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Production and Environmental Management Framework for Sustainable Mushroom Cultivation Efficiency Using IOT

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Abstract — The growth of mushrooms demands a very close monitoring of the environmental factors like temperature, humidity and air quality in order to achieve the best outcome in terms of growth and produce. These parameters are usually difficult to monitor and control manually, which results in decreased productivity and crop losses due to the possibility of human error. The paper gives a proposal of an IoT-based smart environmental management system on the cultivation of mushrooms that would allow automated monitoring, control and remote supervision of the mushroom farming huts. The proposed system combines temperature, humidity, gas, and fire sensors with a NodeMCU microcontroller to measure environmental conditions on the continuous basis. An automated water spraying mechanism and control logic is turned on when the humidity or temperature is out of range of predefined threshold values in order to restore the optimum conditions. This is achieved by enabling the turning on of an exhaust fan in the event of the harmful gases or smoke as well as fire detection turning on the water pump and ventilation system to avoid possible dangerous events. One can also manually operate the system from our mobile device itself as per our need. IoT connectivity transfers sensor data and system status to a mobile application enabling real-time monitoring, alert notifications, and manual control where necessary. The suggested system enhances the efficiency of the cultivation, safety, lowered human intervention, and contributes to sustainable farming practices related to mushroom cultivation as a result of intelligent environmental management.

Keywords— Environmental Management, Efficient Mushroom Cultivation, Sensor Integration, IoT, Automated Agriculture management.

I. INTRODUCTION

Growing mushrooms has become a viable economic and nutritionally important agricultural activity because of the high market demand, short growth period and low land area. Nevertheless, the mushroom farming success is extremely conditional on the ability to preserve the exact environmental parameters: temperature, humidity, quality of air, and safety in the growing conditions. Any slight variation that is not conducive to the ideal situation may cause a negative impact on the growth of mushrooms, yield, and quality. Conventional approaches of mushroom farming are mostly based on manual surveillance and control which is time consuming, labour intensive, and can be subject to human error, especially in small-scale farming and rural farming systems [1]. There is a tremendous shift towards automation and precision farming in agriculture with the fast-changing nature of Internet of Things (IoT) technologies. The IoT allows combining sensors, microcontrollers, communication networks and cloud facilities to ensure real-time monitoring and smart management of environmental parameters. IoT-based systems are more accurate, particularly in terms of scalability and remote accessibility, which is why they are better-suited in controlled-environment agriculture (where the environment is of critical importance), such as mushroom farming [3].

This work is motivated by the fact that mushroom farmers have challenges in ensuring that they maintain optimum environmental conditions at all times. Humidity and temperature variations may result in inadequate growth of mycelia, contamination, and low crop production. Also, the release of dangerous gases, smoke, or even accidental fire in enclosed mushroom huts is very dangerous to the crop and farm facilities. The current solutions are either costly, or have no built-in safety features, or the solutions do not offer real time remote monitoring. It is evident that there is a necessity of cost-effective, automated and intelligent system of management that will help to continuously monitor a number of parameters in the

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environment and respond immediately to the abnormality state of being [5]. Having an IoT platform based on a NodeMCU, the project is expected to offer a smart environmental management system that will minimise the use of manual data handling, increase the efficiency of the operations, and make the process much safer, as well as contribute to sustainable mushroom farming measures. European integration of a mobile application makes the farm system even more realistic, allowing farmers to monitor and control the system remotely, thus making the solution practical and accessible to be implemented into real-life practice.

A number of studies have examined how automation and IoT can be used in agriculture to improve the productivity and efficiency of resources. Initially, simple environmental monitoring techniques were developed with the help of standalone sensors and microcontroller-based systems, which were not highly automated and did not have a remote access. The use of IoT frameworks to facilitate real-time data collection and monitoring on clouds has become more popular in recent studies [7]. Greenhouse monitoring systems that are based on the IoT, sensors of temperature and humidity have shown a positive effect on crop yield and water usage by automatically controlling irrigation. Other reports have dealt specifically with mushrooms growing by introducing sensor-based systems of humidity and temperature regulation by emphasizing the need to keep microclimatic conditions steady [12]. But even most of these systems do not include safety measures like gas and fire detectors that would be very essential in the enclosed agricultural setups. Other studies have integrated both mobile and web-based applications of remote monitoring where farmers can access the environmental data and also be alerted. Even though these systems enhance accessibility, they usually involve a manual intervention in order to take corrective action. Very few studies have suggested complete automated control processes and even lesser have covered the overall environmental control involving the air quality and fire safety [9]. The proposed system, unlike the existing ones, is a combination of environmental monitoring, automated control, safety management, and remote supervision with the use of IoT and a single, unified framework. This study will overcome the drawbacks of other studies by integrating humidity, temperature, gas, and fire sensors along with automated actuators and the mobile application interface to come up with a complete solution to the smart mushroom cultivation management systems [10].

