



IOT HYDROPONIC SYSTEM WITH SENSOR INTELLIGENCE

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ABSTRACT

Hydroponic farming, which uses less water and maximizes nutrient delivery, has become a popular way to grow plants without soil in response to the growing demand for sustainable agriculture. An IoT-enabled solar-powered hydroponic indoor farming and plant growth chamber is presented in this project. Its purpose is to establish a controlled atmosphere for the best possible plant growth. Powered by a solar-powered power source, the system makes use of the ARDUINO microcontroller for automation and real-time monitoring.

A 16x2 LCD screen, a buzzer for notifications, an AC water pump for automatic irrigation, temperature, humidity, and nutrient sensors, and a water level sensor are essential parts. The system has two modes of operation: manual and automatic. Using an Internet of Things platform, users can operate the irrigation pump remotely in Manual Mode. In Automatic Mode, the system automatically modifies the flow of water and nutrients depending on real-time sensor data. Sensor data is continuously uploaded.

to an Internet of Things cloud platform, allowing for remote observation and evaluation. The system's utilization of solar energy guarantees sustainability and energy efficiency while lowering reliance on traditional power sources. Increased yield and resource optimization result from improved plant growing conditions brought about by automated environmental factor control. By optimizing water and nutrients, this clever hydroponic technology reduces the need for human interaction.

KEYWORDS:IoT, Hydroponics, Solar Power, Indoor Farming, Plant Growth Chamber, Cloud Computing

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1. INTRODUCTION

The need for sustainable farming practices is growing as the world's population continues to rise. Obstacles to conventional farming practices include a lack of arable land, erratic weather patterns, and high water usage. One potential remedy for these problems is hydroponic farming. Hydroponics uses nutrient-rich water solutions to grow plants without the need for soil. This technique has a number of benefits, such as the capacity to grow crops in urban settings, quicker plant development, and effective water utilization.

An Internet of Things-enabled solar-powered hydroponic indoor farming and plant growing chamber that offers a regulated atmosphere for ideal plant growth is the goal of this project. The solution guarantees energy efficiency and sustainability by combining solar power and IoT technology, which lessens dependency on traditional power sources. Real-time monitoring and automation of environmental elements are made possible by IoT technology, which improves plant growth conditions and optimizes resources.

Both manual and automatic modes are built into the system's design. With the irrigation pump in Manual Mode, users may operate it remotely using an Internet of Things platform, giving them flexibility and the ability to step in when needed. When in Automatic Mode, the system automatically modifies the flow of water and nutrients in response to real-time sensor data, reducing the need for human interaction and guaranteeing ideal growing conditions for plants.

Sensors for temperature, humidity, and nutrients, a water level sensor, a 16x2 LCD screen, an alarm buzzer, and an AC water pump for automatic irrigation are important parts of the system. By continuously uploading sensor readings to an Internet of Things cloud platform for remote monitoring and analysis, the ARDUINO microcontroller acts as the hub for real-time automation and monitoring.

Utilizing solar power, the device lowers energy usage and encourages environmentally friendly indoor agricultural methods. Increased yield and resource optimization result from improved plant growing conditions brought about by automated environmental factor control. Food security and the economical use of natural resources are two other benefits of this clever hydroponic technology in addition to supporting sustainable agriculture.

A summary:

The IoT-enabled solar-powered hydroponic indoor farming and plant growth chamber is a state-of-the-art technology that optimizes resource efficiency and plant development. Several technologies are combined in this project to provide an extremely effective and self-sufficient indoor agricultural environment. The system makes use of solar energy to reduce its negative effects on the

environment using Internet of Things technology to automate and optimize the conditions for plant growth.

Processing sensor data and managing actuators are the functions of the Arduino microcontroller, which is the system's brain. Numerous environmental characteristics can be automated and monitored in real time thanks to it.

Sensors:

The growth chamber's environmental settings are monitored by temperature and humidity sensors, which make sure the circumstances stay within the ideal ranges for plant growth.

In order to guarantee that plants receive the proper ratio of vital minerals, nutrient sensors measure the content of nutrients in the water.

- **Water Level Sensor:** Keeps an eye on the hydroponic system's water level to keep the pumps from running out.

