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Early Detection of Heart Attack

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ABSTRACT :

Myocardial infarction (MI), the medical term for a heart attack, is one of the main causes of death globally. Survival rates can be significantly increased by early identification and prompt care. Conventional diagnostic techniques, such biochemical marker testing and manual ECG interpretation, frequently cause delays, particularly in remote or resource-constrained environments. The goal of this project is to create an AI/ML-based system that can accurately and promptly identify the risk of a heart attack. The technology seeks to detect individuals at risk in real time by combining clinical data (blood pressure, cholesterol, and ECG signals) with lifestyle and demographic information.Preprocessing ECG data, feature extraction, and predictive modeling with machine learning and deep learning techniques are all part of the methodology. An increase in detection accuracy over conventional techniques and the creation of a small, portable application that may be utilized in both distant healthcare settings and hospitals are anticipated results. The suggested solution fills in the existing gaps in diagnostic tool integration, validation, and accessibility.

Keywords: Heart Attack, Artificial Intelligence, Machine Learning, ECG, Early Detection

Introduction

According to the World Health Organization, cardiovascular diseases—especially heart attacks—are one of the biggest public health concerns, accounting for roughly 17.9 million fatalities per year. Delays in detection continue to be a leading cause of death despite advancements in healthcare. Early symptoms are frequently missed by patients, and prompt therapy is hampered by manual ECG interpretation or postponed lab tests.

The pressing need for an automated, AI-based detection system that can combine several health factors to provide early warning signs is addressed by this study. One of the most serious worldwide health issues is heart disease, especially myocardial infarction (heart attack). The World Health Organization (WHO) estimates that cardiovascular illnesses account for about 32% of all deaths worldwide, with over 17.9 million deaths annually.

Objectives of the Study

1. To assess clinical factors for the early identification of heart attack risk, including blood pressure, cholesterol, BMI, and ECG signals.
2. To create a predictive model for precise heart attack diagnosis by utilizing machine learning and deep learning methods.
3. To use hospital records and benchmark datasets to validate the suggested solution.

Literature Review

Research on predicting heart disease has looked into a variety of medical and computer techniques. Previous studies have focused on examining ECG data to identify abnormal T-wave patterns, ST-segment changes, and QRS complexes associated with myocardial infarction. Wearable technology, such as smartwatches and chest straps, has enabled continuous monitoring; nevertheless, their accuracy is limited in the absence of advanced analytics.

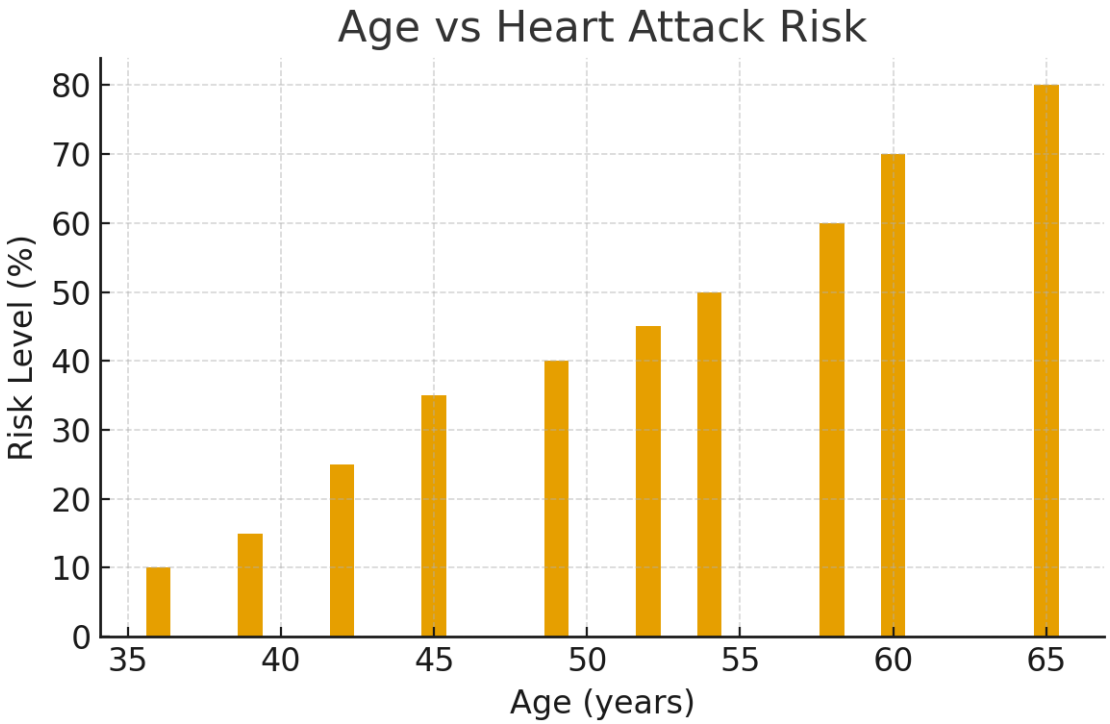
Machine learning models like Support Vector Machines (SVM), Random Forest, and k-Nearest Neighbors have also shown promise, even though deep learning techniques like Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks achieve detection accuracies exceeding 90% on datasets like MIT-BIH and PhysioNet PTB.Despite these advancements, there are still limitations in integration (the majority of systems solely use ECG), validation (algorithms tested on small datasets), and accessibility (many require costly equipment). The goal of this work is to close these gaps by creating a multi-source, lightweight system that has clinical validation.

