

IOT BASED ENVIRONMENT CONTROLLER FOR MUSHROOMS CULTIVATION

Md. Ali Hasan¹, Jakir Hossain², M. Robiul Hoque³, M. Humayun Kabir^{1*}

¹Department of Electrical and Electronic Engineering, Islamic University, Kushtia 7003, Bangladesh.

²Mymensingh Private Polytechnic Institute, Mymensingh 2200, Bangladesh.

³Department of Computer Science and Engineering, Islamic University, Kushtia 7003, Bangladesh.

***Corresponding Author:** humayun@eee.iu.ac.bd

ARTICLE INFORMATION	ABSTRACT
Citation: Md. Ali Hasan, Jakir Hossain, M. Robiul Hoque, & M. Humayun Kabir. (2022). IoT Based Environment Controller for Mushrooms Cultivation. Pakistan Journal of Emerging Science and Technologies, 3(1), 8. https://doi.org/10.5281/zenodo.7227620 Received: 13th May 2022 Revised and Accepted: 29th May 2022 Published On-Line: 6th June 2022	Mushroom is a delicious and delicatessen food all over the world. As they have no skin, moisture is required to produce the fruit or sporophore of mushrooms. For this reason, mushrooms need an environment (humidity 80% to 90% and temperature 14°C to 18°C) that has high humidity to avoid water loss. For this, farmers have to spend much time in the cultivation room to maintain a proper environment. This paper introduces the Internet of Things (IoT) based automatic environment controller. This controller can monitor the ideal environment of the cultivation room ubiquitously. The proposed system can monitor and control the humidity and temperature of the mushroom cultivation room and presents the data on the cloud server every thirty seconds in the form of tables and graphs. A cost-effective solution is provided using the less-costly and low-power consumes hardware to design the controller. The system is evaluated and experimental results show that it can be efficiently used as an environment controller. Keywords: Cloud Computing; Environment Controller; Internet of Things (IoT); Mushroom Cultivation



***Corresponding Author:**
humayun@eee.iu.ac.bd

Pakistan Journal Emerging Sciences and Technologies (PJEST) by [Govt. Islamia College Civil Lines Lahore, Pakistan](#) is licensed under a [Creative Commons Attribution-Share Alike 4.0 International License](#)

1. Introduction

Nowadays, there are about 14000 species of mushrooms in the world. Among them, 2000 species are edible and 600 have significant pharmacological properties [1]. Mushroom has two main parts. The underground part is called mycelia and the aboveground part is called the fruit body. As mushroom is not a plant, it does not have any chlorophyll. Sunlight is not required to form the fruit body of mushrooms. For the growth of mycelia, it takes the dead body around them. In the appropriate environment, mycelia can live many years. For satisfactory growth of fruit, the body requires a temperature of 14°C-18°C and high humidity. To obtain this criterion, we need a cultivation room in a closed environment. As mushroom cultivation is labor inexpensive and requires no outdoor land, so that even the physically disabled and landless people can easily start mushroom cultivation. It also needs low capital. Generally, a water sprayer is used to obtain high

humidity in Bangladesh. But it is not the right way to produce a quality mushrooms. Twenty four hours nursing can ensure maximum production of mushrooms. Somewhere, a thermo-hygrometer is also used to control the humidity and temperature of the mushroom cultivation room. Farmers have to monitor the cultivation room to use a thermo-hygrometer and have to take necessary steps to increase the humidity level. As it is not possible to stay for farmers all the time in the cultivation room, the growth of mushrooms may be disrupted.

We introduced a system that can control humidity and temperature automatically using a embedded open source hardware platform and ultrasonic mist maker. IoT with cloud platform is also introduced with the system. As a result, farmers can access data anywhere in the world through the internet. The remaining part of this paper is organized as follows: Section 2 presents an overview of the related works. Section 3 introduces an overview of mushroom cultivation. Section 4 includes a detailed explanation of the proposed system architecture, Section 5 evaluates the proposed system and finally, Section 6 concludes by mentioning future work.

