International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Smart Heart Rate Monitoring and Heart Attack Detection system based on IOT

Radhika R.Kulkarni [1], Ms. Samruddhi S. Kulkarni[2], Sanchita S Mahamuni [3], Swapnil R.Takale [4]

[1,2,3] *UG Students, SKN Sinhgad Colllege of Engineering, Pandharpur, 413304, India*
[4] *Assistant Professor, SKN Sinhgad Colllege of Engineering, Pandharpur, 413304, India*

A B S T R A C T

In recent years, the application of Internet of Things (IoT) technology in the healthcare sector has significantly improved the monitoring and management of chronic illnesses and urgent health scenarios. This initiative aims to create a real-time IoT-based system for detecting heart attacks and monitoring heart rates, which continuously observes the user's heart rate and other vital signs to identify early indicators of a heart attack. Utilizing sensors like ECG(Electrocardiogram) and PPG(Photoplethysmography), the system gathers comprehensive heart activity data, which is then processed and analyzed by a microcontroller linked to a Wi-Fi module (ESP8266 or ESP32).This information is sent to a cloud server for further examination using machine learning algorithms that detect irregular patterns and potential heart attack risks. The system promptly notifies the user, caregivers, and healthcare professionals through a mobile application, facilitating timely medical intervention. This method of heart attack detection not only enhances preventive care but also improves emergency response and supports remote patient monitoring, providing a scalable and effective solution to decrease cardiac-related deaths.

Keywords: Node MCU, Sensors, I2C module, Buzzers.

Introduction

Heart disease continues to pose a significant health challenge, accounting for millions of fatalities annually and impacting individuals across various demographics. Among the range of cardiovascular issues, heart attacks, or myocardial infarctions, are particularly lethal if not identified and treated swiftly. Often, early warning signs go unnoticed due to insufficient continuous monitoring, particularly in high-risk patients who lack regular medical oversight. Conventional heart rate and ECG monitoring methods typically necessitate patient visits to healthcare facilities or the use of bulky equipment, which restricts the feasibility and accessibility of real-time, ongoing monitoring. The advent of the Internet of Things (IoT) in the healthcare sector has paved the way for innovative methods of monitoring and addressing health emergencies. IoT technology facilitates a network of interconnected devices that can gather, process, and relay data in real-time, enabling the development of wearable devices that can continuously monitor heart health outside of clinical environments. These IoT- driven systems hold the promise of significantly improving the detection and management of heart- related issues by empowering individuals to monitor their heart health in real-time, regardless of their location. This initiative seeks to design and implement an IoT-based system for heart attack detection and heart rate monitoring, utilizing a blend of sensors, microcontrollers, and wireless communication to ensure continuous, real-time heart monitoring. By incorporating ECG (Electrocardiogram) and PPG (Photoplethysmography) sensors, the system gathers extensive data on heart rate variability, blood circulation, and the heart's electrical activity. The microcontroller processes this information locally and subsequently transmits it to a cloud server via a Wi-Fi module (such as the ESP8266 or ESP32). The cloud server employs machine learning algorithms to analyze the incoming data, detecting irregular heart patterns that may signal a potential heart attack or other cardiac conditions.

Age	**Heart Rate**
New born baby	140
7year	85-90
14year	80-85
Adult	70-80
Athletes	60-100

Table 1.1 Table of Average Heart Rate

Heart rate averages differ across age groups, indicating variations in metabolic and cardiac efficiency. Newborns exhibit the highest heart rates, ranging from 100 to 160 beats per minute (bpm). Toddlers typically have rates between 80 and 120 bpm, while school-aged children average between 70 and 100 bpm. For adults, the normal range is generally 60 to 100 bpm. Athletes often present lower heart rates, attributed to superior cardiovascular fitness. In older adults, heart rates may experience a slight increase due to age-related changes in heart function. Keeping track of these ranges is essential for effectively detecting any abnormalities.

