

HYDROPONICS AUTOMATION SYSTEM

Submitted in partial fulfilment of the required for the award of

Bachelor of Computer Science

by

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**DEPARTMENT OF COMPUTER SCIENCE
SCHOOL OF SCIENCE AND HUMANITIES**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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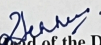
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BONAFIDE CERTIFICATE

Certified the project report titled “**HYDROPONICS AUTOMATION SYSTEM**” is a bonafide work of **Nithyanandan S (40290063)** who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported here in does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

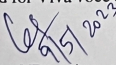

Internal Guide

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DECLARATION

I am, **Nithyanandan S (40290063)** hereby declare that the Project Report entitled **"HYDROPONICS AUTOMATIONSYSTEM"** done by us under the guidance of **Dr.Ulagamuthalvi.V.,M.E.,Ph.D.,**Department of Computer Science at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY,** Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai-600 119 is submitted in partial fulfilment of therequirements for the award of Bachelor of Science degree in Computer Science.

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ABSTRACT

Human population density rises dramatically in densely populated metropolitan areas, reducing accessible farmland. As a result, a landless planting method is required to offer food for civilization. Hydroponics is one of the agricultural technologies that uses water as a nutrition medium. Hydroponics is proved to use 80-90% less water than traditional methods where soil acts as a medium between us and the plant. Hydroponic farming is usually done manually by monitoring nutrition parameters like acidity or basicity (pH), total dissolved solids (TDS), Humidity, Ambient temperature and nutrient solution temperature. In this study, we present a system that uses IOT where a couple of sensors and internet help us record the data in the hydroponic system and the machine learning model helps us automate the process of monitoring the system. The proposed system uses data from Tinkercad cloud in csv format and performs an ensemble learning using supervised machine learning to stack and uses Support Vector Classifier as a meta estimator. Hydroponics is an efficient way of growing plants without soil, using nutrient-rich water solutions. However, it requires careful monitoring and control of various factors, such as water levels, nutrient concentration, pH, and temperature, to ensure optimal growth and yield. An automation system can simplify this process by continuously monitoring and adjusting these variables, reducing the need for human intervention and increasing the accuracy and efficiency of the system. The system consists of a microcontroller-based controller, sensors for monitoring water level, pH, and temperature, and actuators for controlling water flow and nutrient supply. The controller uses feedback from the sensors to adjust the water flow rate and nutrient concentration, ensuring that the plants receive the correct amount of water and nutrients at the appropriate pH level and temperature. The proposed system can reduce the workload for growers while ensuring consistent and reliable plant growth. The system works with 97.66% accuracy.

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CHAPTER-I

INTRODUCTION

Collecting data of a physical object based on a specific already accepted standards is called measurements. Measurements include mass, pressure, temperature, humidity and so on. The measurements are done using sensors which converts physical measure to electrical signal read by an instrument.

Integrating the sensor with computer thorough internet opens gateway for various applications including data analytics, modelling, predictive analysis and other aspects. The controlling system will help in observing an object parameter. A system works to measure object parameters, store and display the measured data on a regular time interval. The system may identify anomalies and indicate the user if the observed data is over a limit. Traditional controlling system stores, displays and works only on a small local area.

The advancement of internet enables communication in several form that include person to person, device to person, person to device which has given rise to IOT applications. By applying recent internet tech on traditional controlling system, we can create an updated controlling system equipped with internet which would allow us to present, store and accessed all over the globe as live data. Even though we say it is live data it actually carries a small delay due to data transmission. This updated monitoring system is called IOT-based monitoring system. This IOT based monitoring system has been researched, studied and applied widely on several fields including environment, agriculture, transportation, health.

Hydroponics is a modern way of agriculture Hydroponics is a method of growing plants without soil but using nutrient solution where plant is mechanically supported

using things like gravel, rock-wool, coir, sawdust. On comparing Traditional agriculture with hydroponic system, we reap lot of advantages that include maximizing space, conserve water, helps micro climate environment, produces greater yields, requires less work, no need of soil, outputs higher quality and healthy food, cuts down the supply chain, faster crop growth. Considering these advantages, it is suitable for the upcoming era for better supply of quality food with food sustainability.

MONITORING HYDROPONIC PLANT PARAMETER

Hydroponics is a modern agricultural technique that involves growing plants in nutrient-rich water instead of soil. This method of farming is gaining popularity due to its numerous advantages, such as increased crop yields, reduced water usage, and decreased need for pesticides and fertilizers. However, maintaining a hydroponic system can be challenging, requiring constant monitoring and adjustments of water pH levels, nutrient concentration, and temperature.

This is where automation technology comes in to make hydroponics easier to manage. An automated hydroponic system uses sensors, controllers, and actuators to monitor and adjust the environment inside the hydroponic setup. With automation, growers can focus on other aspects of farming while the system takes care of the plants' needs.

In this context, an introduction to a Hydroponics Automation System could be a description of how automation technology can help hydroponic farmers achieve greater efficiency, productivity, and sustainability in their operations. The introduction may also touch on the benefits of using an automated system, the types of sensors and

controllers involved, and the potential cost savings associated with automating hydroponic farming.

Hydroponics is a method of planting where nutrient solution is used instead of soil. The nutrient solution is circulated to plants through lines. Temperature is a major parameter for plant growth. In a hydroponic system it is observed that there are at least 2 types of temperatures the temperature of nutrient solution and the solution of the environment of the plants. The environmental temperature is nothing but the ambient air temperature surrounding the plants. Due to heat isolation of the pipeline and different heat capacity both the temperature may not be the same. Usually, the pipelines are PVC material in a hydroponics plant.

PVC is a heat insulator which prevents heat transfer from environment to nutrient solution and conversely. However, the nutrient solution has higher heat capacity than the environment which makes them more inert. Thus, the temperature change should be slower than the environment. The basicity of the nutrient solution is measured using pH meter, pH of a nutrient solution says whether it is basic (≥ 7) or acidic (< 7) in nature.

Higher the pH higher the basicity of the solution. It is important to maintain the plant in a pH for optimal growth because it is directly related to the nutrient availability for the plant. The TDS meter uses ion connection method to measure electrical conductivity and provides the ppm value which is particle per million. With this we can understand the amount of nutrition dissolved. Since a hydroponic plant doesn't have soil-based nutrition the Total dissolved solids in the nutrient solution is the primary and only source of nutrition for the plant. It is vital to maintain this in optimal value for better and healthy growth. Using IoT and maintaining the plant can reduce plant maintenance cost around 23%-70% with increase in growth.

