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Application of Internet of Things Based Monitoring System for indoor Ganoderma Lucidum Cultivation

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Abstract

Most agriculture plantings are based on traditional farming and demand a lot of human work processes. In order to improve the efficiency as well as the productivity of their farms, modern agricultural technology was proven to be better than traditional practices. Internet of Things (IoT) is usually related in modern agriculture which provides the farmer with a real-time monitoring condition of their farm from anywhere and anytime. Therefore, the application of IoT with a sensor to measure and monitors the humidity and the temperature in the mushroom farm that can overcome this problem. This paper proposes an IoT based monitoring system for indoor Ganoderma lucidum cultivation at a minimal cost in terms of hardware resources and practicality. The results show that the data of temperature and humidity are changing depending on the weather and the preliminary experimental results demonstrated that all parameters of the system were optimized and successful to achieve the objective. In addition, the analysis results show that the quality of Ganoderma lucidum produced on the research method conforms to regulations in Vietnam.

Keywords: *Internet of Things, Mushroom, Ganoderma lucidum, Monitoring.*

1. Introduction

Nowadays, Ganoderma lucidum (GL) is one of the favorite plants to be cultivated among Vietnam farmers. If growing GL manually in accordance with the traditional method, at least two persons are needed to take care of GL farms. The workers visit farms regularly and regulate devices to keep reasonable humidity and temperature. However, shaping this product to reflect the right quality and developing the right scale were what many businesses aimed for. In Vietnam, the mushroom plantation industry is growing and thriving due to high demand in the local and outside of Vietnam market. GL that contains high in nutrition and protein have been used for century for food and medicines…. The increase in extracting good in mushroom has make the agriculture sector push for more demands of import and export. The mushroom grower are mostly local villagers that produces mushroom in their own farm using traditional ways [1]. This method of mushroom

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cultivation cannot satisfy the increase in demand of mushroom order and request. Therefore, that is making the mushroom production faced a little difficulty. Currently, the application of IoT technology plays an increasingly important role in the agricultural production process and is becoming a strong development trend. And applying IoT technology in growing GL does not depend on the weather and grower's experience to monitor and control the parameters of temperature, air humidity, light and CO2 concentration in the mushroom house ensuring that mushrooms are grown in the most suitable conditions without human impact is the current development trend.

Many of the researchers developed the environment monitoring system based on Internet of thing for mushroom cultivation [2][3]. A monitoring system was developed for mushroom house using various of sensor to monitor humidity, temperature, concentration of carbon dioxide and light intensity with android device and real live data platform [4]. Application of IoT for monitoring and environment control for indoor cultivation of oyster mushroom was addressed by [5]. The approach utilized machine learning to monitor humidity and temperature in the cultivation of oyster mushroom [6][7]. Although the implementation of these smart mushroom systems has optimized the usage of resources and maximized the productivity of the mushroom but the additional parameters required complex hardware requirements and logical design that increased the initial setup costs and maintenance costs. That leads to increased input costs for large-scale farms. Therefore, this paper proposes IoT based monitoring system for indoor GL cultivation at minimal cost and suitable to the conditions of Vietnam.

2. Experimental Setup

2.1 Methodology

The illustrated diagram for the research methodology is shown in Fig. 1. Sensor system include Light sensor, Humidity sensor and Temperature sensor that are attached in the mushroom house so that they control the light, humidity and temperature indoor. The Cooling Pad system combines with the Fan and the Pump to control the humidity and temperature inside the mushroom house. The light system controls the light inside when it's overcast. Microcontroller will receive the data from sensors and send to IoT Cloud and communication via Cellphone.

