ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue V, May 2026

IOT Based Patient Health Monitoring System

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DOI: https://doi.org/10.51583/IJLTEMAS.2026.150500128

Received: 13 May 2026; Accepted: 18 May 2026; Published: 08 June 2026

ABSTRACT

The rapid advancement of Internet of Things (IoT) technology has significantly transformed the healthcare sector by enabling continuous and remote patient monitoring. This paper presents an IoT-based smart patient health monitoring system using ESP32 that efficiently tracks vital health parameters such as body temperature, blood pressure, and glucose levels in real time. The system utilizes sensors to collect physiological data, which is processed by the ESP32 microcontroller and transmitted via Wi-Fi to a Node.js-based server. The collected data is stored in a database and visualized through a web-based dashboard, allowing caregivers and medical professionals to monitor patient health remotely. Additionally, the system generates alerts when abnormal health conditions are detected, ensuring timely medical intervention. The proposed solution reduces the need for manual monitoring, improves healthcare accessibility, and enhances patient safety. Due to its low cost, scalability, and real-time capabilities, the system is highly suitable for home-based and remote healthcare applications.

Keywords: Internet of Things (IoT), Remote Health Monitoring, ESP32 Microcontroller

INTRODUCTION

The rapid growth of healthcare demands, along with the increasing number of patients requiring continuous monitoring, has created significant challenges for traditional healthcare systems. In many cases, especially for elderly individuals and patients with chronic diseases, regular health monitoring is essential but difficult to achieve due to limited medical resources and the need for constant supervision. Conventional methods of monitoring patient health are often manual, time-consuming, and lack real-time responsiveness, which may lead to delays in diagnosis and treatment.

With the advancement of the Internet of Things (IoT), smart healthcare systems have emerged as an effective solution to address these challenges. IoT enables the integration of sensors, communication technologies, and cloud-based platforms to monitor patient health remotely and continuously. By collecting real-time physiological data and transmitting it to healthcare providers, IoT-based systems improve the efficiency, accuracy, and accessibility of medical services.

In this paper, an IoT-based smart patient health monitoring system using ESP32 is proposed. The system is designed to monitor vital health parameters such as body temperature, blood pressure, and glucose levels using appropriate sensors. The collected data is processed by the ESP32 microcontroller and transmitted via Wi-Fi to a backend server developed using Node.js. The system stores the data in a database and displays it on a web-based dashboard, allowing caregivers and medical professionals to monitor patients remotely. Additionally, the system provides alert notifications in case of abnormal health conditions, enabling timely medical intervention.

The proposed system aims to reduce manual effort, enhance patient safety, and provide a cost-effective and scalable solution for remote healthcare monitoring. It is particularly beneficial for home-based patient care, rural healthcare settings, and situations where continuous monitoring is required.

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LITERATURE REVIEW

Pradhan B., Bhattacharyya S., Pal K. – IoT-Based Applications in Healthcare Devices (Journal of Healthcare Engineering, 2021)

Pradhan et al. discuss the growing importance of IoT in modern healthcare systems, highlighting how connected medical devices enable real-time monitoring of patient health parameters. The study emphasizes that IoT improves

diagnostic accuracy, reduces hospital visits, and enhances patient care through remote monitoring solutions. Their work demonstrates that integrating sensors with cloud platforms can significantly improve healthcare accessibility. Inspired by this approach, the proposed system utilizes sensors and ESP32 to collect and transmit real-time patient data, enabling continuous monitoring and timely medical intervention.

Salman O.H., Taha Z., Alsabah M.Q. – Machine Learning and IoT for Telemedicine and Emergency Healthcare (Computer Methods and Programs in Biomedicine, 2021) Salman et al. explore the integration of IoT with machine learning techniques for emergency healthcare and telemedicine systems. Their study shows that real-time data analysis can help detect critical health conditions and trigger alerts for immediate response. The research highlights the importance of automated systems in reducing response time during medical emergencies. Based on these findings, the proposed system incorporates real-time monitoring and alert mechanisms to notify caregivers when abnormal health conditions are detected.

