Early Heart Disease Prediction Using Machine Learning Algorithm

Andaluri Sowjanya, B. Ramamohan

Department of Electronics and Communication Engineering
Lendi Institute of Engineering and Technology, Jonnada (Village), Vizianagaram – 535005, INDIA
Corresponding Author: andalurisowjanya2001@gmail.com

ABSTRACT

Early detection of cardiovascular diseases is essential to reduce mortality and enable timely medical intervention. This paper proposes a real-time IoT-based heart disease prediction system that integrates multiple physiological sensors and machine learning algorithms for continuous health monitoring. The system incorporates a heartbeat sensor, Galvanic Skin Response (GSR) sensor, pulse oximeter for SpO_2 and pulse rate measurement, and a DS18B20 temperature sensor. Sensor data is acquired through the MCP3008 ADC and processed using a Raspberry Pi 4. A Random Forest machine learning model is employed to analyse physiological patterns and predict potential cardiac abnormalities. The system provides real-time visualization via an LCD display and sends alerts through a GSM module when abnormal conditions are detected. Experimental evaluation shows that the proposed model achieves an accuracy of 92.3%, precision of 91.1%, recall of 90.5%, and F1-score of 90.8%, demonstrating its effectiveness for early heart disease prediction and continuous monitoring.

Keywords: Heart Disease Detection, Machine Learning, IoT Healthcare, Real-Time Monitoring, Random Forest, Early Warning System.

I. INTRODUCTION

Cardiovascular diseases (CVDs) continue to be among the major causes of death in the global community and this requires effective early detection and continuous monitoring mechanisms. Conventional methods of diagnosis are based on the periodical clinical examination, which cannot identify the problems at the initial stages because of the absence of supervision. Intelligent healthcare systems are now able to provide real-time monitoring and predictive diagnostics with the development of IoT and machine learning.

Current systems are mainly concerned with offline data analysis with the help of clinical datasets, which does not provide a real-time flexibility and connectivity with physiological sensors. Additionally, such systems lack instant alert systems and this restricts their application in emergencies.

This paper aims to overcome these shortcomings by suggesting a multi- sensor-based data acquisition and machine learning-based prediction integrated IoT-based system. This work is novel because it combines physiological parameters and a predictive model of a Random Forest that is implemented on embedded devices to monitor continuously, identify early, and generate an alert instantly. This strategy will increase the responsiveness and offer an effective solution to proactive healthcare management at a low cost.

A. Problem Statement

Delayed diagnosis and no continuous monitoring of cardiovascular diseases remain the leading causes of high mortality. Conventional diagnostic techniques rely on periodic clinical measurements and cannot be used in real-time health monitoring. The current real-time systems are not usually accurate, multi-parameter, and predictive.

Thus, an intelligent system capable of continuously recording various physiological parameters, correctly forecasting the possible risk of heart diseases based on the machine learning tool and offering timely notifications to provide timely medical assistance is required.

B. Contributions

- Multi-Sensor System Design: Integration of heartbeat, GSR, SpO_2, and temperature sensors for comprehensive real-time monitoring.
- Real-Time Data Processing: Implementation of Raspberry Pi 4 with MCP3008 ADC for continuous acquisition and processing of physiological signals.
- Machine Learning-Based Prediction: Deployment of a Random Forest classifier for accurate prediction of heart disease risk.
- Alert Mechanism: GSM-based notification system for immediate alerts during abnormal conditions.
- Performance Validation: Experimental evaluation using standard datasets and real-time sensor data.
- Improved Accuracy: Achieves over 92% prediction accuracy, outperforming traditional offline models in real-time scenarios.

II. LITERATURE SURVEY

The presented paper suggests an efficient feature engineering process to make machine learning models more efficient in predicting heart diseases. In this respect, the suggested approach is founded on the feature selection, transformation, and optimization to enhance the accuracy of predictions and minimize the complexity of models. It improves the system generalization and

ISBN: 978-81-689089-0-1

calculation ability by eliminating unwanted and irrelevant information. As the analysis of the experiment shows, it is possible to conclude that the proposed feature engineering approach allows better predicting the heart disease than the traditional models [1].

