Synopsis

On

“Smart Hydroponics System”

Submitted By

Yashita Patil

Shweta Zade

Lucky Bhure

Anushka More

Lakshit Chapre

Under the Guidance of

Dr. Rashmi Jain

Ms. Megha Kalorey

Department of Computer Science & Engineering

S. B. Jain Institute of Technology Management and Research, Nagpur-441501

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CONTENTS

INTRODUCTION:

Hydroponic farming is a modern agricultural technique that enables the cultivation of plants without soil. It is a method that provides plants with the necessary nutrients and water through a controlled environment, allowing them to grow efficiently and abundantly. By using a water-based solution enriched with essential minerals, hydroponic systems create an optimal growing environment for plants.

In a hydroponic system, plants are typically grown in a soilless medium, such as perlite, vermiculite, coconut coir, or Rockwool. These mediums provide support to the plant's root system while allowing for ample aeration. The plants' roots are directly exposed to the nutrient-rich water solution, ensuring they receive the essential elements required for growth.

The water in a hydroponic system is recirculated, meaning it is constantly reused, reducing water waste compared to traditional soil-based farming. This efficient water usage is particularly beneficial in areas where water scarcity is a concern.

To ensure optimal growth conditions, hydroponic systems employ various methods for delivering nutrients and water to plants. Some common techniques include:

1. Nutrient Film Technique (NFT): In this method, a thin film of nutrient solution flows over the roots, providing a constant supply of water and nutrients.
2. Deep Water Culture (DWC): Plants are suspended in a nutrient solution with their roots immersed in the water. Oxygen is provided through air stones or diffusers to prevent root rot.
3. Ebb and Flow: Plants are grown in trays or containers filled with a growing medium. Periodically, the nutrient solution floods the tray, submerging the roots, and then drains away.
4. Drip System: A drip irrigation system is used to provide a slow, regulated supply of nutrient solution directly to the base of each plant.

By precisely controlling factors such as temperature, humidity, light, and nutrient composition, hydroponic farming allows for optimal plant growth and accelerated development. Additionally, the controlled environment minimizes the risk of pests, diseases, and weeds, reducing the need for pesticides and herbicides.

Hydroponics offers several advantages over traditional farming, including higher crop yields, faster growth rates, efficient use of resources, and the ability to grow plants in regions with unfavorable soil conditions. It also provides greater control over plant nutrition, allowing growers to tailor the nutrient composition to meet specific plant requirements.

In recent years, hydroponic farming has gained popularity due to its potential for sustainable food production, vertical farming applications, and the ability to grow crops year-round regardless of seasonal constraints. It is a promising agricultural method that holds significant potential for increasing food production while minimizing environmental impact.

PROBLEM STATEMENT:

Hydroponics is soil-less agriculture farming, which consumes less water and other resources as compared to traditional soil-based agriculture systems. However, monitoring hydroponics farming is challenging due to the simultaneous supervising of numerous parameters, nutrition monitoring and controlling.

LITERATURE SURVEY:

RESEARCH PAPERS:

- The paper presents an Automatic Monitoring System for Hydroponic Farming, emphasizing an IoT-based design and development. Authored by Huu Cuong Nguyen, Bich Thuy Vo Thi, and Quang Hieu Ngo, it was published in the Asian Journal of Agriculture and Rural Development (Vol. 12, Issue 3, 2022). The system aims to enhance hydroponic farming efficiency by leveraging Internet of Things (IoT) technologies for automated monitoring. The short summary encapsulates the design and development of a system poised to contribute to the advancement of sustainable and technology-driven practices in agriculture, spanning 210-219 pages in the mentioned journal issue.

- The paper by Dr. Asawari Dudwadkar et al., titled "Automated Hydroponics with Remote Monitoring and Control Using IoT," published in the International Journal of Engineering Research & Technology (Vol. 9, Issue 06, June 2020), introduces an automated hydroponic system. Employing IoT, it enables remote monitoring and control. The concise review highlights the integration of technology to streamline hydroponics, enhancing precision and efficiency in agricultural practices.

