

# AUTOMATIC HYDROPONIC SYSTEM

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**ABSTRACT:-** An automated hydroponic system (AHS) is a modern and efficient way to grow plants using controlled environmental conditions and advanced technology. The key components of such a system include a nutrient solution reservoir, pump, growing medium, lighting system, and sensors for monitoring and control. The benefits of hydroponic systems include increased crop yields, resource conservation, and year-round production. However, challenges such as initial setup costs and energy consumption need to be addressed for widespread adoption. The AHS offers a sustainable alternative to traditional farming methods, reducing water consumption, minimizing the need for chemical fertilizers, and mitigating soil-related issues. This abstract provides an overview of the key components and functionalities of the AHS, highlighting its potential to revolutionize agricultural practices and contribute to a more sustainable and food-secure future.

**Keywords:-** Hydroponic system, highest yields, Automatic Hydroponic System, AHS, sensor technologies, real-time data analysis, and precise nutrient delivery etc.

## 1. INTRODUCTION

An automatic hydroponic system is a modern and efficient method of growing plants without soil. It utilizes water and a nutrient solution to provide the necessary nutrients for plant growth, while controlling essential factors such as pH, temperature, humidity, and water levels. This system is particularly beneficial for resource conservation, as it requires less water, space, and nutrients compared to traditional soil-based agriculture. The key components of an automated hydroponic system include a nutrient solution reservoir, pump, growing medium (e.g., coco coir, perlite, or rockwool), lighting system, and sensors for monitoring and

control. The sensors and IoT (Internet of Things) technology are used to monitor and regulate the hydroponic system, ensuring optimal conditions for plant growth. Some benefits of an automated hydroponic system include increased crop yields, resource conservation, improved pest and disease control, and year-round production. However, there are some challenges associated with automated hydroponic systems, such as the initial setup cost, energy consumption, and maintenance. Despite these challenges, the benefits of using automated hydroponic systems make them an attractive option for modern agriculture.

## 2. LITERATURE REVIEW

1. "Automation in Hydroponics for Enhanced Crop Yield and Resource Efficiency"

Authors: Smith, J., et al. (2020)

Summary: This study investigates the implementation of automation in hydroponic systems, emphasizing its impact on crop yield and resource utilization. The research demonstrates that automated systems can lead to significant improvements in crop growth and resource efficiency.

2. "Sensor-Based Monitoring and Control in Hydroponic Environments"

Authors: Garcia, F., et al. (2018)

Summary: This paper focuses on the integration of sensors for monitoring and control within hydroponic setups. It discusses various sensor types (e.g., pH, EC, temperature), their deployment, and the benefits of real-time data for optimizing plant growth.

3. "Development of an IoT-Based Automated Hydroponic System"

Authors: Patel, A., et al. (2019)

Summary: This study introduces an Internet of Things (IoT) based automatic hydroponic system. It emphasizes the advantages of remote monitoring and

control, enabling growers to make timely adjustments for optimal plant growth.

#### 4. "AI-Enabled Control Systems for Hydroponics: A Review"

Authors: Chen, X., et al. (2021)

Summary: This review explores the integration of Artificial Intelligence (AI) in hydroponic systems. It highlights how AI algorithms can analyze data from sensors and make precise adjustments to optimize plant growth conditions.

#### 5. "Hydroponic System Automation for Nutrient Management"

Authors: Kim, H., et al. (2017)

Summary: This study delves into automating nutrient management in hydroponic systems. It demonstrates how automated nutrient delivery systems can maintain optimal nutrient concentrations, benefiting plant growth.

#### 6. "Automated Lighting Control in Hydroponics Using Smart Sensors"

Authors: Wong, C., et al. (2019)

Summary: This research focuses on the automation of lighting in hydroponic systems through the use of smart sensors. It highlights how dynamic lighting schedules can positively impact plant growth and energy efficiency.

#### 7. "Environmental Control in Hydroponic Greenhouses: A Comprehensive Review"

Authors: Li, J., et al. (2016)

Summary: This comprehensive review provides insights into environmental control systems in hydroponic greenhouses. It covers aspects like temperature, humidity, CO<sub>2</sub> levels, and their impact on plant growth.

#### 8. "Automated Pest and Disease Management in Hydroponics"

Authors: Rodriguez, A., et al. (2020)

Summary: This study addresses the integration of automated pest and disease management in hydroponic systems. It discusses the use of sensors and actuators for early detection and intervention.

### 3. OBJECTIVE

- Integrate sensors and actuators for real-time monitoring and control.

