Journal on Electronic and Automation Engineering
Vol: 4(2), June 2025
REST Publisher; ISSN: 2583-6951 (Online)
Website: https://restpublisher.com/journals/jeae/
DOI: https://doi.org/10.46632/jeae/4/2/44

Heart Attack Detection and Alerting System Using IOT

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Abstract: *In this project we are implementing a heartbeat monitoring and heart attack detection system using the Internet of things. These days we have an increased number of heart diseases including increased risk of heart attacks. The sensor is then interfaced to a microcontroller that allows checking heart rate readings and transmitting them over internet. The user may set the high as well as low levels of heartbeat limit. After setting these limits, the system starts monitoring and as soon as patient heartbeat goes above a certain limit, the system sends an alert to the controller which then transmits this over the internet and alerts the doctors as well as concerned users, also the system alerts for lower heartbeats. Whenever the user logs on for monitoring, the system also displays the live heart rate of the patient. Thus concerned ones may monitor heart rate as well get an alert of heart attack to the patient immediately from anywhere and the person can be saved on time.*

1. INTRODUCTION

The integration of wearable sensor technology into healthcare applications has paved the way for advanced real-time monitoring systems. This project presents a prototype of a Body Sensor Network (BSN) designed for tracking and monitoring vital physiological parameters such as heart rate, body temperature, and stress levels in real time. The BSN system utilizes various biomedical sensors such as the DHT11 temperature sensor, GSR (Galvanic Skin Response) sensor, and a pulse rate sensor to gather vital health data from an individual—typically a soldier or patient in a critical environment. The sensors are compact, cost-effective, and ideal for portable use, avoiding the bulk and complexity of conventional medical equipment like ECG and EEG machines. The system architecture is based on the ESP32 microcontroller, which is responsible for processing sensor data and managing communication links. Data transmission between the wearable sensors and monitoring systems is enabled through IoT modules, specifically Bluetooth and GSM. The DHT11 sensor captures body temperature, while the pulse rate sensor works on the principle of light modulation caused by blood flow in the fingertip. The GSR sensor measures skin conductivity to detect stress levels, which vary based on emotional and physiological states. This data is transmitted continuously to a mobile application. When any abnormality—such as a heart rate below 60 bpm or a temperature above 38°C—is detected, an SMS alert is triggered and sent to a predefined contact number via the GSM module. This early warning mechanism ensures timely intervention and assistance. The sensors, particularly the pulse sensor, detect changes in blood flow by measuring variations in IR light transmittance through the fingertip. These minute changes are processed using analog components like the LM358 operational amplifier, which amplifies the signal for further digital processing. Accurate pulse rate detection is critical, especially in military and high-risk medical scenarios. However, noise and interference from environmental and physiological sources pose challenges to signal integrity. To overcome this, a hybrid signal processing method is implemented that combines simple analog and digital filtering techniques to suppress noise and enhance signal clarity. The system also aims to handle stress detection using GSR sensors, which measure the skin's electrical conductance. Stress causes physiological changes that are detectable by variations in skin resistance. The GSR module uses two electrodes placed on the fingers and communicates its readings through Bluetooth to the app interface. Along with pulse rate and temperature, these readings contribute to a holistic view of the individual's health condition. Despite being a prototype, the project demonstrates the feasibility of integrating various biomedical sensors with microcontroller-based IoT platforms to create an efficient, portable, and responsive health monitoring solution. This can be particularly beneficial in defense sectors, remote patient care, and emergency response systems. The real-time data acquisition and wireless communication capabilities highlight the potential of such systems in enabling proactive medical assistance. However, as this is a prototype, the system is not intended for clinical deployment due to limitations in sensor accuracy and reliability under diverse environmental conditions. It serves as a proof of concept to validate the integration of microcontrollers and sensors into a real-time health monitoring framework. The project underscores the growing role of microcontrollers in embedded systems and control applications. In modern instrumentation and automation, microcontrollers are at the core of device operations, from data acquisition and signal processing to communication and user interfacing. The ESP32 used in this system supports wireless protocols and provides ample computational power for managing real-time tasks. Furthermore, the Internet of Things (IoT) plays a transformative role in enhancing healthcare delivery. With seamless integration of sensors, communication protocols, and data analytics, IoT enables scalable, efficient, and user-centric health solutions. However, the vast diversity of devices and protocols presents challenges in building standardized architectures for IoT-based health monitoring systems.