Monitoring the condition of the system is made simple with the 16x2 LCD display, which offers an intuitive interface for displaying real-time data from the sensors.

Users are notified via Buzzer of any serious problems, such low water levels or malfunctioning sensors.

By automating the irrigation process, the AC water pump makes sure plants get the proper amount of nutrients and water.

By supplying a renewable energy source, solar panels lessen the system's reliance on traditional power sources and its running expenses. This improves the system's environmental friendliness and sustainability. Continuous uploading of sensor data to an IoT cloud platform allows for remote monitoring and analysis. With an internet connection, users may access real-time data, get alerts, and make changes from any location. This function makes things more convenient and enables proactive agricultural system maintenance.

Benefits:

1. **Energy Efficiency:** Solar energy lowers the system's operating expenses and carbon footprint.
2. **Resource Optimization:** Higher yields and better plant development conditions result from automated environmental factor control.
3. **Sustainability:** By reducing the use of water and nutrients, the system promotes sustainable indoor farming methods.
4. **Decreased Human Intervention:** Automation maximizes system efficiency and dependability by eliminating the requirement for continual human oversight.

Upcoming Events:

Integration with AI: By using previous data to forecast and optimize plant growth circumstances, artificial intelligence can further increase the system's efficiency.

Creating scalable solutions will enable small-scale farmers and urban gardens to use the technology.

sophisticated Sensors: Using sophisticated sensors will allow for early plant disease diagnosis and more accurate environmental condition monitoring.

A major step toward efficient and sustainable agriculture, this project combines hydroponic gardening, solar electricity, and the Internet of Things. It has enormous potential for the future of indoor farming and provides a workable answer to the problems of conventional farming.

MOTIVATION

This project is an outstanding illustration of how creativity and sustainability can coexist. Given the growing emphasis on resource conservation and carbon footprint reduction worldwide, your work with IoT-enabled solar-powered hydroponic indoor farming is an example of environmental stewardship and forward-thinking.

You are at the forefront of agriculture, using technology to develop more sustainable and productive farming methods. Embrace the Future. Consider how your efforts might affect not only regional communities but also the world's food production systems.

Technology Empowerment: By utilizing automation, solar energy, and the Internet of Things, you can enable farmers to produce more with less. The way we grow food might be completely transformed by this degree of efficiency and precision farming, particularly in urban settings where resources and space are scarce.

One of the fundamental principles of sustainability is the dedication to utilizing solar energy and conserving water. As demonstrated by your research, we may satisfy present demands without sacrificing the capacity of future generations to satisfy their own.

Innovation and Automation: Combining automatic modifications with real-time monitoring reduces the need for human involvement while maximizing plant development. A wider use of smart farming techniques is made possible by this degree of innovation, which also makes farming more scalable and affordable.

Motivation for Others: Your work might act as a source of motivation for other people working in the fields of technology and agriculture. By proving the viability and advantages of such sophisticated systems, you inspire others to investigate, create, and support a more sustainable future.

Robert Swan once said, "The greatest threat to our planet is the belief that someone else will save it." the

Eleanor Roosevelt once said, "Those who believe in the beauty of their dreams will have a bright future."



Keep in mind that every action you take to promote sustainable agriculture promotes food security for future generations as well as improves the environment. Continue pushing the envelope of what is conceivable. Your commitment and creativity are essential to building a more sustainable and better society.

AIMS AND OBJECTIVES

Encourage agriculture that is sustainable:

To create a novel farming solution that minimizes the impact on the environment and conserves resources while adhering to sustainable agriculture methods.

Boost the Efficiency of Plant Growth:

to enhance nutrient delivery and environmental management in order to establish a controlled environment that optimizes plant development and output.

Lower the Use of Resources:

to put into practice a hydroponic system that greatly minimizes water usage and maximizes nutrient utilization in contrast to conventional soil-based farming.

Make Use of Renewable Energy:

to make sure the system is sustainable and energy-efficient by using solar energy as its main energy source.

Incorporate Cutting-Edge Technology:

to improve user convenience and system efficiency by integrating IoT and automation technologies for real-time data analysis, control, and monitoring.

The goals are:

Construct and design a hydroponic system:

to create a workable hydroponic system that grows plants without soil by using nutrient-rich water instead.