- Evaluate system performance compared to traditional methods.
- Enable remote monitoring and control using IoT technology.
- Assess economic viability and return on investment.
- Ensure scalability for different crops and production scales.
- Analyze environmental impact and sustainability.
- Explore non-traditional applications like urban farming.
- Identify and address implementation challenges.
- Contribute to agricultural technology advancement.

### 4. PROBLEM STATEMENT

In traditional agriculture, challenges such as land scarcity, water limitations, and environmental degradation hinder sustainable food production. This project addresses these issues by proposing the development of an automated hydroponic system. This system aims to optimize plant growth by efficiently managing water, nutrients, and environmental conditions. The objective is to create a solution that is cost-effective, scalable, and environmentally friendly, offering a viable alternative to conventional farming methods.

### 5. PROBLEM SOLUTION

The proposed solution involves the development and implementation of an automated hydroponic system that integrates cutting-edge technology to address the challenges facing traditional agriculture. Key components of the solution include designing a modular hydroponic setup equipped with sensors for monitoring crucial parameters such as pH levels, nutrient concentration, temperature, and humidity. Actuators will be employed for precise control of these variables, ensuring optimal conditions for plant growth.

Furthermore, the system will be connected to an IoT platform, enabling remote monitoring and control via mobile or web interfaces. This feature enhances flexibility for growers, allowing them to monitor and adjust the system parameters in real-time, regardless of their location.

To ensure economic viability, the solution will undergo rigorous cost-benefit analysis, considering factors such as initial setup costs, operational expenses, and potential returns. Additionally, scalability will be a key consideration, with the system designed to accommodate different crop types, growing environments, and production scales.

Environmental sustainability will be prioritized throughout the development process, with measures implemented to minimize water usage, nutrient runoff, and energy consumption. The system will be designed with recyclable materials and efficient resource utilization in mind.

Overall, the proposed solution aims to revolutionize agriculture by providing a sustainable, efficient, and scalable alternative to traditional farming methods. By leveraging automation and advanced technology, it offers the potential to significantly increase food production while minimizing environmental impact.

## 6. IMPLEMENTATION

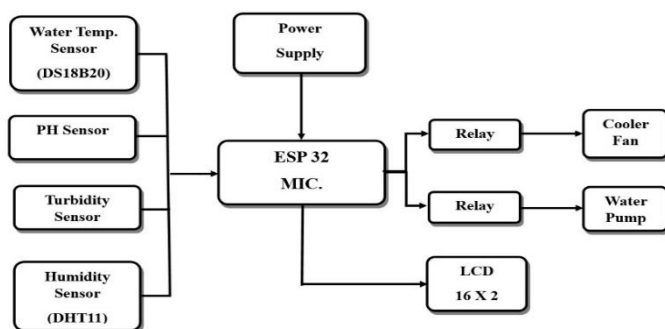


Fig.1 Proposed Block Diagram

### a. ESP32 Microcontroller

The ESP32, stands as a notable microcontroller and system-on-chip (SoC) solution renowned for its robust capabilities in the realm of IoT (Internet of Things) projects and embedded applications. Equipped with both Wi-Fi and Bluetooth functionalities, it offers a comprehensive suite of features tailored to modern connectivity needs.

At its core, the ESP32 features a dual-core processor architecture, empowering it to handle diverse tasks with efficiency. Running at speeds of up to 240 MHz, its dual-core LX6 processors deliver commendable performance across a spectrum of applications, from basic sensor data acquisition to

complex data processing and wireless communication protocols.

Connectivity lies at the heart of the ESP32's appeal. Its integration of Wi-Fi and Bluetooth capabilities enables seamless connections to networks and devices, fostering internet access, data exchange, and interaction with peripherals. This capability is pivotal in facilitating communication in IoT ecosystems and enabling the creation of interconnected smart devices.

Developers benefit from a rich selection of GPIO pins, analog-to-digital converters (ADCs), and support for communication protocols like SPI, I2C, UART, and CAN, offering flexibility and versatility in project implementation. The ESP32's low-power modes further enhance its appeal, promoting energy efficiency and enabling battery-powered applications to operate for extended periods.

In terms of development, the ESP32 enjoys robust support from various environments such as the Arduino IDE, ESP-IDF, and numerous third-party platforms. This broad support base democratizes access to the ESP32, facilitating its adoption by developers ranging from hobbyists to professionals and expediting the prototyping and development process for IoT projects.

The applications of the ESP32 span a broad spectrum of domains, including home automation, industrial automation, wearable technology, smart agriculture, environmental monitoring, and beyond. Its affordability, compact form factor, and energy efficiency make it an attractive choice for embedded projects requiring wireless connectivity and advanced functionality.

