



Automated Hydroponic Set-Up using IOT

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Abstract : Hydroponics is a form of gardening that uses no soil, but instead grows plants in a solution of water and nutrients. A hydroponic system can grow plants and vegetables faster and year-round with an efficient use of resources. Plants grown this way usually yield more, require less space, and conserve soil and water. This system is an ideal solution if you are an apartment dweller who does not have an outdoor gardening plot. Throughout the growing process, one needs to control several factors such as lighting, water quality, air circulation, and more. Here we use Deep water culture (DWC) which is a hydroponic method of plant production by means of suspending the plant roots in a solution of nutrient-rich, oxygenated water. This method uses floating rafts to suspend plant roots into a pond of water. Since there is a relatively large reservoir of nutrient rich water for each plant, there is buffering for pH and temperature, which means these elements of the system won't fluctuate undesirably. For oxygenation of the hydroponic solution, an air stone is added. This air stone is then connected to an airline that runs to an air pump. Sunlight is usually required for the growth of the plants but in hydroponics, it is supplemented with artificial lighting. The lighting has to be according to the plant's type and requirement.

Keywords— Hydroponics, Deep Water Culture, Internet of Things

I. INTRODUCTION

Humans require air, food, water, and living space in order to survive. These things are not endless in nature and thus humans are dependent upon the optimization of land area and the preservation of biodiversity. The human population is increasing and predicted to expand from 7.0 billion to 9.5 billion people within the next 40 years (Sahara Forest Project, 2009). An ever-increasing demand for food species is implied, and it is estimated that food production will have to be doubled in order to compensate and provide availability to all.

The word "Hydroponic" defines as any means to grow plants via a medium that does not include the use of soil but involves inorganic nutrients or nutrient solution. Gericke who described methods of growing plants in liquid media (nutrient solution) introduced the term Hydroponics. Besides Gericke, many attempts were made to adopt the methods of soilless growing plants during thirties. However, technological progress was too inadequate due to insufficient knowledge about the nutrients and high cost involved in the process. Despite of all these things, countries like USA and others were keen to adopt this technology so that growing plants indoors without the favorable soil required as well as controlling the nutrient is possible.

Traditional farming can become very disadvantageous. Weeding, diseases and loss of fertile land after harvest are few drawbacks of traditional farming. These disadvantages can be overcome with soilless farming method known as hydroponics uses only water and nutrients without any use of the soil. The traditional hydroponics system uses the same water in a circulatory motion with only one water tank. This type of usage of only limited amount of water helps reducing overall water usage by about 60 percent than usage of water in a traditional farming method. Water soluble nutrients are used. This circulatory motion of water and nutrients form a nutrient film which is one of the most famous hydroponic setups is nutrient film technique (NFT). Traditional hydroponic system has its own limitations such as it cannot log or fetch live sensing parameters. Hydroponics is one of the best alternatives for plants on narrow land.

II. LITERATURE SURVEY

[2] This paper presented a design and implemented an automated smart hydroponics system using internet of things. The design was implemented using NodeMCU, Node Red, MQTT and sensors that were chosen during component selection based on required parameters and sending it to the cloud to monitor and be processed.

[3] R. Anjini, J. Jenisha Jenifer and Mrs. A. Maria Christina Blessy . 2021 proposed a technique to The production systems are continuously monitored and precisely controlled. An important issue in these highly computerized and automated systems is the quality of information provided by the sensors, as well as the quality of decisions passed to the actuators. The quality of information received from or passed to the system is not checked in the vast majority of automated greenhouse or hydroponic facilities. The major milestone in the development of economic and commercial 2 hydroponics was the NFT concept, which stands for Nutrient Film Technique.

[4] In this study, the crops are grown without the use of soil, instead the nutrients from the soil are directly given to the crops by water reservoir. The adequate nutrients that are required by the plants are measured and added to the water reservoir so that the crops get enough nutrients from the water as equal as from the soil. By the intervention of IoT this whole hydroponic system can be automated. All the data from the hydroponic system are sent to the cloud data for the automation purpose. A mobile application is developed for the user to get notified of the progression of the crops growth. The user also gets information about the hydroponic system with the help of the mobile application. The health condition of the crops is continuously monitored with the help of data that are collected by the sensors and actuators. The digital image processing identifies if there is any infection or disease spreading in the plants and notifies the user through their mobile application. Thus, this hydroponic system can be adopted in any environmental conditions and it is a fully automated setup that can be operated through a mobile application.

