Jurnal Teknologi Informasi dan Pendidikan
Volume 16, No. 2, September 2023
https://doi.org/10.24036/jtip.v16i2.770

P.ISSN: 2086 – 4981
E.ISSN: 2620 – 6390
tip.ppj.unp.ac.id

Temperature and Humidity Control System with Long Range in Mushroom Barn Using Fuzzy Logic

Indah Sari Putri Pratama[1*]✉, Suroso[1], M. Zakuan Agung[1]
[1]Electrical Engineering, Politeknik Negeri Sriwijaya, Palembang, Indonesia
**Corresponding Author:* indahsrptr25@gmail.com

Article Information

Article history:

No. 770
Rec. August 08, 2023
Rev. November 12, 2023
Acc. November 12, 2023
Pub. November 23, 2023
Page. 93 – 102

Keywords:

- *Fuzzy Logic*
- *DHT22*
- *IoT*
- *Long Range*

ABSTRACT

Room temperature and humidity are parameters required for quality mushroom growth. To get the appropriate and stable temperature and humidity values, a control system is needed. This test tries to build fuzzy logic utilizing the Internet of Things to develop a temperature and humidity control system. This temperature and humidity control system, uses the main components of DHT22 sensors, NodeMCU ESP32, Arduino nano, and Lora. The transmitter is placed in the mushroom barn. The transmitter control system stabilizes the temperature and humidity in the barn using a predetermined fuzzy method. After that, the data processed at the transmitter will be sent to the receiver via Lora communication. At the receiver, the device is placed in the mushroom farmer's house, which will capture the data sent by the transmitter. This recognition system has a good level of accuracy against the DHT22 sensor and Hygrometer, which has a difference of 1℃ or a difference of 2.08%. In contrast, for humidity, it has a total difference of 16% or 97.61%. When testing using fuzzy logic, the resulting temperature and humidity are stable, and the predetermined fuzzy logic carries out watering.

How to Cite:
Pratama, I. S. P., Suraso, & Agung, M., Z. (2023). Temperature and Humidity Control System with Long Range in Mushroom Barn Using Fuzzy Logic. Jurnal Teknologi Informasi Dan Pendidikan, 16(2), 93-102. https://doi.org/10.24036/jtip.v16i2.770

This open-access article is distributed under the Creative Commons Attribution-ShareAlike 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. ©2023 by Jurnal Teknologi Informasi dan Pendidikan.

1. INTRODUCTION

Indonesia is known as an agrarian country that relies on the agricultural sector. Most farmers use traditional methods to grow crops. One way to increase crop yields is to apply efficient automated modern technology. Many crops can be cultivated, including oyster mushrooms (Pleurotus Ostreatus) [1]. However, not all regions in Indonesia have suitable temperatures and humidity for oyster mushroom cultivation [2]. Oyster mushrooms depend heavily on their surroundings for growth. Temperature, humidity, light, and air are some environmental elements that have a significant impact on the growth of oyster mushrooms[3]. Oyster mushrooms can produce fruiting bodies at temperatures below 30, with an air humidity range of 80%-90% [4]. Farmers still physically wet the soil with a sprayer to keep the humidity and temperature stable for the growth of oyster mushrooms. A control system must be implemented in order for farmers to automatically control the temperature and humidity.

In previous research[5], the fuzzy logic method was used to create a watering control system in mushroom cultivation. The method of fuzzy logic was chosen to determine the sensor data at the input into data at the output in running the watering control system. The sensor test has produced comparison findings for the DHT11 sensor values. The average inaccuracy of the DHT11 sensor is 4.07%. Ten experiments were run to evaluate the watering control system. The percentage error obtained in this test is 16.66%. The test interval is 45 seconds, with a difference of 500 millimetres of water released. While using fuzzy logic to water plants is more accurate and may be customized to the specific needs of the mushroom barn, manual watering testing takes longer.

From the description above, fuzzy logic implementation testing has been made on controlling temperature and humidity in Lora-based mushroom barns [6]. The control system uses IoT based fuzzy logic with the main components of Lora, ESP32, and DHT22. In this study, Transmitter and Receiver are used in the Transmitter, there is an Esp32 MCU Node component to control the performance and process the program in the form of a DHT22 sensor, turn on the pump, turn on the fan and display data on the LCD16x2 and LoRa module, to send data to the Receiver. The receiver has components such as an Esp32 MCU Node, 16x2 LCD and LoRa module to receive data.

