Environmental Monitoring System for Mushroom Cultivation

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Abstract
The project is designed to monitor temperature and humidity for the cultivation of mushrooms. The real-time temperature and humidity are displayed using a cloud allowing users to track data from anywhere. Mushrooms need a specific temperature and humidity to make sure that the mushroom can grow perfectly. At the expansion phase of the mushroom, it will need a different temperature and humidity, it can be a bit tedious to measure the temperature and humidity in the traditional way. Any drop in the temperature and humidity level for too long will damage the quality and quantity of the mushroom. The main objective of this project is to design and develop a mushroom cultivation monitor system with a programmable reading system to inform users of the current temperature and humidity to adapt to the mushroom cultivation process. This project consists of two main components an ESP32 as a microcontroller, and BME280 for temperature and humidity sensors. All the data will be sent to Favoriot. Based on the result that we get in the data stream we can conclude that our project is working and can be used for Mushroom Cultivation Environment Monitor. The value temperature between 24 °C to 26 °C is the best temperature to cultivate mushrooms and humidity is between 78% and 95% to get the best result for mushroom cultivation.

Keywords: Node MCU microcontroller, Temperature, Humidity, Mushroom, Internet of things (IoT*)*

Introduction

The Internet of Things (IoT) incorporates various established technologies, including Wireless Sensor Networks (WSN), radio frequency identification (RFID), cloud computing, middleware systems, and end-user applications (Elijah *et al.,* 2018). The IoT offers many benefits, such as minimizing human effort, saving time, easy access, real-time tracking, etc. The project is designed to monitor temperature and humidity for the cultivation of mushrooms. This project consists of two main components, an ESP 32, and BME 280 for temperature and humidity sensors. The current temperature and humidity are displayed using a Favoriot platform.

As we know mushrooms need a specific temperature and humidity to make sure that the mushroom can grow perfectly which is between 16 to 30 degree celcius and from 80 to 95 percentage of humidity. It is important to keep the temperature stable otherwise, mycelium can overheat resulting in the death of the mushroom and mushrooms need constantly high humidity to develop properly as discussed in (Agustianto *et al.,* 2021). At the expansion phase of the mushroom, it will need a

different temperature and humidity, it can be a bit tedious to measure the temperature and humidity in the traditional way. Any drop in the temperature and humidity level for too long will damage the quality of the mushroom, reducing yields, and thus lowering the value.

Based on the highlighted issues, there is a need for an environment monitor system. Fikri *et al.* (2022) mentioned the built of monitoring environmental parameters using an Arduino-based microcontroller and sensors. It works as a thermometer for measuring temperature and humidity inside a building; it can measure humidity and temperature outdoors. Compared to the expensive sensor, the Arduino-based monitoring system successfully reduces the power consumption, cost, and complexity of the process. On the contrary, Riskiono *et al.* (2020) stated the use of temperature and humidity monitoring with the integration of applications in smartphones. This system notifies the user of the temperature and humidity data through the smartphone. Aside from that, remote humidity and temperature real-time monitoring system were developed by Balachandran *et al.* (2013) to study seed biology. The recorded data is connected to Wi-Fi and sent to Google docs as a remote monitor. An e-mail alert feature is also implemented in this system.

Although the environment monitor is hassle-free as it measures the temperature and humidity automatically, it may not be convenient to use because we need to go to the device if we want to check the temperature and humidity. Nevertheless, the system proposed will drain the user's smartphone battery consumption for its operation since it requires the integration of Wi-Fi and WhatsApp. Moreover, this system uses dht11 as a sensor that has low accuracy and low resolution. Having said that, the system method proposed may not be effective at all if the place does not have a Wi-Fi connection and the price for this system is quite expensive because it uses many features.

Based on the above discussion, there is still room for improvement in having an effective, portable, and cheap monitoring system. In this work, a prototype of the monitoring system is proposed to inform users of the real-time temperature and humidity data to adapt to the mushroom cultivation process and to measure temperature and humidity data automatically.

