Design of Intelligent Polyhouse with IOT

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ABSTRACT

A polyhouse, often known as a greenhouse, is a building constructed for the controlled growing of plants. It is often built of translucent materials such as glass or plastic and is intended to offer a regulated temperature for plants, shielding them from harsh weather but allowing sunlight to pass through. The study considers various factors such as affordability and feasibility, combines IoT and fuzzy control techniques, uses GPRS for remote control, and creates a smart greenhouse monitoring system that is user-friendly, simple to operate, and performs well. Moreover, there are automated control mechanisms, such as greenhouse doors and windows that roll on and off in response to soil moisture levels. By using IoT to maintain precise parameters like CO2, soil moisture, temperature, and light in the greenhouse, the technology will help farmers increase productivity while reducing the need for physical field visits. An internet connection and an IoT kit are used for the task. The bell pepper plant's greenhouse conditions include CO2, soil moisture, temperature, and light

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INTRODUCTION

A polyhouse, often known as a greenhouse, is a building constructed for the controlled growing of plants. It is often built of translucent materials such as glass or plastic and is intended to offer a regulated temperature for plants, shielding them from harsh weather but allowing sunlight to pass through. It has numerous environmental controls, such as temperature, humidity, and ventilation systems. With the help of these controls, growers may lengthen the growing season and increase agricultural yields by creating and maintaining the perfect growing conditions for plants. Often constructed from translucent materials like glass or plastic, its purpose is to shield plants from inclement weather and allow natural light to enter while maintaining a consistent temperature for them. A polyhouse environmental controls include things like temperature, humidity, and ventilation systems. By extending the growing season and maintaining ideal plant development circumstances, growers can boost agricultural output by implementing these measures.

Modern farming methods have undergone a radical change as a result of the Internet of Things' (IoT) incorporation into agriculture. The creation of IoT-based polyhouse, which have the potential to greatly increase agricultural output and sustainability, is one of the noteworthy uses of IoT in agriculture. Farmers may remotely monitor and control a variety of environmental parameters in polyhouse management by integrating Internet of Things (IoT) technologies, which ensures that plant development occurs under ideal conditions while conserving resources. This essay examines the idea of Internet of Things (IoT)-based polyhouse, including their elements, advantages, and potential effects on contemporary agriculture.

IoT-based polyhouse are a union of cutting-edge technology and conventional farming methods. Utilizing Internet of Things (IoT) devices and sensors, these smart agricultural environments gather data in real-time on soil moisture, temperature, humidity, light levels, and other variables. Farmers can then access the central control system via web-based interfaces or mobile applications once this data has been delivered there. In order to create the ideal microclimate for plant growth, farmers can then make educated decisions about irrigation, ventilation, heating, and cooling. Optimizing resource utilization is one of the main benefits of IoT-based polyhouse. By precisely monitoring and controlling the use of water and energy, these technologies make agriculture more ecologically friendly and sustainable. Furthermore, they reduce the amount of human labor required because many processes may be automated, freeing farmers to concentrate on more advanced decision-making and crop management. The key elements of IoT-based polyhouses, such as sensors, actuators, communication networks, and data analytics tools, will be covered in detail in this paper. It will also examine the possible difficulties and factors to be considered, like scalability and data security, when putting these cutting-edge agricultural systems into practice.

Table 1. Simple Comparison between Traditional and Internet of Things [IOT]

Topic	Traditional Internet	The Internet Of Things [IOT]
Who creates content?	Human	Machine
How is the content consumed?	By request	By pushing information and triggering
How is the content combined?	Using explicitly defined links	Through explicitly defined operators
What is the value?	Answering questions	Actions and timely information
What was done so far ?	Both content creation and content consumption	Mainly content creation

Importance of Iot in Polyhouse Farming

IoT has completely changed a number of sectors, including agriculture, and it is essential to contemporary polyhouse farming. The practice of growing crops in controlled spaces, like greenhouses or polytunnels, in order to maximize growing conditions is known as polyhouse farming. The following are some salient features of IoT's significance in polyhouse farming.

Accurate Agriculture: Temperature, humidity, soil moisture, and light levels are just a few of the environmental factors that can be tracked by Internet of Things devices such as sensors, cameras, and weather stations. Precision agriculture depends on this data because it enables farmers to make necessary adjustments in real time to establish ideal growing conditions. For instance, IoT sensors have the ability to activate automated cooling systems in response to excessive temperature rises.

