Signal and Image Processing Letters
Vol. 6., No. 2, 2024, pp. 57-64
ISSN 2714-6677
https://simple.ascee.org/



# Internet of Things-based Temperature and Humidity Control System

Fathony Nur Bastian [a,1] , Sunardi [a,2,*]

[a] Department of Electrical Engineering, Faculty of Industrial Technology, Universitas Ahmad Dahlan
[2] sunardi@ee.uad.ac.id
* corresponding author

ARTICLE INFO

**Keywords**
DHT11
Relay
ESP8266
IoT

ABSTRACT

The advancement of the industrial revolution 4.0, the use of automation systems and data processing based on the Internet of Things is a new standard that is widely applied to the production and industrial sectors. Air is an important element for daily life, therefore air must have quality so as not to have a negative impact on the body. Therefore, the solution developed in this research is to create an Internet of Things-based room temperature and humidity control system that can be monitored at any time, from anywhere and at any time. The system designed in this research, the ESP8266 microcontroller is used to control and process data from the DHT-11 sensor which is used to detect air temperature and humidity conditions. The results of data processing are then sent to blynk on the smartphone via an internet connection. The relay will turn on the fan when the temperature value is more than 29 °C and will turn off if the temperature is less than 26 °C. From the system testing carried out in the morning until the evening, the temperature error value is 4.46 and the humidity error value is 6.38%. The ability of the system to turn on the fan when the temperature value exceeds a certain limit can also run well.



## 1. Introduction

The advancement of the industrial revolution 4.0 has changed the pattern of human activities to be more efficient, fast and practical [1]. Currently, automation systems and data processing based on the Internet of Things (IoT) have become widely adopted standards in the production and industrial sectors. With the application of IoT in automation systems, the control and supervision process can be carried out efficiently and easily even remotely [2].

Daily life is highly dependent on air because its quality affects human health [3]. There are two types of air, these include outdoor air and indoor air. Therefore, it is important to pay attention to the quality of the air around us, especially when inside buildings, because indoor air pollution is different from pollution that occurs in the outdoor environment. One of the simplest ways to assess the health of a room is to understand its humidity level [4]. Air humidity is different from air temperature, but people often think of them as similar. Air temperature and air humidity have different effects on human comfort and health. An increase in temperature in an object will increase the temperature of the object [5].

Abnormal temperature and humidity conditions can interfere with human health in the room and accelerate damage to the goods stored in it [6]. Therefore, the necessary monitoring system must be a practical, efficient and remotely monitorable option for measuring temperature and humidity in the room. Thus it can ensure that the air conditions in the room are always well maintained [7].

The design of the simulation model in this research applies the use of the ESP8266 microcontroller to process indoor temperature and humidity data sent by the sensor [8]. The DHT-11 sensor is used to measure the temperature and humidity conditions in the environment [9]. The processed data from the sensor will then be sent via internet connection to the Blynk platform. In this way, the temperature and humidity of the room can be monitored in real-time, from various locations and at any time as needed [10].

Wardani, Hadi and Badiarto have conducted research using the DHT11 sensor used showing high sensitivity with minimal error. The temperature test carried out produced 26 data points, with an average error of 0.17 °C. In addition, the air humidity test in the server room produced 26 data points, with an average air humidity error of 0.6% [11].

Gembong, Rahman and Broto have conducted research on the Design of Temperature and Air Humidity Control Systems in IoT-Based Cubicles getting results when the humidity exceeds the 50% set point, the output will turn on, then the sensor will read the room temperature from the heat generated by the dehumidifier and turn on the fan if the temperature has reached 35 °C [12].

Iskandar, Febbiansyah and Firanda have conducted research on Monitoring Temperature and Air Humidity in IoT-Based Closed Rooms at PT Thermbuzz Berkat Alam using the ESP8266 microcontroller and Sensos DHT11 temperature. Getting the results of using the IoT concept can facilitate employees in monitoring the temperature and humidity of air in a closed room in real-time [13].

