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IOT Enabled Smart Plantation and Farming System using Hydroponic Pumps

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Abstract: *Cultivation, integrating up to a paramount aspect in Bangladesh, has been affected tremendously over the past few decades due to the utilization of chemicals. Due to rapid urbanization and industrialization, arable land under cultivation is decrementing enormously. Organic farming, being the desideratum of the hour, is opted as one of the widely chosen methodology to surmount the prevailing problem in cultivation. Advancements in agriculture have proven to accommodate the cultivators in a number of ways. Cultivation of crops is being done at home, which consumes constrained amount of space and cost. To bring in another technological advancement by breaking all barriers, for organic farming is the Hydroponics where consumption of space and water are way too minimal. Hydroponics is a method of growing plants pristinely utilizing water and nutrients, without soil. The proposed hydroponic system is built upon the concepts of embedded system. The system facilitates the magnification of multiple crops under a single controller. Compulsory supplements for the crops are provided predicated on the inputs obtained from the pH sensor and the water level sensor utilized. The water and nutrient supply to the different varieties of crop is controlled and monitored at customary time intervals. An efficient algorithm has been proposed for controlling all the functionalities. Automation of the hydroponic system amends the efficiency and reduces manual work.*

Keywords: *IOT, Hydroponic, Farming, Blynk, PH.*

1. Introduction

Hydroponic is a method where the crops are grown in the absence of soil the nutrients that are acquired from the soil are given to them artificially. The term Hydroponics was acquired from the Greek words ‘hydro’ means water and ‘ponos’ means labour. This soil less culture of originating crops often involves their roots to be immersed in the nutrient solution along with some gravels orperlite medium. The maximum yield is achieved by the supply of sufficient quantity of nutrients and optimum microclimatic conditions are the main goal of hydroponics. Since soil is excluded from production process there will not be any problem related to soil borne diseases, pests and weeds. By the exclusion of these problems, there will not be any usage of harmful plant protection chemicals, so that there is a fresh and healthy yield of crops by the hydroponic method. The setup of hydroponic only demands limited space and limited quantity of water as they recirculate and reuse the water. This eliminates the problems that are caused by soil. This limited space requirement also favors hydroponic as it can be accommodated in terraces, balconies and courtyards. So, there is a high probability of growing crops in urban areas, where cultivable land is limited. Hydroponics does not cause any adverse effect on the quality of fruits and flowers produced by it.

2. Literature Review

Hydroponics or soilless cultivation has been widely used in different countries because of its feasibility and environmental safety. This technique can be considered as the best alternative in areas where serious soil and water problems like soil born pests and diseases, soil and water salinity, chemical residues in soil and water, shortage of water etc. exist. In hydroponics, plants are grown by directly supplying optimum amount of nutrients in water. Composition of nutrient solution, electrical conductivity, pH and oxygen concentration have direct influence on the yield and quality of crops grown under hydroponics. If any of these factors are non-optimal, crops expresses stress symptoms. The yield of tomato cultivars Turquesa and Carmello increased by 32per cent and 21 per cent respectively when grown under NFT using Cooper's nutrient solution (Abou-Hadid, 1989).