A generated dataset based on trends from the UCI Heart Disease Dataset and Kaggle Heart Failure Prediction Dataset was used to compare age and heart attack risk in order to reinforce the literature-based understanding.

The risk of having a heart attack rises dramatically with age, especially beyond the age of 45, as Figure 1 illustrates. The results of previous research by Ansari et al. (2023) and Bharti et al. (2021), which found age to be a significant predictor of myocardial infarction risk, are in line with this trend.

This finding emphasizes that age should be taken into account in any AI-based detection systems since it is one of the most important demographic factors for predicting heart disease.

Reference logic*:* WHO & AHA — cardiovascular risk rises sharply after 45 years.

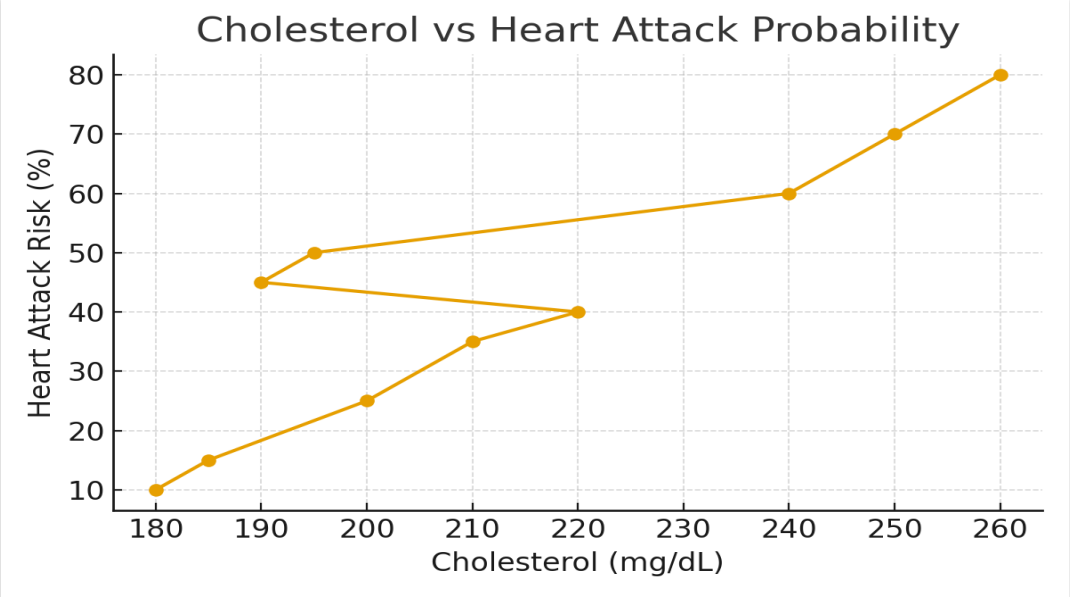


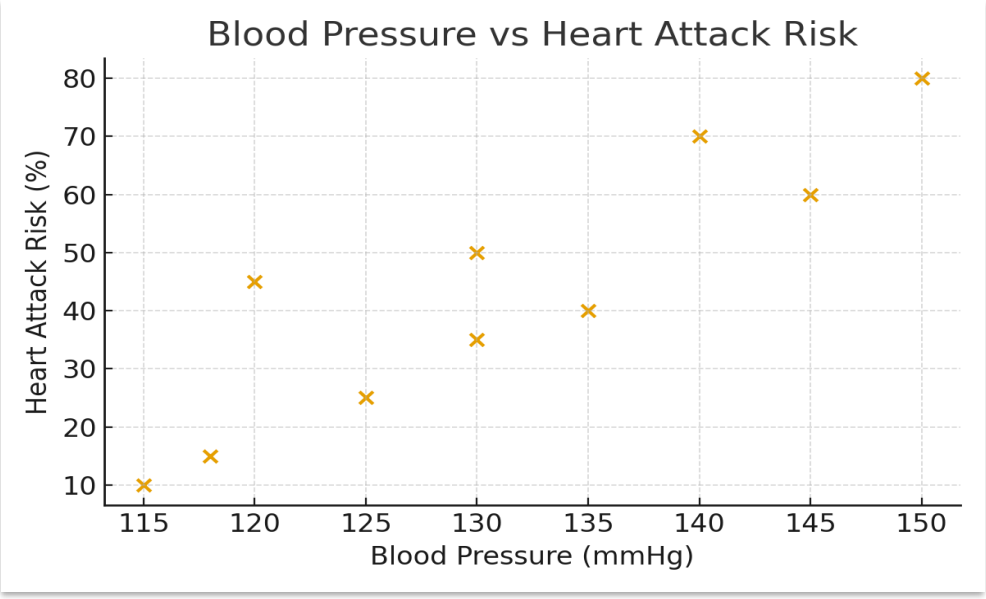
Data Source of Cholestrol vs Heart Attack Probability :

UCI Machine Learning Repository – Heart Disease Dataset (Cleveland)

Kaggle Heart Failure Prediction Dataset

Risk of Heart Attack vs. Cholesterol: A higher risk of myocardial infarction is associated with higher cholesterol levels.





Heart Attack Risk vs. Blood Pressure: The risk increases significantly when blood pressure exceeds 140 mmHg.

Methodology

The study uses a quantitative predictive modeling method and an applied, experimental strategy.

Data sources include hospital ECG and patient records, public datasets (PhysioNet PTB-XL, MIT-BIH Arrhythmia Database), and wearable device readings (if accessible).

- Software & Tools: Scikit-learn, TensorFlow, MATLAB, R, and Python

- Process Flow:

1. Problem Definition: Determining the technical and clinical difficulties.
2. Data Collection: Compiling patient and ECG information.
