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Automation In Smart Hydroponic Greenhouse And Soilless Farming

Sandhiyadevi P[1], Sowmiya S[2], Gokul S[3], Sushmeethaa M[4]

[1]Assistant Professor, Department of Electronics and Communication Engineering,
[2,3,4]UG Student, Department of Electronics and Communication Engineering,
[1,2,3,4]Bannari Amman Institute of Technology

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Abstract - *Climate change and the growing population are the two of the most important causes for the reduction of the arable lands around the world. This makes the cultivation of crops for farmers more difficult. So, to overcome this difficulty we can implement hydroponics which are plants that do not necessarily require soil for their growth. As the majority of the earth's surface is covered by water bodies, hydroponics will be a huge benefit. Hydroponics means a soilless cultivation technique in which the plants are irrigated with a nutrient solution consisting of water and compounds necessary to provide all the essential elements for normal mineral nutrition. For the plants to retain all the nutrients there must be a well-balanced system to monitor them. So, we present a prototype of a hydroponic greenhouse integrated with IOT technology and a Dashboard for viewing data in real time which allows remote monitoring and control of components. We build a system that is capable of monitoring the atmospheric conditions as well as the plant conditions at any time. The dashboard created allows the user to monitor the conditions even from remote places. In this project, we suggest creating a smart hydroponic greenhouse that uses sensors to track the greenhouse's temperature, humidity, light, and water level. Wi-Fi is used to transmit all of the sensor's data to a cloud server, where it is presented in real time on a dashboard with the option for the end user to remotely turn on and off certain components.*

***Key Words*:** Hydroponics, sensors, prototype, soilless, farming.

1.INTRODUCTION

The production of high-quality food for the human population is made possible by agriculture, which is the backbone of human civilization. In the face of difficulties brought on by population increase, climate change, and environmental degradation, hydroponic agriculture is a viable answer for soilless farming. However, to guarantee a suitable environmental setting and a well-balanced nutritional solution, this sort of production calls for a lot of work. In order to enable remote component monitoring and control, we demonstrate a prototype of a hydroponic greenhouse equipped with IoT technology and a dashboard for real-time data viewing. The objective is to create a system that can be altered to meet certain requirements. The agricultural sector has undergone a fundamental transformation recently toward more effective and sustainable farming methods. Automation has emerged as a crucial enabler in the transformation of conventional agricultural practices among these breakthroughs. Precision agriculture has advanced thanks to the use of automation technology in sophisticated hydroponic greenhouses and soilless farming techniques, which provide previously unheard-of levels of control over crop cultivation, resource use, and environmental impact. The volatility of the climate, the scarcity of arable land, and the depletion of natural resources have long been obstacles for traditional agriculture. Smart hydroponic greenhouses and soilless farming have come to light as viable solutions to these problems that can considerably boost food production while putting less stress on the environment. These techniques entail growing crops without the use of soil, depending instead on nutrient-rich fluids and regulated settings to promote the best possible development circumstances. However, only with the seamless integration of automation technologies can the true potential of these soilless systems be completely realized.

1.1 Problem Statement

The existing hydroponic systems often rely on complex and expensive hardware components, which can be a barrier for small-scale industries or businesses with limited resources. The problems to be addressed are

1. Cost-effectiveness
2. Reliable Data Processing
3. Integration and Connectivity

We start with a needs analysis and system design, taking into account crop selection and environmental monitoring, to automate hydroponic greenhouse and soilless farming. Implement automated components for pest control, climate control, lighting, and nutrition management. Utilize remote monitoring for convenience and data analytics for decision support. Continuous improvement should be a top goal, along with regular maintenance and employee training. Make sure everything is legal, sustainable, and perform a financial analysis to gauge ROI. As success is attained, think about expanding the automated system for higher output.

1.2 Advantages Of The System

Water Efficiency: Because water is cycled and nutrient-rich solutions are fed directly to plant roots, hydroponic systems use substantially less water than conventional soil-based agricultural methods.