- The IEEE Access article by Waluyo, Andre Widura, Febrian Hadiatna, and Delvin Anugerah explores "Fuzzy-Based Smart Farming and Consumed Energy Comparison Using the Internet of Things." Published in 2023 (Vol. 11), the paper likely delves into employing fuzzy logic for smart farming, with a focus on energy consumption. It contributes to the field by evaluating and comparing energy usage within IoT-based smart farming systems.

- Authored by Ch. Vasantha Lakshmi, Avarna K, D. Naga Bhavani, and G. Satya Spandana, the paper "Hydroponic Farm Monitoring System Using IoT" was published in ICONIC RESEARCH AND ENGINEERING JOURNALS (IRE Journals), Vol. 3, Issue 10, 2020. The study likely explores the implementation of an IoT-base monitoring system for hydroponic farming, contributing to advancements in precision agriculture and efficient crop management.

- In their work published in the International Journal of Recent Technology and Engineering (Vol. 8, Issue-6, March 2020), Pavan Koge, Nikhil Deshmane, Karan Chhatwani, and P.S. Shetgar focus on the development and monitoring of hydroponics through IoT. The paper likely explores the integration of Internet of Things technologies to enhance the efficiency of hydroponic systems.

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- The article in the Hindawi Journal of Nanomaterials (Volume 2022, Article ID 4435591) outlines the design and implementation of a Smart Hydroponics Farming system. Utilizing an IoT-based AI controller, it integrates a mobile application for efficient monitoring and control.

- The IEEE Access article authored by G. Lakshmi Priya et al., "Revolutionizing Holy-Basil Cultivation With AI-Enabled Hydroponics System" in Vol. 11, 2023, explores innovative AI-based hydroponics for holy basil cultivation, presenting significant advancements in agricultural technology.

- The paper by Srinidhi H K, Shreenidhi H S, and Vishnu G S, presented at the 5th International Conference on RTEICT-2020, introduces a Smart Hydroponics system. It integrates IoT and machine learning algorithms, showcasing advancements in technology for efficient hydroponic cultivation.

- The paper presents an "Automated Hydroponic Plant Growth System Using IoT" by Suhan M et al., focusing on modernizing plant cultivation.

- The paper by Aris Munandar et al. outlines the design and development of an IoT-based smart hydroponic system. This technology-driven approach aims to enhance hydroponic farming practices, fostering efficiency and automation.

- The International Seminar on Research of Information Technology and Intelligent Systems (ISRITI), 2018, provided a platform for cutting-edge discussions in IT and intelligent systems.

AIM/OBJECTIVE:

A smart hydroponic system with IoT aims to revolutionize hydroponic-based agriculture by integrating sensors and connectivity. It enables remote monitoring and control, resource efficiency, data-driven decision-making, automation, and environment sustainability.

OBJECTIVES:

- To be able to provide a better temperature for plants to grow in hydroponic farming.
- To Control nutrient parameters in water.
- To Design such an application which gives the user all information regarding temperature, nutrient composition, and recent crop conditions.

PROPOSED APPROACH/WORK:

- Set up the microcontroller and connect various sensors and actuators.
- Connect the microcontroller to the internet for IoT capabilities.
- Establish communication with Firebase for data storage and retrieval.
- Continuously read sensor data at regular intervals.
- If TDS value exceeds the predefined range, trigger the solenoid valve to drain the tank and refill it from the main water source.
- If the temperature surpasses the predefined range, activate the fan to regulate the environment.
- Develop a mobile application for users to monitor system readings and manage settings manually or automatically.
- Implement manual and automatic controls in the mobile app for controlling the setup.
- Set up notifications and alerts to notify users about critical parameter deviations or system malfunctions.
- Store sensor readings and system statuses in Firebase for historical analysis

TECHNOLOGY:

- **Front End:** XML

  Extensible Markup Language is a markup language and file format for storing, transmitting, and reconstructing arbitrary data.
- **Back End:** Java

  Java is a high-level, class-based, object-oriented programming language that is designed to have as few implementation dependencies as possible.
- **Arduino IDE**

The open-source **Arduino** Software (**IDE**) makes it easy to write code and upload it to the board.

