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A review on Automation in Hydroponics

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Abstract - *Space has always been the big problem for those who live in urban areas. "HYDROPONICS" is the growing of plants in a liquid nutrient solution with or without the use of artificial media. The objective is to identify hydroponic system for those who are living in an apartment in an urban area. Livings in apartments have limited space to do farming activities. to help people so that they can farm in a small area and have limited space in the urban areas. Apart from that continuous use of traditional farming practices with conventional tillage and burning off the crop residues has reduced the soil resource base and intensified soil degradation with decrease in crop production capacity. also, escalating fuel, fertilizers and other input costs; necessitates the effective use of resources in agriculture. In Hydroponics, there is a challenge of precision agriculture, especially for some sensitive plants, e.g., Coriander and lettuce. These kinds of plants need a precise amount of nutrient and water every time to grow ideally. Internet-of-Things (IoT) is a technology that enables regular monitoring of every aspect of human life. By the use of these technologies, we can easily control the nutrients required for the plants to grow.*

Key Words: **Internet-of-things**, **Hydroponics, Nutrients**.

1. INTRODUCTION

Agriculture is the most critical sector in India. With the increasing population every year, the food availability is a necessity that must always be achieved by the agricultural industry. However, with the increasing development, a lot of agricultural lands is converted for uses such as the construction of housing complexes, industrial estates, trade zones and public facilities which will undoubtedly have a negative economic, social and environmental impact. This agricultural land reduction will certainly also cause a decline in agricultural production capacity, thus making the government have to import agricultural products to meet domestic food needs. Agricultural technology is proliferating in urban areas now. One solution that can be done by the community is to develop an agricultural system that can be done with limited land availability or commonly called urban farming or urban agriculture. Urban farming or urban agriculture is one of the practical solutions to overcome the reduction of agricultural land. Urban agriculture uses land that is not used in urban areas, such as roofs, balconies, patios, even on walls of buildings. One of the agricultural techniques used in urban farming is hydroponics. Methods using hydroponics is one of the possible ways to be able to do agriculture even without agricultural land. Hydroponics comes from Greece, hydro means water, and ponies means work. Based on the problems above, one of the researchers tried to solve this by combining hydroponic methods, and IoT technology, and 'fuzzy' logic to make a smart controlling that can automatically control plants nutrition's and water needs. By utilizing internet of things (IOT) technology, the sensor device can communicate and send data to a cloud server to be processed and monitored in real time scenario. Each sensor is connected to Arduino board to control plant needs automatically by using fuzzy logic technology so that the control system will automatically add nutrients to the plant. The results of processing data from

2. History

The Greek words "hydro" (which means water) and "ponos," which means labor, are the origin of the name "hydroponics." This phrase was first used in 1929 by Dr. Gericke, a professor from California who was developing what had previously been a lab technique into a practical way to cultivate plants. During World War II, the U.S. Army used hydroponic culture to grow fresh food for troops stationed on barren Pacific islands. Commercially successful farms existed in America, Europe, Africa, and Asia by the 1950s.

3. Benefits of hydroponics include:

(1) Crops grown hydroponically have a high yield and are free from disease, weed infestation, and soil-borne insects and pests.

(2) Food grown in soilless cultures is organic, and no dangerous toxics or pesticides are used.

(3) Gardening requires less room since plants with short roots can be cultivated near to one another.

(4) Crops grown in hydroponic systems grow twice as quickly and produce twice as much, allowing for increased productivity in the same amount of space.

(5) There is no water waste because the process only applies 1/20th as much water to the crops as conventional farming does.

(6) Demands less work.

(7) Crops can be cultivated without concern for the varying seasons.

4. Limitations:

While hydroponics offers many advantages, it also has some drawbacks. Setting up a large-scale application requires technical expertise. Additional setup costs are expensive and necessitate ongoing oversight. Due to improper management, water-based infections can readily be introduced via hydroponics procedures. Not all crops can be produced using these techniques, which is another significant constraint. Carrot and potatoes are a couple of examples. pH, humidity, and temperature are additional restrictions.

5. Problems:

Since the price of a hydroponics system is considerable, poor Indian farmers cannot afford them. Growing crops need very profound abilities and practical knowledge. Less awareness leads to an unfocused agriculture sector in India. It is not simple to impart knowledge and training to farmers of all income levels, from the poor to the average. Another motive is to help the farmer generate interest and ensure better outcomes and high harvests. The farmers need to hire a horticulture or skilled staff if they are willing to work in this field but lack knowledge of the system. And a major issue is really finding employees at reasonable salaries.

