Automated Hydroponics Greenhouse Monitoring System using Adafruit.io Controlled by Google Assistant

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Abstract: -As the population of the world increases day by day, the demand for the nutrient rich food also increases in the same way, but our traditional soil-based agriculture technique faces some major challenges, one of which is per capita land availability. In 1960 with 3 billion world population, per capita land availability was 0.5 ha. At present it has reduced to 0.25 ha with 6 billion world population and further it is estimated that, by 2050 it is going to be decreased to around 0.16 ha. Due to rapid urbanization and industrialization the arable land under cultivation will also be reduced. So, under these circumstances, in near future it will become impossible to feed the entire population using the soil-based methods of agriculture. Thus, in order to overcome these challenges, it is more relevant to practice soil-less agricultural methods. Hydroponics is one of the most popularly known and well-organized method among various soil less techniques available and has shown some promising results all over the world. Hydroponics growing methods consists of various types, among which, we have used Deep flow technique or commonly known as DFT. In our implementation we measured and controlled various entities such as greenhouse temperature, humidity, nutrients solutions, pH, etc.

Keywords: Hydroponics, NFT, NodeMCU, Adafruit.io, Google Assistant.

1. INTRODUCTION

Hydroponics is a technique of soilless cultivation. It's been there for ever, but is less popular in countries like India because we rely on traditional soil based cultivation methods implemented by our ancestors. This method of hydroponic growing provides more yield when compared to other techniques and also the nutritional value of the hydroponics plants is greater than that of plants grown in soil based methods. Plants in hydroponics are grown very similar to soil based except the roots of the plants are dipped inside the nutrients solution. Plants need air, water, sunlight and nutrients. We must understand that the soil provides just the structure to hold the plants but not the nutrients. The nutrients come from other minerals mixed in the soil. Thus it is more efficient way to provide proper nutrition to the plants. The plants which are grown hydroponically grows much faster and healthier as it is much easy for the roots to suck the nutrients from the water rather than in soil. Thus this paper is intended to provide the information about implementation of Automated hydroponics system, its benefits and its applications.

2. LITERATURE SURVEY

According to Rahul nalwade and Tushar Mote [1] India is at number 4 among the leading food producing countries.

Agriculture has been part of Indian culture since the very beginning of civilization. We know the contribution of Agriculture in the Economic growth of our country. For India's economic growth to be equivalent to that of other grown countries, it is very important to excel in the field of Agriculture to be able to produce our own food to serve the entire population. Thus we need an emerging technology that can improve the situation of the food productivity which could probably lead us towards the expected economy. One such technology which is already centuries old in other western countries, its new in India and very few agree to adopt to the latest methods stepping aside the traditional methods. This it's very important for us to educate the farmers all-round the country to inculcate the latest and most beneficial methods which provides more yield which indirectly leads to better way of living eradicating poverty. Thus introducing the technique like hydroponics would eventually lead to the betterment of the society. The goal of this project is to implement the Hydroponics using automation which would reduce the labour required, and improve the precision in the way of growing.

According to Somchoke Ruengittinun and Sitthidech Phongsamsuan [2] IOT has been the game changer around the world these days, one such example is Thailand which is completely trying to apply the concept of IOT in day to day activities. The basic idea behind introducing IOT is that more and more object can be added to simplify the way of living of human beings. IOT helps us to control numerous amount of devices among various platforms making human tasks easier. The country like Thailand focuses on Agriculture as it's the primary occupation of the people in that country. Although Hydroponics is new to this country it has amused some of them who implemented it [5] [11] and is been a new and interesting methods that people would like to adopt to, as a remedy for the changing weather conditions The main advantages of having Hydroponics system is that, it allows the farmers to grown a variety of different crops that cannot be grown by using their traditional methods, which would eventually amuse the population of Thailand. Although you need not have any expertise in farming, you might need a little of practical knowledge of growing if you are new to Agriculture. This paper gives information on how to control different parameters like Nutrients temperature, humidity, pH and electrical conductivity (E C). The very simple idea of this paper is to provide sufficient information to the interested nonprofessional farmers, people in urban areas and for the people who have limited knowledge in

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this field to start up with the initial setting up of a hydroponic plant. In order to make the process much easier, the concept of IOT is used to control and monitor multiple parameters by using and android application, and also alert the users whenever the farm is in abnormal condition.

According to Saket Adhau, Rishikesh Surwase and K H Kowdiki, with the recent advancements in technology and improvements in hydroponics method of growing there is a rapid demand for Automated system. Although there are some automated systems available, but they haven't made much of an effective breakthrough. This paper is intended to efficiently make use of the sensor data in real-time. They specify the work that aims to build a self- controlled fully automated hydroponic system which is intelligent enough to provide proper amount of required nutrients by using the present day technology. The real-time data collected from multiple sensors are imported into a AVR microcontroller board and the process of automating and monitoring these real time data is carried out. They have provided a cost efficient method of implementing a good automated hydroponic control system. The system is subjected to be rigorous tests for correctness and validation. Once it meets all the required criteria, the system is then provided to the consumers in and across India.

