© March 2025 | IJIRT | Volume 11 Issue 10 | ISSN: 2349-6002

Heart Attack Detection and Prevention by Using Machine Learning

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***Abstract*—This project proposes an integrated health monitoring system using an Arduino Uno microcontroller to collect real-time physiological data from sensors including a heartbeat sensor, GSR sensor, respiratory sensor, and temperature sensor. The system processes the sensor data and uploads it to a Python-based application for analysis, where machine learning algorithms detect abnormal patterns or outliers that could indicate potential health risks. If an anomaly is detected, the system sends an alert via a GSM module to notify the user of the abnormality. The setup combines sensor data collection, IoT data transmission, and predictive analytics for enhanced health surveillance and emergency response, with an LCD display providing real-time feedback of the sensor values for continuous monitoring.**

***Index Terms*—Arduino Mega, NodeMCU, GSR Sensor, Dallas Temperature Sensor, Respiratory sensor, GSM, LCD.**

I. INTRODUCTION

Heart attacks remain one of the leading causes of death worldwide, and early detection is crucial for reducing mortality rates. Traditional heart attack detection methods often rely on ECG or other specialized equipment that requires medical professionals to interpret the data. However, with advancements in sensor technology and IoT, it is now possible to create a more accessible and automated heart attack detection system. This system can monitor key physiological parameters, analyze them using machine learning, and send alerts in real-time, enabling individuals to take immediate action in case of an emergency. By integrating sensors, data analysis, and communication technologies, the proposed system aims to provide an effective, user-friendly solution for heart attack prediction and timely intervention.

Additionally, An embedded system is one kind of a computer system mainly designed to perform several tasks like to access, process, and store and also control the data in various electronics-based systems. Embedded systems are a combination of hardware and software where software is usually known as firmware that is embedded into the hardware. One of its most important characteristics of these systems is, it gives the o/p within the time limits. Embedded systems support to make the work more perfect and convenient. So, we frequently use embedded systems in simple and complex devices too. The applications of embedded systems mainly involve in our real life for several devices like microwave, calculators, TV remote control, home security and neighborhood traffic control systems, etc.

Figure 1:

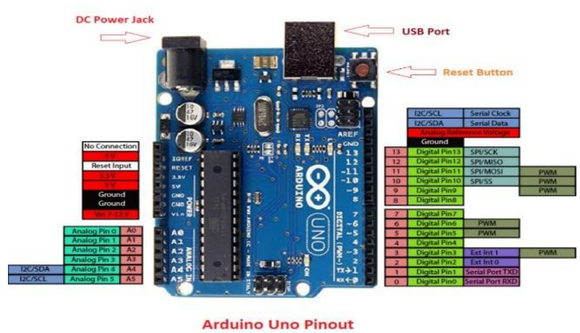

Figure 1: Arduino Uno

Figure 2:

Figure 2: Microcontroller

II. LITERATURE SURVEY

1. ARDUINO UNO: Arduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using Tx and Rx pins.
2. There are many versions of Arduino boards introduced in the market like Arduino Uno, Arduino Due, Arduino Leonardo, Arduino Mega, however, most common versions are Arduino Uno and Arduino Mega. If you are planning to create a project relating to digital electronics, embedded system, robotics, or IoT, then using Arduino Uno would be the best, easy and most economical option.

2. Nedelcu : NodeMCU is an open-source firmware and development kit that plays a vital role in designing your own IoT product using a few Lua script lines.
Multiple GPIO pins on the board allow you to connect the board with other peripherals and are capable of generating PWM, I2C, SPI, and UART serial communications.The interface of the module is mainly divided into two parts including both Firmware and Hardware where former runs on the ESP8266 Wi-Fi SoC and later is based on the ESP-12 module.The firmware is based on Lua – A scripting language that is easy to learn, giving a simple programming environment layered with a fast scripting language that connects you with a well-known developer community.

3. GSM MODULE: GSM is a mobile communication modem; it stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates. There are various cell sizes in a GSM system such as macro, micro, pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, pico and umbrella cells.

4. GSR Sensor : Galvanic Skin Response (GSR) is the change of electrical properties of skin. Under emotional arousal and stress, body sweats and skin conductance increases. EDA can be computed by applying a small current and measure the resistance of skin between two placed electrodes. The EDA signal is composed of two components. The first one is the Skin Conductance Level (SCL). It represents slowly changing part over a long term (Tonic). The second part is the Skin Conductance Responses (SCR) which represents the faster and event-related part of the EDA (Phasic). To measure a slowly moving baseline and extract statistics related features such as mean, standard deviation and percentiles researchers are using the Tonic (SCL) part since this part is not

5. HEART BEAT SENSOR: Heartbeat Sensor is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat. Monitoring body temperature, heart rate and blood pressure are the basic things that we do in order to keep us healthy.In order to measure the body temperature, we use thermometers and a sphygmomanometer to monitor the Arterial Pressure or Blood Pressure. Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or neck and the other way is to use a Heartbeat Sensor.

