Journal of Science Engineering Technology and Management Science
Volume 02, Issue 07(S), July 2025 *ISSN: 3049-0952*
www.jsetms.com *DOI:10.63590/jsetms.2025.v02.i07(S).687-695*

IOT BASED HEALTH MONITORING SYSTEM USING RASPBERRY PI

[1] A.Haripriya, [2] K.SANDYA, [3]T.ESHA, [4]P.POOJA, [5] A.PALLAVI

[1] Assistant Professor, Department of Electronics And Communication , Princeton Institute of Engineering & Technology for Women, Hyderabad, India

[2,3,4,5] B. Tech Students, Department of Electronics And Communication, Princeton Institute of Engineering & Technology for Women, Hyderabad, India

To Cite this Article

A.Haripriya, K.Sandya, T.Esha, P.Pooja, A.Pallavi, "Iot Based Health Monitoring System Using Raspberry Pi", Journal of Science Engineering Technology and Management Science, Vol. 02, Issue 07(S), July 2025,pp: 687-695, DOI: http://doi.org/10.63590/jsetms.2025.v02.i07(S).pp687-695

Submitted: 07-06-2025 *Accepted: 08-07-2025* *Published: 16-07-2025*

Abstract

Healthcare is one of the most critical sectors where continuous patient monitoring can play a significant role in saving lives. Traditional health monitoring systems often require patients to be physically present in hospitals, leading to delays in diagnosis and treatment during emergencies. To address this limitation, this work proposes an IoT-based Health Monitoring System using Raspberry Pi that enables real-time remote monitoring of vital signs. The system employs biomedical sensors such as heart rate, temperature, blood pressure, and SpO_2 sensors, which are interfaced with the Raspberry Pi microcontroller. These sensors continuously capture patient health parameters and transmit the data to a cloud server or web application using Wi-Fi.The Raspberry Pi acts as the processing hub, collecting, analyzing, and forwarding sensor data for visualization and storage. Doctors and caregivers can access this information remotely via a secure web dashboard or mobile application, allowing for early diagnosis and timely medical intervention. In critical situations, the system can automatically generate alerts or notifications via SMS/Email to medical professionals and family members, ensuring rapid response.The proposed IoT-enabled solution provides a low-cost, scalable, and efficient health monitoring framework that reduces hospital visits, supports remote patient care, and improves overall healthcare accessibility. By combining Raspberry Pi, IoT, and cloud computing, this system contributes toward the development of smart healthcare solutions, paving the way for personalized and preventive healthcare services in both urban and rural areas.

I.INTRODUCTION

Healthcare is undergoing a rapid transformation with the adoption of digital technologies, particularly the Internet of Things (IoT), which enables continuous, remote, and intelligent monitoring of patients. Traditional health monitoring systems require patients to visit hospitals regularly or remain admitted for observation, which is often inconvenient, time-consuming, and costly. In critical cases, delays in identifying abnormal health conditions may result in serious complications or even

loss of life. Therefore, there is a growing demand for a system that can remotely monitor vital health parameters in real time and alert caregivers instantly when abnormalities occur.

The Internet of Things (IoT) has emerged as a revolutionary solution to this problem, enabling seamless connectivity between biomedical sensors, processing devices, and healthcare professionals. By integrating IoT with a powerful yet cost-effective computing device like the Raspberry Pi, it becomes possible to design a smart health monitoring system that can continuously measure key parameters such as heart rate, blood pressure, body temperature, and oxygen saturation (SpO_2). The Raspberry Pi acts as a mini-computer that processes the sensor data, stores it, and transmits it to a cloud server or web application using wireless connectivity.

This system allows doctors and caregivers to remotely access patient health records through a web or mobile dashboard, thereby enabling early diagnosis and timely treatment. In emergency cases, the system can generate automatic alerts via SMS, email, or mobile notifications to ensure immediate medical attention. Furthermore, the data collected over time can help in predictive analysis, identifying long-term health risks and supporting preventive healthcare practices.

By leveraging the power of IoT, cloud computing, and Raspberry Pi, this health monitoring framework offers a cost-effective, portable, and scalable solution for both urban and rural healthcare. It not only reduces the burden on hospitals but also ensures continuous care for elderly, chronic patients, and individuals in remote locations. Thus, this system represents a significant step toward building smart healthcare infrastructures and improving the overall quality of patient care.

