

Received date 3 Juli 2025; Revised 5 August 2025; Published 10 August 2025

DOI: 10.25299/ijsr.2024.23687

Monitoring System for Heart Rate, Blood Oxygen Level, and Body Temperature Using MAX30102 Sensor Based on Internet of Things

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Abstract: Human health can be monitored by measuring vital signs such as heart rate, oxygen saturation, and body temperature. A normal heart rate for adolescents ranges between 60–100 beats per minute. Abnormal conditions occur when the heart rate is below 60 bpm (bradycardia) or above 100 bpm (tachycardia). Likewise, normal blood oxygen saturation is between 95%–100%, and any value below this is considered abnormal. In addition to heart rate and oxygen levels, body temperature is also a critical indicator of one's health status. While many health monitoring tools have been developed, most still require manual operation and cannot provide continuous, real-time monitoring. To address this, a health monitoring system was developed using Node MCU ESP8266 as the microcontroller, integrated with the Blynk mobile application for real-time visualization. The system uses the MAX30102 and MLX90614 sensors to measure heart rate, oxygen level, and body temperature, and displays the data on a 0.96" OLED screen. A buzzer is used for alerts, and testing was performed by comparing results from the prototype with commercial-grade equipment. The system achieved an average accuracy of 97% during the tests.

Keywords: Internet of Things, ESP8266, MAX30102, MLX90614, Health Monitoring

1. INTRODUCTION

Health is a state of a person's mental and physical condition. Vital signs such as heart rate, blood oxygen saturation, and body temperature can be used as indicators to determine one's health status. Among vital organs, the lungs play a crucial role in supplying oxygen to the body. Organs like the heart and brain require sufficient oxygen to function properly. A normal resting heart rate for adolescents ranges between 60–100 beats per minute (bpm). A heart rate below 60 bpm is categorized as bradycardia, while a rate above 100 bpm is referred to as tachycardia. Blood oxygen saturation levels in healthy individuals are typically between 95% and 100%. Values below this range are considered abnormal. Likewise, body temperature is a key indicator used to assess a person's health condition.

Regular health checkups are essential for early detection of medical conditions. Ideally, individuals should undergo health monitoring every three months, including checking heart rate, respiratory rate, and body temperature. Early

detection allows for timely treatment and proper medical planning. While numerous health-monitoring devices have been developed, many still require manual operation and cannot continuously monitor in real time. This often leads to inaccurate data collection and delayed diagnosis. This study aims to develop a portable, real-time monitoring device that measures heart rate, oxygen level, and body temperature using IoT-based sensors. The system is designed to simplify the work of medical personnel by providing real-time data via the internet, improving accessibility and efficiency in health monitoring.

2. LITERATURE REVIEW

A pulse oximeter is a non-invasive device used to measure blood oxygen saturation (%) and heart rate (bpm), while sensors such as the DS18B20 are commonly used to measure body temperature in degrees Celsius. These values are transmitted and processed using the Node MCU ESP8266 microcontroller [2]. IoT-based portable heart rate and

temperature monitoring devices have proven beneficial in allowing healthcare professionals to monitor patients remotely. The ECG sensor AD8232 and DS18B20 temperature sensor are examples of components used in such systems [5]. With advancements in microcontroller and sensor technologies, the limitations of manual measurement can be addressed through Android-based IoT systems [6].

According to [7], patient monitoring can also be achieved via the Thing Speak web platform. In their study, system performance was analyzed using two parameters: RTT (Round Trip Time) and Thing Speak performance. The RTT test revealed a minimum data transmission time of 273 milliseconds and a maximum of 305 milliseconds between the device and the server. Overall, the integration of IoT technology in health monitoring devices enables real-time, accurate data transmission that supports both patients and medical professionals in improving healthcare delivery.

3. METHODOLOGY

3.1 Research Flow

This research follows a systematic flow consisting of several stages:

- **Literature Study**
A comprehensive review of existing research related to heart rate, oxygen level, and body temperature monitoring to serve as a reference for the system design.
- **System Illustration**
A visual representation of the proposed system, illustrating the interconnection of sensors and modules according to user requirements.
- **Hardware Configuration**
The selection and arrangement of electronic components such as the Node MCU microcontroller, sensors, display, and power supply.
- **Software Design**
Algorithm development and integration of all components through programming to ensure proper functionality.
- **Testing and Evaluation**
The developed system is tested and compared with standard tools. If errors are identified, revisions are made to the mechanical or software design