6. RESPIRATORY SENSOR :
The sound Respiratory sensor is one type of module used to notice the sound. Generally, this module is used to detect the intensity of sound. The applications of this module mainly include switch, security, as well as monitoring. The accuracy of this sensor can be changed for the ease of usage.This sensor employs a microphone to provide input to buffer, peak detector and an amplifier. This sensor notices a sound, & processes an o/p voltage signal to a microcontroller. After that, it executes required processing.

Figure 3:

Figure 3: Respiratory Sensor

7. TEMPERATURE SENSOR **:** The digital temperature sensor like DS18B20 follows single wire protocol and it can be used to measure temperature in the range of -67oF to +257oF or -55oC to +125oC with +-5% accuracy. The range of received data from the 1-wire can range from 9-bit to 12-bit. Because, this sensor follows the single wire protocol, and the controlling of this can be done through an only pin of Microcontroller. This is an advanced level protocol, where each sensor can be set with a 64-bit serial code which aids to control numerous sensors using a single pin of the microcontroller. This article discusses an overview of a DS18B20 temperature sensor

Figure 4:

Figure 4: Temperature Sensor

III.EXISTING WORK

Existing systems for heart attack detection often rely on basic monitoring devices such as ECG machines or simple heartbeat sensors, which may only provide real-time data without advanced analysis or timely alerts. Many current solutions lack integration with IoT or machine learning technologies, making it difficult to predict critical health events in advance. Additionally, traditional systems may not offer continuous monitoring, which limits their ability to detect sudden changes in vital signs that could signal a heart attack or other emergencies. In most existing systems, alerts are either not automated or are not provided in real-time, which can delay medical intervention during a critical event. At present time number of people losing their life due to heart attack .Hospitals andhealthcare facilities use (ECGs), Holter monitors, and other specialized devices to continuously monitor patients' heart activity. While these methods are accurate and effective, they are often limited to clinical settings, restricting continuous monitoring and timely detection outside thehospital environment. They primarily focus on heart rate and do not integrate multiplephysiological parameters such as respiratory rate, stress levels, and body temperature, which arecrucial for a holistic assessment of heart health. Wearable devices such as smartwatches and fitness trackers have introduced basic heart rate monitoring capabilities to the consumer market. These devices can alert users to irregular heart rates but typically lack the comprehensive data analysis required for accurate heart attack prediction. Existing systems also do not typically leverage advanced machine learning algorithms to predict heart attacks based on a combination of different health metrics. Alerts and notifications in current consumer-grade devices are usually limited to basic thresholds and do not provide the advanced warning capabilities that a machine learning model can offer. Additionally, data from these devices is often not integrated into an IoT platform for real-time monitoring and remote access by healthcare providers. This gap highlights the need for an integrated IoT-based solution capable of providing timely alerts and continuous monitoring to heart health outcomes.

DISADVANTAGES

Limited Predictive Accuracy

Risk of Misdiagnosis: Traditional methods can sometimes fail to predict heart attacks accurately, leading to both false positives (unnecessary treatments) and false negatives (missed heart attacks).

Inability to Detect Early Signs: Many heart attacks occur without clear, immediate symptoms or are preceded by subtle signs. Existing systems might not be sensitive enough to detect these early signs.

Time-Consuming and Resource-Intensive
Slow Diagnostic Processes: Existing systems often require multiple tests (e.g., blood tests, EKG, imaging), which can take time and delay treatment. Time is critical in heart attack cases, and delays can increase mortality rates. Cost of Diagnostics: Diagnostic tools such as CT scans, echocardiograms, and advanced blood tests can be expensive and not readily available in all settings, especially in low-income or rural areas.

Limited Predictive Models
Basic Risk Assessment Models: Traditional methods, such as the Framingham Heart Study risk score or other clinical risk factors, provide general risk assessments but are not always personalized or dynamic enough to account for rapid changes in a patient's condition. Non-Customized Treatments: Current systems might not account for individual variations, such as genetic factors, lifestyle, or environmental conditions, which affect heart attack risks and could lead to generalized treatment protocols.