1.2.1. Higher Crop Yields: Smart greenhouses with controlled surroundings improve growing conditions, resulting in higher crop yields and more rapid growth rates all year long.
1.2.2. Crop Quality: Better environmental management results in more uniform crop quality, less exposure to pests and diseases, and fewer imperfections or abnormalities.
1.2.3. Precision and Automation: Automating irrigation, nutrient supply, and climate control ensures accurate management while requiring less work.
1.2.4. Faster Growth: Because of the ideal nutrient availability and environmental conditions, plants grown in hydroponic systems frequently develop more quickly.
1.2.5. Resource Conservation: Reduced soil erosion, preservation of fertile land, and lessening of resource depletion are all benefits of soilless farming.

1.3 Disadvantages Of The System

1.3.1. High initial costs: For some farmers, setting up a smart hydroponic greenhouse with automated systems and sensors may be prohibitively expensive.
1.3.2. Complexity: The design, installation, and maintenance of the system might be difficult due to the integration of multiple automation components and technologies, necessitating specialist knowledge and abilities.
1.3.3. Technical difficulties: If not resolved right away, technical issues like sensor malfunctions or software bugs can disrupt operations and result in crop losses.
1.3.4. Energy Consumption: Smart systems, such as lighting and climate control, may result in greater energy expenditures, which could have an adverse effect on the environment.
1.3.5. Dependence on Technology: An agricultural operation that relies too much on automation may be subject to cyberattacks or technology failures, which might seriously disrupt operations.
1.3.6. Crop Diversity Is Limited: Some crops may not be well-suited for hydroponic or soilless systems, limiting the variety of crops that can be grown compared to traditional soil-based farming.

1.4 Applications Of The System

1.4.1. Irrigation Systems: Automated irrigation systems provide the right amount of water to crops.
1.4.2. Data Monitoring: Real-time sensor networks collect data on plant health and environmental conditions.
1.4.3. AI Analytics: Artificial intelligence analyzes data to predict and optimize crop growth.
1.4.4. Robotic Farming: Robots perform tasks like planting, harvesting, and maintenance.
1.4.5. Remote Monitoring: IoT-enabled systems allow farmers to monitor and control farms remotely.
1.4.6. Water and Resource Management: Automation minimizes water and resource usage.
1.4.7. Vertical Farming: Automated setups maximize space efficiency in vertical farming.

2. OBJECTIVE AND METHODOLOGY

2.1. History of hydroponics

ASPECT	TRADITIONAL HYDROPONICS	SMART HYDROPONICS
ENVIRONMENTAL CONTROL	Limited control over environmental factors such as temperature and humidity, often relying on manual adjustments.	Precise control of environmental variables through automation and real-time monitoring.
NUTRIENT MANAGEMENT	Manual monitoring and adjustment of nutrient levels based on periodic testing.	Automated nutrient dosing systems with real-time monitoring and data-driven adjustments.
IRRIGATION	Manual irrigation scheduling and control.	Automated drip or nutrient film technique systems with programmable schedules and real-time monitoring.
PEST AND DISEASE CONTROL	Reliance on chemical pesticides. Limited use of integrated pest management (IPM).	Integration of IPM strategies with automated pest detection and control mechanisms, reducing reliance on chemicals.
RESOURCE EFFICIENCY	Higher water and nutrient usage compared to optimized systems.	Efficient resource utilization, reducing water and nutrient waste.

Table 1

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2.2 Objective of the model

A hardware component and a software component make up the project. In order to encourage the best development conditions, sensors are employed to monitor the behavior of the hydroponic greenhouse and the surrounding environment. The user can utilize a dashboard to remotely control the sensors and view real-time data from the hydroponic greenhouse. Our dashboard generally offers the following features: Charts that show temperature, humidity, and water/light content measurements in real-time. Toggle button on the remote control that allows the user to turn on and off the led for violet light.