OBJECTIVE OF THE PROJECT

To develop an end-to-end hydroponic system which observes data using IOT devices and uses ML technique to automate the maintenance process the objective of a Hydroponic Automation System project could be to design and implement a fully automated hydroponic system that can monitor and control various environmental factors such as water and nutrient levels, temperature, humidity, and lighting.

The project could involve the use of sensors to collect data on the environmental conditions in the hydroponic system and automated actuators to adjust those conditions as needed to ensure optimal plant growth and productivity. Additionally, the system could be designed to have a user-friendly interface that allows users to monitor and control the system remotely, set up alerts and notifications, and track the progress of their crops.

Ultimately, the goal of the project would be to create a reliable, efficient, and sustainable hydroponic system that can be used for a variety of applications, such as indoor farming, urban agriculture, and food production in areas with limited access to arable land.

The objective of the proposed hydroponics automation system is to improve the efficiency and accuracy of plant growth in a hydroponic environment by reducing the need for manual intervention.

The system aims to achieve this by utilizing sensors and controllers to continuously monitor and adjust various parameters such as water level, pH, and temperature. The ultimate goal is to create a fully automated system that can provide optimal growing conditions for plants, leading to increased yields and reduced labor costs for growers.

Accurate Monitoring: The Hydroponics Automation System should be able to monitor the growing conditions of the plants accurately. The system should be able to measure parameters such as temperature, humidity, pH, water level, nutrient level, and light intensity.

Automatic Control: The system should be able to automatically control the growing conditions of the plants based on the monitored parameters. For example, if the temperature gets too high, the system should be able to turn on a cooling system to lower the temperature.

Energy Efficiency: The system should be designed to be energy-efficient. It should use sensors and controllers that consume minimal power, and the system should be designed to turn off when not in use.

Remote Monitoring and Control: The Hydroponics Automation System should be accessible remotely through a mobile or web-based application. This would allow the user to monitor the growing conditions of the plants from anywhere and adjust the settings remotely.

Data Logging: The system should be able to log the data collected by the sensors and controllers. This data can be used to analyze the growing conditions of the plants, and make adjustments to improve plant growth and yield.

User-Friendly Interface: The system should have a user-friendly interface that is easy to use and understand. This would allow users with minimal experience in hydroponics to operate the system easily.

MOTIVATION

Hydroponics automation system offers several advantages over traditional soil-based agriculture. It allows for more efficient use of resources such as water and fertilizer, as well as more precise control over the growing environment, resulting in higher crop yields and better-quality produce. Additionally, hydroponic systems can be implemented in a variety of environments, including urban areas with limited space for traditional farming.

Automating the hydroponic system further increases its efficiency and productivity, reducing labor costs and minimizing the potential for human error. The use of sensors and controllers allows for real-time monitoring and adjustment of environmental factors such as temperature, humidity, pH, nutrient levels, and lighting. This helps to ensure that plants receive the ideal conditions for growth and development.

Moreover, the automation system can be integrated with various devices such as smartphones or computers, making it possible to monitor and control the system from a remote location. This makes it easier for farmers to manage multiple hydroponic systems simultaneously and respond quickly to any changes or issues.

In addition to these practical benefits, hydroponics automation system can also have positive environmental impacts. By reducing the need for pesticides and herbicides and minimizing water usage, hydroponic farming can be more sustainable and eco-friendlier than traditional agriculture.

The implementation of hydroponics automation system offers a promising solution to some of the challenges facing modern agriculture, providing a more efficient, sustainable, and profitable way to grow crops.

CHAPTER-II

LITERATURE SURVEY

There have been several proposals on developing IoT based controlling system for hydroponic maintenance. An IoT based monitor for temperature, volume, concentration and pH of the nutrient solution was developed by [1] which used Arduino Uno as microcontroller and ESP8266 as Wi-Fi module to connect to internet and Raspberry Pi 2B as webserver. these values were available in a web page. Another hydroponic system named as iHydro IoT from [2] which uses Arduino Uno (microcontroller) to collect data from sensors, sensors communicate through Bluetooth Low Energy (BLE) module. Raspberry Pi 2 (webserver) receives measurements from Arduino Uno which sends the data for visualization to plotly cloud service. This system was to monitor several parameters of nutrients, air humidity, acidity, concentration, light intensity, volume and CO₂. Research done by [7] applied IoT specifically to monitor pH and nutrient solution temperature in NFT method which shows condition on LCD and send notification via SMS gateway and Automated control over the PH and oxygen pump actuator.

Kularbphittong et al [8] research is a 2 part IoT for hydroponics system where user control vitals such as humidity, light and temperature manually or the system automatically self regulates by checking and refilling. [3] proposes a advanced IoT-based monitoring system for hydroponics which not only performs monitoring but also data analytics using AI (Artificial Intelligence). IT has a complex sensor pack that includes lux, UV, water, dissolved oxygen CO₂, altitude, electrical conductivity pH temperature, water temperature and TDS. The system also collects visual data using 2 cameras. To collect all data from sensors except camera Arduino Mega is used. Raspberry Pi 3B+ is used to collect visual data and to send both measurement and visual data to database via Wi-Fi which is further analyzed using deep learning method for prediction. Previous research works on this subject show that we are not just restricted to show notification and warnings but it can also help in maintenance using artificial

intelligence. The model can make predictions to improve both quality and quantity of the hydroponics production and to make classification in another hydroponics study [9] nutrient management is forecasted by integrating IoT with Deep Neural Network (DNN). The DNN model predicts the label based on the table which have 8 labels and the system outputs sensor values, predicted control label with accuracy percentage. In another research by Shekar[10] prediction using machine learning and IoT was conducted. It was a soil based system with automated irrigation system where the machine learning model used KNN to predict the soil condition.

Previous study, article [11], suggests the application of fuzzy logic with IOT for system monitoring and control. The Internet of Things device is utilized to monitor plant conditions and water demands, while fuzzy logic is employed to precisely manage the delivery of water and nourishment. This study also compares the usage of smart management with a traditional way using lettuce and bok choy plants. The results suggest that applying smart control improves plant growth, which is supported by the outward appearance of the plants.

