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Heartbeat Guardian: Virtual Heartrate Monitoring

Mrs Ignatius Selvarani X[1], Karshan Victor Josh T[2], Shyam A[3], Vignesh S[4]
[1]Assistant Professor, Dept. of CSE, Kamaraj College of Engg. & Tech., Virudhunagar, Tamilnadu, India.
[2,3,4]UG Scholar, Dept. of CSE, Kamaraj College of Engg. & Tech., Virudhunagar, Tamilnadu, India.
Emails: *ignatiusselvaranicse@kamarajengg.edu.in[1], victorjosh@gmail.com[2], ashiyam423@gmail.com[3], viki20472@gmail.com[4]*

Abstract
Heart rate monitoring is a vital aspect of maintaining heart health. People from different age groups have different ranges for maximum and minimum values of heart rate, the monitoring system must be compatible enough to tackle this scenario. In this paper, an IoT based system has been implemented that can monitor the heartbeat from the output given by a hardware system consisting of an Arduino and pulse sensor. Further, an alert system is added which is executed if the heartbeat goes below or above the permissible level given in the devised algorithm. The alert message is given through system database. By using this prototype, the doctors can access the heartbeat data of the patient from database. The nurses or the duty doctor available at the hospital can monitor the heart rate of the patient in the LCD monitor through the real-time monitoring system.
Keywords: *Heart Rate, Sensors, Database, Alert*

1. Introduction
A Heart Beat Monitoring System using wearable technology integrated with a GSM module continuously tracks and transmits real-time heart rate data. This system leverages wearable sensors for accurate, non-invasive monitoring, ensuring user comfort and convenience. The GSM module enables seamless wireless communication, instantly sending data to healthcare providers or caregivers. It is particularly beneficial for remote patient monitoring, especially for individuals with chronic heart conditions or the elderly, providing timely alerts for prompt medical intervention. By combining health monitoring with wireless technology, this system enhances patient care and reduces the risk of critical health incidents. It is a cost-effective and efficient solution for real-time health tracking, especially in remote or underserved areas. Users can proactively manage their health through continuous heart rate data and instant notifications in case of anomalies. The system can store historical data, enabling doctors to analyze trends and make informed decisions. Its compact, portable design ensures ease of use, making it accessible to a wide range of users. This technology bridges the gap between patients and healthcare providers, fostering better health management and emergency response. Additionally, it supports emergency alerts by notifying doctors or family members when abnormal heart rate levels are detected. The device can transmit data via SMS or GPRS, ensuring uninterrupted monitoring even in remote locations. It is energy-efficient, with a long battery life, making it suitable for continuous wear. The wearable sensor can be integrated into smartwatches, wristbands, or chest straps for added versatility. This system is also useful for athletes and fitness enthusiasts who need real-time heart rate monitoring during workouts. Its ability to store and analyze long-term data helps in predicting potential health risks and allows early intervention. By leveraging IoT and mobile connectivity, the system, improving access to healthcare for patients in need.

1.1.Methods
- **Sensor-Based Monitoring:** The system uses wearable heart rate sensors such as MAX30100 or MAX30102 to track heart rate data. These sensors utilize photoplethysmography (PPG) technology to detect blood volume changes and measure pulse rate accurately. Continuous monitoring ensures real-time recording, allowing instant detection of anomalies.

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- **Wireless Data Transmission:** The system integrates a GSM module (e.g., SIM800L or SIM900) to transmit heart rate data wirelessly. The module sends SMS alerts or uses GPRS to upload data to a cloud server, enabling remote access for caregivers. In case of abnormal readings, the system triggers emergency notifications for timely medical intervention.
- **Hardware Utilization:** The wearable device includes a microcontroller (such as Arduino or ESP32) to process heart rate signals. A compact and lightweight design ensures user comfort, making it suitable for continuous wear. The sensor placement on the wrist or chest ensures accurate readings with minimal interference.

2. Tables and Figures

2.1.Tables

The table below (Table 1) provides the categorization of key components related to the heart rate monitoring system using a wearable device integrated with a GSM module. It includes attributes such as sensor technology, data transmission, hardware specifications, and system performance. These specifications play a crucial role in ensuring accurate real-time monitoring and efficient remote health tracking. Table 1 shows Key Metrics. It is a cost-effective and efficient solution for real-time health tracking, especially in remote or underserved areas. Users can proactively manage their health through continuous heart rate data and instant notifications in case of anomalies. The system can store historical data, enabling doctors to analyze trends and make informed decisions. Its compact, portable design ensures ease of use, making it accessible to a wide range of users. This technology bridges the gap between patients and healthcare providers, fostering better health management

Table 1 Key Metrics

Component	Specification	Value
Heart Rate Sensor	PPG-Based Detection	Enabled
Heart Rate Sensor	Continuous Monitoring	Enabled
Wireless Communication	GSM Data Transmission	Enabled (SMS/GPRS)
Wireless Communication	Emergency Alerts	Enabled
Microcontroller	Processing Unit	Arduino/ESP32
Power Management	Battery Type	Rechargeable Li-ion
Data Storage	Cloud & Local Storage	Enabled
Security Features	Data Encryption	AES-256
Security Features	Authentication	Multi-user Support
User Interface	Mobile App & Web Dashboard	Enabled