This project's main goal is to develop, create, and put into operation a cutting-edge smart hydroponic greenhouse and soilless farming system that would constitute a paradigm change in modern agriculture. By carefully regulating environmental factors like temperature, humidity, light, and fertilizer delivery, our comprehensive method first and foremost seeks to enhance crop yields and quality. By establishing a closed-loop hydroponic environment that minimizes water use, decreases fertilizer waste, and encourages resource sustainability in accordance with the principles of responsible agriculture, the system simultaneously aims to achieve water and resource efficiency.

Another key area of concentration will be energy efficiency, with cutting-edge technologies and renewable energy sources integrated to reduce energy usage and the greenhouse's environmental impact. In order to enable precise control of irrigation, nutrient dosing, and environmental conditions, precision agriculture will be at the forefront, leveraging cutting-edge sensors, data analytics, and automation. Automated systems for managing pests and diseases will also be put in place, decreasing the need for chemical pesticides and promoting a healthier farming ecosystem. Scalability and customisation are essential since the system will be built to support a range of crops and be flexible enough to grow in response to changing market demands.

The system's core will incorporate data-driven decision support, enabling real-time insights into crop health, environmental conditions, and resource usage. In order to reduce downtime and crop losses, operational reliability is crucial, with a heavy emphasis on redundancy, rigorous maintenance schedules, and thorough operator training. A guiding theme will be environmental stewardship, with strict environmental rules and best practices followed with an eye toward preventing soil erosion, minimizing chemical runoff, and enhancing ecosystem health. The method will be promoted as a competitive and environmentally friendly alternative in the agriculture sector, satisfying consumer demands for locally sourced, pesticide-free fruit that is fresh. To guarantee the project's sustainability, a thorough economic viability evaluation will be carried out, taking into account initial investments, ongoing costs, and long-term profitability.

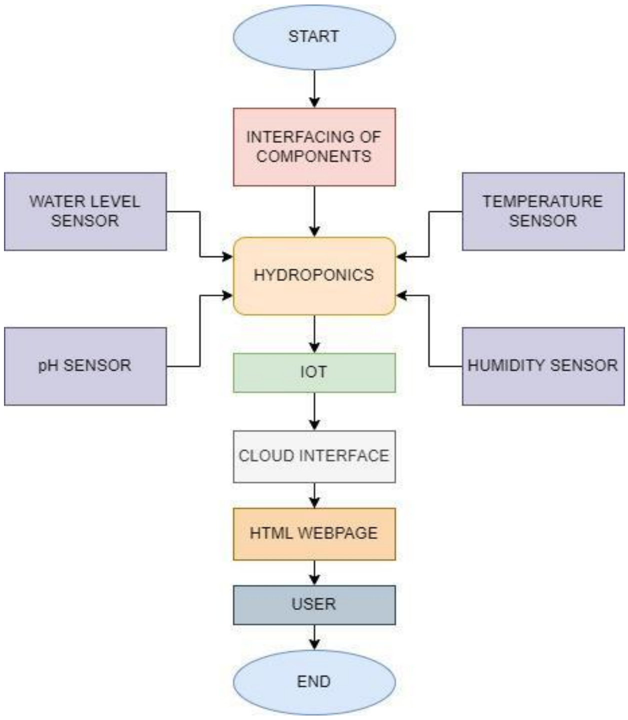

Figure 2.2.1
Overall workflow of the model

2.3 Hardware Implementation

Regarding the hardware components, we employed:

- ESP32 board
- Photoresistor
- Water level sensor
- Temperature/humidity sensor
- TDS sensor
- Blue LED
- Red LED
- Green LED
- Resistors

The main concept is that the ESP32 board controls the sensors and, after gathering data from each one, sends the calculated values to an open-source broker. The photoresistor gauges the quantity of light present, the water level sensor keeps track of the water level in the basin, and the temperature sensor measures the temperature and humidity inside the greenhouse. The red and green LEDs collaborate with the water level sensor, respectively. The red LED begins blinking if the water level is too low and continues to do so until it is at the ideal level. On the other hand, the green LED turns on to show that the hydroponic greenhouse is operating properly if the water level is greater than or equal to 20% of the total water that can be contained in the basin. Finally, a magenta color that is helpful for plant photosynthesis was produced by the

RGB LED. However, this LED is off by default, and only the user has the ability to remotely control it.

