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RESEARCH ON AUTOMATED GREENHOUSE

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ABSTRACT— This paper presents the design and implementation of an automated greenhouse system aimed at optimizing plant growth and resource utilization in agricultural settings. In this paper, we are developing an automated greenhouse system that employs sensors and actuators to monitor and control key environmental factors such as soil moisture, humidity, temperature, and sunlight exposure. We aim to optimize plant growth conditions while minimizing resource usage and labor-intensive tasks for farmers. This paper introduces an automated greenhouse system designed to create an optimal environment for plant growth by utilizing sensors such as soil moisture, humidity, temperature, and light-dependent resistor (LDR), alongside actuators like pumps, foggers, heat sink, exhaust fans, and servo motors. Leveraging IoT technologies, the system integrates a NodeMCU microcontroller with the Blynk platform for remote monitoring and control. The proposed system not only enhances crop yield and quality but also promotes sustainability through efficient resource management, marking a significant step towards modernizing agricultural practices.

Keywords- IoT (Internet of Things) Technology, Automated greenhouse system, Remote monitoring and control.

I. INTRODUCTION

The advent of automation and IoT technologies has revolutionized various industries, including agriculture, by offering innovative solutions to optimize crop production while minimizing resource consumption and labor-intensive tasks. In line with this advancement, this paper introduces an automated greenhouse system designed to create an optimal environment for plant growth. By integrating sensors to monitor crucial environmental variables and actuators to control irrigation, humidity, temperature, and sunlight exposure, the system aims to enhance crop yield and quality. Leveraging IoT capabilities, remote monitoring and control features enable farmers to efficiently manage greenhouse conditions, marking a significant stride towards sustainable and efficient agricultural practices. In this paper, we are developing an automated greenhouse system that utilizes sensors and actuators to monitor and regulate environmental conditions crucial for plant growth. Through the integration of IoT technologies, our goal is to enhance crop productivity and sustainability while reducing manual intervention in agricultural practices.

II. LITERATURE REVIEW

1. Li, Haixia, Yu Guo, et al. In this paper, the author aims to review the intelligent greenhouse monitoring system systematically, serve the data transmission and server processing subsystems by identifying, listing and further explaining the greenhouse environmental parameters and studying the overall design of the greenhouse monitoring system. According to the characteristics of each component of the system, the paper makes a comparative study and obtains its development trend, summarizes the current popular technology and the future development trend of the intelligent monitoring system, and provides support for the research of greenhouse monitoring system.

2. Hoque, MD Jiabul, Md Razu Ahmed, In this paper, the author proposed an automated greenhouse monitoring and controlling system that incorporate various sensors such as temperature sensor, humidity sensor, light sensor and soil moisture sensor to collect possible environmental parameters of greenhouse as well as integrate Arduino Uno R3 (to store and process data), GSM module (to send the measured value of the various parameters to the user cell phone via SMS to ensure efficient growth of plants), solar power system with rechargeable battery (to make sure continuous power supply to the greenhouse system). Moreover, Internet of Things (IoT) is used to store data to a database and process the collected data and finally send the information to the android apps which has been developed for monitoring and controlling of greenhouse by the user. Moreover, the authors compared the proposed greenhouse model with some recent works and found the proposed system cost effective, efficient and effective by analyzing major environmental parameters.

3. Farooqui, Nafees Akhter, In this paper, the author present a fully automated greenhouse system with artificial intelligence embedded in it that uses around 10,000 plant images in it that initially nurture plants under optimum atmospheric conditions by taking real-time decisions, detecting any kind of illness, and interestingly notifying the stage of fruit ripeness. By implementing a neural network-based computer vision approach we were able to keep track of the health status of the plants caused by several microorganisms.

4. Rustia, Dan Jeric Arcega, et al. In this paper, the author presents an automated insect pest counting and environmental condition monitoring system using integrated camera modules and an embedded system as the sensor node in a wireless sensor network. The sensor node can be used to simultaneously acquire images of sticky paper traps and measure temperature, humidity, and light intensity levels in a greenhouse. An image processing algorithm was applied to automatically detect and count insect pests on an insect sticky trap with 93% average temporal detection accuracy compared with manual counting.