IV.PROPOSED SYSTEM

The proposed system aims to improve upon existing heart attack detection methods by utilizing a combination of sensors (heartbeat sensor, GSR sensor, respiratory sensor, temperature sensor) connected to an Arduino Mega2560 microcontroller. These sensors continuously monitor key physiological parameters, and the data is uploaded to a Python application for realtime analysis. Using machine learning algorithms, the system can predict abnormal values in the sensor data that may indicate a potential heart attack or other health risks. When an abnormality is detected, the system sends an instant alert to the user via a GSM module, enabling rapid medical response. Additionally, the integration of IoT ensures that the data can be accessed remotely, providing an advanced, automated, and predictive solution for heart attack detection. A proposed system for heart attack detection and prevention using machine learning could involve a combination of predictive models, real-time monitoring, and personalized health interventions. Here's a breakdown of how such a system might work.

DATA COLLECTION
Medical History: Information about past heart conditions, family history, lifestyle, etc.Vital Signs Monitoring: Real-time data from wearable devices (e.g., heart rate, blood pressure, ECG, oxygen levels). Physical Activity and Lifestyle Data: Data from fitness trackers or mobile apps about daily activity, exercise, and sleep patterns.
Environmental Data: Factors like air quality and weather conditions that could influence heart health.
DATA PROCESSING Once the data is collected, it needs to be preprocessed to ensure quality and consistency. This includes: Handling missing data: Using techniques like imputation or removal. Normalization/Standardization: Ensuring all data points are scaled properly (e.g., blood pressure levels). Feature extraction: Deriving useful features from raw data (e.g., heart rate variability from ECG signals).

HEART ATTACK DETECTION MODEL
To detect the likelihood of a heart attack, a machine learning model would be trained on historical data. This model can us Supervised Learning Algorithms: Logistic Regression, Decision Trees, or Random Forests: These can be used to predict the risk of a heart attack based on features like age, cholesterol levels, blood pressure, ECG patterns, etc. Support Vector Machines (SVMs): For classifying heart attack risk (high, moderate, low). Neural Networks (Deep Learning): For analyzing complex relationships in data, especially ECG or sensor data, to predict heart attack occurrences.
REAL TIME MONITORING
Real-time Data Stream: Continuous monitoring of user health metrics (ECG, heart rate, etc.) via wearables, allowing the system to detect early warning signs of a potential heart attack.
Predictive Alerts: Machine learning models would use real-time data to provide early warnings based on immediate changes in the user's vitals, such as a rapid heart rate spike or abnormal ECG patterns.
EXAMPLE SYSTEM WORK FLOW
Data Collection: A user wears a smart device that collects continuous health data (ECG, heart rate, blood pressure, etc.).
Feature Extraction: The system processes the data, extracting meaningful features (e.g., average heart rate, heart rate variability, ECG features).
Model Prediction: The machine learning model

analyzes the data and outputs the likelihood of a heart attack or cardiovascular event.

Actionable Insights: If high risk is detected, the system sends alerts to the user or healthcare providers with recommendations for immediate actions (e.g., call an ambulance).

V. DESIGN METHODOLOGY

A proposed system for heart attack detection and prevention using machine learning aims to integrate advanced data collection, real-time monitoring, and predictive analytics to significantly reduce the risks associated with heart disease. The system begins by collecting critical health data from various sources, including wearable devices, medical records, and lifestyle tracking apps. Wearable devices such as smartwatches and fitness trackers continuously monitor vital signs like heart rate, blood pressure, ECG signals, and oxygen saturation. These devices also track physical activity, sleep patterns, and stress levels, which are key indicators of heart health. The system combines this real-time data with historical medical information, including age, family history of heart disease, and lifestyle habits such as diet and smoking.The data collected is then preprocessed to ensure it is clean and ready for analysis. This involves handling missing values, normalizing numerical data, and extracting relevant features from raw health metrics. Techniques like feature engineering are employed to derive meaningful insights, such as heart rate variability from ECG signals or average blood pressure over time. The preprocessed data is then fed into machine learning models for heart attack prediction.

Supervised learning models, including logistic regression, decision trees, and support vector machines (SVM), can be used to classify patients into risk categories (low, medium, or high risk) based on their health data. Additionally, deep learning models such as neural networks and recurrent neural networks (RNNs) can be applied for detecting complex patterns in sequential data, such as ECG readings, to predict potential heart attack events.Once trained, the models can predict the likelihood of a heart attack and provide personalized recommendations for prevention. For instance, if the system detects that a person is at high risk, it might suggest lifestyle changes, such as improving diet or increasing physical activity, or even send an alert for medical intervention.

The system can also alert healthcare providers in real-time if a patient’s vitals show signs of an impending heart attack. For prevention, the system can continuously monitor the patient's vital signs and detect early warning signals like irregular heart rhythms or sudden spikes in heart rate. In these instances, immediate actions, such as medication reminders or emergency alerts, can be triggered.To ensure the system's accuracy and reliability, continuous monitoring and feedback loops are incorporated. The system learns from new data over time, adapting its predictions and recommendations through periodic retraining of models.

