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IoT-Based Oyster Mushroom Farming Monitoring System

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Abstract
This paper presents a study on the implementation of an IoT-based Oyster Mushroom Farming Monitoring System. The system aims to provide real-time monitoring and control of environmental conditions crucial for the successful cultivation of oyster mushrooms. Through the integration of IoT technologies, this system offers improved efficiency, productivity and profitability in the mushroom farming industry. The methodology involved the design and development of the system, followed by experimental testing and data presentation. The results indicate significant enhancements in crop yield and quality, validating the effectiveness of the proposed IoT solution. This study demonstrates the potential of IoT technologies in revolutionizing mushroom farming practices.

Keywords: Internet of Things, Oyster Mushroom Farming, Crop Yield

1. Introduction
1.1 Background
The Internet of Things (IoT) environment is a network of interconnected devices, sensors, and actuators that seamlessly communicate with each other. Sensors are responsible for gathering data from the surrounding environment, such as temperature, humidity, or motion, while actuators are devices that can perform specific actions based on received instructions. Connectivity plays a crucial role in the IoT ecosystem, allowing devices to exchange data and information over the internet or local networks. This connectivity enables real-time monitoring, control, and automation of various processes. The IoT platform serves as a central infrastructure, facilitating the management, storage, and analysis of the vast amount of data collected from sensors and actuators. It provides tools and services for device management, data processing, and application development. Finally, IoT applications utilize the data collected from the sensors and actuators to deliver valuable insights, enable intelligent decision-making, and automate tasks.

On the other hands, oyster mushroom cultivation is a popular and profitable venture in the agricultural sector. However, ensuring optimal environmental conditions throughout the cultivation process is crucial for maximizing yield and maintaining product quality. Traditional farming methods often rely on manual monitoring and control, leading to inefficiencies and inconsistencies. The emergence of IoT technologies offers a promising solution by enabling real-time monitoring and automated management of the farming environment.

1.2 Objectives

This study aims to develop and evaluate an IoT-based Oyster Mushroom Farming Monitoring System that integrates sensor networks, data analytics and automation to optimize the cultivation process. By providing precise control over environmental parameters such as temperature, humidity, light and ventilation, the system aims to enhance crop yield, minimize resource wastage, and improve overall operational efficiency.

2. Methodology

2.1 System Design

The IoT Oyster Mushroom Farming Monitoring System consists of sensor nodes strategically placed within the cultivation area, a central control unit, and a cloud-based data management platform. The sensor nodes collect real-time data on temperature, humidity, light intensity, and carbon dioxide levels. The control unit receives this data, analyzes it, and triggers appropriate actions to maintain optimal conditions. The cloud platform facilitates remote monitoring, data storage and analysis. Table 1 shows the optimum environments for indoor oyster mushroom cultivation.

Table 1: Main Parameters for Oyster Mushroom Cultivation

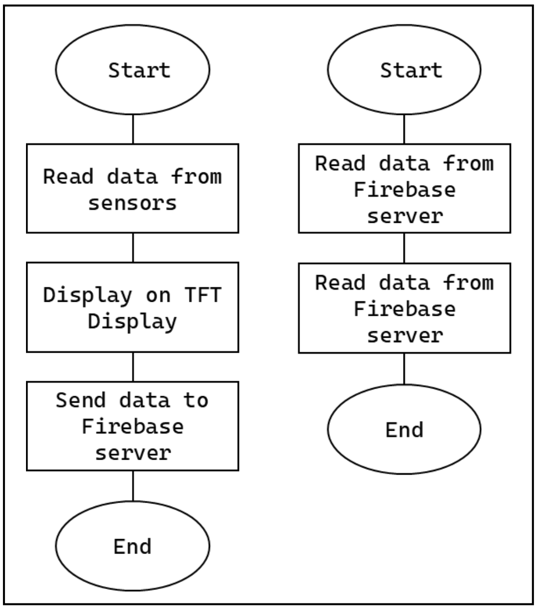
Parameter	Range	Unit
Temperature	27 – 30	°C
Humidity	85 – 95	%rh
Light Intensity	0-500	lux
Carbon Dioxide Level	0-500	ppm

Ensuring the oyster mushrooms grow within the optimum range of temperature, humidity, light intensity, and carbon dioxide levels is vital for promoting growth, maximizing yield and quality, preventing contamination and diseases, achieving consistent production, and optimizing resource efficiency. These factors collectively contribute to successful and sustainable mushroom farming practices.