Put in place IoT-enabled control and monitoring:

In order to monitor and regulate environmental factors like temperature, humidity, water levels, and nutrient

concentration, IoT sensors and actuators should be integrated.

Use a solar power source:

to reduce dependency on traditional power sources and operational expenses by installing solar panels to power the system.

Create two different operating modes:

to provide two operating modes—manual and automatic—for versatile control. Using an Internet of Things platform, users can operate the system remotely in Manual Mode. In Automatic Mode, the system can automatically modify the flow of water and nutrients depending on real-time sensor data.

Make Remote Monitoring and Analysis Possible:

In order to provide remote monitoring and data analysis, sensor readings should be continuously uploaded to an IoT cloud platform. Users will receive real-time information and warnings for proactive management as a result.

Optimize the condition of the environment:

to automate environmental element control, guaranteeing ideal growing conditions for plants. This involves controlling light, humidity, temperature, and the distribution of nutrients.

Reduce Human Involvement:

To decrease the need for continual human oversight and intervention by putting in place automated irrigation and environmental management technologies.

Encourage environmentally friendly indoor farming methods:

to encourage the use of environmentally friendly indoor farming methods by utilizing cutting-edge technology and renewable energy sources.

Make the user experience and accessibility better.

to create an interface for the Internet of Things platform that is easy to use so that

users can monitor and manage the system. Providing individualized reminders and alerts according to schedules is part of this.

2. LITERATURE REVIEW

Sachin Deshpande, Akshay Naik, Mayur Beldar, and Ankita Patil. in 2016. "Smart Farming with Data Mining and Arduino" by Dibya Sai. K et al.'s work "Smart Farming using Arduino and Data Mining" from the 2016 INDIACom conference explores how to enhance farming methods with wireless sensor technologies and Arduino-based devices. It presents an app for smartphones that controls an automated plant watering system¹. Important agricultural data, like seed prices, soil moisture content, weather predictions, and suggested fertilizers and pesticides, are all sent to farmers via the app. The objective is to use contemporary technology to increase crop productivity and decrease resource waste¹. Crop loss and unpredictable weather are two issues that Indian agriculture faces, and this strategy attempts to overcome them.

"Design and Implementation of an IoT Integrated Dual Sensors for Hydroponic Cultivation Root Growth Monitoring System," 2024 IEEE Muhammad Faris Hilmi Ameran, Rina Abdullah, Nuraiza Ismail, Rosmawati Shafie, Suziana Omar, and Siti Aisyah Che Kar The development of a dual-sensor system for monitoring root growth in hydroponic cultivation is covered in the paper "Design and Implementation of an IoT Integrated Dual Sensors for Hydroponic Cultivation Root Growth Monitoring System" that was presented at the 2024 IEEE I2CACIS conference. IoT technology is integrated into the system to deliver real-time data on growing conditions and root health. Through careful control of environmental variables, it seeks to maximize hydroponic farming. The sensors track temperature, pH, and nutrition levels, among other variables. This method gives farmers rapid access to

correct information, which improves crop yield and quality.

Pradnya Vishram Kulkarni, Vinaya Gohokar, and Kunal Kulkarni, "Sensing Methodologies in Hydroponics for Optimal Growth and Nutrient Monitoring"²⁰²⁴ The study examines how sensor networks and the Internet of Things can be used to maximize hydroponic farming. Monitoring variables like pH levels, temperature, and nutritional needs for different plants is its main objective¹. In order to guarantee optimal growth, the study emphasizes how crucial it is to precisely control environmental conditions. The difficulties and unresolved problems in the hydroponics field are also covered. By utilizing contemporary technologies, the objective is to improve crop productivity and quality.

Jaeho Kim, Minwoo Ryu, Jaeseok Yun, Ting Miao, Il-Yeup Ahn, and Sung-Chan Choi. in 2015. "Development and Execution of an Interconnected Farm for Intelligent Farming Technology." The construction of a smart farming system utilizing Internet of Things technology is covered in the article "Design and Implementation of a Connected Farm for Smart Farming System" that was presented at the 2015 IEEE SENSORS conference. Wireless sensor devices and actuators are integrated into the system to monitor and manage environmental factors in an effort to increase agricultural productivity¹. Using smartphones or tablets, farmers may remotely manage their farms thanks to the connected farm. This strategy seeks to decrease agricultural resource waste and increase efficiency¹. The article emphasizes how the Internet of Things has the potential to revolutionize the agriculture industry.