Bayesian Network (BN) was used by Alipio et al. [12] to monitor and regulate a hydroponic system, and they found an improvement in crop output of roughly 67.67% compared to manual fertiliser control. Moisture and temperature sensors have been integrated into an automated system, and (KNN) Mehra et al.

[13] have used a classification machine learning method to analyse and provide predictions about fertiliser and water management. In order to forecast the pH and electric conductivity, which are indicators of the water quality and the variety of nutrients dissolved in it. Herman et al.

[14] used Artificial Neural Networks (ANN). An IoT-based control system for hydroponic fodder setup was described in another study [15] to monitor and manage water spraying, water level, humidity, water pH, ambient light, and nutrient level.

Additional online and mobile applications with a user-friendly graphical user interface (GUI) were created to visualize the sensor data and, if necessary, manually manage the device.

Artificial neural networks have been used in smart farming by Ferentinos and Albright (2007) to regulate the amounts of pH and electrical conductivity in hydroponic systems. Here, a Feed Forward Neural Model is used to provide two outputs for pH and EC based on nine different inputs. These results show that the Neural Network model correctly predicts the pH and EC values needed to regulate the hydroponics system. Another study which put out a knowledge distillation-based low-power deep learning model for detecting plant diseases. The suggested low-power model comprised a straightforward shallow neural network topology. The specifications of the model were decreased by more than 90%. Both the amount of processing needed and the amount of electricity used are decreased. The suggested low-power model obtained a detection accuracy of 99.4% with a maximum power consumption of 6.22 W, which is much less than the current models.

EXISTING SYSTEM

FramBot: The process of growing plants in hydroponic systems can be automated using FramBot, a robotic farming device. In order to track and manage plant growth, it makes use of a computer vision system and a variety of sensors.

Grobo: A fully automated hydroponics system called Grobo enables customers to grow plants in a regulated environment. It has an integrated pH monitoring system, nutrition dosing system, and LED lighting system.

AeroGarden: An indoor hydroponics system that is small and portable is called AeroGarden. It gives plants the ideal growing circumstances with an integrated LED lighting system and fertiliser dosing system.

Seedo: A smartphone app can be used to manage the Seedo automated hydroponic growing system. It has an LED lighting system, a dosing system for nutrients, and an integrated camera.

Urban Cultivator: A hydroponic growing system called Urban Cultivator is intended for usage in homes and restaurants. It gives plants the ideal growing circumstances with an integrated LED lighting system and fertilizer dosing system.

CHAPTER III

METHODOLOGY

A. **Watering System:** The system should have a watering mechanism that can be automatically triggered when the temperature of the hydroponic solution is within the optimal range for plant growth. In the provided code, the watering mechanism is represented by the servo motor connected to pin 3. The servo motor can be used to control a valve that releases water into the hydroponic solution.

B. **Temperature Control:** Temperature control is critical for maintaining plant health in a hydroponic system. The provided code includes a temperature sensor connected to analog pin A0. The system can use this sensor to monitor the temperature of the hydroponic solution and trigger the watering mechanism when the temperature is within the optimal range for plant growth. In the provided code, the optimal temperature range is set to between 18.3 and 26.7 degrees Celsius.

C. **Lighting System:** Plants require specific light conditions to grow properly. The system should have a lighting system that can be automatically turned on and off to provide the plants with the necessary light. The lighting system can be controlled using a relay connected to a digital pin on the Arduino board.

D. **Nutrient Monitoring:** The nutrient levels in the hydroponic solution need to be monitored regularly to ensure that the plants have the proper nutrients to grow. This can be done using a pH sensor and an electrical conductivity (EC) sensor. The pH sensor can be used to measure the acidity or alkalinity of the hydroponic solution, while the EC sensor can be used to measure the concentration of dissolved salts in the solution.

E. **User Interface:** The system can include a user interface that allows the user to monitor and control the system. This can be done using an LCD display connected to the Arduino board. The display can show information such as the temperature, nutrient levels, and lighting status. The user interface can also include buttons or a touch screen to allow the user to control the system, such as turning the lighting system on or off or adjusting the watering schedule.

F. **Sensors:** Sensors are used to monitor the growing conditions of the plants. These sensors can measure parameters such as temperature, humidity, pH, water level, nutrient level, and light intensity.

G. **Controller:** The controller receives data from sensors and uses it to adjust plant growing conditions. The controller can turn on and off various devices such as fans, heaters, cooling systems, water pumps, and nutrient pumps to maintain optimal growing conditions. The controller acts as the brain of the system, making necessary adjustments based on the data collected by sensors. With the help of a controller, it is possible to maintain a stable and ideal growing environment for plants. In summary, the controller is a critical component that plays a vital role in adjusting and maintaining the growing conditions of plants.

H. **User Interface:** The user interface allows the user to monitor the growing conditions of the plants and adjust the settings remotely. This can be done through a mobile or web-based application. The user interface enables users to remotely monitor plant growing conditions and make adjustments through a mobile or web-based application. It provides an easy and accessible way for users to interact with the system. The user interface allows users to view data collected by the sensors and controllers and make necessary changes. With the user interface, users can monitor and control the

AUTOMATED HYDROPONICS GROWING SYSTEM

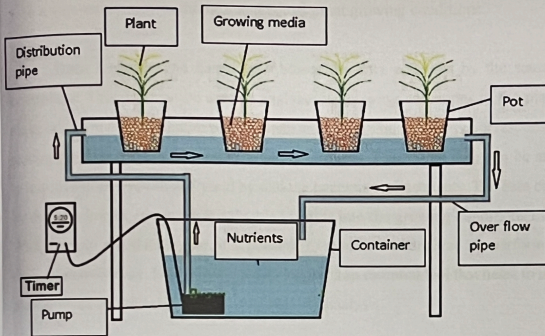


Figure – 1.1 Working of Model

The world's population is predicted to reach 9.15 billion in 2050 [1], and in order to improve food supply globally, even more agricultural advancements must be developed, particularly in crop yields and practices that are more environmentally friendly. Without using soil, hydroponics is a technique for growing plants in water. The approach is referred to as nutrient film technique (NFT) if the roots are sustained using an inert media or suspended in a liquid medium. The plants (lettuce, leafy crops, and herbs) in NFT systems are fed constantly at a rate of about 1 L min⁻¹ in channels (gullies). In addition to being environmentally friendly, hydroponics can also offer several other advantages over traditional farming methods, such as faster growth rates, higher yields, and the ability to grow crops year-round. NFT systems can also be designed to use less space and require less labor compared to traditional farming methods. However, hydroponics does require a significant initial investment in equipment and infrastructure, and it also requires careful monitoring and maintenance to ensure optimal growing conditions for the plants

system remotely. In summary, the user interface is an essential tool that provides users with a convenient way to monitor and adjust plant growing conditions.