2. Literature Review

It is very difficult for a farmer to maintain environmental conditions for mushroom cultivation. For mitigate this issues many researchers propose some work for automatic control of mushroom cultivation. M. N. S. Watkar et. al [2] design a system with PLC Naxgene 1000, measure temperature humidity and CO₂ gas with sensors. This makes the system automatic by controlling the fan, bulb, and water pump with respect to sensors values. Another proposed system uses Arduino Mega hardware platform to collect temperature and humidity with the help of sensors and uses Artificial Neural Network (ANN) for the decision-making of DC fans and mist-maker [3]. Embedded system based on the structure of ARMv7 processor board displays collected data from different sensors (temperature, humidity, CO₂) of a greenhouse using ZigBee [4]. M. F. Mohammed et. al [5] also introduced Internet of Things (IoT) and ATmega 2560 hardware platform is used as a controller. These literature proposed the solutions which are costly, consumes much power and did not considered the usage of cloud platform. Hence, in this paper we utilized the Node MCU hardware module which is less costly and consumes less power than the early solutions. Moreover, it can interface with the cloud platform using wireless communication protocols. It can also be powered with energy harvesting technology.

3. Mushroom Cultivation:

The first cultivation technique of mushroom was picking them from their natural habits in the woods. Mushroom farming was started in 600 A.D. [6]. That natural technique was not implemented in mass production. Nowadays, Mushroom is cultivated in scientific ways. Mushroom cultivation requires four different processes: Compost preparation, Spawning, Casing, and Pinning.

Mushroom cultivation initializes with the starting of compost preparation. Any kind of cereal straw-like paddy, barley, rice, and any agricultural waste can be used to make compost for mushroom cultivation. The moisture level of the straw should be less than 12%. The straw is sliced into small pieces 5-10 cm long. This straw is processed through two processes called phase 1 and phase 2. Cleaning and heating of element subsume in phase where temperature rises to 80°C. Before heat treatment, some minerals such as limestones, gypsum, suge are also mixed with straw during the preparation of substrates. This kills all possible bacteria. In phase 2, compost elements are kept at 56-60°C for 8 hours. Then it is stored for up to 7 days at 45°C temperature for emission. After that, the substrate is packed in a plastic packet and the spawn is mixed with the substrate. In Bangladesh, the usual packet size is 25x20 cm². This bag is placed in a controlled environment for 20-25 days for mycelial growth. The temperature and humidity required for fruit body formation are 15–21°C and 80%~90%. When the first mushroom body is seen, after 3-5 days, the farmer can collect mushrooms for marketing.

4. Proposed Environment Controller

An environment controller is an electronic device that can keep the environment parameter to a predefined level, or value. Figure 1 shows the block diagram of our proposed system.

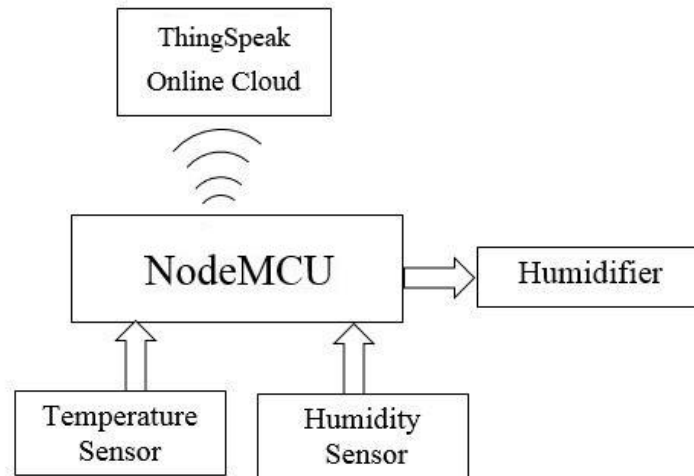


Figure 1. Block diagram of environment controller.

NodeMCU acts as the main controller of the system. It is an open-source firmware. This firmware uses the Lua scripting language. It is also programmed through Arduino IDE. It consists of 16 GPIO pins and an ESP-12E which consists of an ESP-8266EX 32-bit microchip with integrated Wi-Fi. We use the DHT11 module to sense the temperature and humidity of the cultivation room. It is integrated with a high-performance 8-bit microcontroller. It has also a capacitive humidity sensor to measure humidity and a thermistor to sense surrounding air temperature. Those two sensing data are processed by an integrated microcontroller and available as digital data to its single output pin every two second intervals. NodeMCU reads temperature and humidity data from DHT11 and compares it with a specific value. After comparing, it generates a signal which is used to control the humidifier by using a relay. The flow chart for this process is shown in figure 2.