Resource Efficiency: Because polyhouse farming requires controlled conditions, it can be resource-intensive. IoT can aid in resource optimization. For example, farmers can reduce water waste by precisely controlling irrigation through data analysis from soil moisture sensors. Resource management becomes more effective and sustainable as a result.

Crop Health Monitoring: Using cameras and sensors that can identify symptoms of disease or pest infestation, IoT devices can be used to keep an eye on the health of crops. By enabling prompt intervention, early detection lowers the need for chemical pesticides and boosts total crop yields.

Automation and Control: The Internet of Things makes it possible to automate a number of polyhouse operations, including controlling the ventilation, humidity, and temperature. In addition to lowering the need for labor, this guarantees that growing conditions for plants are always optimal.

Data-Driven Decision-Making: By analyzing the data that Internet of Things devices collect, decisions can be made with confidence. Farmers can maximize yields and profits by optimizing planting schedules, choosing appropriate crop varieties, and making other strategic decisions by comparing historical data and trends.

Application of Iot in Smart Polyhouse

To automate and optimize cultivation while preserving resources, IoT technology is increasingly being used in smart polyhouses.

The following is how IoT is used in smart polyhouses:

- Environmental Monitoring: Several environmental factors, including temperature, humidity, light intensity, and CO2 levels, are tracked by IoT sensors inside the polyhouse. Real-time data is gathered by these sensors and sent to the cloud or a central control system for analysis. Automated Climate Control: The data collected by environmental sensors is used to control climate conditions inside the polyhouse automatically. For instance, when the temperature rises beyond a certain threshold, IoT-controlled ventilation systems can be activated to cool down the environment. Similarly, heating systems can be turned on when it gets too cold.
- Water Management: IoT sensors can monitor soil moisture levels to determine when and how much water the plants need. Automated irrigation systems can be triggered based on this data, ensuring that the plants receive the right amount of water without wastage.
- Nutrient Control: This data helps in precise nutrient dosing, ensuring that the plants receive the necessary nutrients for healthy growth.
- Lighting Control: IoT-controlled lighting systems can adjust the amount and intensity of artificial light based on natural light conditions and the growth stage of the plants. This helps optimize energy usage and promote photosynthesis.
- Pest and Disease Management: IoT devices like cameras and sensors can be used to detect early signs of pests or diseases. Alerts can be sent to farmers or automated systems that trigger appropriate pest control measures.

Types of Iot Based Smart Polyhouses

IoT-based smart polyhouses are revolutionizing agriculture by providing automated and controlled environments for optimal crop growth. Here are several different types of IoT-based smart polyhouses, each with its unique features and applications:

- Climate-Controlled Polyhouse: These polyhouses monitor and control temperature, humidity, and ventilation. IoT sensors adjust these parameters based on crop requirements, ensuring optimal growing conditions They are ideal for crops sensitive to temperature and humidity variations.
- Hydroponic Polyhouse: These polyhouses employ IoT systems to manage hydroponic farming setups. Sensors monitor nutrient levels, pH, and water quality to maintain optimal conditions for plant growth They are suitable for growing leafy greens and herbs.
- Aquaponic Polyhouse: Combining aquaculture and hydroponics, these polyhouses use IoT to manage fish tanks and plant beds. Sensors monitor water quality, oxygen levels, and fish health while optimizing nutrient delivery to plants They are suitable for growing both plants and fish in a symbiotic system.
- Vertical Farming Polyhouse: IoT systems control vertical farming structures, such as stacked shelves or towers. Sensors track light intensity, nutrient levels, and water usage, optimizing vertical farming efficiency These are space-efficient solutions for urban agriculture.

- Light-Controlled Polyhouse: These polyhouses focus on optimizing light conditions for plant growth. IoT-controlled LED lights adjust intensity, spectrum, and duration to mimic natural sunlight. They are useful for year-round cultivation and in regions with limited sunlight.
- Nutrient Dosing Polyhouse: These polyhouses automate the delivery of nutrients to plants IoT sensors monitor nutrient levels in the soil, and automated systems adjust nutrient dosing accordingly They are excellent for precision agriculture and reducing resource wastage.

