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Design And Construction of a Non-Contact Body Temperature Measuring Device Using the Mlx90614 Sensor Based on Nodemcu and the Blynk Application

Asni Tafrikhatin, Ajeng Tiara Wulandari, Juri Benedi, Intan Maharani

Department of Electrical Engineering, Politeknik Piksi Ganesha Indonesia, Indonesia, 54311

ajengtiarawulandari993@gmail.com

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Abstract

Body temperature is an important indicator for monitoring a person's health condition. The average normal human body temperature ranges from 36–37°C. Changes in body temperature, whether hyperthermia or hypothermia, may indicate infections or metabolic disorders, making accurate and practical measurement methods essential. Conventional contact thermometers have limitations, such as long measurement times and user discomfort. To overcome these issues, a non-contact body temperature measurement system was designed using an infrared sensor. This sensor works by detecting thermal radiation emitted from the body's surface without requiring direct skin contact. The device utilizes the MLX90614 infrared sensor, an ultrasonic sensor for distance detection, and a switch as an on/off control. Measurement results are displayed on an OLED screen and can be monitored via a smartphone through the Blynk platform. Based on testing, the non-contact body temperature measurement device achieved an accuracy level of 99.3%.

Keywords: Infrared Sensor; Ultrasonic Sensor; NodeMCU; Blynk.

Abstrak

Suhu tubuh merupakan indikator penting untuk memantau kondisi kesehatan, rata rata suhu tubuh normal berkisar 36–37°C. Perubahan suhu tubuh, baik hipertermia maupun hipotermia, dapat menandakan adanya infeksi atau gangguan metabolisme, sehingga diperlukan metode pengukuran yang akurat dan praktis. Termometer kontak memiliki keterbatasan seperti waktu ukur yang lama dan ketidaknyamanan pengguna. Untuk mengatasi hal tersebut, dirancang sistem pengukuran suhu tubuh non-kontak yang memanfaatkan sensor inframerah. Sensor ini bekerja dengan mendeteksi radiasi panas yang dipancarkan oleh permukaan tubuh tanpa perlu kontak langsung dengan kulit. Rancanganan alat ini menggunakan sensor inframerah MLX90614, sensor ultrasonik untuk pendeteksian jarak dan saklar sebagai tombol on/off. Hasil pengukuran ditampilkan pada layar OLED dan dapat dipantau melalui smartphone menggunakan platform Blynk. Berdasarkan pengujian, alat pengukuran suhu tubuh non-kontak memiliki tingkat akurasi sebesar 99,3%.

Kata kunci: *Sensor Inframerah; Sensor Ultrasonik; NodeMCU; Blynk.*

1. Introduction

Health is a crucial aspect of human life, playing a significant role in quality of life and productivity. Maintaining good health is crucial to prevent various diseases that can disrupt daily activities [1]. The average normal human body temperature ranges from 36°C to 37°C [2]. Changes in body temperature, whether increased (hyperthermia) or decreased (hypothermia), often indicate health problems such as infection, inflammation, and metabolic disorders [3] [4]. Conventional body temperature measurements generally use contact thermometers, such as digital or mercury thermometers. While quite accurate, these methods have several limitations, including relatively long measurement times, potential discomfort for the user, and the risk of cross-contamination due to direct contact with the body, especially when shared [5]. These conditions are of particular concern in both medical settings and the general public, particularly in situations requiring rapid and hygienic temperature measurements [6].

Along with technological advancements, non-contact body temperature measurement systems have begun to be developed as a more practical and safer alternative [7]. One widely used technology is the infrared temperature sensor. Infrared sensors work by detecting heat radiation emitted by the body's surface without requiring direct contact with the skin. The main advantages of this sensor are its fast, practical, and more hygienic measurement process, reducing the risk of microorganism spread [8]. Furthermore, advances in Internet of Things (IoT) technology enable real-time health monitoring systems integrated with digital devices [9]. IoT allows sensor devices to connect to the internet so that measurement data can be monitored and analyzed remotely via devices such as smartphones. The application of IoT technology in the healthcare sector offers significant opportunities to increase the efficiency of continuous monitoring of human body conditions.