[5] This paper is focused on developing a Fully Automatic Hydroponics system which helps in monitoring and controlling temperature, Humidity, pH and EC in Hydroponics. We use PIC16F877A microcontroller and four pumps, three of which are used to pump water, nutrient solution, pH solution and the fourth pump is used to control the humidity. A fan is used to control the temperature which increases its speed as the temperature increases. The pumps are turned on depending on the EC and pH values obtained from the electrodes. A passive LCD display is used to display variations in the values.

[6] A system capable of running a hydroponic farm autonomously and remotely monitor through mobile application was developed. System architecture was designed consisting of sensors network, Arduino Uno microcontroller, Raspberry pi 4B microcomputer and actuators. Decision tree algorithm was deployed on the Raspberry pi 4B microcomputer to read sensor values from Arduino Uno, process and activate a particular actuator. A mobile application was developed on Android platform to remotely monitor the hydroponic farm.

III. EXISTING SYSTEM

Sensor Parameters Measured - The sensors being used here to monitor surrounding air parameters along with the water quality essential for plant growth are as follows: Digital humidity and temperature sensor DHT-11 which provides temperature in degrees celsius and humidity in percentage. Light dependent resistor LDR to calculate the luminous flux in lux which is directly related to luminous intensity in lumens. pH sensor indicates the acidity or alkalinity of water-based solutions. The EC sensor measures the electrical conductivity in a solution to monitor the amount of nutrients, salts or impurities in the water in mSiemen/cm. Here, Seeed Studio Grove pH Sensor Kit was used to measure the pH of the nutrient-rich solution whereas the EC sensor was built using a simple type C plug and waterproof temperature sensor DS18B20 for temperature compensation.

Actuator Controlled - This actuator is a simple LED bulb of wattage 5W and around 500 lumen with white light.

Sensory Parts - The most common parameters to be sensed are temperature, pH of water, electrical conductivity of water and water tank level. The pH of the water is near neutral, 6.9 to 7, which is changed once water-soluble nutrients are added. This change of the pH can be a sign of content or amount of nutrients in water. After sometime, the plants absorb the nutrient which again changes the pH of the water. So, by measuring pH of the water one can determine whether it is required to put nutrients or not. Another factor in determining the nutrient amount is measuring electrical conductivity of the water. This measuring conductivity is not used in a continuous fashion but in signal at intervals of time, as ionization of water may occur. Each and every plant has its own pH and electrical conductivity values. Knowing these values is a huge advantage in making automated nutrient feeder controlled by a microcontroller. The tank level is also measured as sometime in future the plants will absorb enough water to lower the water level. Simple ultrasonic sensor, SR04, is used in this case. The temperatures sensor, DHT 11, also helps keep track of surrounding temperature which will further used for data analysis after harvest. The circuitry is very simple. NodeMCU ESP 8266 is connected with sensors also NodeMCU is coded with clouded connectivity as well.

Micro-Controller - The micro-controller used must have internet connectivity for IoT application. One of the famous micro-controller used in many IoT systems is NodeMCU. This micro-controller has a Wi-Fi module which is used for connecting to internet. NodeMCU is also one of the low cost IoT micro-controller which helps in keeping the installation cost low. It runs on ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. This board can be coded by Arduino IDE which is an open-source coding platform for all Arduino boards.

Google Firebase - Firebase is a platform developed by Google for creating mobile and web applications. There are many services provided by Firebase like Cloud Firestore, Realtime Database, Crash Analytics Authentication and much more. The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON (JavaScript Object Notation) and synchronized in real-time to every connected client. When we build cross-platform apps with iOS, Android, and JavaScript SDKs (Software Development Kit), all the clients share one Realtime Database instance and automatically receive updates with the newest data. Here, Android SDK is used for developing the Android Application named Rio along with connecting NodeMCU to the Google Firebase Realtime Database using FirebaseESP8266.h library. So, sensor data is collected, processed and pushed into the real-time database by the NodeMCU in the form of key value pairs of JSON in respective nodes over a WiFi network. Similarly, when the control node in the database is enabled through the Android Application Rio, the grow light connected through a 5V relay is switched on after a small considerable delay to provide light over the plants and subsequently switched off once the control node is disabled through the app remotely. Thus, we have a fully functional smart hydroponic system to grow crops at ease and convenience.

IV. METHODOLOGY

The Hydroponic system developed in our project will be based on the Internet Of Things. The Hydroponic system developed in our project will be small scale in nature. The system will have the following sensors- water level, temperature, pH and light intensity .An app will be created to monitor the water level, temperature, pH and light intensity and it will increase or decrease the water level/temperature/pH/light intensity value based on the inputs received. Here Deep-water culture (DWC) is used which is a hydroponic method of plant production by means of suspending the plant roots in a solution of nutrient-rich, oxygenated water. This method uses floating rafts to suspend plant roots into a pond of

water often 8–12 inches deep. Since there is a relatively large reservoir of nutrient rich water for each plant, there is buffering for pH, EC, and temperature, which means these elements of the system won't fluctuate undesirably. For oxygenation of the hydroponic solution, an air stone is added. This air stone is then connected to an airline that runs to an air pump. Sunlight is usually required for the growth of the plants but in hydroponics, it is supplemented with artificial lighting. The lighting has to be according to the plant's type and requirement.