We use an ultrasonic mist-maker as a humidifier. It consists of an oscillator circuit and a 108 kHz piezo transducer. The oscillator circuit creates a 108 kHz frequency which creates oscillation on the water surface by the piezo transducer. It makes small water bubbles of 5 microns which turn into vapor. The complete circuit diagram is shown in figure 3.

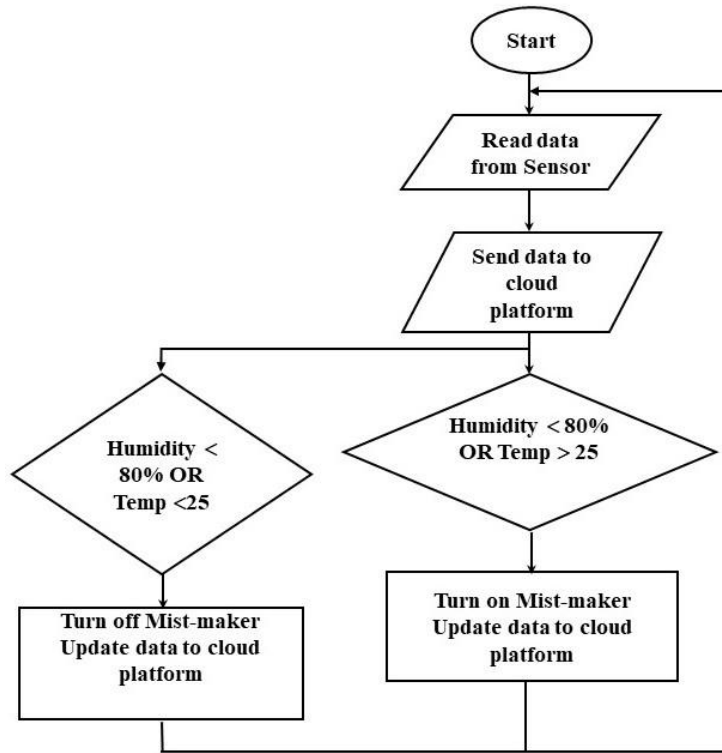


Figure 2. Flow chart of the controller.

In the meantime, it also sends data to ThingSpeak online cloud. Farmer can access data from anywhere by accessing ThingSpeak cloud with a web browser. And can control the ultrasonic mist-maker. A Android Apps was developed in this regard as shown in figure 4.

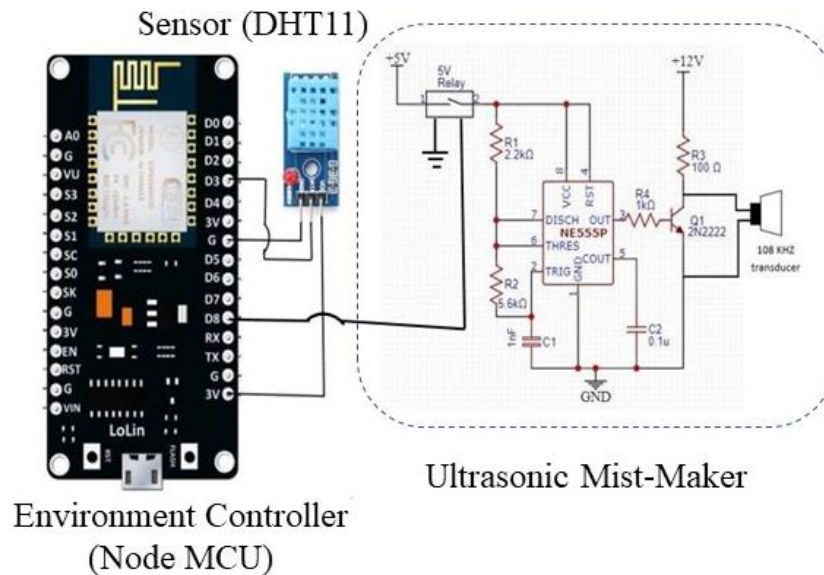


Figure 3. Prototype of environment controller.



Figure 4. Developed Android Apps for mushroom cultivation.