These various types of IoT-based smart polyhouses cater to different crops, environmental conditions, and agricultural goals. They help increase crop yields, reduce resource wastage, and contribute to sustainable and efficient farming practices

Flow Chart and Process of the System

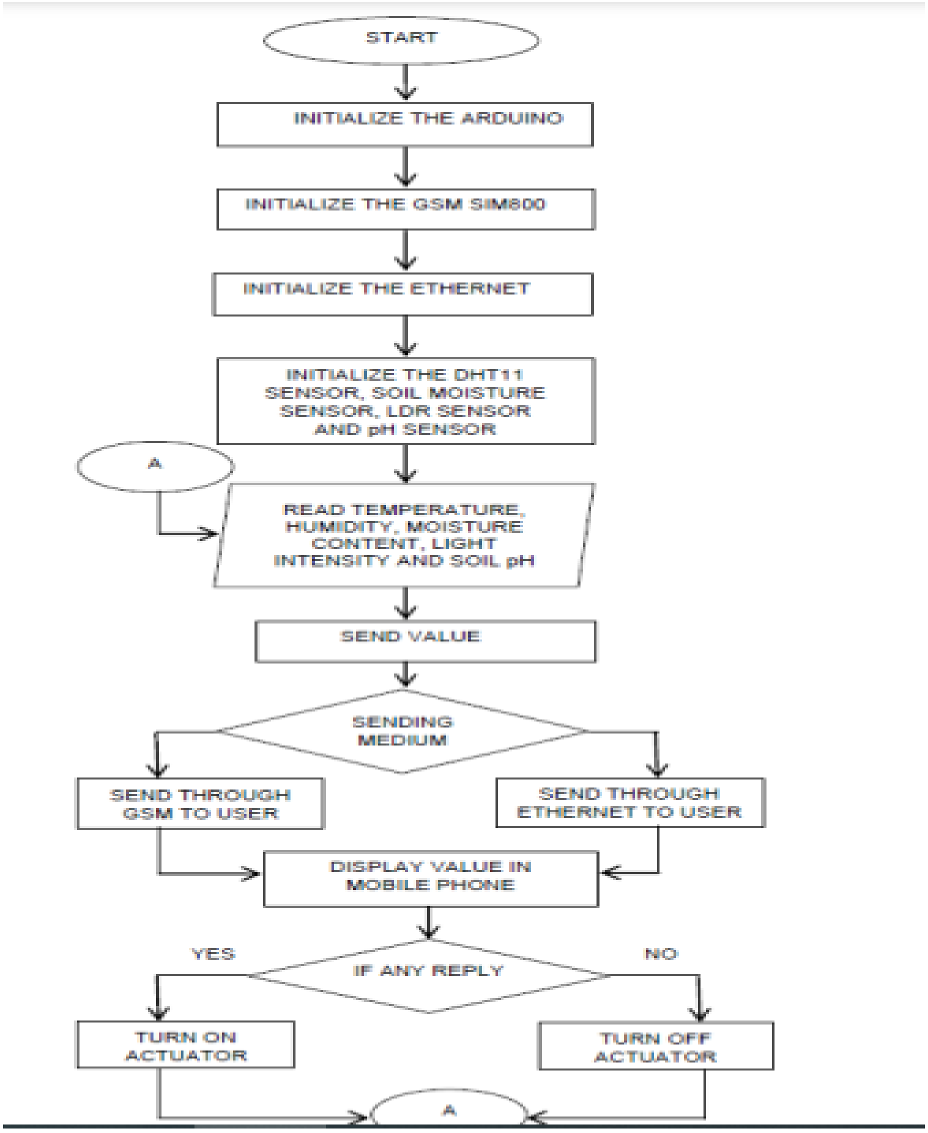

Figure 1. Shows Flow Chart Representing the Working of the Greenhouse System

Working Setup Model

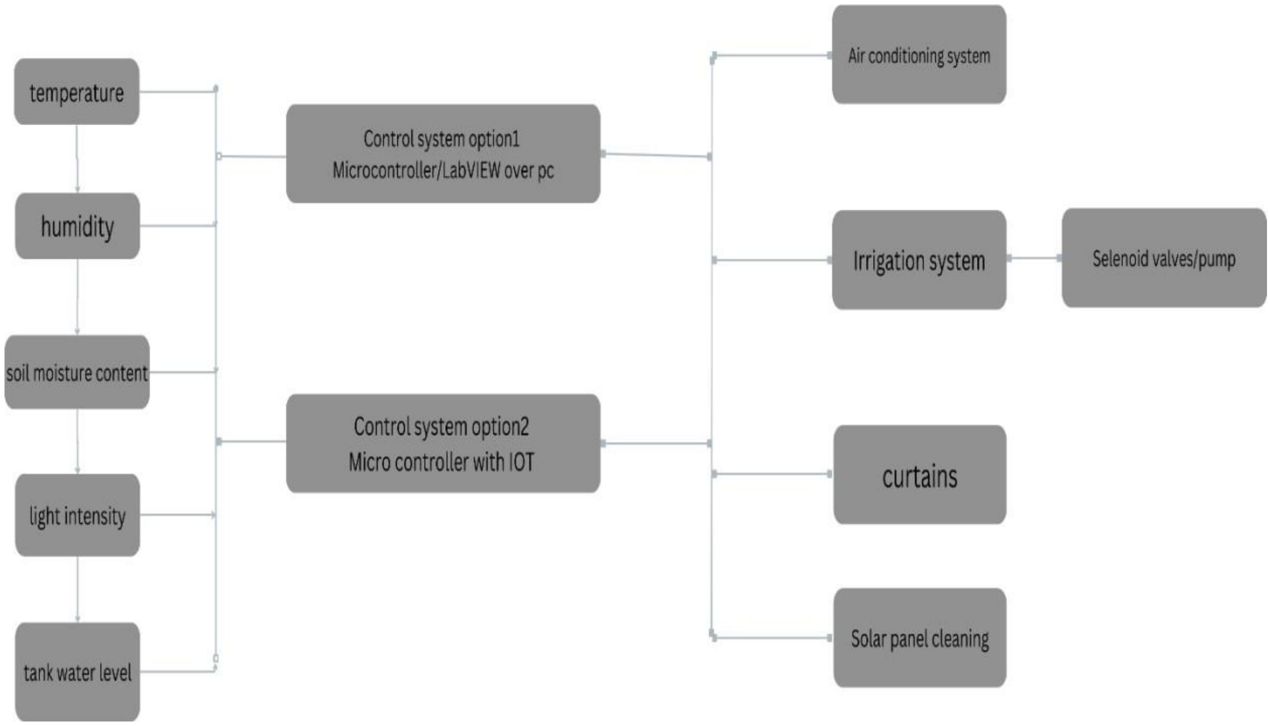

Figure 2. Shows Block Diagram

Hardware Components Selection:

1. Select sensors to monitor environmental parameters such as temperature, humidity, light, and soil moisture.
2. Choose actuators for control mechanisms (for example, fans and irrigation systems).
3. Select a microcontroller for data processing and communication (e.g., Arduino, Raspberry Pi).
4. Internet of Things Connectivity:
5. Connect the IoT devices to a secure network (Wi-Fi, LoRa, etc.).
6. Ensure data encryption and authentication while transmitting data.

Environmental Surveillance:

1) Temperature Monitoring:
2) Install temperature sensors in various areas throughout the polyhouse.
3) Install a continuous monitoring system to ensure that the target temperature range is maintained.

Monitoring Humidity:

1) Position humidity sensors strategically throughout the polyhouse.
2) Take humidity control techniques to improve crop development.

Controlling the Light:

1) Measure natural light levels with light sensors.
2) Use smart lighting systems to augment light as needed.

Monitoring Soil Moisture:

1) In the planting plots, install soil moisture monitors.
2) Implement soil moisture data-driven automatic irrigation.

Sensors Used: The sensitivity of a sensor reveals how much the sensor's output When the input quantity being measured changes, the function changes. The many sensors utilised include:

Humidity and Temperature Sensor : A temperature sensor is a gadget that measures the temperature. Temperature reading at a specific moment. It is a form of resistance. The temperature detector senses temperature variations. It gives high-quality recognition in a timely manner.