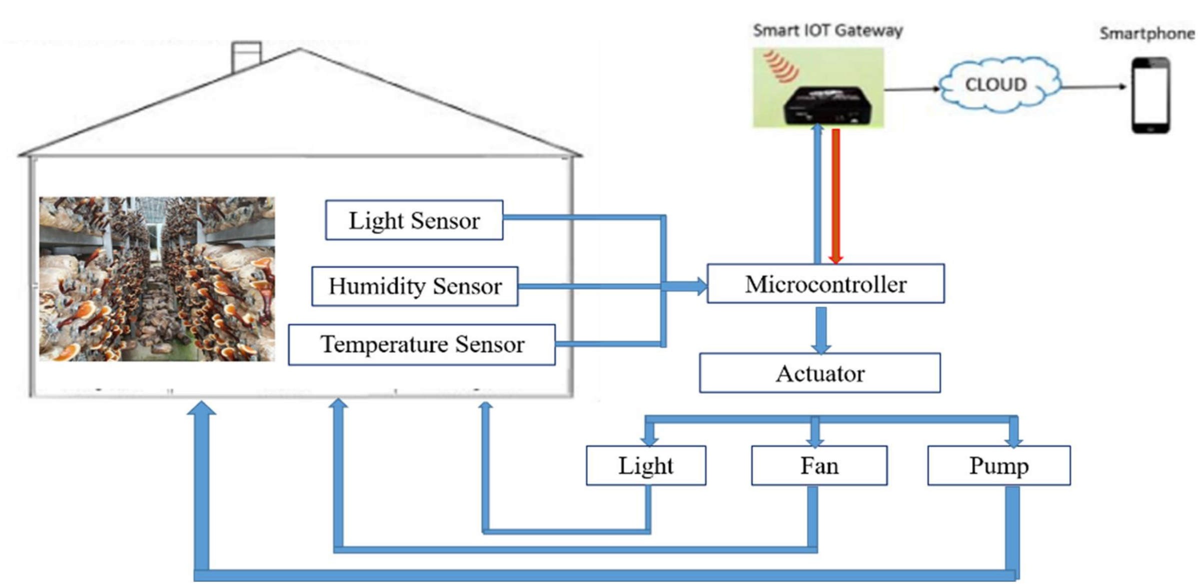

Figure. 1. An illustrated Diagram of IoT based monitoring system for indoor GL cultivation

2.2 Hardware design

The experimental hardware system as shown in Fig. 2. The control system consists of Arduino Uno Rev3, Node MCU ESP32 and DHT 22 [8]. This component can detect the changing of temperature and humidity of the mushroom house. Node MCU ESP 8266 serve as a Wi-Fi to upload the data into the cloud sever that act as IoT platform [9].

Based on the proposed system design and operations, an automatic control system using IoT was installed in an indoor mushroom house. The interfacing of the whole system was done by the Blynk app [10].

