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Intelligent Heart Health Monitoring and Early Alert System using Logistic Regression

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Abstract - *Heart-related disorders are a major cause of death worldwide, making early detection extremely important for improving survival rates. Continuous monitoring of heart activity can help identify abnormal conditions at an early stage and reduce serious health risks. This work presents a smart heart health monitoring and prediction system that combines sensor-based measurement with intelligent data analysis. The system uses a pulse sensor to measure heart activity in terms of beats per minute (BPM) and displays the results in real time. Based on the measured values, the system categorizes heart conditions into normal range, low pulse rate, and high pulse rate. In addition to hardware monitoring, a predictive model is developed using machine learning techniques to analyze patient medical data. The model studies different health parameters such as age, blood pressure, cholesterol level, and heart rate patterns to determine the possibility of heart disease. The proposed approach provides both monitoring and prediction, which improves the effectiveness of healthcare systems. The results show that the system can assist in early identification of cardiovascular problems and support better decision-making in medical applications.*

Key Words: Machine Learning (ML), Pulse Rate Monitoring, Beats Per Minute (BPM), Internet of Things (IoT), Electrocardiogram (ECG), Real-Time Healthcare System.

1 INTRODUCTION

Cardiovascular diseases are becoming increasingly common due to modern lifestyle changes. Factors such as stress, lack of physical exercise, unhealthy diet, and irregular daily routines contribute significantly to heart-related problems. Many individuals remain unaware of their condition until it becomes severe, which highlights the need for continuous monitoring systems.Heart rate is one of the most important indicators of cardiac health. It is usually measured in beats per minute (BPM), which represents the number of times the heart beats in one minute. A sudden increase or decrease in BPM may indicate abnormal conditions such as tachycardia (high rate) or bradycardia (low rate).Traditional diagnosis methods depend on periodic medical checkups and laboratory tests. Although these methods are reliable, they do not provide continuous observation. With the advancement of digital healthcare technologies, it is now possible to design systems that can monitor physiological signals in real time. Machine learning plays a key role in modern healthcare by analyzing large amounts of patient data. It helps in identifying patterns and predicting possible diseases before they become critical. By integrating sensor-based monitoring with predictive algorithms, a smart healthcare solution can be developed. The main aim of this project is to design a system that continuously tracks heart activity and predicts the likelihood of heart disease using data-driven techniques. This approach supports early diagnosis and improves preventive healthcare.

2. LITERATURE REVIEW

Many researchers have focused on developing systems for heart disease prediction using machine learning methods. Different algorithms have been applied to analyze patient data and classify disease conditions. Decision tree models are commonly used because they provide a clear structure for decision-making. They split data into different branches based on conditions, making them easy to understand. Support Vector Machines are also widely used for classification problems due to their ability to handle complex datasets. Random Forest algorithms combine multiple decision trees to improve prediction accuracy and reduce errors. In recent studies, deep learning models such as neural networks have been used to capture complex relationships between medical parameters.

However, most existing approaches focus only on software-based prediction and do not include real-time monitoring. Some systems use wearable devices to track heart activity, but they lack integration with predictive models. This work improves upon existing methods by combining both hardware monitoring and machine learning analysis. The integration provides a more practical and efficient solution for real-world healthcare applications.

3. PROPOSED SYSTEM

The proposed system consists of two main components: a hardware monitoring unit and a software prediction unit. Both components work together to provide accurate and real-time health analysis.The hardware unit uses a pulse sensor to measure heart activity. The sensor detects changes in blood flow and converts them into electrical signals. These

signals are processed to calculate heart rate in beats per minute (BPM).
The system classifies heart conditions into three categories:

- Low heart rate condition
- Normal heart rate range
- High heart rate condition

The measured values are displayed on an LCD screen, allowing users to easily understand their heart status.
The software unit uses a machine learning model to analyze medical data. It considers multiple parameters such as age, cholesterol level, blood pressure, and heart rate trends. Based on these inputs, the system predicts whether the patient is likely to have heart disease.
This combined approach enhances the accuracy and usefulness of the system. It provides both immediate feedback and long-term prediction, making it suitable for healthcare monitoring.

