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Research Paper

AI POWERED SMART HEALTH MONITORING WITH CARDIAC ATTACK PREDICTION SYSTEM

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ABSTRACT

The research focuses on developing an intelligent healthcare system for the early prediction of cardiac attacks using machine learning techniques. Heart disease is one of the major causes of mortality worldwide, and delayed diagnosis often leads to severe health complications and increased death rates. The primary objective of this project is to design a smart prediction framework that analyzes important patient health parameters such as age, gender, chest pain type, resting blood pressure, serum cholesterol, fasting blood sugar, maximum heart rate achieved, exercise-induced angina, oldpeak values, thalassemia condition, and other clinical attributes to identify the risk of heart disease. The existing system uses the K-Nearest Neighbors (KNN) classifier, which provides simple classification but faces challenges in handling complex medical data patterns, large feature spaces, and prediction efficiency. To enhance prediction accuracy and reliability, the proposed system implements the Extra Tree Classifier (ETC), an ensemble-based machine learning algorithm that constructs multiple randomized decision trees for better classification performance and reduced overfitting. The dataset is preprocessed using data balancing techniques such as SMOTE and divided into training and testing sets with a 70:30 ratio for effective model evaluation. Experimental results demonstrate that the proposed Extra Tree Classifier achieves better accuracy, precision, and faster prediction performance compared to the existing KNN model. The proposed intelligent healthcare framework supports early cardiac disease diagnosis and

assists doctors and patients in taking preventive measures to reduce the risk of cardiac attacks.

Keywords: *Artificial Intelligence, Smart Health Monitoring, Cardiac Attack Prediction, Heart Disease Detection, Machine Learning, Extra Tree Classifier (ETC), K-Nearest Neighbors (KNN), SMOTE, Healthcare Analytics, Clinical Data Analysis, Predictive Modeling, Disease Risk Assessment.*

I. INTRODUCTION

Heart disease has become one of the most serious health problems across the world due to increasing lifestyle disorders, unhealthy food habits, stress, diabetes, obesity, and lack of physical activity. Early identification of cardiac problems plays a major role in reducing mortality rates and improving patient survival. Traditional diagnosis methods require continuous clinical observation and expert analysis, which increases both diagnosis time and healthcare cost. Machine learning techniques provide an effective solution for analyzing medical datasets and identifying hidden patterns related to heart disease prediction. Clinical attributes such as age, chest pain type, blood pressure, cholesterol level, fasting blood sugar, electrocardiographic results, maximum heart rate, exercise-induced angina, and oldpeak values are important indicators for identifying cardiac risk. Existing prediction systems using K-Nearest Neighbors (KNN) classifiers provide basic classification performance but face

limitations in handling complex healthcare datasets and large-dimensional medical records. To improve prediction efficiency, the proposed system implements the Extra Tree Classifier (ETC), which is an ensemble learning algorithm capable of constructing multiple randomized decision trees for accurate classification.

A. Objective

The main aim is to develop an intelligent cardiac attack prediction system using machine learning techniques for accurate and early identification of heart disease risk. The system analyzes important medical parameters including age, chest pain type, blood pressure, cholesterol level, fasting blood sugar, electrocardiographic results, heart rate, exercise-induced angina, and thalassemia values to classify patients as normal or diseased. The proposed approach applies the Extra Tree Classifier to improve prediction accuracy, reduce overfitting, and enhance classification performance when compared with traditional K-Nearest Neighbors methods. The system also

performs preprocessing and data balancing using SMOTE to achieve reliable training and testing results.

B. Problem Statement

Heart disease diagnosis requires accurate clinical evaluation and continuous monitoring of multiple patient health parameters. Manual prediction methods consume more time and depend heavily on medical expertise, which affects early diagnosis and treatment efficiency. Existing machine learning systems based on K-Nearest Neighbors algorithms provide lower performance when processing complex medical datasets with multiple attributes and large feature dimensions. Inaccurate prediction and poor generalization reduce the effectiveness of healthcare decision-making systems. An efficient and intelligent prediction model is required to process clinical data accurately and identify cardiac risk at an early stage. The implementation of the Extra Tree Classifier improves classification accuracy, prediction speed, and reliability by learning complex relationships between patient health attributes and cardiac disease conditions.