Methodology

The block diagram of the proposed proof of concept development of the mushroom cultivation environment monitor is shown in Figure 1. The temperature and humidity will be measured by BME280 and will send it to ESP32. The data on temperature and humidity will be processed by the node microcontroller unit (NodeMCU). The microcontroller will check the data value. Then it will send the data to the cloud. If the user wants to check temperature and humidity data, they can check the data in the Favoriot app. In this prototype development, Favoriot will be used as the output.

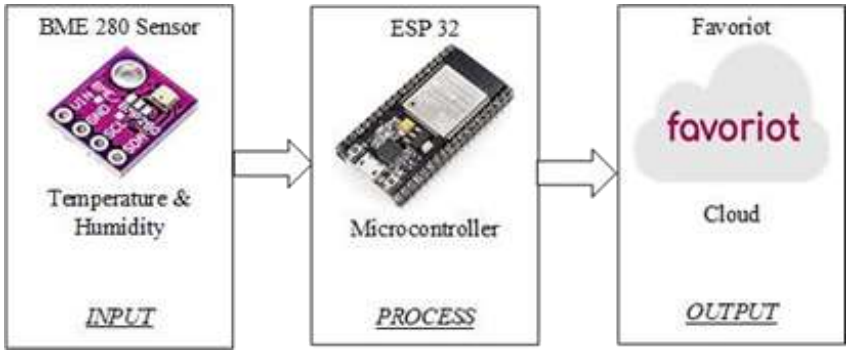

Figure 1: The block diagram of the mushroom cultivation environment monitor

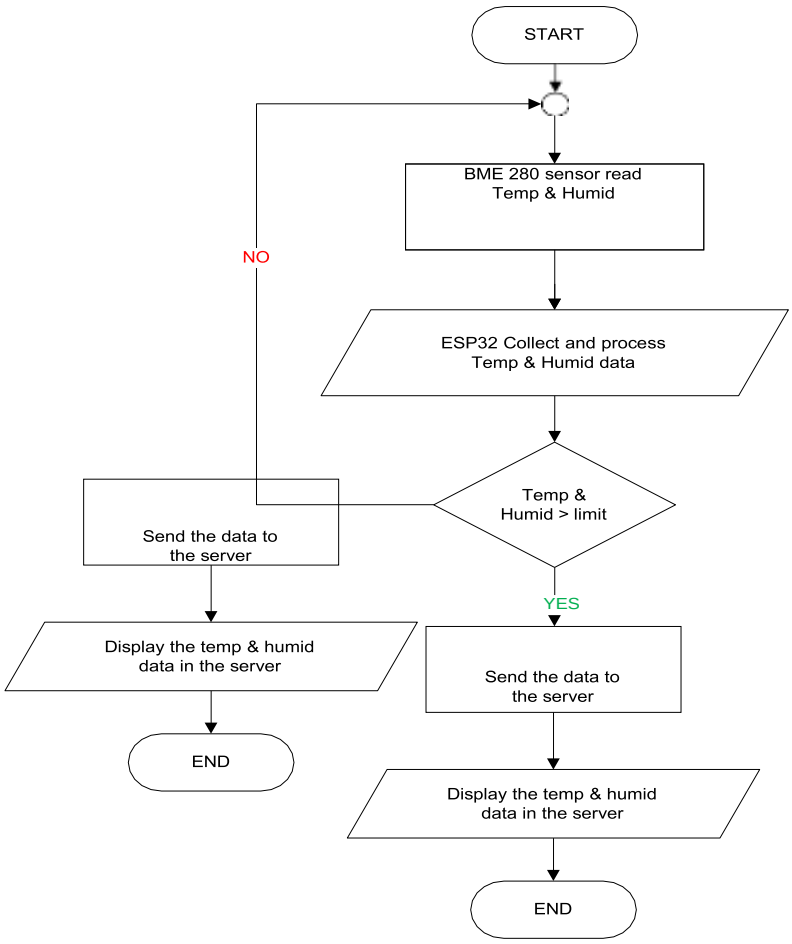

Figure 2: The flowchart of the mushroom cultivation environment monitor

According to the system operational flowchart in Figure 2, the system starts with the initialization of the esp32 module, followed by the BME280 and the cloud for transferring the data(Favoriot). Then, the sensor will measure and calculates the temperature and humidity rate. The temperature and humidity will be readings and also displayed on the cloud Favoriot time by time following time by time and the value also can be shown in another platform known as the Blynk application. The mushroom