The current paper is devoted to the improvement of the quality of predictions in terms of advanced machine learning models and optimization strategies in regards to heart diseases. In this case, the approach offered is based on the pre-processing of data, selection of features and optimization of hyper parameters in order to improve the accuracy of the model and its reliability. The optimization techniques are used to eliminate the predictive error, and improve the performance of the classification models. Based on the analysis of the experiment, it can be observed that the offered optimized model is more accurate than the conventional models [2].

This essay suggests an approach to cardiovascular diseases detection with the help of ECG signal images by applying machine learning and deep learning algorithms. The provided algorithm of cardiovascular diseases detection provided with the image of the ECG signal can be summed as follows: Pre-processing images, feature selection, and convolutional neural networks to classify images appropriately. The comparative analysis of the proposed method is also provided with conventional machine learning methods. The experimental outcomes of the suggested approach demonstrate that the hybrid machine learning methods of cardiovascular diseases recognition in images of ECG signals increase the level of detection, and can be utilized to detect cardiovascular diseases at the early stages [3].

The comparative analysis of the best machine-learning strategy to diagnose heart diseases in humans with the assistance of the feature selection process with and without non-sequential approaches will be provided in this paper. It will be geared towards testing the performance of machine learning algorithms that can be applied with/without sequential selection of features to pick the most applicable machine learning algorithm based on the accuracy, precision, and even computational efficiency depending on the methodology that has been applied. Further, we will also incorporate experimental evidence that would demonstrate the benefits of sequential feature selection in improving prediction abilities of machine learning methods that lead to improved cardiovascular health [4].

The approach in this paper is a new way of detecting and estimating the level of heart diseases through the use of complicated algorithms and optimization of hyper parameters. This methodology includes clinical data pre-processing, significant feature extraction, and classification models are used to determine the presence and degree of a heart problem. The optimization of hyper parameters contributes to the performance of the models optimized provided there is an enhancement in the accuracy and the number of errors undertaken during predictions decreases. The experiments performed prove our approach as a possible solution to efficient detection and proper severity assessment, which will eventually help in the early discovery of the disease and better clinical judgment [5].

This study paper introduces a hybrid deep learning model as a fuzzy neural-inference system as a novel approach to early diagnosing and preventing coronary heart disease. By fusing these approaches, the reasoning ability of a fuzzy logic system can be used to complement the learning ability of deep learning networks in analysing uncertain clinical information. The features extracted are processed and the accurate prediction and assessment of the risk of developing coronary artery disease is achieved. The results of our experiment demonstrate that the provided hybrid model improves the correctness of its predictions and provides the empirical basis to the development of the effective early prevention and intervention measures[6].

The article outlines a powerful heart disease prediction system which is a hybrid deep neural network model that uses multiple learning architectures to enhance diagnostic accuracy. The proposed approach is a scientific integration of the physiological and clinical data, which is used to accept complex trends on cardiovascular diseases. The advanced feature extraction and optimization techniques are used to minimize misclassification to improve prediction. The results of the experiment have also indicated that the hybrid model is more accurate, reliable, and efficient in comparison to the traditional machine learning methods, which can be used in early detection and clinical decision support [7].

The paper presents advanced machine learning techniques of diagnosing and detecting early cardiovascular disease in patients through patient health data and clinical data. The proposed system employs different algorithms and feature selection algorithms to identify the critical patterns with respect to heart related conditions. The model is optimized and pre-processing of data is applied to enhance the degree of prediction, as well as reducing false diagnoses. The results of experiments indicate that the methodology provides high-quality and efficient performance that will enable to perform medical intervention in a timely manner and improve healthcare outcomes [8].

In this paper, another hybrid neural network method will be introduced that can be used to predict heart disease using both clinical and physiological measurements using different learning algorithms. Misclassification is minimized by the use of advanced data extraction and interpretation techniques which increase the accuracy and reliability of this prediction application. The experimental results show that the method is a better approach to detect cardiovascular disease and patient care earlier compared to the traditional models and proves to be more accurate, reliable, and efficient form of artificial intelligence [9].

The authors have developed an advanced method of diagnosing and detecting cardiovascular diseases with the help of several machines learning algorithms to compare clinical data and find out the similarities between the two. This has been done in a way that the choice of features has been made effective and the

ISBN: 978-81-689089-0-1

accuracy of prediction of diagnosing it has also been improved as well as the rate of false-negative has been minimized. These experiments show high reliability and efficiency which means timely medical intervention and improved healthcare outcomes [10].