2. RESEARCH METHOD

In this work, a mechanism to regulate humidity and temperature in oyster mushroom barns was developed. The first stage is the design of the hardware for this device. The transmitter and receiver are part of the hardware in the system in the mushroom barn that controls temperature and humidity. The transmitter is in the mushroom barn, and the receiver is in the mushroom farmer's house. The input, process, and output components make up the input hardware design of the transmitter. Reading of data is done at the input section. Furthermore, in the process section, data processing is carried out to be processed to the output. Finally, in the output section, a data display is carried out.

The input section consists of a power supply, DHT22 and LDR sensors. The DHT22 is a sensor that measures the humidity and temperature in a space[7]. The LDR sensor is

https://doi.org/10.24036/jtip.v16i2.770

used to measure the light intensity value [8][9]. The process section contains the NodeMCU ESP32 microcontroller and Arduino nano. ESP32 is used to process data obtained from inputs. After that, the data processed by ESP32 will be sent to Arduino Nano which will then be sent to the output. These outputs include the water pump, exhaust fan, I2C LCD and the Lora transmitter. The parts contained in the transmitter can be seen in Figure 1.

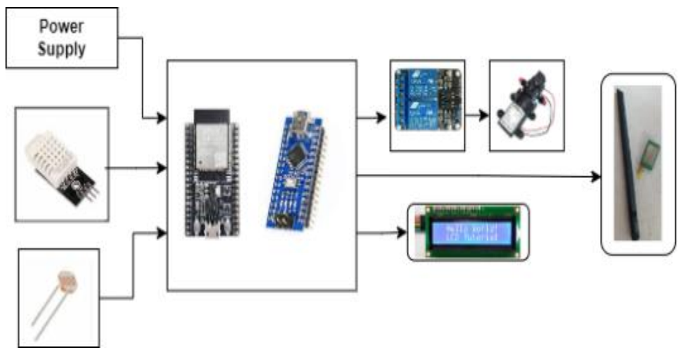


Figure 1. Transmitter Diagram of Control System

After the transmitter processes the data, the data will be sent to the receiver. At the receiver, the data will be received by the Lora receiver as input. Following that, the NodeMCU ESP32 microcontroller will process the data. The final result, data will be displayed on the I2C LCD at the receiver [10].

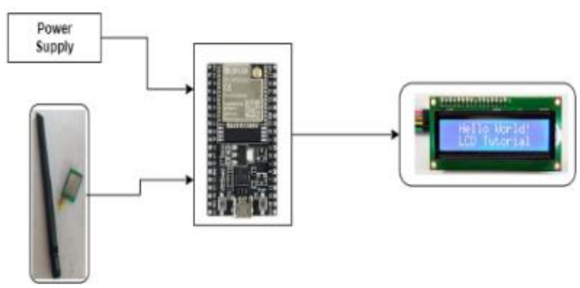
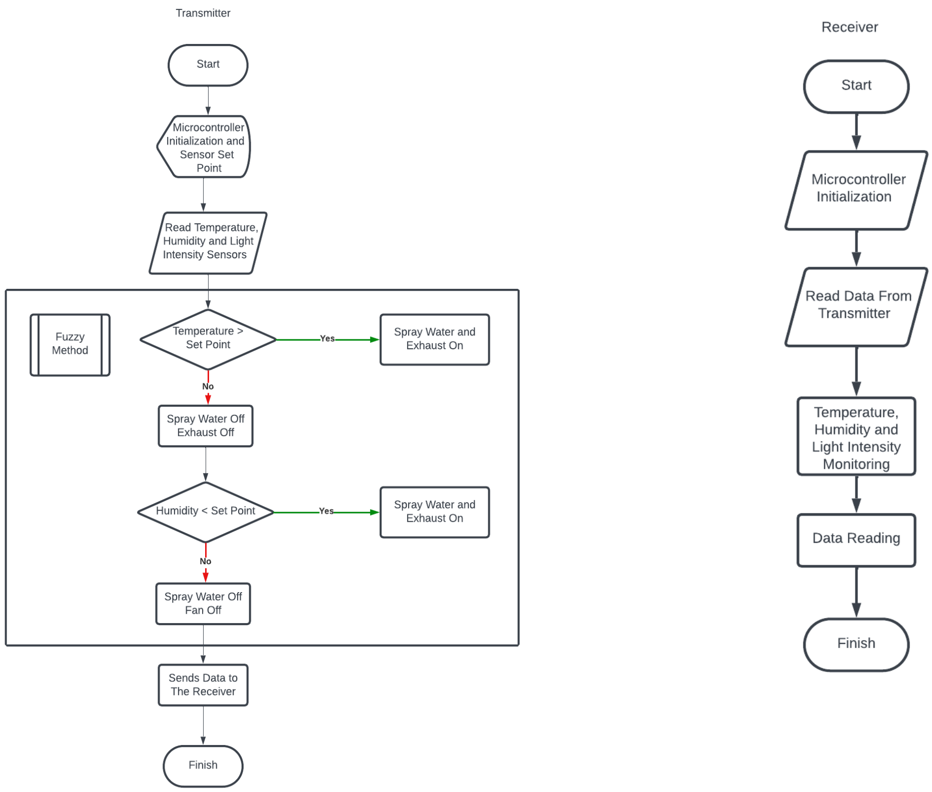


