



## Fabrication of Hydroponic System with Remote Supervision

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**Abstract:** Hydroponic farming is gaining popularity around the globe because of its minimum resource requirement like water, nutrients etc. many people are implementing this farming technique in their homes because of its low space requirements and high space to output ratio. But as a working professional, it is very difficult to manage the inventory of nutrients and provide those to the plants. Also managing the overall plant nutrition, water supply and the system statistics is very difficult. For that the hydroponic system with remote supervision is the optimized solution. The system consists of various sensors, motors and a microcontroller unit to remotely observe and supervise the system. This app based remote supervision system can toggle the water flow through the system. This innovative system offers an efficient and sustainable solution for cultivating plants in controlled environments, promoting optimal growth and health while enabling remote management for convenience and accessibility. To ensure the effective deployment of commercial hydroponic technology, it is critical to develop low-cost procedures that are simple to run and maintain, involve less manpower, and have a reduced overall setup and maintenance cost.

**Keywords:** Blynk IOT, water conservation, nutrient management, Hydroponic market, Sensors.

### 1. INTRODUCTION:

A hydroponic system is a method of growing plants without soil, where the plant roots are directly immersed in a nutrient-rich water solution. This system relies on the controlled delivery of essential nutrients, water, and oxygen to the plants, creating an optimal environment for growth.

The process begins with a reservoir containing the nutrient solution, which is continuously circulated or periodically replenished to ensure consistent availability of nutrients. The plant roots are either suspended directly in the nutrient solution or supported by a medium such as perlite, rockwool, or coconut coir.

To ensure the proper functioning of the hydroponic system, various parameters such as temperature, humidity, pH levels, and nutrient concentrations must be carefully monitored and controlled. This is typically achieved through the use of sensors and automated systems that regulate environmental conditions and nutrient delivery.

One of the key advantages of hydroponic systems is their ability to maximize resource efficiency by delivering nutrients directly to the plant roots, minimizing water and nutrient wastage compared to traditional soil-based farming. Additionally, hydroponic systems can be tailored to suit a wide range of plant species and can be implemented in diverse environments, including indoor settings where space or soil quality may be limited.

Overall, hydroponic systems offer a sustainable and efficient method of cultivation that holds great potential for increasing agricultural productivity while reducing environmental impact.

In urban cities, residents encounter numerous challenges related to cultivating their own vegetables. Limited space, particularly in balconies or small living areas, poses a significant constraint for traditional soil-based gardening practices. Additionally, reliance on store-bought vegetables exposes individuals to produce cultivated with various fertilizers, potentially impacting their health and well-being.

To address these issues, we propose the development of a hydroponic system, offering a solution to urban dwellers seeking a sustainable and convenient method of vegetable cultivation. Hydroponics, a soilless farming technique, enables individuals to grow vegetables in controlled environments without the need for expansive outdoor spaces. By implementing this system, users can enjoy fresh, home-grown produce while minimizing the environmental footprint associated with traditional farming methods.

Moreover, our hydroponic system incorporates remote operation capabilities, allowing users to monitor and manage their vegetable gardens from any location. This feature provides flexibility and convenience, empowering individuals to maintain their crops effectively even amidst busy urban lifestyles.

In summary, our project aims to alleviate the challenges faced by urban residents in accessing fresh and space-efficient vegetable cultivation methods. By offering a soilless hydroponic solution with remote operation capabilities, we strive to promote healthier lifestyles and sustainable food production practices within urban environments.

Hydroponic systems offer innovative solutions for cultivating various plants, including medicinal herbs like aloe vera, mint, and basil. In our project, we have embarked on the fabrication of a sophisticated hydroponic system that integrates advanced technology for remote monitoring and control. Utilizing Blynk IoT platform, our system ensures efficient management of crucial parameters to optimize plant growth and health.

Central to our setup are sensors designed to monitor environmental conditions essential for plant growth. These include temperature sensors to regulate thermal conditions, humidity sensors to maintain optimal moisture levels, and a water pump system for precise irrigation. Additionally, we incorporate a nutrient reservoir to deliver essential elements directly to the plant roots, promoting vigorous growth and nutrient uptake.

Hydroponic system lies the Node MCU, a versatile microcontroller facilitating seamless communication between sensors, actuators, and the Blynk IoT platform. Through this integration, users can remotely supervise and adjust system parameters, ensuring real-time responsiveness to changing environmental conditions.

By leveraging cutting-edge technology and a meticulous approach to design and implementation, our project aims to revolutionize the cultivation of plants, offering a sustainable and efficient alternative to traditional farming methods.