Kelley M.M., Powell T., Camara D. – Mobile Health Applications and Remote Patient Monitoring (Journal of Medical Internet Research, 2024)

Kelley et al. examine the effectiveness of mobile health (mHealth) applications in supporting patient monitoring and care planning. The study emphasizes that mobile and web-based platforms improve communication between patients and healthcare providers, leading to better health outcomes. It also highlights the importance of user-friendly dashboards for real-time data visualization. Inspired by this research, the proposed system includes a web-based dashboard that allows caregivers to monitor patient health remotely in an efficient and accessible manner.

Guo R., Fan H., Xiao S. – Development of Integrated Smart Healthcare Systems (BMC Geriatrics, 2025)

Guo et al. present a smart healthcare model that integrates IoT devices, real-time monitoring, and data analytics to improve elderly care. Their system focuses on continuous monitoring, personalized healthcare, and early detection of abnormalities. The study highlights that integrated healthcare platforms can significantly enhance patient safety and independence. Similarly, the proposed system uses ESP32 and sensors to continuously track vital parameters and provide alerts, ensuring proactive healthcare management.

Shen H., Han Y., Shi W. – IoT and Smart Monitoring for Healthcare Systems (JMIR mHealth and uHealth, 2025) Shen et al. investigate the role of IoT-based monitoring systems in improving healthcare services, especially for

patients requiring long-term care. Their findings suggest that real-time monitoring combined with cloud storage enhances data accessibility and supports better clinical decisions. The study also emphasizes the importance of secure data transmission and storage. In line with this, the proposed system uses Wi-Fi communication and backend servers to securely store and manage patient health data.6. Nwosu N.T. – Healthcare Data Integration Using Advanced BI Tools (World Journal of Advanced Research and Reviews, 2024)

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Nwosu highlights the role of centralized data systems and real-time analytics in improving healthcare efficiency and reducing operational costs. The study shows that integrating multiple health parameters into a single system allows faster

decision-making and better patient outcomes. Inspired by this approach, the proposed system integrates various sensor data into a unified platform.

Proposed System

System Architecture

The proposed IoT-based patient health monitoring system consists of multiple interconnected components including sensors, ESP32 microcontroller, communication module, server, and user interface. The sensors are used to measure vital parameters such as body temperature, blood pressure, and glucose levels. These sensors send data to the ESP32 microcontroller, which processes the information and transmits it to a cloud/server using Wi-Fi. The server stores the data in a database and displays it on a web-based dashboard for real-time monitoring. Additionally, an alert system is integrated to notify caregivers when abnormal conditions are detected.

