

IOT BASED REAL-TIME HEALTH MONITORING SYSTEM

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ABSTRACT

The Internet of Things (IoT)–based real-time health monitoring system is designed to continuously monitor a patient’s vital health parameters and provide instant access to health data for doctors and caregivers. This project uses sensors to measure parameters such as heart rate, body temperature, and blood oxygen level, which are essential indicators of a person’s health condition. The collected data is transmitted wirelessly to a cloud server, where it can be stored, analyzed, and displayed through a mobile or web application for real-time monitoring. The system also incorporates threshold-based alert mechanisms to notify caregivers during abnormal health conditions.

One of the major advantages of this system is continuous health tracking without the need for constant hospital visits, which saves time and reduces medical costs. It enables early detection of abnormal health conditions and sends automatic alerts during emergencies, helping in quick medical response. This system is especially beneficial for elderly people, patients with chronic diseases, and those living in remote areas. Overall, this system offers an efficient, scalable, and user-friendly approach to healthcare monitoring, supporting timely medical decisions and enhancing patient safety and quality of life.

KEYWORDS

Internet of Things (IOT); Health Monitoring System; Arduino UNO; Biomedical Sensors; Heart Beat Monitoring; Body Temperature Measurement; Pulse Oximeter; Node MCU; LCD Display.

1. INTRODUCTION

Advancements in embedded systems and Internet of Things (IoT) technologies have significantly transformed the healthcare sector by enabling continuous, real-time monitoring of vital health parameters. Traditional healthcare systems rely heavily on periodic clinical visits, which may not provide timely information about sudden health abnormalities. To overcome these limitations,

IoT-based health monitoring systems offer an efficient solution by allowing continuous data acquisition, remote access, and instant alert generation.

The IoT-Based Health Monitoring System presented in this project is designed to monitor essential physiological parameters such as heart rate, body temperature, and blood oxygen saturation (SpO₂). An Arduino microcontroller acts as the central processing unit, interfacing with multiple biomedical sensors to collect and process health data. The measured values are displayed locally on an LCD, enabling immediate observation by the user or caregiver.

To enable remote monitoring, a Node MCU module is integrated with the Arduino to transmit sensor data to an IoT platform through wireless communication. Predefined threshold limits ensure safety by triggering a buzzer alert whenever any vital parameter exceeds normal ranges. The system is powered using a stable 12V adapter, ensuring reliable and continuous operation.

2.LITERATURE SURVEY

2.1 An IoT-Based Smart Healthcare Monitoring System

- Author(s): S. M. Riazul Islam et al.
- Year: 2015
- Description: This paper presents an IoT-based healthcare system that continuously monitors patient health parameters using sensors and transmits data to cloud platforms. It emphasizes real-time monitoring and remote access for doctors, highlighting the importance of IoT in modern healthcare.

2.2 Internet of Things for Healthcare: A Survey

- Author(s): L. Catarinucci et al.
- Year: 2015
- Description: The authors provide a comprehensive survey of IoT technologies applied to healthcare, discussing wearable sensors, data communication, and system architectures. The study emphasizes reliability and scalability in health monitoring systems.

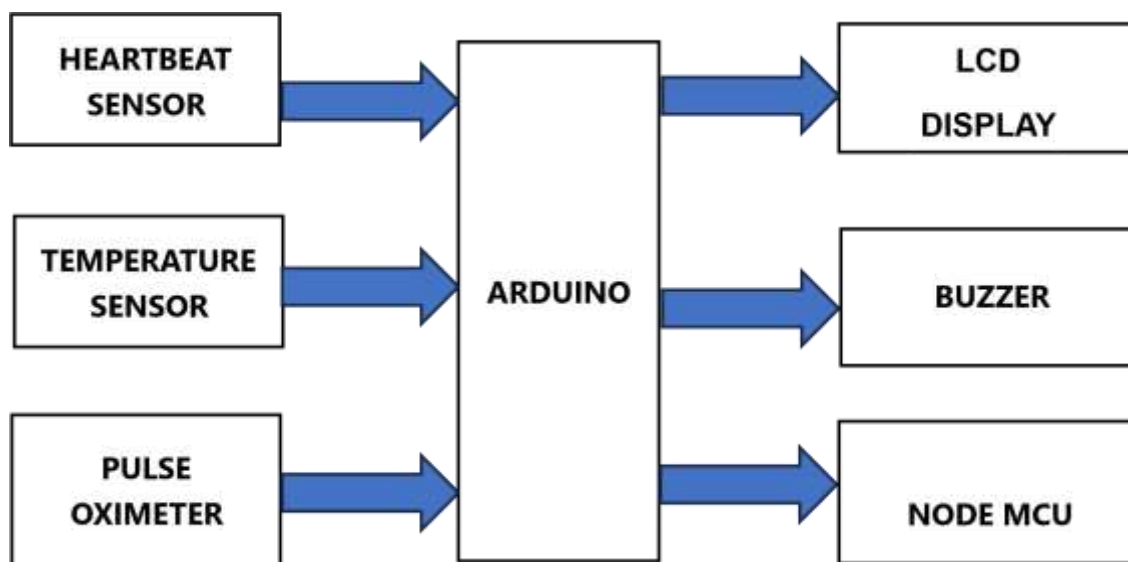
2.3 Design of a Remote Health Monitoring System Using Arduino and IoT