Roberto S. Velazquez-Gonzalez, Adrian L. Garcia-Garcia, Elsa Ventura-Zapata, Jose Dolores Oscar Barceinas-Sanchez and Julio C. Sosa-Savedra [1] describe about the use of hydroponics and associated technologies for medium- and small-scale operations. Essentially, they

examine how hydroponics, which is a method of growing plants without soil, can be used on a smaller scale, like in home gardens or small farms. The author looks at various aspects related to hydroponics, such as the different techniques used, the equipment required, and the benefits and challenges of implementing hydroponic systems. They also discuss the technologies involved in hydroponics, which could include things like automated nutrient delivery systems, sensors for monitoring plant health, and methods for controlling environmental conditions like temperature and humidity. The paper also talks about how new technologies like Raspberry Pi and Arduino, along with sensors and actuators, will make precision agriculture more accessible and affordable for small and medium-scale farmers. This will help them produce food more efficiently in controlled environments.

Ms. Mamta D. Sardare, Ms. Shraddha V. Admane [2] have presented about hydroponics, which is a way of growing plants without using soil. Instead of planting them in the ground, you grow them in water that's enriched with all the nutrients they need. This method is becoming more popular because it can produce more food in less space and often results in healthier plants. The paper goes into detail about how hydroponics works, why people are interested in it, and some of the challenges it faces. It's like a guidebook for anyone who wants to learn about growing plants without soil.

Murugan Prasathkumar a, Salim Anishaa, Chenthamara Dhriyaa, Robert Beckya, Subramaniam Sadhasivam [3] are discussing how certain plants that grow in India can be used for medicinal purposes. They want to explain how effective these plants are in treating different health problems and diseases. The paper goes into detail about the benefits of using these plants for medicine, like how they can help people feel better and improve their health. The authors are basically saying that some plants found in India have special properties that make them useful for treating illnesses. They want to share this information so that people can understand the potential benefits of using these plants for medicinal purposes.

Nisha Sharma, Somen Acharya, Kaushal Kumar, Narendra Singh and O.P. Chaurasia [4] describe about Hydroponics is a modern way of growing vegetables where you don't need soil. Instead, you place the plant roots directly in water that's enriched with all the nutrients they need to grow. This method allows vegetables to grow faster and often results in healthier plants because they can easily access the nutrients they need. In hydroponics, plants are typically grown in containers or trays filled with water. The water is continuously circulated to ensure that the plants get a constant supply of nutrients. Sometimes, special lights are used to mimic sunlight and help the plants grow even faster. One of the big advantages of hydroponics is that you can grow vegetables anywhere, even in places where the soil isn't good for farming. This makes it especially useful in urban areas where space is limited. Plus, since you're not using soil, there's less risk of pests and diseases affecting your plants. Overall, hydroponics is an advanced technique for vegetable production that offers many benefits, including faster growth, healthier plants, and the ability to grow vegetables in places where traditional farming methods might not work as well.

Y.N. Chow, L.K. Lee, N.A. Zakaria, K.Y. Foo [5] in recent years, researchers and innovators have been working on improving hydroponic systems to make them more efficient, sustainable, and accessible. These new systems may incorporate advanced technologies, such as automated nutrient delivery systems, smart sensors for monitoring plant health, or

innovative designs that optimize space and resource usage. One example of a new emerging hydroponic system could be a vertical farming setup, where plants are stacked vertically to maximize space utilization in urban environments. Another example might be a hydroponic system that uses renewable energy sources, such as solar power, to reduce its environmental impact. These new hydroponic systems aim to address some of the limitations of traditional soil-based farming, such as land scarcity, water usage, and reliance on chemical fertilizers. By leveraging cutting-edge technologies and innovative design concepts, they offer promising solutions for sustainable food production in the face of growing population pressures and environmental challenges.

Kavita Krishan\*, Er. Rajesh Agrawal and M. P. Thipathi [6] investigates the design, construction, and performance of a U-shaped hydroponic system within protected structures. Carried out at the Centre of Excellence on Protected Cultivation and Precision Farming, the study examines three variants of hydroponic systems using different pipe materials (PVC, UPVC, and CPVC). It evaluates their impact on lettuce growth parameters, pH, and electrical conductivity (EC) of the nutrient solution. Findings indicate that while there are slight variations in plant growth and nutrient levels among the different pipe materials, the differences are not significant within the first year of cultivation. The study underscores the potential of locally fabricated hydroponic systems as a feasible and economical approach for growers, offering advantages such as enhanced productivity and resource efficiency compared to conventional soil-based methods.