Figure 2. Receiver Diagram of Control System

The mushroom barn's temperature and humidity are maintained by the humidity and temperature control mechanism[11]. When the transmitter and receiver are activated, the device starts working. When the control system device is activated, the water jets in the misting will be sprayed in the form of dew. The fan will turn on if the room temperature is hot. The exhaust fan will turn off if the temperature is cold and normal. The control system is set up on the transmitter part of the appliance. As described in Figure 3.

Jurnal Teknologi Informasi dan Pendidikan
Volume 16, No. 2, September 2023
https://doi.org/10.24036/jtip.v16i2.770



(a) (b)

Figure 3. (a) Flowchart of Transmitter Control System, (b) Flowchart of Receiver Control System

After the device design was done, the data processing was carried out using the fuzzy logic method of Mamdani. Application of fuzzy logic method as watering automation recognition [12]. The fuzzy logic approach is used because fuzzy logic is an approachable and essential mathematical idea in reasoning[13][14]. Another way to think of fuzzy logic is as a murky or gray value that links the input space and the output space[15]. A model of the fuzzy logic approach used to determine the watering procedure is called fuzzy Mamdani. In Figure 4, The temperature and humidity levels in the mushroom cave are taken into account while determining the pump's turn-on time.

P.ISSN: 2086 – 4981
E.ISSN: 2620 – 6390
tip.ppj.unp.ac.id

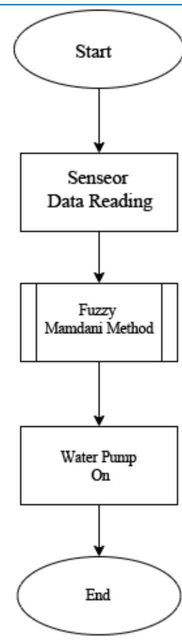


Figure 4. Flowchart System Control Program

By applying the fuzzy logic method as a control system, because fuzzy has a simple mathematical concept to determine the rules to be addressed[16]. Before the entire execution is complete, the process of mapping the input space to the output space is fuzzy[17]. Since each temperature and humidity sensor value has a unique membership, the fuzzification stage maps the sensor membership set. Fuzzification is a process that identifies or maps the sensor membership set[12]. Each measurement from the temperature and humidity sensors has a unique membership.

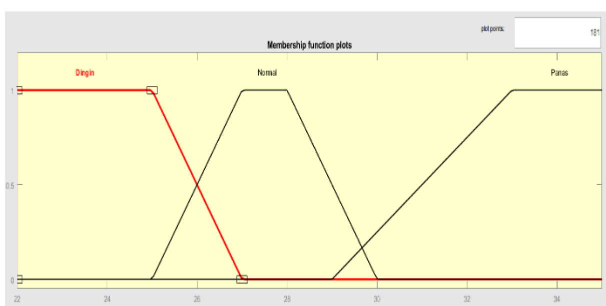


Figure 5. Temperature Membership Set

If the temperature variable's input value is represented by the horizontal axis, and its membership degree is represented by the vertical axis.