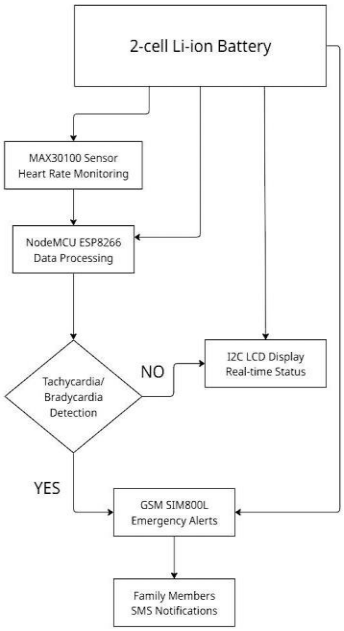


Fig -1 : Flow Chart Of Heart Health Monitoring

4. METHODOLOGY

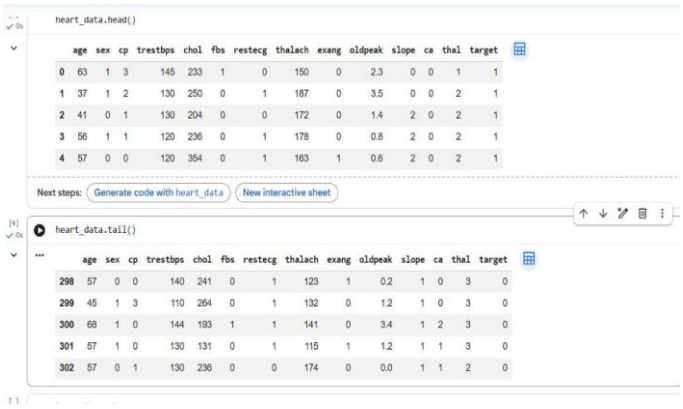
The methodology includes data collection, preprocessing, model training, and prediction.

[1] Data Collection

The dataset used contains important medical attributes related to heart health. These include age, gender, chest pain type, blood pressure, cholesterol level, and maximum heart rate.These parameters help in identifying patterns that are associated with heart disease. The dataset is collected from reliable sources to ensure accuracy.

Table – 1: Sample Dataset Attributes

Attribute	Description
Age	Age of the patient
Sex	Gender of the patient
Chest Pain Type	Type of chest pain experienced
Blood Pressure	Resting Blood Pressure
Cholesterol	Serum cholesterol level
Maximum Heart Rate	Maximum heart rate achieved
Target	Presence or absence of heart disease


heart_data.head()

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
0	63	1	3	145	233	1	0	150	0	2.3	0	0	1	1
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2	1
2	41	0	1	130	204	0	0	172	0	1.4	2	0	2	1
3	56	1	1	120	236	0	1	178	0	0.8	2	0	2	1
4	57	0	0	120	354	0	1	163	1	0.6	2	0	2	1

Next steps: Generate code with heart_data New interactive sheet

heart_data.tail()

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
298	57	0	0	140	241	0	1	123	1	0.2	1	0	3	0
299	45	1	3	110	264	0	1	132	0	1.2	1	0	3	0
300	68	1	0	144	193	1	1	141	0	3.4	1	2	3	0
301	57	1	0	130	131	0	1	115	1	1.2	1	1	3	0
302	57	0	1	130	236	0	0	174	0	0.0	1	1	2	0

Fig -2 : Heart Disease Prediction Dataset

[2] Data Preprocessing

Before training the model, the data is cleaned to remove missing or incorrect values. Normalization techniques are applied to bring all values into a standard range. This step improves the performance of the algorithm. Categorical data is converted into numerical form so that it can be processed by machine learning models.

[3] Model Training

The system uses Logistic Regression for prediction. This algorithm is suitable for binary classification problems, where the output is either presence or absence of disease.
The model is trained using historical data, allowing it to learn relationships between different health parameters. Once trained, it can predict results for new input data.

