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MUSHROOM GROWING MONITORING DEVICE (MUSMOD)

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Abstract

This paper will present about a project entitled Mushroom Growing Monitoring Device which is known as 'MusMoD'. It is a prototype which is developed to enhance mushroom growing by keeping the mushroom at low temperature and with the correct humidity environment. The development of MusMoD involves integration between hardware and software where it allows the owner to monitor the mushroom condition over a network connection. For this project, Raspberry Pi was used as the microcomputer that can be programmed based on what function is needed. The proposed system has proven the effectiveness in producing a quality mushroom compared to the traditional method.

Keywords: Mushroom cultivation; Remote monitoring system; Internet of thing

1.0 INTRODUCTION

People have consumed mushroom a long time ago whereas, at that time, they have collected wild mushroom from jungles and villages. Such country like Malaysia has a large community that consumes mushrooms in their daily life. The demand of the mushroom is, however, higher compared to the number of a mushroom grower [1]. This is driven by the changing lifestyles towards healthy living. Based on the research done, not all the mushroom growers can maintain their mushroom business for a long period. This is due to the lack of knowledge on how to take care of the mushroom while they grow [2]. The mushroom growing process is easy but when unexpected event happens, they have to discard most of them.

The objective of this project is to develop a prototype that can enhance the mushroom growing process and at the same time to be able to monitor the mushroom condition. Individuals or farmers can overcome their problems by growing the mushroom in MusMoD, which is equipped with a system to control the good environment inside it. With MusMoD, it allows the mushroom spores inside of mushroom growing media to grow at their best condition. The system consists of the sensor to read the temperature and the humidity. The humidity and temperature data can be viewed from graphical user interface through laptop or smartphone. The data of temperature and humidity will be transfer using a network connection.

For the time being, this project is developed for an individual who wishes to grow mushrooms for their own purpose. For next stage, the focus is to help the small-scale mushroom growers, so that it will ease their tasks, increase their production and maintain the good quality of mushroom.

2.0 LITERATURE REVIEW

In 2008, not more than 850 of farmers and companies were involved in the cultivation of mushrooms and the numbers have reduced dramatically to less than half later [3]. Mushrooms are among the seven most valuable crops cultivated in Malaysia according to our Ministry of Agriculture, 2011. However in 2012, there are only around 340 farmers involved in the cultivation of mushrooms in Peninsular Malaysia. They are the small farmers who produce 50 – 500 kg of fresh mushrooms a day. At that time, only six companies produce on a large scale of over 500 kg per day while around 60 companies produce in moderate scale (50 – 500 kg per day), and the farmers are considered as small-scale growers. By 2014, the numbers of mushroom growers increase to total of 428 (Table 1).

Table 1. Mushroom grower by state.
(Source: Department of Agriculture Malaysia, 2015)

State	Total of entrepreneurs							
	2007	2008	2009	2010	2011	2012	2013	2014
Perlis	4	4	5	4	5	4	4	5
Kedah	9	9	11	15	14	9	20	26
P. Pinang	13	13	15	17	16	13	21	24
Perak	30	31	36	38	40	30	35	40
N. Sembilan	30	36	35	25	24	30	27	24
Melaka	16	16	14	14	13	16	14	13
Johor	67	87	80	88	90	67	84	91
Pahang	50	45	50	50	47	50	50	46
Terengganu	29	29	29	28	27	29	29	35
Kelantan	22	28	35	40	41	22	38	42
Selangor	50	50	48	55	59	48	57	60
Sabah	13	14	14	13	15	15	15	15
Sarawak	6	13	6	8	7	11	8	7
Total	339	375	378	395	398	344	402	428

One of the factor that affects the production of mushroom is the environmental stability. It is an independent dimension that is very difficult to control, particularly for those who work on agricultural commodities. They have to deal with the hot weather, the low quality seed supply [4], shortage shelf life and also on sanitation practices in keeping the cleanliness during the mushroom growing to avoid the diseases and pest attack. By growing mushroom in a plastic box, it can minimize the risk of infections [5].

Other aspects that need attention is the development of a standard mushroom house that could maximize the production of mushrooms [3]. Due to the current global warming, improper house for mushroom coupled with hot weather causes the mushroom to dry or die. This is among the challenges in growing mushroom.

Individual mostly buys mushroom kit to grow their own mushroom but one thing they overlook is that mushroom needs high humidity to grow big and healthy. The ideal temperature and humidity for mushroom cultivation is 22 – 28 °C with a humidity of 60% - 80% in order to obtain the optimal result [6]. Since mushroom have no skin to prevent losing water to the atmosphere [7], we need to supply them a lot of water vapor in the air before the mycelium starts to form little buds, which will develop into mushrooms later. From this situation, we take the opportunity implementing the current advanced technology to help individuals, controlling the temperature, humidity and provide real-time monitoring of their mushrooms.

3.0 THE PROPOSED SYSTEM

The mushroom house under study basically is like the prototype shown in Fig. 1(a) and Fig 1(b). It consists of sensors to be used to monitor the temperature and humidity variations.