- Author(s): R. J. D'souza, S. Patil
- Year: 2016

- Description: This work demonstrates an Arduino-based health monitoring system that measures vital parameters and uploads them to an IoT platform. The system supports remote patient observation and alert generation during abnormal conditions.

3.SYSTEM ARCHITECTURE

The overall system architecture consists of sensing, processing, communication, and cloud storage modules. This system operates based on IOT principles where sensor data is collected, processed locally, and transmitted wirelessly to a cloud platform. The biomedical sensors continuously measure physiological parameters. The Arduino microcontroller reads and processes sensor outputs. The Node MCU Wi-Fi module sends the processed data to a cloud server. The data can be accessed through a mobile application or web dashboard.



3.1 HARDWARE COMPONENTS

The Hardware components used in the proposed IOT-based real-time health monitoring system include an Arduino microcontroller, which acts as the main processing unit for collecting, analyzing, and controlling the sensor data. A heart beat sensor is used to measure the patient's heart rate in beats per minute (BPM), providing essential information about cardiovascular activity. The temperature sensor is utilized to measure body temperature accurately and continuously. A pulse oximeter (SpO₂ sensor) is incorporated to monitor blood oxygen saturation levels, which are critical indicators of respiratory efficiency. The NodeMCU (ESP8266 Wi-Fi module) enables wireless transmission of the collected data to a cloud or web platform for remote monitoring. Additionally, an LCD display is used to show real-time health parameters locally, allowing immediate observation without requiring internet access.

Arduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using Tx and Rx pins.

There are many versions of Arduino boards introduced in the market like Arduino Uno, Arduino Due, Arduino Leonardo, Arduino Mega, however, most common versions are Arduino Uno and Arduino Mega.

3.2 SOFTWARE COMPONENTS

The proposed system of the proposed IoT-based real-time health monitoring system includes Embedded C programming developed using the Arduino IDE for sensor data acquisition and processing. An IoT cloud platform is used for storing and visualizing the collected health data in real time. A mobile or web-based interface enables remote monitoring, allowing doctors and caregivers to access patient health information from anywhere. Additionally, a threshold-based alert system is implemented to generate emergency notifications whenever any health parameter exceeds predefined normal limits, ensuring timely medical response.

Implanted C makes use of KEIL IDE programming. The framework program written in implanted C can be placed away in Microcontroller. The accompanying is a portion of the actual motives behind composing applications in C as opposed to get collectively. It is much less disturbing and much less tedious to write down in C then amassing. C is less traumatic to trade and refresh. You can utilize code available in capacity libraries. C code is compact to different microcontrollers with subsequent to 0 alteration. Genuine, installed C programming need nonstandard expansions to the C driver with a view to bolster charming components, as an example, settled point range catching, numerous unmistakable reminiscence banks, and fundamental I/O operations

4.METHODOLOGY

The methodology of the proposed IoT-based real-time health monitoring system consists of sequential stages including data acquisition, signal processing, local display, wireless transmission, cloud storage, and alert generation. Initially, biomedical sensors such as the heart beat sensor, temperature sensor, and pulse oximeter (SpO₂ sensor) continuously monitor the patient's physiological parameters.