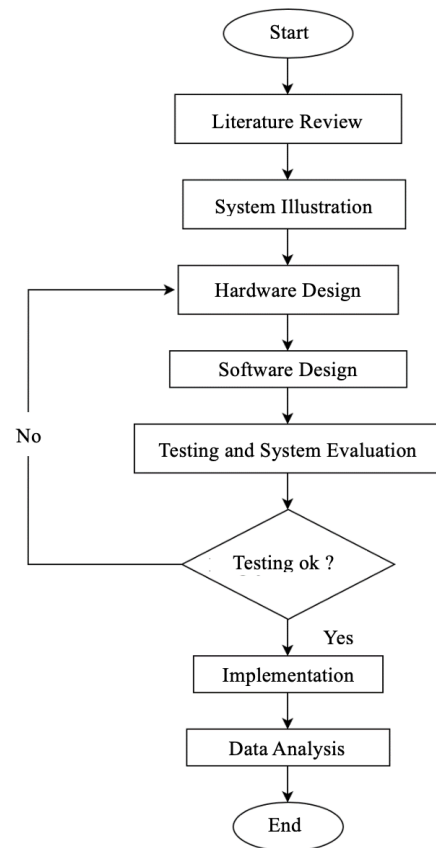


Figure 1. The workflow diagram

3.2 Hardware Design

The hardware setup includes a Li-ion 18650 battery, MT3608 step-up module, 7805 voltage regulator, and a Node MCU ESP8266 microcontroller. Sensors include MAX30102 (heart rate and oxygen level), MLX90614 (body temperature), a 0.96" OLED display, buzzer for alerts, and a push button for start/reset.

All components are assembled in a compact 11 x 5.5 x 3.7 cm enclosure. Figure 2 shows the circuit layout of the monitoring system.

3.3 System Requirements Analysis

To better understand the interaction between users and the system, three types of UML diagrams were used:

- **Use Case Diagram** (Figure 2): Illustrates the interaction between users and the system features.

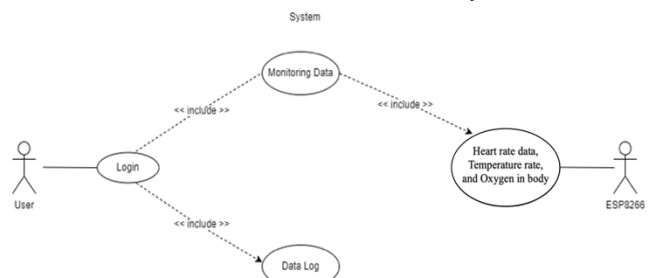


Figure 2. Use case diagram

- **Activity Diagram** (Figure 3): Outlines the sequence of operations within the system.

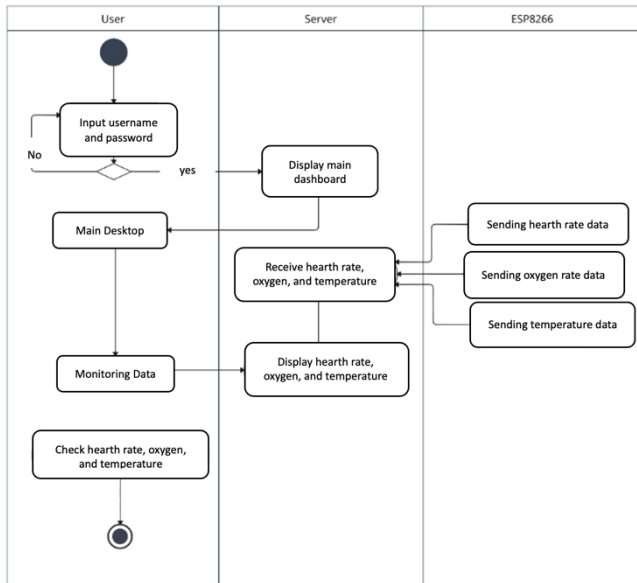


Figure 3. Activity diagram

- **Sequence Diagram** (Figure 4): Depicts the data flow between system components over time.

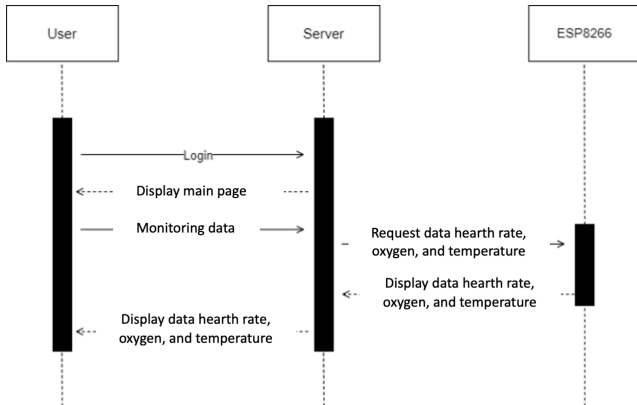


Figure 4. Sequence diagram

4. RESULTS AND DISCUSSION

4.1. Hardware Implementation

The prototype was successfully assembled as described in the methodology. It includes all required components for real-time monitoring. When a user places a finger on the MAX30102 and MLX90614 sensors, the OLED display shows real-time readings.

