Development of Air Temperature

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Development of Air Temperature Measurement Using LM35 Sensor Based on Nodemcu Microcontroller and Internet of Things (IoT)

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Abstract

The purpose of this research is to develop a real-time temperature monitoring instrument based on the Internet of Things (IoT). The research steps were design of a series of tools consisting of a Nodemcu microcontroller and an LM35 sensor, developing a tool that has been designed, testing the tool, and evaluating it. Performance analysis of the tool was carried out by measuring the relative error of the tool that has been developed with a standard thermometer. The result showed that the instrument's accuracy is 99.96% and the relative error percentage is 0.71%. It can be concluded that a room temperature measurement instrument with an IoT-based LM35 sensor can work well.

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INTRODUCTION

Monitoring the temperature of a room is very important, especially in a laboratory room, or a room that has electronic equipment. According to Arlik Sarinda and Sudarti (2017), a comfortable room temperature to live in is ±26 ˚C. Meanwhile, according to Santoso (2012), the comfort zone is at a temperature between 23 ˚C to 26 ˚C. Meanwhile, research conducted by Azizah (2014) showed that in areas with a tropical climate, neutral temperatures for buildings are between 26.1 ˚C – 29.8 ˚C.

Currently, the room temperature monitoring instrument that is often used is a thermometer, both analog and digital thermometers. However, remote room temperature monitoring instruments have not been widely used. Remote monitoring of room temperature can be done using a temperature sensor connected to a microcontroller and connected to the internet so that it can be monitored remotely. Many studies have been carried out on monitoring or measuring temperature. Kunicki et al. (2020) developed data acquisition system for on-line temperature monitoring in power transformers. Hao et al. (Hao *et al.*, 2015) used optical sensor for real time monitoring of power transmission lines temperature. Jihan (2019) used the LM35 sensor to monitor room temperature and temperature control was carried out by turning on the fan automatically. Sarah et al., (2016) conducted a study of temperature readings carried out at three different places, namely the temperature in the room, the temperature in the refrigerator and the temperature outside the room. Temperature readings were carried out using a LM35 sensor and an Arduino Uno where the measurement results were displayed on the LCD. In contrast to the research of Sarah et al. (2016), Supriyanto et al. (2017) developed temperature measurement instrument which the results were displayed on the web. Haryanto and Utami (2019), using a DHT11 sensor controlled by an Arduino Uno microcontroller and then connected via Bluetooth HC05 to transmit temperature value data displayed on Android. In this study, development of an air temperature measurement instrument using an LM35 sensor based on the nodemcu microcontroller and the internet of things (IoT) using Android to control indoor temperature was carried out. IoT is a new technology and enables small processing-capable devices to information from a sensor and send the data to the central computer (Adhiwibowo et al., 2020).

METHODS

Before being assembled, the LM35 sensor was calibrated first by measuring the temperature in several places and the results were compared with the results of measurements using a thermometer. The temperature measurement data were then plotted in a graph to obtain an equation of the relationship between the LM35 measurement results and the thermometer measurement results. The equation obtained was then used as a calibration equation written in the Arduino IDE program. After the calibration process, the assembly of the tool was carried out according to the design as shown in Figure 1.

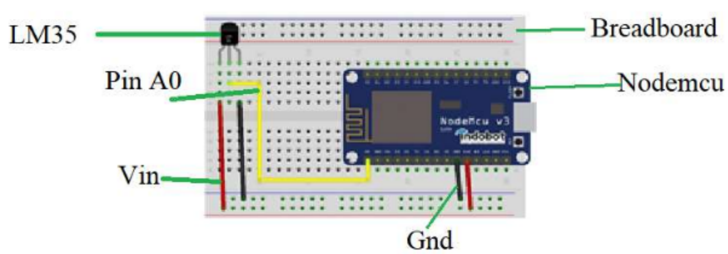

Figure 1: Design of room temperature measurement instrument

The performance test of the tool was then carried out by measuring the room temperature every 30 minutes for 24 hours. For comparison, temperature measurement was also carried out using a thermometer. The relative errors of the developed IoT-based temperature measuring device were calculated by comparing the results with the measurement results from the thermometer.

RESULTS AND DISCUSSION

LM35 sensor calibration

LM35 calibration was done by comparing it with a standard tool, namely an analog room temperature thermometer. Calibration was carried out at five different locations. The first measurement was in the living room, then the second in the third bedroom, the temperature in the fourth closet outside the house and the last one under the hot sun, as shown in Figure 2.

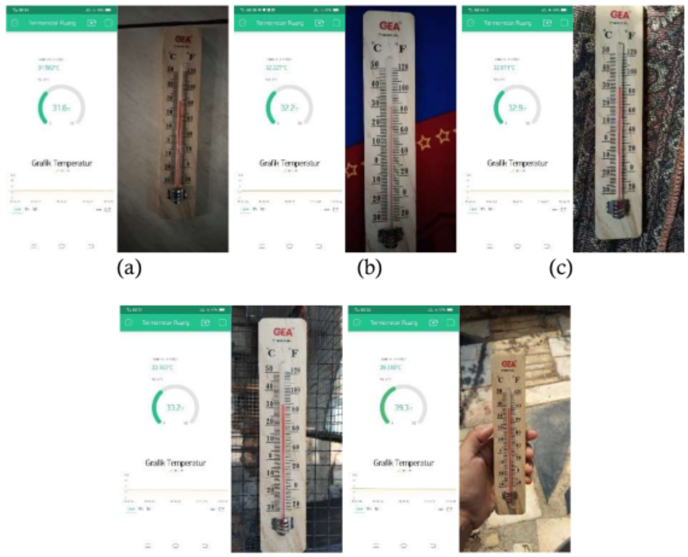

Figure 2. Temperature measurement for calibration in (a) the living room (b) the room (c) in the waldrobe (d) outside the house and (e) under the sun.