I. **Data Logger:** The data logger stores the data collected by the sensors and controllers. This data can be used to analyze the growing conditions of the plants and make adjustments to improve plant growth and yield. The data logger is responsible for storing the data collected by sensors and controllers. This stored data can be analyzed to improve plant growth and yield by making necessary adjustments. The data collected by the data logger can provide valuable insights into the growing conditions of plants. With the help of a data logger, it is possible to monitor and analyze the performance of the system over time. In summary, a data logger is an essential tool that helps to improve plant growth by collecting and storing data for analysis.

J. **Power Supply:** The power supply provides power to the sensors, controller, and other devices. The power supply is an essential component that supplies electricity to various devices such as sensors and controllers. It is responsible for ensuring that the devices receive a steady and stable source of power to function correctly. Without the power supply, the devices would not be able to operate. The power supply is crucial for the proper functioning of an electronic system and is often included as a standard component in most devices. In summary, the power supply plays a vital role in providing power to the different components of an electronic system.

K. **Hydroponic System:** The hydroponic system consists of the growing medium, plants, and nutrient solution. The hydroponic system can be configured in various ways depending on the type of plants being grown and the available space.

Comprehensive Overview

Temperature Sensor:

The temperature sensor should be placed near the plants, but away from any heat sources, such as grow lights or heating elements. Placing the temperature sensor too close to heat sources can cause inaccurate readings. Temperature sensors are commonly used in hydroponics automation systems to monitor the temperature of the hydroponic environment. This information can be used to make adjustments to the environment to ensure optimal plant growth. For hydroponic cultivation to be successful, the right temperature must be maintained because it can affect plant growth, nutrient uptake, and disease susceptibility. In addition to temperature sensors, hydroponics automation systems may also employ various sensors to track the growth environment, including pH sensors, dissolved oxygen sensors, and electrical conductivity sensors.

Humidity Sensor:

The humidity sensor should be placed near the plants, but away from any sources of moisture, such as a water reservoir. Placing the humidity sensor too close to water sources can cause inaccurate readings. A humidity sensor is an electronic device used to measure the amount of moisture or water vapor in the air. In a hydroponics automation system, a humidity sensor is used to monitor the humidity levels of the environment around the plants. The humidity levels need to be carefully monitored and maintained to ensure optimal plant growth and health. The humidity sensor works by measuring the electrical resistance changes caused by the moisture levels in the air. These changes are then converted into a humidity reading that can be used to control the system. In hydroponics, the ideal humidity levels will vary depending on the type of plants being grown and the stage of growth they are in.

pH Sensor:

The pH sensor should be placed in the nutrient solution near the roots of the plants. The pH of the nutrient solution is critical to plant growth, so it is essential to monitor it accurately. Automated hydroponics systems use pH sensors in combination with controllers to adjust the pH level of the nutrient solution automatically.

The controller receives information from the pH sensor and activates dosing pumps or valves to add pH-adjusting chemicals to the solution. This maintains the pH level at the desired range and ensures optimal nutrient uptake by the plants.

Water Level Sensor:

The water level sensor should be placed in the water reservoir. This sensor will monitor the water level in the reservoir and ensure that the plants are receiving an adequate amount of water.

A water level sensor is an electronic device used to measure the depth or height of water in a container or tank. In a hydroponics automation system, water level sensors are crucial for maintaining the proper water levels in the growing containers.

Nutrient Level Sensor:

The nutrient level sensor should be placed in the nutrient solution near the roots of the plants. This sensor will monitor the nutrient level in the solution and ensure that the plants are receiving an adequate amount of nutrients. Nutrient level sensors are used in hydroponics automation systems to monitor the concentration of nutrients in the water solution that is supplied to the plants. These sensors typically measure the electrical conductivity (EC) of the water, which is directly proportional to the concentration of dissolved salts and minerals.

Light Sensor:

The light sensor should be placed near the grow lights. This sensor will measure the intensity of the light and ensure that the plants are receiving the proper amount of light for optimal growth.

Light level sensors are essential for hydroponic growers because they provide information about the intensity and duration of light received by plants. This information can help growers optimize plant growth by adjusting light intensity and duration based on plant needs.

Overall, the placement of sensors in a hydroponics system is critical to ensure accurate monitoring of the growing conditions of the plants. By placing the sensors in the correct locations, the Hydroponics Automation System can adjust the growing conditions to maintain the ideal conditions for plant growth and yield.

In a Hydroponics Automation System, the placement of sensors near the plants is critical to ensure accurate monitoring of the growing conditions. The temperature sensor should be placed near the plants but away from heat sources, while the humidity sensor should be placed near the plants but away from water sources.

The pH and nutrient level sensors should be placed in the nutrient solution near the roots of the plants, while the water level sensor should be placed in the water reservoir. The light sensor should be placed near the grow lights to measure the intensity of light. By placing the sensors in the correct locations, the Hydroponics Automation System can adjust the growing conditions to maintain the ideal conditions for plant growth and yield.

COMPONENT

NAME	QUANTITY	COMPONENT
U1	1	Arduino UNO R3
R3	2	220-ohm Resistor
R1		
PIR 1	1	-1.7016935189521405,-333.3158206495781, -156.11385917719122 PIR Sensor
U3	1	LCD 16*2
U1	1	Temperature Sensor [TMP36]
SERVO1	1	Continuous Micro Servo
R4	1	Photo resistor
L1	1	Light bulb
RPOT 2	1	250 kilo ohm Potentiometer
PING 1	1	Ultrasonic Distance Sensor

Arduino Uno R3:

- This is a microcontroller board that serves as the brain of the system. It can read inputs from various sensors, process the data, and control the actuators to maintain the ideal growing conditions.
- Arduino Uno R3 is a microcontroller board based on the ATmega328P microcontroller. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, power jack, ICSP header, and a reset button. It is widely used in automation systems, including hydroponics systems, to control and monitor various sensors, actuators, and other electronic components.

