Design of IoT-Based Oyster Mushroom Monitoring and Automation System Prototype

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***Abstract*—This study presents the design and implementation of a kumbung prototype to maintain a stable temperature and humidity of the fungus. The input variable comes from the temperature and humidity sensor used, namely the DHT22 sensor. The output variables of this system are temperature and humidity data generated by the DHT22 sensor, mist nozzle, and Peltier. From the research conducted, the average temperature produced is 25.01°C while the average humidity value is 80%. This concludes that the system that has been made has worked well to control the temperature and humidity of the fungus.**

***Keywords*—IoT, monitoring and automatic system**

I. INTRODUCTION

Mushrooms come from the Latin word fungi. Fungi reproduce asexually by producing spores, buds, and fragmentation. Meanwhile, if the fungus reproduces sexually, it will produce zygospores, ascospores, and basidiospores. Mushrooms (fungi) live in humid places, seawater, freshwater, and acidic places, and are symbiotic with algae so that they form lichens. One type of mushroom in great demand in Indonesia is the oyster mushroom. Oyster mushroom is a mushroom that can be consumed and is often used in a business field. In order to grow well the growth of oyster mushrooms is strongly influenced by temperature, humidity, and light factors. The pH of the growing media, aeration, with a good humidity range, is 70-90% and the temperature is 22-28°C.

In this study, we only focused on testing humidity and air temperature for oyster mushrooms because these two things were the most important for fungal growth. Usually, many mushroom farmers still monitor the humidity and temperature of the mushrooms manually, thus making the farmers have to go back and forth to regulate and monitor thehumidity and temperature of the oyster mushrooms and strawmushrooms that have been cultivated. For this reason, to savetime and energy and be able to take advantage of current technological developments, it is necessary to provide an intelligent monitoring system for humidity and temperature in oyster mushroom cultivation. This system will use Arduino IDE-based programming using the C language.

II. METHODE OF RESEARCH

A. System Model

This system consists of 3 main models, namely, data sender, Ubidots platform, and data receiver as shown in Fig 1.In this study, NodeMCU ESP8266 will be used as a microcontroller connected to the designed system, then the results of data measurements will be seen on the Ubidots platform. used as a reference for the monitoring system.

Ubidots is an open-source application platform that is usedto retrieve data from various inputs. In this study, the input used for data collection is the DHT22 Sensor [1]. The measurement data obtained can be viewed on the Ubidots platform dashboard which can be displayed in the form of text,graphics, animations.

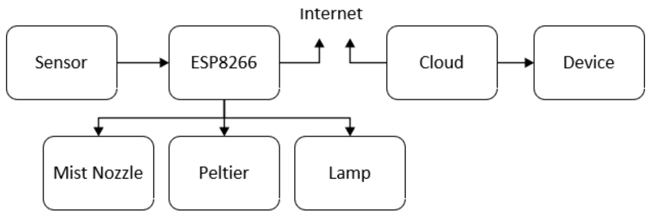

Fig. 1. Control system diagram

B. Hardware Design

The monitoring system requires various hardware components that are connected to the software. In general, this system is a model for monitoring and controlling the temperature and humidity of mushroom plants. The schematic design drawing of the circuit can be seen in Fig. 2. In Figure2 it consists of various interconnected components such as NodeMCU, DHT22, Relay 2 Channel, Motor Pump, and Peltier.

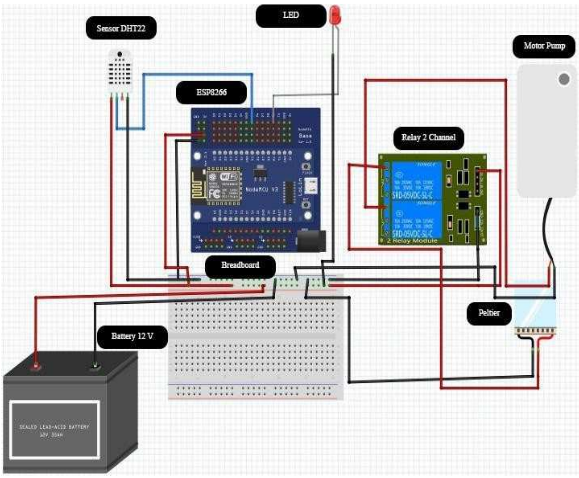

Fig. 2. Hardware Schematic Design

III. Results And Discussion

This experiment was conducted in the city of Bandung with watering time during the day because the city of Bandung experienced a significant increase in air temperature during the day. Fig. 3. displays the process of controlling humidity and room temperature of the mushroom house. Components used to control temperature and humidity in the environment in kumbung mushrooms using blowers and nozzles.

