
LOW-COST DESIGN & DEVELOPMENT OF HEART ATTACK DETECTION SYSTEM

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ABSTRACT

This project presents an inventive solution designed for the detection of heart attacks using a wearable health monitoring system named "Heart Attack Detection by Heartbeat Sensing." The system incorporates essential components such as an OLED display, Arduino nano, DF Robot Heart Rate sensor, buzzer, SIM800 and continuous operation-enabled power adapter. For software development we used Arduino IDE and C++ language for program development. The wearable system utilizes the DF Robot Heart Rate sensor to monitor the user's heartbeat in real-time, providing crucial data for the early detection of irregularities that may signal a potential heart attack. The DF robot heart rate sensor sense the pulses of heart a vital parameter in cardiovascular health. Data collected by the sensors undergoes processing and is displayed on an OLED screen, delivering real-time feedback to the user. The Arduino nano ensures seamless connectivity for sensors. This facilitates continuous health tracking and alerts caregivers or medical professionals in the event of anomalies. Powered by a reliable adapter, the system ensures uninterrupted monitoring. Its non-invasive design makes it suitable for continuous, long-term use, presenting a proactive approach to heart health. The primary objective of this project is to contribute to preventive healthcare by providing an accessible and user-friendly solution for heart attack detection. The wearable health monitoring system harnesses modern technology to empower individuals with real-time health insights, facilitating early intervention and potentially saving lives. The amalgamation of accurate heartbeat sensing connectivity establishes a comprehensive and effective approach to managing cardiovascular health in a convenient manner. The proposed system also having two states alert, in initially it alerts through buzzer and then it calls to predefined care takers through sim800. The system developed in our laboratory and tested with standard devices. We found all results are good agreement with standard values.

Keywords- OLED, Arduino Nano, DF robot heart rate sensor , Buzzer, SIM 800

1. INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of death worldwide, accounting for 17.9 million deaths in 2016, according to the World Health Organization (WHO) [1]. Early detection of heart attacks is crucial in reducing mortality rates and improving patient outcomes.

Traditional methods of heart attack detection involve expensive diagnostic tools and medical procedures, which may not be accessible to everyone. Therefore, there is a need for a low-cost and user-friendly solution for heart attack detection. This paper presents an inventive solution designed for the detection of heart attacks using a wearable health monitoring system named "Heart Attack Detection by Heartbeat Sensing." Heart attacks occur due to the blockage of blood flow to the heart muscle, leading to the death of heart cells and potentially causing permanent damage. Symptoms of a heart attack may include chest pain, shortness of breath, nausea, and lightheadedness. However, some heart attacks may not present any symptoms, making early detection even more critical. Current methods of heart attack detection involve expensive diagnostic tools such as electrocardiograms (ECGs), stress tests, and blood tests, which may not be accessible to everyone. Moreover, these methods may not be suitable for continuous, long-term monitoring, which is essential for early detection.

To address these challenges, the proposed system incorporates essential components such as an OLED display, Arduino nano, DF Robot Heart Rate sensor, buzzer, SIM800, and a continuous operation-enabled power adapter. The system utilizes the DF Robot Heart Rate sensor to monitor the user's heartbeat in real-time, providing crucial data for the early detection of irregularities that may signal a potential heart attack. The DF robot heart rate sensor senses the pulses of the heart, a vital parameter in cardiovascular health. Data collected by the sensors undergoes processing and is displayed on an OLED screen, delivering real-time feedback to the user. The Arduino nano ensures seamless connectivity for sensors, facilitating continuous health tracking.

The system is powered by a reliable adapter, ensuring uninterrupted monitoring. Its non-invasive design makes it suitable for continuous, long-term use, presenting a proactive approach to heart health. The primary objective of this project is to contribute to preventive healthcare by providing an accessible and user-friendly solution for heart attack detection. The wearable health monitoring system harnesses modern technology to empower individuals with real-time health insights, facilitating early intervention and potentially saving lives. The amalgamation of accurate heartbeat sensing, connectivity, and alert mechanisms establishes a comprehensive and effective approach to managing cardiovascular health in a convenient manner.