II.LITERATURE SURVEY

The integration of IoT in healthcare has been widely explored in recent years, with researchers proposing various frameworks for continuous patient monitoring, disease prediction, and remote medical assistance. Early health monitoring systems were primarily hospital-based, where patients were connected to bulky machines to measure vital parameters such as heart rate, blood pressure, and body temperature. Although reliable, these systems lacked portability and required constant supervision by medical staff, limiting their effectiveness outside clinical environments.

With the advancement of IoT and wireless sensor networks, researchers began developing portable health monitoring solutions that could transmit data remotely. For instance, several studies have demonstrated the use of wearable sensors integrated with microcontrollers (such as Arduino or Raspberry Pi) to measure physiological parameters. While Arduino-based systems were lightweight and cost-effective, their processing power and networking capabilities were limited. In contrast, Raspberry Pi provided higher computational ability, making it suitable for integrating multiple sensors, performing local data analysis, and communicating with cloud servers.

Cloud-based healthcare solutions have also been investigated, where patient data collected through IoT devices is uploaded to cloud platforms for real-time monitoring and historical record-keeping. Such systems enable doctors to access patient information from anywhere, ensuring faster diagnosis and decision-making. However,

researchers have pointed out challenges related to data security, privacy, and network reliability, which must be addressed for widespread adoption.

Recent studies have also emphasized the role of machine learning algorithms in enhancing IoT-based healthcare systems. By analyzing sensor data over time, these algorithms can predict abnormal health conditions such as hypertension, arrhythmia, or fever trends before they become critical. For example, wearable ECG and SpO_2 sensors combined with AI models have shown promise in early detection of cardiovascular diseases. Nonetheless, these approaches require continuous data collection, stable connectivity, and energy-efficient devices.

A number of works also explore alert mechanisms, where real-time thresholds are set for parameters like heart rate or blood pressure. Whenever the values exceed safe limits, notifications are automatically sent to caregivers or doctors. While effective, these systems often face challenges with false alarms, requiring advanced calibration and multi-sensor validation to ensure reliability.

From the review of existing research, it is clear that while significant progress has been made in IoT-enabled health monitoring, there remain challenges in terms of accuracy, data privacy, affordability, and scalability. The proposed system addresses these gaps by using Raspberry Pi as the central hub, integrating multiple biomedical sensors, enabling cloud-based storage and real-time alerts, and ensuring that both patients and healthcare professionals benefit from a low-cost, efficient, and intelligent health monitoring framework.

III.EXISTING SYSTEM

In the existing healthcare monitoring systems, patient health parameters such as heart rate, blood pressure, temperature, and oxygen level are usually measured manually in hospitals or clinics using conventional medical instruments. These methods, while accurate in a clinical setting, are time-consuming, expensive, and not suitable for continuous monitoring. Patients are required to visit healthcare centers frequently for routine check-ups, which can be inconvenient, especially for elderly patients and those with chronic illnesses who need regular observation.

Some early IoT-based health monitoring systems have been developed using microcontrollers like Arduino or simple sensor-based devices. These systems can measure a few basic health parameters but suffer from several limitations. They typically lack real-time data transmission to healthcare providers and instead store the collected data locally. This means doctors or caregivers cannot remotely track the patient's health in real time, limiting the scope of emergency response. Additionally, most existing systems do not integrate with cloud platforms, which restricts long-term storage, historical data analysis, and predictive diagnosis.

Another drawback of current solutions is the limited processing power and connectivity of the devices used. For example, Arduino-based systems can collect sensor data but cannot efficiently process or analyze it, nor can they handle multiple sensors simultaneously. In some cases, mobile applications are used to transmit data, but these require constant internet connectivity and depend heavily on smartphones, which may not always be reliable for continuous monitoring.

Moreover, alert mechanisms in existing systems are often inadequate. While some solutions can trigger alarms when abnormal values are detected, many of them lack smart notification systems that can send automated alerts to doctors, caregivers, or family members via SMS, email, or mobile apps. This increases the risk of delays in medical intervention during critical conditions.

Security and privacy are also major concerns in existing healthcare monitoring frameworks. Patient data transmitted without proper encryption is vulnerable to unauthorized access, raising ethical and legal issues. These limitations highlight the need for a more reliable, secure, real-time, and intelligent IoT-based health monitoring system that can overcome the drawbacks of existing approaches.