6. Hydroponic system in total:

6.1 open system

• Rockwool Culture: The hydroponics industry's most popular media. Rockwool is made of heated, ground-up basalt rock that is spun into threads to create wool. It is frequently supplied in cube form and is quite light. Rockwool has the capacity to store water and maintain an adequate amount of air (at least 18 percent) to support healthy root growth.

6.2 Closed system

• NFT and Rockwool: Plants are established on small rockwool slabs positioned in channels containing recycled nutrient solution.

These systems are additionally divided into:

1. passive devices

2. active systems

A wick and growing medium with a high capillary action are used in passive systems. This enables water to be drawn to the roots of the plant. By far, the most straightforward hydroponic system is the Wick System. Active systems function by continuously transferring a nutritional solution to the roots of plants.

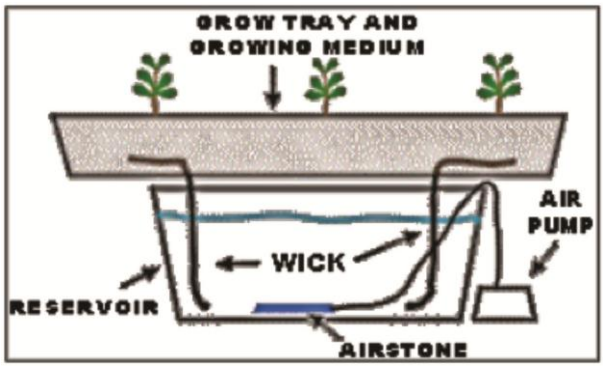

Fig -1: The above figure shows the wick system

7.Techniques for Managing Nutrients

The difficulty of managing nutrients is a closed system's main drawback. There are four basic methods that are frequently used.

7.1 Technique 1

Automatic control of electrical conductivity (EC), pH, and water addition. While the EC provides an estimate of the nutrient content, the pH measures the substrate's acidity and regulates the availability of mineral nutrients. Because overall nutrient availability is optimized at a slightly acidic pH, a hydroponic culture should have a pH between 5.0 and 6.0, and the EC level should be between 1.5 and 3 ds m-1.

7.2 Technique 2

The holding tank's water makeup is automatically controlled, typically by a float valve, so the tank level is maintained. Water and nutrients are present here.

8. Review

B.A. Kratky Et.al in his research he found methods to grow plants in suspended net pot method which used a model growing system consisting of a tank which is filled with 4 to 8 liters of nutrient solution for a plant before planting. Lettuce can be seeded or transplanted into containers containing growing medium. The pot is supported by the tank cover such that their lower portion is initially immersed in nutrient solution. Figure shows the setup model used for the research.

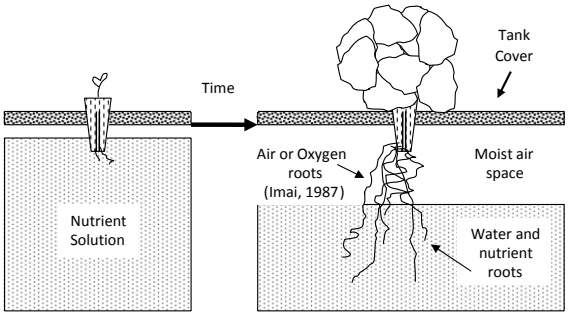

Fig -2: B.A Kratky research

It completes the research concept of non-circulating hydroponics, which can grow plants using water and nutrient solutions without the need for both electricity and pumps. Elongated roots absorb nutrients to form a nutrient solution, and roots hanging in moist spaces provide aeration. The plant grows, expands airspace and lowers nutrient solution, and spreads its roots [1].

Except this Mohd. Hafiz Talib et.al conducted a study on improvising hydroponics systems in Malaysia, where people live in small condominiums and apartments with little space to grow plants to solve the problem. I studied the general layout and based it on him... start looking into the problem. Using the existing shelving system and considering the shortcomings we discussed with local farmers and breeders, we came up with a new design that uses water circulation technology to save space and is easy to use [2].