1.1 Problem Statement

The issue this project seeks to address is the insufficient availability of continuous, real-time heart monitoring solutions for individuals susceptible to heart attacks. Cardiovascular diseases, especially heart attacks, continue to be a primary cause of death globally, often stemming from the lack of prompt detection and intervention. Conventional heart monitoring is typically confined to clinical environments and depends on sporadic check-ups, which restricts the ability to identify early warning signs in everyday life. For those at elevated risk, the absence of ongoing monitoring can lead to delayed medical intervention and unfavorable health outcomes. To tackle this challenge, the project proposes the creation of an IoT-enabled heart attack detection and heart rate monitoring system that facilitates real-time observation of heart activity and delivers immediate notifications for potential irregularities. By integrating ECG and PPG sensors, a microcontroller, and cloud-based analytics, this system will empower users and healthcare professionals to oversee cardiac health beyond clinical settings, ultimately enabling quicker responses, enhancing patient outcomes, and fostering preventive healthcare measures.

1.2 Objectives

The main aim of this research work is to design an IoT based heart monitoring system which continuously monitors physical parameters like heart rate and blood oxygen levels in real time. The system utilizes IoT connectivity and wearable technology in order to enable abnormal heart activity detection, which uses a machine learning anomaly detection algorithm that identifies irregular patterns that could signal an impending heart attack. This system facilitates a swift response to cardiac irregularities by sending immediate alerts to users, caregivers, and healthcare professionals through a mobile application, which is essential for mitigating severe outcomes in heart attack situations. Furthermore, it utilizes a cloud platform for data storage, enabling long-term monitoring and easy retrieval of historical records. This capability aids healthcare providers in making informed, data-driven diagnoses and customizing treatment plans according to individual health trends over time. By delivering a dependable, non-invasive, and real-time solution, this initiative aims to empower individuals at risk of heart attacks to take proactive steps in managing their cardiac health, fostering a transition towards preventive healthcare and promoting active participation in personal health management. Ultimately, the system aspires to connect traditional healthcare environments with everyday settings, enhancing the accessibility and effectiveness of advanced heart monitoring and timely medical interventions.

1.3 Scope of Study

The aim of this research is to design, develop, and evaluate an IoT-based system for detecting heart attacks and monitoring heart rates, offering real-time surveillance and early detection features. This system will primarily integrate ECG (Electrocardiogram) and PPG (Photoplethysmography) sensors to continuously monitor heart rate, blood circulation, and electrical activity, thereby identifying potential heart attack indicators and cardiac irregularities. The research will involve setting up a microcontroller and Wi-Fi module to process and relay the gathered data to a cloud platform, where machine learning algorithms will be employed to identify anomalies. Additionally, the project will include the creation of a mobile application for users, caregivers, and healthcare professionals to receive prompt notifications in the event of any detected irregularities, facilitating timely medical intervention. The system will also be designed to archive historical health data on a cloud server, enabling healthcare providers to access and analyze long-term cardiac health patterns for enhanced diagnosis and tailored care.

This research will encompass the testing and validation of the system's precision, dependability, and responsiveness in identifying abnormal heart rhythms and issuing alerts. However, it will not cover comprehensive clinical evaluations or medical certifications of the device, which would necessitate further regulatory approvals. In summary, this project aims to develop a practical, user-friendly, and scalable system to improve preventive healthcare and cardiac monitoring beyond traditional clinical settings.

2. Proposed Architecture

2.1Node MCU 8266

The Node MCU ESP8266 is a widely recognized open-source platform for the Internet of Things (IoT), integrating the ESP8266 microcontroller with integrated Wi-Fi functionality. This combination makes it particularly effective for IoT applications, including remote data transmission and health monitoring. Its cost-effectiveness and low energy consumption have led to its popularity in projects requiring wireless communication, such as smart home systems, remote sensing, and health monitoring applications. Node MCU supports programming in both Lua and the Arduino IDE, making it user-friendly for beginners and compatible with a broad array of libraries, which simplifies the process of connecting to various sensors and executing complex functions. It features both digital and analog GPIO (General Purpose Input/Output) pins for sensor and device connections, along with an ADC (Analog-to-Digital Converter) for processing analog signals, such as those from heart rate monitors. In a heart rate monitoring and heart attack detection system based on IoT, the Node MCU ESP8266 serves as the main processing unit, interfacing with ECG and PPG sensors to gather essential data.

This data is processed locally and sent to a cloud server via its Wi-Fi module, allowing for real-time monitoring and remote access for healthcare Professionals and caregivers. The capability for immediate alerts in the event of abnormal heart activity enhances timely intervention. With its compact form factor, affordability, and robust community support, Node MCU is an ideal solution for developing cost-effective, scalable, and user friendly IoT health monitoring systems.

