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IoT Based Hydroponics Approach for Soil-less Farming

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Abstract: The impact of modernization and progressive development on our environment and ecosystem had drawn our attention towards depletion of forest and farmland. Precision agriculture like inventions and approaches were continuously introduced and accepted to narrow the gap of the need of fertile soil. Hydroponics is one of soilless technique, utilized as one of the standard methods for plant biology research and is also used in commercial production for several crops, including lettuce and tomato. Here we present a hydroponic System that can be easily applicable in laboratories, home, office etc. The proposed project work provides a IoT based decision support system for regulation and control of rate of required nutrient on hydroponically grown product. It provides generalized, scalable and user friendly web solution using IoT.

Keywords: Hydroponics, IoT, Precision Agriculture, Soil-less Forming, NOD MCU, NFT and Fodder.

I. INTRODUCTION

The average ages of human are improved due to modernization and progressive technological development in the field of medical science and healthcare. It made huge impact on supply chain mechanism of food grain and other agricultural product, finally it sinking farmland and fertile soil. Precision agriculture like inventions and approaches were continuously introduced and accepted to narrow the gap of the need of fertile soil. Precision agriculture (PA) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define an expert system called decision support system-DSS for whole farm management with the goal of optimizing returns on inputs while preserving resources. Development and application areas of IoT based an expert decision support system for agriculture encompass wide-ranging activities of agriculture such as irrigation scheduling, farm management, disease identification & forecasting, and nutrition & fertilizer advisory.
Precision agriculture is an emerging area and it popularly grown in all the domains like farming, aquaculture, horticulture (Hydroponics) and poultry as well as animal husbandry.

What is hydroponics?
To describe the base term of hydroponics, hydroponics is the practice of growing plants using only water, nutrients, and a growing medium. The word hydroponics comes from the roots “hydro”, meaning water, and “ponos”, meaning labor, this method of gardening which does not use soil. Hydroponics is the practice of growing plants using only water, nutrients, and a growing medium. The needs of supply chain of food grains and other farming products as an average with populations of all consumers could be compensated by hydroponics- growing agriculture output.

Hydroponics also sub classified as follows

1. Aeroponics
2. Drip System
3. N.F.T-Nutrient Film technique
4. Ebb Flow
5. Water Culture
6. Wick Culture

In recent years numerous researches has been carried out on hydroponics, mainly focused on how and on which manner the need of nutrients are managed? We refer various research papers on hydroponics and found that the main challenges associated are to supply and regulates main inputs like nutrient reach solutions according to some weather information and subsequently quality of this circulating solution.

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Here we present a hydroponic System that can be easily implemented in laboratories, home, office etc. Our objective to use hydroponic system is to have required garden product in any of the season whether it is suitable or not. This System describes the hydroponic system set up in detail and the preparation of plant material for successful experiments. Most of the materials described in this system can be found outside scientific supply companies, making the set up for hydroponic less expensive and convenient. The use of a hydroponic growth system is most advantageous in situations where the nutrient media need to be well controlled and when intact roots need to be harvested for downstream applications. We also demonstrate how nutrient concentrations can be modified to induce plant responses to both essential nutrients and toxic non-essential elements.

II. MATERIAL AND METHODS

By referring literatures and researches on soil science, we found that the roots are responsible to absorbs essential nutrients and water for plant growth. We conclude the study of soil science by considering pH and EC as prime governing parameters for root morphology and plant uptake. If we maintain pH rages from 6.2 to 8.5, the mobility of essential minerals and nutrients towards the plant root is optimal. It is applicable for EC also.
We are actually doing to implement our project using separate as well as combination of two methods of the hydroponics.
1). Drip type
2). NFT. type
We are going to grow spinach and tomatoes for our project, both of them are suitable for drip as well as NFT system.

1) Drip type
We implemented Drip type system design for 6 different plants, in which the tank as nutrient reservoir will supply this nutrient at fixed rate to hydroponic rack. We checked periodically pH level and its mineral conductivity of these nutrients. Excessive or deficit of the values of pH and EC may cause adverse effect may be plant burn, on plant which grow in hydroponic rack If we found any variation of either pH or Electrical conductivity over the nutrient, than we add few additives of solution to obtain the pH and/or EC following trial and error methods.

2) NFT type
In NFT system we can grow tomatoes using PVC pipe of 4-inch diameter and supportive design. In this system we have to pass the flow of solution through the pipe minimum 10 times per day. So, the nutrients from the water get absorbed by plant roots. So, to maintain electric conductivity daily we have to add some water with nutrition's. And it can be vary with respect to the design and mass of the plant as well as stage of the plant. Refer figure-1.

