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Real Time Heart Attack Detection and Warning System to Prevent Accidents

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Abstract: *Heart attacks are one of the leading causes of sudden death worldwide, often occurring without warning and in situations where immediate medical help is not available. This becomes particularly dangerous when such incidents take place while a person is driving, working alone. To address this critical health and safety issue, we propose the development of a wearable chest belt designed for real-time heart attack detection and accident prevention. The wearable device is equipped with ECG sensors that continuously monitor the user's heart activity from the chest area, providing more accurate readings compared to wrist based alternatives. The collected ECG data is analyzed to detect patterns and anomalies indicative of a heart attack, such as irregular heartbeats or abnormal ST-segment changes. Upon detecting these warning signs, the system can instantly alert the user, nearby individuals, emergency contacts, or medical professionals through a connected mobile application or GSM module. In addition to real-time monitoring and alerting, the system can be extended to integrate with automotive safety mechanisms, offering the ability to reduce the risk of road accidents if a heart attack is detected while the user is driving. The aim is to make intelligent heart monitoring more accessible, reliable, and impactful—ultimately contributing to reduced mortality rates and safer environments for individuals at risk of cardiac events.*

Keywords: Real-time monitoring, Heart attack detection, Wearable medical device, GSM alert system and Emergency response system

I. INTRODUCTION

Our project addresses this life-threatening gap by developing a smart wearable chest belt capable of real-time heart attack detection, with the added potential to prevent secondary accidents caused by sudden cardiac events. The proposed system is a wearable chest band integrated with sensors capable of capturing Electrocardiogram (ECG) signals, which are widely regarded as one of the most reliable indicators of cardiac health. By continuously monitoring the user's heart activity, the device collects real-time ECG data and analyzes it to detect abnormalities that may signal an impending or ongoing heart attack. The goal is to offer instant alerts and automated emergency response features that can notify nearby caregivers, family members, or medical personnel via a connected smart phone application or built-in GSM module. The device has been designed with wearability and practicality in mind. Placed around the chest, it ensures direct and accurate ECG signal acquisition from the heart region, outperforming wrist-based wearables in clinical precision. The data collected is processed using embedded hardware, and once abnormal patterns are detected, an immediate alert is triggered. In future iterations, the system may also be integrated with vehicle safety mechanisms to slow down or stop a car safely in case the driver suffers a heart attack mid-drive. This project combines biomedical signal processing, IoT integration, and machine learning based classification into a single, wearable system. We use an open-source or real-world heart disease dataset for training the model, focusing on key ECG features known to correlate with heart attack risks. Our vision is to provide an accessible, cost-effective device that empowers users to monitor their heart health proactively and get life-saving help when every second counts.
proactively and get life-saving help when every second counts. This project doesn't just aim to detect heart attacks—it aims to save lives by preventing the chain reaction of accidents and medical emergencies that of ten follow when early

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warning signs go unnoticed. As technology continues to merge with healthcare, this chest belt stands as a strong step toward intelligent health monitoring for a safer, more responsive future.

II. METHODOLOGY

1. ECG Signal Acquisition: ECG Sensor collects heart signals from the user using dry electrodes. The analog signal from the ECG sensor is sent to the Node MCU (ESP8266) through analog pin A0. Before this, the signal passes through a Signal Conditioning circuit to amplify and filter the ECG waveform.
2. Real-Time Processing: The Node MCU reads the incoming ECG signal. It runs a program to detect abnormalities such as ST elevation based on predefined threshold values.
3. Relay Activation (Vehicle Speed Control): If an abnormality is detected, the Node MCU sends a control signal to the Relay Module. The Relay is connected to the DC Motor controlling the vehicle. This signal either cuts off or limits power to the motor, thereby slowing or stopping the vehicle.
4. GPS Location Tracking: Simultaneously, the Node MCU communicates with the NEO- 6M GPS module via UART. It retrieves the current latitude and longitude coordinates of the vehicle.
5. Alert Communication: The Node MCU sends a signal to the Arduino Nano, which is connected to the SIM800L GSM Module. The Arduino composes and sends an SMS alert to predefined emergency contacts, containing: A heart attack alert message and the GPS location.
6. Cloud Data Upload: The Node MCU also connects to Wi-Fi and uses HTTP/MQTT protocol to upload ECG data and system status to the Ubidots IoT platform. This enables remote real-time monitoring of the patient's heart condition.
7. Power Management: A regulated power supply module provides multiple voltage outputs: 3.3V, 5V, and 12V are used for different components like Node MCU, Arduino Nano, GSM, and motor.