In addition, Khairul Aidil Azlin Abd Rahman et al. also conducted some research in Malaysia and found that 80% of the food supply was imported and local plant products were exported. And about 65% of a person's income goes to food consumption. Existing hydroponic system designs are not suitable for current lifestyle requirements. This allows users to farm in tight spaces. A hydroponics system could cut him 40% of his living expenses. He then proposed another type of hydroponics method for shelving systems and, in conclusion, this study helped urban dwellers understand the importance of home-grown food while reducing food costs[3].

Apart from these traditional methods, Herman et al. conducted research using IOT (Internet of Things) technology. IoT is a technology that monitors every aspect of human life. This allows you to control the levels of nutrients and aqueous solutions. He used fuzzy logic (fuzzy logic that attempts to solve the open and imprecise data spectrum problem) to control nutrient flow using sensors.

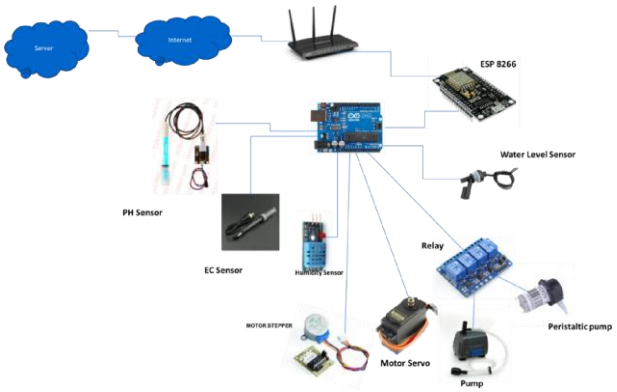

Fig -3: The above figure shows the IOT overview

The above figure shows the general idea of this method. The use of IoT using an Arduino microcontroller to control and analyze data from all connected devices and sensors. The IoT device used here is useful for monitoring humidity, the temperature of nutrient solution, air temperature, PH, and EC using an android application.

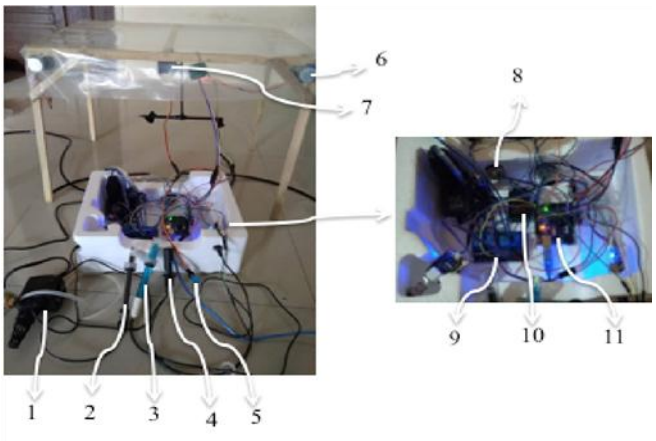

Fig -4: The above figure shows the IOT Controller

Below figure shows the flowchart of the controller programmed output system along with the implementation methods used by the researcher.

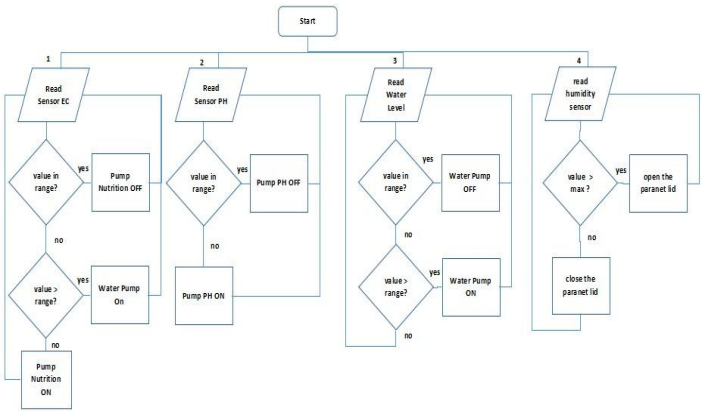

Fig -5: The above figure shows the flow chart

After the experimentation for 4 weeks the research concluded that this hybrid system showed better progress in plant growth than in the traditional one by comparing the data statistics and growth comparison as depicted below

