

Hydroponic Farm Monitoring System Using IoT

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Abstract- *High yielding and high grade of crops are essential in modern day agriculture, this can only be achieved by smart farming technology which is used for making farms more intelligent in sensing its controlling parameters. Manual monitoring is in practice which is a very trivial task because the plants may die out if there is no proper care is taken. The automatic monitoring and control of the environmental events such as Total dissolved solvents (TDS), water temperature, pH, water level or moisture are carried out by connecting sensors and actuators to the Raspberry Pi. The maintenance and automated monitoring are done by the intervention of the IoT that are used to transfer and retrieve data to the internet (mass storage) and a mobile app is used to communicate the current status of the hydroponic system to the user through the use of internet to their mobile phones. This futuristic system can use high data analytics and prolonged data gathering to improve the accuracy of reckoning.*

I. INTRODUCTION

Agricultural lands are declining in the world. This happens due to the conversion of agricultural land into industry and settlement purpose. This happens because of economic and social phenomena, the limitation of land resources, population growth and economic growth. Currently, agricultural technology developed rapidly in urban areas, it is often called urban farming or urban agriculture. Urban farming or urban agriculture is one powerful solution to cope the dwindling agricultural land. The urban agriculture using the unused or empty land in urban areas, such as rooftops, balconies, terraces, even on the walls of buildings. One of the farming techniques used on urban farming is hydroponics. "HYDROPONICS" is the growing of plants in a liquid nutrient solution with or without the use of artificial media. Commonly used mediums include expanded clay, coir, perlite, vermiculite, brick shards, polystyrene packing peanuts and wood fiber. Hydroponics has been recognized as

a viable method of producing vegetables (tomatoes, lettuce, cucumbers and peppers) as well as ornamental crops such as herbs, roses, freesia and foliage plants.

Hydroponics is derived from Greece, hydro meaning water and ponous means work. The hydroponics technique has many compact types and it can overcome the land problems in urban areas, one of them is the NFT (Nutrient Film Technique) that can be arranged vertically. In hydroponic farming system, the water will be used continuously and just diminishes because of evaporation by the Sun or by the photosynthesis process of plants. If it is compared to conventional agriculture, water is used once at the time of irrigation, this system can be said to be very wasteful in the use of water because a lot of water is wasted. In this hydroponic system required particular care in controlling water temperature, water level, acidity (pH) of the nutrient solution, and higher densities of nutrient solution.

The control process still uses the conventional way or still using human power in doing so, for example, in controlling the density level of the nutrient solution is performed at least once a day which if the density of nutrients is too high or too low then add water or nutrients where farmers or owners of hydroponic farming system sometimes spent much time. This becomes a problem which is quite important because it is not effective and less efficient. This paper focused on creating a hydroponic farm management system that could monitor water temperature, water level, higher densities of nutrient solution and the acidity (pH) of a nutrient solution using sensors are related and connected to the microcontroller via a website. Hydroponic farming management system allows the user to perform control and monitor from a distance. The green energy concepts used in the Hommons. The alternative energy source is the sun which was used by utilizing solar panels to convert into Electricity. Associated with this research, previously there have been several studies related to hydroponics and

automation in agricultural systems at a greenhouse. The results of this analysis will be used as input for fertigation systems are already automated to turn on and turn off the pump to deliver water and nutrients to plants.

II. SYSTEM AND DESIGN

The hardware design of the Hydroponic system which consists of sensors, ESP8266, Wi-Fi access point, microcomputer Raspberry Pi and power supply, is shown in Fig.1. Microcomputers which served to accommodate the web server and brokers. Microcomputers used are Raspberry Pi 2 Model B ARM Cortex-A7 architecture. Communication technologies on this system using 802.11 or better known as Wi-Fi by using the internet. The power supply using voltage 5V 2A, this voltage is the standard voltage and easy to find

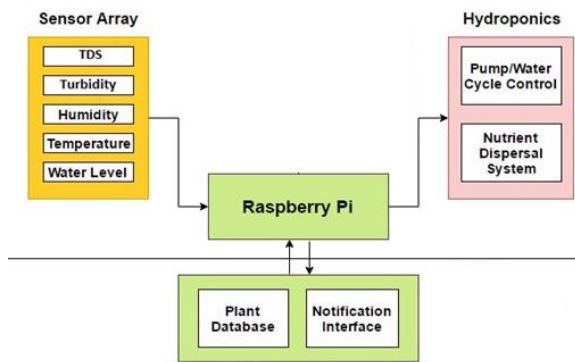


Fig.1 Block Diagram

on any device that is compatible with the USB power supply. Various environmental sensors installed to detect any change in the physical or chemical environments. Changes in value that occur in the environment will be read by the sensors and will become the input to the process management of Hydroponic System.