Fig. 1 –Node MCU 8266.

2.2 DHT 11

The DHT11 is a widely used, affordable digital sensor designed for measuring temperature and humidity, frequently utilized in IoT and embedded systems for environmental monitoring purposes. It can measure temperatures ranging from 0°C to 50°C with an accuracy of ±2°C and relative humidity levels from 20% to 90% with an accuracy of ±5%. While it meets general monitoring requirements, it may not be suitable for applications requiring high precision. The sensor's digital output facilitates easy integration with microcontrollers such as Arduino and Node MCU, removing the need for analog-to- digital conversion. Operating with low power consumption, it employs a single-wire communication protocol, which simplifies connection and configuration across various applications. Its compact form factor enhances its adaptability, making it ideal for small IoT devices or wearable technology. In health monitoring applications, the DHT11 can be instrumental in tracking ambient temperature and humidity, factors that can affect patients' respiratory and cardiovascular health. When combined with other health metrics, the data from the DHT11 can provide a more holistic understanding of a patient's environment, enabling caregivers and healthcare professionals to monitor external influences on a patient's health. In summary, the DHT11 presents a cost-effective and user- friendly option for incorporating environmental monitoring into a diverse array of IoT projects.

Fig. 2 – DHT 11 Sensors

2.3 16x2 LCD

A 16x2 LCD is a popular display module utilized in embedded systems, capable of presenting two lines of text with a maximum of 16 characters per line. This liquid crystal display (LCD) is frequently employed in projects that require straightforward visual feedback, including IoT devices, home automation systems, and health monitoring solutions. Each character on the display is formed by a 5x8 pixel grid, making it effective for showcasing text and simple symbols. It functions through a standard 16-pin interface, which encompasses pins for power, contrast adjustment, data transmission, and control. Most 16x2 LCD modules are compatible with the widely used HD44780 driver, facilitating easy integration with microcontrollers such as Arduino, Raspberry Pi, and Node MCU through libraries that streamline communication and control. The display can operate in both 4-bit and 8-bit modes, with the 4-bit mode utilizing fewer data pins, making it particularly suitable for projects wi In IoT-based health monitoring systems, a 16x2 LCD can present real-time data, including heart rate, temperature, and other essential health indicators, offering immediate feedback to users or patients without the need for a mobile device or external display. Its low power consumption and adaptability render it an excellent choice for battery-operated devices and compact designs, improving user interaction and information accessibility across various applications.th limited GPIO resources.

In IoT-based health monitoring systems, a 16x2 LCD can present real-time data, including heart rate, temperature, and other essential health indicators, offering immediate feedback to users or patients without the need for a mobile device or external display. Its low power consumption and adaptability render it an excellent choice for battery-operated devices and compact designs, improving user interaction and information accessibility across various applications

Fig. 3 16x2 LCD

2.4 Buzzer:

A buzzer is a straightforward yet powerful sound- producing element commonly utilized in embedded systems and IoT applications to deliver audio notifications or feedback. It generates sound when an electric current flows through it, making it suitable for alerts, alarms, and status indicators across a range of projects. Buzzers are categorized into two types: active and passive. Active buzzers contain an internal oscillator, allowing them to emit a continuous sound when energized, whereas passive buzzers depend on an external frequency signal to produce sound, providing greater versatility in tone creation. Frequently integrated into alarm systems, health monitoring devices, and smart home technologies, buzzers play a crucial role in scenarios requiring immediate auditory feedback, such as notifying user of critical health metrics or changes in equipment status. For instance, in a heart rate monitoring system, a buzzer can be programmed to activate an alert upon detecting irregular heart activity, facilitating prompt intervention. With their low power consumption and user-friendly nature, buzzers serve as practical and dependable components for improving user awareness and responsiveness in various IoT and embedded applications.