IV.PROPOSED SYSTEM

The proposed system introduces an IoT-based Health Monitoring System using Raspberry Pi that ensures real-time, continuous, and remote monitoring of patients' vital signs. This system integrates biomedical sensors such as temperature, heart rate, blood pressure, and SpO_2 sensors with a Raspberry Pi, which serves as the central processing and communication unit. The Raspberry Pi collects sensor data, processes it, and transmits it to a cloud server or web application through Wi-Fi. Doctors and caregivers can then remotely access patient health information via a secure dashboard or mobile application.

Unlike existing systems that primarily rely on manual measurement or limited local storage, this system leverages the computational power of Raspberry Pi to handle multiple sensors, perform preliminary data analysis, and ensure real-time communication. Critical health conditions are detected automatically, and immediate alerts/notifications (via SMS, email, or mobile app) are sent to doctors and family members, enabling timely medical intervention.

To ensure reliability, the system is designed with cloud integration, allowing for long-term storage of patient health records. This not only helps doctors analyze trends and predict potential health issues but also provides patients with an electronic health record that can be accessed anytime. Security and privacy are ensured through data encryption techniques, protecting sensitive medical information from unauthorized access.

The system is cost-effective, scalable, and portable, making it suitable for home use, rural healthcare, and remote monitoring of elderly or chronically ill patients. By combining IoT, cloud computing, and Raspberry Pi, this approach bridges the gap between patients and healthcare providers, reduces the burden on hospitals, and enhances the quality of medical care.

V.SYSTEM ARCHITECTURE

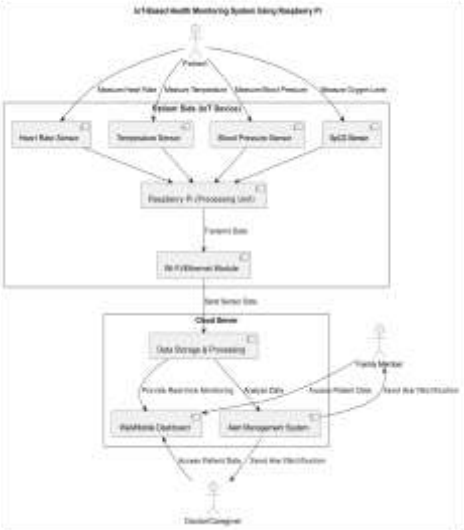

Fig 5.1 System Architecture

The system architecture of the IoT-based health monitoring system using Raspberry Pi is designed to integrate biomedical sensors, data processing, and cloud communication into a seamless framework. At the first level, various sensors such as a heart rate sensor, temperature sensor, blood pressure sensor, and SpO_2 sensor are connected to the Raspberry Pi via GPIO pins. These sensors continuously capture the patient's health parameters and send raw signals to the Raspberry Pi. At the second level, the Raspberry Pi acts as the central processing unit, where it reads sensor data, processes it, and converts it into meaningful health values. The Raspberry Pi, being more powerful than microcontrollers like Arduino, enables advanced computation and supports multiple sensors simultaneously. At the third level, the processed data is transmitted over the Internet using Wi-Fi or Ethernet and uploaded to a cloud server or web application. This enables remote doctors and caregivers to access the patient's health records in real time through a dashboard or mobile app. At the fourth level, the system includes an alert mechanism where abnormal readings trigger automatic notifications via SMS, email, or app alerts to healthcare providers and family members for timely medical intervention. Finally, the system ensures secure storage and analysis of historical health data in the cloud, allowing doctors to identify trends and predict possible future complications. Overall, the architecture ensures real-time monitoring, reliable communication, data security, and scalability, making it suitable for home healthcare, hospitals, and remote patient monitoring.