The temperature sensor is the most difficult to configure of all the prototype's sensors since it requires the exchange of more information than just a single bit. The I2C (Inter-Integrated Circuit) protocol, in particular, has been implemented for this purpose and is utilized in serial communication. I2C is a master-slave protocol that is synchronous, half-duplex, and uses shared lines. Synchronous protocols call for an additional line called the SCL (Serial CLock) line since they employ a clock in their transmissions. In a half-duplex protocol, the SDA (Serial DAta) line, which is used by I2C, is used for both data transmission and reception. Finally, only one device (the master) can initiate communication in a master-slave protocol, and in this case, the master is the ESP32 board.

It is important to note that while most of the sensor outputs are digital, some of them—such as the values from the photoresistor and the water level sensor—are analog. Analog signals, in particular, are signals that gauge continually varying physical quantities. But because we cannot process such quantities as they currently exist, we must transform them into digital signals. An ADC (Analog-to-Digital Converter) module incorporated into the ESP32 board may carry out this function.

Using the board's Wi-Fi module, all collected data is transferred to the broker where it can be accessed and used to build the dashboard. The flow diagram of the hardware implementation is given below:

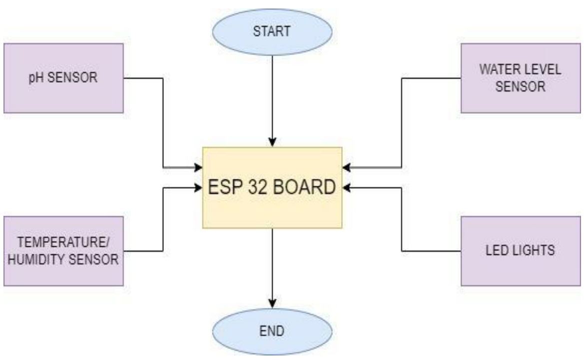

Figure 2.3.1

Modernizing hydroponic greenhouses and soilless farming methods relies heavily on the ESP32 microcontroller platform. The key to its adaptability is its capacity to integrate a wide range of sensors, including those for temperature, humidity, pH, CO2 levels, and light, enabling thorough environmental monitoring. The ESP32 provides easy access to the Internet and mobile devices thanks to its integrated Wi-Fi and Bluetooth capabilities, providing real-time data collecting and remote management of greenhouse conditions. Whether documented locally or sent to cloud-based platforms, this data is thoroughly analyzed to support accurate decision-making. Through ESP32 programming, environmental functions like irrigation, ventilation, and lighting may be automated, assuring stable conditions for the best possible crop development. It is a cost-effective option that is available to a large spectrum of people due to its energy efficiency, scalability, and affordability.

2.4 Web development:

A smart hydroponic greenhouse and soilless farming system monitoring HTML web page development comprises a number of processes and the integration of numerous tools and technologies.

2.4.1. Specify Goals and Conditions:

Start by outlining the monitoring system's goals in detail. Choose the information you must gather and the remote activities you want to carry out. Determine the user requirements, including the data they need to access and any functionality they demand.

2.4.2. Configure Sensors and Hardware:

The hardware elements for your hydroponic greenhouse should be installed. Sensors for measuring temperature, humidity, light intensity, pH levels, and nutrient concentrations are often included.

2.4.3. Pick a Programming Language:

The structure and display of the webpage are handled by HTML, but you'll need to use a server-side scripting language, such as Python, Node.js, or PHP, to communicate with the sensors and provide dynamic content for the web page.

