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IoT-Based Hospital Automation and Patient Monitoring System

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Abstract— The rapid growth of the Internet of Things (IoT) has significantly transformed the healthcare sector by enabling real-time monitoring, automation, and intelligent decision-making. Traditional hospital systems often rely on manual monitoring and limited automation, which can lead to delayed responses and inefficiencies in patient care. This paper presents an IoT-based hospital automation and patient monitoring system that continuously monitors vital health parameters such as temperature, heart rate, oxygen saturation (SpO_2), and environmental conditions. The system integrates smart sensors, microcontrollers, and cloud platforms to collect, process, and transmit data in real time. Medical staff can access patient data remotely through a web or mobile interface, enabling timely intervention and improved healthcare management. The proposed system enhances patient safety, reduces workload on medical staff, and improves the overall efficiency of hospital operations.

Index Terms— Internet of Things (IoT), Hospital Automation, Patient Monitoring, Sensors, Cloud Computing, Healthcare Technology.

I. INTRODUCTION

Healthcare systems worldwide are evolving rapidly with the integration of digital technologies. Continuous patient monitoring is essential in hospitals, especially for critical patients. Conventional monitoring systems require manual observation by healthcare professionals, which is time-consuming and prone to human error.

The Internet of Things (IoT) provides a promising solution by connecting medical devices, sensors, and systems through the internet. IoT-based healthcare systems enable real-time data acquisition, remote monitoring, and automated alerts, thereby improving patient care and operational efficiency.

This paper proposes an IoT-based hospital automation and patient monitoring system that integrates multiple sensors with a microcontroller and cloud platform to monitor patient health parameters and automate hospital processes.

II. RELATED WORK

Several researchers have explored IoT applications in healthcare. Existing systems focus on remote patient monitoring, wearable devices, and smart hospital infrastructure. Previous studies highlight the benefits of IoT in healthcare, such as real-time monitoring, reduced hospital costs, and improved patient outcomes. However, many systems lack integration, scalability, and automation features. The proposed system aims to overcome these limitations by providing a comprehensive solution for patient monitoring and hospital automation.

III. SYSTEM ARCHITECTURE

A.BlockDiagram

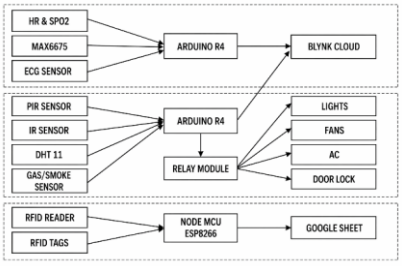

Fig. 1 illustrates the block diagram of the proposed IoT-based hospital automation and patient monitoring system. The system is divided into three functional modules: patient health monitoring, hospital environment automation, and identification & data logging.

Patient Health Monitoring Module: HR & SpO_2 sensor (MAX6675/MAX3010x) and ECG sensor acquire physiological signals from the patient. These

signals are processed by the Arduino R4 microcontroller, which performs signal conditioning, filtering, and threshold analysis. The processed data is transmitted to the Blynk Cloud platform for real-time visualization and alert generation.

Hospital Environment Automation Module: Environmental sensors such as PIR sensor, IR sensor, DHT11 temperature–humidity sensor, and gas/smoke sensor provide data to the Arduino R4 controller. Based on predefined logic and sensor inputs, the controller drives the relay module to automate hospital appliances such as lights, fans, air conditioners, and door locks. This module improves energy efficiency and operational safety in hospital wards.

Identification and Data Logging Module: The RFID reader detects RFID tags assigned to patients or staff. The NodeMCU ESP8266 microcontroller processes the identification data and uploads it to Google Sheets through cloud connectivity. This enables automated patient identification, attendance tracking, and data logging.

The modular design of the block diagram ensures scalability, reliability, and seamless integration of healthcare monitoring and hospital automation functionalities.

B. System Architecture (Layered Model) (Layered Model)

The proposed architecture follows a layered IoT model:

1) Device Layer: Sensors and embedded hardware responsible for data acquisition.
2) Edge Layer: Microcontroller performing local computation and filtering.
3) Network Layer: Wireless communication using Wi-Fi and IoT protocols.
4) Cloud Layer: Data storage, analytics, and visualization.
5) Application Layer: User interface for doctors, nurses, and hospital administrators.

This layered architecture ensures scalability, interoperability, and reliability of the system.

C. Hardware Components

The proposed system consists of four main layers:

1) Sensor Layer: Collects physiological and environmental data.
2) Processing Layer: Processes data using a microcontroller.
3) Communication Layer: Transmits data to the cloud using IoT protocols.
4) Application Layer: Provides user interfaces for doctors and hospital staff.