Dian Siswanto and Wahyu Widoretno [7] describes the development and implementation of a vertical hydroponic system with semi- continuous and continuous nutrient cycling by Dian Siswanto and Wahyu Widoretno from the University of Brawijaya, Indonesia. It addresses the challenges posed by agricultural land conversion and proposes hydroponic systems as a solution. The system integrates the ebb and flow system with the nutrient film technique (NFT) using PVC pipes. The study emphasizes the advantages of hydroponic systems over conventional agriculture, highlighting their potential to increase yield in limited spaces and urban environments. It discusses the design, construction, and testing of the system, concluding that it offers a viable solution for continuous irrigation and nutrient supply.

Aamir Lund, Shakeel Hussain Chattha, Shakeel Ahmed Soomro, Mukhtiar Ali Leghari, Benish Nawaz Mirani, Ghassan Zahid<sup>3</sup> and Khalil Lund [8] aimed to assess the efficacy of a hydroponic system for growing tomatoes. Using PVC pipes, a hydroponic structure was constructed, and tomato plants were transplanted into hydroponic cups. Throughout the experiment, various parameters including water electrical conductivity (EC), pH, temperature, ambient temperature, and solar radiation were monitored. Results indicated that the hydroponic system provided favorable conditions for tomato growth, with the number of leaves per plant increasing from 6 to 22 over 28 days, and plant height rising from 15 to 32 cm. The EC of water ranged between 1.23 to 2.76 dS/m, pH ranged from 5.32 to 6.92, and water temperature varied between 18 to 24 °C. The ambient temperature fluctuated between 21 to 26 °C, while solar radiation ranged from 250 to 325 W/m<sup>2</sup>. The study concluded that the constructed hydroponic system proved effective for growing tomatoes in a controlled environment, with minimal space, fertilizer, and water requirements, thus offering a sustainable solution for agriculture in resource-limited regions.

Biris [9] focuses on addressing challenges in vegetable production, such as population decline in rural areas, climate change, and soil degradation, by proposing a high-tech, small-scale hydroponic system utilizing Internet of Things (IoT) technology. This system allows for remote monitoring and automation during vegetable cultivation, using low-cost materials and sensors. Experimental investigations with lettuce cultivation demonstrate that the hydroponic system effectively maintains optimal environmental conditions, achieving a 75% germination rate in the initial experiment. Key advantages include easy management, simple installation, and remote monitoring capabilities, making it accessible to users with limited technical expertise.

The system shows promise for sustainable indoor farming of leafy vegetables year-round, particularly beneficial for small and medium-sized vegetable growers facing agricultural challenges.

Anees Abu Sneineha, Arafat A.A. Shabanehb [10] presents a hydroponics monitoring system using IoT technology. It utilizes an ESP32 microcontroller and sensors to monitor parameters such as temperature, pH, and nutrient levels in hydroponic systems. The system automatically adjusts conditions as necessary and enables remote monitoring and control via a smartphone app. Experiments demonstrate its effectiveness in maintaining optimal conditions for plant growth. The system offers potential benefits for improving agricultural productivity and sustainability.

## **LIST OF CROPS THAT CAN BE GROWN IN SOIL- LESS CONDITION**

When we use hydroponics, we usually don't need pesticides because pests aren't as much of a problem. Even if the plants don't get enough carbon dioxide or sunlight, they still grow well because they get all the nutrients they need directly to their roots.

Some greenhouse setups even pump extra carbon dioxide into the air to help the plants grow better (which is called CO<sub>2</sub> enrichment), or they add more lights to make the days longer and control how the plants grow.

| <b>Types of Crops</b>     | <b>Name of the crops</b>   |
|---------------------------|--|
| Cereals                   | Rice, corns  |
| Fruits                    | Strawberry   |
| Vegetables                | Tomato, Chilli, Brinjal, Green bean, Beet, Winged bean, Bell pepper, Cabbage, Cauliflower, Cucumbers, Melons, Radish, Onion. |
| Leafy Vegetables          | Lettuce, Kang Kong.  |
| Condiments                | Parsley, Mint, Sweet basil, Oregano  |
| Flower / Ornamental crops | Marigold, Roses, Carnations, Chrysanthemum   |
| Medicinal crops           | Aloe vera, Coleus  |
| Fodder crops              | Sorghum, Alfalfa, Barley, Bermuda grass, Carpet grass.   |