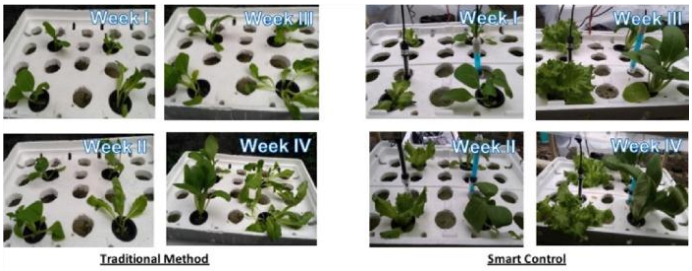

Fig -5: Comparison of traditional and Smart control

So concluding that smart controlling is better than traditional methods[4].

Subhrajit Saha Et.alfrom USA made a research by comparing the methods of growing plants without soil i.e Hydroponics and aquaphonics. As study tanks of 95 L (25 Gal) capacity dark polyethylene containers (16.88" 18.75" 27 cm3 - h " w " d) were employed. Hydroponics and aquaponics were each given four tanks. Tanks were stocked with 83 L (22 Gal) of pH-neutral tap water. All tanks were equipped with a double air pump (75-225 L capacity) and two air stones (30 mm round).

Each aquaponic tank received the release of four mature crayfish. Because crayfish are territorial, each tank was filled with various pieces of PVC pipe shelters to deter conflict and enhance crayfish survivability. Gallardo-Coll et al. utilised PVC shelters in a similar manner (2014). Each container lid had a surface area of 506.25 cm2 (18.75 cm " 27 cm). Five circular cuts, one in each, were made on the lids.The net pots holding the seedlings should be inserted into each corner and one in the centre.

Basil was planted at a density of 5 seedlings per 506.25 cm2 (100 plants per square metre). In this investigation, slotted net pots with a diameter of 12.7 cm (5 in) were employed. To hold the basil seedlings, pots lined with coconut coir and vermiculite (60:40) were constructed. On August 14, 2015, seedlings that were three weeks old were sown in net pots and transferred to tanks.

And after the experimentation comparison he concluded that Basil may be grown in soilless hydroponic and aquaponic systems with little water, which has the potential to solve the problems of land and water scarcity. Compared to hydroponic basil, aquaponic basil produced plants with 14% greater height and 56% greater fresh weight. We come to the conclusion that the extra nutrients provided by the crayfish excreta and unconsumed feed are what are responsible for the increased growth and yield in AqB. Therefore, aquatic creatures like crayfish could be used to produce crops in aquaponic systems.However, we found no distinctions between the two soilless systems in terms of plant quality (chlorophyll) or leaf nutrient levels. These two characteristics were unaffected by the addition of extra fertilisers to the aquaponic systems[5].

Martin P.N. Ghent et al. studied the metabolites of plants affected by sunlight, such as diurnal altitude and water content, and analyzed the tissue structure of lettuce and the variety of hydroponically produced lettuce (Lactuca sativa L.). We collected the sizes AM or PM. And their compositions were measured. The range of insolation integrals was 4 to 14 mol mL2 day. In this study, plant sizes ranged from 2 to 260 g fresh weight (FW)/plant and photosynthetically active irradiance. The increase in dry matter content in normalized irradiance per unit area can be used to explain much of the variation in tissue composition on a FW basis. Except for nitrate, metabolite concentrations increased with FW-based irradiation, and changes with irradiation were greater in the afternoon than in the morning harvest.

After considering the data collected, he concluded that the leaf area index and light absorption per unit leaf area or weight vary between plants of different sizes. Small plants have widely spaced leaves that are exposed to all of the sunlight that falls on the canopy. Since larger plants have more leaf area and more leaf overlap, there is typically less light intensity per unit leaf area. Small plants should be predicted to have faster rates of photosynthesis and nitrate reduction and, thus, bigger changes in sugars and nitrate than large plants because of the higher light intensity per unit leaf area [6].

PERFORMANCE OF VEGETABLES UNDER HYDROPONICS SYSTEM [7]

Type of crops	Name of the crops
Cereals	Rice, Maize
Fruits	Strawberry
Vegetables	Tomato, Chilli etc
Leafy vegetables	Lettuce, Spinach
Condiments	Methi, Parsley

Aquaponics:

Aquaponics is a bio-integrated system that links recirculating aquaculture with hydroponic vegetable, flower, and/or herb production. Recent advances by researchers and growers alike have turned aquaponics into a working model of sustainable food production. This publication provides an introduction to aquaponics with brief profiles of working units around the country. An extensive list of resources points the reader to print and Web-based educational materials for further technical assistance [8].