Temperature and Humidity are displayed in the Blynk application as a graph and meter too. The user and buyer could just access the Blynk application on their smartphone to monitor the mushroom temperature and humidity conditions. The proposed system sends data to the Blynk server via the internet to establish a successful connection between the user's device and the hardware. The Blynk application sends a ping signal to ensure the connection establishment and waits for the server to confirm the connection.

The located point for a normal mushroom level temperature rate is between 23°C to 25°C and the humidity will reach 80% to 90% per reading the set point for another type of mushroom can reach around 75% and above. If the sensor detects an abnormal value, the user and buyer will receive or detect the value when using Blynk application and this is in line with the project name 'Mushroom Cultivation Environment Monitor'. However, if the temperature and humidity rate is normal and controlled, the sensor will continuously measure or checks the mushroom's conditions on a real-time basis.

The circuit diagram of the proposed project is shown in Figure 3. Based on the circuit diagram, the input for this project starts with the BME 280 sensor. The BME 280 sensor will read the temperature and humidity. The ESP 32 will send the input data to the cloud output and display the output through the Favoriot platform. We should connect the VCC terminal of BME280 with 3.3V of ESP32, ground with the ground (common ground), SCL of the sensor with SCL of ESP32, and SDA of the sensor with the SDA pin of the ESP module. The I2C pin in ESP32 for SDA is GPIO21 and for SCL is GPIO22. As shown in the following schematic diagram.

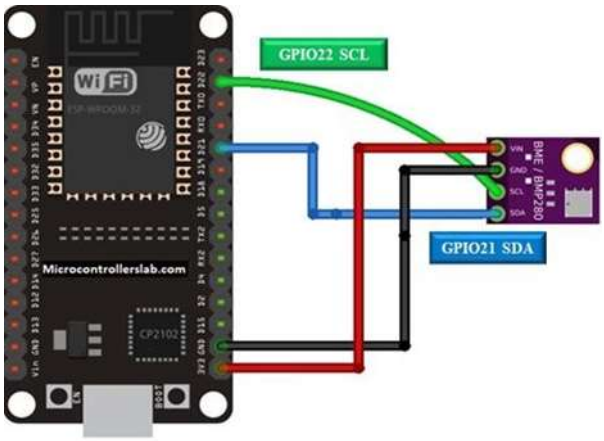

Figure 3. Circuit diagram of the proposed system

Results and Discussion

This project was developed to monitor the mushroom cultivation environment status, i.e., the temperature and humidity of the surrounding environment. The developed project prototype is shown in Figure 4. The product shall be put near or in the same room as the cultivated mushroom. The performance evaluation was conducted between 3rd January 2023 and 5th January 2023. To start the system evaluation, the respective micropython file codes were downloaded and run on the ESP32 microcontroller via uPyCraft IDE. The BME280 sensor is connected to ESP 32.