5. Abbassy, Mohamed M., et al. In this paper, the author proposes a utilizing IOT innovation to help farm's owner to control and monitor through screen and sense valuable information from their farms by their smartphone application to help in the quality improvement and the crop amount. The proposed system offers a full-automated control over the climate changes in the greenhouse to improve the agricultural conditions for the different

plants in the greenhouse.

6. Zaguia, Atef. In this paper, the author presents an IoT-based intelligent greenhouse management system that utilizes various sensors and a fuzzy adaptive PID controller to efficiently manage greenhouse temperature and humidity. The system also includes a cloud-based platform for real-time data visualization and a mobile app for remote control. A clustering algorithm pre-processes the data and eliminates duplicates and inconsistencies. The novelty of this paper lies in the use of a fuzzy adaptive PID controller and a clustering algorithm in an IoT-based intelligent greenhouse management system to efficiently manage greenhouse temperature and humidity.

7. Waghmare, R. B., R. V. Chimankare, et al. In this paper, the author uses the powerful combination of agri voltaics and image processing to create a sustainable and efficient solution for greenhouse management, powered by Raspberry Pi. Agrivoltaics, which integrates crop cultivation with solar energy generation, optimises plant growth while reducing energy consumption. Real-time data collection through sensors, along with image processing techniques using PiCam, enables monitoring of plant health and early disease detection. The system also includes solar tracking technology to maximise solar energy generation. Actuators such as fans, heaters, LEDs, and a pump for drip irrigation are controlled based on sensor data, ensuring precise environmental control for optimal crop growth. The remote monitoring and control capabilities through a user-friendly Blynk dashboard enable farmers to conveniently access and manage the greenhouse conditions from anywhere.

8. Wang, Feng. et al. In this paper, the author, in order to better serve the entire industry chain of agricultural forecasting, production and sales, proposes to create an integrated intelligent management system that integrates pre-production, mid-production and post-production. Organically combining agricultural production equipment and agricultural operations is the research focus of agricultural informationization.

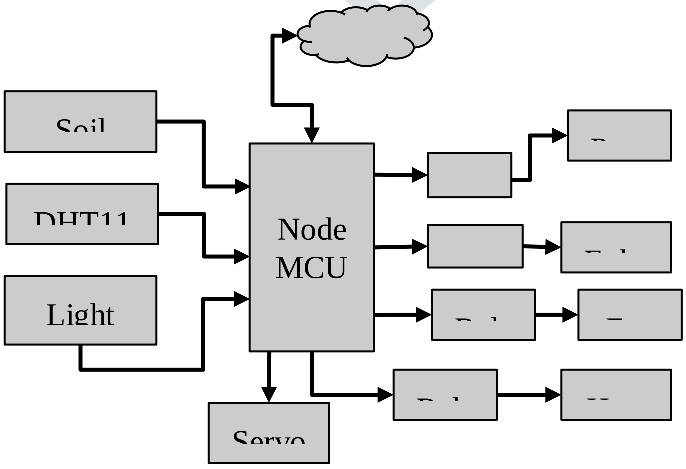
9. Bersani, Chiara, Carmelina Ruggiero, et al. In this paper, the author, in order to efficiently control indoor parameters such as exposure to light, ventilation, humidity, temperature, and carbon dioxide level. This paper presents the current state of the art in the IoT-based applications to smart greenhouses, underlining benefits and opportunities of this technology in the agriculture environment.

10. Pandi, Muhammad Syamim Mohammad, et al. In this paper, the author focuses on developing a greenhouse monitoring system by using IoT technology. It aims to assist the local farmers in monitoring their greenhouse, instead of applying the conventional methods that are tedious and require more labour work. For data collection, parameters for chilli plants are measured using temperature and humidity sensors, soil moisture sensor, and light dependent resistor (LDR) sensor. The data are sent to the microcontroller and transferred to the Ubidots cloud for the monitoring purpose. Watering pump and exhaust fan can be activated to control the plant parameters so that the plant remains in its normal condition. The sensor data are processed through classification using Support Vector Machine (SVM) to analyse the plant condition, whether the proposed method is suitable or not for the chilli plant to grow.