2.5 5V Power Supply

A 5V power supply plays a crucial role in numerous electronic and IoT applications, delivering the stable 5-volt output necessary for various sensors, microcontrollers, and additional modules. Typically sourced from USB connections, batteries, AC adapters, this power supply guarantees that connected devices receive a consistent and safe power level for reliable operation. In embedded systems, microcontrollers such as Arduino and Node MCU, along with peripherals like LCDs, sensors, and communication modules, frequently operate at 5V.Ensuring proper voltage regulation is vital in these systems to avoid power fluctuations that could result in data inaccuracies or device failures. Many 5V power supplies are equipped with voltage regulators to sustain a steady output, even when the input voltage changes. Compact, cost-effective, and readily accessible, a 5V power supply is essential for projects that demand a dependable power source, easily fitting into both portable and stationary configurations. In scenarios like health monitoring systems, a 5V power supply is instrumental in ensuring that all components, including heart rate sensors and displays, operate accurately and consistently, thereby enhancing the overall stability and reliability of the device.

3. IMPLEMENTATION AND WORKING

The operation of the IoT-based heart attack detection and heart rate monitoring system initiates with the acquisition of real-time physiological data via sensors like ECG (Electrocardiogram) and PPG (Photoplethysmography). These sensors are specifically engineered to monitor the heart's electrical activity and fluctuations in blood volume, respectively, thereby delivering crucial insights into cardiac function. The information collected from these sensors is transmitted to a microcontroller, such as the Node MCU ESP8266, which serves as the central processing unit. The Node MCU interprets the sensor data and wirelessly transmits it over Wi- Fi to a cloud platform or remote server for comprehensive analysis. Once on the cloud server, sophisticated algorithms or machine learning models scrutinize the incoming data for any anomalies, including irregular heart rhythms or indications of a potential heart attack. The system is programmed to identify these irregularities and generate immediate alerts. In the event of detecting an abnormal heart rate or other alarming signals, the system promptly sends notifications through a mobile application, text message, or email, informing users, caregivers, or healthcare professionals of the situation. Moreover, the system features a 16x2 LCD display that continuously presents the user’s heart rate and other pertinent information, ensuring that critical data is readily available without the need for a mobile device. For emergencies, a buzzer is integrated into the system to provide an auditory alert, facilitating quick recognition of situations that require immediate action. This comprehensive approach guarantees that the system not only offers continuous monitoring but also delivers timely alerts through both visual and auditory signals, enabling swift medical intervention and mitigating the risk of serious heart-related events. Additionally, the cloud-based data storage of the system supports long-term monitoring of an individual’s heart health, allowing healthcare providers to access historical data for better patient management. Photoplethysmography is an advanced form of plethysmography that utilizes a straightforward optical arrangement to monitor variations in blood volume within peripheral circulation. This non- invasive technique operates by taking measurements directly from the skin's surface. It employs optoelectronic devices, including a red or near-infrared light source, to illuminate the skin, while a photo detector captures fluctuations in light intensity in the targeted area. Typically, red or near-infrared light is used for skin illumination, which penetrates the tissues and is absorbed by various elements such as pigments, bones, and blood. The PPG sensors detect alterations in blood flow volume by monitoring these changes in light intensity.