According to the study of P Sihombing, N A Karina, J T Tarigan and M I Syarif the developments in technology along with the combination of science has been resulted in some of the brilliant ideas that could improve the way the agricultural practices have been carried out. In this paper they have developed a control tool that could automatically control the flow of nutrients to the hydroponics plants by using a smartphone. Arduino Uno microcontroller is used as the base of hardware part and Arduino programming is used in programming. Simple if statements are used to control the flow of nutrients. Various parameters like Fluid level, temperature and humidity are continuously monitored using the smartphone. The height of the nutrients in the reservoir is determined by using an ultrasonic sensor, which is used to fill the water or nutrients solution to a specified level after which the flow of water is automatically stopped. The temperature is measured by using an LM35 temperature sensor. The reading from these sensors are directly displayed on the LCD display. This helps the farmers to control different parameters of their farm from remote areas. The only limitation in country like India is internet connection. If the sufficient amount of internet speed is available, the controlling happens without any lags.

3. METHODOLOGY

Different techniques available in hydroponics:
There are many techniques available in hydroponics, the most popular among those are listed below:
1. Nutrient film technique(NFT)
2. Deep flow technique(DFT)
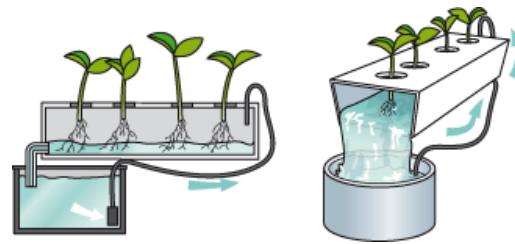3. Capillary action Technique.

3.1 Nutrient Flow Technique

Figure 1: Nutrient Film Technique.

Nutrient film technique provides a constant amount of nutrients for the plants. An automated system for controlling the flow of nutrients can be implemented but can be subjected to severe waterlessness if the flow of nutrients solution stops for any reason. Thus automated system is designed in such a way that a notification is sent to the user if in case the nutrients flow stops abruptly. There are 4 main phases in automated NFT as listed below:
1. Filling the reservoir with water.
2. pH control.
3. Nutrients Addition.
4. Nutrients circulation.
 The first 3 phases are similar to that of DFT, but the last phase (Nutrients Circulation) is where the nutrients are pumped to the pipes where the plants are placed.

3. 2 DFT hydroponics system
1.   Filling the reservoir with water. 2.pH testing.
3.Nutrients addition.

Figure 2: Deep Flow Technique.

3.2.1 *Filling the reservoir with water*
 Required amount of water (say 10Liters) is transferred to the reservoir.
3.2.2 *pH testing*
 In this phase pH of water is tested using pH sensor. The ideal pH of water required for hydroponics system is in range of 5.5 to 6.5. If the measured pH value is above the range pH down solution is added to the water using peristaltic pump if the measured pH value is below the range PH up solution is added.
3.2.3 *nutrients addition*
 Once the pH level is maintained required amount of nutrients (40ml to 10L of water) is added to the water using pumps.
3.3 *Capillary Action Technique:*
This technique is also known by the name Wick system hydroponics. It's one of the simplest and most reliable type of hydroponics technique. That is because it doesn't have any moving parts, thus requires neither pumps nor electricity. The working of wick system is

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pretty cool. Typically, a good wick system will have two or more good sized wicks dipped in nutrients tank, and the container where the plants are, is placed right above the reservoir. The wick itself is the most significant part in this technique, because without it being a good absorbent, plants would not get the required amount of nutrients and might end up dying. While it's true that the roots must be able to get sufficient amount of oxygen from the air holes given in the growing medium, but they also absorb the dissolved oxygen from the nutrients solution. Thus an optional air pump and air stone can be used to oxygenate the nutrients solution in the reservoir. The only limitation of this technique is that it won't work out for larger plants (fruiting plants) that needs plenty of water.
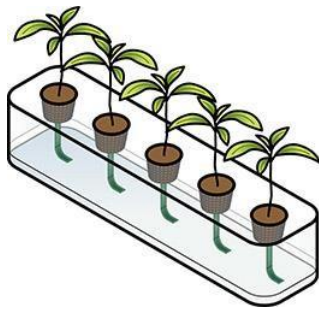

Figure 3: Wick system Hydroponics.

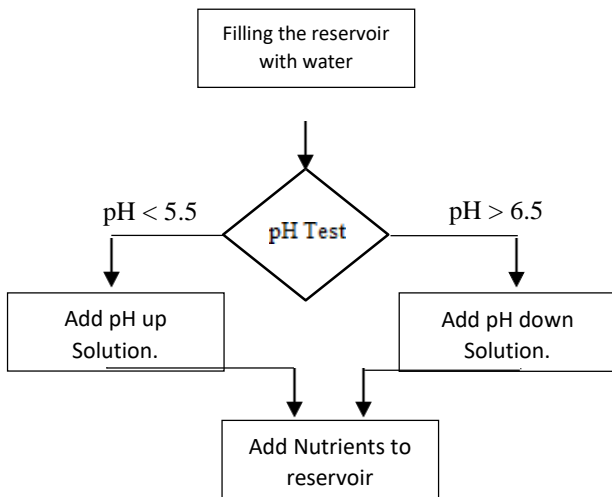## 4. IMPLEMENTATION AND SYSTEM DESIGN

Figure 4: Stages in Implementation.