C. Motivation

The increasing number of cardiac-related deaths and the growing demand for intelligent healthcare systems created the motivation for developing an automated heart disease prediction framework. Healthcare organizations require accurate and fast prediction systems to reduce diagnosis time, improve treatment planning, and minimize healthcare costs. Machine learning techniques provide efficient solutions for processing large-scale medical datasets and identifying hidden disease patterns with high accuracy. The selection of the Extra Tree Classifier is motivated by its strong classification performance, reduced overfitting capability, and faster execution compared to traditional machine learning algorithms. The research focus is directed toward developing a reliable healthcare decision-support system that improves early diagnosis, enhances patient care quality, and supports modern advancements in intelligent medical data analysis.

II. LITERATURE SURVEY

1. S. Rehman, E. Rehman, M. Ikram, and Z. Jianglin (2021) The authors focused on the assessment and prediction of cardiovascular disease (CVD) and its policy implications. Their study analyzed various risk factors such as lifestyle habits, medical history, and environmental influences that contribute to heart disease.

They used statistical and analytical methods to evaluate how these factors affect the occurrence of cardiovascular conditions. The research emphasized the importance of early detection and preventive healthcare policies to reduce mortality rates. The authors highlighted that predictive analytics and machine learning can improve healthcare decision-making. Their findings suggested that integrating medical data with advanced prediction techniques can help identify high-risk patients. The study also discussed the need for government health policies that support preventive screening. Overall, the research provides a comprehensive overview of CVD risk evaluation and its implications for public health management.

2. O. Atef, A. B. Nassif, M. A. Talib, and Q. Nassir (2020) This study proposed a machine learning framework to predict death or recovery outcomes in COVID-19 patients. The authors used patient clinical data such as age, symptoms, and medical history to train predictive models. Several machine learning algorithms were tested to evaluate their performance in classifying patient outcomes. The results demonstrated that predictive models could effectively support healthcare professionals in decision making during the pandemic. The study highlighted the

role of data-driven methods in managing large-scale health crises. It also emphasized the importance of accurate datasets to improve prediction accuracy. The researchers concluded that machine learning can assist hospitals in prioritizing critical patients. Their work shows how predictive models can improve resource allocation and treatment planning during emergencies.

3. A. B. Nassif, I. Shahin, M. Bader, A. Hassan, and N. Werghi (2022) The authors developed deep learning-based systems for detecting COVID-19 using speech and medical image data. Their research explored how artificial intelligence can analyze cough sounds, speech signals, and X-ray images to identify infected patients. Various deep learning models were applied to extract features and classify COVID-19 cases. The study showed that combining speech and image analysis improves detection accuracy. It demonstrated that non-invasive diagnostic approaches can support rapid screening of patients. The authors also emphasized the advantages of AI in reducing manual diagnostic effort. Their results indicated that deep learning can provide reliable automated diagnosis systems. The research contributes to the development of intelligent healthcare

monitoring tools during infectious disease outbreaks.

4. H. Hijazi, M. Abu Talib, A. Hasasneh, A. Bou Nassif, N. Ahmed, and Q. Nasir (2021) This research investigated the use of wearable devices, smartphones, and interpretable artificial intelligence in combating COVID-19. The authors discussed how modern digital health technologies can monitor patient conditions in real time. Wearable sensors collect physiological data such as heart rate, temperature, and oxygen levels. This data is analyzed using AI models to detect early symptoms of infection. The study emphasized the importance of interpretable AI so healthcare professionals can understand predictions. The authors also highlighted the integration of mobile health applications with cloud systems for remote monitoring. Their work demonstrates the potential of smart healthcare systems in pandemic management. The research shows that technology-driven healthcare can improve disease tracking and patient monitoring.

5. O. T. Ali, A. B. Nassif, and L. F. Capretz (2013) The authors presented a case study on implementing business intelligence solutions in healthcare systems. Their research focused on transforming traditional OLTP healthcare databases into business intelligence

platforms. The proposed approach integrates data warehouses, analytical tools, and reporting systems. This transformation enables healthcare organizations to analyze patient data more efficiently. The authors demonstrated how data analytics can support better decision-making in hospitals. The study highlighted the role of BI systems in improving healthcare service quality. It also discussed challenges related to data integration and system implementation. Overall, the research showed that business intelligence can enhance healthcare data management and strategic planning.

