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Implementation Of Monitoring and Control Temperature and Humidity Based on IoT in The Oyster Mushroom Cultivation Room

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Abstract **– Oyster mushroom is one of the favorite horticultural commodities consumed by Indonesian people. In the cultivation of oyster mushrooms, there are many obstacles faced by farmers, including the difficulty in maintaining the temperature and humidity of the kumbung room so that to maintain the stability of temperature and humidity, farmers must always check and do regular watering. With these problems, a temperature and humidity monitoring and control system is needed to maintain the stability of temperature and humidity in oyster mushroom cultivation by automatically watering and heating the room temperature of the kumbung. The design of the system was designed based on the results of interviews with oyster mushroom farmers regarding the constraints faced, then proceed with the design and manufacture of hardware and software for an IoT-based oyster mushroom kumbung watering and heating system. The result of this research is that the system can respond to changes in temperature and humidity conditions in the kumbung room by automatically watering and heating the kumbung room. To return to the setpoint temperature value (25ºC-28ºC), it is necessary to heat the kumbung room with an average duration of heating of 383 seconds, and to return to the setpoint humidity value (75%-90%), it is necessary to water the kumbung room with an average watering time of 115 seconds.**

Keywords: *Temperature, humidity, Oyster Mushroom, Internet of Things, Website.*

I. INTRODUCTION

Oyster mushroom (Pleurotus sp) is a type of horticulture and a type of vegetable that is widely cultivated by Indonesian people. Mushrooms are one of the horticultural commodities that contain good protein. USDA released in every 100-gram mushroom there are 3.1 grams of protein. It also tastes delicious and is good for the health of the body. Mushrooms are also believed to relieve cancer, prevent HIV and a series of other disease-fighting benefits. In addition, the demand for oyster mushrooms on the market is increasing every year.[1]

In the cultivation of oyster mushrooms or other edible mushrooms, several preparatory steps are required, including preparing the right or suitable location for placing the mushroom house, preparing mushroom seeds, preparing sterile growing media and other treatment facilities.[2]

From the results of an interview with one of the oyster mushroom farmers in Menawan Village, Kudus Regency, information was obtained that to produce good quality oyster mushrooms, farmers need to maintain temperature and humidity stability in oyster mushroom cultivation kumbung. To maintain the stability of the temperature and humidity of the kumbung room, all this time it has been done by watering and heating the room manually by periodically checking the condition of the temperature and humidity of the kumbung.

Many studies have been carried out regarding monitoring and control systems for temperature and humidity in mushroom cultivation kumbung, including research conducted by M. Hudan Taufiqul, et al with the title of automatic oyster mushroom sprinkler application using BLYNK.[3] This research does not explain the performance of the system's response to changes in temperature and humidity of the kumbung and uses blynk, a ready-made IoT platform. Next is research from Arfend Atma Maulana, et al with the title model of a room temperature and humidity control system for drug production based on NODEMCU ESP32.[4] Temperature control is applied to the drug production room. Research conducted by Chindra Saputra, et al with the title application of a temperature control system and monitoring and humidity in an IoT-based oyster mushroom barn using the fuzzy logic method, in this study the test was carried out for 2 hours but the results of the system response time test for changes in temperature and humidity have not yet been seen.[5]

Based on the various backgrounds of the problems that have been described, it is necessary to develop a temperature and humidity monitoring and control system with better performance and to

increase effectiveness it is necessary to create a temperature and humidity monitoring and control system for oyster mushrooms using the internet. The process of monitoring the parameters that affect the growth of oyster mushrooms and can be accessed with a smartphone without the need to go to the location of the kumbung to monitor the growth of mushroom cultivation and reduces human labor in caring for and maintaining the cultivated mushrooms.

In this study the authors created a temperature and humidity monitoring and control system for oyster mushroom cultivation based on IoT and have been applied to oyster mushroom cultivation in Menawan Village, Gebog District, Kudus Regency with a website that can be accessed for iOS, Android, Windows, and Linux. to monitor and control the temperature and humidity in the kumbung. This website can be used to monitor and control hardware devices and is equipped with automatic features and manual features. The microcontroller modules used are NodeMCU and DHT22 as temperature and humidity sensors in the mushroom house. The measurement results are displayed on the LCD and the website. If the website is set automatically, the temperature and humidity measurement results will be an option to turn on/off the watering pump or heating lamp. If the setting point is less than the temperature read, the light will turn on, the light will turn off if the temperature read has touched the setting point. Likewise with humidity, if the setting point is less than the humidity reading, the watering pump will turn on and will stop when it hits the setting point. So that the temperature and humidity return to normal according to standards, then the watering pump and or lights can be turned on with the manual features on the website.