The construction of an AI-based system for hydroponic farming is covered in the article "An AI Based System Design to Develop and Monitor a Hydroponic Farm" that Glenn



Dbritto presented at the 2018 ICSCET conference for the ICSCET. The technology grows crops without soil in a controlled setting to address problems like soil erosion and excessive fertilizer use¹. A combination of fertilizer and water solutions is automatically delivered to plant roots via sensors. Tomato F1 Hybrid Suhyana seed growth rate is the main subject of the study, which also compares it to plants grown in soil¹. This strategy lessens losses from flooding and drought while also conserving water.

2024 1st International Conference on Advanced Computing and Emerging Technologies (ACET): Urmila Pilania, Manoj Kumar, "Automated Monitoring of Hydroponic System using IoT and Cloud based Technology for Sustainable Agriculture" The 2024 ACET conference featured a paper titled "Automated Monitoring of Hydroponic System using IoT and Cloud based Technology for Sustainable Agriculture," which explored the integration of cloud and IoT technologies for hydroponic farming. Water level, nutrient content, temperature, and humidity are just a few of the environmental characteristics that the system seeks to monitor and adjust in real time. By storing and analyzing data using cloud-based technologies, it helps farmers make wise decisions. The objective is to support sustainable farming methods while increasing crop yield and quality. By improving resource utilization and minimizing environmental effect, this method tackles the difficulties associated with conventional farming.

"AI based Plant Growth Monitoring System using Computer Vision" by Archana Bhamare, Vivek Upadhyay, and Payal Bansal, 2023 IEEE The presentation of the paper "AI based Plant Growth Monitoring System using Computer Vision" at the 2023

IEEE conference covers the application of AI and computer vision to plant growth monitoring. To measure growth parameters like height, leaf area, and biomass, the system takes pictures of plants and examines them. It seeks to offer real-time data in order to maximize crop management and raise production. The study emphasizes how crucial accurate monitoring is to agriculture's sustainability. This method increases the efficiency of farming techniques and lessens the demand for manual work.

Shreya P. Patil, Lincy Meera Mathews, Arvind Kumar G, Sanchi B. Motgi, and Utkarsh Sinha, "AI-Driven Hydroponic Systems for Lemon Basil," 2023 International Conference on Network, Multimedia, and Information Technology (NMITCON) The paper "AI-Driven Hydroponic Systems for Lemon Basil" was presented at the 2023 International Conference on Network, Multimedia, and Information Technology (NMITCON). The creation and application of an AI-powered hydroponic system intended especially for growing lemon basil are covered. The system maximizes growth and yield through sophisticated monitoring and control methods. The advantages of using AI to hydroponic farming are highlighted in the article, including increased plant health, less resource use, and increased efficiency. The goal of the research is to integrate AI technology with hydroponic farming to give a sustainable and effective solution. It investigates how automation may be used into hydroponic systems to improve sustainability and efficiency. The utilization of sensors, climate control, and controlled nutrient supply to maximize plant development is highlighted in the paper. The advantages of automation, including better resource use, lower labor costs, and higher crop yields, are highlighted by the writers. By using cutting-edge automation



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technology, the project seeks to offer a sustainable solution for contemporary farming. With an emphasis on natural fertigation for organic vegetable growing, it talks about the deployment of an Internet of Things-based hydroponic farming system. The system monitors and regulates the fertilizer distribution to plants using sensors and Internet of Things technologies, guaranteeing ideal growing conditions. The advantages of IoT use in hydroponics are highlighted in the paper, including increased plant health, decreased resource use, and increased efficiency. The goal of the research is to integrate IoT technology to give an effective and sustainable solution for organic farming. It talks about a completely automated hydroponic system that includes components for monitoring and control. In order to turn agricultural greenhouses into smart greenhouses, the method relies on deploying them into small-scale stages. It tracks temperature, water level, CO₂ supply, and light intensity using sensors and actuators. Additionally, the system offers data and warnings on plant health and crop output, as well as pre-harvest disease identification through image processing and machine learning.