Software Implementation

In this project, a microcontroller called ESP8266 is used, which has a built-in Wi-Fi module. It was programmed using the C++ language with Arduino IDE software. The controller captures readings from various sensors and displays them on the display. It also sends the sensor data to Firebase server as the IoT platform. The controller itself can connect to a Wi-Fi router with internet access. A customized mobile application and web application is developed using Ionic and Angular framework to display the data and control the system remotely. The sensor data collected by the controller is sent to the Firebase server and users can view the readings on their Android or iOS phones through the developed app. The working diagram of the software implementation is shown in Figure 1.

Figure 1(a) and (b): Algorithm Data Transfer by The ESP8266 To Firebase Server and From Firebase Server to The Mobile Application for Mobile Monitoring and Controlling



(a) (b)

Hardware Implementation

The IoT mushroom farming monitoring system utilizes several hardware components to monitor and control the environmental conditions. These include the DHT22 sensor, light sensor, carbon dioxide sensor, and a relay to control the mist maker.

DHT22 Sensor: The DHT22 sensor, also known as a humidity and temperature sensor, is a vital component in the mushroom farming system. It measures both the temperature and humidity levels within the cultivation area. The sensor provides accurate readings, allowing growers to monitor and maintain the optimal conditions required for mushroom growth.

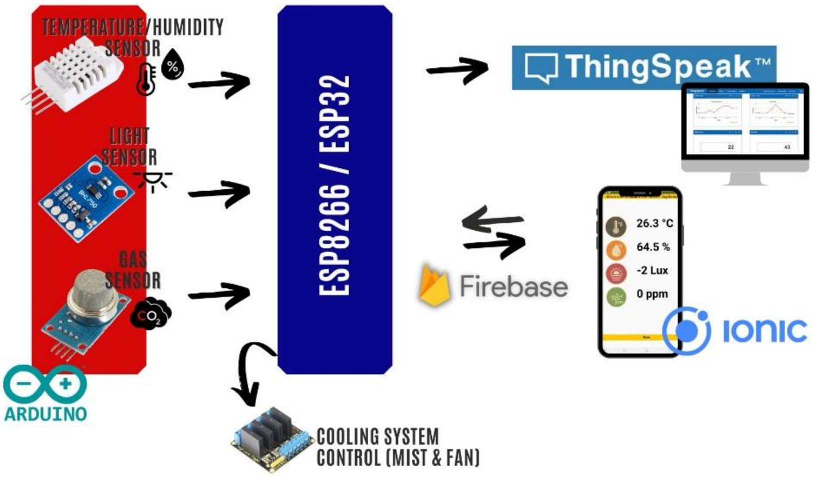
Light Sensor: The light sensor is employed to measure the intensity of light in the mushroom farming environment. It helps determine whether the lighting conditions are within the desired range for proper mushroom growth and development. By monitoring the light levels, growers can adjust artificial lighting systems or ensure adequate natural light exposure for the mushrooms.

Carbon Dioxide Sensor: The carbon dioxide (CO_2) sensor is responsible for measuring the CO_2 levels within the cultivation area. Mushrooms require a specific range of CO_2 concentration for optimal growth. Monitoring CO_2 levels helps ensure proper ventilation and air circulation, preventing the buildup of excess CO_2 that could hinder mushroom development. The sensor enables growers to maintain an appropriate CO_2 balance in the farming environment.

Relay: The relay is a switching device used to control the mist maker in the mushroom farming system. The mist maker generates a fine mist of water or nutrient solution, which helps maintain the required humidity levels for mushroom cultivation. The relay acts as a switch, controlling the mist maker's operation based on the humidity readings from the DHT22 sensor. When the humidity falls below the desired threshold, the relay triggers the mist maker to produce mist, increasing the humidity in the cultivation area.