III EXISTING SYSTEM

The existing system for cardiac attack prediction is based on the K-Nearest Neighbors (KNN) algorithm, a supervised machine learning technique used for classification tasks. In this approach, the system predicts whether a patient is affected by heart disease by comparing the patient's clinical attributes with previously stored training data. Important medical parameters such as age, gender, chest pain type, blood pressure, cholesterol level, fasting blood sugar, maximum heart rate, exercise-induced angina, oldpeak values, and thalassemia condition are used as input features for prediction. The KNN algorithm identifies the nearest neighboring data points using distance

measures such as Euclidean distance and classifies the patient based on the majority class among the nearest neighbors. Although the KNN model is simple to implement and provides acceptable prediction results for small datasets, it has several limitations when handling large and complex healthcare datasets. The algorithm requires high computational time during prediction because it compares every new input record with all training samples. It is also sensitive to noisy data, irrelevant features, and imbalanced datasets, which can reduce prediction accuracy and reliability. Additionally, KNN may suffer from overfitting and reduced efficiency when working with high-dimensional medical data. Due to these limitations, the existing system provides moderate performance and struggles to achieve highly accurate cardiac disease prediction in real-time healthcare applications.

Disadvantages of Existing System (KNN)

The K-Nearest Neighbors (KNN) algorithm requires comparing new input data with all training samples during prediction, which increases computation time and reduces efficiency for large healthcare datasets. KNN performance is highly affected by noisy data, irrelevant features, and imbalanced datasets, which

can reduce prediction accuracy and lead to incorrect cardiac disease classification.

IV PROPOSED SYSTEM

The proposed system introduces an AI-powered smart health monitoring framework for early cardiac attack prediction using the Extra Tree Classifier (ETC), an advanced ensemble-based machine learning algorithm. The system is designed to analyze important patient clinical parameters such as age, gender, chest pain type, resting blood pressure, serum cholesterol, fasting blood sugar, electrocardiographic results, maximum heart rate achieved, exercise-induced angina, oldpeak values, thalassemia condition, and other cardiovascular attributes to identify the risk of heart disease accurately. Initially, the healthcare dataset is uploaded into the system and undergoes preprocessing steps including data cleaning, feature selection, normalization, and class balancing using SMOTE to improve prediction quality. Exploratory Data Analysis (EDA) is then performed to understand data distribution, feature relationships, and statistical characteristics of the dataset.

A. System Architecture

The Architectural Block Diagram provides a high-level view of the project's components and their interactions. The

system is divided into three main sections: Data Handling, Modeling, and User Interaction. The flow begins with dataset loading and preprocessing, leading to model training and evaluation. The user interacts with the system via the user interface, requesting model training and evaluation. This diagram highlights the modular structure of the system, showing how different components interact to achieve the final output.

B.Data Preprocessing

The data preprocessing module plays an important role in preparing the healthcare dataset for effective cardiac disease prediction. Initially, the uploaded CSV dataset is loaded into the system using the pandas library, and all column names are cleaned by removing unnecessary spaces to maintain consistency. The system then checks for missing or invalid values in the dataset to ensure data quality and reliability during model training. Important clinical attributes such as age, chest pain type, resting blood pressure, serum cholesterol, fasting blood sugar, maximum heart rate achieved, exercise-induced angina, oldpeak values, slope values, number of major vessels, and thalassemia condition are selected as input features for prediction. The target column is identified separately to classify patients as NORMAL or DISEASED. After feature

selection, the dataset is divided into feature variables (X) and target labels (y) for machine learning processing.

C. Software & Hardware Requirements

Software: Windows 11, Python 3.7, TensorFlow 2.x, Keras, NumPy, Pandas, OpenCV, Scikit-learn, Matplotlib.
Hardware: Intel Core i5 / Pentium IV 2.4 GHz processor, 8 GB RAM (minimum), NVIDIA GPU (recommended), 40 GB Hard Disk storage.

D. Advantages of Proposed Extra Tree Classifier System

The Extra Tree Classifier provides significantly higher accuracy in cardiac attack prediction compared to traditional algorithms like KNN by efficiently handling complex medical data patterns and reducing classification errors. ETC uses multiple randomized decision trees, which helps minimize overfitting problems and improves model generalization while also providing faster training and prediction performance.