Presented at the 2024 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), the paper "Automated IoT Indoor Hydroponic Farm" by A Sharmila Agnal, V P Sanaadhani, and L Reshma explores the incorporation of IoT technology in indoor hydroponic farming. Temperature, humidity, and light intensity are among the environmental parameters that the system uses sensors to track. By automating the supply of water and nutrients to plants, it guarantees ideal growing circumstances. Monitoring and control are possible in real time thanks to the analysis and storage of the sensor data in the cloud. Reducing manual labor while increasing

agricultural yield and quality is the goal of this strategy. The study emphasizes how the Internet of Things could transform indoor agricultural methods.

The paper "IoT based Monitoring and Investigation of the Effect of Water Level, Temperature, and Humidity to the Hydroponic based Plant" was presented at the 7th International Conference on Electrical, Electronics, and System Engineering (ICEESE) in 2024. It was written by Bernard Juk Jangan and Nina Korlina Madzhi. The use of an Internet of Things-based system to track and examine how temperature, humidity, and water level affect hydroponic plants is covered. The system optimizes plant development conditions by using sensors to gather real-time data and analyzing it. The advantages of IoT use in hydroponics are highlighted in the paper, including increased plant health, decreased resource use, and increased efficiency. The goal of the research is to integrate IoT technology to produce a sustainable and effective hydroponic farming system.

"Thingspeak Based Monitoring IoT System for Hydroponics System" by Lovina Siechrist T. Agbayani and Jocelyn Flores Villaverde was presented at the 7th International Conference on Information and Computer Technologies (ICICT) which took place in 2024. The use of the Thingspeak platform to deploy an Internet of Things-based hydroponic farming monitoring system is covered. The system gathers information on important variables like pH, temperature, and electrical conductivity (EC) in order to maximize plant growth. The advantages of IoT use in hydroponics are highlighted in the report, and these include better plant health, increased efficiency, and real-time monitoring. The goal of the research is to integrate IoT technology to produce a

sustainable and effective hydroponic farming system.

"Development of Monitoring System Website Based on IoT Devices as a Solution to Plant Planting and Maintenance Process in Water Media" by Muhammad Irfan Syauqi and Ahmad Nurul Fajar was presented at the 2023 10th International Conference on ICT for Smart Society (ICISS). They were the authors of the paper. It talks about how IoT devices can be used to create a monitoring system website that will improve the water-based media planting and maintenance process. To maximize the circumstances for plant growth, the system gathers real-time data on important variables including temperature, humidity, and water level. The advantages of IoT use in hydroponics are highlighted in the research, and these include increased plant health, decreased resource use, and increased efficiency. By incorporating IoT technologies, the study seeks to offer a sustainable and effective hydroponic farming option.

3. EXISTING SYSTEM

The current IoT-based solar-powered hydroponic indoor farming and plant growth chamber systems are highly sophisticated and integrate a number of technologies to maximize plant development. The following are some essential elements and characteristics of these systems:

IoT-Powered Hydroponic Tanks

1. Sensors: A range of sensors are used by these systems to keep an eye on the surroundings. Typical sensors are as follows:
o DHT11 to monitor temperature and humidity.

Soil moisture levels can be detected using moisture sensors.

Water quality is assessed using turbidity sensors.

pH sensors to measure the amount of acidity.

2. Lighting: To simulate natural sunshine and improve plant growth, RGB LEDs are frequently utilized to create adjustable illumination.

3. Automation: Using IoT systems, users can remotely monitor and control environmental parameters to maximize plant development circumstances.

4. Continuous sensor data collection is transmitted to an Internet of Things platform for real-time analysis and display.

Plant Growth Chambers

1. Environment Control: Plant growth chambers offer an environment that is precisely controlled in terms of CO₂, light, humidity, and temperature.

2. Types: Two primary categories of plant growing chambers exist:

Reach-in Chambers: Perfect for smaller labs, these chambers are small and adaptable.

Larger rooms that can hold enormous plant specimens or large-scale testing are called walk-in chambers.

3. Applications: Research investigations and food cultivation are just two of the many agricultural uses for these chambers.

4. Modern plant growth chambers are outfitted with sophisticated HMI (Human-Machine Interface) systems that allow for precise control of inside variables, guaranteeing ideal growing circumstances.

