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Urban kisan-a Smart and Sustainable Hydroponic Using Recycled water

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ABSTRACT: An integrated system based on Internet of Things (IoT) for monitoring and management of the hydroponics system is proposed. With the rising trend of IoT and automation, the issues of managing these resources are solved. This system provides the ideal environment of plants growth. a system where pH meter, water level sensor, temperature and relative humidity are constantly monitored. Additionally, with the use of simple mechanisms, this system provides controlled irrigation of water, and nutrient solution intake. Through the data gathered by the sensors and the use of cloud based technology as the backend, information is stored, managed, applied and shared via internet by users. Management of resources in a hydroponics set up would become easier and more efficient based on the success.

Key words: smart hydroponics, Aeroponics, recycled water,IoT, NFT Technique.

I. INTRODUCTION

This study focuses on making an Internet of Things (IoT) system that can manage the temperature, relative humidity, pH level, the inflow and outflow of water, and nutrient solution intake in a hydroponics system. The significance of hydroponics is in providing a way for an average person to grow their own food without the need of soil, especially for those people who are living in flats and inner city areas. Correct pH level, air temperature, relative humidity, PH level, nutrient level of the water, and correct irrigation of water is critically important in hydroponics. Therefore, the help of a management system that monitors these factors is valuable and will ensure higher success and efficiency rates of the grower.

Hydroponics Management System (HMS) is a hydroponics system that enables users to control certain mechanisms for refilling sprinkling, draining and many more thru the web application. They can also monitor the pH level, relative humidity, air temperature and water level, which is data collected from the sensors. As long as there is an internet connection viable, the user should be able to monitor and control these anytime andanywhere.

II. LITERATURE SURVEY

Tsung-Han Wu [1], developed an Intelligent Plant Care Hydroponic Box, from the experimental measurement results of IPCH-Box, the developed environment driven control methods include light, water sprinkler and water pump which can effectively lower the CO_2 concentration, the temperature and increase water level, respectively. Specifically, the time of CO_2 concentration reduction in IPCH-Box is 38.53% faster than the plant system without our mechanism. Sensor technology has been intensively applied to plant care system. There exist two kinds of plant care systems

Jumras Pitakphongmetha et.al[2] analysed that, the effects of the global warming, and the plants are affected with UV rays. For this reason more difficult to planting in uncontrolled environment for this reason, planting in a greenhouse is easy to maintain and to control important factors such as light, temperature, and humidity. Using of sensors in a greenhouse as Wireless Sensor Networks System are the efficiency of technology used in agricultural development by sending data to the cloud and controlling values such as temperature, light, etc. The results of his study will be useful for the farmer and related organizations applying in the farm.

Chanya Peuchpanngarm et.al[3], developed a DIY sensor-based automatic mobile application for hydroponics. The application enables automatic environmental control for hydroponics via different types of sensors including water, temperature sensor, temperature and humidity sensor, and light intensity sensor. It also consists of the functions for planning,

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monitoring, as well as harvest data recording, of hydroponic gardening to fulfill the planting demands. The harvest data will be used for hydroponics planning in the next grow. In addition, users can monitor the plant growing progress remotely.

Dr. D.K. Sreekantha et.al[4] analyzed that the Internet of things (IOT) is remodeling the agriculture enabling the farmers with the wide range of techniques such as precision and sustainable agriculture to face challenges in the field. IOT technique helps in collecting information about conditions like weather, moisture, temperature and fertility of soil, Crop online monitoring. It enables the detecting level of water, pest detection, and animal intrusion in to the field, crop growth, and agriculture

Foughali Karim et.al[5] reviews that, as water supplies become scarce because of climatically change, there is an urgent need to irrigate more efficiently in order to optimize water use. In this context, farmers' use of a decision-support system is unavoidable. Indeed, the real- time supervision of microclimatic conditions is the only way to know the water needs of a culture In this paper they proposed an application prototype for precision farming using a wireless sensor network with an IoT cloud.

P Sihombing,N AK P Sihombing, N A Karina, J T Tarigan and M I Syarif[6], Developed hydroponics nutrition plants systems using arduino uno microcontroller based on android, in this paper the hydroponics system is made automated using sensors and intervened android application Blynk and its been controlled and accessed, instead of human intervention.