5. Evaluation of the System

We placed our Internet of Things (IoT) based environment controller for mushroom cultivation in a cultivation room. Figure 5 shows the experimental setup of the proposed system.



Figure 5. Internet of Things (IoT) based environment controller for mushroom cultivation.

Data is shown to ThingSpeak online cloud in the form of graphs. Figure 6 and figure 7 show humidity and temperature data controlled by the controller respectively.

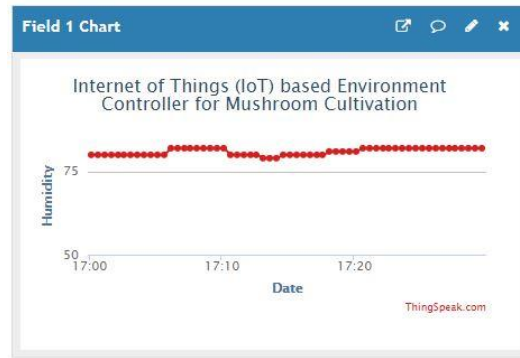


Figure 6. Humidity data controlled by the controller.

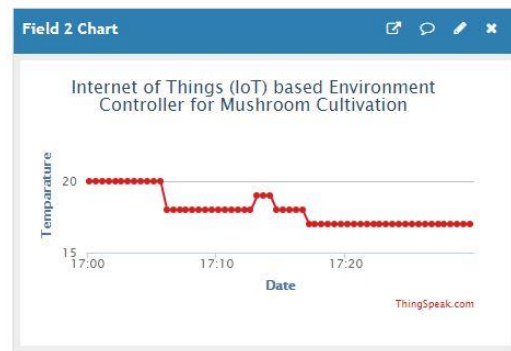


Figure 7. Temperature data controlled by the controller.

When spawn bags are placed in the mushroom cultivation room, then we use this controller. The environment of Bangladesh is warm. As a humidifier uses the effect of ultrasonic vibration to make water into mist, the temperature of the mist is low which helps to reduce the temperature of the farming room. This controller maintains the humidity 80% to 90% and temperature 14°C to 18°C in the cultivation room. As it provides twenty four hours monitoring, the growth of mushrooms is sufficiently high.

6. Conclusion

We utilize the twenty four hours automatic nursing environment for mushroom cultivation using this system. This performance of this controller is satisfactory. It can successfully maintain the temperature and humidity of the cultivation farm. This replaces manual controlling of humidity and temperature with automatic controlling. So, the production of mushrooms is increased. It also reduces human care. The power taken by the controller is very low. During load shedding, this controller can also be operated by battery. This environment controller consumes less power and it is cost-effective. Its installation is user friendly. Moreover, this platform is also flexible and

expandable. In future, we can adopt reinforcement machine learning techniques in the environment controller.

Acknowledgement

This work was supported by the NST fellowship funded by Ministry of National Science and Technology (NST), Government of the People's Republic of Bangladesh (July 2020 to June 2021).

References:

- [1] R. Singh, "A review on different benefits of mushroom," *IOSR Journal of Pharmacy and Biological Sciences*, vol. 12, no. 1, pp. 107-111, 2017.
- [2] S. Watkar, N. Dawande, Suresh, and S. Shelke, "Automatic monitoring and controlling system using PLC for mushroom plant," *International Journal of Research Publications in Engineering*, vol. 3, no. 7, 2017.
- [3] P. Kachanov, O. Yevseienko, and A. Pivnenko, "Mushroom Farm Automated Control System," *J Редакційна колегія*, p. 35, 2020.
- [4] J. Ma and Q. Liu, "Design of control system in mushroom greenhouse based on embedded platform," *Bio Technology*, vol. 1023, 2014.
- [5] M. Mohammed, A. Azmi, Z. Zakaria, M. Tajuddin, Z. Isa, and S. Azmi, "IoT based monitoring and environment control system for indoor cultivation of oyster mushroom," in *Journal of Physics: Conference Series*, 2018, vol. 1019, no. 1, p. 012053: IOP Publishing.
- [6] G. Straatsma, J. P. Gerrits, J. T. Thissen, J. G. Amsing, H. Loeffen, and L. J. J. B. T. Van Griensven, "Adjustment of the composting process for mushroom cultivation based on initial substrate composition," vol. 72, no. 1, pp. 67-74, 2000.