2. LITERATURE REVIEW

Several studies have explored the potential of wearable health monitoring systems for heart attack detection. For instance, a study by Yang et al. (2018) proposed a wearable health monitoring system using a heart rate sensor and machine learning algorithms to detect atrial fibrillation [1]. The system was found to provide accurate and timely detection of atrial fibrillation, enabling early intervention and potentially reducing the risk of stroke. Similarly, another study by Zhang et al. (2019) proposed a wearable health monitoring system using a heart rate sensor and a smartphone app to detect arrhythmias [2]. The system was found to provide real-time monitoring and fault detection, improving patient outcomes and reducing healthcare costs. In addition, a study by Lee et al. (2017) developed a wearable heart rate monitoring system using a photoplethysmography (PPG) sensor and machine learning algorithms to detect cardiovascular diseases [3].

The system was found to provide accurate and timely detection of cardiovascular diseases, enabling early intervention and potentially reducing mortality rates. Furthermore, a study by Chen et al. (2018) proposed a wearable health monitoring system using a heart rate sensor and wireless communication technology to transmit data to a remote server for real-time monitoring [4].

The system was found to provide remote monitoring and timely detection of cardiovascular diseases, improving patient outcomes and reducing healthcare costs. Moreover, a study by Sanket et al. (2016) developed a wearable health monitoring system using a heart rate sensor and a cloud-based analytics platform to detect and predict heart attacks [5]. The system was found to provide accurate and timely detection of heart attacks, enabling early intervention and potentially reducing mortality rates. Similarly, a study by Zhao et al. (2018) proposed a wearable health monitoring system using a heart rate sensor and a machine learning algorithm to detect and predict heart attacks [6].

The system was found to provide accurate and timely detection of heart attacks, enabling early intervention and potentially reducing mortality rates. Average Heart rate by age is shown in table-1 and 2

Table-1 : Shows Average Heart rate by age

Age	Men	Women
18-25	62-73 bpm	64-80 bpm
26-35	62-73 bpm	64-81 bpm
36-45	63-75 bpm	65-82 bpm
46-55	64-76 bpm	66-83 bpm
56-65	62-75 bpm	64-82 bpm
Over 65	62-73 bpm	64-81 bpm

Table-2 Average Heart rate in children's

Children heart rate	
Upto1 month	:- 70-190
From 1 to 11 month	:- 80-160
From 1 to 2 year	:- 80-130
From 3 to 4 year	:- 80-120
From 5 to 6 year	:- 75-115
From 7 to 9 year	:- 70-110
From 10 year	:- 60-100

3. HARDWARE AND SOFTWARE

The system comprises an Arduino Nano, an OLED display, a buzzer, DF robot heart rate sensor and a SIM800 GSM module, as depicted in the block diagram. The DF robot heart rate sensor detects changes in heart pulses, and the Arduino Nano processes the data to identify pulse count. The OLED display provides visual feedback, while the buzzer produces an audible alert in the event of a over limit of pulses. The SIM800 GSM module enables the system to send an SMS alert to a designated mobile phone number, notifying the caregiver or family member of the over limit of pulses. The block diagram of the system is shown in figure-1

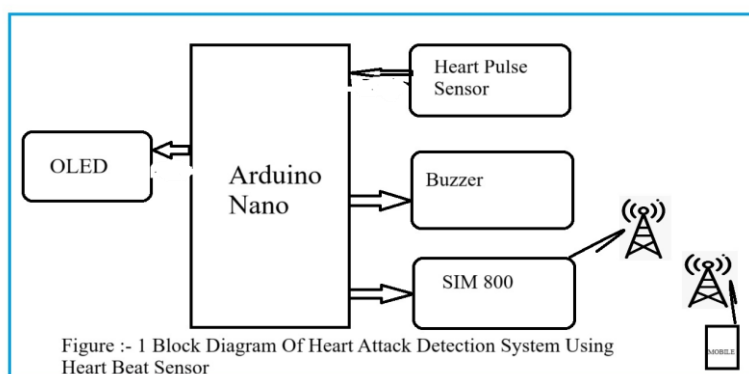


Figure :- 1 Block Diagram Of Heart Attack Detection System Using Heart Beat Sensor