III. METHODOLOGY

In the Automated Greenhouse system, each component executes its function seamlessly to ensure optimal plant growth. The NodeMCU serves as the central hub, coordinating the actions of the system. The Soil Moisture Sensor continuously monitors soil moisture levels, triggering Relay 1 to activate the pump when moisture is low, ensuring adequate hydration for plants. The DHT11 Sensor tracks temperature and humidity, communicating with Relays 2 and 3. When the temperature is high, Relay 2 triggers the exhaust fan, and if humidity is low, Relay 3 triggers the fogger. An LDR detects sunlight, signaling the Servo Motor SG90 to open the greenhouse window during daylight hours for natural light exposure, promoting natural light intake for plant growth. Temperature data from the DHT11 also influences Relay 4, which activates the heat sink when temperatures drop, stabilizing the greenhouse environment. Powered by a 5V 5A SMPS module, the system integrates with Blynk for remote monitoring and control.

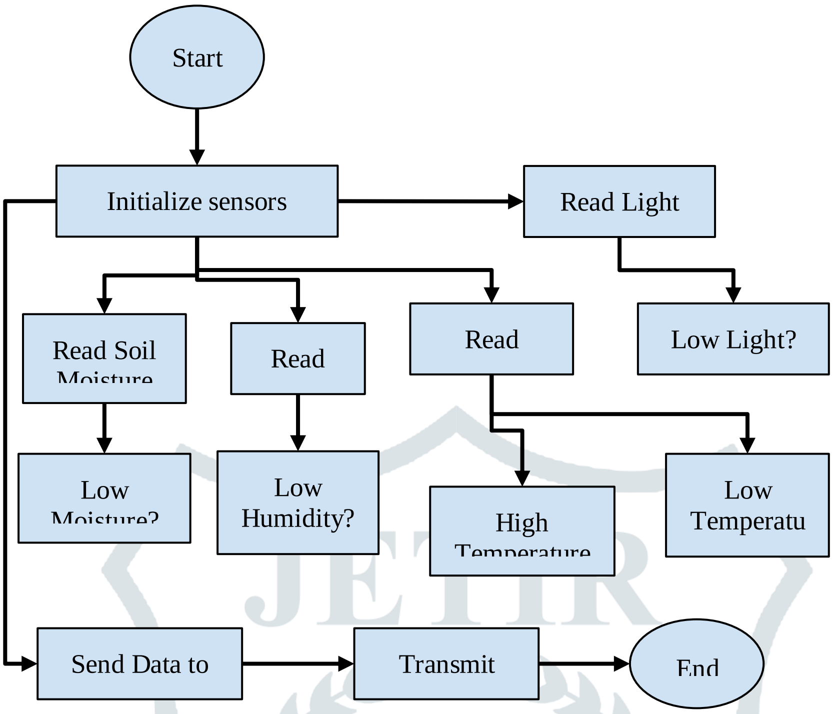
BLOCK DIAGRAM



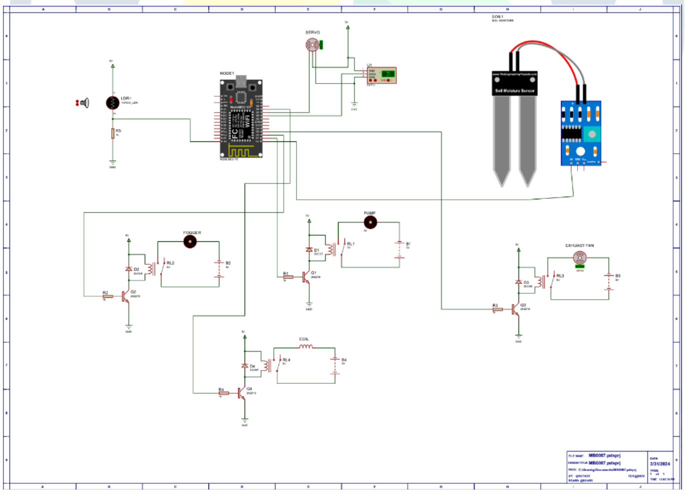
DESCRIPTION

In the above Block diagram we have used NodeMCU as a microcontroller. In the input device we have used the Soil moisture sensor, DHT11 sensor and LDR. And we have used the Pump, Fogger, Relay, Heat sink, Exhaust fan and Servo motor SG90 connected to the microcontroller as an output device. And we have used the Blynk Application to show all the notifications.

FLOW CHART



CIRCUIT DIAGRAM



WORKING

The aim of the "Automated Greenhouse" project is to provide an ideal environment for plant cultivation. In this project, we have used the NodeMCU as the central controller, it orchestrates various components seamlessly. The Soil Moisture Sensor constantly monitors soil moisture levels, activating Relay 1 to engage the pump when hydration is required. Meanwhile, the DHT11 Sensor tracks temperature and humidity, communicating with