Several previous studies have discussed body temperature measurement using infrared sensors. Research by Putra et al. (2020) developed a body temperature measuring system based on the MLX90614 sensor that displays measurement results on an LCD [10]. The results showed that the infrared sensor was capable of measuring body temperature with sufficient accuracy and a fast response time. Another study by Sari and Hidayat (2021) implemented an infrared temperature sensor based on an Arduino microcontroller for non-contact body temperature measurement [11]. This system was designed for standalone use without integration with an internet network. The study emphasized the system's advantages in terms of hygiene and measurement speed.

Furthermore, Rahman et al. (2022) developed an IoT-based body temperature monitoring system using an infrared sensor and an ESP8266 module [12]. Temperature data was displayed via a web-based application. This study demonstrated that IoT integration enables real-time remote body temperature monitoring. Based on several previous studies, it can be concluded that most non-contact body temperature measurement systems still have limitations, including: Some systems only display temperature data locally without integration with mobile devices; The developed IoT systems are still limited to web-based displays and are not yet optimal for use with interactive mobile applications; Not all studies combine local displays and remote monitoring simultaneously; and few studies emphasize ease of use and real-time data visualization via user-friendly smartphone applications [13].

Therefore, this research offers novelty by developing an IoT-based non-contact body temperature monitoring system that integrates an MLX90614 infrared temperature sensor, an ESP8266 microcontroller, an OLED display as a local display, and the Blynk application as a medium for real-time body temperature monitoring via smartphone. This system is expected to provide a more practical, efficient, and easy-to-use solution in monitoring human health.

2. Method

The research method used in this study is Research and Development (R&D), a research method aimed at developing and producing a product and testing its effectiveness. The product developed is a non-contact body temperature monitoring system based on the Internet of Things (IoT) that utilizes an MLX90614 infrared sensor to detect human body temperature. This system is controlled by a NodeMCU microcontroller, which functions as a data processing center and connects to the internet. An OLED display is used to directly display measurement results, while remote monitoring is performed via the Blynk application on a smartphone.

The initial stage of the Research and Development (R&D) method is to identify potential and potential problems, based on the limitations of contact thermometers. Contact thermometers have several drawbacks, such as relatively long measurement times, impracticality, and the risk of spreading infection due to direct contact with the user's body. These challenges formed the basis for developing a more hygienic and efficient non-contact body temperature measurement system.

The next stage was information gathering, conducted through literature review from various sources, such as scientific journals, reference books, and technical documentation. This study included a discussion of the operating principles of the MLX90614 infrared sensor, Internet of Things (IoT) technology, the use of the NodeMCU microcontroller, and the concept of a non-contact body temperature measurement system. The information obtained was used as a basis for designing a system that met the research needs.

Next, the system was designed, consisting of several main components: an MLX90614 infrared temperature sensor to detect body temperature, an HC-SR04 ultrasonic sensor to detect object distance, a NodeMCU to control the system, an OLED display as a local display, and the Blynk application to monitor body temperature via smartphone. This system design is illustrated in the form of a block diagram showing the relationships between components in the non-contact body temperature measurement device.

The product development stage involves assembling all components according to the predetermined design. Each component is assembled and configured to function optimally according to the development objectives. After assembly is complete, product testing is conducted to ensure the system is operating properly and that each component is functioning according to its intended specifications. This testing aims to determine sensor accuracy, system stability, and the reliability of data communication to the Blynk application.

Based on the test results, systematic product improvements were made to address deficiencies or errors discovered during the trial. The improvement process was carried out until the device could operate stably, accurately, and meet user needs. With these steps, it is hoped that the developed non-contact body temperature monitoring system will provide benefits in assisting with practical and efficient human health monitoring.

3. Result and Discussion

3.1 System Implementation

The system implementation in this study began with the design of a schematic and circuit layout for a NodeMCU-based non-contact body temperature measurement device. The schematic and circuit layout were created using Canva software as a system design visualization tool. This design aims to provide a comprehensive overview of the relationships between the components used, thereby facilitating the assembly and development process of the device. The designed system consists of an MLX90614 infrared temperature sensor, an HC-SR04 ultrasonic sensor, a NodeMCU as the main controller, an OLED display as the local display, and the Blynk application for remote monitoring via a smartphone. The overall system schematic is shown in **Figure 1.**