II. BASIC OF TEORY

Mushroom is one type of horticulture that is easy to cultivate, and is a favorite food for most people, so that it becomes a food commodity that is increasingly increasing and is known as a highly nutritious vegetable, protein content with complete amino acid levels so that oyster mushroom cultivation is a promising business opportunity. This oyster mushroom plant usually grows optimally in a kumbung which has good conditions with terraced shelves. Good conditions are rooms with temperatures ranging from 25oC - 28°C, humidity 75% -90%, low lighting, and sufficient air circulation.[6].

The Internet of Things is a concept or program in which an object could transmit or transmit data over a network without using the help of computers and human devices. The Internet of Things or often referred to as IoT is currently experiencing many developments. It is used to monitor the development of monitored media [7] and for monitoring and controlling the monitoring system is needed so that this system will work as a tool to help human power to monitor the state of an object [8].

Internet of things is a development of network communication from objects that are interrelated, connected to each other via internet communication and can exchange data which then turns it into information. NodeMCU is basically the development of ESP 8266 with e-Lua based firmware.[9] NodeMCU is equipped with a micro usb port that functions for programming and power supply.

Figure 1. Node MCU

Node MCU is an open-source Internet Of Things (IoT) hardware/platform like Arduino. This platform includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif System, and on hardware based on ESP-12 modules or the ESP8266-12E chip. Node MCU is basically a development of ESP8266 with e-Lua based firmware.[10] In this study, Node MCU is used as a hardware control system. The results of temperature and humidity sensor measurements are sent to Node MCU and displayed in the form of an IoT dashboard that is easy to use and operate using an internet network.

ESP32 is a microcontroller successor to the ESP8266 which has more CPU cores, GPIO or input output pins, faster WiFi, and supports Bluetooth 4.2 with low power consumption.[11]

Figure 2. DHT22 Sensor

The DHT22 sensor uses a capacitive sensor and thermistor to detect changes in the surrounding air temperature.[12] The sensor has an accurate calibration with compensation for the adjustment room temperature with the coefficient values stored in the integrated OTP memory. The DHT22 sensor has a wide temperature and humidity measurement range, the DHT22 is able to transmit the output signal over a cable up to 20 meters making it suitable for placement anywhere, but if the cable is longer than 2 meters a 0.33µF buffer capacitor must be added

between pin#1 (VCC) to pin#4 (GND). Figure 2 is the physical form of the DHT22 sensor. A humidifier is a device that functions to moisten the air by spraying water vapor into the air. This water vapor from the tool will increase the humidity of the air so that it is within the specified or ideal range.[13]

Figure 3. 12DCV Pump

A pump is a tool that can apply pressure to a liquid so that it is able to move the liquid. The pump works to convert mechanical energy into kinetic energy, this energy is used to flow fluids and increase speed, pressure, and overcome obstacles along the way.

The working principle of the pump is to apply pressure and suction to the fluid. On the suction side of the pump (suction), the pump element will lower the pressure in the pump chamber so that there will be a pressure difference between the surface of the fluid being sucked and the pump chamber.[14] Relays are needed to activate pumps and heating lamps, relays use the electromagnetic principle to move the switch contacts so that with a small electric current (low power) they can conduct electricity with a higher voltage.[15]

Figure 4. Light Bulb

An incandescent lamp that produces light by heating a metal wire filament to a high temperature so that it produces light. The hot filament is protected from air by a glass bulb filled with an inert gas or by a vacuum. Incandescent lamps are made in various forms and are available for working voltages ranging from 1.25 volts to 300 volts. Incandescent lamps are used because in addition to being able to illuminate a room, incandescent lamps also emit heat so that the heat from incandescent lamps can be used to heat the surrounding space.

The electrical energy required for incandescent lamps to produce bright light is greater than that of other artificial light sources such as fluorescent lamps and light diodes, so gradually in several countries the circulation of incandescent lamps began to be limited. Incandescent lamps produce light by heating the incandescent fibers or filaments so that the temperature emitted by these lamps is relatively high.[16]

III. METHODS

The method used in this study is the research method Research and development (research and development), namely research that applies, tests and evaluates the ability of a theory that is applied in solving practical problems. Which aims to develop products, so that these products have a higher quality. In this research, namely monitoring and controlling temperature and humidity in oyster mushroom cultivation kumbung based on IoT.