2.4.4. Construct the Server-Side Backend:

Write a server-side script that gathers data from the sensors, processes it, and gets it ready for displaying on the HTML page.

To manage data processing and communication with the sensors, use libraries or frameworks that are appropriate for your chosen scripting language.

2.4.5. Create the HTML user interface:

Create the HTML webpage's structure and visual appeal. To make the interface visually appealing and user-friendly, think about using CSS for styling.

Placeholders should be used for data that will be dynamically changed based on current events.

2.4.6. Use Dynamic Content:

Integrate JavaScript or another client-side scripting language to asynchronously receive data from the server-side script and change the HTML page without necessitating a complete page refresh.

To give consumers a clear picture of the greenhouse conditions, display real-time sensor data in graphical or tabular representations, such as charts, graphs, or tables.

2.4.7. User Authentication and Security:

Implement user authentication and authorization to ensure that only authorized users can access the monitoring system.

Sensitive data is protected during secure connection between the server and the webpage utilizing encryption methods (like HTTPS).

2.4.8. Mobile responsiveness:

To give users easy access from anywhere, make sure the HTML webpage is responsive and suitable with a range of devices, including smartphones and tablets by using media.

2.4.9. Testing and stumbling:

Test the website thoroughly by simulating various scenarios and confirming the data's accuracy.

To ensure the dependability of the system, debug any problems with the user interface, client-side code, or server-side script.

2.4.10. Hosting Service:

2.4.10.1. GitHub Pages:

Hosting can be done by using Git and GitHub for version control. Simply create a GitHub repository, upload the HTML file, and enable GitHub Pages in the repository settings.

2.4.10.2. Netlify:

Netlify is a user-friendly platform for hosting static websites. We can connect our GitHub repository or directly drag-and-drop our HTML file onto Netlify. It provides additional features like continuous integration and custom domains.

2.4.11. Updates:

If you make changes to your HTML file, simply update it in your repository and the hosting service will automatically reflect those changes on your live webpage.

2.4.12. Security and Maintenance:

Keep your HTML file and any associated assets secure and regularly update them as needed. You can also add security features like SSL certificates for HTTPS.

2.4.13. Continuous Monitoring and Maintenance:

Regularly check the website's performance and the system's functionality to find and fix any problems.

Update the system as necessary with new software, security fixes, and enhancements.

2.4.14. User Training and Documentation:

Train users of the complete webpage with the monitoring system and provide them with user documentation so they can properly utilize the interface and analyze data.

It takes a lot of work to create an HTML webpage for monitoring a smart hydroponic greenhouse and soilless farming system since it combines hardware installation, server-side scripting, web construction, and continuous maintenance. To help improve crop development and resource management in the greenhouse, a user-friendly interface that offers useful real-time information is important.

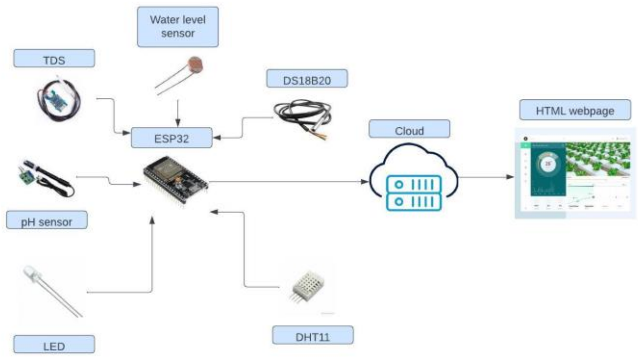

Figure 2.4.1

2.5. Components and tools used:

- ESP32 board
- Photoresistor
- Water level sensor
- Temperature/humidity sensor
- RGB LED
- Red LED
- Green LED
- Resistors of 100 Ω
- HTML webpage

The ESP32 is a versatile and cost-effective microcontroller board known for its wireless capabilities, low power consumption, and a broad range of I/O options. It has become a staple in the development of IoT projects and embedded systems due to its flexibility and extensive community support.