The results of temperature readings at five points were plotted in a graph to get the relationship between the LM35 measurement results and the thermometer as shown in Figure 3. From the graph, it was found that the correlation factor was 0.9983 with regression equation

$$y = 1.0553x - 3.5128 \quad (1)$$

where y was the temperature measured by the thermometer and x was the temperature measured by the LM35. Equation (1) was then entered into the Arduino IDE program.

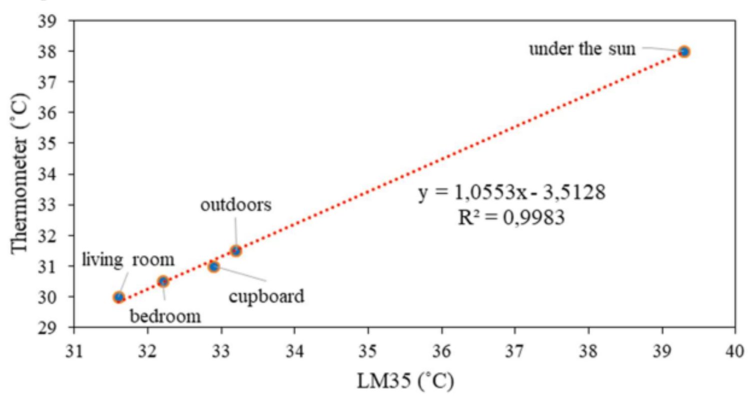

Figure 3. Comparison graph of LM35 Sensor and Room Thermometer

Instrument Assembly

The IoT-based temperature measuring device is shown in Figure 4. The measuring instrument has the main components, namely the Nodemcu V3 and LM35 Microcontrollers, with the Nodemcu placed in the Nodemcu Microcontroller holder (Nodemcu Base version 1.0). The LM35 sensor has 3 legs, namely Vin, PIN, GND. Vin was connected to a voltage of 3 volts on the Nodemcu, Vout was connected to PIN A0, and Ground was connected to GND Nodemcu.

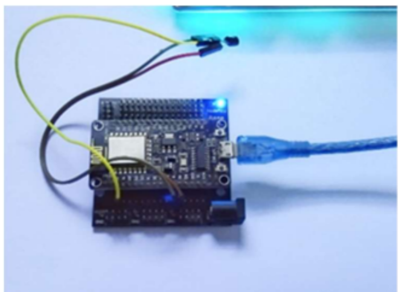

Figure 4. IoT-based temperature sensor tool

The Blynk application from android was used as a display of temperature readings at real time. Blynk's appearance can be changed as desired. The Blynk display can be seen in Figure 5, which displaying the measured temperature and a graph of temperature readings every 30 minutes. The display in Blynk is quite simple with 3 Widgets namely Value Display, Gauge, and Superchart. The Value Display function is to display the LM35 sensor reading, while the Gauge serves to display the readings from the Value Display in the form of a diagram. The room temperature reading is displayed with a reading range of 0°C - 50°C, and the superchart which function to display the temperature in graphical form and also to store temperature readings in CSV form.

Figure 5. Temperature monitoring on Blynk

Instrument Performance Test

The results of the instrument performance test are shown in Figure 5. The data were obtained from Blynk data storage and then exported to CSV which was sent via email. It can be seen that the highest room temperature is 34.50°C at 13.00 WIB and the lowest temperature was 26.41°C at 23.00 WIB.

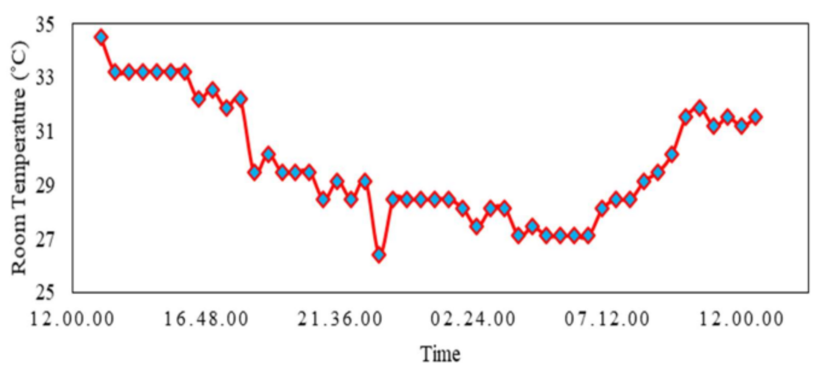

Figure 6. Graph of room temperature reading for 24 hours using an IoT-based temperature measuring device.

The relative error of the instrument compared to a room temperature thermometer is shown in Table 1. It can be seen that the largest relative error of the instrument was 0.71%. This shows that the accuracy of the tool was 99.96%. Therefore, a room temperature measuring instrument with an IoT-based LM35 sensor can work well and is feasible to use for remote room temperature monitoring.

Table 1. Performance test results of IoT-based temperature measuring instruments.

No.	Tool Temperature (˚C)	Thermometer Temperature (˚C)	Relative error (%)
1	27.8	28.0	0.71
2	28.1	28.0	0.36
3	28.5	28.5	0
4	28.5	28.5	0
5	28.5	28.5	0
6	28.5	28.5	0
7	28.1	28.0	0.36
8	28.5	28.5	0
9	27.8	28.0	0.71
10	28.1	28.0	0.356

CONCLUSION

An IoT-based room temperature measuring instrument has been developed. The results of the tool performance test showed that the largest percentage of the tool's relative error was 0.71%. Therefore, it can be concluded that a room temperature measuring instrument with an IoT-based LM35 sensor works well and can be used for remote and real time monitoring of room temperature.

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GENERAL COMMENTS

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