attack Risk Prediction System is designed to provide accurate and reliable prediction of heart disease using machine learning and deep learning techniques. The system analyses patient medical information such as age, blood pressure, cholesterol level, chest pain type, fasting blood sugar, and other clinical attributes to determine the risk of heart disease. Data is collected from the Cleveland Heart Disease Dataset and undergoes preprocessing operations including data cleaning, normalization, scaling, and feature selection to improve data quality and model efficiency.

The system implements CNN and a hybrid CNN-LSTM model for heart disease prediction. The CNN model is used to extract significant features from the dataset, while the LSTM model learns the relationships and dependencies among medical attributes. By combining both techniques, the hybrid CNN-LSTM model effectively captures complex patterns in the data and improves prediction accuracy. The system also includes modules for user authentication, patient registration, data management, prediction, and result visualization.

The proposed approach provides a user-friendly platform that assists healthcare professionals in making informed decisions. Experimental results indicate that the hybrid CNN-LSTM model achieves an accuracy of 98.47%,

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outperforming individual models and reducing prediction errors. Therefore, the proposed system offers an efficient, accurate, and intelligent solution for early heart disease detection and preventive healthcare management.

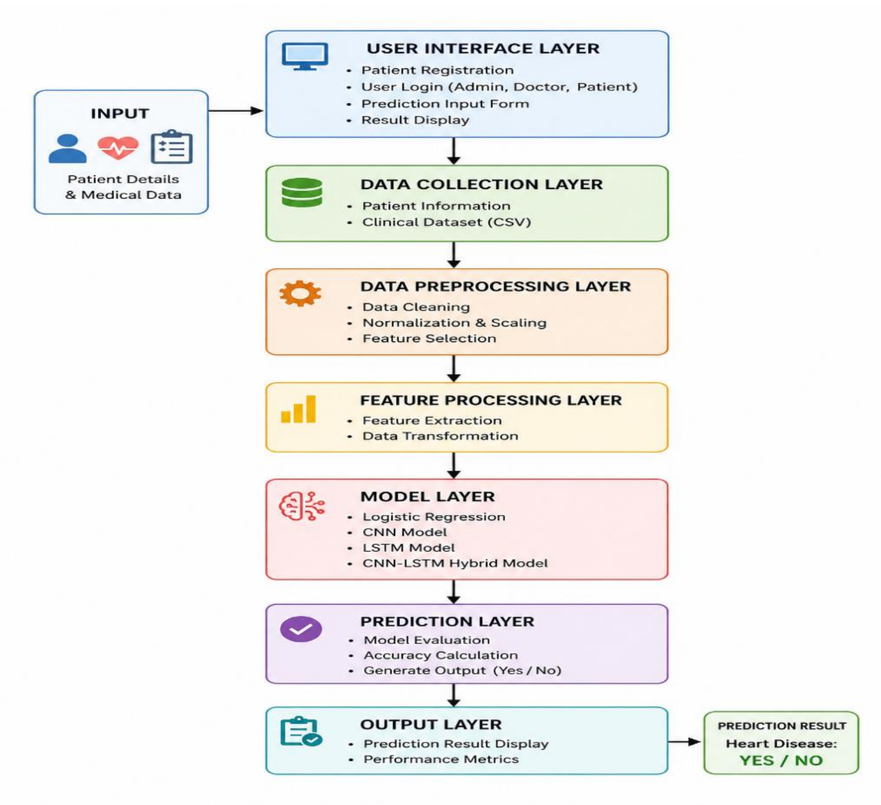

Fig 1: Architecture of the Proposed System

CNN-LSTM Model

The CNN-LSTM model is a hybrid deep learning architecture that combines the strengths of Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks for heart disease prediction. The CNN component automatically extracts important features and patterns from the input medical data, while the LSTM component learns the dependencies among extracted clinical features. By integrating both models, the CNN-LSTM architecture effectively captures complex data characteristics, resulting in improved prediction accuracy and reduced classification errors. In the proposed system, the CNN-LSTM model achieved the highest accuracy of 98.47%, demonstrating its effectiveness and reliability for early heart disease diagnosis and healthcare decision-making.