2. LITERATURE SURVEY

Heart disease remains a leading cause of death worldwide, highlighting the need for early detection and timely intervention. IoT-based healthcare solutions have enabled real-time monitoring of heart-related parameters such as ECG, heart rate, blood pressure, and SpO2 using wearable sensors. Studies like those by Kumar et al. (2019) and Sharma & Verma (2020) have developed systems that combine cloud computing and machine learning to improve detection accuracy and provide timely alerts. Low-cost microcontrollers with GSM modules have also been used to notify emergency contacts during critical events. Advances in Bluetooth Low Energy and mobile apps enhance usability and power efficiency, while platforms like ThingSpeak support long-term health tracking. Despite progress, challenges like data privacy and false positives remain, but the potential of IoT in cardiac care is promising.

3. EXISTING METHODS

IoT-based systems have significantly advanced heart rate monitoring and heart attack detection by enabling real-time, remote access to patient data through devices like Node MCU and pulse sensors. These systems monitor heartbeats and trigger alerts when readings fall outside normal ranges, notifying healthcare providers via mobile apps. ECG signals play a key role in detecting myocardial infarctions, with machine learning models like CNNs showing high accuracy in classifying abnormal patterns. Wearable devices further support continuous monitoring by tracking heart rate, ECG, blood pressure, and SpO2. Studies highlight that combining multiple sensors improves detection accuracy and allows early intervention, making these technologies vital for preventive cardiac care.

The objective of proposed method is to create a real-time monitoring system for both heart rate monitoring and heart attack detection. This entails integrating multiple sensors to detect potential heart problems early on, preventing them from escalating. Additionally, a doctor alert system is developed to swiftly disseminate warnings and aid in prompt response and rescue efforts. This includes implementing an alarm mechanism comprising various devices like panic switches LCD screens, and GMS modules to alert doctor about patient condition earlier.

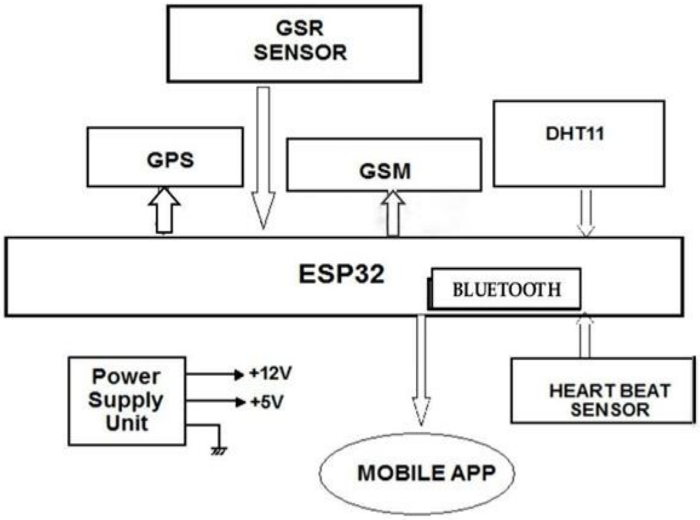


FIGURE 1. Block Diagram

4. HARDWARE DESCRIPTION

The ESP32 is a low-cost, low-power microcontroller with built-in Wi-Fi and Bluetooth, making it ideal for IoT applications. It features either an Xtensa LX6/LX7 or RISC-V processor, with dual-core or single-core options. The chip includes components like antenna switches, RF balun, power amplifier, and power management modules. Often integrated into development boards, the ESP32 provides GPIO pins and connectors, offering flexibility for various embedded systems and sensor-based projects.

- Xtensa single-/dual-core 32-bit LX6 microprocessor
- Supports single-precision Floating Point Unit (FPU)
- Wi-Fi: 802.11 b/g/n
- Bluetooth: v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)
- 34 GPIOs × 12-bit SAR ADCs, up to 18 channels
- 12× 8-bit DAC

Key Features of CPU: The ESP32 employs a Tensilica Xtensa LX6 microprocessor, available in both dual core and single-core variations, operating at 160 or 240 MHz. It can perform up to 600 DMIPS.
Ultra-Low-Power Co-Processor: This co-processor is designed for low-power applications, allowing the main processor to remain in a low-power state while still performing tasks.