The flow of this research includes literature studies, software design, hardware design, hardware manufacture, and website creation. After this flow has been passed, the next process is to do hardware and website testing. After all the processes are carried out the next stage is the process of collecting data on the system that has been built.

Before designing and manufacturing monitoring and control tools for temperature and humidity in an IoT-based oyster mushroom barn, it begins with a literature study and continues with software design and hardware design, then manufactures hardware and websites and tests hardware and websites if successful, continue data collection and if not repeated starting from the literature study stage.

Testing is carried out in two stages, namely the testing stage for each component that will be used, after testing each component is completed then the components are assembled and installed in the test barn and then the overall system is tested using either manual or automatic features. The workings of the IoT-based temperature and humidity monitoring and control system are presented in Figure 5. This system is designed with the ability to read temperature and humidity in kumbung and all of this can be monitored and controlled through an application on a smartphone in real time. The system can be operated manually or automatically. Mushroom farmers can monitor temperature and humidity conditions in real time and can turn on space heating and watering manually via a smartphone and the system can also work automatically.

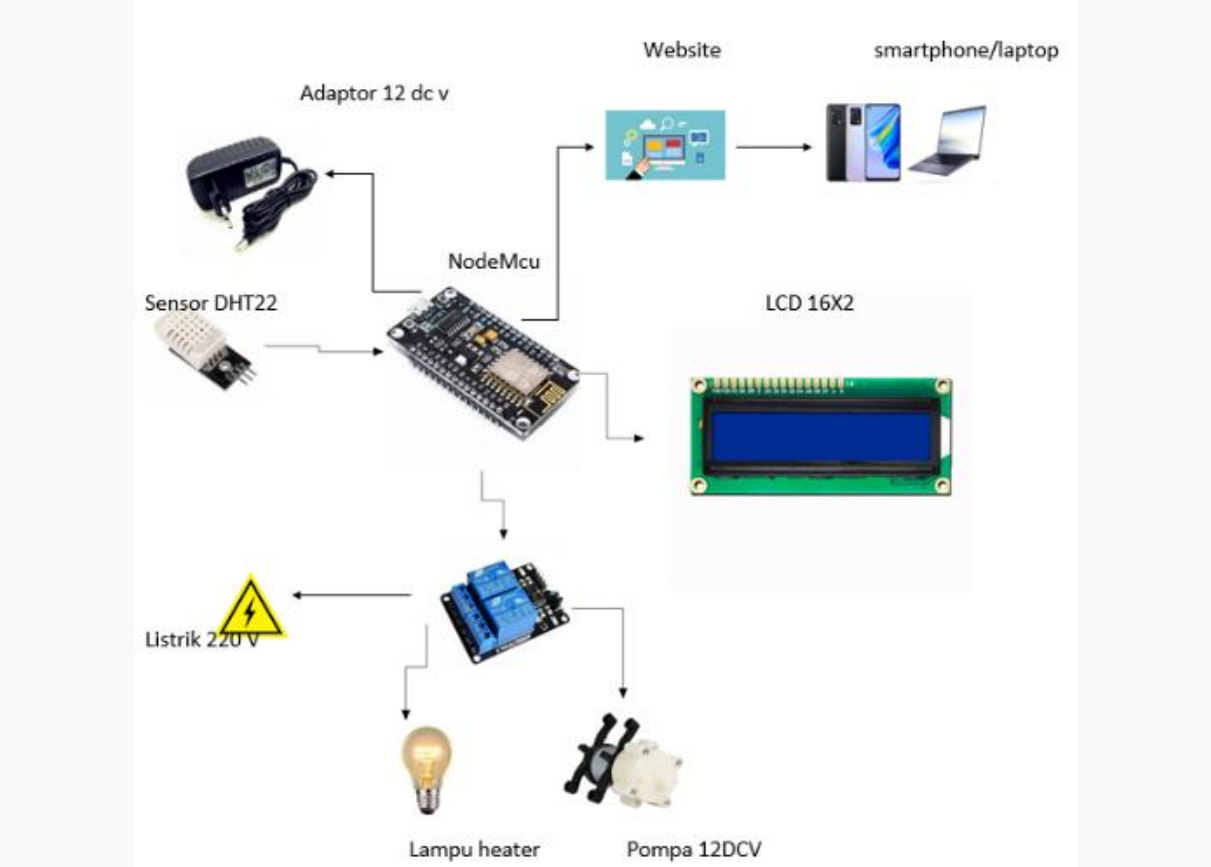

Figure 5. Scheme of the Monitoring and Control Series of Temperature and Humidity of the Oyster Mushroom Kumbung