A research carried out by Maritsa Vegetable Crops Research Institute, Bulgaria, proved that the tomato cultivar Lucy produced more vegetative growth and better yield in Cooper's solution than Plant an solution under hydroponics (Miliev,1997).The potassium in the nutrient solution affected the pigment concentrations and beta carotene content of tomato fruits in hydroponics (Zahedifar, 2012).In a study the effect of nitrogen and salinity levels of nutrient solution on the fruit yield and chemical composition of tomatoes under hydroponic culture proved that nitrogen concentration and salinity levels in the nutrient solution gradually increased the vitamin C content of tomato fruits (Ikeda,2012).With increase in nitrate ratio to urea in the nutrient solution, the yield of tomato in Nutrient Film Technique (NFT)increased by 25 per cent (Leal,2012).When nitrogen and potassium were added at a concentration of 177.2and 188.7 mg/l respectively in hydroponic nutrient solution, the size of tomato increased, stating that in nutrient solution N and K should be in the ratio of 1:1 (Glenn & Hamdarel, 2018).On the supply of different nutrient solutions, observed that there is a qualitative trait in lettuce, Hoagland solution was the best in hydroponics (Akashi, 2018).The effect of levels of N, P and K on the dry matter production and mineral nutrition of hydroponically grown green onion cultivar 'TodoAno" (*Allium fistulosum* L.) (Victor, *et.al*, 2016).Nitrogen fertilization in hydroponic cultivation of tomato, proved that, the reduction in nitrogen concentration (11, 9 and 7milli eq. nitrogen/l) did not decrease the tomato production and it did not make any significant variation on the diameter and dry and wet weights of tomato (Jumras, *et.al*, 2016). In a study on the potassium level, physiological response and fruit quality of hydroponically grown tomato showed that the addition of potassium at the rate of 300 mg/l to the hydroponic medium proved the plant growth, yield and quality of tomato. The addition of potassium directly influenced the postharvest preservation and processing (Saaid, *et.al*, 2015). The pH of your growing medium can be acidic, basic or alkaline, or neutral; generally, plants thrive with a pH of about 5.5 to 6.5. Below that, plants are acidic, and above that, they're basic or alkaline (Padma, *et.al*, 2014). To keep plants thriving, the nutrient solution and water solvent must be kept at proper temperatures. Experts agree that the best water temperature for hydroponics is between 65°F and 80°F. This temperature range provides anideal setting for healthy roots and optimal nutrient absorption. To get a bit more technical, when temperatures are between 65°F and 80°F, high levels of dissolved oxygen are available at the root zone. Additionally, these ideal temperatures encourage plant disease suppression (Padma, *et.al*, 2014). All the study mentioned above deals with hydroponics system with manual processing and monitoring which gives less yield and efficiency. Nutrient mixing is the important aspect of the system which directly affects the plant growth. Maintaining and controlling the nutrient mixer manually is ate dious process and may lead to human errors which will affect the overall yield. Our proposed system is an automated system which will overcome the disadvantages of the previous system.

3. Methodology

The seed of the desired crop is used and placed in the crop bed in phase-2 manually. A domestic power source is used to power the system. The user can select the crop that is to be planted from his mobile application which is connected through IoT. After the crop selection is done, the water is pumped from the main tank to the automatic nutrient mixing tank, the water pump stops pumping once the water level is reached. Here the water is mixed with the nutrients inappropriate proportions according to selected crop. After the completion of this process the user is notified through the mobile application. Users can also see level of nutrients present in water through his mobile application. The nutrient rich water is then flowed through pH tank with the help of solenoid valve. The user is notified once the pH tank is filled with the nutrient rich water. The pH tank has a pH sensor which monitors the pH of the water. If the pH of water is undesirable, then the system sends an alert to the user that pH is not in correct proportion and asks the user to enable the Pump P1 with 'YES' or 'NO'. If the answer is 'YES' than the Pump P2 opens and the water is poured out to reuse tank. If the pH of water is in correct proportion then the water is oxygenated by the oxygen pump. Once the water is completely oxygenated the user gets notified that pH is OK and water is oxygenated and ready to flow to the plants. Water pump P2 is used to pump water to the plants as well as from the plants by this way the water is circulated. The temperature and humidity of the environment is measured by temperature sensor and the readings are shown in the mobile application.

4. Proposed System

The magnification environment differs for each and every crop predicated on the morphological and genetic structure. The proposed work deals with integrating the growing environment for individual crops on to a signal system. A well-organized setup is built for the smooth functioning of the system. Appropriate nutrient solution is supplied to the crops, mixing them with the required quantity of water. Various sensors are utilized for monitoring the pH level of the nutrient solution and the water level. The input obtained from these sensors will enable the controller to regulate the water and nutrient flow in correct proportion. The controller is programmed with an efficient algorithm which will systematically regulate the flow. The system once built is tested upon for meeting an individual crop's requisite and then all of which are integrated. This integrated system will improvise the magnification of crops rapidly. The soul of this system is the controller which enables the entire functioning. Processor performs all the control actions necessary for the system. pH meter and water level sensors are used for calibrating the appropriate measurements needed for the plant growth.