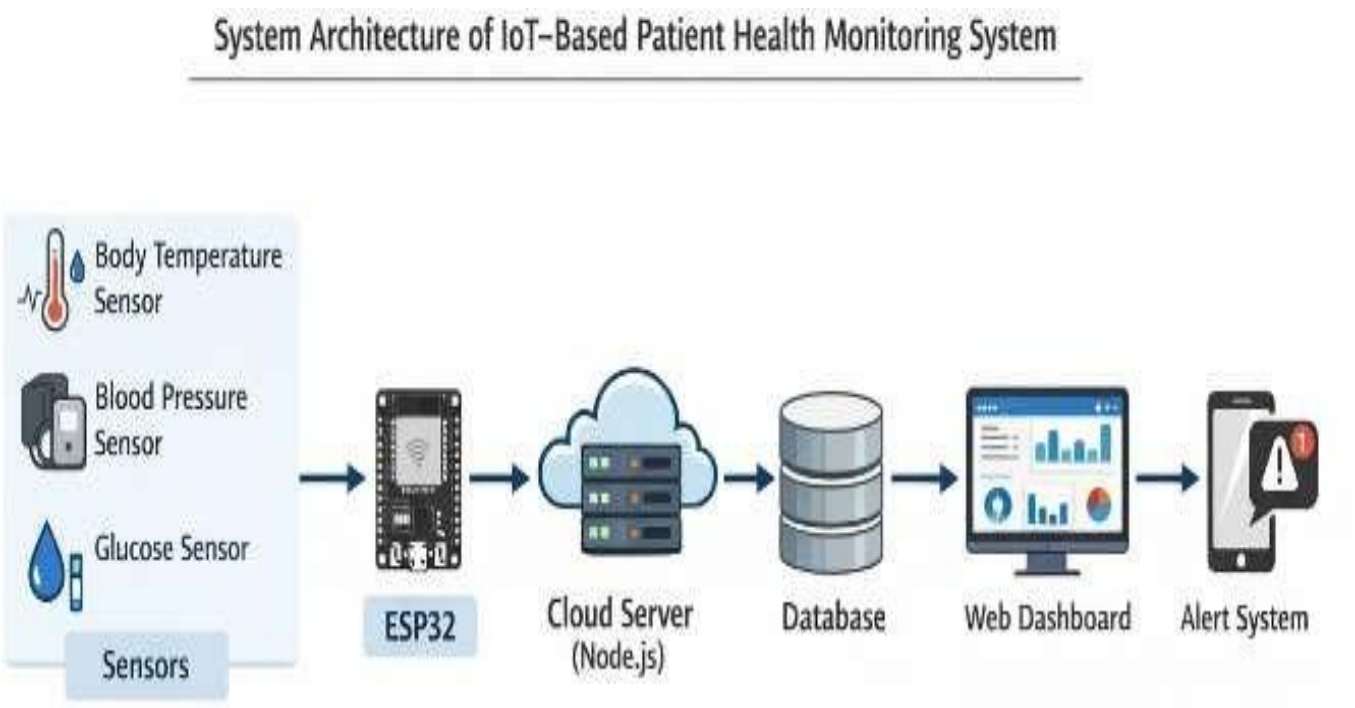

Fig. 1. System Architecture

Working Flow / System Workflow

The working of the system begins with the sensors continuously collecting patient health data such as temperature, blood pressure, and glucose levels. The collected data is sent to the ESP32 microcontroller, where it is processed and converted into digital form. The ESP32 then transmits this data via Wi-Fi to a backend server. The server stores the data in a database and updates it on a web dashboard for remote monitoring. If any parameter crosses the predefined threshold, the system generates an alert notification for immediate medical attention.

Fig. 2. System Workflow

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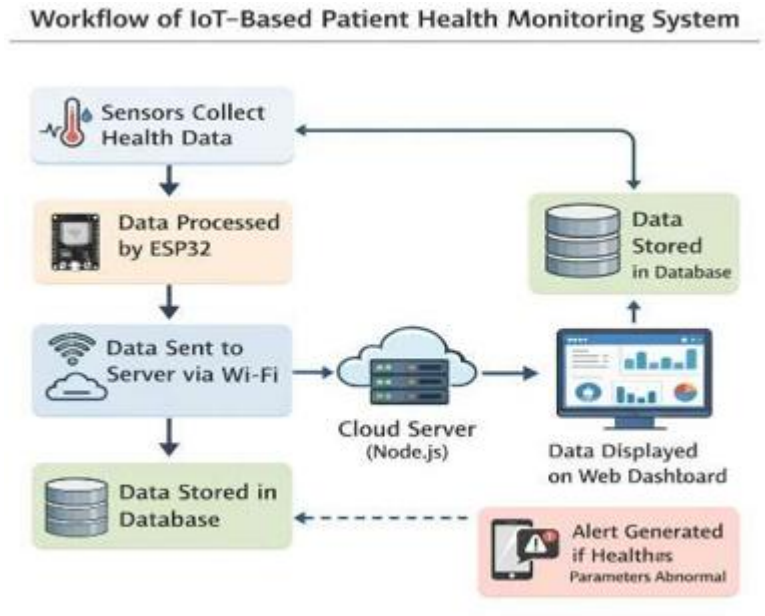

