Microcontroller based automatic temperature control for oyster mushroom plants

P Sihombing¹, T P Astuti¹, Herriyance¹ and D Sitompul¹
¹Faculty of Computer Science and Information Technology, Universitas Sumatera Utara, Jl. Dr. Mansyur No.9, Padang Bulan, Medan, Sumatera Utara 20155
Email: poltakhombing@yahoo.com¹

Abstract. In the cultivation of Oyster Mushrooms need special treatment because oyster mushrooms are susceptible to disease. Mushroom growth will be inhibited if the temperature and humidity are not well controlled because temperature and inertia can affect mold growth. Oyster mushroom growth usually will be optimal at temperatures around 22-28ºC and humidity around 70-90%. This problem is often encountered in the cultivation of oyster mushrooms. Therefore it is very important to control the temperature and humidity of the room of oyster mushroom cultivation. In this paper, we developed an automatic temperature monitoring tool in the cultivation of oyster mushroom-based Arduino Uno microcontroller. We have designed a tool that will control the temperature and humidity automatically by Android Smartphone. If the temperature increased more than 28ºC in the room of mushroom plants, then this tool will turn on the pump automatically to run water in order to lower the room temperature. And if the room temperature of mushroom plants below of 22ºC, then the light will be turned on in order to heat the room. Thus the temperature in the room oyster mushrooms will remain stable so that the growth of oyster mushrooms can grow with good quality.

1. Introduction

In the beginning, most mushrooms grow outdoors in some parts of the world. So that mushroom farmer only depends on the condition of the natural environment, as if wild mushrooms grow in a natural atmosphere. But now, the farmers in certain areas have been able to regulate the growth of mushrooms for commercial purposes as well as for personal use. The farmers today are no longer just dependent on the growth of mushrooms naturally but they are able to produce mushrooms by making their own plantings. The room for mold growth can be controlled by utilizing technology, which can control temperature and inertia automatically. They have been able to plant and harvest mushrooms only by utilizing the land as in the warehouse or garage around the house [1].

In mushroom plants, the most important consideration is to watch for the prevention of possible pests and pathogens in addition to understanding the relationship between temperature, humidity, and air exchange. In this paper, we focus on discussing of room conditions i.e. room temperature, humidity, and air movement circulation. In the room is closed, when the room temperature rises, then the humidity of the air is relatively down. When the outside air flows into the room, the temperature and humidity of the room is relatively changed according to the condition of the outside air. Furthermore, to regulate the temperature of the room to remain stable at temperatures suitable for mushroom cultivation, it is necessary for the air circulation to be controlled automatically. Automatic room control will greatly assist mushroom farmers to create optimum room conditions to keep them in accordance with the needs of mushroom plants.

Related to this project, we will develop Arduino Uno Microcontroller based automatic tool and Android smartphone to support mushroom crops in the small area. We use sensors to detect the air
temperature and humidity. Then the detection results of those sensors will be sent to the Microcontroller Arduino Uno which serves as the brain of this tool to monitor the temperature and humidity of mushroom plants. The heat and the humidity of the mushroom plant room will also be displayed on the monitor of the Arduino Uno microcontroller. All of the data will be sent to the Android smartphone using WIFI (Wireless Fidelity) network, and Android smartphone can also to control the Arduino Uno microcontroller.

2. Related Work
There are a number of proposed systems in the past few years. One of them is a temperature and humidity monitoring system using AT89S52 as the microcontroller, SHT10 as the temperature and humidity sensor and TC35i GSM (Global System for Mobile communication) Module for wireless communication. When the temperature and humidity exceeds the limit, the system will send short messages to the mobile phones to alert the user [1]. Another system is a greenhouse monitoring and control system based on GSM. This system is more complicated if we compared to the previous system, because as it does not only allow a data acquisition, but it also allows the user to control humidity, temperature and soil moisture via SMS (Short Message Service) [2].

Mushroom cultivation is significantly grown in a controlled environment. Based on mushroom growth follows a very complex and sensitive procedure. Automatic environment control on mushroom cultivation has been introduced by using Trend IQ3 controllers. By using the IQ3 Trend controller, the system automatically controls and monitors the environment at every stage of the growth cycle to maximize the yield of oyster mushrooms with good quality [3]. The control system interfaces are continually improved to monitor the condition of the rooms and the operation of plants and to adjust the needs of oyster mushroom plants [4].

The other research related to this project is using a controls that can be used to monitor plants in the real-time have been done by Dan Wang, et al in 2015 [5]. This study conducted the data monitoring on aquaponic plants that can be sent to smartphones via an internet.

The next related study is about the addition of the water automatically made by Rajeev L.M and Preet Jain in 2015 [6] which use an electrode as a benchmark of the amount of water in the plants. They developed if the water is below of the amount of a plant needs, then the pump will do watering to add the water.

There is another related research that develops about automatic plant watering has been done by Devika et al [7]. They developed the watering of the plants grown on soil where moisture sensors will detect soil moisture levels. If the soil is not moist / dry, then the system will automatically do watering on the plant.

3. System Description
To develop automatically control of the temperature of an oyster mushroom system, we use an Arduino Uno microcontroller. The sensors are placed around the root of oyster mushroom and will transmit the detection result every time to the Arduino microcontroller. The Arduino Uno microcontroller is the main part of automatic temperature control for this oyster mushroom plants. At the previously, we have embedded a module program on this microprocessor to support this control system. The Arduino Uno microcontroller is also serves to set the real-time system to set the Alarm to the water pump. When the alarm is activated, the Relay will be activated and the water pump will send the water solution into the oyster mushroom area. And if the relay is off (off), then the water pump will stop to supply water.