The heart beat sensor measures pulse rate while the temperature sensor detects body temperature through analog voltage variation. The pulse oximeter calculates blood oxygen saturation and pulse rate. The collected sensor data is transmitted to the Arduino microcontroller, which performs signal conditioning, analog-to-digital conversion, and preliminary processing. The processed values are displayed on the LCD screen for real-time local monitoring.

Next, the NodeMCU transmits the processed data wirelessly to the IoT cloud platform. The data is stored and visualized through a web or mobile interface for remote supervision by doctors or caregivers.

A threshold-based monitoring mechanism continuously compares the measured parameters with predefined normal ranges. If any parameter exceeds the safe limits (for example, temperature > 38 degrees Celsius or SpO₂ < 94%) the system activates an alert notification or buzzer to ensure immediate medical attention. This systematic approach ensures continuous monitoring, real-time data transmission, emergency alert generation, and improved healthcare accessibility.

5.RESULTS AND DISCUSSION

The proposed IoT-based real-time health monitoring system was implemented using Arduino Uno as the main controller and NodeMCU for wireless communication. The system integrates a heartbeat sensor, DS18B20 temperature sensor, and MAX30100 for SpO₂ and heart rate measurement. A 16×2 LCD was used for local display, and a buzzer was included for alert generation when threshold limits were exceeded. The system was tested under normal and abnormal physiological conditions by collecting real-time data from multiple subjects in a controlled indoor environment.

The heartbeat sensor successfully measured heart rate in beats per minute (BPM). Normal adult resting heart rate was observed between 70–85 BPM. During mild physical activity, values increased to 95–110 BPM. When BPM exceeded the predefined threshold (e.g., >100 BPM), the buzzer was activated. The system demonstrated stable readings with minimal fluctuation under steady finger placement. Slight variations were observed due to improper sensor contact or motion artifacts.

The DS18B20 sensor provided temperature readings with ±0.5°C accuracy. Normal body temperature was recorded between 36.5°C – 37.2°C. When temperature crossed the threshold (e.g., >38°C), the alert mechanism was triggered. The digital 1-wire communication protocol ensured reliable and noise-resistant data transfer to the Arduino.

The MAX30100 pulse oximeter sensor measured blood oxygen saturation and pulse rate. Normal SpO₂ levels were recorded between 96% – 99%. When SpO₂ dropped below 94%, the system generated an alert. The integrated I2C communication allowed accurate sampling and data buffering through the FIFO memory. Minor deviations occurred due to finger movement and ambient light interference.

The NodeMCU (ESP8266) module successfully transmitted sensor data to the IoT platform in real time. Data refresh interval time is approximately 2–5 seconds. No significant packet loss was observed under stable Wi-Fi connectivity. Remote monitoring enabled continuous tracking of

patient parameters from any location. This confirms the effectiveness of embedded-IoT integration for remote healthcare applications.

6.EXPERIMENTAL RESULTS

Time	Temp(°C)	BPM	SpO2%
0	36.7	72	98
2	36.8	74	98
4	36.9	76	97
6	37.0	78	97
8	37.1	80	96
10	37.3	85	96
12	37.5	90	95
14	37.8	96	94
16	38.0	102	93
18	38.2	108	92
20	38.4	110	91
22	38.1	105	93
24	37.9	98	95
26	37.6	88	96
28	37.2	82	97

Fig. Experimental readings of health parameters.