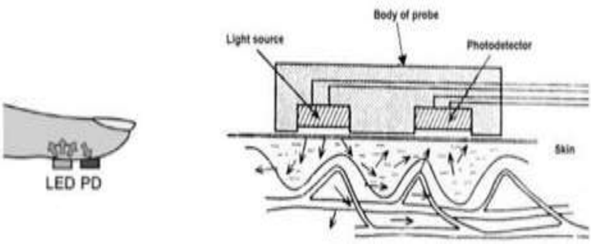

Fig. 4. Working of Heart Rate Sensor

3.2 Block Diagram:

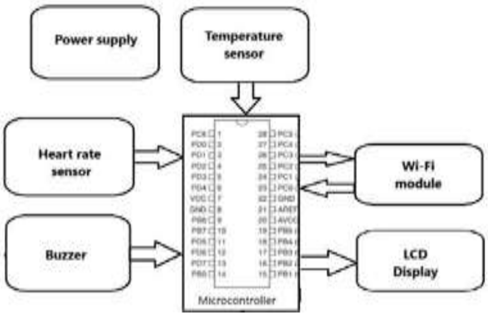

Fig. 5 . Block Diagram

The block diagram of an IoT-based heart attack detection and heart rate monitoring system comprises several essential components that collaborate to monitor, process, and notify users of critical heart conditions. The system initiates with heart rate sensors, such as ECG or PPG, which capture the heart's electrical signals or blood flow, gathering real-time data on heart rate and other vital signs. This information is relayed to a microcontroller, commonly a NodeMCU ESP8266, which processes the data and utilizes its integrated Wi-Fi module to wirelessly transmit the information to a cloud platform or server. The cloud platform conducts further analysis, frequently employing machine learning algorithms to identify any irregularities or indications of a heart attack. Upon detecting abnormalities, alerts are dispatched to a mobile application, caregiver, or healthcare provider through SMS, email, or app notifications. Furthermore, the microcontroller operates a 16x2 LCD display to present real-time heart rate data, enabling users to monitor them condition directly. In emergency situations, a buzzer is triggered to provide an audible alert, ensuring prompt attention. The entire system is powered by a reliable 5V power supply, which guarantees the seamless operation of all components. Collectively, these elements function in harmony to deliver continuous heart monitoring, real-time data transmission, and timely alerts for the early detection of heart-related issues, thereby enhancing patient safety and healthcare intervention. .

4. Results:

The implementation of the IoT-based heart attack detection and heart rate monitoring system yields a dependable and effective solution for real-time health surveillance, facilitating the early identification of potential cardiac issues. This system adeptly gathers heart rate data using sensors such as ECG or PPG, which is then processed by a microcontroller that wirelessly transmits the information to a cloud server. On the server, machine learning algorithms or established logic analyze the data for any irregularities, including abnormal heart rhythms or increased heart rates that may signal a heart attack. Upon detecting any anomalies, the system promptly sends alerts to the user, caregivers, or healthcare professionals through a mobile application or email. Furthermore, real-time feedback is provided on a 16x2 LCD, and an audible alarm is activated via a buzzer, ensuring immediate notification for the user. The system operates effectively with a stable 5V power supply, serving as a crucial tool for ongoing heart health monitoring.

The outcomes highlight the system's ability to improve the early detection of cardiac emergencies, thereby ensuring timely medical response and enhancing patient outcomes. The inclusion of a buzzer significantly improves the system's capabilities by delivering an audible alert, ensuring that important notifications are recognized even in high-pressure scenarios. With its low power requirements and consistent 5V power supply, the system is designed for dependable, long- term operation, making it an effective choice for home health monitoring. In summary, the system's combination of sensors, data processing, alert features, and user interfaces creates a thorough health monitoring solution that enhances the early identification of heart issues, offering users reassurance and the potential to save lives through prompt medical intervention.

Fig.6: IOT Based Heart Attack Detection & Heart Rate Monitoring

The IoT-based heart attack detection and heart rate monitoring system integrates input and output processes to deliver precise monitoring and prompt notifications. The primary inputs consist of data gathered from sensors such as ECG and PPG, which track the heart's electrical activity, pulse rate, and blood circulation in real time. These sensors capture essential physiological signals that the microcontroller processes to identify any irregularities.

Furthermore, additional inputs from environmental sensors like the DHT11 can provide temperature and humidity data, offering valuable context regarding external factors that may influence heart health. The system's outputs are crafted to ensure immediate feedback and effective alerting mechanisms. A 16x2 LCD display serves as a local visual output, showcasing heart rate and other critical parameters for instant monitoring. In case of emergencies, a buzzer provides an audible alert to quickly draw attention Additionally, data is wirelessly transmitted to a cloud platform for storage and further analysis. The system generates notifications or alerts that are sent through mobile applications or emails to keep caregivers or healthcare professionals informed about any abnormal conditions. This combination of accurate input data and responsive outputs guarantees reliable real-time monitoring, continuous tracking, and timely interventions to avert heart-related emergencies.

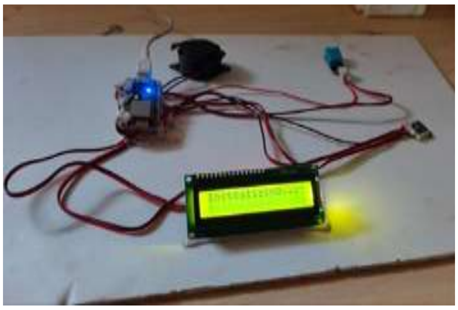

Fig. 7: IOT Based Heart Attack Detection & Heart Rate Monitoring

Fig. 8: IOT Based Heart Rate Monitoring

Displaying the IP address on a mobile device within an IoT project requires utilizing the NodeMCU ESP8266 to establish a web server that presents the IP address on a web page. Upon connecting to a Wi-Fi network, the router assigns an IP address to the device. The NodeMCU obtains this address through the WiFi.localIP() function and configures a web server. Users can access this server by entering the IP address in a mobile browser.

