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Intelligent Monitoring of Grey Oyster Mushroom Cultivation with IoT

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Abstract: Classifications of Mushrooms as vegetables in the food world are not accurate as they belong to the fungi kingdom. Mushrooms provide several important nutrients like protein, vitamins, minerals, and antioxidants. They become important part of Indian food market. Cultivation of mushrooms fills the lack in nutrient contents among the people and also helps to recycle the wastes produced by the agriculture in India. Grey oyster mushroom is the one which can be grown artificially for commercial purposes. Cultivation of grey oyster mushrooms by manual methods, require lot of time and labor. And the labors have to maintain the hygiene and cleanliness. Also, environment conditions have to be maintained. All these things handling manually are difficult and yield lesser production. To make things simpler and improve the production, this paper proposes an intelligent system for monitoring of grey oyster mushroom cultivation using IOT. In this system we are continuously monitoring the environment conditions in the spawn mycelium growing room by using sensors and microcontroller and it is informed to the farmer through the IOT. This system continuously monitors and controls the indoor (spawn mycelium growing room) environment to provide good yield and it is informed to the farmer through the IOT. ATMega328 Microcontroller gives real-time monitoring and controlling of all these environmental parameters, which helps in maintaining the required environment for the growth of grey oyster mushroom with IoT.

Keywords: *Cultivation farm, Grey oyster, IoT, Intelligent System, Mushroom, Sensors*

1. Introduction

Mushrooms are considered as high valued medicinal products and nutritional food in many parts of the world. These are also used as medicine by people in the countries of Asia. Several research works are carried out by researchers on the medicinal features of the mushrooms. In medicinal treatments by folks and in Ayurveda mushrooms are used [1].

Agriculture is the backbone for many countries like India. So there will be large quantity of agriculture waste will be produced in every year and is approximately 620 million [2]. To utilize and recycle these agriculture waste, cultivation of mushrooms is one of the options. Mushroom cultivation fills the lack of nutrient contents among the people. There are various types of mushrooms available and in that many are edible mushrooms and some mushrooms are poisonous, which are not edible. Some of the edible mushrooms are: White Button Mushroom, Crimino Mushroom, Portabello Mushroom, Shiitake Mushroom, Maitake Mushroom, Oyster Mushroom, Enoki Mushroom, Beech Mushroom, King Trumpet Mushroom, Black Trumpet Mushroom, Chanterelle Mushroom, Hedgehog Mushroom, Morel Mushroom, Porcino Mushroom, Milky Mushroom.

Grey oyster mushroom is the one which can be grown artificially for commercial purpose. In an average, the mushroom is cultivated and processed by means of manual methods starting from spawn production to packing. Mushroom cultivators have to work hard and spend more time in maintaining the environment conditions and to maintain hygienic conditions in the cultivation area. This is

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very difficult and thus chances of occurrence of pests and diseases are much more which sometimes damages mushroom crop to a great extent thereby leading to severe reduction in the production [3].

IoT – Internet of Things is defined as the network of gadgets, mechanical machines and digital machines which are embedded with the sensors, software and technologies required for connection and exchange of data between the other systems and other devices that are connected through internet. In this paper we are presenting a grey oyster mushroom cultivation monitoring intelligent system in the indoor environment which is based on IoT. This intelligent system is has low maintenance, requires less human power and it also conserve space. Thus, it is very useful in grey oyster mushroom farming in urban areas. The complete intelligent system can be automated in real-time using the proposed model. In this paper [4], a general process for the improvement and extension of plantation in a conventional system is proposed.

2. Review of existing systems

The paper [5], is the practical application of internet of the practical application of Internet of Things that connects the former using sensor to monitor the real time conditions of white button mushrooms. This work was developed to monitor the environmental condition in the mushroom farming. The environmental conditions are humidity, moisture, temperature and intensity of light. A simple microcontroller unit was used and using cloud platform. The data was programmed using Arduino programming language. The prototype was successful implementation for small scale industries. This also contributed for increasing in yield for the farmers.

