

IOT-Based Smart Advanced Agriculture System Using Hydroponics

SHIVANAND¹, RAMYAKRISHNA P²

¹ Lecture Senior Scale, Department of Computer Science and Engineering

² Lecture, Department of Electronics and Communication Engineering

^{1,2} Government Polytechnic, Karatagi, Koppal, Karnataka, India

Abstract: A hydroponics system that uses the Internet of Things and automation means that important environmental parameters, such as pH, temperature, humidity, and nutrient levels, are monitored and controlled by the Internet of Things. This enables accurate adjustments and optimal plant growth through automated actions based on real-time data collection from sensors, all of which are remotely managed via a connected device, such as a smartphone. By utilizing this technology, the system creates a smart home by lowering human labor, increasing energy efficiency, and making the house easier to access. The Bluetooth module, NodeMCU, and 4-channel relay module make up the suggested setup. This module is very user-friendly and easy to install, and it controls the household appliances.

Index Terms – Hydroponics, Agriculture.

I INTRODUCTION:

In order to reduce space during planting and eliminate the need for chemicals in the soil, the hydroponics method uses water and nutrients instead of soil to produce plants. Numerous cutting-edge methods, such as the nutrient film technique, deep flow technique, dynamic root floating technique, and others, are used in hydroponics and are not just for plants grown in water. Additionally, there are two main categories of soilless cultivation: substrate culture and water culture. The plants are entirely nutrient-rich, have a high yield, and may be planted more quickly than in soil. Integration with the Internet of Things (IoT) enables real-time data retrieval and transfer. By integrating these cutting-edge technologies, the suggested hydroponic hardware prototype may maximize yields, minimize resource waste, and create the ideal growing environment for plants.

How does Hydroponics works?

Instead of using soil, hydroponics uses a nutrient-rich water solution to produce plants. When the liquid solution is combined with water, plants take up the nutrients from it.

- Nutrient solution: The system is pumped with a nutrient-rich water-based solution.
- Exposure of the roots: The nutritional solution comes into contact with the plants' roots.
- Support: An inert media like as gravel, perlite, or other substrates may be used to support the roots.
- Aeration: Enough air must reach the roots.

Advantages:

- Effective nutrient uptake: Because plants have steady access to nutrients, they develop more quickly and expand more than they would if they were cultivated in soil.
- Conservation of water, land, and resources: Hydroponic crops conserve these resources.
- Sustainable agriculture: One essential element of sustainable agriculture is hydroponics.

Hydroponic system types

A common option for home growers is the wick system.

A well-liked technique for extensive commercial operations is the Nutrient Film Technique (NFT).