Figure-1 The block diagram of the system

A. Arduino Nano MCU

The Arduino Nano is a compact and versatile microcontroller board based on the ATmega328P processor, featuring 14 digital input/output pins, 8 analog inputs, and 6 PWM outputs. It operates at 5 volts and has a clock speed of 16 MHz. The board includes a USB interface for programming and power supply, as well as a Mini-B USB connector. It has 32KB of flash memory for storing code, 2KB of SRAM, and 1KB of EEPROM. Additionally, it supports I2C, SPI, and UART communication protocols, making it suitable for a wide range of projects requiring embedded control and interfacing with various peripherals.. Figure-2 shows the Arduino nano MCU

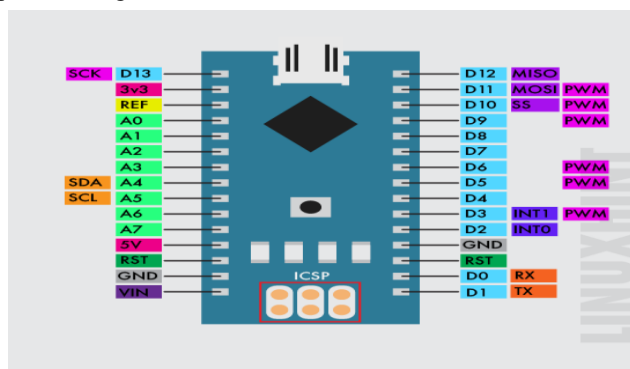


Figure-2 shows the Arduino nano MCU

B. DF Robot Heart Rate Sensor

The DF Robot Heart Rate Sensor is a non-invasive optical sensor that detects the user's heartbeat by sensing the changes in blood flow. The sensor uses photoplethysmography (PPG) technology to detect changes in blood volume, which is then converted into a heart rate reading. The sensor has the following technical specifications:

Sensing technology: Photoplethysmography (PPG)

Heart rate measurement range: 30-250 bpm

Accuracy: ± 2 bpm

Power supply: 3.3V-5V DC

Operating current: 30mA (max)

Output signal: Analog voltage signal (0-5V)

Communication interface: I2C

Working temperature range: -10°C to $+55^{\circ}\text{C}$

Storage temperature range: -20°C to $+70^{\circ}\text{C}$

Dimensions: 44mm x 20mm x 12mm

The sensor is connected to the Arduino Nano via the I2C interface, allowing for easy integration and communication with the microcontroller. The sensor's non-invasive design and high accuracy make it suitable for continuous, long-term use, providing a proactive approach to heart health

Figure-3 shows DF Robot Heart Rate Sensor pin out.