Once connected, the mobile interface shows a webpage that includes the IP address along with additional pertinent information, such as system status or heart rate metrics. This method allows users to easily determine the device's network position and interact with it remotely via their smartphones.

References

1)M. Akkas & M. Aydin (2020). IoT based Heart Attack Detection and Heart Rate Monitoring IJACSA), 11(4),123-129.https://doi.org/10.14569/IJACSA.2020.0110415

2) Patel, H., and Kotecha, K. (2018) Heart attack detection and heart rate monitoring system based on2IoT 43,378-386. https://doi.org/10.1007/s10916-018-1013-0 Journal of Medical Systems, March 28th specifying all three items.

3) Mishra, A., & Singh, S. (2021). Survey of machine learning techniques for heart attack detection International Journal of Computer Applications, 975(07), https://doi.org/10.5120/ijca2021921544

4) A, K., & R, K. (2019). IoT Based Heart Attack Prediction Using Machine Learning */ Publication International Journal of Engineering Research & Technology 8(5), 1-6. Heart-attack detection system using IoT and machine learning. https://www.ijert.org/research/heart-attack-detection-system-using-iot-and-machine-learning- IJERTV8IS05002.pdf

5)Vaibhav Godase. (2024). SMART PLANT MONITORING SYSTEM. In International Journal of Creative Research Thoughts (Vol. 12, Number 5, pp. b844–b849). Zenodo. https://doi.org/10.5281/zenodo.11213525

6)Vaibhav Godase, Akash Lawande, Kishor Mane, Kunal Davad and Prof. Siddheshwar Gangonda . "Pipeline Survey Robot." International Journal for Scientific Research and Development 12.3 (2024): 141-144.

7)Vaibhav Godase, Yogesh Jadhav, Kakade Vishal, Virendra Metkari and Prof. Siddheshwar Gangonda . "IOT Based Greenhouse Monitoring And Controlling System." International Journal for Scientific Research and Development 12.3 (2024): 138-140.

8)Godase, Vaibhav, Amol Jagadale, and SKNSCOE, Korti, Solapur University-413304, India. “Three Element Control Using PLC, PID & SCADA Interface.” Journal-article. IJSRD - International Journal for Scientific Research & Development. Vol. 7, 2019. https://www.ijsrd.com.

9)Godase, Vaibhav, Prashant Pawar, Sanket Nagane, and Sarita Kumbhar. “Automatic Railway Horn System Using Node MCU.” Journal of Control & Instrumentation 1 (2024): 11–19. https://journals.stmjournals.com/joci.

10)Godase, V., Mulani, A., SKN Sinhgad College of Engineering, Pandharpur, Godase, V., Mulani, A., Ghodak, R., Birajadar, G., Takale, S., SKN Sinhgad College of Engineering, Pandharpur, & Kolte, M. (2024). A MapReduce and Kalman Filter based Secure IIoT Environment in Hadoop. In SKN Sinhgad College of Engineering, Pandharpur [Journal-article]. https://www.researchgate.net/publication/383941977

11)Godase, V., & Godase, J. . (2024). Diet Prediction and Feature Importance of Gut Microbiome using Machine Learning. Evolution in Electrical and Electronic Engineering, 5(2), 214-219. https://publisher.uthm.edu.my/periodicals/index.php/eeee/article/view/16120

12)Godase, Vaibhav, et al. “Smart Agriculture Automation Using ESP8266 Node MCU.” Journal of Electronics, Computer Networking and Applied Mathematics (JECNAM) ISSN : 2799-1156, 1 Aug. 2023, journal.hmjournals.com/index.php/JECNAM/article/view/2417.

13)Mr. Sanket K Nagane, Mr. Prashant S Pawar, & Prof. V. V. Godase. (2022). Cinematica Sentiment Analysis. Journal of Image Processing and Intelligent Remote Sensing(JIPIRS) ISSN 2815-0953, 2(03), 27–32. https://doi.org/10.55529/jipirs.23.27.32