Putri, Rahayu and Ginantaka have conducted research on Arduino 2560 based Room Temperature Controller and DHT 22 sensor with an accuracy level of 99.8%, indicating that the use of the Arduino 2560 in the long term with system settings that utilize fuzzy logic will maintain the stability of its measurements [14].

Nudian, Dede and Widiawaty have developed a room temperature and humidity data collection system using DHT11 sensors and Arduino as a microcontroller. The data collected by the DHT11 sensor is processed by Arduino and then sent to the Thingspeak webserver. The data results from the DHT11 sensor are displayed in graphical form on Thingspeak. A reference error of 1.73% was found when comparing the temperature measured by the DHT11 with the data generated by the Vernier thermocouple sensor [15].

## 2. Methods

This research makes a system that is able to monitor and control the temperature and humidity values based on IoT through Blynk. when the temperature and humidity values exceed predetermined limits, the system will normalize the state of the room. The system design goes through two stages. The first stage is hardware design which contains the creation of system block diagrams and system sensor circuits until ready to be tested. The second stage is software design in the form of making programs or commands on the system used in the operation of the control system. Data collection is taken in a 3x4 m room which is a sleeping room and the collection is done once an hour from 05.00 - 00.00 WIB.

### 2.1. Block Diagram

The block diagram of this system uses a DHT11 sensor connected to a NodeMCU that can read the sensor value. The sensor value will be displayed on the LCD and sent to Blynk using the Internet network. If the temperature exceeds the predetermined maximum limit, the system will turn on the relay that can turn on the fan. The block diagram is shown in Fig. 1.

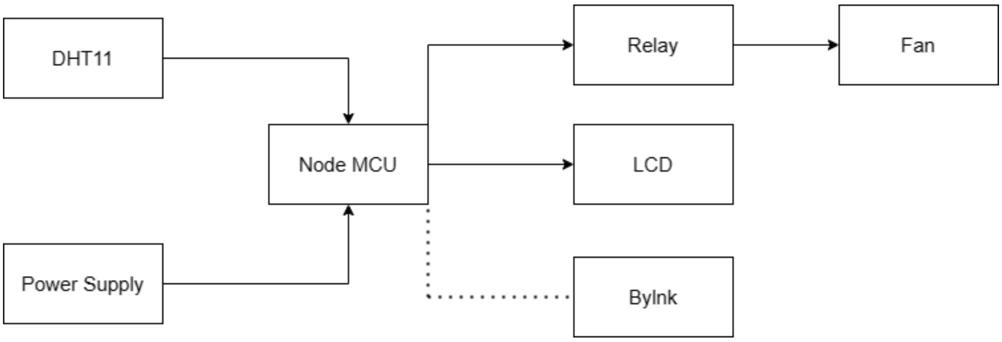


**Fig. 1.** System Diagram

## 2.2. Flowchart

In the first step, NodeMCU connects to the internet, then the DHT11 sensor readings will be sent to NodeMCU for processing. If the temperature read is more than 29 °C then the relay will turn on which will then turn on the fan, if the temperature read is less than 26 °C the relay will turn off which then turns off the fan. Flowchart display in Fig. 2.

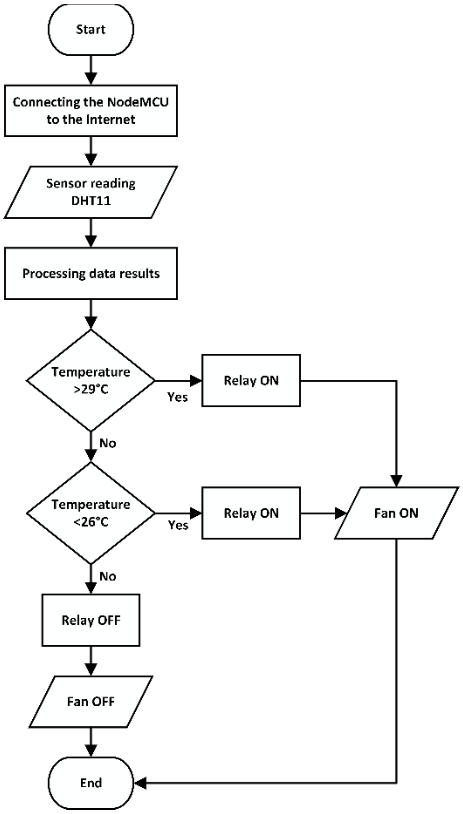


**Fig. 2.** Flowchart

## 2.3. Tool Circuit

The tool circuit can be seen in Figure 3 which is a component of the tool that has been connected into a circuit that is used as a reference in the tool making process. Display of the tool circuit in Fig. 3.