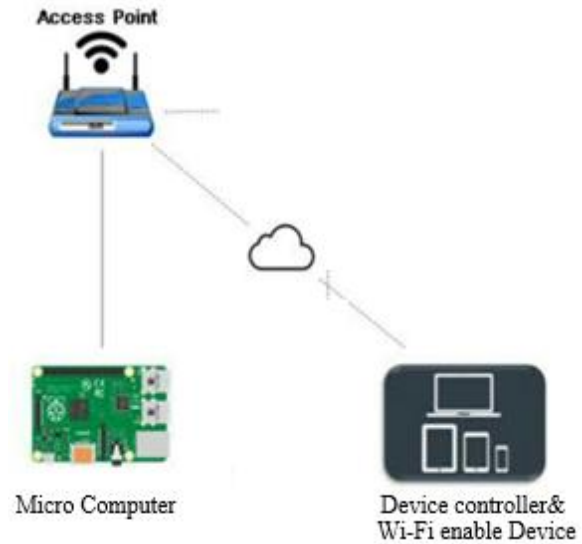


Fig.2 Software Design

Fig.2 describes the connection between Raspberry Pi & mobile or PC with Wi-Fi. Such that when sensors are connected to Raspberry Pi we further dump the python code to Raspberry Pi, and the sensors sense the changes occurred in Hydroponic system, these readings are posted to the Thing speak cloud and we can observe the readings from time to time, and further we can monitor with the mobile app, this is nothing but called automation using IoT.

III. METHODOLOGY

In the process of hydroponic farming, as shown in Fig.3, initially seeds are sown in the soil and they remain in the soil until the roots are grown. Now these baby plants are placed in the hydroponic system, where pipes are filled with nutrient solution. Here nutrient solution is that, whatever the plants require nutrients from soil, are well mixed in the water and they are filled in the pipes. And the plants are placed such that roots are exposed to nutrient solution in pipes as shown in Fig.4. Hence plants get sufficient nutrients, enough water they want, even photosynthesis is also carried out adequately.



Fig.3 Hydroponic Farming



Fig.4 Plant roots placed in pipes

There are many techniques followed in Hydroponic Farming but NFT- Nutrient Film Technique is the popular one that is practiced widely in Hydroponic farming and it is shown in fig.5 as below.

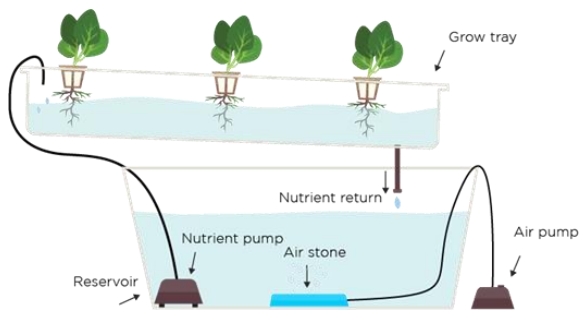


Fig.5 NFT System

What you need to build a nutrient film technique system (NFT)

1. A reservoir to contain the nutrient solution
2. Nutrient pump
3. Tubes to distribute water from the nutrient pump to the NFT growing tubes
4. Channel for the plants to grow in
5. Net pots to contain plants and growing media to start seedlings in

6. Return system (tubing, channel) to guide the used nutrient solution back to the reservoir

In the NFT system, there are 2 main components: the grow tray (or channel) and the reservoir that contains water and nutrients.

In the grow tray, there are net pots that contain the growing media (perlite, coconut, Rockwool) to hold the plants and reserve nutrients from the nutrient solution. But in reality, most growers don't use growing media in the NFT system as the roots have had enough moisture, nutrients, and oxygen from the system.

The NFT system uses a pump to deliver water to the grow tray and a drained pipe to recycle the unused water nutrient solution. How does this work? The grow tray is placed at an angle (supported by a rack or on a bench) to let the water flow down towards the nutrient return pipe. The excess nutrient solution will flow out of this pipe and move into another channel or tube, where it is re-circulated through the system again.

The roots of the plants hang down to the bottom of the channel where they come into contact with the shallow film of the nutrient solution and absorb the nutrients from them.

The thin film of the nutrient solution allows the plants to be watered but not entirely soaked. This thinness also allows the upper part of the roots to remain dry and have access to oxygen in the air.

IV. ALGORITHM

Hydroponics is a method of cultivation without soil. Its lexical meaning of hydro is water. However, this method requires other planting media such as gravel, sand, coconut fiber, a substance silicate, broken rock or reef, pieces of wood, and foam.

In the growth and development process of watercress is influenced by independent variables, namely levels of nutrients, acidity, and temperature

Those independent variables can be used as input variable system to predict the watercress growth and

development.

Variables used in this study were the variables of input system:

- a. Variable of the TDS
- b. Variable of water level
- c. Variable of water temperature
- d. Variable of pH

The Algorithm it follows is shown in fig.6. We use TDS, Water temperature & moisture sensors. There are some limitations for the growth of plants in hydroponic system. So, sensors are connected to Raspberry Pi and we dump the python code to Raspberry Pi, and further it is connected to Thing speak using IoT, here the readings from sensors can be observed from time to time. If the values are not within the range when observed in Thing speak. We can regulate them manually according to the requirement of plant growth.