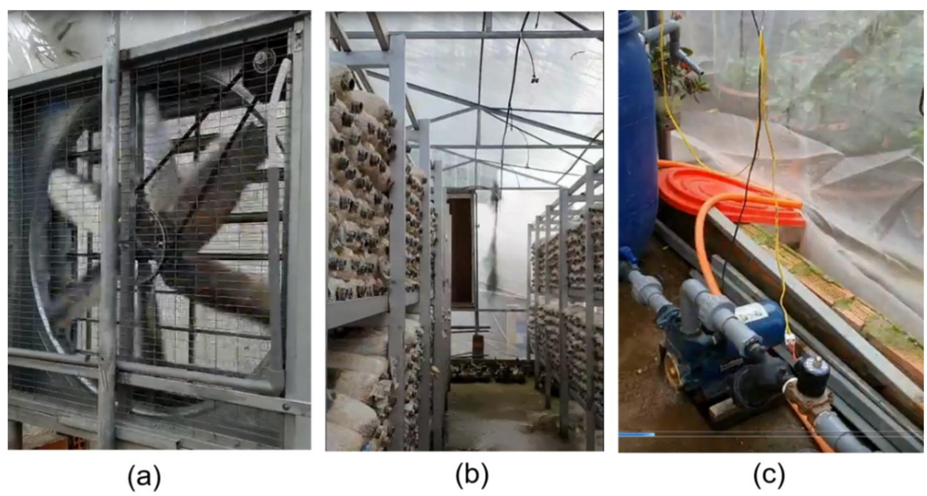

Figure. 2. Components of Control system (a) Fan, (b) Cooling Pad and (c) Pump

3. Results and Discussion

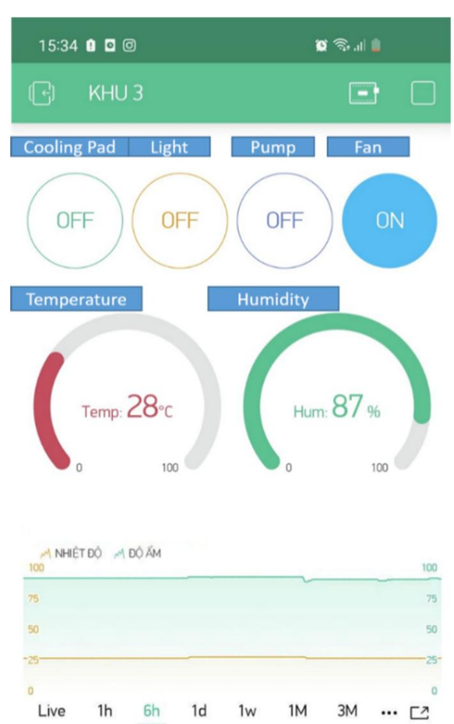

Figure. 3. Apps dashboard for data monitoring in the GL house

In order to evaluate and monitor the effectiveness of the IoT system, we designed the apps which runs on the Android and IOS operating system as shown in Fig. 3. The push button turns on/off the actuator device (Pump, Fan, Light…). The chart is used for monitoring the temperature and humidity inside the mushroom house in real time with follow-up time of 1h, 6h, 1day, 1 week, 1 month and 3 months.

The results of growing process of indoor GL cultivation are shown in Fig.4. After two weeks, the GL grows in Fig.4 (b) and after four weeks the GL grows in Fig.4 (c) and after eight weeks the GL grows in Fig.4 (d).

Figure. 4. The growing process of the indoor GL cultivation (a) preparing and (b) after two weeks; (c) after 4 weeks and (d) after 8 weeks

Figure. 5. (a) Harvest and (b) Drying by using solar energy and (c) vacuum packing

After about 10 weeks, we proceed to harvest (Fig. 5(a)) and dry by using solar energy (Fig.5(b)) and vacuum packing (Fig. 5(c)). Furthermore, to check the quality of GL according to the standards prescribed by the Ministry of Health (Decision 46/2007/QD-BYT, QCVN 8-1:2011/BYT and QCVN 8-2:2011/BYT). We take samples of GL for testing. The test results are as shown in Fig. 6.

KẾT QUẢ THỬ NGHIỆM/ *ANALYSIS RESULTS*

Chỉ tiêu/ *Parameter*	Đơn vị tính/ *Unit*	Kết quả/ *Result*	LOD	Phương pháp/ *Analysis method*
Total Plate Count/ Tổng vi sinh vật hiếu khí (30ºC)	CFU/g	3.8×10^3		ISO 4833-1:2013 (*)
Coliforms	MPN/g	0		ISO 4831:2006 (*)
Escherichia coli	MPN/g	0		ISO 7251:2005 (*)
Total the spores of Yeast, Mould/ Tổng bào tử men mốc	CFU/g	<10		FDA/BAM Chapter 18:2001
Bacillus cereus	CFU/g	<10		ISO 7932:2004 (*)
Clostridium perfringens	CFU/g	<10		ISO 7937:2004 (*)
Staphylococcus aureus	MPN/g	0		ISO 6888-3:2003 (*)
Total Aflatoxin (B1, B2, G1, G2)/ Aflatoxin tổng (B1, B2, G1, G2)	µg/kg	Not detected	2.0	WRT/TM/LC/01.13:2019 (LC-MS/MS) (*)
Ochratoxin A	µg/kg	Not detected	1	WRT/TM/LC/01.10 (LC/MS/MS)
Moisture/ Độ ẩm	%	9.88		TCVN 3700:1990(*)

[Xem trang kế/ *See next page(s)*]

Figure. 6. Analysis results of the GL

Analysis results show that the quality criteria of GL are in accordance with regulations.

4. Conclusion

In this paper, we have designed and implemented an IoT-based monitoring system for cultivating GL in an indoor space. The results show that the data of temperature and humidity are changing depending on the weather and the preliminary experimental results demonstrated that all the systems were optimized and successful to achieve the objective. Even though there are many similar climate control systems used in smart urban farming, our proposed work is different as our design was kept at a minimal cost in terms of hardware resources and practicality. The success of this system improves the productivity of mushroom farming especially the labor needed in monitoring and maintaining the mushroom house environment requirement.

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