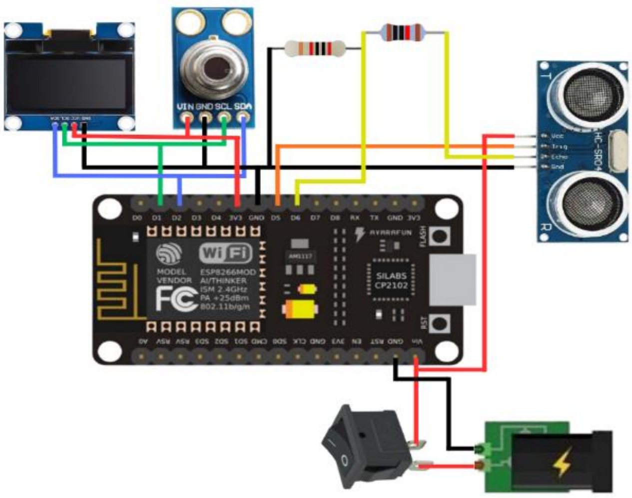

Figure 1. Schematic of the Entire System Circuit

3.2 How the Technology Object Works

The non-contact body temperature measurement device begins when the device is turned on. In the initial stage, the NodeMCU initializes all system components, including the MLX90614 infrared temperature sensor, the HC-SR04 ultrasonic sensor, the OLED display, and the network connection for communication with the Blynk application. Once the initialization process is complete, the system's initial status will be displayed on the OLED display as an indicator that the device is ready for use.

When an object approaches the device, the ultrasonic sensor detects the distance between the object and the device. If the object is detected as being less than 15 cm away, the system will activate the body temperature measurement process. The NodeMCU then activates the MLX90614 infrared temperature sensor to read the temperature of the object in front of the sensor without direct contact. The distance reading data from the ultrasonic sensor and the temperature value from the MLX90614 sensor are then sent to the NodeMCU for processing.

The measurement results are then displayed directly on a 0.96-inch OLED screen with a resolution of 128 × 64 pixels as a local display. In addition, body temperature data is also sent via the internet and displayed on a smartphone screen using the Blynk platform, so users can monitor the measurement results in real time remotely. The overall workflow of the NodeMCU-based non-contact body temperature measurement system is shown in Figure 3 in the form of a flowchart.

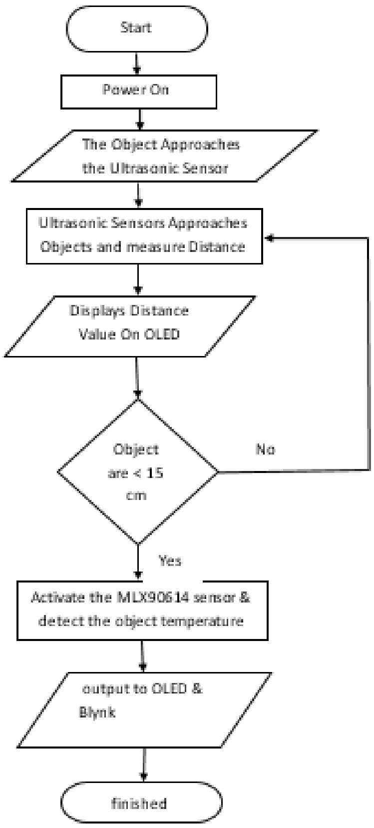

Figure 2. Overall Product Flow Diagram

3.3 Test Results

Testing was conducted to obtain performance data from the circuit created in accordance with the product planning and design. The following are the tests performed: Component Testing First, NodeMCU Testing: The NodeMCU was tested using the Arduino IDE to determine whether the NodeMCU was functioning properly. This was done to determine whether the NodeMCU could receive and process data from the MLX90614 and send data to the Blynk application.