Fig.1 List of crops that can be grown on commercial level

### **SUPPLY OF NUTRIENTS TO THE PLANTS**

Because of the system's low nutrient-buffering capacity and ability to make rapid adjustments in hydroponics, careful monitoring of the system is required. Two components of nutrition must be considered: nutrient supply from the nutrient transport mechanism and plant nutrient response. Most nutrient essential levels have been identified for the most common crop plants. The amount and frequency of the nutrient solution supplied are determined by the substrate utilised (volume and physical chemical properties,

| Source   | Element | Characteristics                   |
|--|---------|-----------------------------------|
| Potassium nitrate<br>KNO <sub>3</sub>                  | N, K    | Highly soluble salt               |
| Potassium phosphate<br>KH <sub>2</sub> PO <sub>4</sub> | P, K    | Maintains Phosphorus in system    |
| Magnesium sulphate<br>MgSO <sub>4</sub>                | S, Mg   | Affordable, solubility, pure salt |
| Iron chelates  | Fe Cit  | Sources iron                      |
| Boric acid H <sub>3</sub> BO <sub>3</sub>              | B       | Source Boron                      |
| Calcium nitrate Ca<br>(NO <sub>3</sub> ) <sub>2</sub>  | N, Ca   | Highly soluble salt               |

Fig.2 Sources of nutrient element

the crop being grown (species and stage of growth), the container size, the crop and irrigation systems used, and the prevailing weather conditions. Plants should be fed on a daily basis. The optimal time for administering the nutritional mixture is between 6 and 8 a.m., though water requirements fluctuate greatly during the day and from day to day. To avoid damage and the appearance of illnesses, the solution should be given to the roots while avoiding wetting the leaves. Under no circumstance should plants be subjected to water stress, as this will have an impact on their final yield. It is normally recommended that you just water the plants once a week in order to flush away any remaining surplus salts. Use twice as much water as usual, but without the addition of nutrients. To avoid harmful ion accumulation and an increase in conductivity of electricity in the root area, about 20 and 50% of the solution's contents should be drained. Excess fertiliser solution discharged from pots during every day's watering can be recycled in the following watering. This liquid can be thrown at the end of the week.

## METHODOLOGY

The hydroponics setup includes components like Node MCU, Blynk IOT, temperature sensor, humidity sensor, pump, water reservoir, and nutrient reservoir. The temperature sensor and humidity sensor sense the environment and send its data to the Node MCU which reflects its values on the mobile screen via Blynk Iot.

The water reservoir is connected to the setup by a pump and pipes through which there is a continuous supply of water to the plants in the hydroponics setup.

The nutrient reservoir is also connected to the setup through the pump and the pipe. When the operator sees there is a

need for nutrients to the plant, the operator can switch on the nutrient solution pump from the mobile itself leading to the flow of nutrients through the setup.

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Fig.3 Hydroponic system

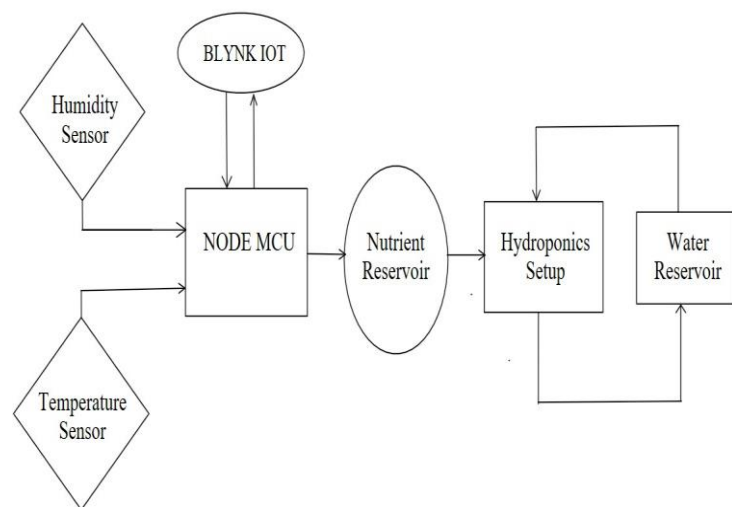


Fig.4 Block diagram of Hydroponic system

## **WATER CONSERVATION IN HYDROPONIC**

As water becomes more precious and valuable as a resource, the utilisation of hydroponic cultivation and other water-saving crop- production technologies are urgently needed and will become more popular over time. Hydroponics need significantly less water than earth gardening. In soil farming, most of the water that we supply to the plants is leached deep into the soil and is unavailable to the plant roots, whereas in hydroponics, plant roots are either submerged in water or a film of nutrients mixed in water is constantly encompassing the root zone, keeping it hydrated and nourished. This procedure does not waste water because it is recovered, filtered, replenished, and recycled. Crops grown in hydroponic systems can use waste nutrient solutions as an alternative supply of water. the reductions in irrigation water, fertiliser, and improvement in food and water productivity when using a hydroponic system against conventional agriculture. By recycling run-off water, NFT-based hydroponics can cut irrigation water usage by 70% to 90%. Under controlled hydroponic conditions, it is feasible to grow high-value, high-quality crops while consuming 85 to 90% less water per acre than typical soil-based agriculture.