FIGURE 2. ESP 32 Board

- RAM: 520 KiB SRAM.
- ROM: 448 KiB
- Wireless Connectivity
- Wi-Fi: Supports 802.11 b/g/n standards.
- Bluetooth: Version 4.2 BR/EDR and BLE, sharing the radio with Wi-Fi.

Wi-Fi on ESP32:

The ESP32 stands out from other microcontrollers due to its built-in WiFi capabilities, supporting three primary modes: Station Mode, where the ESP32 connects to an existing WiFi network like a mobile device; Access Point Mode, where it creates its own network for initial setup or direct connections; and Combined AP-STA Mode, where it connects to a WiFi network while simultaneously acting as an access point. Typically, the ESP32 is used in Station Mode for IoT applications.

DHT 11 Sensor:

Various temperature sensing methods like RTDs, thermocouples, thermistors, and sensor ICs are commonly used, each selected based on factors such as accuracy, range, cost, and design complexity. However, due to the high cost of real-time temperature sensors, this project uses a potentiometer to simulate body temperature readings as a prototype demonstration. Additionally, humidity—defined as the amount of water vapor in the air—plays a crucial role in many physical, chemical, and biological processes.

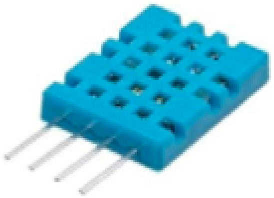


FIGURE 3. DHT 11 Sensor

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring), 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%.

GSM Modem:
In this project, a microcontroller is interfaced with a GSM module to send alerts about abnormal medical parameters like movement, heart rate, and temperature to an authorized doctor. GSM (Global System for Mobile Communication), developed in 1985, enables wireless communication without range limitations, making it ideal for remote health monitoring. It operates using digital signals and Time Division Multiple Access (TDMA), supporting both voice and data calls. GSM networks include components like base stations, mobile switches (MTSO), and use frequency bands such as GSM-900 and GSM-1800. The GSM modem functions like a mobile phone with a SIM card, using standard AT commands to send and receive messages via the microcontroller.

FIGURE 4. GSM Modem

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. GSM modem can be used just like a dial-up modem.

GPS System:
GPS (Global Positioning System) is a radio navigation system that determines precise location, time, and velocity across land, sea, and air, regardless of weather conditions. Originally developed by the U.S. military in the 1960s, GPS is now widely used in various industries, from agriculture to aviation. In this project, the Pro Gin SR-87 GPS module is preferred due to its high sensitivity, reliability, and ability to track up to 20 satellites simultaneously with 1Hz navigation updates. Its quick time-to-first-fix and consistent performance make it ideal for real-time tracking applications like vehicle monitoring and handheld devices.

FIGURE 5. GPS System

The ProGin SR-91 GPS receiver, operating at a 9600-baud rate, is used in this project to capture data such as latitude and longitude from satellite signals. This data is processed by the microcontroller and transmitted via the GSM module. The receiver excludes non-essential details like time, altitude, and satellite names, focusing only on location coordinates (e.g., LAT: 1728.2470, LOG: 7843.3089). With high sensitivity and urban tracking capability, it delivers location accuracy within 50 to 100 meters using trilateration. The receiver continuously outputs GPS data using NMEA commands, making it ideal for real-time vehicle tracking and embedded system integration.

GSR Stress Sensor:
The GSR (Galvanic Skin Response) sensor measures the skin’s electrical conductance, which varies with sweat gland activity triggered by emotional or physical arousal. In this project, the CJMCU-6701 GSR sensor is used to detect stress or emotional changes by attaching electrodes to fingers. The data is read by an Arduino Nano and sent to an

ESP32, which activates a buzzer and transmits data to the Blynk app when abnormal readings occur. The CJMCU-6701 supports analog and SPI communication, works with 3.3V/5V systems, and is ideal for emotion tracking, stress monitoring, and wearable applications due to its high sensitivity and compact size.