Relays 2 and 3. Relay 2 triggers the exhaust fan in high temperatures, while Relay 3 activates the fogger to maintain optimal humidity levels. Additionally, an LDR detects sunlight, prompting the Servo Motor SG90 to open the greenhouse window during daylight, allowing natural light exposure for enhanced growth. Temperature data from the DHT11 influences Relay 4, activating the heat sink to stabilize temperatures when necessary. We have used a 5V 5A SMPS module for power supply and Blynk for remote monitoring and control, our system ensures efficient and automated greenhouse management, fostering optimal plant growth conditions.

IV. SYSTEM REQUIREMENT

HARDWARE REQUIREMENT

1. NodeMCU
2. Soil Moisture Sensor
3. DHT11 Sensor
4. LDR
5. Servo Motor SG90
6. Pump
7. Fogger
8. 4 Relays
9. Hit sink
10. SMPS Module
11. Exhaust fan (5v)

SOFTWARE REQUIREMENT

1. Arduino IDE
2. Proteus
3. Blynk Application

EXPERIMENTAL SETUP

Fig. shows the outer part of the hardware setup

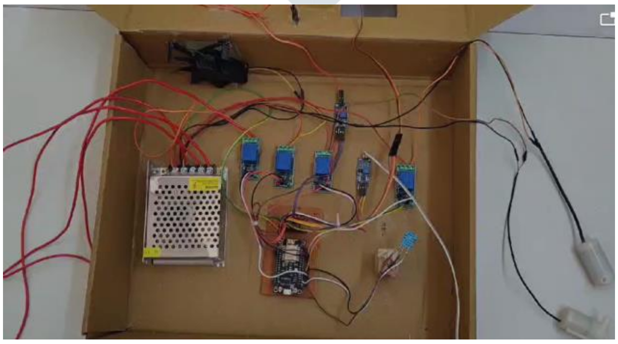


Fig. shows the inner part of the hardware setup

RESULT

The implementation of the Automated Greenhouse system demonstrates significant enhancements in plant growth conditions and management efficiency. Through continuous monitoring and precise control mechanisms, the system ensures optimal soil moisture levels, temperature, humidity, and sunlight exposure, crucial factors for plant health and productivity. The seamless coordination of components facilitated by the NodeMCU central hub enables proactive adjustments to environmental parameters, promoting vigorous plant growth while conserving resources. Integration with Blynk for remote monitoring and control empowers users to oversee greenhouse operations from anywhere, further enhancing convenience and accessibility. Overall, the results showcase a sophisticated yet user-friendly solution for greenhouse cultivation, promising improved yields and sustainable agricultural practices.

