MUSHROOM GREEN HOUSE MONITORING and CONTROL SYSTEM USING FUZZY LOGIC METHOD

1st Grahito Ardani Bimanta
Faculty of Information Technology and Bussiness
Institut Teknologi Telkom Surabaya
Surabaya, Indonesia
grahito.ardan@ student.ittelkom-sby.ac.id

2nd Helmy Widyantara
Faculty of Information Technolgy and Bussiness
Institut Teknologi Telkom Surabaya
Surabaya, Indonesia
helmywid@ittelkom-sby.ac.id

3th Khodijah Amiroh
Faculty of Information Technolgy and Bussiness
Institut Teknologi Telkom Surabaya
Surabaya, Indonesia
dijaamirah@ittelkom-sby.ac.id

Abstract*— Mushroom cultivation has great potential for wider development because of its economic and environmentally friendly value when using waste as a medium of cultivation. Mushrooms are cultivated in a medium that has suitable temperature and humidity conditions. To obtain good quality, the temperature and humidity conditions of the squid mushroom must be stable at 24 °C–25 °C and 80%–85%. To cope with this condition, mushroom farmers do it manually by applying water spray to lower temperatures and humidity so that the temperature and moisture of the mushrooms remain intact. If the temperature and humidity conditions do not reach these values, then the harvested mushrooms are of poor quality. For that, a system was built to monitor and control the temperature and humidity of mushrooms using fuzzy logic methods by implementing the Internet of Things. The design of the system and the tools used in this research can run well and can monitor temperature and humidity accurately, as can the implementation of the fuzzy logic method on temperature and moisture parameters by moving the motor fan with a fuzzi set that has been specified. The results of the control, monitoring, and actuator status will be displayed on the website. Parameter readings as well as actuators can run with a temperature reading error value of 0.58% and a humidity reading error of 1.78%. Differentiate the error value on the fuzzy logic simulation on the Matlab with an system percentage of 0.81%, which indicates the accuracy of the system and the tool running well and optimally. The author chose the fuzzy logic method of Mamdani because the output of such a method is a fuzzy set that matches the design of the system.

Keywords— ***DHT-11, ESP32, Fuzzy, IoT, Mushroom, Mushroom Green House, Monitoring.***

I. INTRODUCTION (*HEADING 1*)

The Indonesian Institute of Sciences (LIPI) promotes the cultivation of edible mushrooms so that they can be consumed properly and widely by the people of Indonesia. Mushrooms cultivated in Indonesia have a high nutritional value; even mushrooms contain 19–35 percent more protein than rice (7.38 percent) and wheat (13.2 percent) [1]. Mushroom cultivation has the potential to be developed more broadly because it has economic value and is environmentally friendly because it utilizes waste as a planting medium, namely cotton waste, straw, palm dregs, and sawdust. To get good quality, the temperature and humidity conditions of the oyster mushroom bed must have a stable temperature and humidity of 24°C–25°C and 80%–85% humidity[2]. To overcome this condition, mushroom farmers do it manually by spraying water to lower the temperature and humidity so that the temperature and humidity in the mushroom house are maintained. If the temperature and humidity conditions do not reach these values, then the mushrooms harvested are of poor quality. In addition, the nutrients contained will decrease.

II. SYSTEM CONFIGURATIONS

In designing a mushroom control and monitoring system where the fan speed can be adjusted so that it can maintain a stable temperature and humidity according to the needs of mushroom growth, the system configuration is shown in Fig.1. Fig 1 explains using two input parameters, namely temperature and humidity, with fan speed output. where the two input parameters are obtained from the dht11 sensor readings, the data will be processed on the ESP 32 as a microcontroller. In Fig. 1, this system uses fuzzy logic to generate fan speed values and an if-else condition to determine whether the mist maker is on or not.