The temperature and humidity monitoring and control system is designed using components including NODEMCU, LCD, DHT22 sensors, 2 relays, 5watt lamps and 15watt lamps, 12 DCV pumps and for DHT22 sensors used to read temperature and humidity, the relay oversees disconnecting and connect mains voltage. The design design is presented in Figure 5. Where is it for a computer or smartphone. can be used to monitor and control hardware devices, by means of automatic features and manual features. The microcontrollers used are NodeMCU and DHT22 as temperature and humidity sensors in the mushroom house. The measurement results are displayed on the LCD and the website. If the website is set automatically, the system will automatically measure the actual temperature and humidity in the hut room, if the temperature and humidity are outside the setpoint value, the system will automatically turn on and turn off the pump and heating lamp until the actual temperature and humidity values return to the setpoint value. The setpoint values for temperature and humidity are adjusted according to the temperature and humidity values recommended by mushroom farmers. All temperature and humidity sensor reading data in the kumbung will be sent to the website in real time so that mushroom farmers can monitor the condition of the kumbung to water and/or heat the kumbung according to actual conditions.

Research on the application of a monitoring system or monitoring the temperature and humidity of the oyster mushroom cultivation kumbung room was carried out in the oyster mushroom cultivation kumbung with dimensions of 2m x 2m x 2m where the walls were with UV (ultra violet) plastic and bricks to install the control panel and indoors there are 22 mushroom bags and 6 dew sprayers which function to increase humidity and lower temperature and 2 heater lamps to increase temperature and reduce humidity for sensors using a DHT22 sensor.

At the location of the kumbung, a control panel is also provided to monitor the conditions of temperature and humidity of the kumbung via the LCD display. The research was carried out using a part of the kumbung room owned by oyster mushroom farmers in the charming village, all components and equipment were directly installed at the location of the oyster mushroom cultivation kumbung.

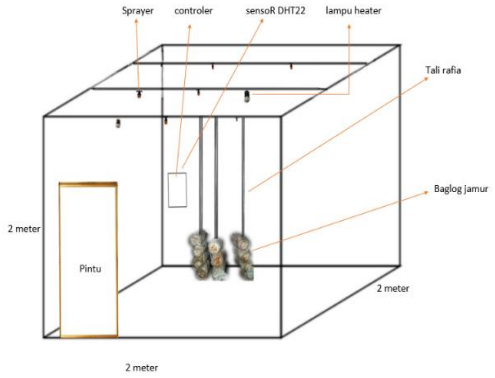

Figure 6. Design of the Kumbung Research Area for Oyster Mushroom Cultivation

Figure 7 is a design for the application of a monitoring and control system for temperature and humidity in oyster mushroom cultivation. The room is designed to be closed so that the temperature outside the room does not affect the temperature and humidity conditions in the room.

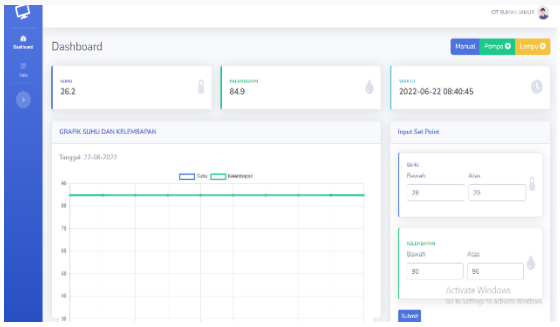

Figure 7. Website design for monitoring and controlling the temperature and humidity of the mushroom house.

From Figure 9 it can be explained that the website created is used for monitoring and controlling temperature and humidity for manual and automatic feature choices. For the use of automatic features on the website, columns have been provided to determine the recommended temperature and humidity setpoint values. In this study the temperature setting point was 25°C with a tolerance of up to 28°C and for humidity of 75% with a tolerance of up to 90%. In addition, there is a manual feature to turn on or turn off the water pump and lights. The temperature and humidity data displayed on the website are made in graphical form so that it is easy to monitor changes in temperature and humidity in real time.