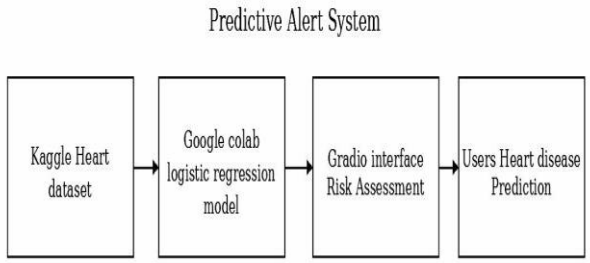


Fig – 3 : Block Diagram of Predictive Alert System

5. RESULTS AND DISCUSSION

The system was tested using both hardware and software components. The pulse sensor successfully measured heart rate and displayed the results on the LCD screen.

Heart rate values were categorized based on beats per minute (BPM):

- Below 60 BPM indicates low heart rate
- Between 60 and 100 BPM indicates normal condition
- Above 100 BPM indicates high heart rate

These classifications help in identifying abnormal conditions quickly. The machine learning model analyzed patient data and provided predictions with good accuracy. The system achieved approximately 85% accuracy, which indicates reliable performance. The results show that combining real-time monitoring with predictive analysis improves healthcare efficiency. The system can be used as a supportive tool for early diagnosis.

Table – 2: Heart Rate Classification

Heart Rate (BPM)	Condition
< 60 BPM	Bradycardia
60 – 100 BPM	Normal
>100 BPM	Tachycardia

5.1 HARDWARE RESULTS

The hardware system was tested to measure heart rate using a pulse sensor. It detected heartbeats and calculated the rate in beats per minute (BPM). The output was shown on the LCD screen in real time. The system classified the readings as low, normal, or high. The results were stable and updated quickly. This shows that the hardware works well for basic heart monitoring.

Fig - 4: LCD Display Showing Tachycardia

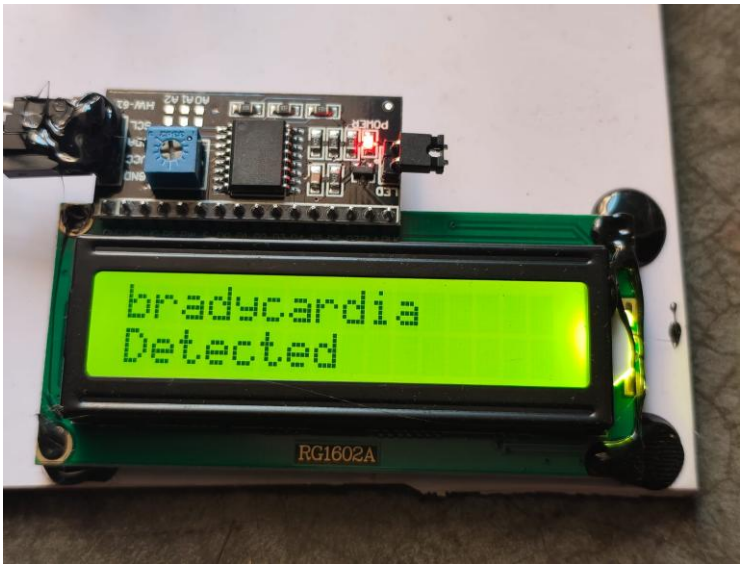


Fig - 5: LCD Display Showing Bradycardia

Fig - 6: LCD Display Showing Normal Heart Rate

5.2 SOFTWARE RESULTS

The software model was used to predict heart disease based on patient data. It analyzed factors like age, blood pressure, and cholesterol. The system gave results showing whether the person may have heart disease or not. Logistic Regression was used for prediction. The model achieved around 85% accuracy. The results were fast and easy to understand.