Light Sensor: The Light sensor measures the intensity of light in the polyhouse. A light sensor is a device that detects the current ambient level of light, i.e. how bright or dark it is. INVNT_10 Lm393 optical photosensitive LDR light sensitive sensor was utilised. It is linked to both analogue and digital output pins on the board, which are designated AO and DO, respectively. When there is light, the resistance of the LDR decreases in proportion to the intensity of the light. The lower the resistance of LDR, the greater the intensity of light. A potentiometer knob on the sensor may be changed to modify the sensitivity of the LDR to light. It is also intended to make advantage of reducing frame work

Soil moisture sensor: The soil moisture sensor is a device that measures the amount of water in the soil. Soil moisture assessment is critical for farmers to operate their irrigation systems

CO2 Sensors: Carbon dioxide sensors monitor the CO2 levels within the polyhouse. Controlling CO2 levels is important for photosynthesis and plant growth.

Water Quality Sensors: Water quality sensors can monitor the quality of water used for irrigation. They check factors like pH, EC (electrical conductivity), and nutrient levels.

Camera Sensors: Cameras can be used for visual monitoring of plant growth, disease detection, and even for security purposes in the polyhouse.

Table 2. Shows Key Parameters of Track and Control

PARAMETER	VALUE	DESCRIPTION
Temperature °C	25.5	Current temperature inside the polyhouse
Humidity %	60	Current humidity level
Light Intensity [Lux]	1500	Current light intensity
Soil moisture %	40	Soil moisture level in the polyhouse
CO2 Level PPM	400	Carbon dioxide concentration
Irrigation Status	on	Whether irrigation system is active
Ventilation Status	Closed	Status of polyhouse ventilation
Shade Control	automatic	Control of shading system
Heater Status	Heating system status	
Camera Feed	Live Stream	| Live video feed from the polyhouse

Table 3. Comparison of Crop Produced

Crop type	Traditional yield (kg/acre)	Smart polyhouse (kg/acre)	Improvement percentage
Tomatoes	500	800	60
Lettuce	300	600	100
cucumber	400	700	75

Data Preparation and Analysis

Data Gathering:

1) Continuously or at predetermined intervals, collect data from sensors.
2) Save information in a local database or on a cloud server.
3) Data Examination:
4) Create algorithms to analyse the data collected.
5) Detect abnormalities and provide notifications when they occur.

Remote Control and Monitoring

Dashboard Creation:

1) Develop an easy-to-use online or mobile application for remote monitoring.
2) Display real-time and historical data

Control Mechanisms:

1) Allow remote control of actuators (e.g., fans, irrigation) via the application.
2) Use preset presets for different crop kinds and development phases.

Alerts and Notifications:

Alert Generation:

1) Configure automated notifications for crucial circumstances (e.g., temperature extremes, low humidity).
2) Send alerts by email or SMS.

Energy Efficiency

1) Energy Management:
1) Make use of energy-efficient components.
2) Use scheduling to optimise energy use.

Crop Monitoring and Yield Prediction:

Image Analysis:

1) Take pictures of crops with cameras.
2) Use image analysis and machine learning to evaluate crop health.

Yield Prediction:

1) Crop yields may be predicted using historical data and machine learning algorithms.

Maintenance and Upgrades

Regular Maintenance:

1) Create a maintenance schedule for sensors and equipment.
2) Ensure that all systems are operational
3) Keep up to date on emerging IoT technology and farming practices.
4) Upgrade the system on a regular basis to improve performance.

METHODOLOGY

The entire farming process is split into two parts using this methodology: the crop field, where production is carried out, and the warehouse, which stores the harvested products. Each of the two portions has a variety of sensors. With the assistance of the sprayer that is attached to it, the system automates the process of applying fertilizer and insecticides. The microcontroller receives data from the soil moisture sensor, which it uses to determine whether to turn on or off the motor pump. The purpose of the obstacle sensor is to let the vehicle identify any impending obstacles so that it can avoid collisions and alter its course as soon as one is seen.

Finding pests on the crops is a crucial element that has been included to this system. A significant factor in crop productivity is pests. The farmer must spray more insecticide in response to an increase in the number of pests. Crop cultivation and productivity may be impacted by this. Therefore, a quicker and more accurate image processing technique has been utilized to detect the presence of cropping.