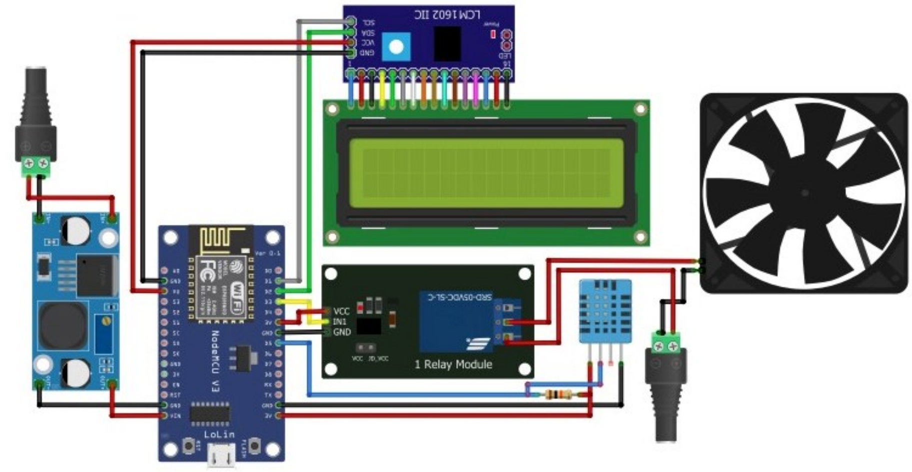


**Fig. 3.** Tool circuit

## 3. Results and Discussion

From the results of the tests that have been carried out in this study to determine the performance of the tools and sensors that have been made. These tests include hardware testing, sensor testing, Internet of Things testing and testing the results of room monitoring.

### 3.1. Hardware Testing

This test is carried out by measuring the input voltage and output voltage in this system, which includes NodeMCU, DHT11 Sensor, relay, LM2596 and LCD, then uniting all components that have been installed on the PCB board. Thus, this system will become a single unit that can work efficiently in accordance with the research objectives. Display of the circuit system tool check in Figure 4.

**Fig. 4.** Voltage Testing

When the system is running, the system will read the temperature and humidity sensor value data in the room. To support its operation, the system utilizes a power source from a power outlet, then the voltage will be lowered by a step down. The system will be active when it receives a power supply and will turn off if there is no voltage entering the system circuit. The results of the system circuit voltage test are shown in Table 1.

**Table 1.** Voltage Testing

| No | Component | Voltage (v) | Information |
|---|---|---|---|
| 1 | Node MCU | 5 | Normal |
| 2 | Sensor DHT11 | 5 | Normal |
| 3 | Relay | 5 | Normal |
| 4 | LM2596 | 5 | Normal |

### 3.2. DHT 11 Sensor Testing

This test tests the DHT11 sensor which will be processed by ESP8266 to read the temperature and humidity sensors in the room. After the DHT11 sensor can be used properly, the value is taken and calibration is carried out to compare the value of the DHT11 sensor with the Thermometer and Hygrometer sensors. This calibration aims to measure the difference value and the error value on the DHT11 sensor can be calculated using equation (1) and equation (2).

$$Difference = |Reference\ Value - Sensor\ Value| \tag{1}$$

$$Percentage\ error = \frac{|Difference|}{|Reference\ Value|} \times 100\% \tag{2}$$

Temperature and humidity data collection is carried out in a 4x3 meter room and data collection is carried out once a hour from 05.00 - 00.00 WIB. There are variables tested from the DHT11 sensor, namely temperature and humidity values. Testing the temperature value and humidity value in Table 3 and Table 4.