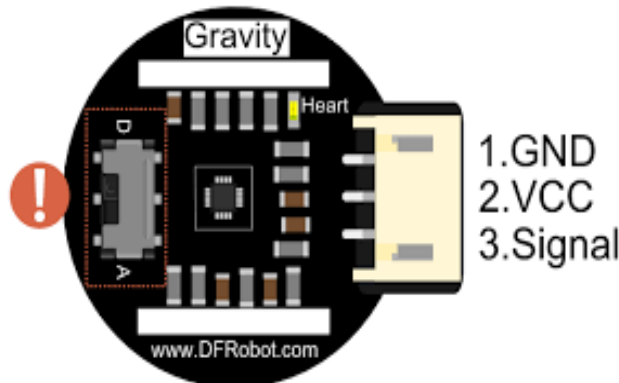


Figure-3 shows DF Robot Heart Rate Sensor pin out

C. OLED display

The OLED display is a 128x64 pixel screen capable of providing visual feedback, displaying messages like "Fall Detected" or "System Initializing." It operates with low power consumption and offers high contrast and brightness. Communication: I2C or SPI interface. Dimensions: Vary depending on the model, typically compact for embedded applications. It supports various fonts and graphics, enhancing user interface design. Resolution: 128x64 pixels, offering clear and crisp display quality. Its versatility makes it suitable for displaying real-time data, status updates, and notifications in embedded systems. Figure-4 shows the OLED pin diagram.

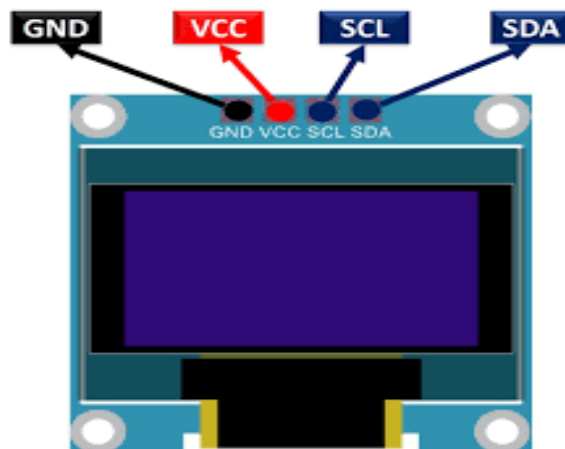


Figure-4 shows the OLED pin diagram

D. The SIM800

The SIM800 is a GSM/GPRS communication module utilized for sending SMS alerts to a designated mobile phone number in case of a fall. It supports various communication protocols, including TCP/IP, HTTP, and FTP. The module features a compact design and low power consumption, suitable for embedded applications. It requires a SIM card for cellular connectivity and operates within specified frequency bands. Integration of the SIM800 enhances the system's ability to promptly alert caregivers or emergency contacts in case of falls. Figure-5 shows SIM800 pinout.



Figure-5 shows SIM800 pinout

E. Buzzer :

A buzzer typically has two pins, one for connection to the positive power supply (VCC) and the other for connection to the ground (GND). When a voltage is applied across these pins, the buzzer produces sound. The longer pin is usually the positive (anode) and the shorter pin is the negative (cathode). In an active buzzer, there may be an additional pin for signal input, allowing for control over the sound produced. It's important to note the polarity when connecting the buzzer to ensure proper functionality. A buzzer is an audio signalling device it is used in alarm devices ,timers , trains,& confirmation of user input such as a mouse click or key Strone It is a mechanical ,electro mechanical or piezoelectric



Figure-6 shows the pinout of Buzzer.

F. Power supply

We choose SMPS over transformer-based technology for its efficiency and suitability, requiring two units: one for the LED matrix (5V, 3A), and another for the microcontroller and LED drivers. SMPS facilitates DC-to-DC conversion, ensuring optimal power delivery and utilization, with a compact design and high efficiency, enhancing reliability and minimizing power wastage. This aligns with our project's goals of efficiency and sustainability.