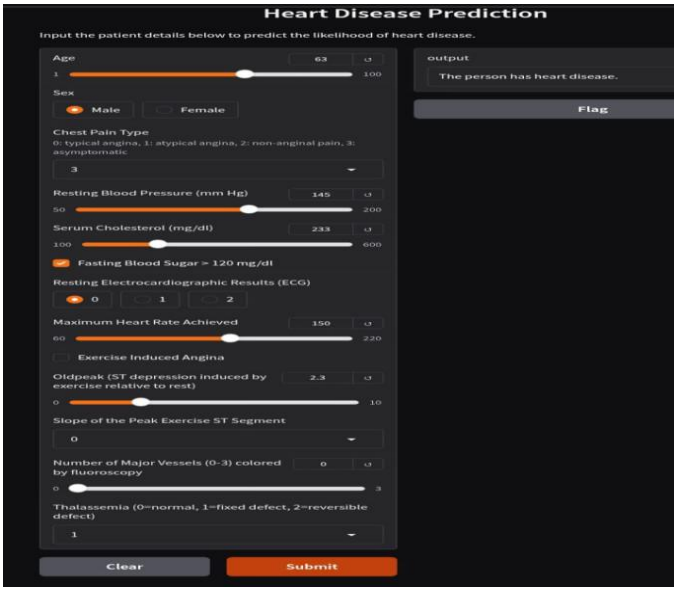


Fig -7: Software Output Showing Heart Disease Detected

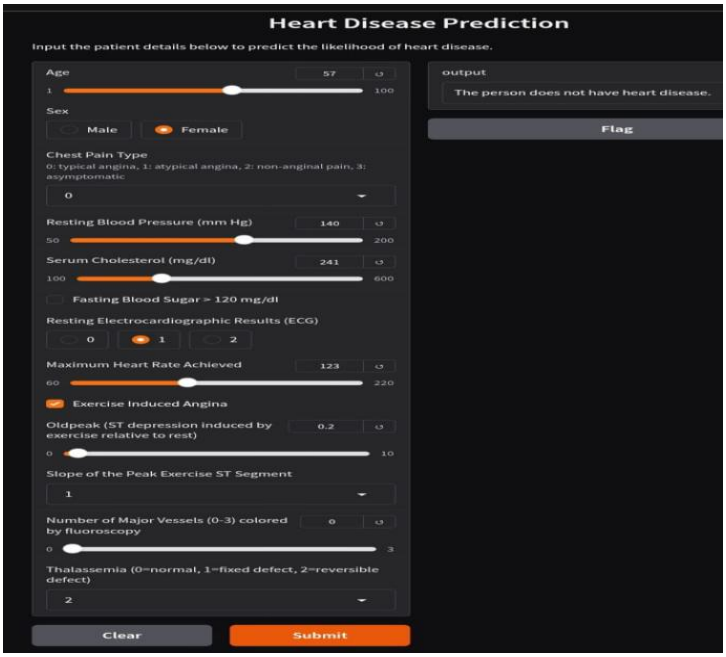


Fig -8: Software Output Showing No Heart Disease

6. CONCLUSION

The developed system provides an effective solution for monitoring heart activity and predicting heart disease. It combines sensor-based measurement with machine learning techniques to deliver accurate results. The hardware unit measures pulse rate and displays real-time data, while the software model analyzes health parameters to predict disease risk. This dual approach enhances the functionality of the system. The results demonstrate that the system can assist healthcare professionals in early detection and monitoring. It also helps individuals become more aware of their health condition. Overall, the integration of smart technologies in healthcare improves efficiency and supports preventive medical practices.

6.1 FUTURE SCOPE

The system can be further improved by integrating Internet of Things (IoT) technology for remote monitoring. This will allow doctors to access patient data from any location. Additional parameters such as oxygen level, body temperature, and ECG signals can be included to improve prediction accuracy. These parameters provide more detailed information about heart health. Advanced algorithms such as deep learning can be used to enhance prediction performance. Mobile and web applications can also be developed to make the system more user-friendly.Future developments can include alert systems that

notify users during abnormal conditions. This will improve emergency response and patient safety.

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