Groundwater and dam/river water typically contain elements that might impact plant yield and plant condition, such as salinity, dissolved solids, and pathogens. While a few of these elements are helpful to crops, others must be avoided.

## **FUTURE SCOPE OF HYDROPHONICS**

The future scope of hydroponics projects holds significant potential in various areas:

1. **Urban Agriculture:** Hydroponics allows for efficient food production in urban environments, addressing land constraints and enabling local food supplies.
2. **Resource Efficiency:** Hydroponic systems offer improved water and nutrient use efficiency, reducing the environmental impact of traditional agriculture.
3. **Vertical Farming:** The development of vertical agricultural structures further maximizes space utilization, making hydroponics a key component in vertical farming initiatives.
4. **Wastewater Reuse:** The study's focus on wastewater reuse highlights the potential for sustainable practices, contributing to water conservation and environmental sustainability.
5. **Crop Quality Improvement:** Ongoing research and advancements in hydroponics may lead to enhanced crop quality through precise control of nutrient levels and environmental conditions.
6. **Technology Integration:** Integration with emerging technologies, such as sensors, data analytics, and automation, can optimize hydroponic systems for increased productivity and reduced resource consumption.
7. **Global Food Security:** Hydroponics has the potential to play a crucial role in meeting the growing global demand for food by providing a reliable and efficient method of crop production.

8. Biofortification Programs: Hydroponic systems can be employed for biofortification, enriching crops with essential nutrients, contributing to improved nutritional content in food.
9. Economic Opportunities: As hydroponics gains wider acceptance, it opens avenues for economic opportunities, including commercial hydroponic farming, technology development, and consultancy services.

## **CONCLUSION**

As soil growing conditions deteriorate, the adaptations to hydroponics technology are likely to increase rapidly in the future. Particularly in a country like India, where urban concrete conglomeration is rising by the day, there is no choice but to embrace soil-less culture to help boost yield and quality of produce in order to secure our country's food security. However, government action as well as research institute interest in this technology can push its implementation. To stimulate commercial hydroponic farms, low-cost hydroponic technologies that reduce reliance on human labour and lower overall startup and operational expenses are needed.

## **REFERENCES**

- [1]“A Review on Hydroponics and the Technologies Associated for Medium- and Small-Scale Operations” by Roberto S. Velazquez- Gonzalez, Adrian L. Garcia-Garcia, Elsa Ventura-Zapata, Jose Dolores Oscar Barceinas-Sanchez and Julio C. Sosa-Savedra.
- [2]“A REVIEW ON PLANT WITHOUT SOIL – HYDROPONICS” by Ms. Mamta D. Sardare 1, Ms. Shraddha V. Admane.
- [3]“Therapeutic and pharmacological efficacy of selective Indian medicinal plants – A review” by Murugan Prasathkumar, Salim Anishaa, Chenthamara Dhriyaa, Robert Beckya, Subramaniam Sadhasivam.
- [4]“Hydroponics as an advanced technique for vegetable production: An overview” by NISHA SHARMA, SOMEN ACHARYA, KAUSHAL KUMAR, NARENDRA SINGH and O.P. CHAURASIA.
- [5]“NEW EMERGING HYDROPONIC SYSTEM” by Y.N. Chow1, L.K. Lee N.A. Zakari,a1 , K.Y. Foo.
- [6]“Fabrication and Performance Evaluation of U-Shaped Hydroponic System” by Kavita Krishan\*, Er. Rajesh Agrawal and M. P. Thipathi.
- [7]“Design and Construction of a Vertical Hydroponic System with Semi-Continuous and Continuous Nutrient Cycling” by Dian Siswanto and Wahyu Widoretno.
- [8]“Construction and evaluation of a hydroponic system for cultivation of tomato” by Aamir Lund, Shakeel Hussain Chattha, Shakeel Ahmed Soomro , Mukhtiar Ali Leghari, Benish Nawaz Mirani, Ghassan Zahid and Khalil Lund.

[9]“Design of a Small-Scale Hydroponic System for Indoor Farming of Leafy Vegetables” by Neiko V Nikolov, Atanas Z. Atanasov, Boris Evstatiev, Valentin N. Vladut and Sorin-Stefan Biris.

[10] “Design of a smart hydroponics monitoring system using an ESP32 microcontroller and the Internet of Things” by Anees Abu Sneineha, Arafat A.A. Shaban