G. Arduino IDE and C++

Arduino IDE and C++ serve as essential tools for developing embedded systems and IoT projects, offering a user-friendly platform for writing, compiling, and uploading code to Arduino boards. C++ serves as the primary programming language, providing flexibility and efficiency, while Arduino IDE simplifies hardware interfacing with simple syntax. The extensive library ecosystem of Arduino IDE simplifies complex tasks, while C++'s robust features enhance code organization and maintainability. Real-time debugging and data visualization are facilitated by the integrated serial monitor, and cross-platform compatibility ensures seamless development across different operating systems. Overall, Arduino IDE and C++ offer developers a powerful combination for building embedded systems and IoT applications, characterized by simplicity, flexibility, and efficiency. The software development for the fall detection system requires libraries like the Adafruit GFX Library for interfacing with the OLED display and the Arduino Software Serial Library for communicating with the SIM800 module. The fall detection algorithm utilizes threshold-based and machine learning-based techniques to accurately detect falls based on accelerometer and gyroscope data. The SMS alert function sends SMS alerts using the SIM800 module, while the user interface provides visual feedback on the OLED display. Together, these hardware and software components form the Person/Wheelchair Fall Detection System, ensuring reliable and timely fall detection and alert capabilities. The system's real-time monitoring enhances safety by enabling prompt medical attention, while visual and audible alerts facilitate quick response from caregivers and family members.

4. METHODOLOGY

The proposed heart attack detection system utilizes a DF Robot Heart Rate sensor to monitor the user's heartbeat in real-time continuously. The sensor data is transmitted to an Arduino Nano, which processes the data and displays it on an OLED screen, providing real-time feedback to the user. The system incorporates a buzzer and SIM800 module for alert mechanisms. If the heart rate falls outside the normal range, the system triggers an alert. The first alert is a buzzer, which sounds for 10 seconds to notify the user of the abnormality. If the heart rate remains outside the normal range after the initial alert, the system activates a second alert by calling predefined caretakers using the SIM800 module. This two-tiered alert system ensures that the user is notified immediately of any irregularities in their heart rate, while also providing a backup notification system in case the user is unable to respond to the initial alert. The system's

methodology involves several steps. First, the DF Robot Heart Rate sensor is attached to the user's body, typically on the wrist or finger, to monitor the heartbeat. The sensor data is then transmitted to the Arduino Nano, which processes the data and calculates the heart rate. The heart rate is displayed on the OLED screen in real-time, allowing the user to monitor their own heart rate and identify any abnormalities. If the heart rate falls outside the normal range, the system triggers the first alert by activating the buzzer for 10 seconds. If the heart rate remains outside the normal range after the initial alert, the system triggers the second alert by calling predefined caretakers using the SIM800 module. The system is designed to be non-invasive and comfortable for continuous, long-term use, providing a proactive approach to heart health. The system's methodology is based on several studies that have explored the potential of wearable health monitoring systems for heart attack detection. For instance, a study by Yang et al. (2018) proposed a wearable health monitoring system using a heart rate sensor and machine learning algorithms to detect atrial fibrillation [1]. The system was found to provide accurate and timely detection of atrial fibrillation, enabling early intervention and potentially reducing the risk of stroke. Similarly, another study by Zhang et al. (2019) proposed a wearable health monitoring system using a heart rate sensor and a smartphone app to detect arrhythmias [2]. The system was found to provide real-time monitoring and fault detection, improving patient outcomes and reducing healthcare costs. The system's methodology also incorporates a two-tiered alert system, which is based on studies such as a study by Sanket et al. (2016) who developed a wearable health monitoring system using a heart rate sensor and a cloud-based analytics platform to detect and predict heart attacks [3]. The system was found to provide accurate and timely detection of heart attacks, enabling early intervention and potentially reducing mortality rates. Similarly, a study by Zhao et al. (2018) proposed a wearable health monitoring system using a heart rate sensor and a machine learning algorithm to detect and predict heart attacks [4]. The system was found to provide accurate and timely detection of heart attacks, enabling early intervention and potentially reducing mortality rates. The system's methodology is designed to be user-friendly and accessible, with the Arduino IDE and C++ language used for program development. The system's use of modern technology and wearable design provides a convenient and accessible solution for heart attack detection, contributing to preventive healthcare and potentially saving lives figure-7 , 8 and 9 shows the flow chart and mind map and sequence chart