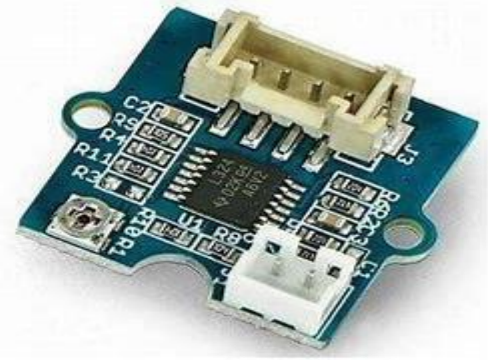


FIGURE 6. GSR Sensor

The image shows a MEMS digital accelerometer sensor module, commonly used in embedded systems to detect motion and acceleration. It likely belongs to the ADXL or MPU series, popular in robotics and IoT applications. The central black chip is the accelerometer IC, mounted on a small PCB with passive components for signal conditioning and voltage regulation. The module features a 4-pin JST connector for microcontroller interfacing and a 3-pin connector, possibly for power or additional outputs. It measures acceleration in multiple axes (X, Y, Z) and communicates via I2C or SPI, making it ideal for applications like gesture recognition, vibration monitoring, and orientation detection in devices like drones and fitness trackers.

Heart Beat Sensor:

A heartbeat sensor, commonly used in Arduino-based projects, measures pulse rate by detecting blood flow using infrared (IR) sensors placed on the fingertip or ear. The sensor emits IR light through the finger, and an IR sensor on the opposite side monitors the light intensity variations caused by blood flow. These changes generate digital pulses that are counted by a microcontroller. The sensor operates on 4mA current and 5V voltage, suitable for mobile applications. If the pulse rate drops below 60 beats per minute, the system sends an alert via GSM. This sensor is widely used in various fields for real-time heartbeat monitoring.

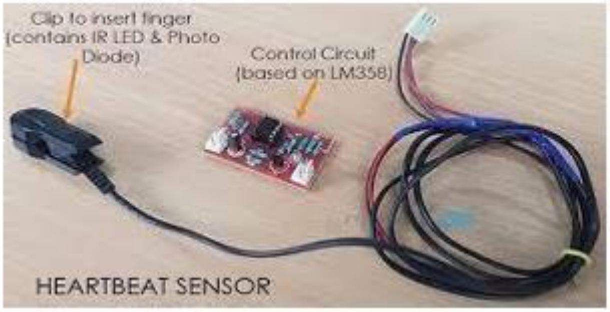


FIGURE 7. Heart Beat Sensor

The heart rate measurement method described here involves calculating beats per minute (BPM) by counting pulse beats over a set time. While the average calculation is simple, it doesn't account for variations between individual heartbeats, making beat-to-beat calculation more accurate for reflecting the heart's response to exercise, stress, or environmental changes. This project uses infrared (IR) sensors in a photoelectric method to monitor blood volume changes at the fingertip, generating digital pulses based on light absorption due to blood flow. The pulse data is then transmitted via a GSM transmitter for monitoring. This method provides a more detailed and precise measurement of heart rate and blood flow.

Bluetooth Module:

Bluetooth wireless technology enables short-range communication between devices, operating over the 2.4 GHz frequency within a 10-meter range. This project uses Bluetooth to control a robotic vehicle via an Android phone, utilizing Bluetooth apps for command input. Android, an open-source platform based on Linux, supports Bluetooth through versions 2.3.4 and above. The Bluetooth module, such as HC-03 or HC-05, facilitates wireless communication between devices by allowing serial data exchange without the need for physical cables. These modules support both master and slave configurations, enabling versatile communication for various applications, including controlling robotic vehicles. The Bluetooth module communicates with the controller through AT commands.

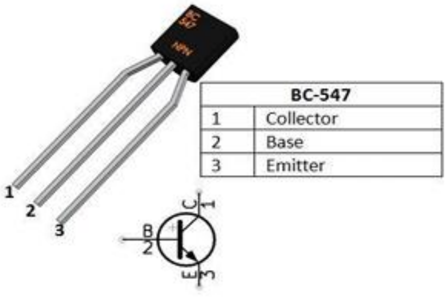
FIGURE 8. Bluetooth Module

BC 547 Transistor:

BC547 is a NPN transistor hence the collector and emitter will be left open (Reverse biased) when the base pin is held at ground and will be closed (Forward biased) when a signal is provided to base pin. If you are a complete beginner with BJTs you can check out this article on the Basics of BJT and How to use them, to get a complete understanding, now lets look more into the BC547 Transistor.