Clinical Features Used for Heart Disease Prediction

The proposed heart disease prediction system utilizes several important clinical features obtained from patient medical records to assess the risk of heart disease. These features include age, gender, chest pain type, resting blood pressure, cholesterol level, fasting blood sugar, resting electrocardiographic (ECG) results, maximum heart rate achieved, exercise-induced angina, ST depression, number of major vessels, and thalassemia. These attributes provide valuable information about a patient's cardiovascular health and are used as input to the CNN-LSTM model. By analysing the relationships among these clinical features, the proposed system can accurately predict the presence or absence of heart disease and support early diagnosis and effective healthcare decision-making.

VI. IMPLEMENTATION

Phase 1: Data Collection

In this phase, the Cleveland Heart Disease Dataset is collected and the required clinical attributes are gathered for prediction analysis.

Phase 2: Data Preprocessing

The collected data is cleaned and processed by handling missing values, applying normalization, scaling, and standardization techniques to improve data quality.

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Phase 3: Feature Selection
The most significant clinical features are identified using feature selection techniques to reduce data complexity and improve model performance.

Phase 4: Model Development
CNN and CNN-LSTM models are developed and configured for heart disease prediction.

Phase 5: Model Training and Testing
The processed dataset is divided into training and testing sets, and the models are trained and evaluated using the prepared data.

Phase 6: Performance Evaluation
The performance of each model is assessed using evaluation metrics such as accuracy, precision, recall, F1-score, and confusion matrix analysis.

Phase 7: Prediction and Result Generation
The trained model analyses new patient data and predicts whether heart disease is present or absent, generating the final prediction result.

Phase 8: User Interface Implementation
A user-friendly interface is developed to facilitate patient registration, data entry, prediction analysis, and result visualization.