4.2. Hardware Implementation

The system was tested by evaluating sensor outputs and integration with the Blynk application. Table 1 summarizes the test results:

Table 1. Software Testing

4.3. Blynk Monitoring Display

When connected to the internet, the system transmits sensor data to the Blynk app, allowing real-time monitoring. Table 1 as shows writing the configuration of the house and feed need to consume as table in figure 1.

Function to be test	Method of test	Expected results	Results	Conclusion
Sensor MAX30102 and OLED	Touch finger to the sensor MAX30102	Show results to the sensor values OLED	Expected results	Valid
Sensor MLX90614 dan OLED	Touch finger to the sensor MLX90614	Show results to the sensor values OLED	Expected results	Valid
Blynk	Sending and receive data to the Blynk	Show data send and receive from sensor to OLED	Expected results	Valid

Table 1. Data detected from sensor

This data can be exported as an Excel file for further analysis.

4.4. Accuracy Testing

- **Heart Rate Test** (Table 2):

Comparison of prototype readings with a commercial pulse oximeter showed an average

Table 2. Heart rate test

Hearth Rate				
Name	Oxymeter (bpm)	Equipment Prototype (bpm)	Accuracy Level	Error (%)
Nurlisa Andriani	94	94	100	0
Chici Syafiliati	89	87	97.8	2.2
Widy Utami Adha	89	85	95.6	4.4
Via Saragih	87	89	97.8	2.2
Bagas Ocha	94	90	95.8	4.2
M Iqbal	101	98	97.1	2.9
Rizna Akmaliyah	80	77	96.25	3.75
Eka Mulyani	84	82	97.7	2.3
Erika Pendriana	95	90	94.8	5.2
Kelvin Prawira	88	85	96.6	3.4
Febri Ananda	90	87	96.7	3.3
Rata-Rata Error (%)				3.0

- **Oxygen Saturation Test** (Table 3):

Average accuracy of **97.6%**, with an error rate of **2.4%**.

Table 3. Oxygen saturation test

Amount of Oxygen in Blood				
Name	Oxymeter (SPO2)	Equipment Prototype (SPO2)	Accuracy Level	Error (%)
Nurlisa Andriani	98	97	99	1.0
Chici Syafiliati	89	88	98.9	1.1
Widy Utami Adha	98	103	94.9	5.1
Via Saragih	101	98	97.1	2.9
Bagas Ocha	93	95	97.9	2.1
M Iqbal	99	96	97	3.0
Rizna Akmaliah	97	95	98	2.0
Eka Mulyani	94	90	95.8	4.2
Erika Pendriana	99	97	98	2.0
Kelvin Prawira	96	97	99	1.0
Febri Ananda	90	88	97,8	2,2
Rata-Rata Error (%)				2.4

- **Body Temperature Test (Table 4):**
Average accuracy of **97.8%**, with an error rate of **2.2%**.

Table 4. Body Temperature Test

Body Temperature				
Name	Thermometer (°C)	Equipment Prototype (°C)	Accuracy level	Error (%)
Nurlisa Andriani	35.0	34,4	98.3	1.7
Chici Syafiliati	35,5	34	95.8	4.2
Widy Utami Adha	34.0	34	100	0
Via Saragih	34,3	34	99.5	0.8
Bagas Ocha	36.0	35	97.3	2.7
M Iqbal	36,5	36,0	98.7	1.3
Rizna Akmaliah	34.0	34	100	0
Eka Mulyani	35.0	33.1	84.6	5.4
Erika Pendriana	34.0	33	97.1	2.9
Kelvin Prawira	34.0	33	97.1	2.9
Febri Ananda	36,0	35	97,3	2,7
Rata-Rata Error (%)				2.2

4.5. Discussion

The system successfully monitors three vital parameters and transmits them to a remote server in real-time. The average accuracy from multiple test subjects shows that the device is reliable. Initial calibration was necessary to minimize

errors, but after refinement, the device performed within expected accuracy ranges.

5. CONCLUSION

A This study developed a portable IoT-based monitoring device for measuring heart rate, oxygen saturation, and body temperature using MAX30102 and MLX90614 sensors.

Key conclusions:

- The device is effective in detecting vital signs with real-time visualization via the Blynk application.
- Accuracy achieved:
 - Heart Rate: **97%**
 - Blood Oxygen Level: **97.6%**
 - Body Temperature: **97.8%**

ACKNOWLEDGMENT

The authors would like to thank the Department of Informatics Engineering, Universitas Islam Riau, for their support and facilities provided during this research and Universiti Teknologi MARA, Malaysia for their support in facility and human resources.

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