220-ohm Resistor:

- This is a component used to limit the current flow through an LED or other components. 220-ohm resistor is an electronic component that is commonly used in hydroponics automation systems to limit the current flow in a circuit.
- It acts as a protection device for other components in the circuit, particularly LEDs, by limiting the current flowing through them and preventing them from burning out. In hydroponics automation systems, the 220-ohm resistor is typically used to limit the current flowing through the LED display, ensuring that it doesn't exceed its maximum current rating.

LCD 16x2:

- This is a display that shows the data collected by sensors and the system status. It is commonly used in electronic devices to display various information such as system status, sensor data, or messages. The display is controlled by a microcontroller,

which sends data to the display to update the information being shown. The LCD 16x2 is widely used due to its low power consumption, low cost, and simplicity of use.

Temperature Sensor [TMP36]:

- This is a sensor that measures the temperature of the growing medium and sends t
The TMP36 is a temperature sensor that can be used to measure the temperature of a growing medium or any other object or environment. It is an analog sensor that outputs a voltage proportional to the temperature it is measuring.
- The Arduino Uno R3, which is a microcontroller board, can read this voltage and convert it into a temperature value using a formula. The formula relates the voltage output of the sensor to the temperature being measured.
- Once the temperature value is calculated by the Arduino, it can be processed or displayed as needed. Overall, the TMP36 temperature sensor is a reliable and accurate way to measure temperature in various applications, including agriculture and gardening. He data to the Arduino Uno R3.

Continuous Micro Servo:

- This is an actuator used to adjust the water flow to the plants. The servo can be controlled by the Arduino Uno R3 to maintain the ideal water level.
- In a hydroponics system, the Continuous Micro Servo can be used to control the water release mechanism. By rotating the servo motor, the water valve can be opened or closed, allowing the system to release water as needed for the plants.
- continuous micro servo is a type of actuator or motor that can rotate continuously in either direction, as opposed to a standard servo which can only rotate within a limited range of angles.
- In a hydroponic system, the continuous micro servo can be used to control the flow of water to the plants. By connecting the servo to a water valve or gate, the Arduino

Uno R3 microcontroller can rotate the servo to open or close the valve as needed, adjusting the water flow to maintain the ideal water level for the plants.

Photoresistor:

- This is a sensor that measures the intensity of light and sends the data to the Arduino Uno R3. A photoresistor, also known as a light-dependent resistor (LDR), is an electronic component that changes its resistance based on the amount of light falling on its surface.
- The resistance of the photoresistor decreases as the intensity of light falling on it increases, and vice versa. Photoresistors are used in hydroponics automation systems to measure the intensity of light in the grow area.

Light bulb:

- This is a component that emits light and can be controlled by the Arduino Uno R3 to adjust the light intensity. bulbs are used in hydroponics automation systems to provide artificial light to plants.
- They emit light in the visible spectrum that plants can use for photosynthesis. Different types of light bulbs are used in hydroponic systems, including fluorescent, LED, and high-pressure sodium bulbs. Fluorescent bulbs are a popular choice because they are energy-efficient and emit less heat than other bulbs, reducing the risk of overheating in the hydroponic system.

250- ohm potentiometer:

- This is a variable resistor that can be used to adjust the intensity of light or the position of the Continuous Micro Servo. In a hydroponics automation system, a 250-ohm potentiometer is an electrical component used to adjust the brightness of a light

source. The potentiometer, also known as a variable resistor, allows the user to vary the resistance of the circuit, thereby controlling the amount of current that flows through the

- In a hydroponics automation system, a 250-ohm potentiometer is an electrical component used to adjust the brightness of a light source. The potentiometer, also known as a variable resistor, allows the user to vary the resistance of the circuit, thereby controlling the amount of current that flows through the circuit. This, in turn, controls the amount of power that is delivered to the light source, which affects its brightness.

Ultrasonic Distance Sensor:

- This is a sensor that measures the distance of the water level in the reservoir and sends the data to the Arduino Uno R3.
- An Ultrasonic Distance Sensor is a type of sensor that uses high-frequency sound waves to measure the distance between the sensor and an object. It consists of a transmitter and a receiver that sends and receives sound waves respectively.
- The sensor works by sending a high-frequency sound wave towards the object and measuring the time it takes for the sound wave to bounce back to the receiver. By knowing the speed of sound, the distance between the sensor and object can be calculated.

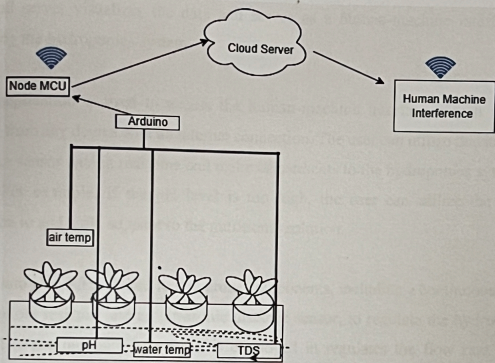


Figure – 1.2 Working of Model

An innovative way to grow plants without soil is through hydroponics, which uses water and nutrient-rich solutions. It might be difficult to maintain the right circumstances for plant growth, such as pH, water temperature, and TDS (total dissolved solids). Automation can help in the situation.

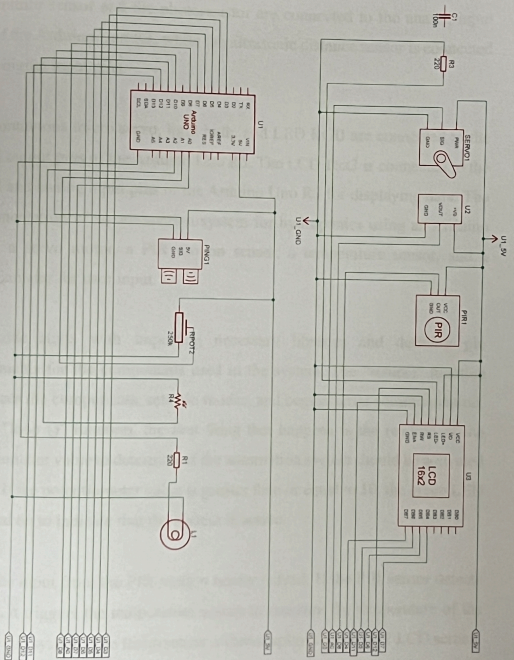
Several sensors are employed in this hydroponics automation system to keep track of the pH, water temperature, and TDS of the nutrient solution. A pH sensor, a temperature sensor, and a TDS sensor are among the sensors. A node MNC receives the data from the sensors and feeds it to it using an Arduino Uno R3, which is attached to the sensors.