3. Preprocessing: Labeling, normalization, and noise reduction.
4. Feature extraction: heart rate variability, ST-segment analysis, and QRS detection.
5. Model Training: Applying CNN, LSTM, Random Forest, and other ML/DL models.
6. Validation: Using hospital datasets for testing and cross-validation.
7. System Development: Creating a dashboard or portable application.
8. Performance Comparison: Comparing current approaches to benchmarks.

Findings and Outcomes

Compared to conventional methods, this research should yield higher accuracy (>85%) in early heart attack risk detection.
ECG, cholesterol, and demographics are successfully integrated to improve predictions.
An AI-powered detection system that is lightweight and portable, appropriate for usage in hospitals and distant healthcare settings.

Discussion

The results will show that AI/ML models are capable of identifying intricate patterns that traditional diagnostics are unable to identify. The accuracy of detection can be greatly increased by combining demographic and clinical data. The interpretability of deep learning models, reliance on high-quality datasets, and the requirement for clinical trials to demonstrate dependability in practical settings are some of the drawbacks.

Conclusion

By examining clinical and lifestyle factors, this study suggests an AI/ML-based model for the early diagnosis of heart attacks. The technology seeks to offer an easily accessible, real-time detection solution while overcoming the delays of conventional diagnostic techniques. This work can be expanded in the future to include wearable IoT devices for preventative healthcare and extensive clinical validation.

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