The paper [6], is a study of how automated mushroom is a study of how automated mushroom farming can be done using fuzzy logic algorithm. Using the fox logic, the microcontroller device was analysed how it works in the mushroom nursery. The appropriate temperature, the appropriate heat and mist spray system was also introduced using fuzzy logic algorithm. The crop that was grown was Angel mushroom. The experiment was conducted in a 3X5X3.5 metre room. The prototype was able to control the humidity and temperature for the mushroom growth.

The paper [7], proposals a smart mushroom house that can be used for the cultivation of mushrooms. An automated system was developed, to grow the extremely expensive mushroom called Shiitake. The sensors were used to provide an environment that enables an optimal growth of the mushrooms. WSN and control technology are used to enable this. The crucial conditions were given to maintain the same balance in the room. The house was able to witness the control of carbon dioxide inside the room with the proposed prototype.

3. Grey Oyster Mushroom Cultivation in Indoor Room

Indoor room for cultivation has a measurement of length 5.5meter, width of 4.5 meter and a height of 2.65meter. This room was constructed using concrete blocks residing at Doddaballapur Town, Bengaluru Rural. The walls of the room are made by using mud bricks, which are baked and plastered with cement. Five to six racks made up of iron are placed in the room. Ventilation is made at the roof so that there will be exchange of air between the indoor room and the outside environment. Thus, fresh air can enter the room with filtration. Similarly, side walls are provided with the ventilation at the bottom. The mushroom spawn running bags are horizontally placed in the racks with the help of nylon rope that is vertically hanging. 10-12 bags are placed in a single column rope. Each column is separated by a distance of 30 centimeters. This is for providing humidity and air circulation between the two columns in a proper manner and also to maintain the temperature [8][9].

The best suitable range of values of humidity (80% to 90%), temperature (26^0C to 290^0C) and light (50lux to 300lux) for the growth of grey oyster mushroom are listed in the Table-1. To maintain these ranges of humidity and temperature we are using humidifier and an exhaust fan. The required amount of light to the indoor grey oyster mushroom cultivation room is provided by fluorescent lamps [10].

Table-1: List of parameters range for Grey Oyster Mushroom Cultivation

Parameter	**Value Range**	**Units**	**Controlling Device**
Temperature	(26 – 29)	^{0}C	Fans
Light	50-300	Luxs	Lamps
Humidity	(80 – 90)	% RH	Humidifiers

4. Hardware and Software Used

The hardware required for this system can be easily accessible. The components that are connected in this project are different sensors for sensing the different environment parameters and a microcontroller to control them. These sensors are located in the indoor mushroom cultivation farm. The software for this project is also easily available and is used for programming the microcontroller and store the information in cloud using IoT technology. The software is also used for accessing required information from the cloud using the end user devices.

A. Temperature Sensor

The temperature sensor is an electronic device embedded with the thermocouple for measuring the temperature from the particular place. This device converts the measured temperature into an electrical signal that can be given as input to the microcontroller [11].

One such device is the LM35 and is the commonly used sensor for the measurement of temperature in Celsius. The measuring accuracy of the LM35 sensor device is much better than the thermistor. Heat produced by this sensor is very less and is not more than the 0.1 degree Celsius [12]. The operating voltage of this device is +5V and less than 60 µA of stand by current. LM35 can measure a wide range of temperature from −55°C to +150°C.

B. Humidity Sensor

Hygrometer or the humidity sensor can sense and measure the amount of moisture present in the air in a particular area. It also measures the air temperature in that. Relative humidity (RH) is defined as the ratio of moisture content in the air to the peak moisture content at a given temperature [13]. DHT11 is the sensor used in this project to measure the humidity in the grey oyster mushroom cultivation indoor room. DHT11 can be operated by a dc voltage of 5V and it can store up to 95% of relative humidity.

C. CO2 Sensor

The gas sensing device MQ 135 is an electronic device that can sense the quality of air in a particular place [14]. It can detect different gases like Ammonia, Nitrogen oxides, carbon dioxide, benzene, alcohol and even the smoke present in the atmosphere of an indoor room. The sensor has a wide detecting scope and provides quick output with higher sensing capability. It gives steady output and is more durable. The operating input voltage is +5V and gives an output analog voltage of 0volt to 5 Volt. It also provides an output digital voltage of 0V or 5V. Sensitivity of this device can be adjusted by varying the potentiometer provided.