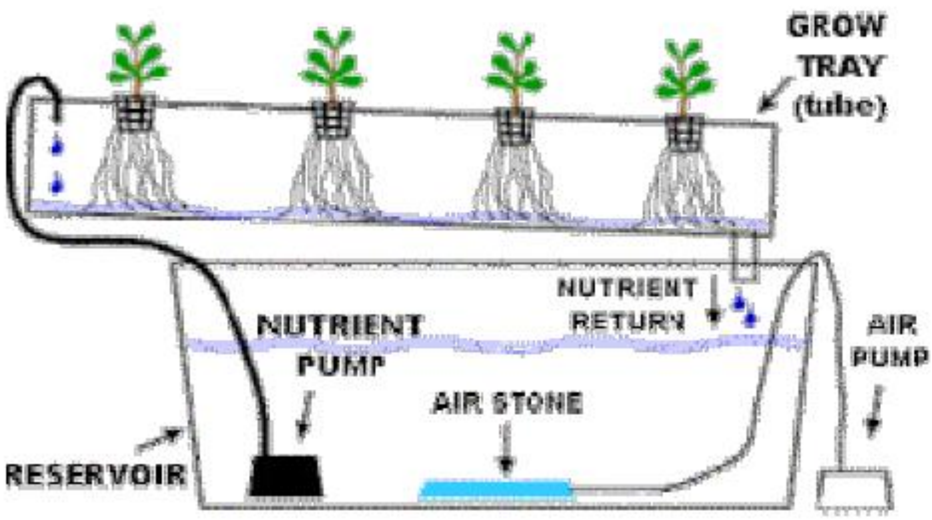

Figure-1: Nutrient Film Technique

Figure-2 shows functional block diagram of IoT based Hydroponic system with all necessary hardware and components. The instrumental techniques adopted here to acquire information of variables dynamically, and send it to web server on data base or data clouds. System integrators developed unique algorithm that provide essential controls over proposed IoT based hydroponic system. Following components comprises as an IoT based project.
1. Weather Data Sensors-Temperature and Humidity
2. Level sensor

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3. Electrical conductivity sensor
4. HM-meter pH sensor
5. Light Intensity sensor
6. Electric pump
7. Node MCU
8. Rack structure and supporting materials
9. TDS Meter

Node MCU
Node MCU is an open-source somatic computing platform built on a simple microcontroller board and a development environment that implements the processing language. Projects done with Arduino can be individual or they can communicate with software running on a computer. Our design needs to be co-operating, so it can make it much easier to create an environment in which learning can be achieved by doing, receiving feedback and cleansing understanding and building new knowledge.

pH level
The control of pH is extremely important, not only in hydroponics but in soil as well. Plants lose the capability to absorb different nutrients when the pH differs. Different plants have a particular pH that is optimal for them, generally though most

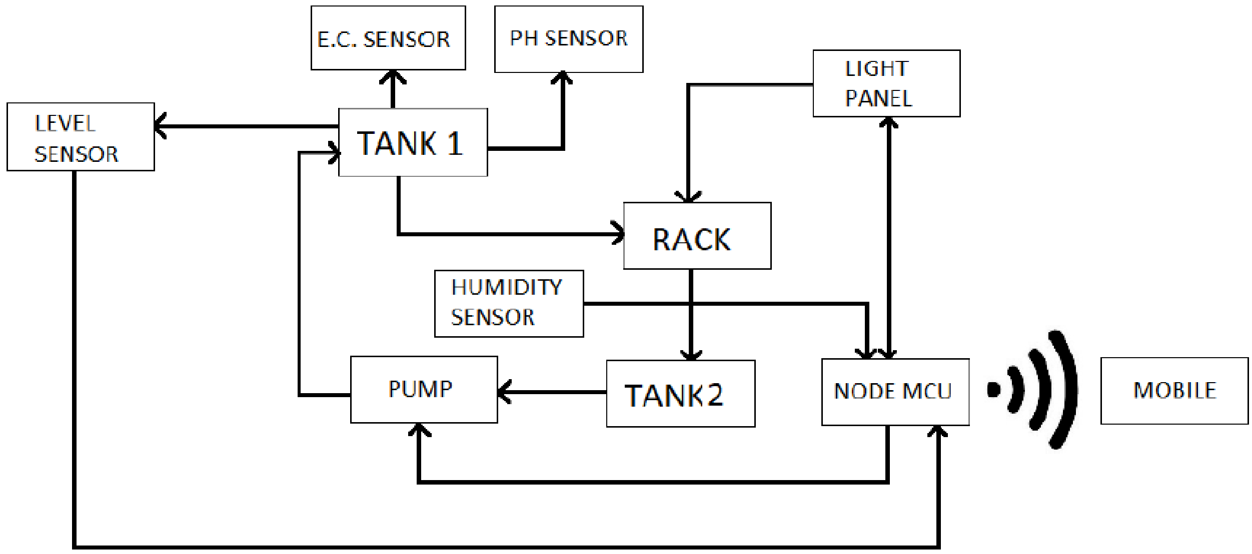

Figure 2: Functional Diagram of IoT based Hydroponic system

plants prefer a slightly acid growing environment. An ideal pH level is between 6.5 and 7.8. Changing the pH level too quickly is not a good idea as this will stress the plant out too much. Generally, just make sure that the pH level is between the ranges above. The pH of solution is periodically measured by Off-Line approach and decided as per plant requirement. We make fair compensation of the value of pH of solution if it alters within specified range. Sometime it is tedious method and prone to error.