A photoresistor, sometimes referred to as an LDR or a photocell, is a passive electronic component that changes its electrical resistance in response to the brightness of incident light. Photoresistors are widely used in a variety of applications, including light-sensitive switches, light meters, and ambient light management systems. They are often manufactured from a semiconductor material, such as cadmium sulfide (CdS). A photoresistor's resistance drops when it is exposed to light, facilitating easier current flow. The resistance rises in low-light or dark environments, limiting the current flow. A device called a water level sensor is made to gauge the height or depth of a liquid surface, usually water. The sensor comes into touch with the liquid, and changes in electrical conductivity or capacitance are then detected. Water level sensors come in many different varieties, such as float switches, pressure sensors, and ultrasonic sensors. These sensors are frequently utilized in a variety of applications, including industrial operations, environmental monitoring systems, and water tanks. They are valuable tools for fluid-level monitoring and control because they play a critical role in providing effective management and control of water resources, preventing overflows, and setting off alarms or automatic actions when particular water levels are reached.

A temperature/humidity sensor, often referred to as a combined or integrated sensor, is a compact electronic device designed to measure and report both temperature and relative humidity levels in its immediate environment. These sensors are equipped with built-in sensing elements, such as thermistors or thermocouples for temperature and capacitive sensors for humidity, enabling them to provide accurate and real-time data about the ambient conditions. Temperature/humidity sensors are commonly used in various applications, including climate control systems, weather stations, indoor environmental monitoring, and HVAC systems. Their ability to simultaneously measure temperature and humidity makes them essential tools for maintaining comfortable indoor conditions, optimizing energy efficiency, and ensuring the well-being of people, animals, and sensitive equipment in a wide range of settings.

An analytical tool called a pH sensor measures a solution's acidity or alkalinity and outputs a numerical pH value that represents the amount of hydrogen ions present in the liquid. These sensors use an electrode that is pH-sensitive or a combination of electrodes, and they typically produce a voltage proportional to the pH of the fluid being tested. pH sensors are frequently employed in many different applications, such as the study of water quality, chemical reactions, agriculture, and food production. They are crucial for maintaining ideal conditions in fields like agriculture, aquaculture, and wastewater treatment, as well as in fields like scientific research and environmental monitoring, by ensuring exact control over the pH of solutions.

Fundamental passive electronic components called resistors are frequently utilized in electrical and electronic circuits. They are made to stop electrical current from flowing, transforming the electrical energy into heat. Typically, resistor values are defined in ohms (), and they can be either fixed resistors with constant resistance values or variable resistors (potentiometers) with human resistance adjustment. In electronics, resistors perform a number of crucial tasks such as voltage division, current limiting, and signal conditioning. They play a crucial role in regulating the current that passes through components, safeguarding equipment from high currents, and making sure that circuits function within predetermined bounds. Resistors are an essential component of innumerable electronic applications, from simple lighting circuits to intricate microelectronics, and are available in a wide range of resistance values and power ratings.

The foundation of the World Wide Web is HTML websites, which act as the basic building blocks for online content presentation. To make user-friendly and engaging interfaces, they combine structured text, hyperlinks, and multimedia components. Developers can specify the organization and layout of web content, such as text, photos, forms, and videos, using HTML (Hypertext Markup Language). These websites are necessary for a variety of activities, such as information exchange, online shopping, and entertainment. HTML web pages offer a flexible platform for distributing information and communicating with people across a range of devices and browsers thanks to their capacity to construct dynamic and responsive designs, making them a pillar of the contemporary digital world.