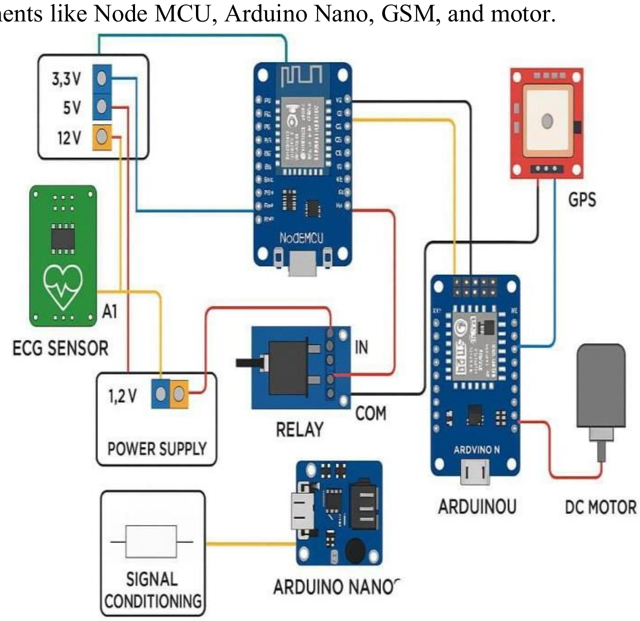

Fig 1: System Design

III. OBJECTIVES

Continuous ECG Monitoring: The chest belt is embedded with medical-grade ECG sensors strategically positioned around the chest to monitor the electrical activity of the heart in real time. These sensors work continuously, even during motion or physical activity such as driving, ensuring reliable signal acquisition. This uninterrupted monitoring allows the system to capture vital data during both normal and abnormal heart rhythms, providing the foundation for accurate and timely cardiac event detection.

Heart Attack Detection Using Machine Learning: The continuous ECG data collected is analyzed by a machine learning model trained on real-world heart disease datasets. This model is designed to detect critical signs of heart attacks, such as ST-segment elevation and arrhythmias. It runs locally on an embedded system, ensuring real-time analysis without the need for cloud processing. This approach enables the device to deliver fast, life-saving insights even in areas without internet connectivity.

Real-Time Alert System: Upon detecting any irregular or dangerous heart activity, the chest belt immediately activates an alert mechanism. This could include vibration feedback, beeping sounds, or a voice message to warn the user. If the person is driving, this warning serves as a critical signal to pull over and seek help before losing consciousness. The immediate alert feature is vital to preventing road accidents caused by sudden cardiac events while on the move.

System Integration and Wearability :All components of the system—including ECG sensors, microcontrollers, power sources, and communication modules—are compactly integrated into a single, wearable chest belt. Designed for daily use, the belt is lightweight, breathable, and non-intrusive, allowing the user to wear it comfortably for long periods. The system's modular design also makes it easy to maintain and upgrade. This high level of wearability ensures consistent usage, which is key for continuous health monitoring.

Emergency Contact Notification: The system is designed to notify emergency contacts instantly when a heart attack is suspected. Using a GSM module or a smartphone connection, it sends an SMS or app based alert including the user's status and timestamp. Optional GPS functionality can also share the exact location of the user, helping responders reach the individual quickly. This ensures that the user receives help even if they are alone or unable to communicate.

HARDWARE REQUIREMENT:

- Electrodes: Detects heartbeats using skin sensors. Cleans and boosts the signal to make it clear. Sends data to a phone, computer, or microcontroller.
- ECG Sensor: Measures the electrical activity of the heart in real time. Sends analog heart signal data to the microcontroller for processing. Detects abnormal heart rhythms or irregularities by monitoring signal peaks.
- Neo-6M GPS Module: Receives signals from GPS satellites to determine real-time location. Provides latitude, longitude, altitude, speed, and time data. Sends location data to microcontrollers (like Arduino or Node MCU) via serial communication.
- Node MCU ESP8266: Connects the system to the internet via Wi-Fi. Sends emergency alerts with GPS location using GSM. Controls other devices like relays to trigger alarms or vehicle safety.
- Power Supply: Converts high voltage (like 220V AC or 12V DC) to a lower, usable voltage (like 5V or 3.3V). Provides stable and continuous power to all electronic components. Protects the circuit from voltage fluctuations and overcurrent.
- Relay: Acts as an electronic switch for controlling the vehicle speed. Disconnects or reduces power to the motor upon heart abnormality.
- GSM: Sends and receives SMS messages using a mobile network. Makes and receives voice calls through GSM communication. Connects to cellular networks to transmit data wirelessly.
- Arduino Nano: Reads heart signal data from the ECG sensor. Sends AT commands to GSM module to trigger SMS alerts. Controls the timing and logic of emergency message sending.
- DC Motor: Converts electrical energy into mechanical rotation. Controls the speed and direction of rotation based on input voltage or signals. Provides mechanical movement to drive wheels, fans, or other components.