Fig. 3. Hardware Schematic Design

In designing this temperature and humidity monitoring tool, several important steps must be carried out so that they can be implemented in the cultivation of oyster mushrooms and straw. These stages are divided into several, namely:

A. Abbre ESP8266 Programming Stage As System Microcontroller

ESP8266 is a wifi module that functions as a microcontroller enhancement such as an Arduino so that it can connect directly to wifi and make TCP/IP connections. By having three wifi modes, namely Station, Access Point, and Both (Both). This module is also equipped with a processor, memory, and GPIO where the number of pins depends on the type of ESP8266 used.

The NodeMCU ESP8266 circuit as shown in Figure 4, uses the power of 3.3v as a voltage source which is connected to a 2-channel relay, this relay serves to cut off the AC voltage, with NC (Normally Closed) conditions. The sensor used is DHT22 which functions to measure temperature and measure humidity. This sensor can be quite fast and accurate as well asa wide reading distance. This sensor works in the humidity range of 0-100% and temperature in the range of 40-80°C. Theaccuracy of the DHT22 sensor is 0.50C for temperature readings and ±2% for humidity readings (DHT22 Datasheet) [3].

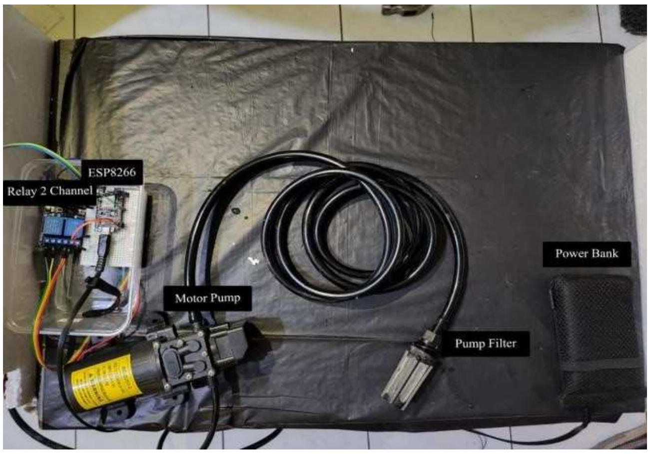

Fig. 4. System Circuit

B. Linking System Design to the Cloud Using Ubidots

After the NodeMCU ESP8266 can be connected to the DHT22 sensor and the sensor measurement data is visible on the Arduino IDE software serial monitor, the next step is to connect the system to the Ubidots platform. Ubidots is an IoT platform that is used to receive output data generated by sensors on the system that has been designed. The data displayed on Ubidots can be accessed on a laptop or smartphone connected to the internet [2].

C. Monitoring Temperature and Humidity Using Ubidots Widget

Ubidots is a cloud service that can store and analyze sensor data in real-time. Ubidots are used to monitor the state of the mushroom house which includes temperature, humidity, and light intensity which can be accessed anytime and anywhere. Monitoring using Ubidots was chosen because it is easier to manage for the user. Ubidots can be accessed using the WEB so that it can be accessed on all smartphones, there are menus for devices, dashboards, events, and settings. The device is a menu containing devices connected by the Ubidots cloud database. A dashboard is a menu that will display widgets that can be customized as needed. This dashboard will retrieve data from the device and will be displayed on the related widget [4]. Ubidots User Interface view can be seen in Fig 5.

Fig. 5. Ubidots Widget Display

Overall system testing is a combination of all the systems that have been tested into one system. This test is divided into two parts, namely testing the microcontroller which is connected to sensors and relays. And testing on Ubidots as a viewer of the readings of the sensors connected to the microcontroller. The following is a test of sending sensor readings that are displayed on the Ubidtots website.

D. Result of System Monitoring Tool Design

Mushrooms have three main factors that must be taken care of when it is at the stage of planting in a mushroom house. These factors are temperature, humidity, and light intensity. Temperature affects the quality of oyster mushrooms. If the temperature is too high or too hot, the mushrooms will fail to harvest. When the temperature in the mushroom house is less or too cold, the mushrooms will also experience crop failure. Excessive humidity will cause the mushrooms to rot quickly. When the air humidity is less it will make the mushrooms fail to harvest. The hood on the oyster mushroom will crack or break which causes the quality of the mushroom to decrease if the intensity of the light received or that enters directly into the mushroom house exceeds the mushroom's needs. This study only focused on humidity and temperature values in a kumbung. The system made is that when the DHT22 sensor.

Base on the results of the comparison test, the parameter value of the temperature reading on the DHT22 sensor with a detects a temperature that is too hot or close to 28°C, the mist nozzle will create dew which will reduce the temperature in the mushroom kumbung. The output data generated by the DHT22 sensor will be displayed on the Ubidots platform. Table I is the measurement data for the kumbung mushroom.