To support this project, we first have designed a Virtuino application on Android smartphone that serves to see the water level and temperature around the oyster mushroom plant. This application will control the Arduino microcontroller. Before running the Virtuino application design, we first provide the data storage by using the thingspeak.com module. This thingpeak.com module serves the store of data sent by the sensor to the microcontroller and other necessary data.
In Figure 1, we can see that a simple flow of the system starts from the detection of proximity sensor and temperature sensor. Other relays are connected to the microcontroller port. When the port pin of relay is high, means the pump will run the water and when the port pin of relay is low, and then the water pump will stop running water. Thus the water circulation will be flow regularly. This pump will be controlled by a relay to turn on and off the water flow. We also use the LCD screen to display the current time and date of the system.

3.1 General Architecture of Our System
For more details, we will describe the general Architecture of the system that we have developed. The architecture of the temperature control system and the moisture flow of the mushroom plant are shown in figure 1 below.

![Diagram of System Architecture]

**Figure 1.** The General Architecture of Automated Mushroom Nutrition Plants Systems

The working process of the temperature control system and humidity of oyster mushroom plant are as follows; the temperature sensor (HSM - 250G) will detect the overheating value of the oyster mushroom area in units of the °C range. If the temperature increased more than 28°C in the room of mushroom plants, then this tool will turn on the water pump automatically to run the water in order to lower the room temperature. And if the room temperature of mushroom plants below of 22°C, then the light will be turned on in order to heat the temperature room area.

3.2 The Flowchart of Automatic Temperature Control for Oyster Mushroom plants Systems
The system flow begins with the detection of the temperature sensor. In the temperature sensor, if heat and humidity are detected, the fan and pump will ignite and do the condensation. And if normal temperature and normal humidity (22-28°C) then the fan does not turn on, as well as cold temperatures and wet humidity then the fan also will not on. If any of the conditions are met then the results will show on the LCD and will connect to Android Smartphone with the help of Bluetooth. The system flowchart is presented in figure 2.
3.3 The Coding Program
To support this project, we have embedded the module program in Arduino Uno microcontroller. A part of our coding program is presented in Figure 3 below.

Figure 3. The program module
4. The Experimental setup and Result

The design and implementation of the Automatic Temperature Control for Oyster Mushroom plants Systems automatically using Arduino Uno microcontroller performed is shown in Figure 4 below.

![Figure 4. The Experimental setup](image)

In table 1 below shows, the Wi-Fi module will send the humidity of water level and temperature values of to the mushroom area.

4.1 Automatic Temperature Control System

In this experiment, automated and manual system testing has been performed. Testing is automatically done with control via smartphone. We have developed an application on a smartphone to control the temperature automatically. In applications that have been designed on this smartphone can be done by clicking the option of the automatic button. Through this system, if the room temperature has reached 30 °C, then the system will automatically order the pump relay to do the spraying to reduce the room temperature. Thus the room temperature in oyster mushrooms will be kept stable at the range 25-29 °C. The results of the tests on each hour are presented in table 1 and figure 5.

| Time  | Humidity (%) | Temperature (°C) | Spraying | Information                          |
|-------|--------------|------------------|----------|--------------------------------------|
| 8.00  | 72           | 27               | No       | Normal Condition                     |
| 9.00  | 71           | 28               | No       | Normal Condition                     |
| 10.00 | 70           | 29               | No       | Normal Condition                     |
| 11.00 | 67           | 30               | Yes      | Temperature conditions exceed normal limits |
| 12.00 | 65           | 31               | Yes      | Temperature conditions exceed normal limits |
| 13.00 | 64           | 32               | Yes      | Temperature conditions exceed normal limits |
4.2. Manual Temperature Control System

Manual testing has also been done by giving commands through applications that have been designed in the Android Smartphone. To run the system manually is done by clicking a selection of manual buttons on the smartphone. In this way, the system will be able to run the water pump by the user if the user wants to drain water or to heat the room temperature. By this manual system, the user can also adjust the system performance by directly activating or disabling the options button for a lamp, pump, or fan anytime. Users can also turn off the feature if needed to set the temperature and humidity in the room oyster mushrooms.

5. Conclusion

In this paper, we have described how to control the temperature and humidity of air in oyster mushrooms, whether done automatically by using a microcontroller run through a smartphone or to flow the water manually. All components of automatic temperature control device in the cultivation of oyster mushrooms can run as planned. An Arduino microcontroller tool can work well that is controlled via handphone. At temperatures greater than 29 °C the pumps appear to live automatically to perform the fogging (condensing) temperatures in the room of the fungus. Data communications made to transmit temperatures or moisture to Android smartphones can be done via Bluetooth or with available Wi-Fi or using a Thing-Speak online cloud for monitoring and storage. The data could be accessed by the user anytime by using a computer that is connected to the Internet. The control system was able to control ac-powered humidifier, light, and fan based on the feedback of the sensors to maintain temperature, humidity, and light intensity at optimum growth condition in an actual mushroom farm. The experimental results show that at 67% humidity and the temperature is 30 °C, the system starts to turn on the cooling fan and turn on the water pump to lower the room temperature and anticipate staying within the range of 25-29 °C.
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