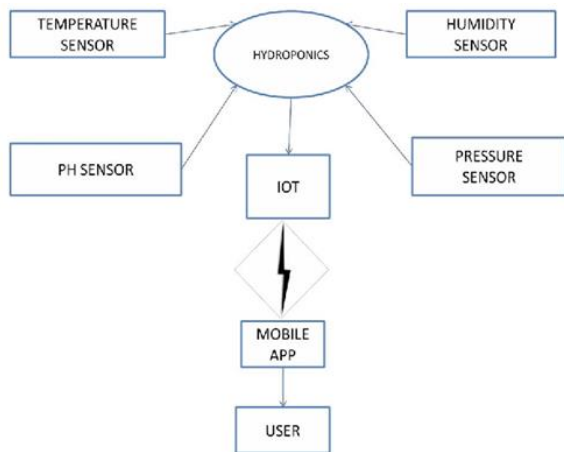


Fig.6 Algorithm for Hydroponics

It is mandatory to check TDS- Total Dissolved Solvents in the nutrient solution. Because plants should be supplied with sufficient nutrients if any of the quantity is less then there will not be a better growth of plants. The following result shows TDS graph that varies time to time even when salts are increased or decreased. TDS range should be in between 200-500 ppm, and it is different for different vegetables.

The water temperature should be in the range 18-26 C. It should in that limit only otherwise the plant may die,

if more or less temperature the water has. The purpose of this sensor is to detect whether the water or nutrient solution level is upto a sufficient height for plant growth or not . That is to detect if water or nutrient solution is present in the pipes or not. The pH of the nutrient solution for most nutrient film technique is 6.0-7.0.

V. RESULT

Readings from sensors & its values that are posted in Thingspeak cloud via Raspberry Pi can be observed from time to time. There are some limitations for the growth of plants in hydroponic system. Figures 7 and 8 show the sample view of TDS, water temperature graph posted in Thingspeak cloud. The maintenance and automated monitoring are done by the intervention of the IoT that are used to transfer and retrieve data to the internet and a mobile app is used to communicate the current status of the hydroponic system to the user through the use of internet to their mobile phones. Through mobile app we can turn on or off the motor, can control the temperature of nutrient solution etc. and some are done manually.

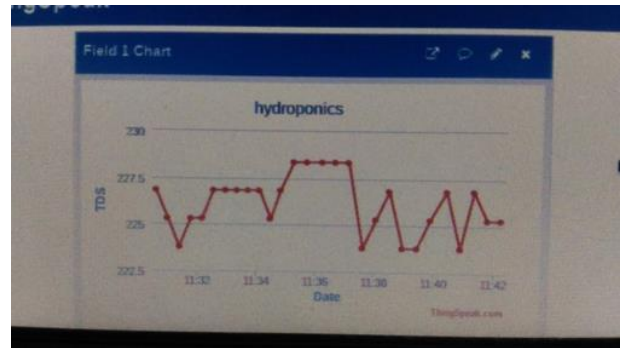


Fig.7 TDS graph in Thingspeak cloud



Fig.8 Water Temperature graph in Thingspeak cloud

VI. CONCLUSION & FUTURE SCOPE

Hydroponically grown plants do not come in contact with soil borne pests and diseases thus saves costs of soil preparation, insecticides and fungicides. Since the amount of nutrients is fed directly to the plants, there is no wastage of water due to run off or evaporation. Today, hydroponics is an established branch of farming. Progress has been on large scale and results obtained in various countries in the world have proved that this technology is thoroughly practical and has very definite advantages over conventional methods of crop production.

Many IOT enabled hydroponic farms such as rooftop farms, vertical farms and green buildings can be placed near the city areas which will directly cut transportation costs & using IOT plants can be transported safely. A standard website can be made which will take sensor data place correct graphs and help farmers to attain information. This way every farm will be used for research purposes. Government, big co-operations will jump into hydroponics because of low arable land, availability of water, costs, climate change and increasing population.

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- [7] Jones, J.B. 2005. Hydroponics: a practical guide for the soilless grower. CRC Press. Boca Raton. Fla.
- [8] v Mason, J. 1990. Commercial hydroponics. Kangaroo Press, Kenthurst, NSW.
- [9] Dr. D.K. Sreekantha, Kavya.A.M “Agricultural Crop Monitoring using IoT- A Study” IEEE 2017 11th International Conference on Intelligent Systems and Control (ISCO), pp. 134-139, 2017.
- [10] Foughali Karima, Fathalah Karimb, Ali Frihidab “Monitoring system using web of things in precision agriculture” ELSVIER The 12th International Conference on Future Networks and Communications, Vol. 110, pp. 402-409, 2017.

REFERENCES

- [1] International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 6 Issue III, March 2018- Available at www.ijraset.com
- [2] Hommons: Hydroponic management and monitoring system for an IOT based NFT farm using web technology; Conference: 2017 5th International Conference on Cyber and IT Service Management (CITSM)
- [3] IoT Based Automated Hydroponic Cultivation System; International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 11, 2019 (Special Issue) © Research India Publications. <http://www.ripublication.com>
- [4] <https://www.greenandvibrant.com/nutrient-film-technique>
- [5] <https://en.wikipedia.org/wiki/Hydroponics>
- [6] IoT based Hydroponic Farm; <https://ieeexplore.ieee.org/abstract/document;>