Data is gathered from many sources and sent to the cloud server by the node MNC. The node MNC in this system is in charge of sending Sensor data is sent to a cloud server. The cloud server visualizes the data and serves as a human-machine interface for controlling the hydroponics system.

A web application is used to access the human-machine interface, which may be accessed from any device with an internet connection. The user can utilize this interface to monitor sensor data in real time and make adjustments to the hydroponics system as needed. For example, if the pH level is too high, the user can utilize the online application to add a pH adjuster to the nutritional solution.

The Arduino Uno R3 is linked to numerous components, including a continuous micro servo, a photo resistor, and an ultrasonic distance sensor, to regulate the hydroponics system. The continuous micro servo is employed in regulates the flow rate of the nutritional solution, while the photo resistor and ultrasonic distance sensor check the light and water levels, respectively.

Overall, this hydroponics automation system offers a convenient and efficient method of monitoring and controlling the hydroponics environment, ensuring optimal plant growth and productivity.



SCHEMATIC VIEW

The schematic view of this hydroponics automation system shows how the different components are connected to the Arduino Uno R3 board. The temperature sensor and the photoresistor are connected to the analog input pins of the Arduino Uno R3, while the ultrasonic distance sensor is connected to the digital input pins.

The continuous micro servo, light bulb, and LED RGB are connected to the digital output pins of the Arduino Uno R3. The LCD 16x2 is connected to the digital and analog input pins of the Arduino Uno R3 for displaying data. The implementation of an automation system for hydroponics using an Arduino board, a servo motor, a PIR motion sensor, a temperature sensor, and a potentiometer for user input.

The code starts with importing necessary libraries and defining pin assignments for the components used in the system. The "setup()" function initializes the components, sets pin modes, and begins serial communication. In the "loop ()" function, the first thing that happens is the reading of the potentiometer value to determine if the automation system should be activated or not. If the potentiometer value is greater than or equal to 10, the green LED is turned on to indicate that the system is active.

Next, the input from the PIR motion sensor is read. If the PIR sensor detects motion, it triggers the temperature sensor to measure the temperature of the hydroponic system. The temperature is then displayed on a 16x2 LCD screen. If the temperature is within the optimal range for plant growth (18.3 to 26.7 degrees Celsius), the green LED is turned on, and the servo motor is activated to release water into the hydroponic system. Otherwise, the red LED is turned on, indicating that no water should be released.

Working:

Inputs:

- Potentiometer value (int)
- LDR value (int)
- Ultrasonic sensor value (int)
- Temperature sensor value (int)
- PIR motion sensor value (int)

Outputs:

- Servo motor position (int)
- Greenhouse bulb state (HIGH/LOW)
- Plant bulb state (HIGH/LOW)
- LCD display output (string)

Steps:

1. Read potentiometer value and store it as potValue.
2. Read LDR value and store it as ldrValue.
3. Use ultrasonic sensor to measure the distance between the water level and the sensor and store it as inches.
4. Use temperature sensor to measure the temperature and store it as temp
5. If inches < 4.4: a. Clear the LCD display b. Display the water level and temperature on the LCD display c. Move the servo motor to release water d. Turn off the greenhouse bulb e. Read PIR motion sensor value and turn on the greenhouse bulb if it is HIGH.
6. If inches > 4.4: a. Clear the LCD display b. Display "Do Not Water" on the LCD display c. Move the servo motor to close the water release valve d. Read PIR motion sensor value and turn on the greenhouse bulb if it is HIGH and LDR value is less than 7, else turn off the greenhouse bulb.
7. If temp < 18.4 and LDR value is less than 7 or pot Value is greater than 0: a. Turn on the plant bulb.
8. Else: a. Turn off the plant bulb.
9. Repeat steps 1-8 in a loop.

Implementation

Step 1: Set up the Tinker cad workspace. Open Tinker cad in your browser and log in to your account. Create a new project and give it a name. Drag and drop the necessary components onto the workspace.

Step 2: Design the hydroponics system. Begin by creating the hydroponics system. This could be a simple setup with a water tank, a pump, and tubing, or it could be more complex with additional components such as sensors, valves, and filters. Use Tinker cad's component library to select the appropriate parts and position them in the workspace. Connect the components with wires to complete the circuit.

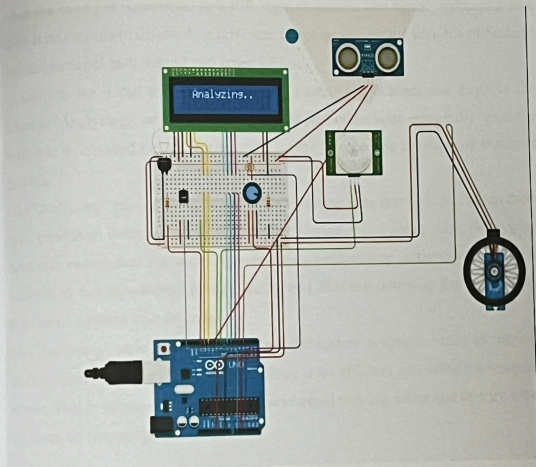
Step 3: Add automation features. Add an Arduino microcontroller to the workspace. Connect the microcontroller to the hydroponics system with wires. Add sensors to monitor the temperature, pH, and nutrient levels of the water. Use Tinkercad's code editor to write a program that reads the sensor data and controls the pump and other components accordingly. Test the automation system to ensure that it is working properly.

Step 4: Customize and improve the system. Experiment with different components and designs to optimize the hydroponics system. Add features such as LED lighting to improve plant growth. Use Tinkercad's simulation feature to test the system under different conditions. Once you are satisfied with the design, save the project and share it with others.