IV. ANALYSIS AND DISCUSSION

From the results of designing, manufacturing, and installing a temperature and humidity monitoring and control system in an IoT-based oyster mushroom cultivation barn which is used to maintain temperature and humidity stability in the kumbung room according to the recommended temperature and humidity values for oyster mushroom cultivation. To maintain the temperature and humidity of the kumbung room, 2 bulbs of 15 watts and 5 watts were used and a 12 VDC pump with a pressure of 75 psi was used. Figure 8 is a display of the installation of system components on an oyster mushroom cultivation barn.

This tool works according to the instructions given through the website, namely when it is set automatically, when the temperature read is less than the setting point, the light will turn on and off after reaching the setting point. likewise with humidity, when the humidity read by the sensor is less than the setting point, the pump will work and sprinkle dew water.

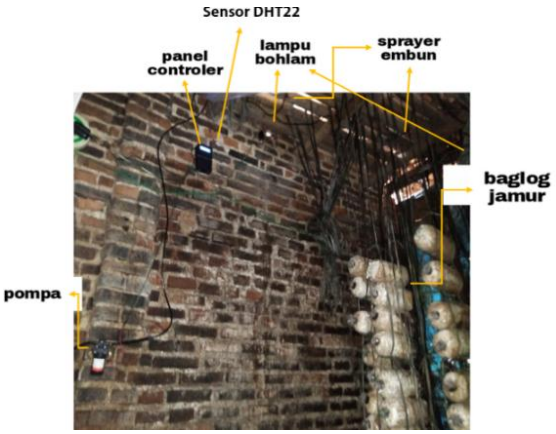

Figure 8. Overall tool installation

Testing of the temperature and humidity monitoring and control system was carried out directly in the oyster mushroom cultivation barn located in the charming village of RT 01 RW 01, Gebog District, Kudus Regency. The tests carried out included testing the DHT22 temperature and humidity sensors. The test was carried out in a hut room with a size of 2m x2m x 2m.

Testing the temperature on the DHT22 sensor is carried out by first carrying out a calibration process between the DHT22 sensor and a standardized temperature and humidity measuring instrument, namely a hygrometer. The test results for the DHT22 temperature sensor are presented in Table 1.

Table 1. DHT22 Temperature Testing

No	Rated Temperature DHT22 (°C)	Temperature Hygrometer Value (°C)	*Error* (%)	Accuracy (%)
1	24,7	24,6	0,4	99,6
2	25,8	25,6	0,8	99,2
3	26.7	26,8	0,4	99,6
4	27,6	27,8	0,8	99,2
5	28,1	28	0,4	99,6

The comparison of the test results between The DHT22 temperature sensor and the hygrometer at various temperature values obtained a high level of accuracy, namely an average of 99.4% and an average error rate of 0.56%, so it is concluded that the DHT22 temperature sensor suitable to be used for monitoring the temperature of oyster mushroom kumbung.

The next test is the humidity test with the DHT22 sensor, the results of the room humidity test with the DHT22 sensor compared to the hygrometer are presented in Table 2.

Table 2. DHT22 Moisture Test Results

No	DHT22 humidity value (%)	Humadity Hygrometer (%)	*Error* (%)	Accuracy (%)
1	89,4	89	0,4	99,6
2	86,7	86	0,7	99,2
3	83,3	83	0,3	99,7
4	82,9	82	0,9	99,1
5	80,4	80	0,4	99,6

In Table 2 the comparison of the test results between the DHT22 humidity sensor and the hygrometer at varying humidity values obtained a high level of accuracy, namely an average of 99.4% and an average error rate of 0.54%, so it is concluded that the DHT22 humidity sensor is suitable for monitoring the humidity of the oyster mushroom barn.

The temperature and humidity monitoring and control system in the oyster mushroom cultivation shed can be monitored in real time through a mobile smartphone-based IoT application and a desktop computer-based application. The system created can be operated in manual or automatic mode. Figure 10. Is a website dashboard display using a smartphone to use the manual control feature.