Fig. 1(a). Sketched side view of MusMoD

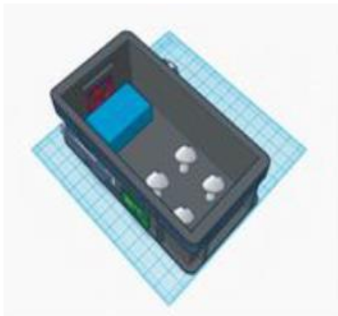


Fig. 1(b). Sketched top view of MusMoD

The development of this prototype is divided into three main parts; the mechanical process, the hardware and the software design.

Mechanical Process

This part consists of the casing development for MusMoD. The material used for the casing is plastic. It is recommended to use a good quality of plastic if not it will affect the humidity of the mushroom. The box contains two parts where the first part, the outside box is used to keep the circuit and system.

And the second part, which is the inside box, is where the growing process occurred.

Fig. 2. The casing in the making.

Hardware Design

For this prototype, the hardware component consists of Raspberry Pi, temperature sensor, humidity sensor, relay, fan and air pump. Raspberry Pi is the main component that controls the whole operation of the system. The fan is to ventilate the surrounding of the mushroom while the air pump is to simulate the chill ambient. The two sensors are to collect the reading of temperature and humidity [8]. The fan, relay, air pump were placed outside the casing while the temperature and humidity sensor were placed inside the casing.

Fig. 3(a). Outside view of prototype.

Fig. 3(b). Inner view of prototype.

System Design

Raspberry Pi uses Raspbian as its operating system (OS). The programming was done in Python for interfacing with General Purpose Input/output (GPIO) from the Raspberry Pi.

The monitoring system allows the user 'hundreds of meters away' to be alerted about the mushroom house condition [9]. The interface developed for MusMoD is shown in Fig. 4(a) and Fig. 4(b). Some of the features included in the system are the information about types of mushroom, ON and OFF setting for the air pump and fan, also the links to a database.

Fig. 4(a). MusMoD first page interface.

Fig. 4(b). MusMoD demo interface.

The user can use the web browser and enter the Raspberry Pi IP address to view the monitoring system. Every temperature changes is captured and stored in MySQL database.

The flowchart in Fig. 5 shows the overall process of the MusMoD. At start, the Raspberry Pi connects to the wireless router. When the system is ready, the temperature and humidity sensors start to read and send the values of the monitored environment parameters inside the box to the database for logging [10]. Then, the air pump and fan were set to ON mode for 30 seconds in order to ventilate and keep the environment moisture and humid. After 5 days of experiment, we stop the system.

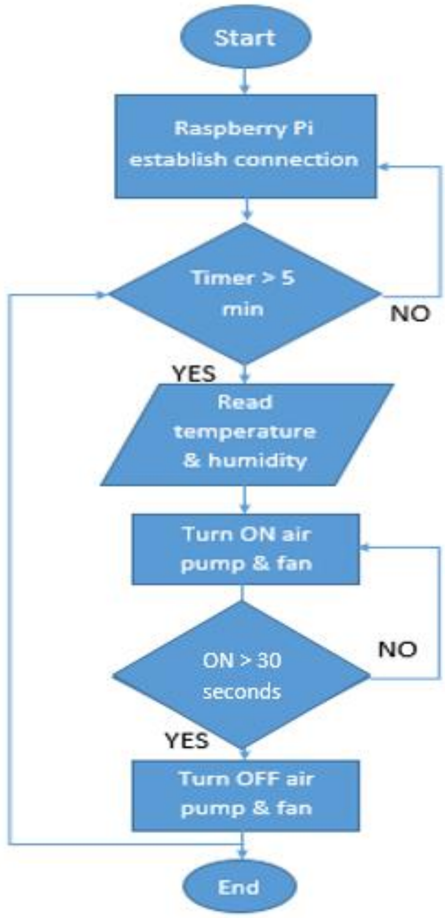


Fig. 5. Flowchart of the system.

4.0 RESULTS AND DISCUSSION

After all the hardware and software parts have been completely assembled and coded, the prototype is ready to be tested as a whole. This testing phase is conducted to make sure the prototype function accordingly and achieve the objectives set.

Unit Testing

Unit testing is conducted to test the individual unit of source code and program module to determine whether it can function appropriately. Once all of the units in a program are workings and free from errors, the larger components of the program were evaluated through integration testing. The modules tested are DHT sensor (humidity and temperature), the air pump, the fan and the GoogleDocs etc. The results received showed all modules are functioning as per setting.

Integration Testing

In this part of testing, the overall system is tested to determine if the requirements of the system specifications are met. It can be used to evaluate the prototype by testing it with the end users. The users get the chance to understand the system flow and feel them and give comments on what they think about the system. The user manages to control the system remotely. By default, the system runs automatically accordingly to the set timer however the user able to remotely control the turning on and off the fan and the air pump through the web browser.