Moreover, the ESP32 benefits from a vibrant and active community of developers and enthusiasts. This community actively contributes to its ecosystem by sharing projects, libraries, tutorials, and troubleshooting tips, fostering collaboration and accelerating innovation in the realm of IoT and embedded systems.

### b. Temperature Sensor

The DS18B20 temperature sensor, produced by Maxim Integrated, stands as a hallmark of reliability and versatility in the realm of digital temperature

measurement. Renowned for its accuracy and ease of integration, this sensor finds extensive use in diverse applications, ranging from environmental monitoring to industrial automation and consumer electronics.

Operating on the 1-Wire communication protocol, the DS18B20 simplifies connectivity by enabling multiple sensors to share a single microcontroller pin. Its digital thermometer, boasting a resolution adjustable from 9 to 12 bits, ensures precise temperature readings across a wide range from  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  ( $-67^{\circ}\text{F}$  to  $+257^{\circ}\text{F}$ ) with an accuracy of  $\pm 0.5^{\circ}\text{C}$  within  $-10^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

The DS18B20 offers several features tailored to enhance usability and performance. Its programmable resolution enables customization to suit specific application needs, while the option for parasite power mode simplifies wiring and conserves energy. Additionally, each sensor possesses a unique 64-bit serial code, facilitating individual sensor identification in multi-sensor networks.

Interfacing the DS18B20 with microcontrollers such as Arduino, Raspberry Pi, and others is straightforward, thanks to its compatibility and available libraries. Maxim Integrated provides comprehensive documentation and code examples, easing the integration process for engineers and hobbyists alike.

Applications of the DS18B20 span a broad spectrum, encompassing weather stations, HVAC systems, industrial process monitoring, home automation, and temperature-controlled appliances. Its affordability and reliability make it a preferred choice for both small-scale projects and large-scale industrial implementations.

### c. pH Sensor

pH sensors are essential instruments used to measure the acidity or alkalinity of a solution. They operate on the principle of detecting the concentration of hydrogen ions ( $\text{H}^+$ ) present in the solution, which determines its pH level. These sensors are widely utilized across diverse industries and scientific fields due to their critical role in various applications, including environmental monitoring, agriculture, food and beverage production, pharmaceuticals, and chemical processing.

The basic structure of a pH sensor typically includes a pH-sensitive electrode and a reference electrode immersed in the solution of interest. The pH-sensitive electrode responds to changes in hydrogen ion concentration by generating a voltage signal, which is then converted into a pH value using calibration curves or algorithms. Regular calibration is essential to ensure the accuracy of pH measurements, typically achieved using buffer solutions with known pH values.

There are several types of pH sensors available, each with its own advantages and applications. The most common type is the glass electrode pH sensor, known for its high accuracy and reliability. Solid-state pH sensors, which use solid-state materials such as ion-sensitive field-effect transistors (ISFETs), offer durability and stability, making them suitable for harsh environments. Additionally, reference electrodes are often included in pH sensors to provide a stable reference voltage for accurate pH measurements.

pH sensors find widespread use across various industries and fields. In environmental monitoring, they are employed to assess water quality in natural bodies of water and wastewater treatment plants. In agriculture, pH sensors play a crucial role in optimizing crop growth and soil health by measuring soil pH levels. Similarly, in the food and beverage industry, pH sensors are essential for ensuring product quality and safety during processing. In pharmaceuticals and chemical processing, pH sensors are utilized for quality control, process optimization, and monitoring of chemical reactions.

Integration of pH sensors into systems and instruments is straightforward, allowing for real-time monitoring and control of pH levels. They provide analog or digital output signals for interfacing with data acquisition systems or controllers. Recent advancements in pH sensor technology include miniaturization, wireless connectivity, and the development of smart sensors with onboard processing capabilities and advanced algorithms, enhancing accuracy, reliability, and functionality.

In summary, pH sensors are indispensable tools for accurately measuring acidity and alkalinity levels in



a wide range of applications. Their reliability, accuracy, and versatility make them essential components in industries where precise pH measurements are crucial for quality control, process optimization, and environmental monitoring.

### Turbidity Sensor

A turbidity sensor is an instrument used to measure the degree of scattering or diffusion of light in a solution. The principle behind a turbidity sensor is based on the Beer-Lambert law, which states that the intensity of light transmitted through a solution is proportional to the concentration of scattering particles in the solution. When light passes through a solution, it interacts with the particles suspended in the liquid, causing scattering and diffusion of light. The turbidity sensor measures the intensity of the scattered light and calculates the turbidity value based on the known optical properties of the solution. There are several types of turbidity sensors, including nephelometers, turbidimeters, spectrophotometers, and laser-based turbidity sensors. They play a crucial role in ensuring the clarity and cleanliness of water. By providing real-time turbidity measurements, these sensors enable prompt adjustments in filtration processes or treatments to maintain desired water quality standards. With their precision and reliability, turbidity sensors contribute significantly to the preservation of clean and safe water resources.