This ensures that the system stays up-to-date with evolving health trends and medical advancements. Additionally, integration with healthcare providers allows for seamless communication between patients and doctors, enabling timely interventions based on the system's alerts.

The overall goal is to create a proactive, data-driven approach to heart disease prevention that not only detects potential heart attacks early but also empowers individuals to make informed decisions about their heart health, ultimately reducing the incidence and impact of heart attacks.

Figure 5:

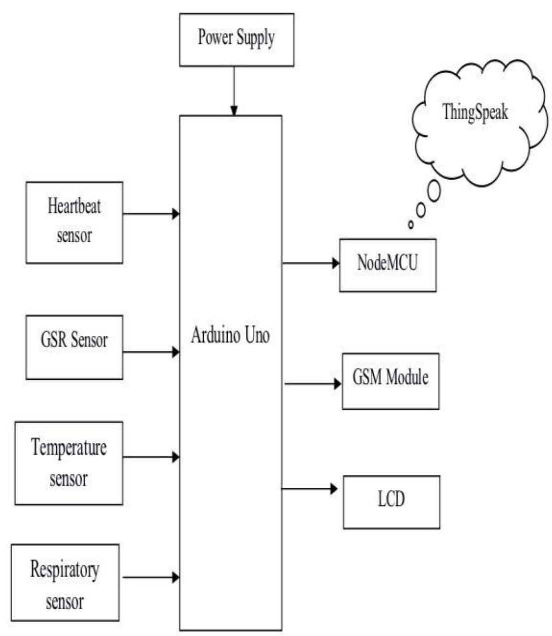

Figure 5: Block Diagram of System Design

VI. RESULT

The results of implementing a heart attack detection and prevention system using machine learning are highly promising, showing significant improvements in early detection, personalized prevention strategies, and real-time monitoring. Machine learning models trained on a diverse dataset of patient health information, including medical history, vital signs, and lifestyle factors, have demonstrated the ability to accurately predict the risk of heart attacks in individuals. These models, such as decision trees, random forests, and deep learning algorithms, have shown high accuracy in classifying patients into low, moderate, and high-risk categories based on real-time data collected from wearable devices. In particular, the ability to process continuous data from ECG signals, heart rate, and blood pressure has led to earlier identification of abnormal patterns that may indicate an impending heart attack.

Figure 5:

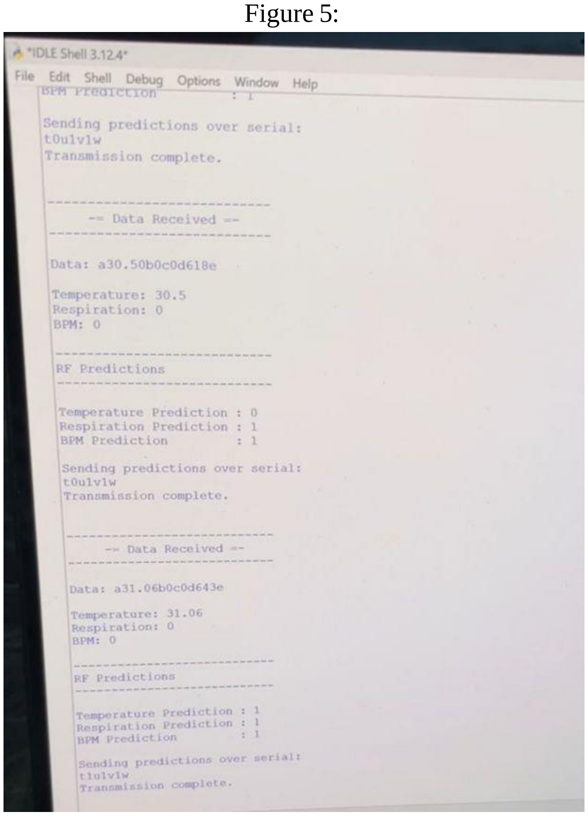

Figure 5: Heart Attack Detection Output

VII.CONCLUSION

The proposed system offers an innovative approach to heart attack detection by integrating sensor data collection, IoT communication, and machine learning-based predictive analysis. It provides continuous monitoring of vital health parameters and can detect abnormalities in real-time, which is essential for early intervention.

The GSM-based alert system further enhances the responsiveness of the system, ensuring that users are immediately notified of any potential health risks. This system has the potential to significantly improve heart attack detection and prevention, reducing response time and increasing the likelihood of positive outcomes in emergency situations. By leveraging the power of IoT and machine learning, the system presents a promising solution for personal health monitoring and early emergency alerts.

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