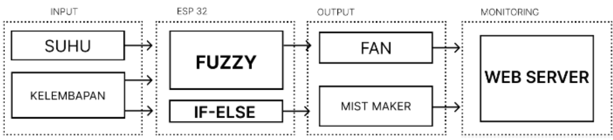

Fig 1 System diagram

A. Fuzzy Logic

In this final project, the design of the controller is aimed at adjusting the temperature and humidity to match the temperature specified at the set point. The fuzzy logic controller will manage the output from the system. In this paper, the controller design is intended to control a suitable temperature and humidity at a specified set point. generate fan speed for mushroom kumbung. In designing the controller, the mathematical model of the plant is not necessary to search for. In Mamdani-type fuzzy logic, human language rules are transformed into a fuzzy inference system to produce interpretable fuzzy output. This process includes fuzzyification, fuzzy inference using language rules, and defuzzification to return the fuzzy output back to a hard value. The Mamdani-type fuzzy logic approach is widely used in various applications, such as control systems, decision-making, and models involving aspects that are difficult to measure clearly in complex field environment conditions [3]. The fuzzy logic process is showed as the following [4].

1. *Fuzzyfication* : Fuzzification is the process of changing input from crisp to fuzzy (input

variable) presented in a fuzzy set with the membership of each function.

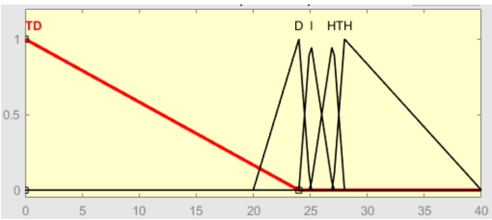

Fig 2 Desain of membership function input"Temperature"

There are 5 temperature membership functions, namely TD, D, I, H, and TH, with predetermined limits in each function. The temperature level is expressed as a value of 0-100°C, where 0-20°C is TD, 24°C is D, 25°C is I, 27°C is H, and 28-40°C is TH. The membership function input temperature design is shown in Fig. 2.

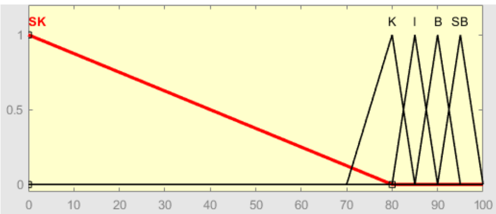

Fig 3 Desain of membership function input"Humidity"

There are 5 humidity membership functions, namely SK, K, I, B, and SB, with predetermined limits in each function. The membership function input humidity desaing is shown in Fig 3.

Like the two inputs, the output also has a membership function based on the knowledge base. The fan speed output membership function is shown in the fig 4.

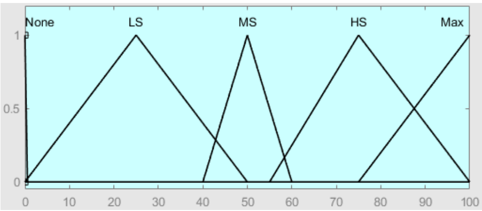

Fig 4 Desain of membershio function output"FanSpeed"

There are 5 fan speed membership functions, namely none, LS, MS, HS, and max.

2. *Inference :* the process where decision-making is based on fuzzy input and fuzzy rules so that fuzzy output is obtained. Combining the processes of implication and aggression, which makes min-max, or what can be called mamdani. This logic rule is derived from a combination of temperature and humidity inputs and fan speed output. the number of membership functions of each input and output variables is five so that the rule base obtained is twenty five

3. *Deffuzyfication :* The input of this process is a fuzzy set obtained from the composition of fuzzy rules, while the output is a number in the domain of the fuzzy set. One method for defuzzification is the centroid method, or composite moment. This method takes the center point (z*) of the fuzzy area [5].

B. Maintaining the Integrity of the Specifications

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

III. RESULT AND DECISSION

A. Hardware Implementation

Hardware design is the stage where the author combines all hardware components, which can later be integrated with the entire system with actuators. Hardware implementation of the monitoring and control system for mushroom houses based on the Internet of Things for mushroom houses with dimensions of length x width x height (70cm x 60cm x 40cm) can be seen in Fig.5.

Fig 5 Mushroom greenhouse

This design uses a black rectangular electronic box. In this hardware design, there are hardware components that are located inside and outside the electronic box. Here are the components that are located in the box, as shown in Fig 6. Components located in the box include the ESP32 as a microcontroller, the L298N motor driver, which functions as a speed control device or PWM, a 4-channel relay as a regulatory switch between the microcontroller and the Peltier and Mist Maker, and a female 24V voltage source for the Mist Maker.