RESULT ANALYSIS

The IoT-based Patient Health Monitoring System demonstrated efficient and reliable performance in monitoring vital health parameters such as temperature, blood pressure, and glucose levels in real time. The sensors successfully collected patient data, which was processed by the ESP32 microcontroller and transmitted to the server via Wi-Fi without noticeable delay. The system ensured continuous monitoring, and the web-based dashboard provided a clear and user-friendly interface for visualizing patient health data. Caregivers and healthcare providers were able to remotely access real-time information, improving patient supervision and reducing the need for manual monitoring.

The system also proved effective in generating alert notifications when abnormal health conditions were detected, enabling timely medical intervention and enhancing patient safety. The integration of IoT technology minimized human errors and improved overall efficiency in healthcare monitoring. Additionally, the system is cost-effective, scalable, and suitable for home-based applications. Overall, the results indicate that the proposed system provides a reliable and practical solution for remote healthcare monitoring, improving accessibility and response time in critical situations.

Future Directions and Enhancements

To further improve the proposed IoT-based Patient Health Monitoring System, future research should focus on developing more intelligent, scalable, and user-friendly solutions that can be seamlessly integrated into modern healthcare environments. Enhancements should aim at improving system accuracy, expanding functionality, and ensuring better accessibility for both patients and healthcare providers.

Integration of Advanced Technologies: Future systems can incorporate Artificial Intelligence (AI) and Machine Learning (ML) techniques to analyze patient health data and predict potential health risks in advance. Predictive analytics can help in early detection of diseases and provide timely recommendations. Integration with wearable devices and mobile applications can further enhance real-time monitoring and user convenience.

Enhanced Data Management and Security: As healthcare data is highly sensitive, future developments should focus on secure data transmission and storage using cloud computing and encryption techniques. Implementing blockchain technology can further ensure data integrity and privacy.

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Additionally, integrating the system with hospital management systems and electronic health records (EHR) can improve data sharing and coordination among healthcare professionals.

User-Centric Design and Accessibility: Future systems should prioritize user-friendly interfaces and accessibility, especially for elderly patients. Voice-based interaction, multilingual support, and simplified dashboards can make the system easier to use. Including telemedicine features such as video consultations and automated appointment scheduling can further enhance healthcare accessibility and provide a complete remote healthcare solution.

CONCLUSION

The IoT-based Patient Health Monitoring System provides a comprehensive, efficient, and user-friendly solution for continuous healthcare monitoring. By integrating sensors, ESP32 microcontroller, and real-time data transmission, the system enables accurate tracking of vital health parameters such as temperature, blood pressure, and glucose levels. The use of a web-based dashboard allows caregivers and healthcare professionals to monitor patient conditions remotely, while alert mechanisms ensure timely response during abnormal health situations. This significantly improves patient safety and reduces the dependency on manual monitoring.

The proposed system enhances healthcare accessibility by allowing patients to be monitored from home, which is especially beneficial for elderly individuals and those with chronic illnesses. It minimizes human errors, reduces hospital visits, and ensures that critical health data is always available in real time. The system is cost-effective, scalable, and easy to deploy, making it suitable for both urban and rural healthcare applications.

Looking ahead, the system can be further enhanced by integrating advanced technologies such as Artificial Intelligence for predictive health analysis, wearable devices for continuous monitoring, and mobile applications for improved user interaction. Future developments may also include cloud-based analytics, telemedicine support, and secure data management systems. Overall, the IoT-based Patient Health Monitoring System serves as a reliable and smart healthcare solution that improves patient care, enables timely medical intervention, and contributes to the advancement of modern digital healthcare systems.

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