D. LDR Sensor

The LDR (Light Dependent Resistance) sensor is a passive electronic device that takes light as input and converts it into an electrical signal. The light can either from the visible spectrum or infrared spectrum. As the name suggests, the device will change its resistance depending on the amount of light that falls on it [15]. The general operating range of temperature is -20 degree Celsius to +75 degrees Celsius. These devices are also known as the photo sensors or photoelectric devices as these devices perform the conversion of light i.e., photons into electric signals i.e., electrons.

E. Microcontroller

The microcontroller used in this project is ATMEGA328 manufactured by MegaAVR family. It operates with a DC voltage of +5 volts. It has 14 digital input/output pins and 6 analog input/output pins. The direct current for each input/output port is 40mA. It has 0.5 Kilo bytes of boot loader memory along with a flash memory of 32 Kilo bytes. The operating frequency is of 16 Mega Hertz. It has a Wi-Fi module which is of low cost. Wi-Fi module works with TCP/IP protocols and helps to connect with the internet.

F. Cooler Fan

The cooler fan is operated based on the input from the temperature sensor [16][17]. The system automatically operates the cooler fan depending on the temperature. When the temperature goes above predefined value of 29^0C the cooler fan is turned on. Similarly when the temperature drops below the predefined value of 26^0C, the cooler is turned off. This system saves power as it operates automatically without the interaction of the humans.

G. Exhaust Fan

The primary purpose for having an exhaust fan is to remove the carbon dioxide (CO_2) out of the room. These fans help to control and eliminate dangerous gases in the room. Additionally, they add to the safety of the mushroom cultivation farm by reducing fumes produced by the mushroom bags.

H. Light

Fluorescent lamps are used provide the required intensity of light for the mushroom bags, so that mycelia can grow in good manner. These lamps provide the light intensity from (50-300) lux, which is predetermined value for mushroom mycelium growth.

I. Water Sprayer

Water sprayers are used to spray the water in the mushroom cultivation room to maintain the predetermined humidity percentage of relative humidity (RH). Water sprayers are automatically turned ON to spray the water, when the humidity level goes below the preset value of 80%RH. It also turns off automatically, when the humidity goes above the 90%RH.

J. Relay Module

It is an electrical and electronic device which supplies both AC and DC. Relay modules the programmable boards that contain a set of switches and relays. These are setup to operate voltage supplying device with the help of input terminals and output terminals. Each channel in these boards can be programmed individually in real time to control the devices that are connected to it.

5. Methodology

The proposed intelligent system block diagram for monitoring grey oyster mushroom cultivation is shown in Figure-1. It has sensors that are uniformly located in the indoor cultivation farm, such a way that every sensor covers predefined amount of area in the farm. The intelligent system consists of a sensor for temperature, a sensor for carbon dioxide sensing, a sensor of Light Dependent

Resistor (LDR), a sensor for the humidity measurement. It also contains Ethernet shield connected to the server for uploading the data into the webpage.

The power supply is from the renewable source of power like solar, which is readily available in location. Every node or the module has identical design which is shown in the proposed diagram. Microcontroller ATMega328 takes all sensors readings data and makes decision. IoT – Ethernet module is the primary device in the proposed system. This module will collect all the environmental sensed data and sends to internet for analysis and monitoring. ATMega328 microcontroller is the main control board. Finally, Ethernet module has been used to transfer data to server.

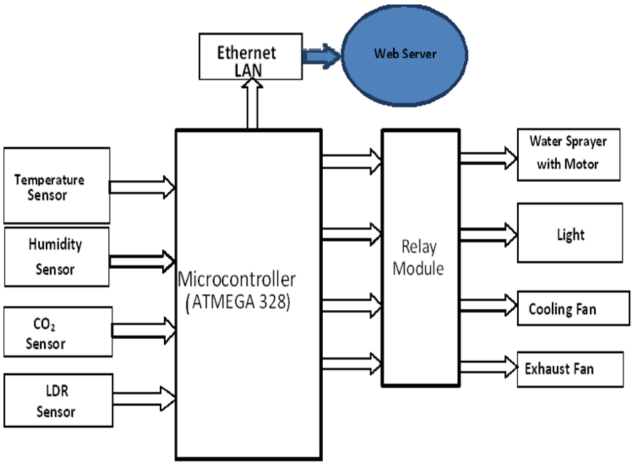

Fig 1: Proposed intelligent system block diagram for monitoring grey oyster mushroom cultivation.