In summary, to implement a hydroponics automation system using Tinkercad, you need to design the hydroponics system, add automation features, customize and improve the system, and test it to ensure that it works properly. With Tinkercad's intuitive interface and powerful simulation tools.

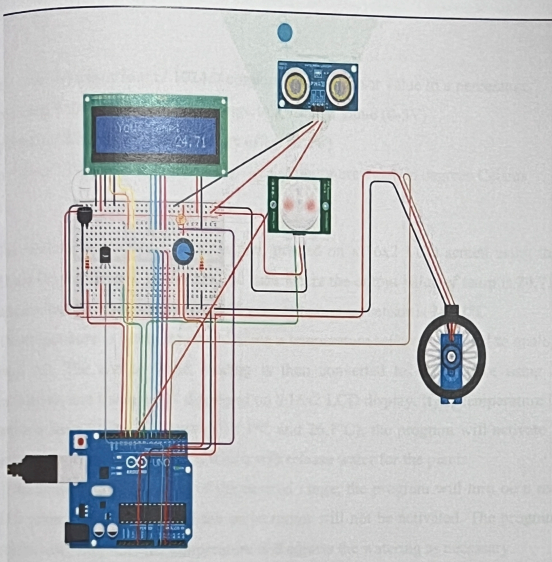
CHAPTER V

RESULT AND DISCUSSION



- The "Analyzing" is a function that is executed when there is no movement detected by the PIR sensor. This function is essentially a waiting state, indicating that the code is waiting for movement to be detected before taking any action.
- When the PIR sensor does not detect any movement, the LCD display will show "Analyzing." The servo motor will move back to the initial position of 0 degrees, and both the red and green LEDs will be turned off.

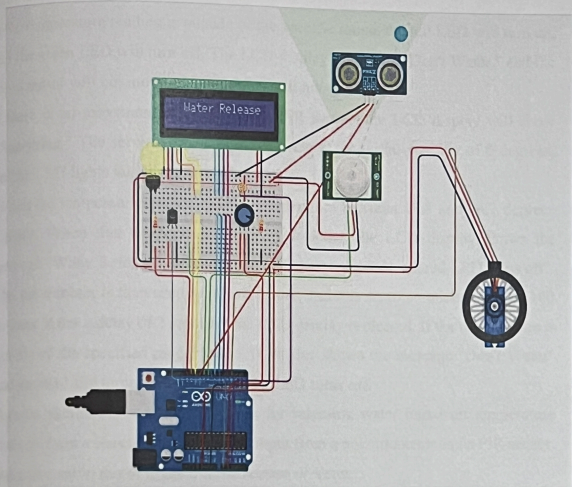
- This function helps to conserve energy and resources by preventing unnecessary water release when there is no movement detected by the PIR sensor. It also ensures that the system is always ready to respond quickly when movement is detected, making it an efficient and effective watering system.
- when the input pin (connected to a PIR sensor) reads a low signal, indicating that there is no movement detected. In this case, the program sets the variable `pirState` to low and turns off both the red and green LEDs.
- It also sets the initial position of the servo motor to 0 degrees and displays the message "Analyzing." on the LCD screen. This part of the code essentially waits for motion to be detected before proceeding with the temperature sensing and watering process.
- The "Analyzing" part of the code serves as a waiting state that activates when there is no movement detected by the PIR sensor. During this waiting state, the system conserves energy and resources by preventing unnecessary water release. This is achieved by turning off both the red and green LEDs and returning the servo motor to its initial position of 0 degrees.
- The "Analyzing" state helps to ensure that the system is always ready to respond quickly when movement is detected, making it an efficient and effective watering system. This is important because it helps to avoid wasting water and energy when the plants do not require watering.



- The variable `temp` is used to store the temp value obtained from an `analogtemp` sensor connected to the Arduino board via the `sense` Pin (A0). The temperature sensor used in this code seems to output a voltage that varies linearly with temperature in the range of 0.5V to 4.5V (0°C to 100°C).
- The code first reads the raw sensor input value using the `analog Read()` function, which returns a value between 0 and 1023, corresponding to the voltage input range of 0 to 5V. Then, the raw sensor input value is converted to a temperature value in degrees Celsius using the following formula:

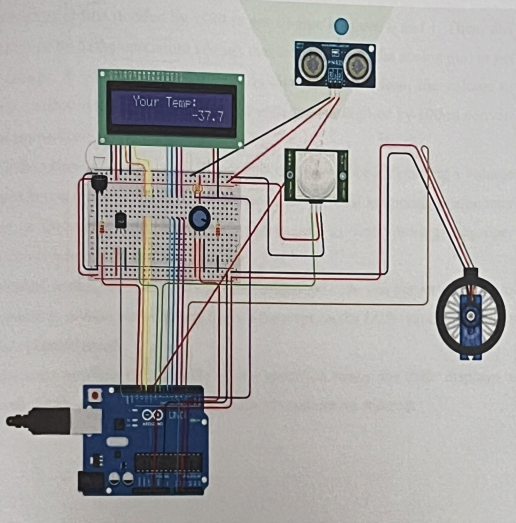
```
temp = (double)sensor Input / 1024; // convert the raw sensor value to a percentage  
temp = temp * 5; // convert the percentage to a voltage value (0-5V)  
temp = temp - 0.5; // subtract the voltage offset (0.5V)  
temp = temp * 100; // convert the voltage to a temperature value in degrees Celsius
```

- The resulting temperature value is then printed on a 16x2 LCD screen using the Liquid Crystal library. In the specific case where the output value of temp is 24.71, it means that the temperature sensed by the temperature sensor is 24.71°C
- The temperature is being measured using a temperature sensor connected to analog input A0. The analog input reading is then converted to temperature using a calculation, and the result is displayed on a 16x2 LCD display. If the temperature is within a specific range (between 18.3°C and 26.7°C), the program will activate a servo motor connected to pin 3, which will release water for the plants.
- If the temperature is outside of the desired range, the program will turn on a red LED connected to pin 10 and the servo motor will not be activated. The program continuously monitors the temperature and adjusts the watering as necessary.
- The temperature sensing and watering system for plants using a servo motor and an LCD display. It describes how the temperature is measured, how it is converted to a readable value, and how the servo motor is activated to water the plants if the temperature is within the desired range.