II. METHODOLOGY

The proposed methodology introduces an Internet of Things enabled smart environmental management system that will operate to automate the monitoring, control, and safety processes in units where mushrooms were cultivated. The system combines environmental sensors and safety sensors with automated actuators based on a NodeMCU microcontroller and allows real-time monitoring with the help of a mobile application that is connected to the cloud [14]. The methodology has been designed in such a way that it has guaranteed reliability, responsiveness and effective use of resources.

The system architecture is equipped with a layered system architecture that is composed of sensing layer, control layer, actuation layer and application layer. The layer of sensing will incorporate temperature, humidity and gas and fire sensors that are installed in the mushroom farming hut to gather real-time information on the biodiversity and safety of the environment [8]. The control layer is also based around a NodeMCU microcontroller, which receives sensor inputs and runs control logic. Actuation layer consists of a water pump, solenoid valve, and an exhaust fan which are linked up by relay of modules to undertake environmental regulation and emergency responses. The application layer will support cloud storage, data visualisation, alert generation and remote control by the use of a mobile application so that there is uninterrupted monitoring and interaction with the users [3].

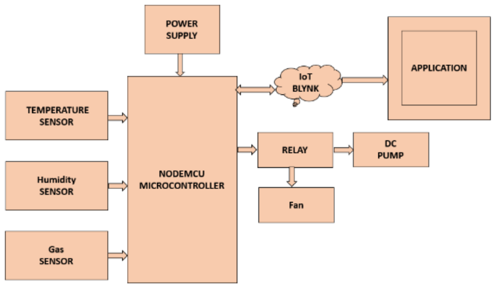

Fig 1: Architecture of the Smart System

1. Sensor Data and Threshold based Decision

The sensor data are collected at a constant rate so that proper representation of the microclimate inside is provided. Temperature and humidity sensors ensure that climatic conditions which are critical in growing mushrooms are monitored and the gas sensor is able to detect the presence of smoke or toxic gases that could compromise the quality of crops and their safety [6]. The fire detector detects the presence of flames or unnatural changes in thermal conditions that are evidence of fire threats. The NodeMCU samples sensor signals periodically and provides them with basic preprocessing, such as noise removal and range checking, and then proceeds to further analysis. This will provide confidence in data transfer and reduce spurious elicitation of control activity [9].

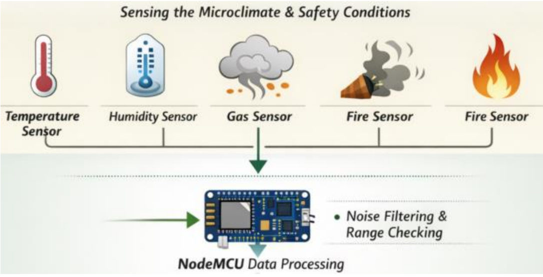

Fig 2: Sensor Data Acquisition

The control strategy is based on a threshold to define optimal growing conditions and be safe. The predetermined threshold values are set with regard to the normal mushroom farming standards and safety aspects. This is accomplished by a rule-based decision mechanism on a continuous basis in which the NodeMCU compares real time sensor readings against these thresholds [4]. The corrective measures are triggered in case of temperature or humidity that falls outside the allowed range. The gas detection or fire occurrence triggers the system; this is the safety requirement where the system engages the immediate response to the occurrences. This reasoning logic allows the quick and automatic reaction of a system without having to involve a person.

Actuator control mechanism converts control selection to physical actions in the mushroom hut. Relay modules are employed to interface control signals of low voltages with high-power devices safely. Water pump and solenoid valve is then turned on to control the humidity level and prevent any fire conditions and exhaust fan then assist to control temperature conditions and get rid of any lethal gases or smoke [2]. Actuators are closed-loop, meaning that they are active until the sensor values are back to acceptable levels thus providing a stable condition of the environment and efficient use of resources.