SOFTWARE REQUIREMENT:

The heart attack detection system is built using two main microcontrollers: Node MCU (ESP8266) and Arduino Nano. Node MCU handles real-time ECG signal processing using dry electrode ECG sensors and sends data to the ubiots IoT platform via HTTP/MQTT for live monitoring.

It also processes GPS location data using the NEO-6M GPS module and controls a relay module to reduce vehicle speed in case of emergency. The Arduino Nano interfaces with the SIM800L GSM module to send SMS alerts to predefined emergency contacts when heart abnormalities such as ST elevation are detected.

The software, developed in C/C++ using the Arduino IDE, is optimized for fast (1–2 seconds) and lightweight performance on low- memory microcontrollers. It is designed to be fully automatic, requiring no user input, and modular in code structure to simplify maintenance.

Security is maintained through local decision- making and restricted communication. The system also includes onboard serial monitoring for easy debugging and uses stable power supply modules (3.3V/5V/12V) to ensure reliable and uninterrupted operation.

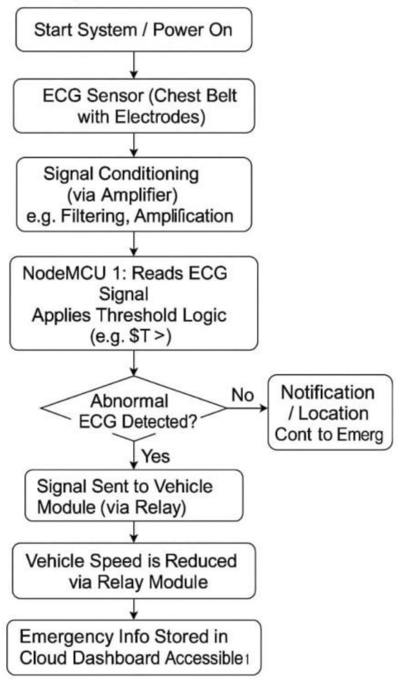

Fig 2: flow chart.

IV. RESULTS AN DISCUSSION

The proposed real-time heart attack detection and warning system was successfully implemented and tested in a controlled environment. The primary goal of detecting abnormal ECG signals using a threshold- based logic and initiating emergency safety responses was achieved with consistent accuracy. The system's core functionality—monitoring the ECG signal through a wearable chest-belt sensor—demonstrated reliable performance in capturing the heart's electrical activity under rest and motion conditions. The analog ECG signal was effectively processed by Node MCU 1, and the threshold-based algorithm correctly identified simulated abnormal heart conditions such as ST elevation.

Upon detection of an abnormal condition, the system automatically triggered two critical responses. First, the connected relay module was activated, which successfully reduced the speed of the DC motor, simulating a vehicle slowdown mechanism. This validated the effectiveness of the relay-based vehicle control integration. Second, the GSM module sent a well-structured SMS alert containing a warning message and the user's real-time GPS location to predefined emergency contacts. The message was received successfully within a few seconds, even under varying GSM signal conditions.

Simultaneously, the GPS module (NEO-6M) accurately retrieved location coordinates and passed them to Node MCU 2, which then uploaded both ECG status and location data to the Ubidots cloud platform. The data was displayed in

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real-time on a dashboard with a location map and ECG status indicators. The Ubidots interface reflected changes with minimal latency, allowing caregivers or remote users to monitor the subject's health status and location without delay.
The system was tested with simulated abnormal signals, and in all test cases, it was able to detect the abnormality, send an alert, reduce vehicle speed, and update the cloud dashboard successfully. The SMS alert format was clear, concise, and correctly embedded the GPS link, allowing emergency contacts to locate the individual instantly.
The power supply modules provided stable operation throughout the testing period, and no data loss or system crashes were observed during continuous use.
In conclusion, the system performed all its intended functions reliably and in real time. It demonstrated that even with a simple threshold-based algorithm and minimal hardware cost, an effective and life-saving wearable heart monitoring solution can be built. The integration of ECG monitoring, GPS, GSM communication, cloud updating, and vehicle control validates the feasibility of deploying such a system in real-world scenarios like driver health monitoring or patient emergency alert systems.