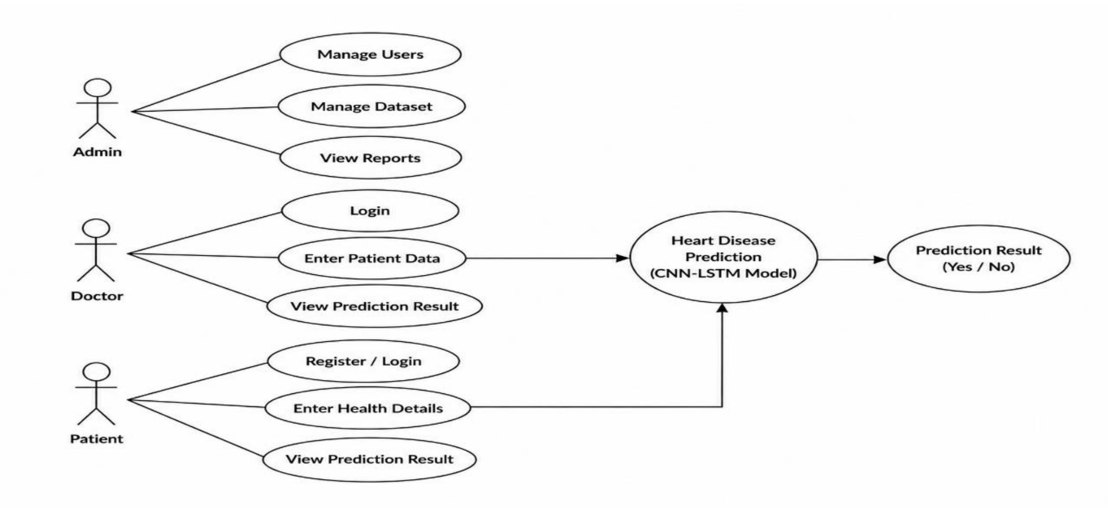

Fig 2: Use case Diagram

VII. RESULTS

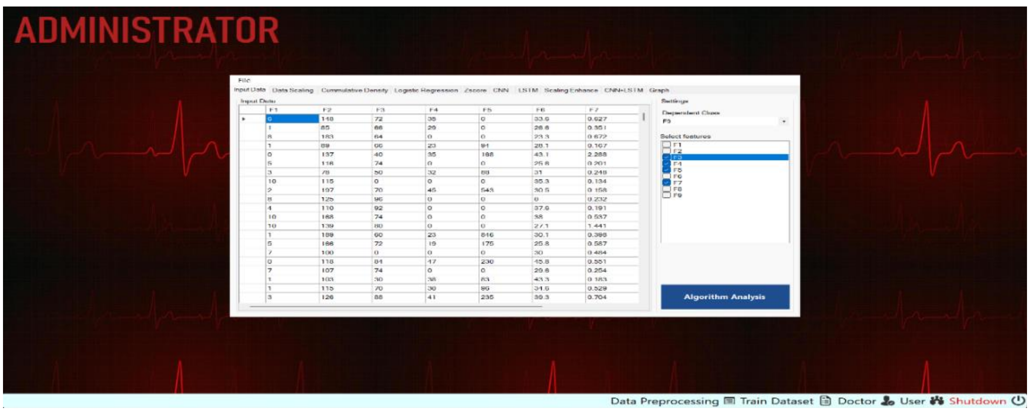

Fig 3: preprocessing

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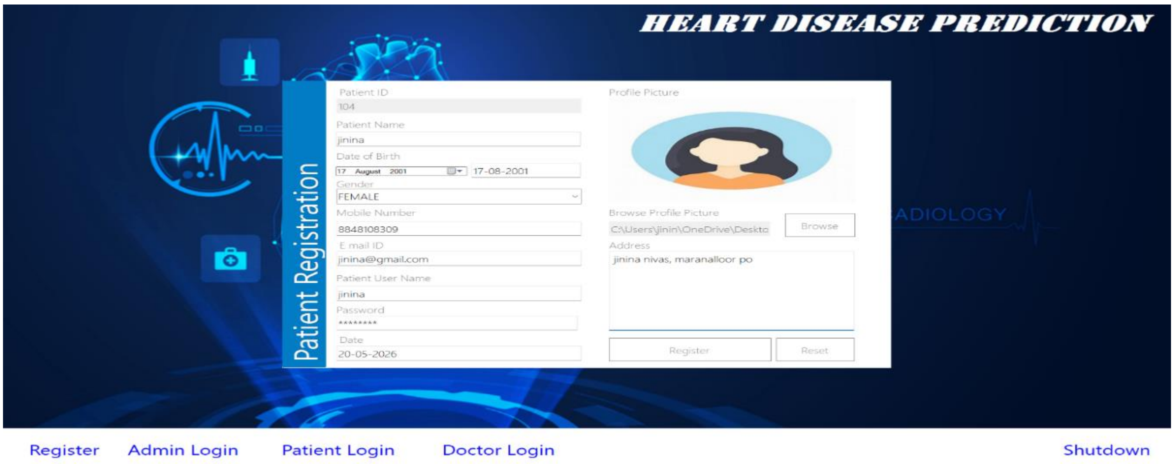

Fig 4: patient registration

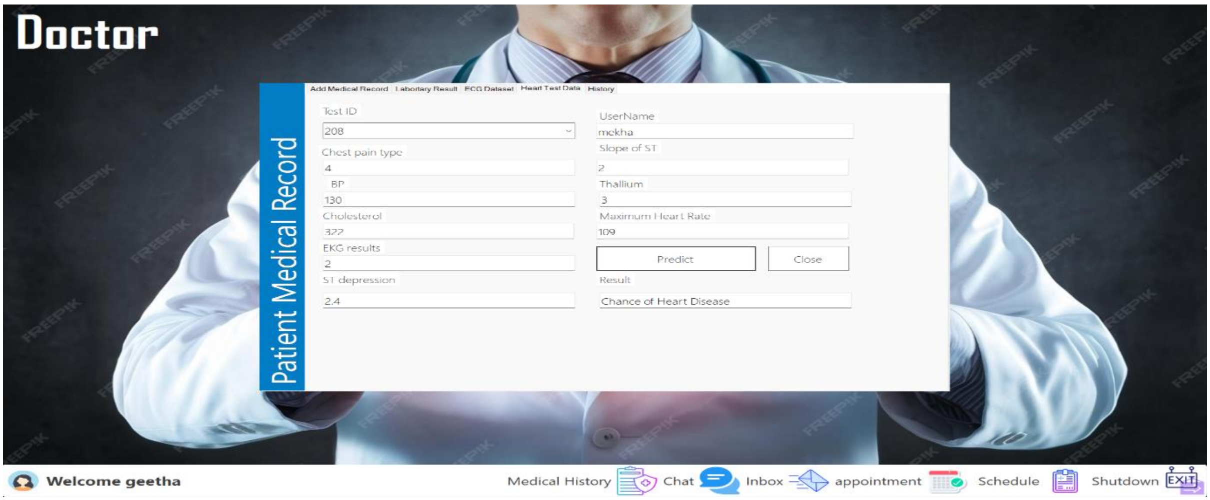

Fig 5: detection and result

Model	Accuracy	Precision	Recall	F1-Score
CNN	93.12%	93%	93.1%	93%
CNN + LSTM	98.47%	98.4%	98.5%	98.4%