Table 2 is the data from the temperature value test. The tolerance value of the DHT11 sensor for temperature measurement is 2 °C. In this study, the difference data obtained from the sensor and thermometer readings resulted in a difference value of 1.36 °C with an error value of 4.46%. So, the temperature value test can be said to have been successful because the difference value is below 2 °C, which is 1.36 °C.

Table 3 is the data from the humidity value test. The tolerance value of the DHT11 sensor for humidity measurement is 5%. In this study, the data obtained from the difference between the humidity readings of the sensor and the hygrometer resulted in a difference value of 2.5% with an error value of 6.38. So, the humidity value test can be said to have been successful because the difference value is below 5%, which is 2.5%.

**Table 2.** Temperature Value Testing

| No | DHT11 Temperature (℃) | Thermometer (℃) | Difference (℃) | Error (%) |
|---|---|---|---|---|
| 05.00 | 28.9 | 27.5 | 1.4 | 5.09 |
| 06.00 | 29 | 28 | 1 | 3.57 |
| 07.00 | 29.8 | 29 | 0.8 | 2.76 |
| 08.00 | 30.2 | 29.1 | 1.1 | 3.78 |
| 09.00 | 30.3 | 28.9 | 1.4 | 4.84 |
| 10.00 | 31.8 | 30.5 | 1.3 | 4.26 |
| 11.00 | 32.8 | 31 | 1.8 | 5.81 |
| 12.00 | 33.5 | 31.7 | 1.8 | 5.68 |
| 13.00 | 33.8 | 32 | 1.8 | 5.62 |
| 14.00 | 33.6 | 31.9 | 1.7 | 5.33 |
| 15.00 | 31.1 | 30.7 | 0.4 | 1.30 |
| 16.00 | 32.3 | 30.8 | 1.5 | 4.87 |
| 17.00 | 33 | 30.8 | 2.2 | 7.14 |
| 18.00 | 32.8 | 30.7 | 2.1 | 6.84 |
| 19.00 | 32.6 | 30.5 | 2.1 | 6.89 |
| 20.00 | 31.8 | 31 | 0.8 | 2.58 |
| 21.00 | 32.6 | 31.4 | 1.2 | 3.82 |
| 22.00 | 32.8 | 30.9 | 1.9 | 6.15 |
| 23.00 | 31.2 | 30.8 | 0.4 | 1.30 |
| 00.00 | 30.6 | 30.1 | 0.5 | 1.66 |
| **Average** | **31.725** | **30.365** | **1.36** | **4.46** |

**Table 3.** Validity Value Testing

| No | DHT11 Humidity (%) | Hygrometer (%) | Difference (%) | Error (%) |
|---|---|---|---|---|
| 05.00 | 46 | 49 | 3 | 6.12 |
| 06.00 | 46 | 48 | 2 | 4.17 |
| 07.00 | 45 | 45 | 0 | 0 |
| 08.00 | 42 | 45 | 3 | 6.67 |
| 09.00 | 42 | 45 | 3 | 6.67 |
| 10.00 | 37 | 39 | 2 | 5.13 |
| 11.00 | 33 | 36 | 3 | 8.33 |
| 12.00 | 31 | 36 | 5 | 13.8 |
| 13.00 | 32 | 36 | 4 | 11.1 |
| 14.00 | 33 | 36 | 3 | 8.3 |
| 15.00 | 42 | 41 | 1 | 2.4 |
| 16.00 | 41 | 41 | 0 | 0 |
| 17.00 | 36 | 41 | 5 | 12.2 |
| 18.00 | 37 | 39 | 2 | 5.13 |
| 19.00 | 38 | 39 | 1 | 2.56 |
| 20.00 | 40 | 37 | 3 | 8.11 |
| 21.00 | 36 | 37 | 1 | 2.7 |
| 22.00 | 34 | 37 | 3 | 8.11 |
| 23.00 | 42 | 37 | 5 | 13.51 |
| 00.00 | 42 | 41 | 1 | 2.44 |
| **Average** | **38.75** | **40.25** | **2.5** | **6.38** |

### 3.3. Internet of Things Testing

In this researcher, the media used is Blynk. The display of data read by the sensor will be displayed by Blynk which can be seen from a smartphone so that it is easily understood by the reader and can be seen in real-time. Blynk display in Fig. 5. Fig. 5 is the display of the Blynk page functions as a medium in displaying temperature and humidity data. Blynk has auto / manual mode used to select automatic or manual settings, fan on / off display to make it easier for users to turn on the fan and turn off the fan through the Blynk application.