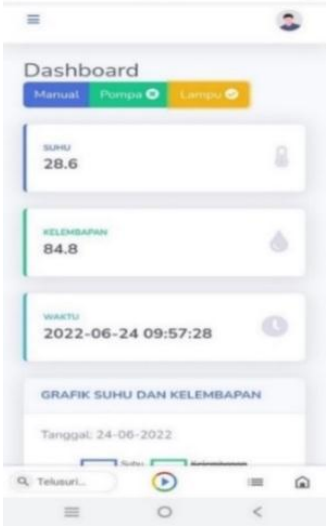

Figure 10. Display of manual features on websites with smartphones

The next test is testing the temperature and humidity control response manually via a smartphone. This test was carried out to find out how fast the response of the pump for watering and heating lamps for the kumbung room is controlled On/Off via a smartphone. The results of testing the response of the pump and heating lamp on the manual control feature via smartphone are presented in Table 3.

Table 3. Pump and Light Response Tests Using Smartphones on Manual Features

No	Order Via Smartphone		Actual Actuator Response		Response Time (Seconds)	
	Bulb	Pump	Bulb	Pump	Bulb	Pump
1	*OFF*	*ON*	*OFF*	*ON*	4	3
2	*ON*	*OFF*	*ON*	*OFF*	2	3
3	*OFF*	*ON*	*OFF*	*ON*	3	2
4	*ON*	*OFF*	*ON*	*OFF*	2	4
5	*OFF*	*ON*	*OFF*	*ON*	3	3
Average Actuator Response Time					2,8	3

In testing the response time of the actuators in the form of pumps and lights with manual control via a smartphone, namely by turning on and off the lights and pumps with commands through the website monitoring and controlling the temperature and humidity of the Kumbung oyster mushroom cultivation based on IoT which is done 5 times with intervals of taking From the data every 3 minutes, the success rate in the trial is 100% and the average response time for the lights on/off is 2.8 seconds and the average response time for the pump on/off is 3 seconds.

The next test is the response time test for on/off heating lamps and pumps in automatic control mode based on setpoint values for temperature and humidity. Figure 11 is the dashboard display for automatic feature selection.

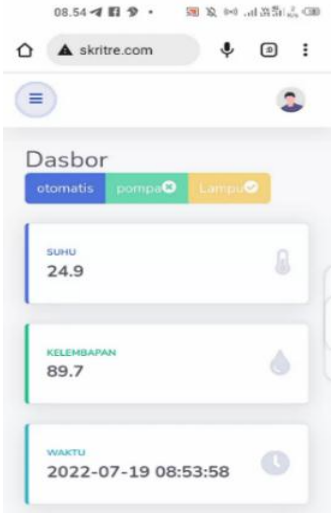

Figure 11. Automatic features on website display on smartphones

The results of testing the actuator response time for both heating lamps and sprinkler pumps for the use of automatic features are presented in Table 4

Table 4. Automatic Feature Testing Results

No	DHT Sensor Data		Working Time (Seconds)	
	Temper-ature (°C)	Humadity (%)	Bulb	Pump
1	23,3	93,3	427	-
2	24,7	89,9	365	-
3	24,9	89,7	359	-
4	26	74,7	-	82
5	27	72,5	-	123
6	28,2	71,2	-	140

In this test the IoT-based temperature and humidity monitoring and control website is set at a set point with a temperature value of 25°C to 28°C while for humidity it is set at a value of 75% to 90%. This arrangement is a conditional temperature and humidity that is regulated in kumbung. In this test, 22 baglogs of mushrooms were used which were stored in the kumbung. In Table 4 it is known that when the room temperature is 23.3oC it takes 427 seconds to turn on the heating lamp to return the room temperature to within the 25oC – 28oC range, at 24.7oC it takes 365 seconds to turn on the heating lamp, at 24, 9oC takes 359 seconds to light up and when the room temperature is within the range of the setpoint value, the heating lamp is not working.

And for humidity, at a humidity value of 74.7% it takes 82 seconds to water the kumbung to return the humidity in the kumbung back to a vulnerable humidity value of 75% - 90%. At a humidity value of 72.4%, watering takes 123 seconds, at a humidity value of 71.2%, watering takes 140 seconds. And when the humidity in the storage room is within the setpoint value, the sprinkler pump is not working.

IV. CONCLUSION

Based on the analysis and discussion carried out, it can be concluded that the DHT22 sensor tested for temperature and humidity was able to achieve an accuracy level of 99.44% for temperature and 99.4% for humidity. The website can give orders to the actuator with a response time delay of 2.8 seconds for the heating lamp and 3 seconds for the pump. Watering and heating the kumbung room for oyster mushroom cultivation works based on the temperature and humidity conditions of the kumbung room against predetermined temperature and humidity setpoint values and with an average watering time of 115 seconds and for an average heating lamp duration of 383 seconds.

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