Figure 4: Project prototype for the mushroom cultivation environment monitor

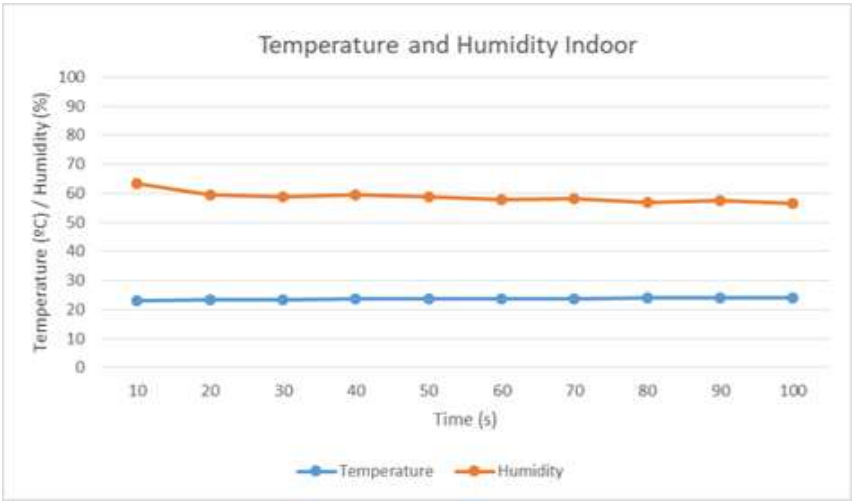

Figure 5: Data stream graph inside of the room

Figure 6: Favoriot display the result taken by mushroom cultivation environment monitor

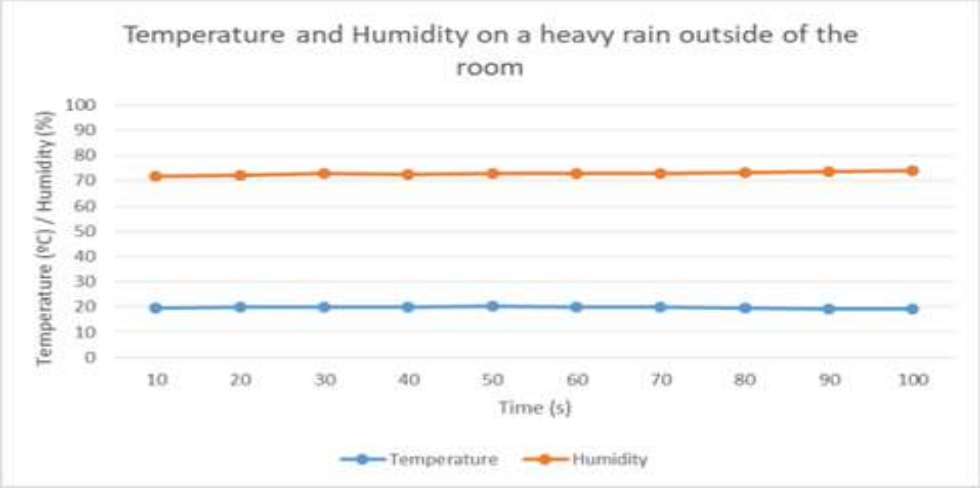

Figure 7: Data stream graph on a heavy rain outside of the room

Fig. 8. Result taken on a heavy rain day outside of the room by mushroom cultivation environment monitor

From the recorded data by Mushroom Cultivation Environment Monitor, the temperature between 24 °C to 26 °C is the best temperature to cultivate mushrooms. Therefore, the recommended temperature would be 25 °C. In addition, the humidity level was not in the recommended range, as the humidity level was taken inside at 59% and the humidity level taken outside at 73%. Both data taken on humidity are not in the recommended range. We recommend that the user keep the humidity between 78% and 95% to get the best result. Based on the result analysis from the DataStream taken on Favoriot we conclude that the project was a success. The normal range for temperature was set between 24 °C to 26 °C, while the humidity value is set between 78% and 95%.

Conclusion

In this work, a prototype of a monitoring system for the mushroom cultivation environment is proposed. The test of the results achieved showed that the proposed system offers new possibilities for freely developing smart devices with a small budget and simple work. The monitoring system is a portable device that successfully reduces the cost and complexity of the process. The system's performance was accurate and reliable, with certain measurement errors and the limits of the sensor used. In addition, the proposed system achieved Industry Revolution 4.0 (IR4.0). This is done through

the concept of the Internet of Things (IoT) for device-to-device communication and real-time data management in a cloud-based database. For the recommendation in the future, we can add more output for this system like heat control and fanning system to become like fully automated mushroom fruiting chamber that can control the temperature and humidity automatically.

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