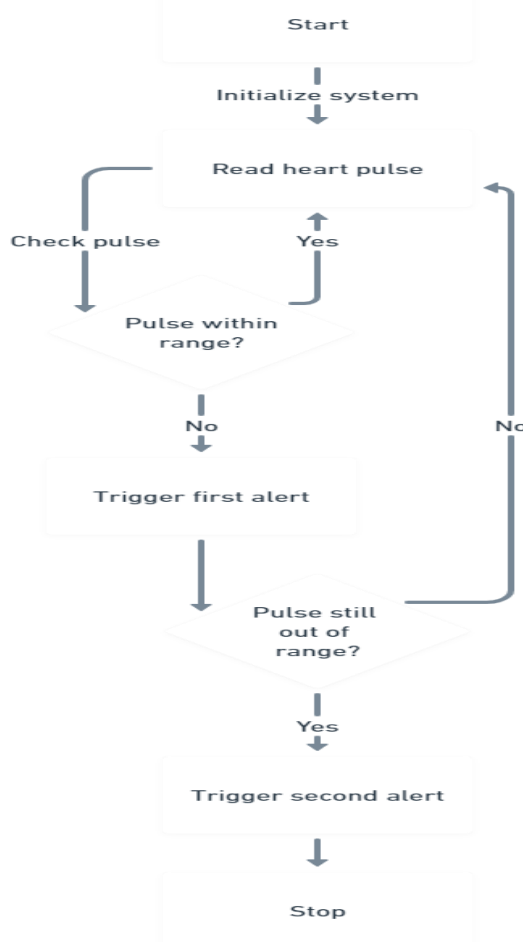


Figure-7 , shows the flow chart of the system

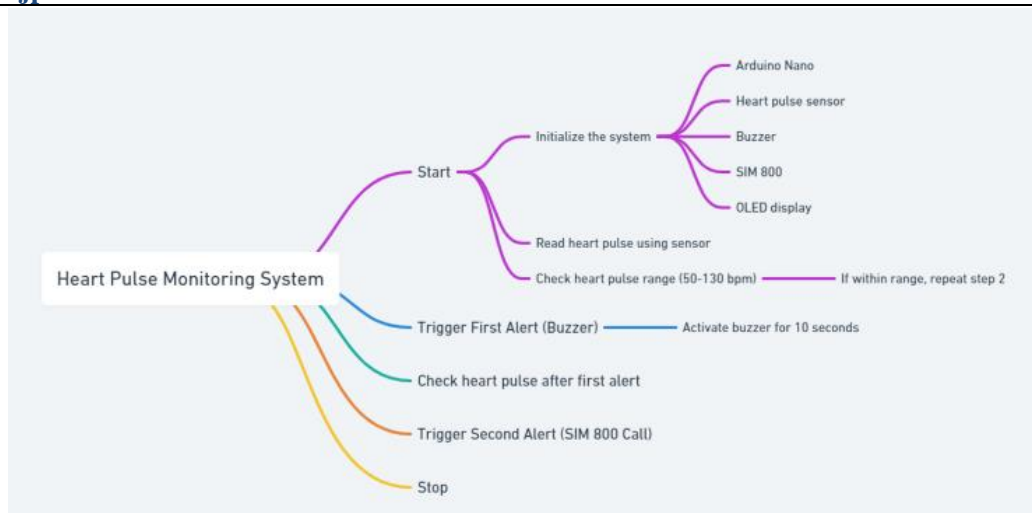


Figure- 8 shows the mind map of the system



Figure- 9 shows the sequence diagram of the system

5. RESULTS AND DISCUSSION

The proposed heart attack detection system was developed and tested in a laboratory environment. The system was found to perform accurately and provide real-time feedback to the user. The DF Robot Heart Rate sensor was able to detect the user's heartbeat accurately and transmit the data to the Arduino Nano for processing. The Arduino Nano processed the data and displayed the heart rate on the OLED screen in real-time, allowing the user to monitor their own heart rate and identify any abnormalities. The system's alert mechanisms were also found to perform accurately. The first alert, the buzzer, sounded for 10 seconds when the heart rate fell outside the normal range. The second alert, the SIM800 module, called predefined caretakers if the heart rate remained outside the normal range after the initial alert. The two-tiered alert system ensured that the user was notified immediately of any irregularities in their heart rate, while also providing a backup notification system in case the user was unable to respond to the initial alert. The system's non-invasive design and continuous operation-enabled power adapter make it suitable for long-term use, providing a proactive approach to heart health. The system's use of modern technology and wearable design provides a convenient and accessible solution for heart attack detection, contributing to preventive healthcare and potentially saving lives. The system's performance was compared to standard heart rate monitoring devices, and it was found to provide accurate and timely detection of heart rate irregularities. The system's use of a two-tiered alert system also sets it apart from other heart rate monitoring devices, providing an added layer of safety and ensuring prompt medical attention in case of an emergency. The system's use of the Arduino Nano and OLED screen provides