VI.IMPLEMENTATION

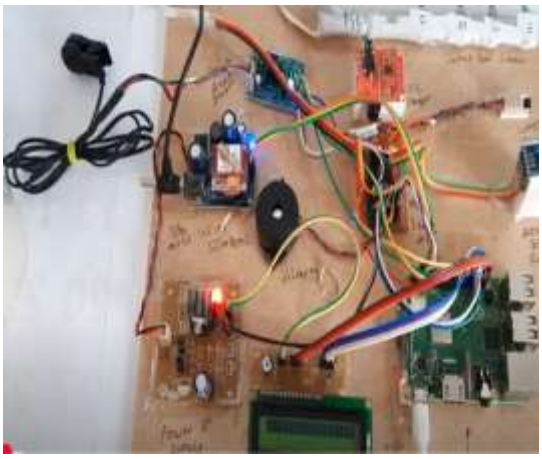

Fig 6.1 kit

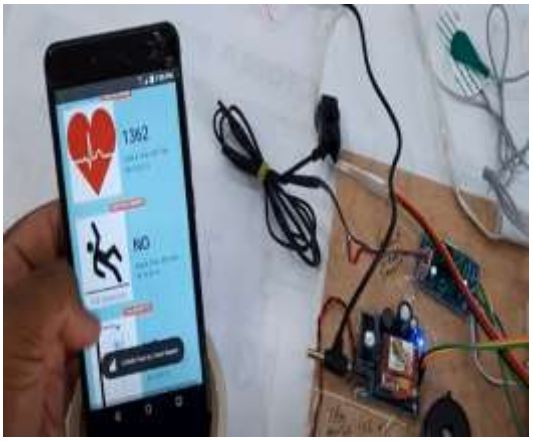

Fig 6.2 Mobile Results

Fig 6.3 Final Results

Fig 6.4 Alert Message

VII.CONCLUSION

The proposed **IoT-Based Health Monitoring System Using Raspberry Pi** offers an efficient and intelligent solution for continuous patient monitoring, addressing the limitations of traditional healthcare methods. By integrating biomedical sensors with the Raspberry Pi, the system is capable of **real-time acquisition, processing, and transmission** of vital health parameters such as heart rate, blood pressure, temperature, and SpO_2 levels.This system ensures that doctors, caregivers, and family members can remotely access patient health data through a **web or mobile dashboard**, enabling timely medical intervention and improving overall patient safety. The automatic alert mechanism further enhances the responsiveness during emergencies, ensuring that critical conditions are reported immediately.In addition to real-time monitoring, the system's cloud-based architecture allows for **long-term storage, trend analysis, and predictive insights**, which can be leveraged for preventive healthcare and chronic disease management. The use of Raspberry Pi makes the system **cost-effective, portable, and scalable**, suitable for home, hospital, and remote healthcare applications.Overall, this IoT-enabled health monitoring framework demonstrates how **technology-driven healthcare solutions** can reduce hospital dependency, improve patient care, and contribute to the development of **smart healthcare infrastructures**. It lays the foundation for future enhancements such as AI-based predictive analytics, wearable integration, and smart alert prioritization, making it a versatile and impactful tool in modern healthcare.

VIII.FUTURE SCOPE

The proposed IoT-based health monitoring system offers a strong foundation for remote patient care, but there are several avenues for future enhancements to make it even more intelligent, reliable, and comprehensive. One major advancement would be the integration of Artificial Intelligence (AI) and Machine Learning (ML) algorithms to analyze real-time and historical health data. This would enable the system to predict potential health risks, detect early signs of diseases such as cardiovascular problems or respiratory issues, and provide proactive recommendations to patients and doctors.

Another promising enhancement is the use of wearable IoT devices that can continuously monitor additional parameters like ECG, glucose levels, or body

movement patterns. These devices can communicate directly with the Raspberry Pi hub or cloud server, creating a more comprehensive and continuous health monitoring system.The adoption of 5G and edge computing can further reduce latency in data transmission, ensuring ultra-fast alerts and real-time response, which is especially crucial in critical health scenarios. Additionally, integration with smart home systems or emergency services could automate medical assistance, such as triggering ambulance services or alerting nearby healthcare centers instantly when a critical event occurs.Privacy and security can also be enhanced using blockchain-based secure data management, ensuring that sensitive patient information remains tamper-proof and accessible only to authorized personnel.Finally, large-scale deployment of such systems could facilitate population health management, allowing hospitals and government authorities to analyze trends, identify health hotspots, and make informed decisions for preventive healthcare programs.In summary, the future scope of the system includes AI-driven predictive healthcare, wearable integration, ultra-low latency communication, secure data sharing, and smart healthcare ecosystems, making it a scalable, intelligent, and proactive tool for modern healthcare.

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