Practically we have implemented DFT Hydroponics, and has shown some promising results. Automation is carried out by using the concept of IOT. NodeMCU opensoure IOT platform is used along with the Arduino programming. Two 4-channel relays are used to control different peristaltic pumps (pH control and nutrients addition), grow light (Artificial light) and motors. A 16 channel multiplexer is used to read multiple sensor reading.Adafruit.io open source IOT platform is used to

store, monitor and display sensor values. The main advantage of using adafruit.io is that it can store multiple sensor data for 30 days.

The interface of adafruit.io is very user friendly thus configuring it is very simple.

1. First we need to create a dashboard with the project name.
2. Multiple blocks are created as per the number of sensors used.
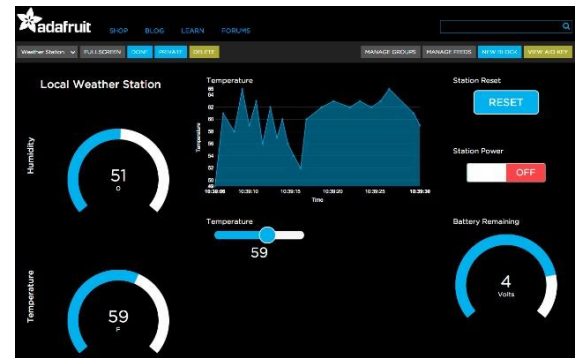3. Feeds are created accordingly to display the sensor values.

Figure 5: Adafruit.io interface showing multiple sensor readings.

IFTTT android application is free and open source application available in play store is used to give interface between the Adafruit.io and google Assistant. We need to create different applets (previously known by the name recipe's) in IFTTT to carryout different operations. Say light on applet to switch on the grow light and light off applet to switch off the light. The light is connected to the relay, thus the ON and OFF commands eventually controls ON and OFF of particular channels in the relay module.

Figure 6: IFTTT application Interface.

Google assistant is an intelligent personal assistant that is used to give voice command to control many devices like light, pump and motors used for different operations like pH control, nutrients addition and temperature control. Various sensors like LM35, Gas sensor and a flame sensor are continuously monitored and the values are displayed in Adafruit.io. Also an E-mail service is provided when there is any kind of abnormal activates noticed. Say if the temperature goes more than the critical value (> 45 deg Celsius) an E

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mail is sent to the user indicating the temperature has raised above the optimum value please switch ON the cooler fan. Then the user just gives a voice command by using google assistant. For example, Okay, google switch on the cooler, which automatically triggers on the relay channel ON, indirectly switching on the cooler fan. Also in case if there is a fire accident the water in the tank (filled separately for this purpose) is pumped up into the greenhouse to put off the fire.

Figure 7: Google Assistant Interface.

Advantages of Hydroponics:

1. It is a reliable solution for the farmers if their land is not suitable for growing (Soil nutrients might not suit for plant growth).
2. Hydroponics plants can be grown in changing weather conditions.
3. Hydroponics technique needs only $1/20^{th}$ of water when compared to soil based techniques.
4. Plants in hydroponics grows two times faster as the roots can directly absorb the nutrients form nutrients solution.
5. Hydroponics requires less space as the plants in NFT can be grown using vertical farming.
6. Hydroponics plants does not need any additional fertilizers and pesticides as in soil based cultivation.
7. Required nutrients for hydroponics are easily available in online marketing platforms.
8. Hydroponics plants will grow much healthier as there is no chance of exposure to the soil borne diseases or pests.
9. Hydroponics, when used with automation, needs less attention and thus reduces labour requirements.
10. Easy to monitor and harvest.

Limitations of Hydroponics:

1. Initial cost for setting up Hydroponic system is pretty high.
2. There are chances of roots getting rotten if there is no enough sunlight for the plants.
3. Requires lots of practical knowledge to grow Hydroponic plants.

Applications of Hydroponics:

1. Farming in smart cities (Rooftop farming).
2. Farming in ships.
3. Research on plants breeds in labs.
4. Research and development of roots and their growth (access to roots are possible in hydroponics system).

5. CONCLUSION AND FUTURE WORK

The purpose of implementing hydroponics was to determine whether the usage of water and nutrients solutions is sufficient for healthier growth of the plants instead of soil. In this experiment we implemented DFT Hydroponics technique for growing different types of plants. Astonishingly the results were pretty good and the plants were in a way much healthier and grew much faster than in soil. Many improvements can be done in future such as solar panel can be used to power up the automated controller which opens up wide range of opportunity to implement automated systems in places, where in electricity is not regular. In NFT, Drip irrigation technique can be used to provide the nutrients directly to the roots of the plants with drip pipes instead of passing nutrients solution in larger pipes. Thus we hope in future this technique is installed in larger fields of India and help the farmers get larger yields and larger income indirectly a better way of living.

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