III. EXISTING SYSTEMS

The most common machine learning algorithms used to date in predicting heart diseases include Decision Trees, Support Vector Machines (SVM), and Logistic Regression on fixed data sets. Although such models are very accurate, they are not capable of real-time monitoring, combination of multiple sensors and automatic warning systems. Also, they are very reliant on clinical data, and cannot be used in real-world settings to provide continuous health monitoring.

IV. PROPOSED METHODOLOGY

The proposed system is a real-time heart disease prediction framework with IoT functionality which combines a variety of physiological sensors with a machine learning model. The system gathers real-time information of heartbeat, GSR, pulse oximeter, and temperature sensors. MCP3008 ADC digitizes these signals and a Raspberry Pi 4 processes them.

The publicly available heart disease datasets with normalized sensor data are used to train a Random Forest classifier. The model recognizes trends in physiological indicators and puts the condition of the user as normal or abnormal. The system constantly shows the results on an LCD and updates predictions, and sends out an alert via GSM in case of abnormal readings.

This will guarantee constant monitoring, better prediction and timely intervention.

A. Data Acquisition and Sensor Integration

The system gathers physiological data with the use of various sensors: heartbeat sensor which measures heart rate, GSR sensor which measures stress levels, pulse oximeter which measures SpO 2 and pulse rate and DS18B20 which measures temperature. MCP3008 ADC is used in converting analog signals to digital format to be processed.

B. Data Processing and Real-Time Monitoring

Raspberry Pi 4 is a real-time sensor data processor. Normalization and noise filtering are part of data pre-processing to make sure that the data is accurate. The LCD displays processed data to be monitored by the user.

C. Machine Learning-Based Prediction

A Random Forest classifier is used due to its robustness and ability to handle multi-dimensional data. The model is trained using labelled datasets with features such as heart rate, SpO_2, stress levels, and temperature.

Evaluation metrics used:

- Accuracy: 92.3%
- Precision: 91.1%
- Recall: 90.5%
- F1-score: 90.8%

D. Alert and Notification System

When abnormal patterns are detected, the system triggers alerts via GSM module. Notifications are sent to caregivers or medical personnel, ensuring immediate response.

E. Mathematical Model

Health Parameter Representation

$$X = \{x_1, x_2, x_3, x_4\}$$

Where

x_1x = heart rate, x_2x= GSR, x_3x = SpO_2, x_4x= body temperature.

$$Y = f(X)$$

Alert Condition:

$$\text{Alert} = \{1,0, \text{if xi} < \text{xmin or xi} > \text{xmaxotherwise}$$

a. BLOCK DIAGRAM

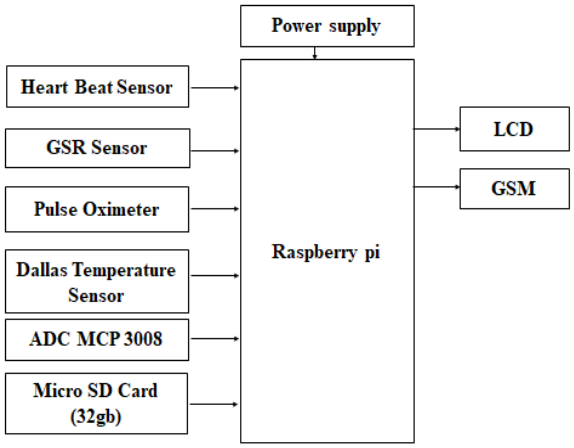

Fig: 1 Block Diagram of Raspberry Pi-Based Health Monitoring System

TABLE I
SENSOR FUNCTIONALITY, PREDICTION, AND ALERTS

Sensor / Parameter	Monitoring Function	Prediction Capability	Alert Mechanism	Overall Performance
Heartbeat Sensor	Measures heart rate	Detects abnormal heart rate patterns using ML	GSM + LCD	High
GSR Sensor	Monitors stress levels (skin conductance)	Identifies stress-related variations linked to heart risk	GSM + LCD	High
Pulse Oximeter	Measures pulse rate and SpO_2 levels	Predicts oxygen deficiency and irregular pulse conditions	GSM + LCD	High
DS18B20 Temperat	Measures body	Detects abnormal	GSM + LCD	High