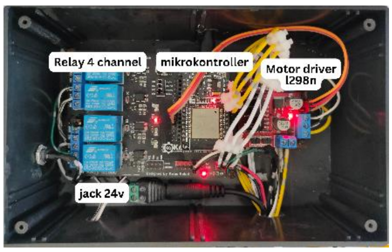

Fig 6 Component inside box

Components located outside the box include a power supply adapter as a voltage source for the peltier and fan motor, mist maker, peltier, 4 fan motors where 2 fans are for removing hot air produced by the peltier and the rest are for blowing cool air inside the mushroom greenhouse, and 3 dht11 sensors as shown in Figure 7.

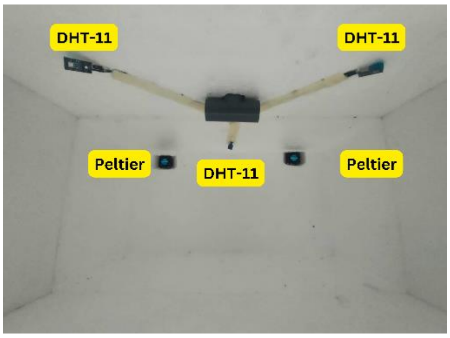

Fig 7 Inside mushroom greenhoouse

B. *Data processing*

in this final project using sample data obtained from a running system based on certain conditions, where the data amounted to 100. The data obtained will be compared with Matlab with the same rules.

Table 1 Data

No	Suhu (°C)	Kelembapan (%)	Fan Speed Matlab (%)	Fan Speed Arduino (%)	Selisih Error (%)
1	28,73	82,33	90,69	90,43	0,26
2	28,67	82,00	90,98	90,71	0,27
3	28,67	81,67	91,24	90,97	0,27
4	28,67	81,33	91,48	91,20	0,28
5	28,67	80,67	91,83	91,54	0,30
6	28,67	80,00	91,96	91,64	0,31
7	28,67	79,00	91,96	91,59	0,37
8	28,67	79,33	91,96	91,63	0,33
9	28,50	81,67	91,24	90,97	0,27
10	28,43	82,00	90,98	90,71	0,27
...	...	...	...	...	...
90	24,93	84,33	34,85	43,44	8,59
91	24,97	84,00	42,03	46,05	4,03
92	25,10	80,67	54,96	55,35	0,38
93	25,10	81,33	55,20	55,43	0,24
94	27,73	81,00	84,09	83,43	0,66
95	27,77	81,33	84,66	83,91	0,75
96	27,80	80,33	85,61	84,55	1,06
97	27,77	80,33	84,83	83,99	0,84
98	27,77	81,67	84,28	83,67	0,61
99	27,63	82,33	81,39	81,08	0,31
100	27,67	82,00	82,31	81,93	0,37
Error Average					**0,81**

The table shows that the results of simulation testing using Matlab and testing of the system on the input parameters of temperature and humidity with the output of the fan speed show the output difference in the percentage of small error values, namely 0.81%. The error value is the difference between the system FanSpeed value and the Matlab FanSpeed value. It can be concluded that the error value arises from several factors, including the inaccuracy of the DHT-11 sensor readings on the parameters of temperature and humidity in the mushroom house. Besides that, the use of equipment and wiring built by the authorThe smallest error value was obtained in this study, namely 0%. Obtained when the temperature is 25 °C and humidity is 83%, temperature is 20 °C and humidity is 86.30%, temperature is 25 °C and humidity is 81%.From the simulation in MATLAB, it can be described in the form of a graph where the values of humidity, temperature, and MATLAB fan speed are shown. On the graph, the minimum value for humidity is 79%, and the maximum value is 86.30%. Meanwhile, the minimum value of temperature is 20 °C, and the maximum value is 28.73 °C.With the test results on the tool and the simulation on Matlab, the optimal value for the air humidity parameter is 80% for a temperature range of 24 °C to 25 °C.