Prior to the implementation of the automated greenhouse system, the temperature within the greenhouse environment fluctuated significantly, reaching an average of 30 degrees Celsius during peak daytime hours. These fluctuations were attributed to the varying outdoor weather conditions, with temperatures occasionally soaring beyond 35 degrees Celsius during heatwaves and dropping below 25 degrees Celsius during cooler periods.

Additionally, humidity levels within the greenhouse were observed to be inconsistent, ranging from 40% to 70% relative humidity. This variability in humidity adversely affected plant growth and contributed to suboptimal growing conditions.

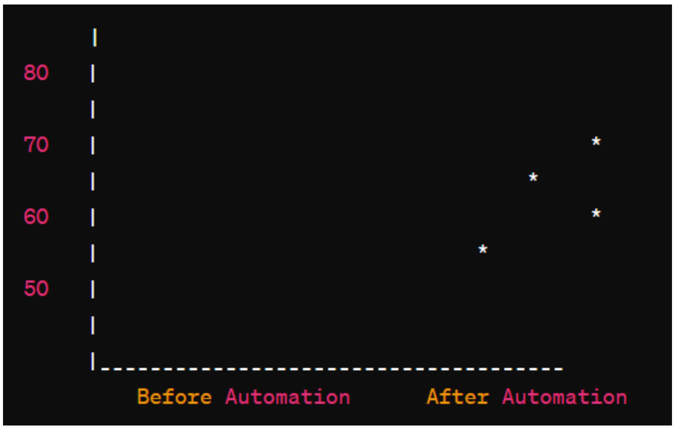
Furthermore, soil moisture levels exhibited similar fluctuations, with moisture content levels ranging from 50% to 80%. These fluctuations were largely influenced by irregular irrigation practices and inadequate monitoring of soil moisture levels.

Upon the implementation of the automated greenhouse system, significant improvements in temperature, humidity, and moisture control were observed. The system effectively regulated the greenhouse environment, maintaining temperature levels within the desired range of 20 to 25 degrees Celsius, regardless of external weather conditions. Additionally, humidity levels were stabilized within the target range of 60% to 80% relative humidity, promoting optimal plant growth and transpiration. Soil moisture levels were also consistently maintained at the desired level of 60% to 70% relative moisture content, ensuring adequate hydration for plant roots and minimizing the risk of over or under-watering.

Temperature:

Humidity:

Moisture:



Overall, the automated greenhouse system demonstrated its ability to mitigate the adverse effects of temperature fluctuations, humidity variability, and irregular soil moisture levels, thereby creating an optimal environment for plant growth and maximizing crop yield.

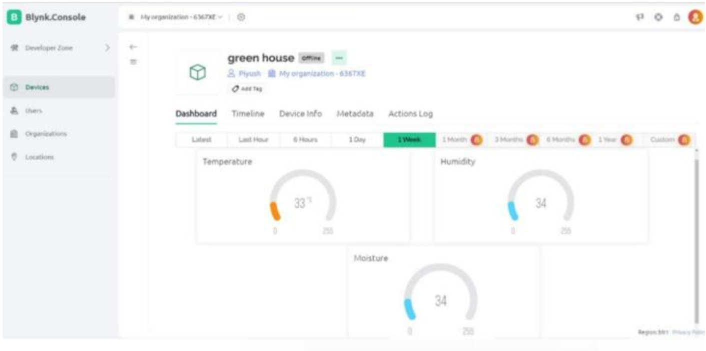


Fig. shows Temperature: 33°C, Humidity: 34%, Moisture: 34%

V. CONCLUSION

In conclusion, the development and implementation of the automated greenhouse system have demonstrated significant advancements in agricultural technology. By effectively monitoring and controlling key environmental variables, such as soil moisture, humidity, temperature, and sunlight exposure, the system has showcased its potential to optimize plant growth conditions while minimizing resource usage and labor requirements. The integration of IoT capabilities has facilitated remote monitoring and control, offering farmers greater flexibility and efficiency in managing greenhouse operations. This paper underscores the importance of technological innovation in modernizing agricultural practices and promoting sustainability in food production.

VI. REFERENCE

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