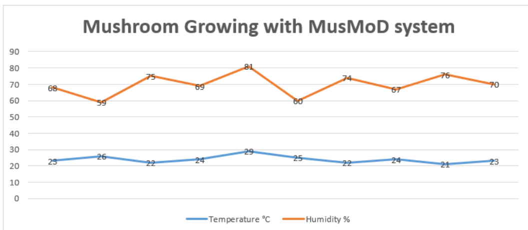
Experiment Session

In order to further evaluate MusMoD, the real mushroom has been experimented in two scenarios; with and without MusMoD. The mushroom was left to grow inside the MusMoD with the system running for the first experiment while for the second experiment; the mushroom was left to grow inside the MusMoD but without the system running. Each experiment takes up to 5 days before the result can be seen. Oyster mushroom kits were used during the testing.

- **Mushroom Growing with MusMoD**

For the first experiment, the testing was conducted using MusMoD system. The oyster mushroom kits were left inside MusMoD with the fan and air pump automatically ON and OFF during the testing.

a. First experiment - Result



	0:00:17 30/3/2015	12:00:17 30/3/2015	0:00:17 31/3/2015	12:00:17 31/3/2015	0:00:17 1/4/2015	12:00:17 1/4/2015	0:00:17 2/4/2015	12:00:17 2/4/2015	0:00:17 3/4/2015	12:00:17 3/4/2015
Temperature °C	23	26	22	24	29	25	22	24	21	23
Humidity %	68	59	75	69	81	60	74	67	76	70

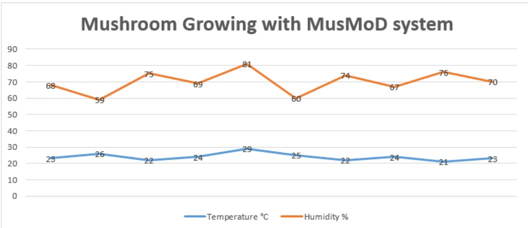
Fig. 6. Temperature and humidity reading with MusMoD.

Fig. 7. Mushroom condition grew with MusMoD.

- **Mushroom Growing with MusMoD**

For the second experiment, the scenario is; the mushroom was left to grow inside the same box without the MusMoD system turned on. This method is similar to the traditional method.

a. Second experiment – Result



	0:00:17 30/3/2015	12:00:17 30/3/2015	0:00:17 31/3/2015	12:00:17 31/3/2015	0:00:17 1/4/2015	12:00:17 1/4/2015	0:00:17 2/4/2015	12:00:17 2/4/2015	0:00:17 3/4/2015	12:00:17 3/4/2015
Temperature °C	23	26	22	24	29	25	22	24	21	23
Humidity %	68	59	75	69	81	60	74	67	76	70

Fig. 8. Temperature and humidity reading without MusMoD.

Fig. 9. Mushroom condition grew without MusMoD.

We compare the results as shown in Fig. 6 to Fig. 9. The graph in Fig. 6 shows a high reading in term of humidity when compared to the graph in Fig. 8. This proves that with MusMoD, it keeps the mushroom grows in good condition. The mushroom grew in MusMoD received the low temperature and humidity to accommodate its need. After 5 days, the mushroom shown in Fig. 7 was fresh, big and it looks healthy. However the mushroom grew without MusMoD shown in Fig. 9 turned yellowish, bad quality, dried off and almost die. The result is due to high temperature, no enough air ventilation, and low humidity.

Time	Temperature	Humidity
2015-04-26 15:45:05	29.0	57.0
2015-04-21 10:40:03	21.0	62.0
2015-04-21 10:35:03	21.0	65.0
2015-04-21 10:30:04	21.0	62.0
2015-04-21 10:25:04	21.0	62.0
2015-04-21 10:20:04	21.0	62.0
2015-04-21 10:15:03	21.0	62.0
2015-04-21 10:10:03	21.0	63.0
2015-04-21 10:05:03	21.0	63.0
2015-04-21 10:00:03	20.0	71.0
2015-04-21 10:00:03	21.0	62.0
2015-04-21 09:55:03	20.0	69.0
2015-04-21 09:55:03	21.0	62.0
2015-04-21 09:50:04	20.0	71.0

Fig. 10(a). Reading collected from sensors.

Date	Air Pump	Fan
2015-04-26 15:45:35	OFF	OFF
2015-04-26 15:45:05	ON	ON
2015-04-26 15:45:05	ON	ON
2015-04-21 10:45:34	OFF	OFF
2015-04-21 10:45:04	ON	ON
2015-04-21 10:45:03	ON	ON
2015-04-21 10:40:33	OFF	OFF
2015-04-21 10:40:03	ON	ON
2015-04-21 10:40:03	ON	ON
2015-04-21 10:35:33	OFF	OFF
2015-04-21 10:35:03	ON	ON
2015-04-21 10:35:02	ON	ON

Fig. 10(b). Air pump and fan status.

5.0 CONCLUSION

Based on the result, we can say that the MusMoD prototype has successfully achieved the objectives set earlier. The proposed system has proven the effectiveness in producing a quality mushroom compared to the traditional method. In the future, the MusMoD system has potential to contribute to agricultural technology advancements.

Acknowledgement

This project was demonstrated to Malaysian Agricultural Research and Development Institute (MARDI) and it received a high recommendation from the institute.

Recommendation

For future enhancement, we are working on the design of the mushroom house itself so that it can cater the real need of small-scale mushroom grower.

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