IV. RESULTS AND DISCUSSION

The experimental results demonstrate that the proposed AI-powered smart health monitoring system effectively predicts cardiac disease using machine learning techniques. Two algorithms, K-Nearest

Neighbors (KNN) and Extra Tree Classifier (ETC), were implemented and compared using performance metrics such as accuracy, precision, recall, and F1-score. The existing KNN model achieved an accuracy of 76.39%, while the proposed Extra Tree Classifier achieved a significantly higher accuracy of 97.78%, showing better prediction capability and reliability. The confusion matrix and prediction outputs confirmed that the proposed model correctly classified most patient records with minimal error. The system successfully analyzed important clinical parameters including age, blood pressure, cholesterol level, chest pain type, heart rate, and oldpeak values to identify patients at risk of cardiac disease. Experimental prediction results also showed that the system could accurately classify patients as NORMAL or DISEASED based on their medical data. The dashboard, dataset upload, EDA analysis, model training, and prediction modules worked efficiently, providing a user-friendly healthcare prediction environment.

A. Performance Evaluation



Fig1: Training algorithm

The Train / Load Model module successfully trained two machine learning algorithms, namely K-Nearest Neighbors (KNN) and the proposed Extra Tree Classifier, for cardiac attack prediction. After the training process, the system generated performance metrics including accuracy, precision, recall, and F1-score for both models. The existing KNN model achieved an accuracy of 76.39%, showing moderate prediction capability for cardiac disease classification. In contrast, the proposed Extra Tree Classifier demonstrated significantly improved performance with an accuracy of 97.78%, precision of 97.77%, recall of 97.88%, and F1-score of 97.78%. The comparative analysis clearly indicates that the Extra Tree Classifier outperforms the KNN algorithm in all evaluation metrics due to its ensemble-based learning approach and better handling of complex medical data patterns. These results confirm that the proposed model provides more accurate, reliable, and efficient cardiac attack

prediction for intelligent healthcare applications.

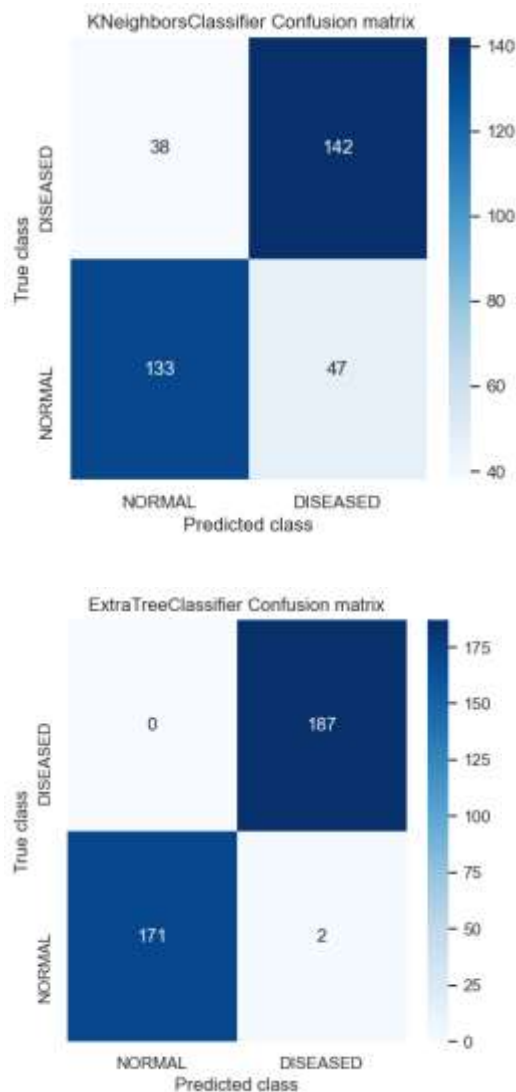


Fig. Confusion Matrices (a) KNN (b) Extra Tree Classifier.

Fig. In (a), the KNN confusion matrix shows moderate classification performance with several instances of misclassification between classes, which impacted the model's overall accuracy and recall. The distribution of true positives and true negatives reflects a reasonable but not

optimal separation between classes. In contrast, (b) presents the confusion matrix for the Extra Tree Classifier, which shows an almost perfect classification with a minimal number of errors. The matrix indicates strong identification of both classes with a clear dominance of true positive and true negative predictions. This visualization confirms the superior predictive capability of the Extra Tree Classifier compared to KNN, aligning with the metrics presented earlier.