BC547 Transistor Features:

- Bi-Polar NPN Transistor
- DC Current Gain (hFE) is 800 maximum
- Continuous Collector current (IC) is 100mA
- Emitter Base Voltage (VBE) is 6V
- Base Current(IB) is 5mA maximum
- Available in To-92 Package



BC-547	
1	Collector
2	Base
3	Emitter

FIGURE 9. BC 547 Transistor

5. SOFTWARE DESCRIPTION

C Language:

C is a general-purpose, high-level programming language created by Dennis Ritchie at Bell Labs in the 1970s. It's known for its efficiency, flexibility, and portability, making it a popular choice for system programming, embedded systems, and other applications. C is often considered a foundational language in computer science and is the basis for many modern programming languages.

Key Characteristics of C:

General-purpose: C can be used for a wide variety of applications, from system-level programming to embedded systems.

High-level: C provides a higher level of abstraction compared to assembly language, making it easier to understand and use.

Procedural: C programs are structured using procedures or functions, which are blocks of code that perform specific tasks.

Efficient: C is compiled, meaning it is translated into machine code, resulting in fast execution speed.

Portable: C programs can be easily transferred to different computer platforms with minimal modifications.

Applications of C:

Operating systems: C was used to develop the UNIX operating system and continues to be used for other operating systems.

Embedded systems: C is used to write software for devices like microcontrollers and embedded processors. System programming: C is used for developing software that interacts directly with the hardware, such as drivers and kernels.

Game development: C is used for game engine development and other game-related tasks.

Database management systems: C is used in the development and implementation of database systems.

In summary, C is a powerful and versatile language that has been widely used for over 50 years. Its efficiency, flexibility, and portability make it a valuable tool for various programming tasks, including system programming, embedded systems, and game development.

6. RESULTS

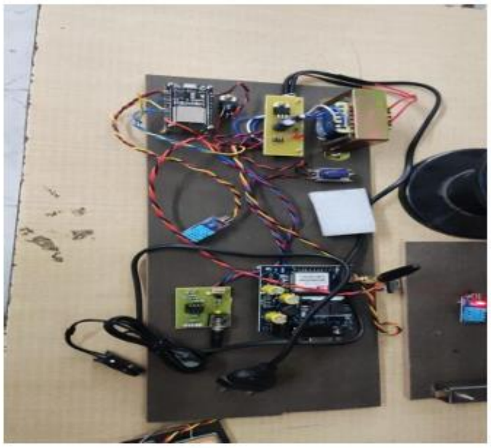


FIGURE 10. Hardware Prototype

Heart rate monitoring is commonly found in wearable like fitness trackers and smart watches, using sensors that detect heart signals and convert them to digital data via an ADC like the Max10300. The ESP32 microcontroller processes and transmits this data through IoT, supporting languages like Micro Python and Arduino. Real-time algorithms can detect irregular rhythms, such as ventricular fibrillation, and trigger alerts for medical help. While useful for monitoring heart health, these devices should not replace professional medical advice or treatment.