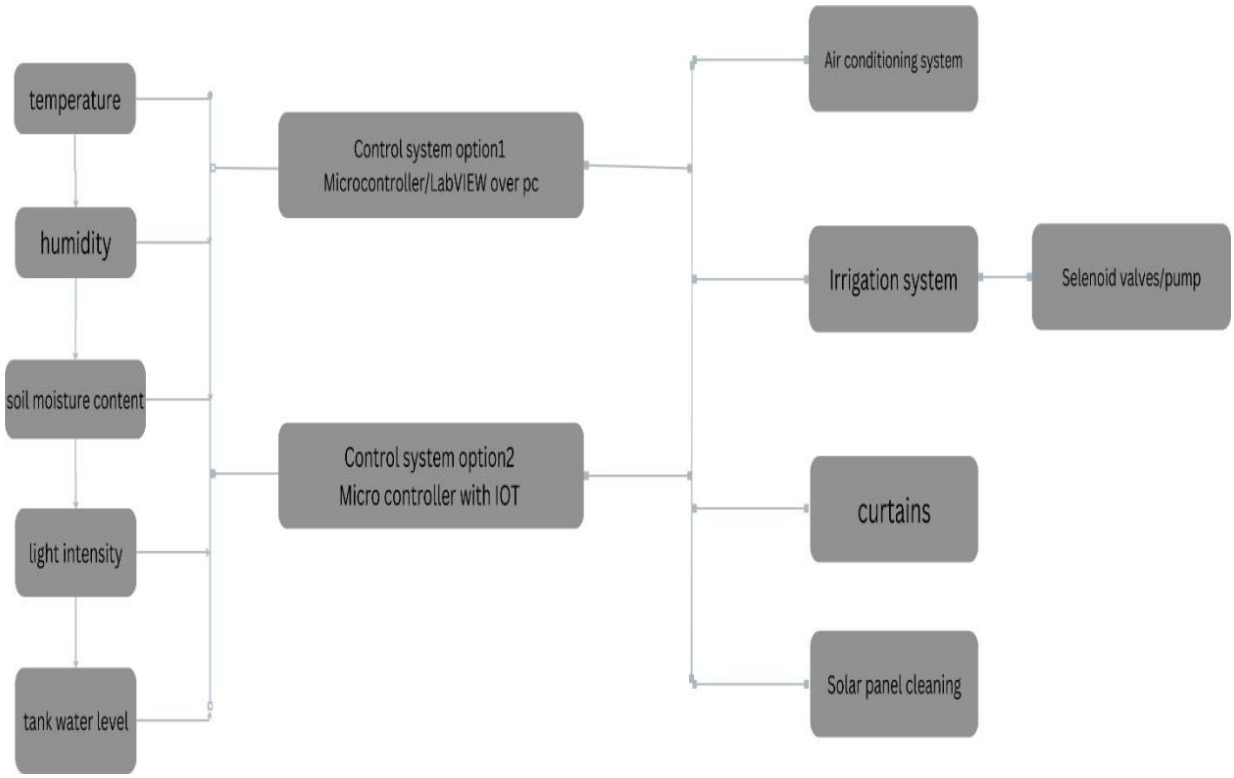

Figure 3. Image Processing Technique

The temperature sensor continuously monitors the temperature by sensing the ambient air around it.

Relative humidity (%RH), which is the percentage of humidity in the air, will be measured by a humidity sensor in the greenhouse.To maintain an appropriate environment for plants, an exhaust fan will be turned ON if the humidity level rises beyond the predetermined limit. This will remove humid air from the greenhouse.To regulate light density, light sensors measure the surrounding light density and establish the ideal light level for the plants in the greenhouse.When there isn't enough light for the plants in the greenhouse, an artificial fluorescent light will be turned on automatically by the light sensor with the assistance of a relay. When the plants receive enough light from the sun, the light will be turned off automatically.

RESEARCH RESULT AND DISCUSSION

Discussed the information gathered by the IoT sensors deployed in the polyhouse. Temperature, humidity, light intensity, soil moisture, and other essential environmental factors should be included in the form of tables, graphs, or charts. Include data on crop growth within the polyhouse. This can include crop height, leaf area, blooming, and yield statistics. If relevant, compare this data to classic non- IoT ways. Provide statistics on energy use if your IoT system measures energy usage for temperature control and other systems. Discuss any observed energy-saving benefits or inefficiencies. Assess how successfully IoT-controlled automation systems have performed in sustaining ideal agricultural growth conditions.