4.1 System Architecture

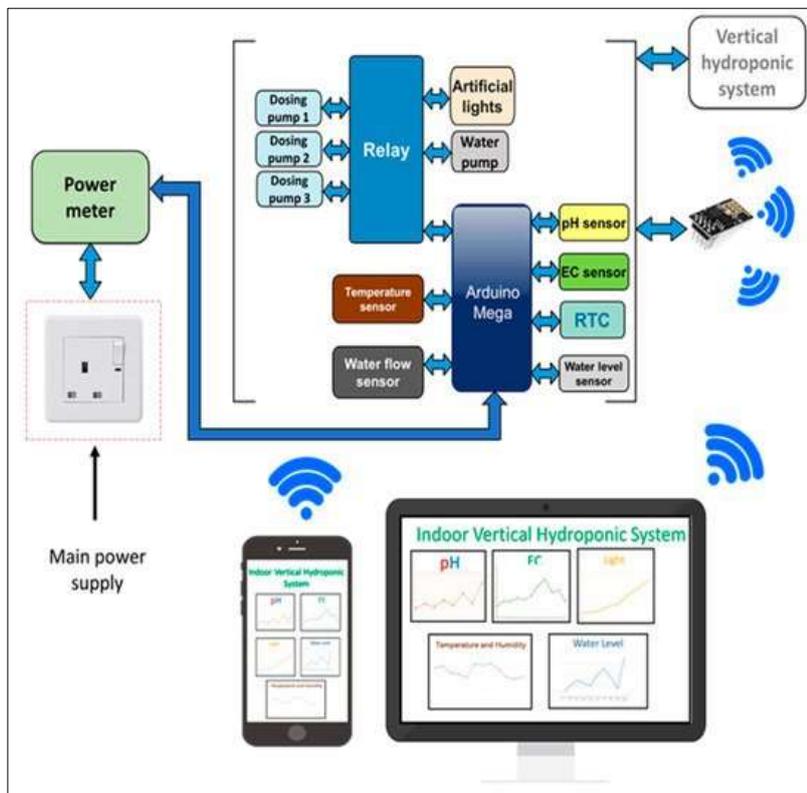


Fig 1: System Architecture of Hydroponic Systems

The proposed scheme system works based on data sent from sensors installed in greenhouse land. The nutrient pump is on because there is data from the humidity sensor. The lower limit of the humidity value is 45% and for the duration of the watering pump, the works are determined by the calculation between the value of humidity and the value of room temperature on the greenhouse land. Long time this automation system is designed to work for 24 hours.