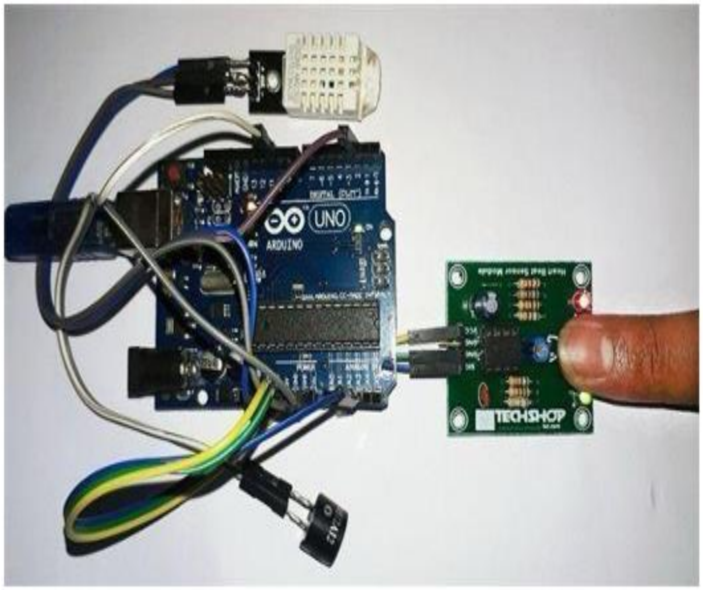


FIGURE 11. Heart Rate Monitoring

All things considered, a heart attack detection and heart rate monitor using an IoT ESP Node MCU 32 and a Max10300 heart rate sensor can be a valuable tool for keeping an eye on heart health and spotting impending cardiac problems. It's crucial to remember that a device like this shouldn't be used in place of expert medical guidance and treatment.

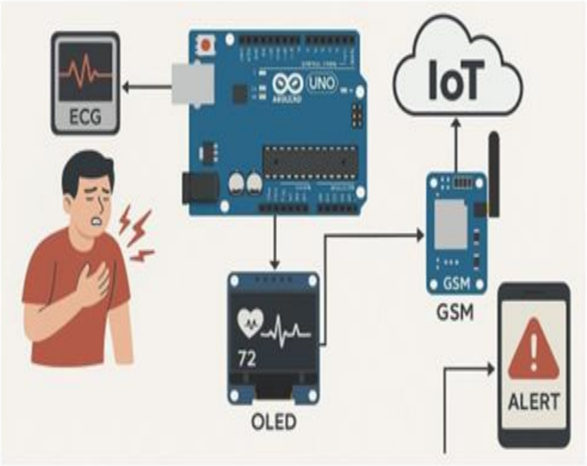


FIGURE 12. Heart attack Detection

This system uses various sensors connected to an ESP32 microcontroller for real-time heart health monitoring. It includes a heartbeat sensor (Max10300), GSR sensor for stress detection, and optionally, temperature, oxygen level, and ECG sensors. The ESP32 processes the data and detects signs of a potential heart attack, with built-in Wi-Fi and Bluetooth for communication. Bluetooth transmits data locally to smartphones or wearable, while the GSM module sends SMS alerts to emergency contacts or medical personnel. The GPS module provides location details, helping responders reach the user quickly. Alerts are triggered through smartphone apps for immediate awareness. Though helpful for monitoring heart health, this system should complement professional medical advice, not replace it.

7. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

Existing heart attack detection systems, while advanced, have several limitations. These include issues with accuracy, such as false positives (alerts triggered by non-heart attack events) and false negatives (undetected heart attacks), as well as limited data interpretation that doesn’t consider personal history or context. Real-time limitations like alert latency and poor connectivity can hinder effectiveness, while hardware issues like battery life and sensor calibration challenges persist. Additionally, advanced devices can be costly and inaccessible to low-income or rural populations. However, the advantages include early detection that saves lives, automated emergency alerts, continuous 24/7 monitoring, and support for at-risk groups like the elderly. These systems are also cost-effective in the long term by reducing hospital visits and offering insurance incentives. They are particularly useful in military, rural healthcare, and areas with limited access to specialized care.

8. CONCLUSION

The "Heart Attack Detection and Alerting System" prototype was successfully developed, demonstrating effective monitoring of heart rate, body temperature, and location, particularly for military or defense applications. While the prototype uses locally available components and is not fully optimized, it highlights the potential for a low-cost, high-precision wireless biomedical system. This system integrates advancements in wireless and embedded technology to enhance soldier safety and security during critical missions. By providing real-time health data and location alerts, it can reduce casualties and improve the overall defense system, showcasing the importance of MHealth in ensuring the well-being of soldiers.

Future Scope: The future of heart attack detection and alerting systems will be revolutionized by advancements in AI, machine learning, and IoT, offering real-time predictive analytics based on vital signs, health data, and lifestyle patterns. Wearable devices will become more compact, energy-efficient, and noninvasive, enabling continuous monitoring with minimal intervention. With enhanced connectivity via 5G and cloud computing, emergency responses will be faster and integrated with telemedicine. These systems will offer personalized health recommendations and adaptive alerts, empowering individuals to take control of their heart health. As these technologies become more accessible, they will improve public health, particularly in remote areas, reduce mortality rates, and enhance quality of life for at-risk populations.

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