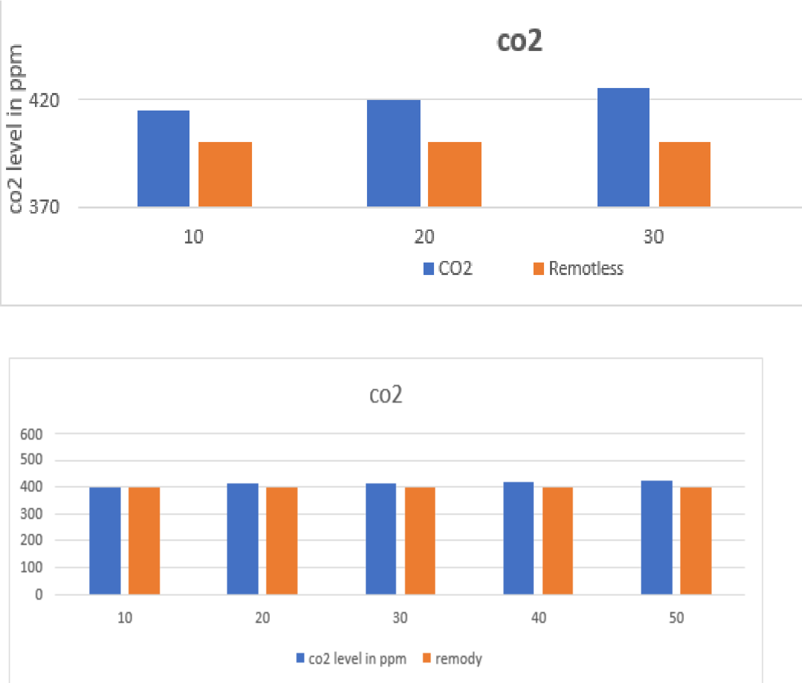

Figure 4. CO_2 Concentration Level in Greenhouse

As opposed to during the day, at night the plant's photosynthesis process requires a much higher concentration of CO_2 and water. With the help of these two energies, the photosynthesis process helps the plant grow quickly and keeps it cool. After completing an experiment to determine the CO_2 concentration level in a greenhouse, it was kept at a maximum level at night as depicted in the figure since the greenhouse starts consuming CO_2 at daybreak and continues to do so until nightfall.

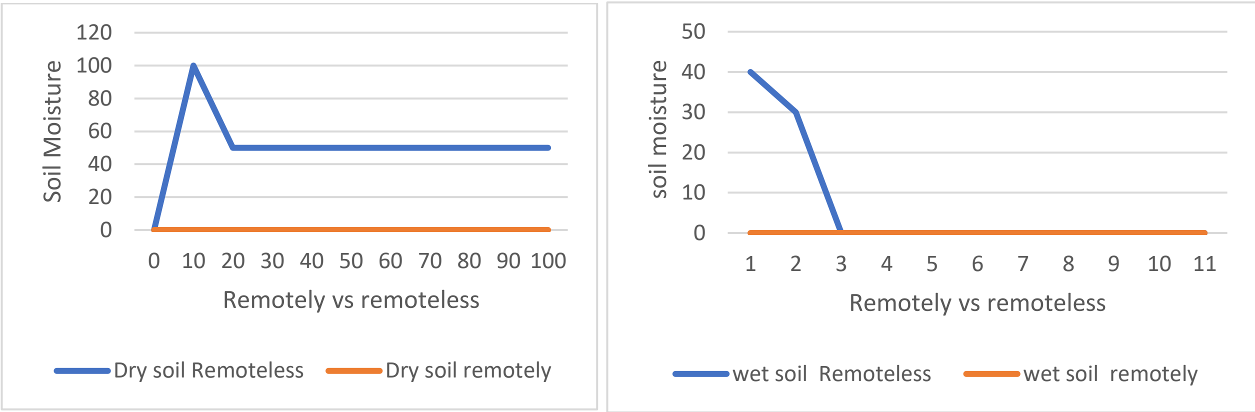

Figure 5. Soil Moisture Measurement in Greenhouse

A key consideration for plants is the amount of water in the soil since too much water can result in a fungal infection, while too little water causes plants to dry up or occasionally incur damage.