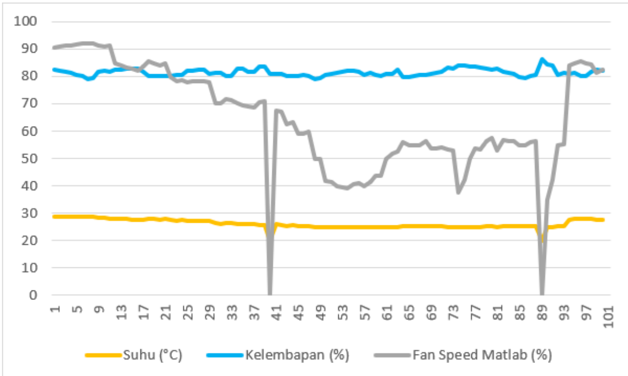

Fig 8 Test data on Matlab

The error value generated from the Matlab simulation results and testing on Arduino shows almost the same graphic results. The total error value of 0.81% can be seen in table 1. The blue graph is the fan speed from the Matlab simulation results, while the orange color is the fan speed from the test results on the tool.

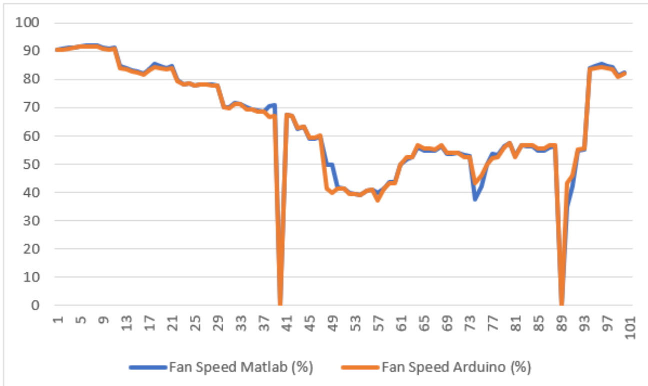

Fig 9 system comparison with matlab

IV. Conclusions

1. The temperature and humidity monitoring and control system can run well according to plan with parameter readings, and the actuator can run with an

error reading of 0.58% temperature and 1.78% humidity. It can be monitored through a website that can display temperature output, humidity, fan speed, and mist maker status in real time. Data numbers 79–88 show optimal results, validating that the system is able to effectively maintain the condition of the mushroom barn.

2. Testing the data with temperature and humidity parameters on Matlab, the system gets a small error value difference of less than 15, which is 0.81%. Test results on the tool and Matlab simulation obtained optimal values for the air humidity parameter, which is 80%, and for the temperature parameter, which is 24 °C to 25 °C.

ACKNOWLEDGMENT

All academicians of Institut Teknologi Telkom Surab aya.

REFERENCES

[1] Agustianto, K., Wardana, R., Destarianto, P., Mulyadi, E., & Wiryawan, I. G, "Development of automatic temperature and humidity control system in kumbung (oyster mushroom) using fuzzy logic controller", In IOP Conference Series: Earth and Environmental S cience (Vol. 672, No. 1, p. 012090). IOP Publishing, 2020.

[2] C. Saputra, R. Setiawan, and Y. Arvita, "Penerapan Sistem Kontrol Suhu Dan monitoring serta Kelembapan Pada Kumbung Jamur tiram berbasis IOT menggunakan metode fuzzy logic," Jurnal Sains dan Informatika, vol. 8, no. 2, 2022. doi:10.34128/jsi.v8i2.504

[3] S. Widaningsih, "Analisis Perbandingan Metode Fuzzy Tsukamoto, Mamdani dan Sugeno dalam Pengambilan Keputusan Penentuan Jumlah Distribusi Raskin di Bulog Sub. Divisi Regional (Divre) Cianjur," Infoman's, vol. 11, no. 1, pp. 51–65, 2017, doi: 10.33481/infomans.v11i1.21.

[4] M.P.P. Mary and V. Sivachidambaranathan, "Fuzzy Logic Controller based Multi-port LED Driving," 2017 International Conference on Computation of Power, Energy Inf.

[5] Hakim, G.P. et al. (2022) 'Fuzzy Mamdani performance water chiller control optimization using fuzzy adaptive Neuro Fuzzy Inference System assisted', Indonesian Journal of Electrical Engineering and Computer Science, 28(3), p. 1388. doi:10.11591/ijeecs.v28.i3.pp1388-1395.