III. METHODOLOGY

The system uses NodeMCU to run an open source automation and to control the system. Once the NodeMCU receives the input data, it updates the server. The technique used for this hydroponics is Nutrient film technique (NFT).The Nutrient Film technique uses an automated pump and reservoir system to supply and recycle nutrients. NFT system has constant flow of nutrient solution so no timer required for the submersible pump. The nutrient solution is pumped into the growing tray and flows over the roots of the plants and then drain back into the reservoir. The main drawback of this system is that the plants can suffocate and die because of a lack of oxygen using this system .The system of Nutrient Film Technique (NFT) was originally designed and developed by Allen Cooper.

The concept is described by Cooper as follows: “A very shallow stream of water containing all the dissolved nutrients required for growth is re-circulated past the bare roots of crop plants in a water tight gully. Ideally, the depth of the re- circulating stream should be very shallow, little more than a film of water-hence the name nutrient film. This ensures that the thick root mat which develops in the bottom of the gully has an upper surface which although moist is in the air. Consequently, there is an abundant supply of oxygen to the roots of the plants”. The nutrient film technique (NFT) is similar to the ebb and flow system in that it utilizes a pump to move nutrients in a continuous constant flow.The difference with NFT is that the solution flows directly over the roots. The nutrient film technique use shallow tubes that are slightly angled so that the pump moves the nutrient solution to the higher portion of the system. The nutrient solution gradually moves by gravity to the lower portion. A tube system with holes bored for the plants is used instead of trays, mainly because this system is easier to angle for proper flow over the roots.Most horticulturalists plant directly through the holes, but it is okay to use net pots and many horticulturalists use no planting medium (e.g., potting soil) with the nutrient film system. The roots fall through the net directly into the nutrient solution. The nutrient solution does not completely soak the roots. The film ensures that the entire root is not submerged so the upper part of the roots remains dry. While using the nutrient film technique it is important not to grow heavy plants that require a lot of support because the roots are not in a medium that can sustain the weight of a heavy plant. It is necessary to use a self-standing trellis to support plants with heavy fruits such as tomatoes. The Crops grown in NFT system are tomatoes, lettuce, endive, Chinese cabbage and similar leafy crops, cucumbers, zucchini and courgettes, beans, sweet peppers, egg plants, chilies, parsley and other herbs, silver beet, strawberries and many types of ornamentals. The system is not, in its normal form adapted for the production of root and tuber crops.In the NFT system, the root system of the plant are in direct contact with organic nutrient solution frequently and this method was thought to be better to measure the minimum absorption concentration compared with other growing systems. Hence, NFT was adopted in this study. Also in NFT system the water consumed by plants is less compared to conservation method.

i. Software

ThingSpeak: Its an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates".

ThingSpeak Features:

• Collect data in private channels

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• Share data with public channels
•RESTful and MQTT APIs
• MATLAB® analytics and visualizations
•Alerts
•Event scheduling
•App integration
•Worldwide community

ii. BLOCK DIAGRAM

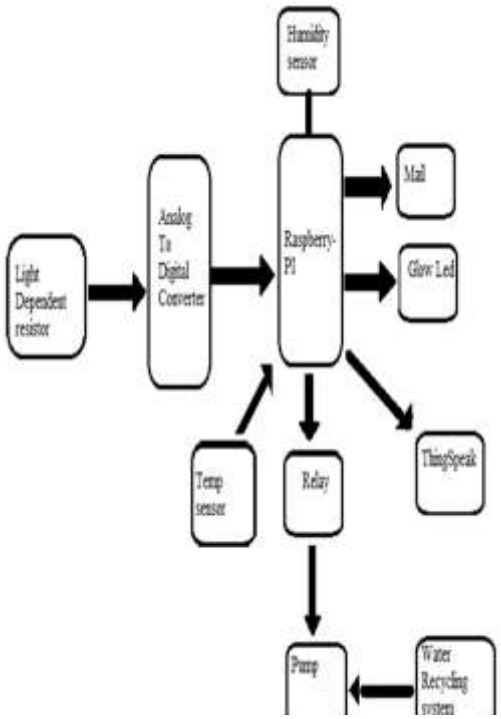

Fig 1: Block diagram of Urban kisan - A smart and Sustainable Hydroponics.