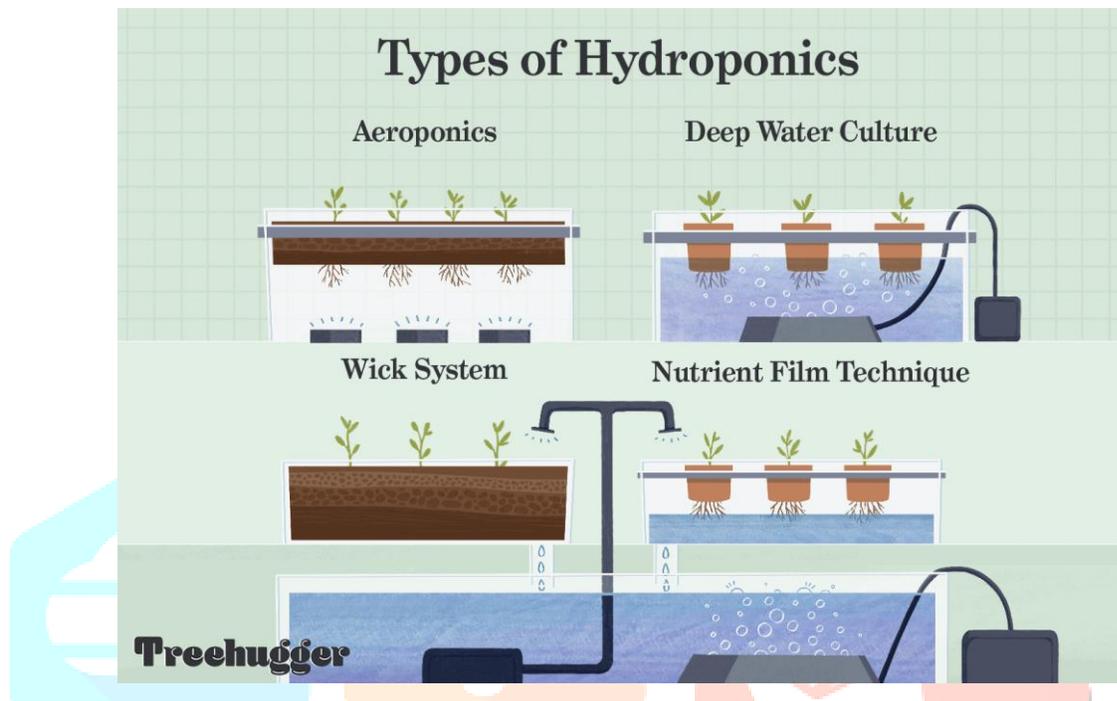


Fig 1: Types of Hydroponics

Each of the six primary varieties of hydroponic systems has pros and cons and is appropriate for a certain set of crops. Since NFT is comparatively simpler for novices and even qualifies as an entry-level type, that is why we chose it. Lettuce, spinach, kale, asparagus, and other leafy vegetables can all be grown with this variety.

Nutrient Film Technique

Most people think of this type of hydroponic system when they think about hydroponics. A timer is not necessary for the submersible pump in N.F.T. systems because the nutritional solution flows continuously. The nutritional solution is poured into the growth tray, which is often a tube, passes over the plant roots, and then returns to the reservoir.

Drip Systems

Probably the most popular kind of hydroponic system in the world is the drip system. It is easy to operate; a submerged pump is controlled by a timer. A tiny drip line drips fertilizer solution onto each plant's base when the timer activates the pump. The extra nutritional solution that runs off is gathered and put back into the reservoir for later use in a recovery drip system. The runoff is not collected by the non-recovery system.

Aeroponics

The most advanced form of hydroponic farming is most likely the aeroponic system. Similar to the N.F.T. system, air makes up the majority of the growing medium. The roots are misted with nutritional solution and dangle in midair. Typically, the misting is carried out every several minutes. If the misting cycles are broken, the roots will quickly dry out since they are exposed to the air, much like the N.F.T. system.

Ebb and flow system

The nutritional solution is momentarily flooded into the grow tray by the Ebb and Flow system, which subsequently drains the solution back into the reservoir. Typically, a timer-connected submersible pump is used to accomplish this task. The fertilizer solution is pumped into the grow dish when the timer goes off. The nutritional solution returns to the reservoir when the timer turns off the pump. Depending on the size and kind of plants, the temperature, humidity, and growing media type, the timer is programmed to turn on multiple times during the day.