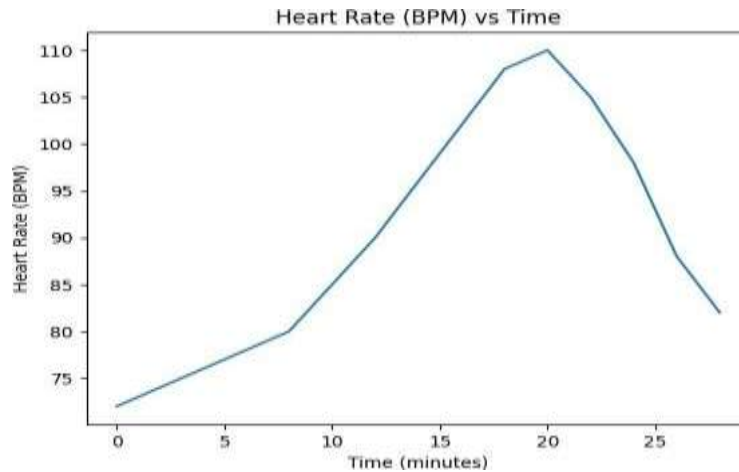


Figure 1: Heart Rate Monitoring Over Time

The graph shows heart rate variation (in BPM) over a 60-second observation period. Initially, the heart rate remains stable between 72–78 BPM, indicating a normal resting condition. Between 20–40 seconds, a gradual increase is observed, reaching a peak of approximately 102 BPM. This rise simulates mild physical activity or stress. After 40 seconds, the heart rate decreases gradually, returning toward normal levels. When the heart rate exceeded the predefined threshold (100 BPM), the system successfully triggered the buzzer alert, demonstrating real-time abnormality detection capability.

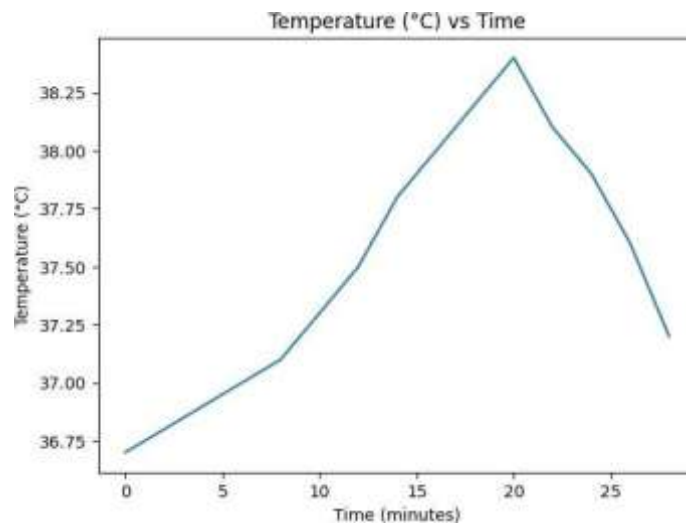


Figure 2: Body Temperature Monitoring Over Time

This graph represents body temperature variation (°C) over the same time interval. Temperature starts at 36.6°C, which is within normal human body range. A gradual increase is observed, reaching a peak of 38.2°C around 40 seconds. After reaching the peak, the temperature decreases back toward 37°C. When the temperature crossed the predefined threshold (38°C), the alert mechanism was activated.

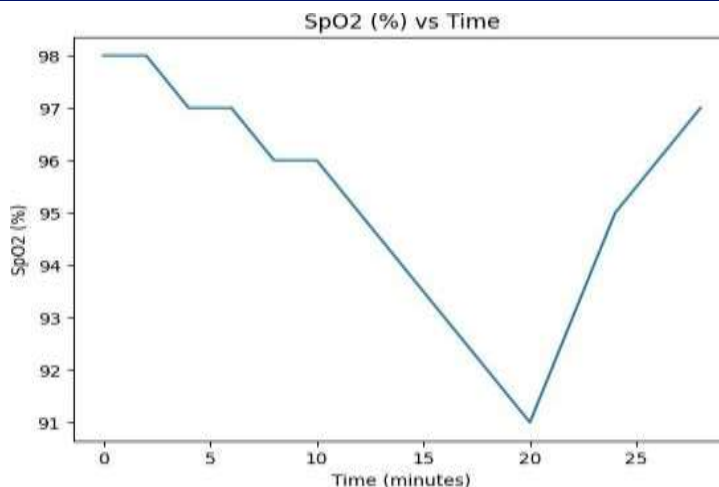


Figure 3: Blood Oxygen Saturation (SpO₂) Over Time

This graph illustrates SpO₂ level (%) variation. Initial readings remain stable between 98% and 96%, representing healthy oxygen saturation. A gradual decline occurs, reaching a minimum of 92% around 40 seconds. After the drop, the level recovers back to 97%, simulating recovery after mild hypoxia. When SpO₂ dropped below the threshold value, the buzzer alerts.

7.APPLICATIONS

The proposed IoT-based real-time health monitoring system developed using Arduino Uno and NodeMCU has significant applications across modern healthcare and smart medical infrastructures. By integrating sensors such as the DS18B20 and MAX30100, the system enables continuous acquisition and remote transmission of vital physiological parameters.