- **Firebase**

  Firebase is a comprehensive mobile and web development platform by Google, offering a range of services to streamline app development. It includes real-time database, authentication, hosting, and cloud functions

- **Android Studio**

  Android Studio is the official integrated development environment for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development.

APPLICATIONS:

- **Urban Agriculture**
- **Climate Control in Greenhouses**
- **Hydroponic Hobbyists**

SOFTWARE/HARDWARE REQUIREMENTS:

Software Requirement

- **OS** – Windows 10
- **Modelling and Implementation tool** – Eagle 9.6.0
- **IDE** – Arduino IDE & Android Studio
- **Database** – Firebase

Hardware Requirement

- Microcontroller (ESP32)
- Air Temperature and Humidity Sensor (DHT 11)
- Water Quality Sensor (TDS Sensor)

- Water Temperature Sensor (DS18B20)
- Water PH Sensor
- Water level (Float)
- Fan
- Solenoid valve
- Submersible Pump

EXPECTED PROJECT OUTCOMES:

- **Automation and Remote Monitoring:**

  The smart hydroponic system should enable the automation of various processes, such as nutrient delivery, pH regulation, and lighting control. It should also allow for remote monitoring of crucial parameters like temperature, humidity, water levels, and nutrient concentrations. The outcome would be a system that reduces manual intervention and allows for real-time monitoring and control.

- **Improved Crop Yield and Quality:**

  The project aims to optimize the growing conditions for plants through precise control and monitoring. With the implementation of a smart hydroponic system, the expected outcome would be an improvement in crop yield and quality. The system can ensure that plants receive the right amount of nutrients, light, and water, leading to healthier and more productive plants.

- **Resource Efficiency:**

  The smart hydroponic system should focus on optimizing resource usage. Through accurate monitoring and control, the system can minimize water consumption by delivering precise amounts of water to plants. It can also optimize nutrient usage, reducing wastage and environmental impact.

  The expected outcome is an efficient use of resources, leading to cost savings and reduced ecological footprint.

- **Data-Driven Insights:**

  The IoT-enabled system collects data from various sensors and devices. By analyzing this data, the project can generate valuable insights regarding growth patterns, environmental conditions, and crop health. The expected outcome is the availability of data-driven insights that can guide decision-making, such as adjusting nutrient levels, modifying lighting schedules, or identifying potential issues early on.

- **Scalability and Flexibility:**

The smart hydroponic system should be designed with scalability and flexibility in mind. It should be adaptable to different crop types, growth stages, and system sizes. The expected outcome is a system that can be easily expanded or modified to accommodate changing needs or requirements.

- **Enhanced User Experience:**
  The project aims to improve the overall user experience for growers or operators. The smart hydroponic system should provide user-friendly interfaces for monitoring and controlling the system. It should offer intuitive dashboards, alerts, and notifications. The outcome would be an enhanced user experience, making it easier for growers to manage and optimize their hydroponic operations.
- **Integration and Connectivity:**
  The IoT aspect of the project involves connecting various devices, sensors, and components within the smart hydroponic system. The expected outcome is seamless integration and connectivity, ensuring smooth communication and interoperability between system elements.

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Sr.No.	USN No.	Name of the Projects	Projects Signature	Domain	Guide's Signature
1.	CS20079	Yashita Patil			
2.	CS20080	Shweta Zade			
3.	C'S20018	Lucky Bhure			
4.	CS20005	Anushka More			
5.	CS20099	Lakshit Chapre			