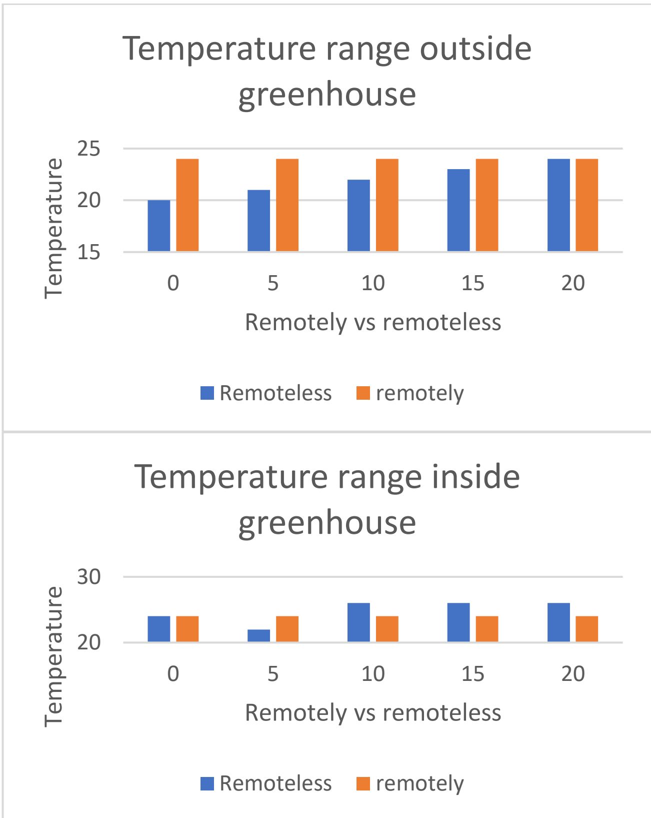

Figure 6. Temperature Range Control in Greenhouse

Another crucial factor in greenhouses is temperature, which should be kept at its highest level. Because the temperature promotes the growth of flowers, fruits, and seeds as well as photosynthesis. As a result, the temperature range inside the greenhouse was kept at its maximum, as illustrated in figure (b), as opposed to the temperature range outside the greenhouse.

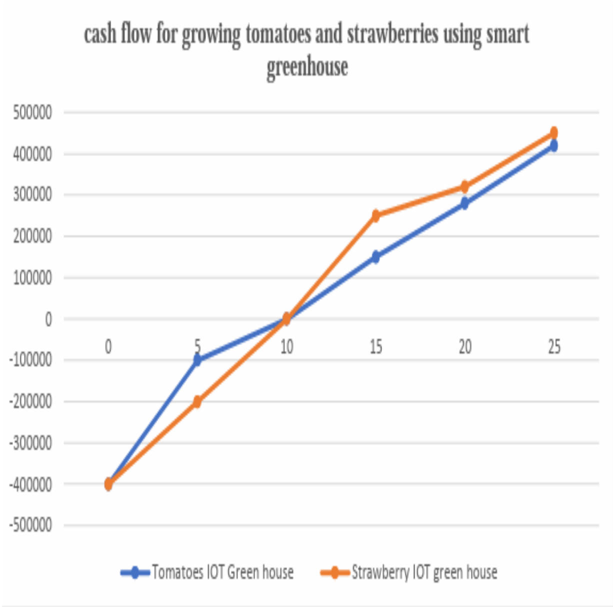

Figure 7. Shows Cash Flow for Growing Tomatoes and Strawberries Using Smart Greenhouse

CONCLUSIONS AND RECOMMENDATIONS

Finally, it should be noted that intelligent agriculture has gained popularity recently and is attracting the interest of both academic and industrial institutions. The study considers feasibility, affordability, and other factors while combining IoT and fuzzy control techniques, using GPRS for remote control, and developing a smart greenhouse monitoring system that is user-friendly, straightforward, and performs well. Automated control mechanisms are also available, such as greenhouse doors and windows that operate based on the moisture content of the soil. By using the Internet of Things to maintain precise parameters like CO2, soil moisture, temperature, and light in the greenhouse, the technology will help farmers increase productivity while reducing the need for physical field visits. An IoT kit and an internet connection are needed to complete the project. The greenhouse elements, including temperature, CO2, and soil moisture, The greenhouse factors such as CO2, soil moisture, temperature, and light for the bell pepper plant.

ADVANCED RESEARCH

In writing this article the researcher realizes that there are still many shortcomings in terms of language, writing, and form of presentation considering the limited knowledge and abilities of the researchers themselves. Therefore, for the perfection of the article, the researcher expects constructive criticism and suggestions from various parties.

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