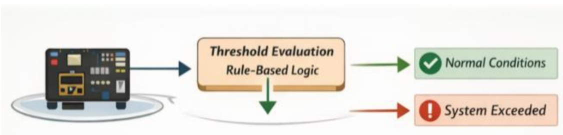

Fig 3: Insisting Threshold Decision

2. IoT Integration and Smart Management based on Mobile Application

The IoT integration is a very important aspect as it allows managing the proposed mushroom cultivation system smartly by allowing the real-time communication between the physical farm and the user interface. The NodeMCU microcontroller has an inbuilt Wi-Fi feature, and thus, it can be easily connected to an online IoT service. The sensor data obtained in the mushroom hut, temperature, humidity, the gas level, and the state of fire are periodically sent to the cloud server through lightweight communication protocols like HTTP or MQTT [15]. The cloud platform serves as a central data storage, in which real time and historical sensor data are stored, processed, and visualized [3]. This helps in constant monitoring of the state of the environment and the work of the system. Any change in defaulted threshold values results in automatic alerts that are immediately sent to the mobile application of the user. These messages help keep users updated on abnormal situations in sufficient time including the presence of excessive humidity, variations in temperature, gas leakage, or fire detection. It has a specific mobile application that is the main interface of smart control over the mushroom farming environment. The users can use the application to view live sensor readings, actuator status, and analyse historical trends that enable informed decision-making. Besides automated control, the application also has a manual override option, where the user can remotely control the water pump and exhaust fan when the need arose.

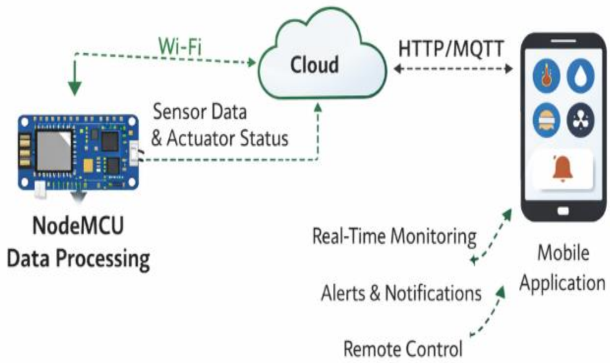

Fig 4: Cloud Based IoT Control

Such a dual system of operation, that is, automatic and manual, increases the flexibility and reliability of the system. IoT along with mobile-based monitoring helps to dramatically enhance the number of visits that farmers make to the accumulation area since the process of monitoring and controlling cultivation operations can be performed remotely and effectively [9]. The proposed system provides a scalable and intelligent solution towards smart management of mushroom farm using real-time sensing, cloud connectivity, automated actuation, and mobile accessibility.

III. RESULT AND DISCUSSION

Intelligent Management Prespective
The mushroom cultivation system suggested using an IoT was reviewed in the framework of the concept of smart management, i.e., how it allows implementing automated environmental control, safety guarantees, and remote monitoring of operations. The findings show that the system is useful in minimising the use of manual interventions, maximising the utilisation of resources, and timely corrective measures.

1. Environmental and safety Management
The system ensured that the environment is at an optimum level through automatic control of humidity and temperature in the mushroom hut. Upon reaching a relative humidity that was higher than the preset limit, the water pump was activated, and the humidity was back to the desired level within a couple of minutes [13]. On the same note, temperature variances were controlled by switching on fans or water sprinklers when the need arose. Such an automatic control guarantees the stability of microclimate control, which allows minimizing crop stress, chances of contamination, and losses. The closed-loop system successfully helps in dynamic control of the environmental conditions without necessitating the close supervision of human beings.

Combined gas and fire alarms are important in improving safety management in the mushroom hut. Smoke or the presence of harmful gases was detected by the gas sensor and the exhaust fan was turned on to restore the air quality, whereas the fire sensor turned on the water pump and the fan and blocked possible fires. The automated reactions indicate the fact that the system has an aspect of proactive hazard management whereby any hazards that may threaten the safety of crops and infrastructure are mitigated in time.

2. IoT-based Operational Management
The IoT integration on the NodeMCU platform allows remote operation control using a mobile application. The mobile interface enables farmers to monitor in real-time the environmental parameters, as well as to receive alerts on the occurrence of abnormal conditions and to remotely control the actuators. This saves on visiting the premises to check on the happenings as well as enabling proper management on several mushroom huts at a given time. The mobile application also tracks historical data, which can be used to make decisions based on data and optimise operational schedules [13].

Fig 5: IoT Smart Management System

The automated control system which involves the use of the threshold will make the utilization of water and energy resources efficient. Water pumps are used to make sure that the humidity level is lower than desired, and fans are used to make sure that the temperature or gas levels are above the desired level. This wise resource application eliminates exhaustion, minimizes operational expenses and enhances sustainability in mushroom production.