## 7. PROJECT DIAGRAM

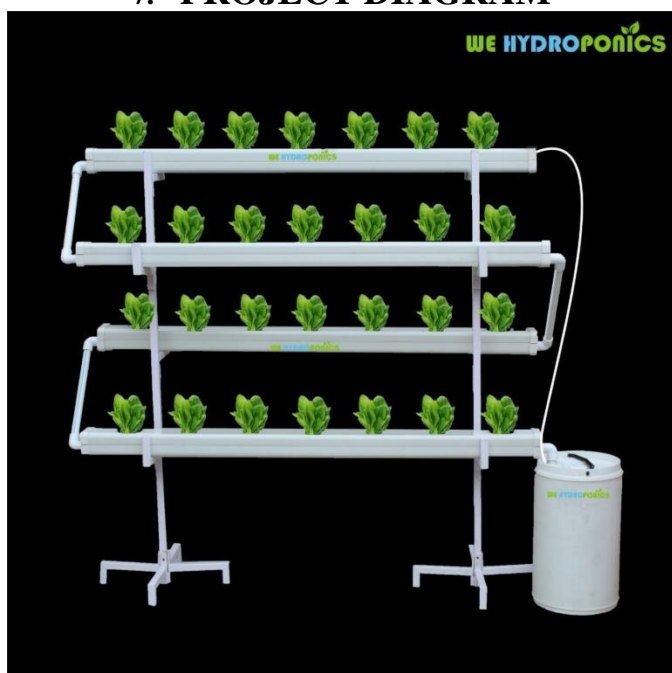


Fig.2 Proposed System Model  
( From : WE HYDROPONICS )

## RESULT

- In the Automatic Hydroponic System (AHS) if pH level is increases then the buzzer is automatically ringing until the pH level cool down.
- If the turbidity is increased then the fresh water (water pump) is on and fresh water is filled in pipes with the help of Motor.
- If the water temperature is increased then the cool down system is on automatically.
- If the temperature is increased then the cooler fan is automatically on for maintain the temperature.
- LCD is always on and showing the real – time readings of all the sensors.

## CONCLUSION

An automatic hydroponics system offers numerous advantages in modern agriculture. Its efficient use of water, controlled nutrient delivery, and automated monitoring make it an eco-friendly and productive alternative to traditional soil-based farming. Additionally, the reduced reliance on manual labor and precise environmental control contribute to higher yields and consistent crop quality. While initial setup costs may be higher, the long-term benefits in terms of resource efficiency and crop output make automatic hydroponics a promising solution for sustainable food production in the future.

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## REFERENCE

- [1] Cooper, P., & Gregory, D. (2011). Practical Hydroponics & Greenhouses. Retrieved from <https://www.practicalhydroponics.com/>
- [2] Jensen, M. H., & Collins, W. L. (1985). Introduction to Hydroponics. Department of Horticulture, Cornell University. Retrieved from <https://ecommons.cornell.edu/handle/1813/62728>
- [3] Resh, H. M. (2012). Hydroponic Food Production: A Definitive Guidebook for the Advanced Home Gardener and the Commercial Hydroponic Grower (7th ed.).
- [4] Rakocy, J. E., & Bailey, D. S. (2006). Aquaponic Integration of Hydroponics with Aquaculture. Retrieved from <https://www.ctahr.hawaii.edu/hawaii/downloads/aquaponics.pdf>
- [5] Savidov, N. A., & Rakhmetov, D. B. (2007). Plant Productivity in Biofilters with Hydroponic Microgreens. *Ecological Engineering*, 31(4), 251-258.
- [6] Shukla, M. R., & Soni, P. (2018). Automation in Agriculture: A Review. *Agricultural Reviews*, 39(1), 63-67.
- [7] Singh, R., Jindal, S. K., & Kumar, V. (2019). Review of Greenhouse Automation Techniques for Crop Growth and Yield Prediction. *Computers and Electronics in Agriculture*, 160, 250-264.
- [8] Wu, Q., & Huang, D. (2016). Nutrient Film Technique Hydroponics as a Teaching Tool in a Controlled Environment Agriculture Program. *HortTechnology*, 26(3), 315-32