6. Results

After the implementation of the proposed system (single unit is shown in Figure-2) for grey oyster mushroom in indoor cultivation farm, the results were obtained. The hardware was tested and verified for the various values of the environment parameters, which includes LM-35 for temperature sensing, DHT-11 for humidity sensing, carbon dioxide sensor for sending the bad gases and light dependent resistance sensor for sensing the amount of light in the farm. All the data provided by the sensors were calibrated as per the standards of the weather station. ATMega328 Microcontroller gives real-time monitoring and controlling of all these environmental parameters, which helps in maintaining the required environment for the growth of grey oyster mushroom. The output of the intelligent system is grey oyster mushroom grown is shown in Figure-3 and it shows the healthy well grown mushroom. The Figure-4 shows sample hardware unit of proposed intelligent system for monitoring of grey oyster with the parameters such as temperature, humidity and intensity of light are maintained.

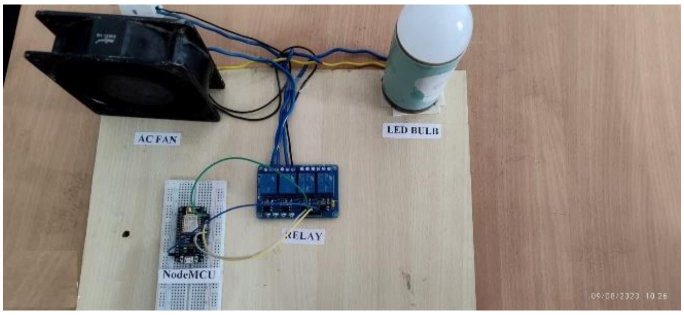

Fig 2: Single unit implemented in the indoor farming

Fig 3: Grey oyster mushroom grown by using the intelligent monitoring system

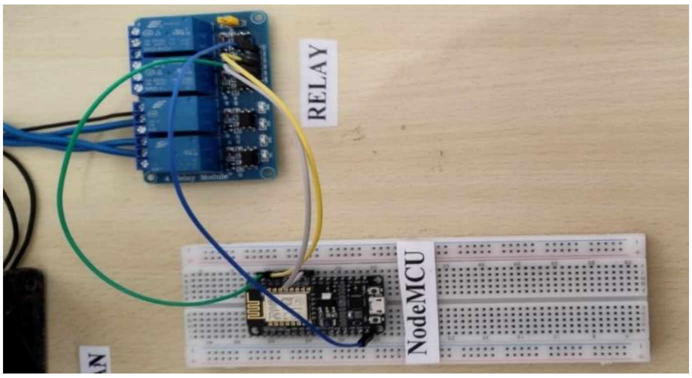

Fig 4: Sample Hardware unit of proposed intelligent system.

7. Conclusion and Future Scope

This paper gives a new idea for the agronomists and farm developers. In monitoring, managing, and analyzing the data, IoT introduced an innovatory change. Primary sensors like humidity sensor, temperature sensor, and LDR sensor data are transferred to IoT based platforms for retrieving, assessment, and monitoring purpose. In general, any mushroom farm cultivation needs constant monitoring of many parameters of environment. The proposed intelligent system gives significant step in the area of automating the grey oyster mushroom farms. The idea of proposed system is gives benefits for monitoring the mushroom plants and implements the automation. This also gives assistance to the farmers to increase the yield of the crops in agriculture and it efficiently takes care of the production of mushroom crops. The temperature was controlled using fans within the range of 26^0C to 29^0C. The brightness of the lamp was maintained in the range of 50 Luxs to 300 Luxs. The humidity was monitored between (80 to 90)% of relative humidity (RH). Thus, the proposed intelligent system provides real-time update of the environment parameters and monitors the growth of mushroom and reduces the manpower.

As a part of future extension, the same model can be adopted to green house plants to monitor the growth. The model can also be upgraded using mobile application to control the parameter of interest in the environment. The same model can be used to monitor different types of mushroom farming by adjusting the parameters.

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