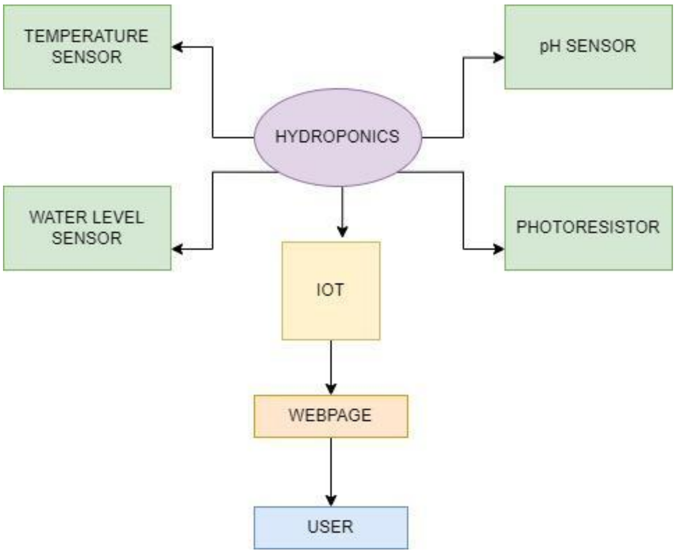

Figure 2.5.1

3. PROPOSED WORK AND MODULES

Based on the workflow, we divided the project into four distinct phases followed as

1.Sensor Integration and Data Acquisition
2.Energy Management and Sustainability
3.Scalability and Future Expansion
4.WebPage Creation

3.1 SENSOR INTEGRATION AND DATA ACQUISITION:

The main goal of this module is to integrate various sensors into the greenhouse environment in order to collect crucial information for monitoring and decision-making. The carefully chosen sensors for characteristics like temperature, humidity, pH levels, nutritional concentrations, light intensity, and water levels will be one of the subtopics. We may gather and process data using the right communication protocols by connecting these sensors to microcontrollers like Arduino or Raspberry Pi. Real-time monitoring will give prompt feedback through the user interface, while data preparation will guarantee the accuracy and dependability of the data.

3.2 ENERGY MANAGEMENT AND SUSTAINABILITY:

We focus on maximizing energy utilization and encouraging sustainable practices in the greenhouse environment throughout this phase. Implementing energy-efficient systems, such as incorporating LED lighting, better insulation, and adopting HVAC (Heating, Ventilation, and Air Conditioning) systems that decrease energy usage, is one of the main goals. We also consider using clean energy to run greenhouse activities by incorporating renewable energy sources like solar and wind energy. Another area of focus is resource conservation, where we create algorithms to carefully control the usage of essential resources like water and nutrients, minimizing waste and promoting sustainability.

3.3 SCALABILITY AND FUTURE EXPANSION:

We concentrate on developing a modular architecture that enables the seamless integration of new technologies and features as well as the addition of additional greenhouse units as agricultural requirements change. This phase also investigates the incorporation of Internet of Things (IoT) gadgets, providing opportunities for sophisticated automation, real-time data collection, and remote monitoring tools. We construct a dedicated research and development component to sustain the system's relevance and competitiveness, ensuring that ongoing innovation and adaptability to evolving agricultural techniques remain at the forefront of the undertaking. The project's long-term viability and flexibility in the rapidly changing world of smart hydroponic greenhouse and soilless agricultural technologies are crucially dependent on the Scalability and Future Expansion phase.

3.4 WEB PAGE CREATION:

The development of a user-friendly web interface that enables real-time monitoring and control of the sophisticated hydroponic greenhouse and soilless farming system will be our main focus. This involves both building a solid backend using computer languages like React or Node Js and an intuitive frontend interface using HTML, CSS, and JavaScript. In order to store and retrieve information on greenhouse conditions, crop health, sensor readings, and user preferences, we will also incorporate a database system. This subtopic will require secure user authentication and the usage of data visualization tools.