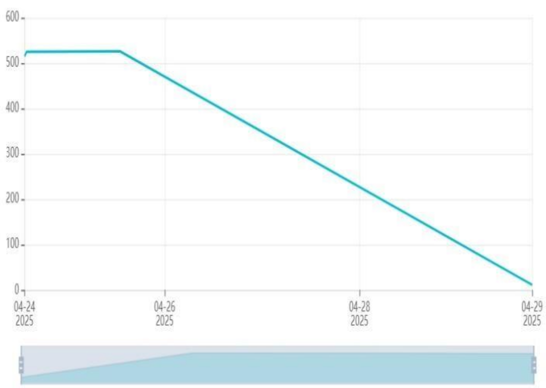

Fig 3: Graph

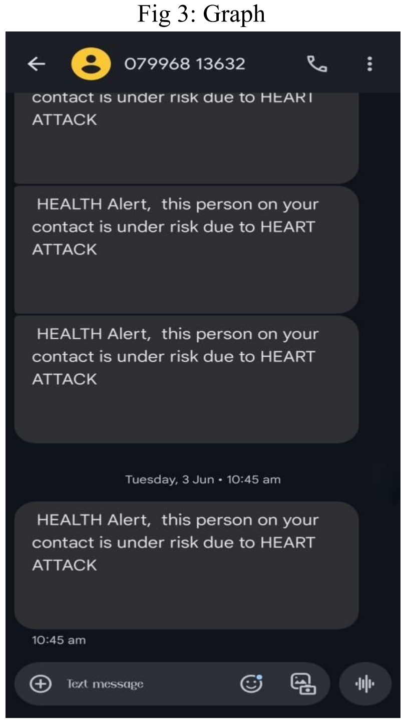

Fig 4: Alert Message

V. ADVANTAGES

- Early Detection of Heart Attacks: The system continuously monitors ECG signals and detects early signs of myocardial infarction (e.g., ST-segment elevation, irregular QRS). This real-time detection provides a crucial time window for life-saving intervention.
- Real-Time Alerts and Emergency Response: Immediate alerts are sent via GSM module to Emergency contacts. Enables quick response, even when the patient is alone or unconscious.
- Accurate Readings via Chest-Based ECG Sensors: Chest placement ensures direct and high-fidelity ECG signal acquisition, significantly better than wrist-based devices. Improves the reliability and clinical relevance of the data.
- Accident Prevention in High-Risk Scenarios: Designed for use while driving. Can be integrated in the future with vehicle safety systems to automatically slow or stop the vehicle during a cardiac event.
- Wearable and User-Friendly: Designed as a lightweight and comfortable chest belt for long-term daily use.
- Cost-Effective and Scalable Solution: Uses affordable sensors and open-source tools, making it feasible for wider adoption, especially in resource-limited areas. Scalable architecture allows for easy updates and feature additions (e.g., GPS, alerts, health record sync).
- Supports Preventive Healthcare Approach: Encourages proactive heart health monitoring and early risk detection, which helps reduce emergency hospitalization and healthcare costs.

VI. CONCLUSION AND FUTURE SCOPE

This project presents the design and implementation of a real-time heart attack detection and warning system using a hardware-based approach without relying on datasets or ma chine learning algorithms. The primary goal is to reduce the risk of accidents caused by sudden cardiac events, particularly in critical environments such as while driving. The system uses affordable and widely available components including a Node MCU microcontroller, heart rate sensor, relay module, GPS, and GSM module, all powered by a stable power supply.

The Node MCU serves as the central controller, collecting real-time heart rate data from the sensor. When it detects an abnormal heart rate (such as a rapid drop or spike indicative of a heart attack), it triggers immediate responses. These include activating a relay (to control connected systems like vehicle ignition or an alert system), sending an SMS alert through the GSM module to preconfigured emergency contacts, and transmitting GPS location data to help responders locate the individual quickly.

The project demonstrates that a simple, cost- effective system can provide timely alerts and location tracking in case of a cardiac emergency. This can significantly enhance safety in high-risk environments and potentially save lives through early detection and rapid response. The key takeaway is that sophisticated software or AI models are not always necessary—effective safety systems can be built with reliable hardware and simple logic.

While the system works well in test scenarios, real-world deployment poses several challenges. Signal reliability from sensors, power stability, and GSM/GPS signal availability in remote or enclosed areas can affect performance. Additionally, making the system user-friendly and fail-safe is critical for real-life usage.

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