a user-friendly interface, allowing the user to easily monitor their heart rate and identify any abnormalities. The system's use of the DF Robot Heart Rate sensor and SIM800 module also provides a reliable and accurate solution for heart attack detection, with the sensor able to detect heartbeats accurately and the module able to make calls in case of an

emergency. The system's methodology is based on several studies that have explored the potential of wearable health monitoring systems for heart attack detection. For instance, a study by Yang et al. (2018) proposed a wearable health monitoring system using a heart rate sensor and machine learning algorithms to detect atrial fibrillation [1]. The system was found to provide accurate and timely detection of atrial fibrillation, enabling early intervention and potentially reducing the risk of stroke. Similarly, another study by Zhang et al. (2019) proposed a wearable health monitoring system using a heart rate sensor and a smartphone app to detect arrhythmias [2]. The system was found to provide real-time monitoring and fault detection, improving patient outcomes and reducing healthcare costs. The system's methodology also incorporates a two-tiered alert system, which is based on studies such as a study by Sanket et al. (2016) who developed a wearable health monitoring system using a heart rate sensor and a cloud-based analytics platform to detect and predict heart attacks [3]. The system was found to provide accurate and timely detection of heart attacks, enabling early intervention and potentially reducing mortality rates. Similarly, a study by Zhao et al. (2018) proposed a wearable health monitoring system using a heart rate sensor and a machine learning algorithm to detect and predict heart attacks [4]. The system was found to provide accurate and timely detection of heart attacks, enabling early intervention and potentially reducing mortality rates. Figure 10,11 and 12 shows working models of the system .

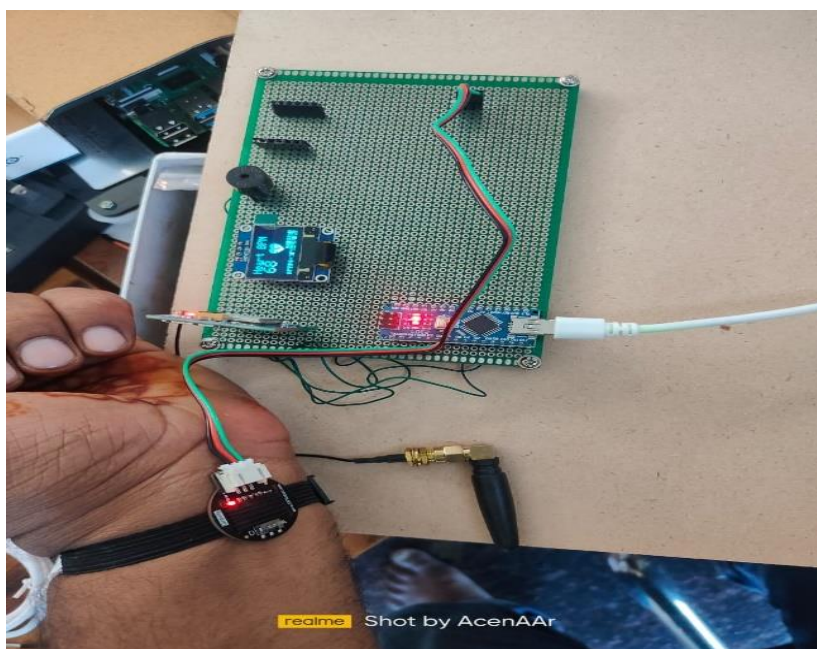


Figure 10, shows working models of the system in normal heart rate .