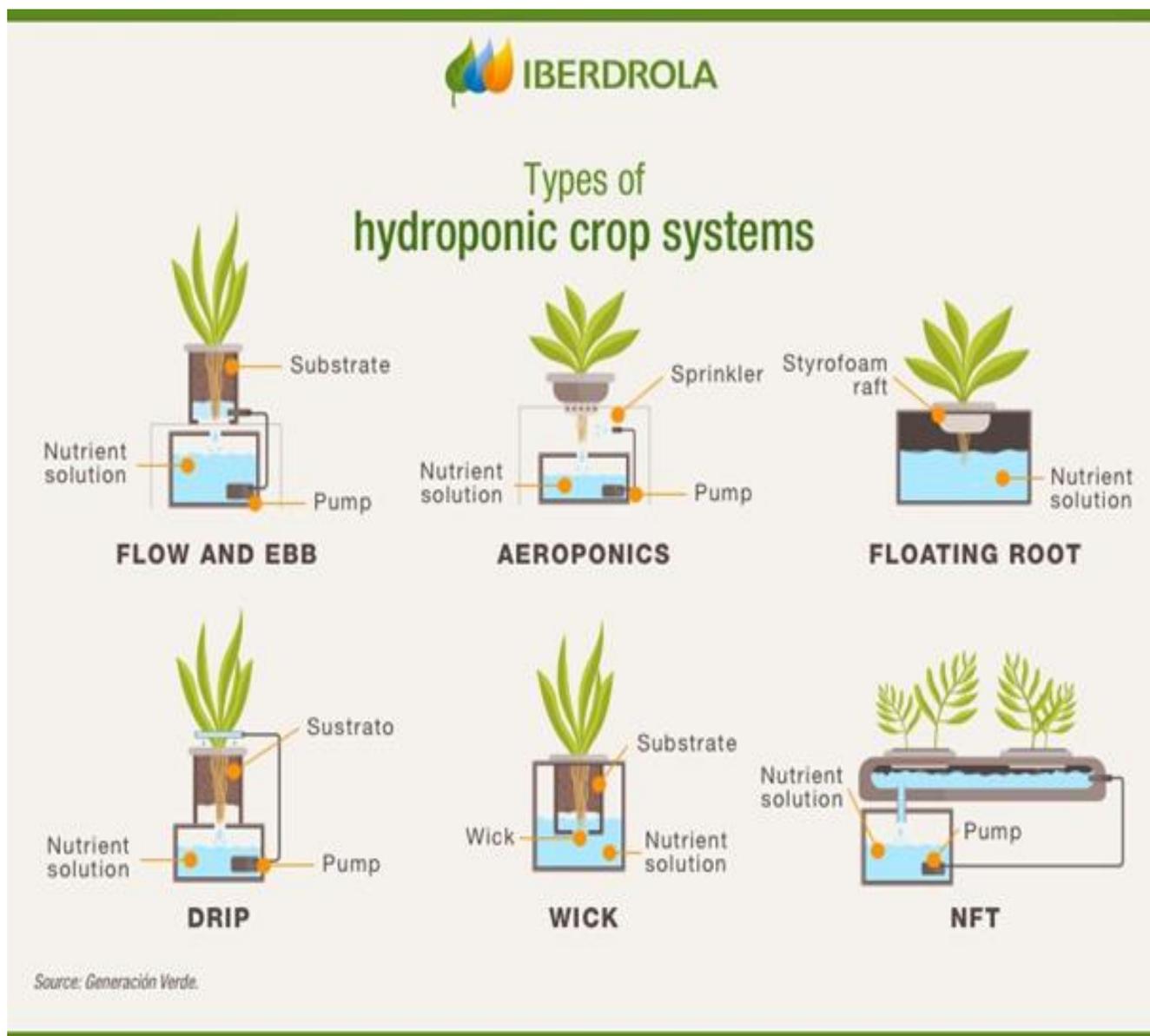


Fig 2: Types of Hydroponics

Objectives of the work:

- Automate data collection and the hydroponics process.
- To comprehend the significance of a technology-agricultural hybrid strategy that can boost yield

Standard features of Hydroponics:

Higher Yields: Produces Higher Yields. Global food shortages are common enough that we should prepare for them as a matter of routine.

Faster growth: Increased Growth Rate. It's been proven that plants that are grown in hydroponics systems are able to grow at a faster rate when compared to traditional

Less space: Maximizes Space - Hydroponics requires much less space than plants planted in the ground. Depending on the system.

Minimal weeding: Without soil, there's no need to worry about weed growth, reducing the time and effort required for weed control

II.LITERATURE REVIEW

Quantifying productivity and characterizing the growth and development of basil cultivars grown in hydroponic systems using the nutrient film technique (NFT) and deep flow technique (DFT), measuring the impact of nutrient solution electrical conductivity (EC) on the growth of basil species and cultivars grown under high and low DLIs, measuring the impact of air temperature on the growth and development of basil species, and measuring the impact of plant density and DLI on the growth and yield of green and purple sweet basil are the main goals of **Kelli J. W.** When undamaged roots must be removed for use in subsequent processes and nutrient medium must be carefully regulated, a hydroponic growth system is the most beneficial option.

Measurements of electrical conductivity, pH, dissolved oxygen, and temperature are necessary for proper water and fertilizer management in the hydroponic system because ion concentrations in the nutrient solutions fluctuate over time, leading to nutrient imbalance. Real-time measurements of every nutrient are necessary in closed hydroponic systems, however they are not accessible because of technical issues. **Shreyas M. et al.** conducted research based on these findings.

The study by **Mamtha D. S.** focuses on the point at which arable land under cultivation will continue to decline as a result of growing urbanization, industrialization, and iceberg melting (a clear effect of global warming). Once more, the level of soil fertility has reached saturation, and further fertilizer application does not result in further increases in productivity. Furthermore, food production under traditional soil-based agriculture is threatened by a number of factors, including poor soil fertility in some cultivable areas, a decrease in the chance of natural soil fertility build-up by microbes due to continuous cultivation, frequent drought conditions, unpredictable climate and weather patterns, rising temperatures, river pollution, poor water management and massive water waste, declining ground water levels

III.METHOD AND METHODOLOGY:

Hydroponics is a method of growing plants using mineral nutrient solutions, in water, without soil. In this system plant can be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel, mineral wool, or coconut husk.