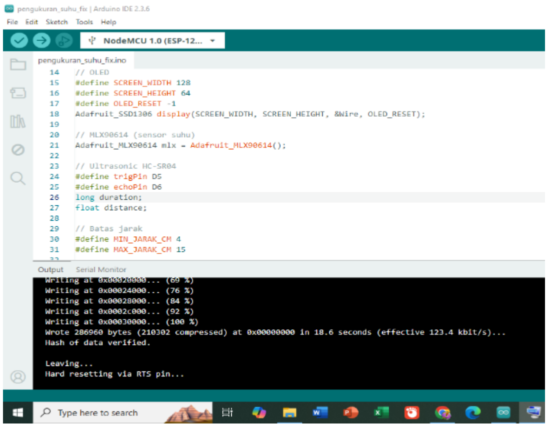

Figure 3. NodeMCU ESP8266 Test

OLED display testing was conducted to ensure that the OLED display was capable of properly displaying body temperature data processed by the NodeMCU. Test results showed that the OLED display could display temperature information clearly and in real time according to the data received from the sensor, thus functioning as planned. The OLED display test results are shown in **Figure 4.**

Figure 4. OLED Display Test

Network testing was conducted to ensure the system could connect to the internet stably without any issues. In this test, the NodeMCU successfully connected to the Wi-Fi network and transmitted body temperature data to the Blynk application in real time. This indicates that the system's network connection is functioning properly. The network test results are shown in **Figure 5**.

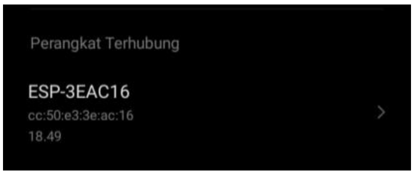

Figure 5. Network Testing

Testing of the MLX90614 infrared temperature sensor was conducted to ensure that the sensor can function properly in detecting body temperature based on infrared radiation emitted by objects. The test results show that the MLX90614 sensor is able to detect body temperature consistently and provide stable readings. Documentation of the MLX90614 sensor test results is presented in **Figure 6.**

Figure 6. MLX90614 Sensor Test

Next, ultrasonic sensor testing was conducted to ensure the sensor's ability to measure the distance between the sensor and the object. Test results showed that the ultrasonic sensor could detect distance effectively and automatically trigger temperature measurements when the object was less than 15 cm away.

The Blynk application was tested to ensure the application was connected to the NodeMCU and capable of receiving and displaying body temperature data sent by the system. Based on the test results, the Blynk application successfully displayed body temperature data in real time and synchronized with the OLED display. The Blynk application display during testing is shown in **Figure 7.**

Figure 7. Blynk Application Trial

The entire system was tested to determine the overall performance of the device. Data was collected on 10 individuals, then the results of non-contact body temperature measurements using the MLX90614 sensor were compared with those using commercially available digital thermometers. The test results are presented in a comparison table to determine the temperature sensor measurement error.

Temperature Sensor (° C)	Thermometer (° C)	Difference	Error
33,4	33,6	0,2	0,59
36,5	36,9	0,4	1,08
34,4	34,8	0,4	1,14
36,5	36,8	0,3	0,81
36,4	36,7	0,3	0,81
35,9	35,9	0	0
36,9	37,1	0,2	0,53
36	35,5	0,5	1,40
37	36,7	0,3	0,81
37	37,2	0,2	0,53
Average Error			0,7

The table above shows the results of a comparison between a temperature sensor and a digital thermometer to obtain the error value of the temperature sensor. Based on this average value, the percentage temperature difference is 0.00, and the accuracy level of the temperature sensor circuit is calculated using the equation:

Accuracy = 100% - average percentage error

= 100% - 0,7%

= 99,3%

Based on the calculation results, an average error percentage value of 0.7% was obtained. The accuracy level of the temperature sensor circuit was calculated using the equation, namely accuracy equals 100% minus the average error percentage. Thus, an accuracy value of 99.3% was obtained, indicating that the developed non-contact body temperature detector has a high level of accuracy and is suitable for use as a fast, practical, and hygienic body temperature monitoring tool.

4 Conclusion

Based on the design and testing results, it can be concluded that the non-contact body temperature detection device was successfully designed and implemented, utilizing an MLX90614 infrared sensor, an ultrasonic sensor, a NodeMCU, an OLED display, and the Blynk application as a remote monitoring medium. All system components are able to work in an integrated manner according to the planned functions, from distance detection to measuring and displaying body temperature data. The developed system can automatically detect body temperature when an object is less than 15 cm away, then display the measurement results in real time on the OLED display and the Blynk application. Based on the testing results, this non-contact body temperature detection device demonstrated an accuracy rate of 99.3%, thus being declared effective and suitable for use as a fast, practical, and hygienic body temperature monitoring tool.

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