Because these systems are created to give plants the best possible circumstances to thrive, they are very successful and efficient for both commercial and research uses.

4. PROPOSED SYSTEM

The goal of the proposed IoT-based solar-powered hydroponic indoor farming and plant growth chamber system is to integrate cutting-edge technology to increase the efficacy and efficiency of plant production.

Key elements and aspects of the suggested system include the following:

Suggestions for System Features

1. Integration of Solar Power: By using solar panels to produce renewable energy, the system will become less reliant on traditional power sources and become more sustainable.

2. Advanced Sensors: A range of sensors will be integrated into the system to track and regulate environmental conditions, such as:

- o Sensors for temperature and humidity: To keep the ideal growing environment.

- o pH and EC sensors are used to track and modify the nutritional solution.

Artificial lighting is controlled by light sensors, which take into account the amount of natural light present.

To guarantee a steady flow of water, water level sensors are used.

3. IoT technology will be used by the automated control system to automate a number of tasks, including:

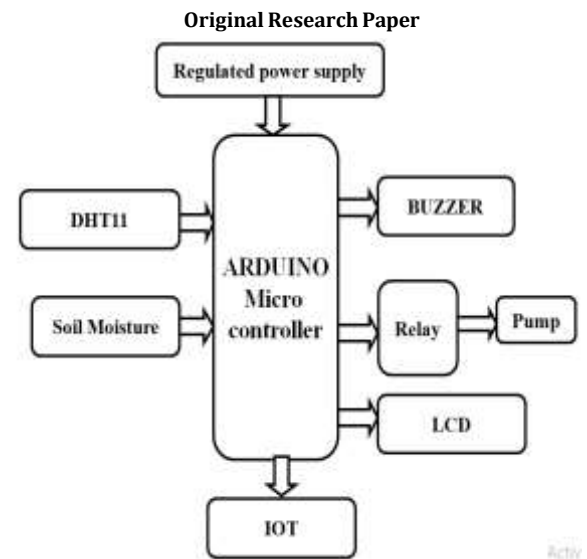
The proper quantity of nutrients will be supplied to the plants using automated pumps.

- o Proper water circulation will be ensured by automated water pumps.

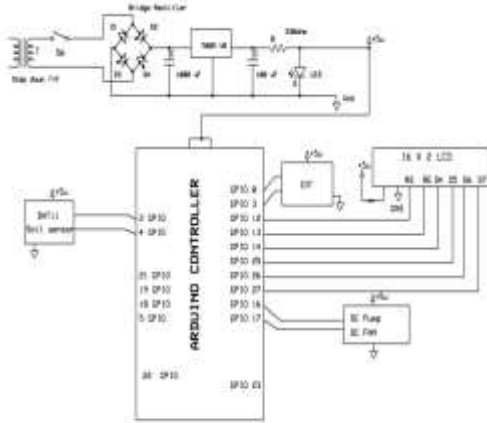
- o Lighting Control: The availability of natural light and the requirements of the plants will determine how the LED lights are turned on.

4. Data Collection and Analysis: For real-time monitoring and analysis, the system will leverage cloud-based platforms in conjunction with sensor data collection. By using this data, crop output will be increased and growth conditions will be optimized.

5. Utilizing a computer or smartphone, users will have the ability to remotely monitor and manage the system. Convenience and flexibility in farming system management would be offered by this feature.



6. The system will feature an easy-to-use interface that makes it simple for users to monitor and modify settings. This interface will show data in real time and send out alerts for any problems that require attention. The goal of this suggested system is to improve plant development and resource utilization by utilizing the Internet of Things and renewable energy sources to create a regulated and effective indoor farming environment. Hydroponic farming, which uses less water and maximizes nutrient delivery, has become a popular way to grow plants without soil in response to the growing demand for sustainable agriculture. An IoT-enabled solar-powered hydroponic indoor farming and plant growth chamber is presented in this project. Its purpose is to establish a controlled atmosphere for the best possible plant growth. Powered by a solar-powered power source, the system makes use of the ARDUINO microcontroller for automation and real-time monitoring. An Internet of Things smart irrigation system driven by an ARDUINO microcontroller is seen in the block diagram. The battery that powers the system is charged by a solar panel. Temperature, humidity, and soil moisture sensors are among the several