**Fig. 5.** Blynk display

### 3.4. Room Monitoring Results

In this research to find out the performance of the system works well or not. The data tested is the value of temperature and humidity, if the temperature value exceeds the predetermined by the system will turn on the relay. System test results in Table 4. Table 4 is the temperature and humidity values in the room measured in the morning, afternoon, evening and night. The fan is on at 05.00 and 06.00, while the fan off occurs at 07.00-00.00 because the temperature exceeds the specified limit. The temperature and humidity value data is in the form of a graph in Fig. 6. Fig. 6 is a graph of temperature and humidity value data. From the graph above, it can be observed that the temperature graph rises and the humidity decreases. The more the temperature rises, the lower the humidity will be and vice versa.

**Table 4.** System Testing

| WIB | Temperature Value (℃) | Humidity Value (%) | Fan Condition |
|---|---|---|---|
| 05.00 | 28.9 | 46 | OFF |
| 06.00 | 29.0 | 46 | OFF |
| 07.00 | 29.8 | 45 | ON |
| 08.00 | 30.2 | 42 | ON |
| 09.00 | 30.3 | 42 | ON |
| 10.00 | 31.8 | 37 | ON |
| 11.00 | 32.8 | 33 | ON |
| 12.00 | 33.5 | 31 | ON |
| 13.00 | 33.8 | 32 | ON |
| 14.00 | 336 | 33 | ON |
| 15.00 | 31.1 | 42 | ON |
| 16.00 | 32.3 | 41 | ON |
| 17.00 | 33.0 | 36 | ON |
| 18.00 | 32.8 | 37 | ON |
| 19.00 | 32.6 | 38 | ON |
| 20.00 | 31.8 | 40 | ON |
| 21.00 | 32.6 | 36 | ON |
| 22.00 | 32.8 | 34 | ON |
| 23.00 | 31.2 | 42 | ON |
| 00.00 | 30.6 | 42 | ON |

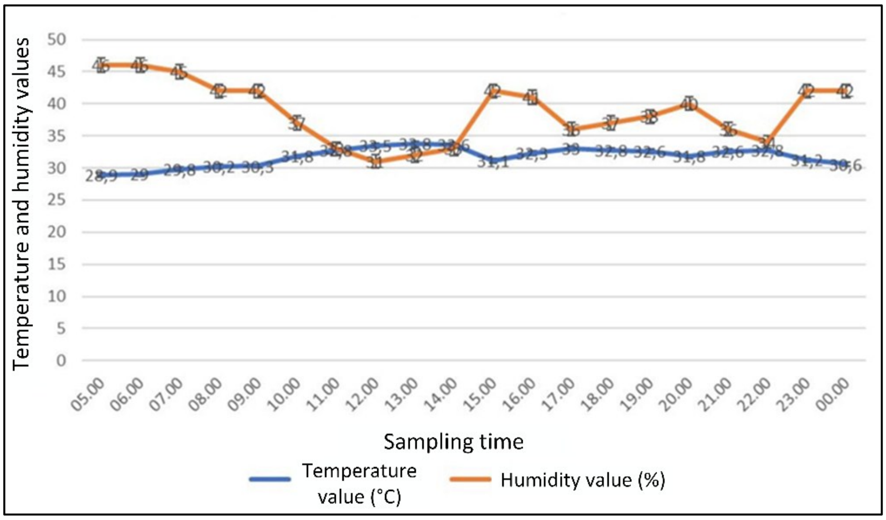


**Fig. 6.** Temperature and Humidity Graph

## 4. Conclusion

The DHT11 sensor can connect with NodeMCU in reading the temperature and humidity values, which are then LCD and sent to Blynk. The implemented system can function as a temperature and humidity control tool, providing assistance to users in monitoring temperature and humidity conditions in the room. For the work of the system produced with the basic capabilities of temperature measurement has an error value of 4.46% and humidity has an error value of 6.38% and Blynk works well so that temperature and humidity data can be easily understood.