Three fuzzy sets are defined in the humidity variable: dry, normal and wet. The dry fuzzy set is represented by a descending linear form, the normal fuzzy set by a trapezoidal form, and the wet fuzzy set by an ascending linear form[18][19].

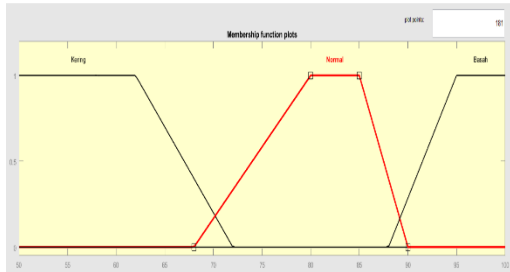


Figure 6. Humidity Membership Set

where the vertical axis represents the membership level of the input value and the horizontal axis represents the input value of the humidity variable.

The minimum, half, and maximum fuzzy sets are defined in the watering PWM variable. When the output value's membership degree is represented by the vertical axis and the horizontal axis is the humidity variable's input value.

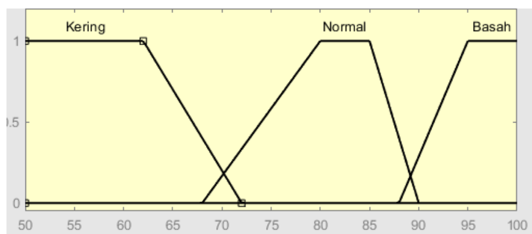


Figure 9. PWM Membership Set

After fuzzification, the next step is to determine inference. Fuzzy rules are to be determined via inference. Data gathered during the fuzzification stage in the form of membership values for the temperature and humidity sets will be subject to the pertinent fuzzy rules[20].

Tabel 1. Inference Fuzzy Rules

No	Temperature	Humidity	Rules
1	Cold	Dry	Half
2	Cold	Normal	Minimum
3	Cold	Wet	Minimum
4	Normal	Dry	Maximum
5	Normal	Normal	Half
6	Normal	Wet	Half
7	Hot	Dry	Maximum
8	Hot	Normal	Maximum
9	Hot	Wet	Half

3. RESULTS AND DISCUSSION

The temperature and humidity control system's component parts are all constructed on a PCB. After that, the circuit will be inserted into the box. This control system device uses a voltage source in the form of an adapter. In addition to the adapter, this control system device can use a power bank as a voltage source. Figure 8 displays the outcomes of this control system hardware.

(a)

(b)

Figure 10. (a) System Control Transmitter, (b)System Control Receiver

The test's results are broken down into two sections: data on the comparison of the DHT22 sensor's values with those from a hygrometer to assess the accuracy of the sensor; and test results obtained using the fuzzy mamdani approach. This test attempts to assess the degree of accuracy between the Hygrometer measuring device and the DHT22 sensor readout.

Tabel 2. Sensor Testing Results

Time	DHT22 °C/%	Hygrometer °C/%	Difference
12:05	32°C/83%	33°C/85%	1/2
12:25	29°C/81%	30°C/87%	1/6
12:45	28°C/97%	29°C/95%	1/2
13:05	29°C/95%	29°C/95%	0/0
13:25	29°C/93%	29°C/95%	0/0
13:45	27°C/94%	28°C/94%	1/0
14:05	27°C/95%	28°C/94%	1/1
14:25	28°C/96%	28°C/95%	0/1
14:45	29°C/89%	29°C/95%	0/6
15:05	30°C/94%	31°C/90%	1/4
Total	288°C/917%	294°C/925%	6/12

In the table above, it can be seen that the difference between temperature and humidity is different. However, the comparison results obtained are accurate. In the temperature result data between DHT22 and Hygrometer has a total difference of only 6 °C or 2.08%. The percentage difference and accuracy level can be calculated as follows:

$$\% \text{ Temperature Difference} = \frac{Total\ Difference}{DHT22\ Sensor} \times 100\ (\%)$$