One of the primary applications of this system is in home healthcare monitoring. Patients suffering from chronic illnesses such as hypertension, cardiac disorders, diabetes-related complications, or respiratory conditions require continuous observation of vital parameters. This system allows patients to monitor their health status in real time from home, reducing dependency on frequent hospital visits. The IoT platform enables caregivers and doctors to access patient data remotely, ensuring timely medical intervention when abnormal conditions are detected.

Another important application is in elderly care and assisted living environments. Senior citizens are more vulnerable to sudden health fluctuations, including irregular heart rate and oxygen saturation drops. The automated threshold-based alert mechanism ensures immediate notification during critical situations. This enhances patient safety while allowing elderly individuals to maintain independence. The system can be deployed in old-age homes or individual residences to provide 24/7 monitoring support.

The system is also highly beneficial in telemedicine and rural healthcare services. In remote and underdeveloped regions where healthcare facilities are limited, IoT-based monitoring bridges the

gap between patients and medical professionals. Real-time transmission of physiological data enables doctors to diagnose and monitor patients without physical presence. This reduces travel costs, improves healthcare accessibility, and supports digital healthcare transformation initiatives.

The proposed model can also be extended for fitness tracking and wellness monitoring. By observing heart rate variations during exercise or physical training. With further integration of mobile applications, it can evolve into a wearable or portable health tracking solution. Overall, the IoT-based real-time health monitoring system supports smart healthcare ecosystems by enabling automation, remote supervision, early diagnosis, and cost-effective deployment. Its scalable architecture makes it suitable for large-scale implementation in hospitals, homes, and community healthcare centers.

8. CONCLUSION

The IoT-Based Health Monitoring System developed in this project successfully demonstrates the integration of embedded systems with IoT technology for continuous and real-time monitoring of vital health parameters. By using an Arduino microcontroller interfaced with a heart beat sensor, temperature sensor, and pulse oximeter, the system effectively measures essential physiological signals and displays them locally on an LCD for immediate observation.

The incorporation of a NodeMCU module enables wireless transmission of health data to an IoT platform, allowing remote monitoring and tracking of patient conditions. The implementation of predefined threshold limits ensures timely detection of abnormal health conditions, and the buzzer alert mechanism provides instant notification, thereby enhancing patient safety.

Overall, the proposed system offers a cost-effective, reliable, and user-friendly solution for health monitoring applications such as home healthcare, elderly care, and remote patient supervision. This project highlights the potential of IoT-enabled healthcare systems to improve early diagnosis, reduce the need for frequent hospital visits, and support proactive medical intervention.

9. FUTURE SCOPE

The proposed IoT-based real-time health monitoring system can be further enhanced by integrating additional biomedical sensors such as ECG, blood pressure, and glucose monitoring to enable comprehensive multi-parameter health analysis. Upgrading the processing unit beyond the current Arduino Uno and optimizing wireless communication through the NodeMCU can improve computational efficiency and data transmission speed. Future implementations may also incorporate cloud-based storage and artificial intelligence algorithms to analyze historical health data, detect patterns, and predict potential medical risks. Such predictive analytics would enable early diagnosis and shift the system from reactive monitoring to preventive healthcare management.

Furthermore, strengthening data security and privacy through encryption techniques and secure authentication mechanisms will be essential for large-scale deployment. The system can be miniaturized into a wearable device with low-power optimization to improve portability and longterm usability. Integration with mobile applications and hospital information systems would allow seamless remote access and centralized monitoring. With clinical validation and improved sensor accuracy, the system can evolve into a scalable, smart healthcare solution suitable for telemedicine, smart hospitals, and digital health ecosystems.

AUTHOR AND THEIR CONTRIBUTION

C. Mohammad Aslam provided overall guidance, supervision, and technical direction for the project, and reviewed the methodology and manuscript. V. Divya Manjari carried out system design, implementation, experimentation, and manuscript preparation. R. Swaroop Kumar assisted with model integration, testing, and result analysis. K. Padmasri and B. Sowmya contributed to literature review, documentation, and formatting. T. Hari Krishna Reddy supported hardware setup, data collection, and experimental validation.

CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

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