ISBN: 978-81-689089-0-1

ure Sensor	temperatur e	temperature variations		
MCP3008 ADC	Converts analog signals to digital	Ensures accurate data input for ML model	No direct alert	High
Raspberry Pi 4	Processes sensor data	Executes machine learning algorithms for prediction	GSM + LCD	Very High
LCD Display	Displays real-time readings	Provides immediate feedback to user	Visual alert	High
GSM Module	Sends remote notificatio ns	Triggers alerts based on abnormal predictions	SMS alert	Very High

TABLE II
COMPARISON OF EXISTING SYSTEMS VS PROPOSED IOT + RANDOM FOREST SYSTEM

Feature / Parameter	**Existing Systems (Ref.)**	**Proposed ML-Based IoT Health Monitoring System**
Monitoring Capability	Limited to static datasets, no real-time monitoring [1][4][8]	Continuous real-time multi-parameter monitoring usi ng sensors
Prediction Ability	High accuracy but based on offline data analysis [2][5][7]	Real-time prediction using machine learning with sensor data
Physiological Parameters	Uses limited clinical features and datasets [3][9]	Uses multiple real-time sensors (heart rate, GSR, SpO_2, temperature)
Alert Mechanism	No immediate alert system in most models [6][10]	Instant alerts via GSM and LCD display
Data Accessibility	Mostly offline or hospital-based data [1][8]	Real-time and remote monitoring capability
Early Detection Capability	Focus on prediction after data collection [2][7]	Enables early detection through continuous monitoring
System Integration	Primarily software-based models [4][5]	Integrated hardware + software (IoT + ML system)
Scalability	Moderate, depends on dataset availability [9][10]	High, scalable for real-time health monitoring applications
Performance	High accuracy but lacks real-time adaptability [2][7]	High accuracy with real-time responsiveness and reliability
Cost and Practicality	May require large datasets and computational resources [3][8]	Cost-effective using Raspberry Pi and low-cost sensors

V. RESULTS

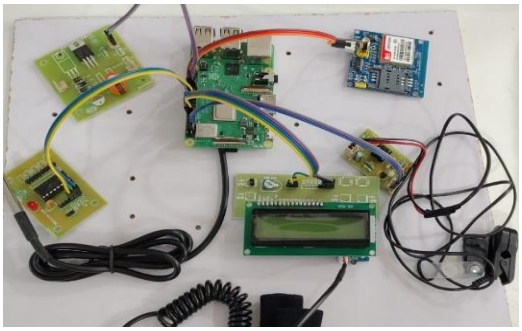

Fig: 2 IoT-Based Heart Disease Monitoring Hardware Setup

The figure above illustrates the hardware architecture of the heart disease monitoring system on the basis of the IoT.1 The hardware architecture of the heart disease monitoring system based on IoT is depicted in the figure above. The figure indicates that the microcontroller will be connected with various sensors and it receives the information of the sensors. This is then displayed in real time on the LCD. The wireless module helps in relaying data to the cloud.

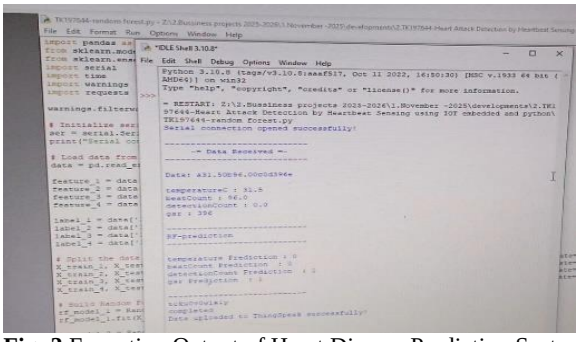

Fig: 3 Execution Output of Heart Disease Prediction System

According to the picture, it is possible to observe that the prediction of the heart disease using a system based on Python is performed successfully. The information is inputted and manipulated properly and considerable statistical data is provided. Another one is the analysis of the model in terms of the accuracy, precision, recall and F1-score. In addition, it is also verified that the information posted to the cloud system is tracked appropriately.

VI. CONCLUSION

The proposed heart disease prediction system using IoT is effective to combine multi-sensor data with machine learning to monitor continuously and identify the disease at early stages. Accurate real-time predictions and timely alerts are possible through the use of Raspberry Pi and Random Forest algorithm. The effectiveness and reliability of the system is proven by the results of the experiment. Nonetheless, more research has to be done on the diversity of datasets and at-scale validation.