= $\frac{6}{288}$x100(%)
= 2.08%
Accuracy level = 100 – (% Difference)
= 100 – 2.08% = 97.92%
In the humidity comparison results, the accuracy obtained is good with a total difference of 12% or 2.39% with an accuracy rate of 97.61%. The percentage difference and accuracy level can be calculated as follows:
% Humidity Difference = $\frac{Total\ Difference}{Sensor\ DHT22}$ x 100 (%)
= $\frac{12}{917}$x100(%)
= 2.39%
Accuracy level = 100 – (% selisih)
= 100 – 2.39% = 97.61%

This test aims to make the temperature and humidity in the barn stable by using the fuzzy method. This fuzzy method also aims to regulate watering carried out in mushroom barns after knowing the temperature and humidity levels. In this fuzzy method, the membership of the watering carried out has been determined. So that the value of the pump power is known and the membership set is known when watering. Testing the fuzzy method by placing the system in a mushroom barn is the steps. Program code reading utilizes writing with the Arduino IDE development configuration. The system is then run, the temperature and humidity sensor values obtained will be converted into cold, normal and hot membership sets, on dry, normal and wet humidity sensors.

Tabel 3. Control System Data Results Using Mamdani Fuzzy Logic

Time	Them	Hum	PWM	Rules Fuzzy	Exhaust
12:05	32°C	83%	201	Maks	1
12:25	29°C	81%	126	Sedang	0
12:45	28°C	97%	126	Sedang	0
13:05	29°C	95%	126	Sedang	0
13:25	29°C	93%	126	Sedang	0
13:45	27°C	94%	126	Sedang	0
14:05	27°C	95%	126	Sedang	0
14:25	28°C	96%	126	Sedang	0
14:45	29°C	89%	125	Sedang	0
15:05	30°C	94%	196	Maks	1

P.ISSN: 2086 – 4981
E.ISSN: 2620 – 6390
tip.ppj.unp.ac.id

4. CONCLUSION

The control system uses IoT-based fuzzy logic with the main components of Lora, ESP32, and DHT22. In this study, Transmitter and Receiver are used in the Transmitter, there is an Esp32 MCU Node component to control the performance and process the program in the form of a DHT22 sensor, turn on the water pump, the fan, and the LCD 16x2 and LoRa module to display data and transfer it to the receiver. This control system has a good level of accuracy against the DHT22 sensor and Hygrometer which has a difference of 1 °C or a difference of 2.08% while for humidity, it has a total difference of 16% or 97.61%. When testing using fuzzy logic, the resulting temperature and humidity are stable and watering is carried out by the predetermined fuzzy logic.

REFERENCES

[1] H. Fitriawan, K. Ali, D. Cahyo, S. Purwiyanti, and S. Alam, "Pengendalian Suhu Dan Kelembaban Pada Budidaya Jamur Tiram Berbasis IoT IoT Based Controlling Temperature And Humadity On Oyster Mushrooms Cultivation," 2020, [Online]. Available: http://dx.doi.org/10.23960/jtep-l.v9.i1.28-37
[2] A. Arafat, D. I. Puspitasari, and W. Wagino, "Sistem Pengendalian Suhu dan Kelembaban Kumbung Jamur Tiram secara Realtime Menggunakan Esp8266," *J. Fis. FLUX*, vol. 1, no. 1, p. 6, 2019, doi: 10.20527/flux.v1i1.5928.
[3] Direktorat Budidaya Tanaman Sayuran & Biofarmaka, *Budidaya Jamur Tiram.pdf*. 2010.
[4] Ade Barlian Tandiono, Moch. Rusli, and Muhammad Aziz Muslim, "Pengendalian Suhu dan Kelembaban pada Budidaya Jamur Tiram dengan Menggunakan Metode Kontrol Logika Fuzzy," *J. EECCIS (Electrics, Electron. Commun. Control. Informatics, Syst.*, vol. 10, no. 1, pp. 16–19, 2016, [Online]. Available: http://jurnaleeccis.ub.ac.id/index.php/eeccis/article/view/478/303
[5] Handi, H. Fitriyah, and G. E. Setyawan, "Sistem Pemantauan Menggunakan Blynk dan Pengendalian Penyiraman Tanaman Jamur Dengan Metode Logika Fuzzy," *J. Pengemb. Teknol. Inf. dan Ilmu Komput.*, vol. 3, no. 4, pp. 3258–3265, 2019.
[6] A. Ullah, O. B. Kharisma, and I. Santoso, "Fuzzy Logic Implementation to Control Temperature and Humidity in a Bread Proofing Machine," *Indones. J. Artif. Intell. Data Min.*, vol. 1, no. 2, p. 66, 2018, doi: 10.24014/ijaidm.v1i2.5664.
[7] Y. A. Sihombing and S. Listiari, "Detection of air temperature, humidity and soil pH by using DHT22 and pH sensor based Arduino nano microcontroller," *AIP Conf. Proc.*, vol. 2221, 2020, doi: 10.1063/5.0003115.
[8] W. Setya *et al.*, "Design and development of measurement of measuring light resistance using Light Dependent Resistance (LDR) sensors," *J. Phys. Conf. Ser.*, vol. 1402, no. 4, 2019, doi: 10.1088/1742-6596/1402/4/044102.
[9] M. Silalahi, "JDP Volume 10 No 1 APRIL 2017_2," vol. 10, no. 1, 2017.
[10] A. R. Susanto, A. Bhawiyuga, and K. Amron, "Implementasi Sistem Gateway Discovery pada Wireless Sensor Network (WSN) Berbasis Modul Komunikasi LoRa," *J. Pengemb. Teknol. Inf. dan Ilmu Komput.*, vol. 3, no. 2, pp. 2138–2145, 2019.