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2.2.Figures

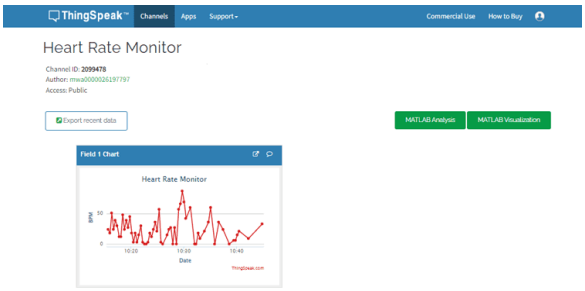

Figure 1 Heart Rate Monitor

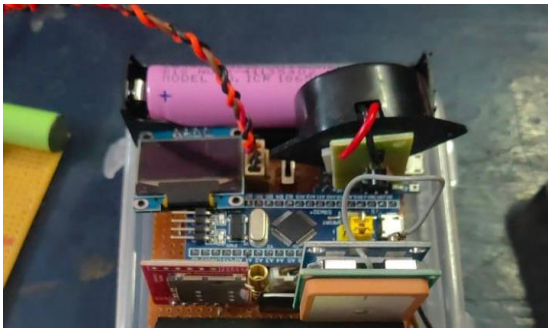

Figure 2 Connections

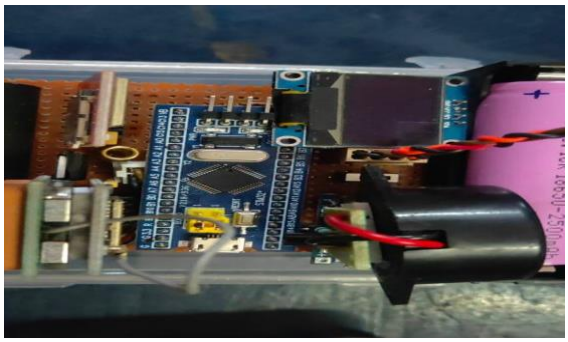

Figure 3 Connections

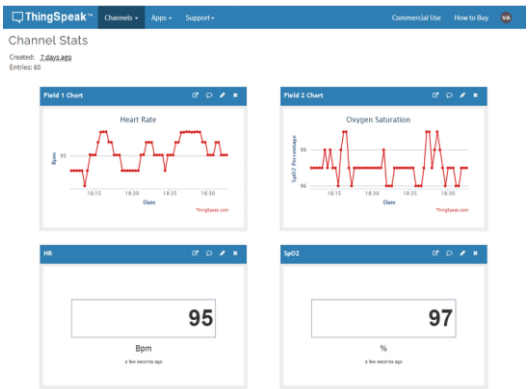

Figure 4 Channel States

3. Results and Discussion

3.1.Results

The heart rate monitoring system using a wearable device and GSM module successfully tracks and transmits real-time heart rate data. Continuous monitoring ensures accurate detection of pulse rate variations, improving early anomaly detection. Wireless transmission via GSM allows remote access to health data, enabling timely medical intervention. The system effectively sends emergency alerts in case of irregular heart rate readings. Data storage on cloud and local servers supports historical analysis for better diagnosis. The wearable design ensures user comfort, making it suitable for daily use. Battery optimization ensures long-lasting performance, reducing the need for frequent recharging. The integration of a microcontroller enhances processing efficiency and minimizes latency in data transmission. The system is tested under various conditions, demonstrating reliability in different environments. Overall, it enhances remote healthcare, emergency response, and proactive health management Figure 1 shows Heart Rate Monitor, Figure 2 shows Connections, Figure 3 shows Connections, Figure 4 shows Channel States [1-3]

3.2.Discussion

The heart rate monitoring system using a wearable device and GSM module provides an effective solution for real-time health tracking and remote monitoring. Continuous monitoring and instant alerts ensure timely medical intervention, reducing the risk of critical health issues. The integration of GSM technology enables seamless data transmission, making it highly useful for patients in remote areas. The system's compact and wearable design enhances user comfort and encourages long-term usage. Overall, it contributes to improved healthcare accessibility, proactive health management, and emergency response efficiency.

conclusion

The heart rate monitoring system using a wearable device and GSM module provides a reliable and efficient solution for real-time cardiac health tracking. By integrating advanced sensors and wireless communication, the system ensures continuous monitoring and instant data transmission

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to healthcare providers. The use of GSM technology allows remote access, making it especially beneficial for patients in rural or underserved areas. Emergency alerts help in timely medical intervention, reducing the risk of severe health complications. The device's compact and comfortable design ensures ease of use, encouraging long-term adoption. Data storage capabilities support historical analysis, aiding doctors in better diagnosis and treatment planning. The system is energy-efficient, ensuring extended usage with minimal maintenance. Overall, this technology enhances telemedicine, improves patient care, and bridges the gap between individuals and healthcare services.

Acknowledgements

We express our sincere gratitude to everyone who contributed to the development of this heart rate monitoring system using a wearable device and GSM module. Special thanks to our mentors, researchers, and technical experts for their valuable guidance and support. We also appreciate the efforts of our team members in designing, testing, and implementing this system successfully.

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