TABLE I. MONITORING RESULT

Day	Date	Times	Monitoring	
			Humadity (%)	Temperature (°C)
1	15 May 2022	07.00 AM	81	25.4
		09.00 AM	78	25.3
		12.00 AM	74	26.12
		14.00 PM	72.21	27.12
		16.00 PM	71.13	28.2
2	16 May 2022	07.00 AM	81.12	23.8
		09.00 AM	76	25.8
		12.00 AM	74	26.9
		14.00 PM	72.23	27
		16.00 PM	71	27.56
3	17 May 2022	07.00 AM	81	25.45
		09.00 AM	79	25.1
		12.00 AM	75	25
		14.00 PM	73.23	27.05
		16.00 PM	72.15	28.2

Mushroom spraying activities are carried out when the kumbung temperature is below the predetermined standardization value, namely in the temperature range of 22-28 °C and humidity of 70-90%. For monitoring kumbung mushrooms, it is done by focusing on the data displayed on the ubidots platform. DHT22 sensor, provides information that the average temperature value is 25.01 °C for the humidity value reading has an average of 75%.

TABLE II. COMPARISON OF TEMPERATURE MEASUREMENT RESULT USING DHT22 AND HYGROMETER

Date	**Times**	**Monitoring**		**DHT2 2 Result Referen ceValue**	**Error %**
		Referenc eValue	**DHT22**		
15 May 2022	07.00 AM	25.4	25.4	0	0
	09.00 AM	26.4	25	1	3.787
	12.00 AM	26.12	26.12	0	0
	14.00 PM	27.1	27.1	0	0
	16.00 PM	28.5	27.5	1	3.546
16 May 2022	07.00 AM	24.8	23.8	1	4.322
	09.00 AM	26.8	25.8	1	7.462
	12.00 AM	27.9	26.9	1	3.5842
	14.00 PM	28.56	27	1	3.5014
	16.00 PM	27.56	27.56	0	0
17 May 2022	07.00 AM	25.45	25.45	0	0
	09.00 AM	25.1	25.1	0	0
	12.00 AM	25	25	0	0
	14.00 PM	27.05	27.05	0	0
	16.00 PM	28.2	28.2	0	0
Average error					1.24

Sttandard measuring instrument, namely a hygrometer, obtained an accuracy value of 98.76%, this sensor has been functioning properly and can be implemented to retrieve data, this is because the average temperature error is obtained value 1.24 °C. According to Riskiono et al. (2020), the average DHT22 temperature reading error value is 0.465 °C. The DHT22 sensor datasheet has a temperature reading range of -40 °C to 80 °C with an accuracy of ± 0.5 °C [3]. This shows that the DHT22 sensor is functioning properly and the level of accuracy, stability, and sensitivity of the sensor measurementis quite accurate because when compared with standard measuring instruments the results of the test are still within theerror tolerance range of the DHT22 temperature sensor. The test result data can be seen in table 2.

TABLE III. COMPARISON OF HUMIDITY MEASUREMENT RESULTUSING DHT22 AND HYGROMETER

Date	**Times**	**Monitoring**		**DHT22 Result Referenc eValue**	**Erro r %**
		Referenc eValue	**DHT22**		
15 May 2022	07.00 AM	81	81	0	0
	09.00 AM	79	78	1	1.26
	12.00 AM	74	74	0	0
	14.00 PM	72.21	72.21	0	0
	16.00 PM	72	71.13	1	1.38

Date	Times	Monitoring		DHT22 Result Referenc eValue	Erro r %
		Referenc eValue	DHT22		
16 May 2022	07.00 AM	82	81.12	1	1.21
	09.00 AM	78	76	2	2.56
	12.00 AM	75	74	1	1.33
	14.00 PM	73	72.23	1	1.36
	16.00 PM	71	71	0	0
17 May 2022	07.00 AM	81	81	0	0
	09.00 AM	79	79	0	0
	12.00 AM	75	75	0	0
	14.00 PM	73.23	73.23	0	0
	16.00 PM	72.15	72.15	0	0
Average error					0.61

Based on the results of the comparison test, the value of the humidity reading parameter on the DHT22 sensor with a standard measuring instrument, namely a hygrometer, obtained an accuracy value of 99.38%, it is known that the average error is 0.611% indicating Based on the data obtained, the humidity parameter has a level of accuracy, stability, and good sensitivity because the difference in the error value is not too significant, so it is still within the tolerance limit. Judging from the DHT22 sensor datasheet, the accuracy is in the range of ±2% RH. The data from the test results are displayed in the form of table 3.

From the existing data, both temperature and humidity data, the average value is still in accordance with the working system of the smart kumbung tool. The value is still small and is still in the working area of the DHT22 component when referring to the datasheet. The accuracy of this sensor is 0.5°C for temperature readings and ±2% for humidity readings (DHT22 Datasheet)[3].