The findings substantiate the idea that the suggested system will help mushroom growing to be managed holistically with the help of environmental control, safety monitoring, and remote operation [11]. The system also lowers labour dependency as compared to the traditional manual management, minimizes human error as well as faster response to abnormal conditions. Moreover, the mobile-based IoT monitoring helps to improve the operational control and facilitate proactive decision-making and management of several cultivation units at the same time. The management targeted results show that the system could help turn a conventional mushroom production into an intelligent, automated, and safe system, that would increase productivity and sustainability.

IV. CONCLUSION

This work introduced a smart environmental management system on the cultivation of mushrooms using IoT, incorporating temperature, humidity, gas, and fire sensors into the project with automated actuators and monitoring the mobile application. The suggested system was able to prove the capacity of the optimal environmental conditions keeping, guaranteeing safety, and offering real-time remote operational control, which means that the most serious problems of mushroom farming in the traditional form were addressed. As experimentation showed, the threshold-related automated control proved to be efficient in stabilizing humidity and temperature, whereas the combined gas and fire detection system demonstrates greater effectiveness in terms of safety control as it allows addressing the threats in a timely manner. The IoT system (based on the NodeMCU) and mobile app enabled remote monitoring, timely alerts and manual override, which provided farmers with more flexibility, operational efficiency and proactive decision-making. The system on the whole is a complete solution to intelligent management of mushroom growing, lessening human effort, minimizing mistakes, resource utilization and enhancing crop production as well as safety. Future work can incorporate the prediction and machine learning to manage the adaptive threshold, the trend to multi-hut farms and the energy-efficient design improvements to further enhance scalability and sustainability.

REFERENCES

1. S. Sharma and R. Patel, “Smart Mushroom Cultivation using IoT,” Int. J. Eng. Res. Technol., vol. 9, no. 6, pp. 1123–1127, Jun. 2020.
2. A. Kumar and P. Singh, “Intelligent Mushroom Monitoring System,” Int. J. Eng. Technol., vol. 7, no. 4, pp. 215–220, Dec. 2018.
3. M. R. Khan, S. Ahmed, and L. George, “IoT Based Monitoring System for White Button Mushroom Farming,” MDPI Proc., vol. 32, pp. 45–52, 2019.
4. J. Li and H. Zhao, “IoT in Smart Agriculture: Mushroom Cultivation Case Study,” IEEE Access, vol. 7, pp. 181–190, 2019.
5. P. Das and S. Roy, “Wireless Sensor Networks for Mushroom Farming,” Springer Smart Agric. Conf., pp. 89–96, 2017.
6. T. Nguyen and K. Lee, “IoT-Enabled Smart Farming for Mushroom Production,” Elsevier Agric. Syst., vol. 165, pp. 79–90, 2018.
7. B. Thomas and A. Joseph, “Climate Control in Mushroom Cultivation using IoT,” Taylor & Francis J. Agric. Eng., vol. 53, no. 2, pp. 134–140, 2016.
8. R. Gupta and S. Mehta, “IoT-Based Agricultural Monitoring Systems,” Sensors, vol. 17, no. 12, pp. 2711–2720, Dec. 2017.
9. L. Chen and Y. Wu, “Smart IoT Framework for Sustainable Mushroom Farming,” Inderscience Int. J. Agric. Innov., vol. 5, no. 3, pp. 201–210, 2019.
10. F. Silva and M. Costa, “IoT Applications in Controlled Environment Agriculture,” MDPI Sensors, vol. 18, no. 12, pp. 3995–4004, Dec. 2018.
11. S. Banerjee and R. Das, “IoT-Based Automation in Mushroom Production,” Res. J. Agric. Sci., vol. 9, no. 2, pp. 145–152, 2017.
12. K. Ramesh and V. Kumar, “IoT for Agricultural Productivity Enhancement,” IEEE Int. Conf. IoT Agric., pp. 55–60, 2016.
13. H. Park and J. Choi, “IoT-Driven Environmental Monitoring in Mushroom Huts,” Springer Smart Farming Series, pp. 211–220, 2019.
14. G. Singh and A. Verma, “Smart Farming with IoT: Mushroom Case Study,” Elsevier Procedia Comput. Sci., vol. 132, pp. 1052–1059, 2018.
15. D. Patel and K. Shah, “IoT-Based Decision Support for Mushroom Cultivation,” ACM Int. Conf. Agric. IoT, pp. 87–94, 2020.