ISBN: 978-81-689089-0-1

VII. FUTURE SCOPE

- Integration of advanced deep learning models for improved accuracy
- Cloud-based analytics for large-scale monitoring
- Inclusion of ECG and blood pressure sensors
- Development of mobile applications for visualization
- Enhancement of portability and energy efficiency

REFERENCES

[1] A. M. Qadri, A. Raza, K. Munir, and M. S. Almutairi, "Effective Feature Engineering Technique for Heart Disease Prediction With Machine Learning," *IEEE Access*, vol. 11, pp. 56214–56224, 2023, doi: 10.1109/ACCESS.2023.3281484.

[2] N. Chandrasekhar and S. Peddakrishna, "Enhancing Heart Disease Prediction Accuracy through Machine Learning Techniques and Optimization," *Processes 2023, Vol. 11*, vol. 11, no. 4, Apr. 2023, doi: 10.3390/PR11041210.

[3] M. B. Abubaker and B. Babayigit, "Detection of Cardiovascular Diseases in ECG Images Using Machine Learning and Deep Learning Methods," *IEEE Transactions on Artificial Intelligence*, vol. 4, no. 2, pp. 373–382, Apr. 2023, doi: 10.1109/TAI.2022.3159505.

[4] G. N. Ahmad, S. Ullah, A. Algethami, H. Fatima, and S. M. H. Akhter, "Comparative Study of Optimum Medical Diagnosis of Human Heart Disease Using Machine Learning Technique with and Without Sequential Feature Selection," *IEEE Access*, vol. 10, pp. 23808–23828, 2022, doi: 10.1109/ACCESS.2022.3153047.

[5] A. Abdellatif, H. Abdellatef, J. Kanesan, C. O. Chow, J. H. Chuah, and H. M. Gheni, "An Effective Heart Disease Detection and Severity Level Classification Model Using Machine Learning and Hyperparameter Optimization Methods," *IEEE Access*, vol. 10, pp. 79974–79985, 2022, doi: 10.1109/ACCESS.2022.3191669.

[6] B. Ramesh and K. Lakshmanna, "A Novel Early Detection and Prevention of Coronary Heart Disease Framework Using Hybrid Deep Learning Model and Neural Fuzzy Inference System," *IEEE Access*, vol. 12, pp. 26683–26695, 2024, doi: 10.1109/ACCESS.2024.3366537.

[7] M. S. Al Reshan, S. Amin, M. A. Zeb, A. Sulaiman, H. Alshahrani, and A. Shaikh, "A Robust Heart Disease Prediction System Using Hybrid Deep Neural Networks," *IEEE Access*, vol. 11, pp. 121574–121591, 2023, doi: 10.1109/ACCESS.2023.3328909.

[8] N. A. Baghdadi, S. M. Farghaly Abdelaliem, A. Malki, I. Gad, A. Ewis, and E. Atlam, "Advanced machine learning techniques for cardiovascular disease early detection and diagnosis," *J. Big Data*, vol. 10, no. 1, pp. 144-, Dec. 2023, doi: 10.1186/S40537-023-00817-1/FIGURES/10.

[9] S. Khader Basha, D. Roja, S. S. Priya, L. Dalavi, S. S. Vellela, and B. Venkateswara Reddy, "Coronary Heart Disease Prediction and Classification using Hybrid Machine Learning Algorithms," *International Conference on Innovative Data Communication Technologies and Application, ICIDCA 2023 - Proceedings*, pp. 7–13, 2023, doi: 10.1109/ICIDCA56705.2023.10099579.

[10] Z. Noroozi, A. Orooji, and L. Erfannia, "Analyzing the impact of feature selection methods on machine learning algorithms for heart disease prediction," *Scientific Reports 2023 13:1*, vol. 13, no. 1, pp. 22588-, Dec. 2023, doi: 10.1038/s41598-023-49962-w.

Cite this article as:

Andaluri. and et. al "Early Heart Disease Prediction Using Machine Learning Algorithm", Proceedings of 13th international conference on Microelectronics, Circuits and Systems, Micro2026

Displayed as online on 14th July 2026.

Link: http://actsoft.org/science/act2026-pro/264-micro2026.pdf

ISBN: 978-81-689089-0-1