## References

[1] M. M. J. Samodro, R. D. Puriyanto and W. Caesarendra, “Artificial potential field path planning algorithm in differential drive mobile robot platform for dynamic environment,” *International Journal of Robotics and Control Systems*, vol. 3, no. 2, pp. 161-170, 2023.

[2] E. Hamid, M. A. Zolkepli, N. Bahaman, S. Anawar, and Z. Ayop, “Smart Room Temperature Controller IoT System,” In *Progress in Intelligent Decision Science: Proceeding of IDS 2020*, pp. 178-184, 2021.

[3] M. Fayaz, I. Ullah, and D. Kim, “An optimized fuzzy logic control model based on a strategy for the learning of membership functions in an indoor environment,” *Electronics*, vol. 8, no. 2, p. 132, 2019.

[4] M. Zhang and X. Li, “Design of smart classroom system based on internet of things technology and smart classroom,” *Mobile Information Systems*, vol. 2021, no. 1, p. 5438878, 2021.

[5] S. Zanni, G. Motta, M. Mura, M. Longo, and D. Caiulo, “The challenge of indoor air quality management: A case study in the hospitality industry at the time of the pandemic,” *Atmosphere*, vol. 12, no. 7, p. 880, 2021.

[6] Sreenivasulu, G., & Anithaashri, T. P. (2022). Implementation of IoT-based intelligent patient healthcare monitoring system using KNN algorithm. In *Computer Networks, Big Data and IoT: Proceedings of ICCBI 2021* (pp. 215-222). Singapore: Springer Nature Singapore.

[7] V. Rao and K. V. Prema, "Internet-of-Things Based Smart Temperature Monitoring System," *2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, pp. 72-77, 2018.

[8] S. Shakthidhar, P. Srikrishnan, S. Santhosh and M. K. Sandhya, "Arduino and NodeMcu based Ingenious Household Objects Monitoring and Control Environment," *2019 Fifth International Conference on Science Technology Engineering and Mathematics (ICONSTEM)*, pp. 119-124, 2019.

[9] D. Yendri, Adrizal, D. Yolanda and J. F. Sibarani, "Temperature And Humidity Control System of Duck Egg Incubator Based On Proportional Integral Derivative," *2021 International Conference on Computer Science and Engineering (IC2SE)*, pp. 1-7, 2021.

[10] M. Dholu and K. A. Ghodinde, "Internet of Things (IoT) for Precision Agriculture Application," *2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI)*, pp. 339-342, 2018.

[11] W. F. Cheung, T. H. Lin, and Y. C. Lin, “A real-time construction safety monitoring system for hazardous gas integrating wireless sensor network and building information modeling technologies,” *Sensors*, vol. 18, no. 2, p. 436, 2018.

[12] F. Sharmin *et al*., "Humidity Based Automated Room Temperature Controller Using IoT," *2019 Third International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, pp. 226-231, 2019.

[13] R. Mumtaz *et al*., “Internet of things (Iot) based indoor air quality sensing and predictive analytic—A COVID-19 perspective,” *Electronics*, vol. 10, no. 2, p. 184, 2021.

[14] M. A. A. Razali, M. Kassim, N. A. Sulaiman and S. Saaidin, "A ThingSpeak IoT on Real Time Room Condition Monitoring System," *2020 IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS)*, pp. 206-211, 2020.

[15] N. Z. Malika, R. Ramli, M. H. Alkawaz, M. G. Md Johar and A. I. Hajamydeen, "IoT based Poultry Farm Temperature and Humidity Monitoring Systems: A Case Study," *2021 IEEE 9th Conference on Systems, Process and Control (ICSPC 2021)*, pp. 64-69, 2021.