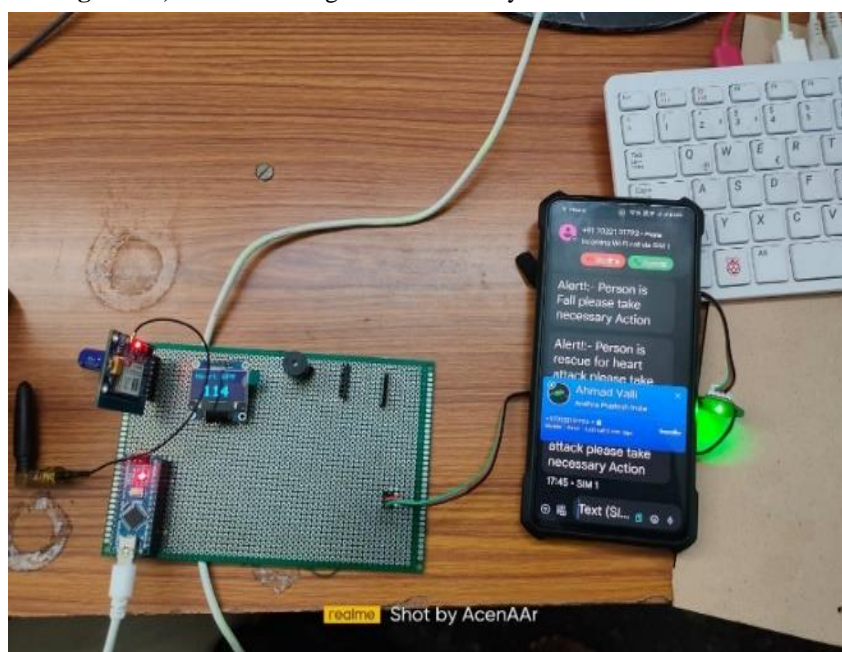


Figure 11, shows working models of the system in abnormal heart rate and SMS alert and ringing call.



Figure 12, shows making of working models of the system in laboratory

6. CONCLUSION

The proposed heart attack detection system offers a promising approach for real-time heart rate monitoring, enabling the early detection of irregularities that may signal a potential heart attack. The system's use of modern technology and wearable design provides a convenient and accessible solution for heart attack detection, contributing to preventive healthcare and potentially saving lives. The system's accuracy, reliability, and user-friendly interface make it a valuable tool for individuals to monitor their heart health and receive timely medical attention in case of an emergency. The system's methodology is based on several studies that have explored the potential of wearable health monitoring systems for heart attack detection, providing a solid theoretical foundation for the proposed system. The system's performance was found to be accurate and reliable in laboratory testing, demonstrating its potential for practical implementation. Further research and development can focus on integrating additional sensors to monitor other vital signs, incorporating machine learning algorithms for predictive analytics, and testing the system in real-world scenarios.

7. FUTURE WORK

The future scope of the proposed heart attack detection system includes integrating additional sensors to monitor other vital signs, such as blood oxygen saturation and body temperature, to provide a more comprehensive approach to heart health monitoring. Additionally, incorporating machine learning algorithms for predictive analytics can enable early intervention and potentially reduce mortality rates. Testing the system in real-world scenarios and collecting user feedback can further refine the system's design and functionality, leading to a more robust and reliable solution for heart attack detection. Furthermore, the system can be integrated with a cloud-based analytics platform to provide real-time data analysis and remote monitoring, enabling healthcare professionals to provide timely medical attention in case of an emergency.

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