Recently, hydroponics techniques have been proposed as a clean and relatively simple method, devoid of the possibility of soil-borne diseases, insect or pest infections of crops, thus reducing or eliminating the use of pesticides and reducing the resulting toxicity. In addition, compared to field-grown crops, the plant's growth time is reduced because the roots are mechanically unhindered and all nutrients are readily available to the plant. This technique is very useful in areas where environmental stress (cold, hot, desert, etc.) is a major problem (Polycarpou et al., 2005). Plants in hydroponic systems are considered off-season and can grow all year round as they are immune to climate change (Manzocco et al., 2011) [9]. In addition, commercial hydroponic systems are automated, expected to reduce labor and eliminate traditional farming practices such as weeding, spraying, watering and tillage (Jovicich et al., 2003). . Hydroponics saves a lot of water because it doesn't require irrigation or other types of spraying and doesn't hold water. Pest and disease issues are easily controlled, while weeds are virtually non-existent. Yields are higher due to the larger number of plants per plant compared to conventional farming. [10].

9. Fodder Production Under Hydroponics

Growing plants without soil in greenhouses (high-tech or low-cost equipment) in water or nutrient solutions for short periods of time (about 7-8 days) is hydroponic forage production. In India, hydroponic forage production prefer corn kernels over other grains. Hydroponic diets have other health benefits due to their palatability, digestibility, and nutritional value. Hydroponic feed can be produced to feed dairy cows using inexpensive equipment in situations where farmers cannot successfully grow conventional feed (Ramteke et al., 2019). Land is 529.7 million, of which 187 million (19.89%) cattle, 108.7 million (19.89%) buffalo, 71.56 million (13.51%) sheep, 140.54 million (26

54%) goats and 11 million pigs. Over the past 56 years (1951 to 2007), growth rates for cattle (28.19%), buffalo (142.72%), sheep (83.02%) and goats (197.76%) show an increasing trend, showing an overall The growth rate is 80.91. % (GOI, 2012). Domestic feed and fodder demand is increasing due to the increase in livestock due to the intensive breeding system.

10. Crops Grown on Soil-Less or Hydroponics Culture

This technology makes it possible to grow practically any kind of vegetables, fruits, fodder and crops. Flowers give better flowering and color in hydroponics. Hydroponics systems can be automated, so they are well controlled and better suited for collecting the final product. Some crops such as vegetables, fruits, flowers and medicinal plants can be grown without soil or hydroponically (Sardare and Shraddha, 2013) [13].

Significant differences in yield quality were observed between hydroponic lettuce and conventionally grown lettuce (Murphy et al., 2011). Tomato flavor and acidity, carotenoids and vitamins were superior in the hydroponic system (Gruda, 2009). A mixture of 80% pumice + 10% perlite + 10% peat was found to produce 30% more tomato yield compared to soil (Matouri et al., 2005). Hydroponic tomatoes were thought to be softer and tastier than conventionally grown tomatoes. [14].

11. Quality Improved by Hydroponics

Consumption of fruits and vegetables significantly reduces the risk of many types of chronic diseases in humans (Giovannucci et al., 2002; Dorais et al., 2008). Some bioactive compounds and nutrients, such as beta-carotene and antioxidants found in vegetables, have beneficial effects on health. Therefore, eco-friendly techniques like hydroponics can be used to increase health-promoting compounds and improve the quality of fruits and vegetables. It is widely used for environmental control and protected agriculture. used to address uncertainties in soil moisture and nutrient status in You can also change the nutritional value of fruits and vegetables by controlling light and temperature [15].

12. Conclusion Indian hydroponics market potential:

Some countries with dry and arid climates like Israel are using hydroponics to great effect. It has great potential for food production. With population growth and soil degradation due to poor land management, people are turning to innovative techniques such as hydroponics and aeroponics to feed the country. Climate change and natural disasters such as droughts and floods require a switch to the latest technologies to ensure safe food production. According to research, the global hydroponics market is projected to be worth $17.9 billion by 2026. The technology is still in its early stages in India, but there are signs it is on the rise. [16].

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