The block diagram Fig.1, shows the flow of data in the hydroponics hardware system. The Raspberry Pi is used to control the components in the hydroponics system based on the command that was retrieved from the Blynk- a real time sensor logging system cloud service. The Raspberry Pi is also used to control the data retrieval from the sensors and the data is then uploaded to Firebase. The data stored from blynk is shown in the Hydroponics Web Application called ThingSpeak.

IV. RESULTS AND DISCUSSION

- Using the recycled water, the aim of hydroponics can be achieved without soil intervention.
- The constant supply of nutrients allows the plants to grow faster and healthier.
- Optimized water utilization is achieved for greater yield.
- Organic food production with a minimal resources and space.
- More yield can be produced through vertical stacking.

i.Oasis &Cocopeat

Oasis is a trademarked name for wet floral foam, the spongy phenolic foam used for real flower arranging. It soaks up water like a sponge and acts both as a preservative to prolong the life of the flowers and a support to hold them in place. Cocopeat is a multipurpose growing medium made out of coconut husk. The fibrous coconut husk is pre washed, machine dried, sieved and made free from sand and other contaminations such as animal and plant residue. Cocopeat is a very good alternative to traditional peat moss and Rock wool.

Fig. 1. Oasis & Cocopeat.

ii.Seed Germination , Plant Growth Observation

Germination is the process of seeds developing into new plants. When water is plentiful, the seed fills with water. The water activates special proteins, called enzymes that begin the process of seed growth. During seed germination they undergo five changes:

(1) Imbibition.
(2) Respiration.
(3) Effect of Light on Seed Germination.
(4) Mobilization of Reserves during Seed Germination and Role of Growth Regulators.
(5) Development of Embryo Axis into Seedling.

These seed saplings are transferred into net pots and then shifted into stacks of hydroponics system for the plant growth. Later using the NFT technology the plants grow in a faster and healthier way in less duration of time.

Fig. 2. Seed Germination.

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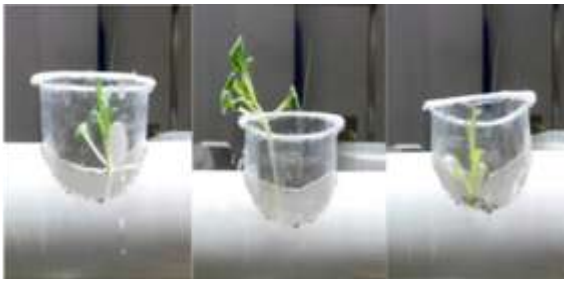

Fig.3. Plants Saplings Transferred to stacks.

Fig. 5.5. Next Stage of Plant Growth.

The hardware on the hydroponic NFT management system integrated, sensors need to be tested to quantify the level of accuracy. This test includes testing of Ultrasonic sensors, pH, temperature, and the tds. The results of these tests can be seen in table 1,2,3,4.

Table.1. PH SENSOR TEST RESULT.

Testing Number	pH Nutrient Solution	
	pH Sensor	pH Meter
1	6,70	6,8
2	6,76	6,9
3	6,57	6,9
4	6,78	6,9
5	7,0	7,0
6	6,97	7,0
7	7,27	7,1
8	6,95	7,1
9	7,11	7,1
10	7,14	7,2

Testing Number	Nutrient Solution Height (cm)	
	HC-SR04 (Ultrasonic)	*Ruler*
1	7	6
2	7	6
3	7	6
4	9	9
5	9	9
6	8	9
7	9	9.5
8	10	9.5
9	10	9.5
10	10	9.5

Table.2. HEIGHT SENSOR TEST RESULT

Testing Number	Nutrient Solution Temperature (°C)	
	Temperature sensor	*TDS Meter*
1	26,8	27,0
2	26,8	26,9
3	26,7	26,9
4	26,5	26,5
5	26,3	26,3
6	26,3	26,4
7	26,3	26,4
8	26,2	26,4
9	26,2	26,4
10	26,2	26,3

Table.3. TEMPERATURE SENSOR RESULT

Testing Number	Nutrient Solution EC
	TDS Meter (EC / PPM)
1	0,42 / 300
2	0,42 / 300
3	0,42 / 300
4	0,42 / 300
5	1,18 / 830
6	1,19 / 839
7	1,20 / 841
8	1,20 / 841
9	1,19 / 838
10	1,20 / 842

Table.4. TDS SENSOR TEST RESULT

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