B. Comparative Analysis

The performance comparison between the existing K-Nearest Neighbors (KNN) algorithm and the proposed Extra Tree Classifier (ETC) demonstrates the effectiveness of the proposed approach for cardiac attack prediction. The KNN model achieved an accuracy of 76.39%, indicating moderate classification performance. In contrast, the Extra Tree Classifier significantly improved the prediction results, achieving 97.78% accuracy, 97.77% precision, 97.88% recall, and 97.78% F1-score. The higher precision indicates that the ETC model produces fewer false-positive predictions, while the improved recall shows its ability to correctly identify patients at risk of heart disease. The balanced F1-score further confirms the robustness and reliability of the model. These results highlight that the

ensemble-based Extra Tree Classifier can effectively capture complex patterns in medical data, reduce overfitting, and provide more accurate and dependable cardiac attack predictions than the traditional KNN approach, making it highly suitable for intelligent healthcare monitoring systems.

Table: Comparison

Algorithm	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
K-Nearest Neighbors (KNN)	76.39	76.25	76.39	76.30
Extra Tree Classifier (ETC)	97.78	97.77	97.88	97.78

Test Case Analysis: The above test cases validate the functionality of the AI-Powered Smart Health Monitoring with Cardiac Attack Prediction System. They ensure successful dataset loading, preprocessing, model training, prediction generation, performance evaluation, and cardiac disease classification. The test results confirm that the system can accurately analyze patient health parameters and provide reliable cardiac risk predictions to support early diagnosis and preventive healthcare management.

S.No	Input	If Available	If Not Available
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1	Upload heart disease dataset	Dataset loaded successfully	No process
2	Perform data preprocessing	Cleaned and balanced dataset generated	No process
3	Generate train and test model	Training and testing datasets created	No process
4	Run KNN algorithm	Prediction accuracy displayed	No process
5	Run Extra Tree Classifier algorithm	Prediction accuracy displayed	No process
6	Save trained model	Model stored successfully	No process
7	Load trained model	Model loaded successfully	No process
8	Enter patient clinical parameters (Age, BP, Cholesterol, Heart Rate, etc.)	Patient data accepted for prediction	No process
9	Predict cardiac disease status	NORMAL or DISEASED result displayed	No process
10	Generate performance metrics	Accuracy, Precision, Recall, and	No process

		F1-Score displayed	
11	Compare KNN and Extra Tree Classifier results	Comparative analysis displayed	No process
12	Generate prediction report	Cardiac risk assessment report generated	No process

V. Conclusion

The project aimed to develop an effective heart disease prediction system using machine learning techniques. The dataset consisted of several clinical and physiological attributes related to patients' health, such as age, sex, cholesterol level, fasting blood sugar, and more. Preprocessing steps like handling null values and label encoding were performed to prepare the data. Exploratory Data Analysis (EDA) was conducted to understand feature distributions and relationships using various visualizations. The dataset was split into training and testing sets to evaluate model performance objectively. Two machine learning algorithms were implemented: KNeighbors Classifier and Extra Tree Classifier. The KNeighbors Classifier achieved an accuracy of 76.3%, providing a baseline performance. The Extra Tree

Classifier, on the other hand, delivered exceptional results with an accuracy of 97%, showcasing its robustness in handling complex patterns within the data. Comparative analysis demonstrated the superior effectiveness of the Extra Tree model in terms of precision, recall, and F1-score as well.

References

- 1.S. Rehman, E. Rehman, M. Ikram, and Z. Jianglin, "Cardiovascular disease (CVD): assessment, prediction and policy implications," *BMC Public Health*, vol. 21, no. 1, p. 1299, 2021, doi: 10.1186/s12889-021-11334-2.
2. O. Atef, A. B. Nassif, M. A. Talib, and Q. Nassir, "Death/Recovery Prediction for Covid-19 Patients using Machine Learning," 2020.
3. A. B. Nassif, I. Shahin, M. Bader, A. Hassan, and N. Werghi, "COVID-19 Detection Systems Using Deep-Learning Algorithms Based on Speech and Image Data," *Mathematics*, 2022.
4. H. Hijazi, M. Abu Talib, A. Hasasneh, A. Bou Nassif, N. Ahmed, and Q. Nasir, "Wearable Devices, Smartphones, and Interpretable Artificial Intelligence in Combating COVID-19," *Sensors*, vol. 21, no. 24, 2021, doi: 10.3390/s21248424.

5. O. T. Ali, A. B. Nassif, and L. F. Capretz, “Business intelligence solutions in healthcare a case study: Transforming OLTP system to BI solution,” in 2013 3rd International Conference on Communications and Information Technology, ICCIT 2013, 2013, pp. 209–214, doi: 10.1109/ICCITechnology.2013.6579551.

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