[11] W. Widyasmoro, T. Hidayat, T. K. Hariadi, N. Bin Mohamed Sepet, and W. E. Soon, "Application of Internet of Things (IoT) Technology to KWT 'Sido Makmur' Oyster Mushroom Cultivation," *Berdikari J. Inov. dan Penerapan Ipteks*, vol. 11, no. 1, pp. 25–41, 2023, doi: 10.18196/berdikari.v11i1.18325.

[12] A. Rusman, "Logika Fuzzy Tahani Sistem Penunjang Keputusan Penentuan Lulusan Terbaik," *J. Inform.*, vol. 3, no. 1, pp. 31–40, 2016.

[13] L. Santya, M. Miftah, V. Mandala, S. Saepudin, and D. Gustian, "Penerapan Metode Fuzzy Mamdani untuk Pendukung Keputusan Penentuan Jumlah Produksi Lantak Si Jimat," *J. Rekayasa Teknol. Nusa Putra*, vol. 7, no. 1, pp. 35–41, 2019, [Online]. Available: https://jurnal.nusaputra.ac.id/rekayasa/paper/44

[14] S. Maria, "Penentuan Kualitas Ruang Rawat Inap Dengan Menggunakan Fuzzy Logic," vol. 9, no. 1, pp. 108–114, 2016.

[15] P. Dengan and M. Metode, "38-Article Text-43-1-10-20180414," vol. 10, no. 1, 2017.

[16] N. T. Wirawan and R. Devita, "Implementasi Algoritma Fuzzy Logic Pada Robot Arm Dengan Memanfaatkan Accelerometer Smartphone Android," *J. Teknol. Inf. dan Pendidik.*, vol. 10, no. 2, pp. 1–12, 2017, doi: 10.24036/tip.v10i2.27.

[17] N. Nasron, S. Suroso, and A. R. Putri, "Perancangan Logika Fuzzy Untuk Sistem Pengendali Kelembaban Tanah dan Suhu Tanaman," *J. Media Inform. Budidarma*, vol. 3, no. 4, p. 307, 2019, doi: 10.30865/mib.v3i4.1245.

[18] suryani & N. Rahmat, "Jamur Tiram Menggunakan Metode Kontrol Logika Fuzzy Tugas Akhir Program Studi S1 Teknik Komputer Oleh : Muhammad Dedy Kurniawan," 2019.

[19] Z. Zulwisli, A. Herayono, A. Ambiyar, and W. Simatupang, "Evaluation of Student Ability in Laboratory of Electronics Engineering Department with Fuzzy Logic Calculation," *J. Teknol. Inf. dan Pendidik.*, vol. 15, no. 1, pp. 65–75, 2022, doi: 10.24036/jtip.v15i1.515.

[20] Fajar Rohman Hariri, "Penerapan Metode Fuzzy Sugeno Dalam Pendaftaran Siswa Baru di SDN Sonopatik 1 Nganjuk," *Tek. Inform. Univ. Nusant. PGRI Kediri*, vol. 3, no. 1, pp. 41–46, 2016.