4. RESULTS AND DISCUSSION

Automation in smart hydroponic greenhouse and soilless farming systems has revolutionized the way we grow plants. These advanced systems utilize technology to create an optimal environment for plant growth, leading to increased productivity and efficiency. One of the key benefits of automation is the precise control it offers over environmental factors such as temperature, humidity, and nutrient levels. By maintaining these parameters at ideal levels, plants can thrive and grow faster compared to traditional soil-based farming methods. This level of control also allows farmers to grow crops year-round, regardless of external weather conditions. Another advantage of automation in smart hydroponic greenhouse and soilless farming systems is the reduction in manual labor required. With automated systems, tasks such as watering, nutrient delivery, and pest control can be performed automatically, minimizing the need for human intervention. This not only saves time but also reduces labor costs, making these systems more economically viable. Additionally, automation enables farmers to remotely monitor and control their operations. Through the use of sensors, cameras, and data analysis, farmers can keep track of plant health, detect any issues early on, and make necessary adjustments from anywhere, providing convenience and flexibility. Furthermore, automation in these farming systems promotes resource efficiency. Hydroponic and soilless farming techniques already use significantly less water compared to traditional soil-based agriculture. By incorporating automation, water usage can be further optimized through precise irrigation systems that deliver the right amount of water directly to the plants' roots. This reduces water waste and ensures that plants receive the necessary hydration without overwatering. Additionally, automation allows for the efficient use of nutrients, as they can be precisely dosed and delivered to the plants, minimizing wastage and maximizing plant uptake. However, there are a few drawbacks to consider when implementing automation in smart hydroponic greenhouse and soilless farming systems. One of the main challenges is the initial setup cost. Setting up an automated system can require significant investment in infrastructure, technology, and equipment. This can be a barrier for small-scale farmers or those with limited financial resources. Additionally, technical expertise is necessary to operate and maintain these systems effectively. Farmers need to have a good understanding of the technology involved, as well as the ability to troubleshoot any issues that may arise. This may require additional training or hiring specialized personnel, adding to the overall cost.

5. CONCLUSION

Automation in smart hydroponic greenhouse and soilless farming systems has revolutionized the way we grow plants. These advanced systems utilize technology to create an optimal environment for plant growth, leading to increased productivity and efficiency. One of the key benefits of automation is the precise control it offers over environmental factors such as temperature, humidity, and nutrient levels. By maintaining these parameters at ideal levels, plants can thrive and grow faster compared to traditional soil-based farming methods. This level of control also allows farmers to grow crops year-round, regardless of external weather conditions.

Another advantage of automation in smart hydroponic greenhouse and soilless farming systems is the reduction in manual labor required. With automated systems, tasks such as watering, nutrient delivery, and pest control can be performed automatically, minimizing the need for human intervention. This not only saves time but also reduces labor costs, making these systems more economically viable. Additionally, automation enables farmers to remotely monitor and control their operations. Through the use of sensors, cameras, and data analysis, farmers can keep track of plant health, detect any issues early on, and make necessary adjustments from anywhere, providing convenience and flexibility.

Furthermore, automation in these farming systems promotes resource efficiency. Hydroponic and soilless farming techniques already use significantly less water compared to traditional soil-based agriculture. By incorporating automation, water usage can be further optimized through precise irrigation systems that deliver the right amount of water directly to the plants' roots. This reduces water waste and ensures that plants receive the necessary hydration without overwatering. Additionally, automation allows for the efficient use of nutrients, as they can be precisely dosed and delivered to the plants, minimizing wastage and maximizing plant uptake.

However, there are a few drawbacks to consider when implementing automation in smart hydroponic greenhouse and soilless farming systems. One of the main challenges is the initial setup cost. Setting up an automated system can require significant investment in infrastructure, technology, and equipment. This can be a barrier for small-scale farmers or those with limited financial resources. Additionally, technical expertise is necessary to operate and maintain these systems effectively. Farmers need to have a good understanding of the technology involved, as well as the ability to troubleshoot any issues that may arise. This may require additional training or hiring specialized personnel, adding to the overall cost.

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