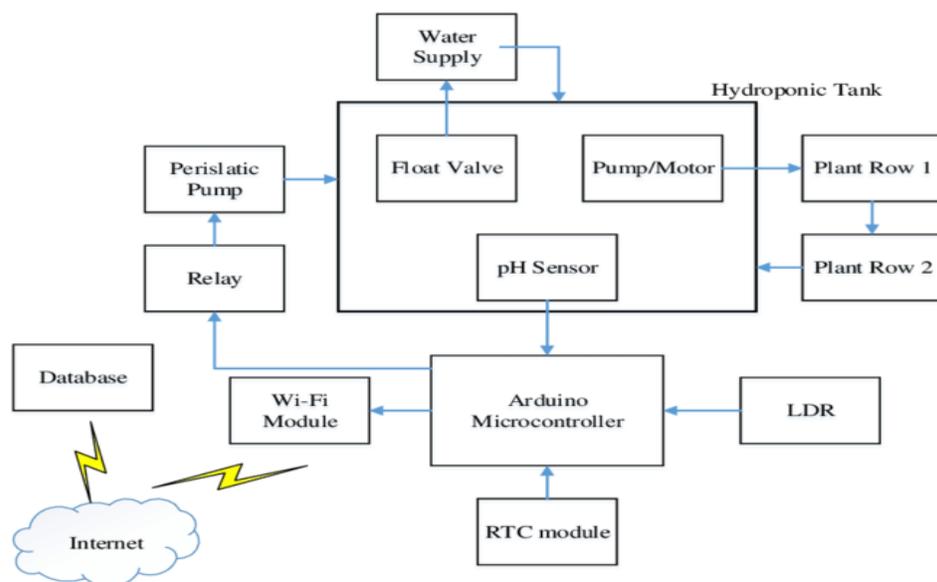


Fig 3: Block Diagram of Hydroponics system

Using a variety of systems, such as deep water culture, nutrient film technique (NFT), drip irrigation, ebb and flow, or aeroponics, the hydroponics methodology involves growing plants without soil by suspending their roots in a nutrient-rich water solution, usually in a controlled environment. Each system has a unique setup for delivering the nutrient solution to the plant roots; important factors include choosing the right plant variety, preparing the nutrient solution with precise nutrient levels, monitoring environmental factors like temperature, pH, and light, and handling potential problems like root rot or nutrient deficiencies.

Steps in a typical hydroponic growing process:

Choose a plant variety: Select plants suitable for hydroponics based on their growth habits and nutrient requirements.

Prepare the nutrient solution: Mix the necessary nutrients in water according to recommended concentrations.

Set up the hydroponic system: Assemble the chosen system, including containers, pumps, tubing, and growing medium (if used).

Plant propagation: Propagate plants through seeds or cuttings.

Transfer to hydroponic system: Carefully place seedlings or plant cuttings into the system.

Monitor and adjust: Regularly check the nutrient solution pH, EC (electrical conductivity), and environmental parameters, making adjustments as necessary.

Harvest: Harvest crops when they reach maturity.

PRECISION FARMING:

By carrying out crop production techniques at the appropriate time, location, and method for maximum profitability, sustainability, and land resource protection, an information and technology-based farm management system detects, evaluates, and controls field variability.

A significant amount of research has been done, but only a small percentage of farmers have used precision agriculture (PA) technologies to restructure the entire agricultural system toward low-input, high-efficiency, and sustainable farming. Compared to conventional cultivation methods, precision farming increases average yields by using inputs in precisely the right proportions.

IV. RESULT AND DISCUSSION:



Fig 4: Model of Hydroponics

A working model of hydroponics demonstrates how plants can grow without soil by utilizing a nutrient-rich water solution that directly feeds the roots, typically displayed in a container with a circulating water system, showcasing the key elements like a reservoir, growing medium (like rockwool or coco coir), a pump to circulate the nutrient solution, and a plant support structure, highlighting the concept of controlled environment cultivation with precise nutrient delivery.

Benefits of Hydroponic:

Hydroponic farming is rapidly gaining popularity as a substitute for conventional growing techniques among gardeners worldwide because of its more environmentally friendly approach to resource usage. Here are only a handful of its many benefits: Hydroponic farming totally does away with the need for pesticides and herbicides when compared to conventional soil gardening, which benefits the environment and the product that is produced. Hydroponic farming reduces the need for a constant supply of fresh water by reusing any water that is consumed in the system.

V.CONCLUSION:

Although a hydroponic system can be used to grow almost anything, certain crops perform better than others. Certain plants, like lettuce, tomatoes, cucumbers, capsicums, strawberries, and leafy greens, do not mind moisture and do not grow too large for their surroundings.

When establishing a hydroponic garden, one must also decide whether to use only a solution culture or some kind of growth media, depending on the size, durability, and root development of the plants to be grown as well as the system's design. Leafy greens and other plants with shallow roots do well in solution cultures. Conversely, heavy crops like cucumbers and plants with deep roots like beets benefit from growth media.

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