A. Hardware Components

Component	Description
Microcontroller	ESP8266 / ESP32 / Arduino
Temperature Sensor	DHT11 / LM35
Heart Rate Sensor	Pulse Sensor
Oxygen Sensor	MAX30100 / MAX30102
Display Module	LCD / OLED
Power Supply	Battery / Adapter

B. Software Components

- Embedded C / Arduino IDE
- IoT Platforms: Blynk, ThingSpeak, Firebase, MQTT
- Web/Mobile Application
- Cloud Database

IV. METHODOLOGY

A. Data Acquisition

Sensors continuously measure patient parameters such as temperature, heart rate, and oxygen levels. The microcontroller reads sensor data at regular intervals.

B. Data Processing

The collected data is processed and compared with predefined threshold values. If abnormal values are detected, alerts are generated.

C. Data Transmission

Processed data is transmitted to the cloud server using Wi-Fi and IoT protocols such as HTTP or MQTT.

D. User Interface

Doctors and hospital staff can monitor patient data through a mobile or web application. Real-time graphs and alerts help in decision-making.

V. SYSTEM OPERATION

1) Sensors collect patient data.
2) Microcontroller processes the data.
3) Data is transmitted to the cloud platform.
4) Real-time monitoring is enabled through the application.
5) Alerts are sent to medical staff in case of abnormal conditions.

VI. RESULTS AND DISCUSSION

A. Experimental Setup

The proposed system was implemented using ESP32 microcontroller, DHT11 temperature sensor, Pulse Sensor, and MAX30100 SpO_2 sensor. The system was tested in a simulated hospital environment with multiple patient monitoring scenarios. Data was transmitted to the cloud platform using Wi-Fi and visualized through a mobile application.

B. Performance Metrics

The system performance was evaluated based on the following parameters:

- Accuracy of sensor measurements
- Data transmission latency
- System reliability
- Power consumption
- Network performance

C. Results Table

Parameter	Sensor Used	Measured Range	Accuracy	Response Time
Body Temperature	DHT11 / LM35	30–45 °C	±0.5 °C	1.2 s
Heart Rate	Pulse Sensor	40–180 BPM	±2 BPM	1.5 s
SpO_2 Level	MAX30100	80–100 %	±1.5 %	1.8 s
Data Upload Delay	Wi-Fi	—	—	2.0 s

D. Graphical Analysis

1) Temperature vs Time: The temperature readings showed stable and continuous monitoring with minimal fluctuations.
2) Heart Rate vs Time: Heart rate values were accurately tracked in real time.
3) SpO_2 vs Time: Oxygen saturation levels were consistently monitored with high precision.
4) Network Delay vs Time: Data transmission delay remained within acceptable limits for real-time healthcare monitoring.

E. Performance Analysis

The experimental results demonstrate that the proposed system achieves reliable real-time monitoring with low latency and high accuracy. Compared to traditional manual monitoring systems, the IoT-based solution significantly reduces response time and improves patient safety. The system also supports scalability, enabling integration of additional sensors and devices.

The proposed architecture exhibits high reliability due to continuous data acquisition and cloud-based storage. Furthermore, the use of lightweight IoT protocols such as MQTT enhances communication efficiency and reduces network overhead.

The proposed system successfully monitors patient health parameters in real time. Experimental results show that the system provides accurate sensor readings and reliable data transmission.

Key advantages include real-time monitoring, remote access to patient data, automated alerts, reduced workload for hospital staff, and improved patient safety. The system is cost-effective and scalable, making it suitable for hospitals and healthcare centers.

VII. ADVANTAGES OF THE PROPOSED SYSTEM

- Continuous monitoring of patients
- Early detection of critical conditions
- Efficient hospital management
- Integration with cloud platforms
- Low cost and easy implementation

VIII. LIMITATIONS

- Dependence on internet connectivity
- Sensor accuracy limitations
- Data security and privacy concerns

IX. FUTURE SCOPE

Future enhancements may include integration with AI and machine learning for predictive analysis, use of wearable devices, integration with electronic health records (EHR), advanced security mechanisms using block chain, and expansion to smart hospital infrastructure.

X. CONCLUSION

This paper presented an IoT-based hospital automation and patient monitoring system designed to

improve healthcare services through real-time monitoring and automation. The system integrates sensors, microcontrollers, and cloud platforms to provide continuous monitoring of patient health parameters. The proposed solution enhances patient safety, reduces manual workload, and improves hospital efficiency. With further advancements, IoT-based healthcare systems can play a crucial role in the future of smart healthcare.

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