5. RESULTS

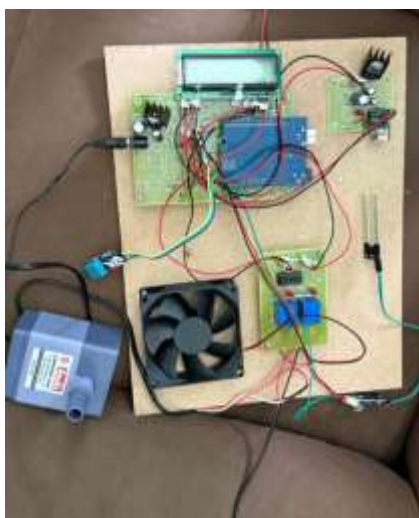


Figure.1 Proposed Hardware Setup

The image shows the prototype model of the IoT Hydroponic system Charging Station setup. The system is built on a wooden base board, consisting of key electronic components interconnected to demonstrate automation and control. At the center is the arduino microcontroller board, which acts as the brain of the system, connected to a 16×2 LCD display for showing user inputs, status messages, and transaction details. A relay driver circuit is used to control external devices like the AC fuel pump



Figure.2. Proposed LCD output

S.No	Supervisor	Quantity	Measure	Unit	Pump	Date
1	31	60	Day	000	000	2023-08-22 10:00:00
2	30	60	Day	000	000	2023-08-22 10:00:00
3	31	60	Day	000	000	2023-08-22 10:00:00
4	32	60	Day	000	000	2023-08-22 10:00:00
5	31	60	Day	000	000	2023-08-22 10:00:00
6	31	60	Day	000	000	2023-08-22 10:00:00
7	31	60	Day	000	000	2023-08-22 10:00:00
8	31	60	Day	000	000	2023-08-22 10:00:00
9	31	60	Day	000	000	2023-08-22 10:00:00
10	30	60	Day	000	000	2023-08-22 10:00:00
11	30	60	Day	000	000	2023-08-22 10:00:00
12	30	60	Day	000	000	2023-08-22 10:00:00
13	30	60	Day	000	000	2023-08-22 10:00:00
14	30	60	Day	000	000	2023-08-22 10:00:00
15	30	60	Day	000	000	2023-08-22 10:00:00
16	30	60	Day	000	000	2023-08-22 10:00:00
17	30	60	Day	000	000	2023-08-22 10:00:00
18	30	60	Day	000	000	2023-08-22 10:00:00
19	30	60	Day	000	000	2023-08-22 10:00:00
20	30	60	Day	000	000	2023-08-22 10:00:00

Figure.3. Proposed Web Server output

Figure.3. Proposed Web Server Shows the complete project output parameter like temperature, humidity and soil moisture data will post into IoT server.

A 16x2 LCD screen, a buzzer for notifications, an AC water pump for automatic irrigation, temperature, humidity, and nutrient sensors, and a water level sensor are essential parts. The system has two modes of operation: manual and automatic. Using an Internet of Things platform, users can operate the irrigation pump remotely in Manual Mode. In Automatic Mode, the system automatically modifies the flow of water and nutrients depending on real-time sensor data. Sensor data is continuously uploaded.

to an Internet of Things cloud platform, allowing for remote observation and evaluation. The system's utilization of solar energy guarantees sustainability and energy efficiency while lowering reliance on traditional power sources. Increased yield and resource optimization result from improved plant growing conditions brought about by automated environmental factor control. By optimizing water and nutrients, this clever hydroponic technology reduces the need for human interaction.

6. CONCLUSION

An ARDUINO microcontroller is used in the hydroponics system to automate important environmental controls, ensuring effective plant development. In order to optimize irrigation and fertilizer delivery, the system uses specialized sensors to continuously measure temperature, humidity, and soil moisture levels. It is powered by a solar-charged battery. While an LCD monitor allows for real-time data visualization, an automatic/manual switch allows for operational flexibility. Resource management accuracy is ensured by an IoT module, which permits remote monitoring and control. The system uses a buzzer for notifications and

effectively controls an AC pump for nutrient circulation, increasing dependability. Hydroponics farming can be made more sustainable by utilizing intelligent automation, which increases crop output while preserving water and nutrients.

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