- The "water release" is a function of a servo motor that controls the opening and closing of a valve that releases water. In this code, the water release function is activated when the temperature reading from the sensor is within a specific range, i.e., between 18.3 and 26.7 degrees Celsius.
- When the temperature reading meets this condition, the green LED will turn on, and the red LED will turn off. The LCD display will show "Water Release," and the servo motor will turn 180 degrees, which will open the valve and release the water. After two seconds, the LCD display will be cleared.

- If the temperature reading is outside of the specific range, the red LED will turn on, and the green LED will turn off. The LCD display will show "Don't Water," and the servo motor will not move, i.e., the valve will not open.
- If there is no movement detected by the PIR sensor, the LCD display will show "Analyzing." The servo motor will move back to the initial position of 0 degrees, and the LED lights will be turned off.
- When the temperature sensor reads a temperature between 18.3 and 26.7 degrees Celsius. When this temperature range is detected, the LCD display shows the message "Water Release" and the green LED turns on while the red LED turns off.
- The servo motor is then used to release water, and it is set to an initial angle of 180 degrees. After a delay of 2 seconds, the LCD display is cleared. If the temperature is outside of the specified range, the LCD display shows the message "Don't Water" and the red LED turns on while the green LED turns off.
- Arduino sketch that controls a system for releasing water based on temperature readings from a sensor. The code reads input from a potentiometer and a PIR sensor, and uses a servo motor to control the release of water.
- If the PIR sensor detects movement and the temperature reading falls within a specific range, the system releases water and displays "Water Release" on an LCD screen.
- If the temperature is outside the acceptable range, the system displays "Don't Water" on the LCD screen. If there is no movement detected by the PIR sensor, the system displays "Analyzing" on the LCD screen and does not release any water.



- The variable "temp" is being used to store the temperature reading from an analog sensor connected to pin A0 of the Arduino board.
- The following lines of code are used to convert the analog reading to the corresponding temperature value in Celsius:

```

    sensor Input = analog Read(A0);
    temp = (double)sensor Input / 1024;
    temp = temp * 5;
    temp = temp - 0.5; temp = temp * 100;

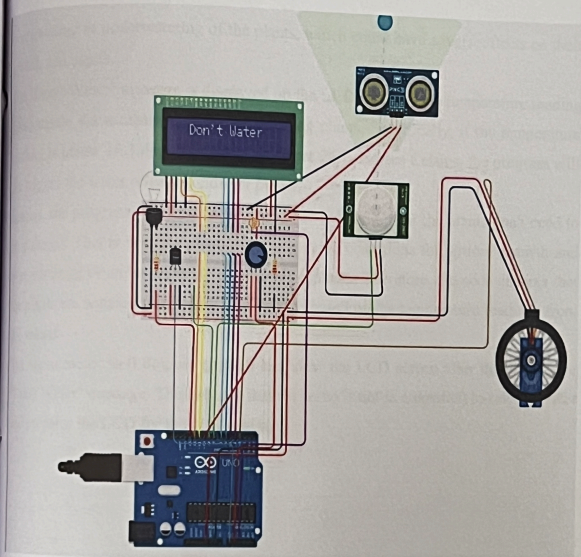
```

The analog reading is first divided by 1024 to get a value between 0 and 1. Then, this value is multiplied by 5 (the maximum voltage that can be read by the analog pin) to get the actual voltage. A constant value of 0.5V is then subtracted from the voltage to account for the offset in the sensor. Finally, the voltage is multiplied by 100 to convert it to Celsius temperature units.

Therefore, if the value of "temp" is -37.7, it means that the sensor is detecting a voltage that corresponds to a temperature of -37.7 degrees Celsius. This temperature value may be incorrect or inaccurate due to various reasons such as faulty wiring, improper calibration, or environmental factors.

- If the temperature reading is within the specified range, the code sets the servo motor to a certain position to release water and displays a message on the LCD screen indicating that water has been released.

- If the temperature reading falls outside of the specified range, the code displays a message on the LCD screen indicating that water should not be released.



The "Don't Water" is a function that is executed when the temperature reading from the sensor is not within the specified range, i.e., when the temperature is either below 18.3 or above 26.7 degrees Celsius.

When the temperature reading meets this condition, the red LED will turn on, and the green LED will turn off. The LCD display will show "Don't Water," and the servo motor will not move, i.e., the valve will not open.

This function is essentially a warning message indicating that it is not suitable to release water at that time due to the temperature being outside the desired range. It helps prevent

overwatering or underwatering of the plants, which could have adverse effects on their growth and health.

The "Don't Water" message is displayed on the LCD screen if the temperature reading falls outside the acceptable range for watering plants. Specifically, if the temperature reading is below 18.3 degrees Celsius or above 26.7 degrees Celsius, the program will not trigger the water release action for plants.

Instead, the program will turn on the Red LED indicating that the plants don't need to be watered. This is because plants require specific conditions for optimal growth and over-watering or under-watering can harm the plants. Therefore, the code ensures that the plants are watered only when they need it, based on the temperature readings from the sensor.

The servo motor to 0 degrees (initial) and clear the LCD screen after displaying the "Don't Water" message. This ensures that the servo is not in a position to release water and prepares the LCD for the next reading.

CONCLUSION

The hydroponics automation system is an effective solution to increase plant growth and yield, while reducing the amount of water and nutrients used. The system presented in the code provided includes several important features such as temperature sensing, moisture detection, and automatic water release, which can help to maintain ideal growing conditions for the plants.

However, there is still room for improvement and future works in this field. One possible improvement is to integrate a more advanced monitoring system that can detect and respond to changes in plant growth and health in real-time. This can be achieved by using advanced sensors and machine learning algorithms to analyze the data collected from the plants.

Another possible improvement is to automate the system further by incorporating robotic arms or other mechanical devices that can perform tasks such as pruning, harvesting, and fertilizing. This can not only reduce labor costs but also improve the accuracy and efficiency of the entire system.

In addition, the use of renewable energy sources such as solar or wind power can make the system more sustainable and reduce energy costs. Finally, the development of new and more efficient hydroponic techniques and systems can lead to even greater improvements in plant growth and yield, and further increase the efficiency and sustainability of hydroponics agriculture.

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