4.2 Block Diagram

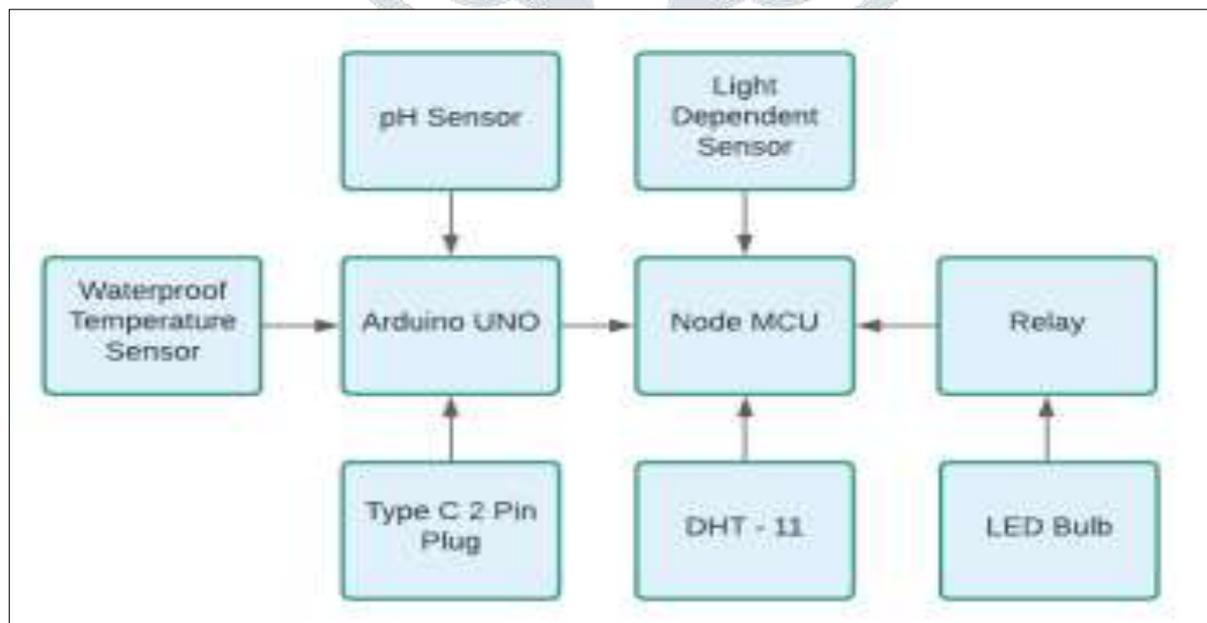


Fig 2: Block Diagram

The block diagram illustrates the interaction between all the sensors, actuators and the respective microcontrollers or SoC (System-on-Chip) involved in the hardware.

Following are the components used for development of the automated hydroponics set-up using IoT.

Table 1: Hardware Requirement Specifications

Sl.No	Components	Specification
1	Processor	Arduino Mega
2	Sensors	Temperature sensor, DS8466, DHT12, Ph sensor.
3	Power	Li-on Battery 9V
4	Motor	12V DC Motor 100 RPM

V. IMPLEMENTATION

1. Interface Implementation

Website is the user interface used in this hydroponic water circulation monitoring and control system. On the website page, in accordance with the existing interface planning, it will display data on temperature, humidity, pH, reservoir water level and existing pump status.

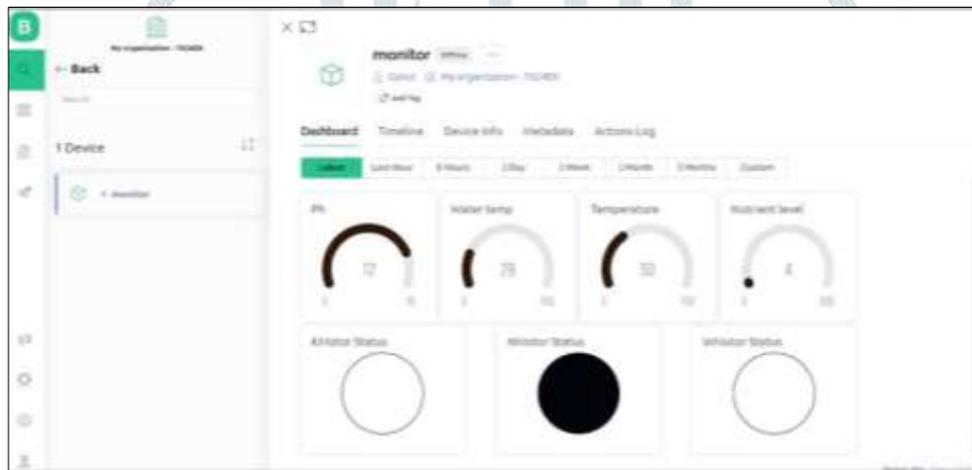


Fig 3: Sensor readings shown on Blynk

2. Hardware Implementation

In the implementation phase, especially hardware installation, DFT hydroponics manufacturing process and microcontroller circuit are used. The hydroponic circuit is made from 2.5-inch pipe as a place to put mustard plants. Then it is equipped with a water container and a 220V water pump to channel nutrient water from the container into the pipe.



Fig 4: Complete Setup

In the above figure, things like Wi-Fi module, temperature sensor, Arduino board, motors and power supply are seen, which helps us in further procedure to conduct the experiment. The Wi-Fi module is connected to send messages through Blynk app to monitor the growth of plant.

VI. CONCLUSION

In this system that we developed, the crops are grown without the use of soil, instead the nutrients from the soil are directly given to the crops by water reservoir. The adequate nutrients that are required by the plants are measured and added to the water reservoir so that the crops get enough nutrients from the water as equal as from the soil. By the intervention of IoT this whole hydroponic system can be automated. A web page is developed for the user to get notified of the progression of the crops growth. The user also gets information about the hydroponic system with the help of the web page. In this system that we developed, we showed that the production of terrestrial crops by the usage of hydroponic system is beneficial in proper resource management and can yield much larger amount of healthy crops than traditional farming. The developed automated hydroponics system based on IoT has facilitated the cultivation and the system helped in adjusting and controlling important environmental factors that affect plant growth with notifications which makes the process more convenient and easier.

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