Table 1: Result Analysis

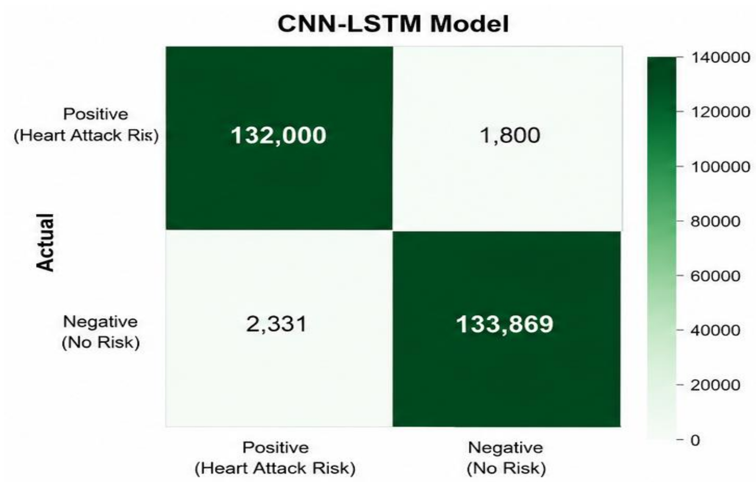

Fig 6: Confusion metrics

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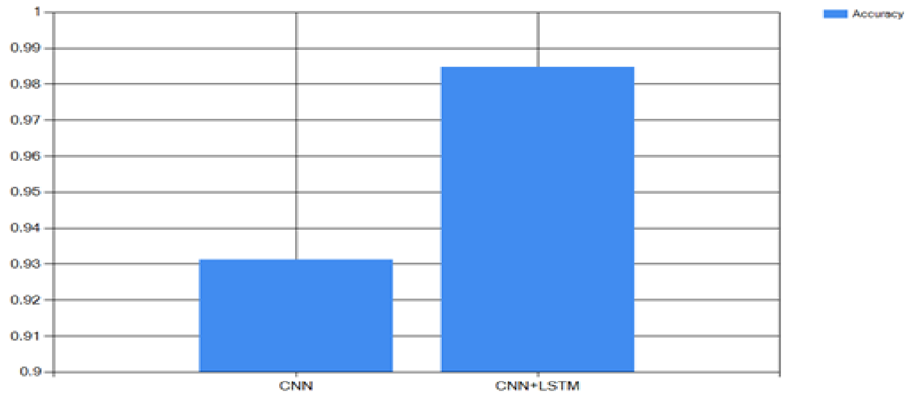

Fig 7: Accuracy Comparison

The graphical representation clearly shows that the CNN+LSTM model outperformed the CNN model in all performance metrics. The hybrid model achieved higher accuracy, precision, recall, and F1-score due to its capability to learn complex feature interactions and dependencies among clinical attributes. The feature selection process further enhanced performance by eliminating irrelevant attributes and reducing execution time. The experimental analysis confirms that the proposed CNN+LSTM-based heart disease prediction system is highly accurate, efficient, and reliable for intelligent healthcare applications.

VIII. CONCLUSION

The proposed Heart Attack Risk Prediction System successfully demonstrates the effective use of machine learning and deep learning techniques for early detection of heart disease. The system integrates CNN and a hybrid CNN-LSTM model to analyse patient clinical data and provide accurate predictions. Data preprocessing techniques such as normalization, scaling, and feature selection significantly improve the quality of input data and enhance model performance. Experimental results show that the CNN-LSTM model achieves the highest accuracy of 98.47%, outperforming other models in terms of prediction reliability. The system also provides a user-friendly interface for easy interaction and result visualization. Overall, the proposed approach proves to be an efficient and accurate solution for heart disease prediction, which can assist healthcare professionals in early diagnosis and support better medical decision-making.

IX. FUTURE SCOPE

The proposed Heart Attack Risk Prediction System can be further enhanced by integrating real-time data from wearable devices and Internet of Things (IoT)-based health monitoring systems to enable continuous patient monitoring. The system can also be extended into a mobile or web application to improve accessibility for patients and healthcare professionals. Future improvements may include the use of more advanced deep learning architectures, hyperparameter tuning, and Explainable Artificial Intelligence (XAI) techniques to increase model transparency and interpretability. Additionally, incorporating larger and more diverse datasets along with multi-class risk prediction (low, medium, and high risk) can further improve the accuracy and practical applicability of the system in real-world healthcare environments.

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