These hardware components work together to enable real-time monitoring and control of the mushroom farming environment. The sensors provide data on temperature, humidity, light intensity, and CO2 levels, which are essential for maintaining optimal conditions. With this information, the system can automate actions through the relay, such as activating the mist maker when humidity is low to ensure the ideal growth environment for oyster mushrooms. Figure 2 shows the hardware configuration and their integration with software implementation.

Figure 2: Hardware Configuration and The Integration with Software Implementation



2.1 Experimental Setup

To evaluate the system's performance, a series of experiments were conducted in controlled mushroom farming environments. Two cultivation areas were established, one employing the IoT monitoring system and the other using traditional manual methods as a control. Multiple batches of oyster mushrooms were cultivated in each area with data collected and analyzed for comparison. Figure 3(a) and (b) shows one of the oyster mushroom cultivation locations.

Figure 3(a) and (b): Experimental Setup in Kolej Kemahiran Tinggi MARA Petaling Jaya and the Oyster Mushroom Cultivation Process During Experiment

(a) (b)

3. Results

3.1 System Monitoring Function Test

Figure 4, Figure 5, Figure 6 and Figure 7 present visualization of the application interface and data obtained from the IoT server platform, showcasing examples of IoT dashboard apps used in the system. These parameters are sampled every 10 minutes, and the data is obtained from the IoT server platform. Users can access and monitor this data not only through web app but also from the customized Android app that has been developed specifically for this project. This approach provides users with flexibility in monitoring their mushroom farming system. Implementing this IoT-based system has yielded promising results, surpassing traditional methods in terms of both productivity and the duration of the mushroom growing process.

Figure 4: User Interface and Data Visualization for the Monitoring System Application

Figure 6: Cooling System Interface in Mobile Application

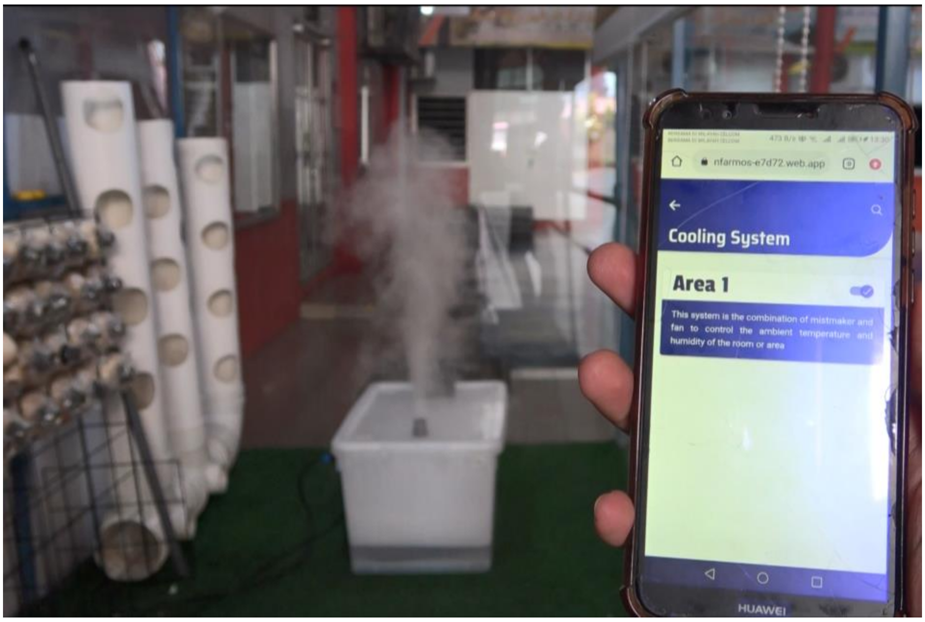


Figure 7: Data Visualization Through IoT Web Platform

4. Conclusion

The implementation of an IoT-based Oyster Mushroom Farming Monitoring System offers substantial benefits for the mushroom farming industry. Through real-time monitoring, precise control of environmental conditions, and automated management, the system improves yield, quality, and operational efficiency. The experimental results confirm the superiority of the IoT-enabled approach over traditional manual methods. This study highlights the potential of IoT technologies in transforming agricultural practices and provides a foundation for further research and development in this field.

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