All components can work properly and in accordance with the workings of the tool where if the status of Relay channel-1 is Normally Closed (NC) then turning on the Peltier and Relay channel-2 with NC status will turn on the water pump and immediately turn on the nozzles automatically. If both channel relays are in Normally Open (NO) status, then all components are in effect otherwise they will turn off.

In testing the automation system, data retrieval was carried out 5 times in 1 day as shown in Table III. Table III shows how the system responds to different temperatures and humidity.

TABLE IV. AUTOMATION SYSTEM

Date	Times	Automation			
		Humidity (%)	Mist Nozzle (s)	Temperature (°C)	Lamp (s)
15 May 2022	07.00 AM	80	5.6	25.5	0
	09.00 AM	83.76	3.5	24.75	0
	12.00 PM	84.22	2.4	24.56	0
	14.00 PM	72.21	0	25.12	0
	16.00 PM	81.13	4.2	26.05	6.7
16 May 2022	07.00 AM	84.12	6.7	24.7	0
	09.00 AM	71.21	0	24.06	0
	12.00 PM	88.23	8.2	26.1	0
	14.00 PM	82.21	5.3	24.49	0
	16.00 PM	70.2	0	26.04	12.4
17 May 2022	07.00 AM	88.23	8.2	24.06	0
	09.00 AM	82.21	5.3	26.52	0
	12.00 PM	78.12	0	25.43	0
	14.00 PM	80.21	3.7	24.49	0
	16.00 PM	87.13	7.7	24.21	0

The working test of the temperature and humidity control system of the oyster mushroom kumbung has been carried out. The tests carried out were the ability of the system to stabilize the temperature and humidity of the oyster mushroom kumbung with a good air humidity range of 70-90% and for the temperature of 22-28°C. In the microcontroller used, it hasbeen set that if the humidity in the mushroom kumbung approaches or exceeds 90%, the light will turn on automatically, and the light turns to reduce the humidity of the mushroom kumbung. As with humidity, temperature stabilization is automatically set on the microcontroller. If thetemperature exceeds 28°C, the mist nozzle will turn on automatically to reduce the temperature of the oyster mushroom kumbung. The delay time used to run this systemis 5,000ms.

In table IV the average value resulting from the measurement of the humidity of the oyster mushroom kumbung is 80.87%, while the average value of the temperature of the oyster mushroom kumbung is 25.07°C. This value is obtained from the measurement results using the DHT22 sensor with an accuracy of ± 2% humidity measurement. RH (max ±5%) and temperature measurement accuracy < ±0.5 Celsius.

The test results show that the actuator runs according to theminimum and maximum sensor measurements that have beenset. Table III shows the results of testing the automatic controlsystem. System measurement data can be viewed on the Ubidots platform. It is necessary to develop this system for automatic monitoring and control of other parts of oyster mushroom cultivation.

IV. CONCLUSSION

The monitoring system using the Ubidots platform can be done easily because it can be accessed using a smartphone connected to the internet. The design of the tool is said to be feasible because the results of the data released by the DHT22 sensor meet the standardization of mushroom temperature, which is no more than 29°C and humidity less than 90% RH. The monitoring system carried out on this system resulted in significant fungal growth, these results concluded that the proposed system was running well to control the temperature and humidity of the fungus..

REFERENCES

[1] D. Kuriando, A. Noertjahyana, and R. Lim, “Pendeteksi Volume Air pada Galon Berbasis Internet of Things dengan Menggunakan Arduino dan Android,” J. Petra, vol. d, pp. 2–7, 2017.

[2] Leo Raju,Sajna G.,Prithika rani M, "IoT Based Advance Energy Management of Micro-Grids", International Journal of Pure and Applied Mathematics, Vol. 120, No. 6, pp. 1443-1453, 2018.

[3] Wajiran , S. D. Riskiono , P. Prasetyawan and M. Iqbal "DESAIN IOT UNTUK SMART KUMBUNG DENGAN THINK SPEAK DAN NODEMCU" Volume 6, No. 2, 2020.

[4] Prasetyo Wibowo and Dedi Ary Prasetya "Rancang Bangun Data Logger Multi Kanal Terhubung IoT (Internet Of Things) Sebagai Pengukur Temperatur dengan Sensor Thermocouple" Vol.21 No. 02 September 2021.

[5] Riskiono, S. D., Prasetyawan, P., Mulyanto, A., Iqbal, M., dan Prabowo, R. 2020. Control and Realtime Monitoring System for Mushroom Cultivation Fields based on WSN and IoT. In Journal of Physics: Conference Series (Vol. 1655, No. 1, p.012003). IOP Publishing.

[6] Yuli Wibowo1, Febriansah Eka Prasetyadana1, Bertung Suryadharma1 “Implementasi Monitoring Suhu dan Kelembaban pada Budidaya JamurTiram dengan IOT”Vol. 10, No. 3 (2021): 380-391