DHT11 Temperature sensor
The DHT Temperature sensor provides the information of surrounding temperature and humidity to Node MCU. This was chosen as its temperature range falls well into the range required for growing food, which is 0-50°C It also has a temperature accuracy of ±2°C. However, this can be improved by using an offset in the SW to configure it to the actual temperature using a mercury-based thermometer. The sensor can only get new data once every 2 seconds. This should not be a problem though for hydroponics. The chances of a big fluctuation in air temperature within two seconds are not very likely.

IOT
Precision agricultural is a concept quickly gathering on in the agricultural business. Present high-precision crop control, useful data collection, and automated farming techniques, there are clearly many advantages a networked to hydroponic farm. Node MCU is a small devise give the flexibility of controlling the system with the programming. First we test the

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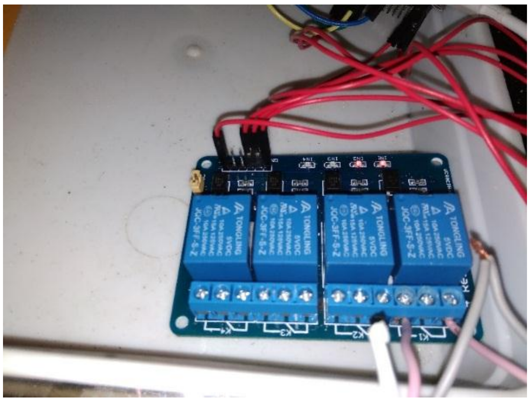
On-Off LED using Node MCU with the help of telegram bot library. We use the telegram bot library to monitor and control purpose. Node MCU transfer the data like pH of water, tank level, humidity, temperature, LED on-off condition etc. to our telegram bot so we can monitor our system as well as control of it from anywhere in the world.

III. SIMULATION & RESULTS

We had design NFT system using PVC pipe rack and supportive structure. We have planted vegetation like spinach, coriander, tomatoes, and green chilies. The goal is already achieved successfully.



Key Features
Flexibility: This system can grow any crops in any of the season. Some time we can create an artificial environment which make supportive environment to specific crop.
Portability: Drip system supports mobility, so it can be used for home gardening and decoration.
Water saving: 90% water can be saved in hydroponics compare to the conventional cultivation system.
Remote monitoring: Some factors can be monitored remotely using internet of things (IoT).
Hygiene and Healthy Product: The system skipping the use of pesticide so obviously it offer hygiene and healthy yields compare to conventional cultivation system.

IV. ADVANTAGES AND LIMITATION

ADVANTAGES
Space saving: Hydroponic saves space an incredible amount of space compared to traditional soil gardening. Usually, a plant's roots need space to spread out through the soil.
Instead of using soil, as a carrier for the nutrients your plants need, hydroponic uses a customized nutrient solution to surround your plants with perfectly calibrated nutrition all of the time, because of this, you get to pack your plants closer together, resulting a huge space saving.

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Hydroponic saves water: Usually every few days they dump a good amount of water into their soil, ensuring good penetration into the soil roots can suck it up. While in hydroponic there is only small amount of water is used by the plant. Hydroponic solves this problem by using what is called a recirculating nutrient reservoir in most types of system.
Less pests and diseases: Pests and diseases are drastically reduced in hydroponics. Soil is taken out of the picture and replaced with one of the common hydroponic growing media.
Time saving: As we are giving all the nutrients directly to the roots of the plant, the growth of the plant will get faster than conventional cultivation system.
We observed one of the benefits of Hydroponic As per one of the literatures of the japan, the nutrition of the crop can be modified up to bounded level, which can be used to prevent humans from certain disease.

LIMITATION
Very sensitive: If care is not taken then possibility of crop failure is high.
Nutrient solution can be varied with respect to crop.
High initial cost
Internet is required for IOT
Initial training must be given to the end customer

V. CONCLUSION

Drip system: - This is one of the cheaper systems that suited for home gardening as well as decoration. The photos shown in the chapter 3 indicate the outcome obtained from the drip system. Spinach as well as other leafy plants can be grown through this system with help of leafy solutions A &b. In addition, some fruitree plants also can be grown through this system.
Nutrient film technique: -The setup and design for the nutrient film technique is costly but worthy as it is one-time investment for the designing the structure. The system has one-time initial cost of PVC pipe rack, water tank, pump and nutrient solution but we can take it as an alternative cost of the land and water in conventional method of farming. We also require seeds, water and nutrition for individual crop and little bit electricity for IOT purpose. The major research gap is to maintain nutrition level in circulating solution in either drip or NFT techniques.

VI. FUTURE SCOPE

Our intention is to analyze the specific crop for specific design deeply and by getting the observation we can have the proper way to make algorithm to have one more step in automation. In addition, we can make our own green house for the well demanded crops which can help us for improvement in making system as well as it can be the business. One more business plan regarding green fodder for the dairy animals. The companies provide the air-conditioned fodder machine price starts in lacs. And in the India we are very rich in terms of sunlight and we can utilize it by making open air fodder machine which is very chip compare to the machine provided companies. It can worth only of the plates and pipeline required for the total area and height of vertical design

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