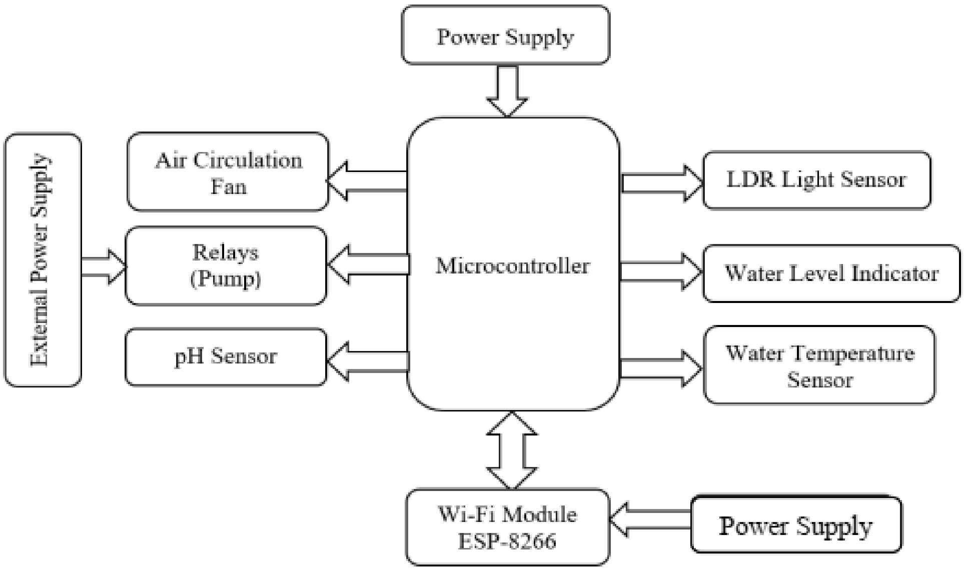

Figure 1: Block Diagram of Proposed System

5. Implementation Technique

The flow diagram to implement this project is showed in fig 2. Here the microcontroller takes a decision when it collect the Water from the tank. Nutrient solution is delivered to the crop roots in the substrate and then it flooded over into the tank. The process is automatic as the pump turn ON and turn OFF function is with the help of sensor. When the pump is on starts delivering nutrient solution with the help of water to the roots. When it is off the solution gets into the tank by drain outlet. After all the solution is gone into the tank the process is repeated.

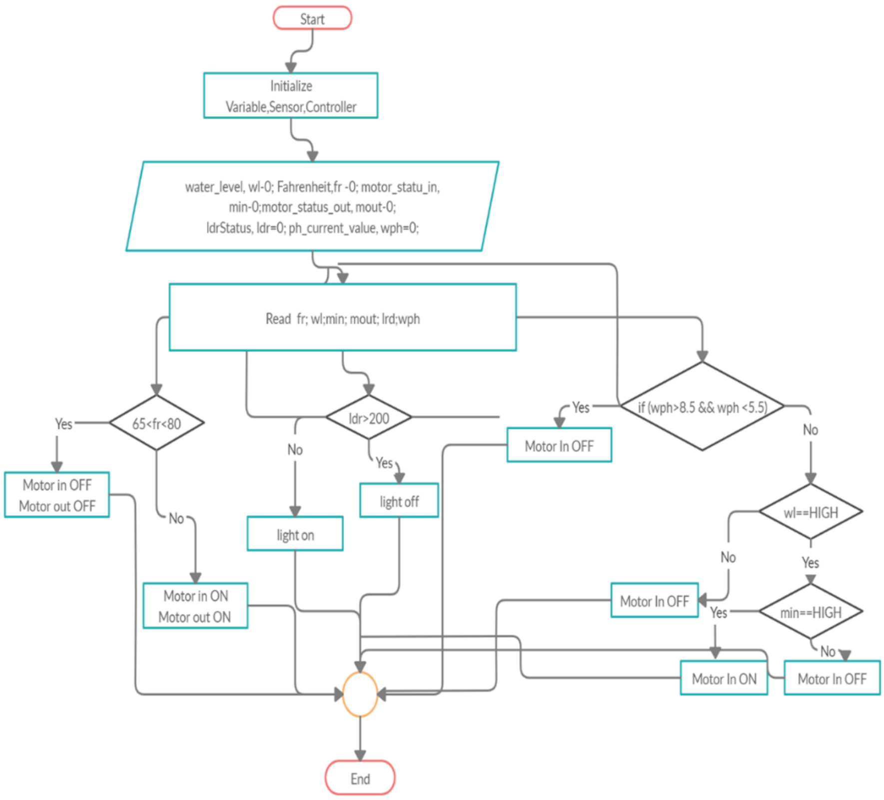

Figure 2: Flow Chart for Implement Circuit

In this technique, we ensure that plant gets all nutrients from the water solution. Hydroponic systems can accomplish this by allowing crop production in urban environments not available for conventional farming. In our project, the parameters are controlled automatically. Also, the cultivators can know the conditions of the plant growth and control the parameters remotely by using IOT technology. Here we have considered the arduino micro controller with three types of sensors such as temperature sensor, Water flow sensor and PH sensor for plant. ESP8266 is a wi-fi module to communicate by using internet of things with the server. The GSM module is to communicate and relay is used to automatically turn on/off the water supply from the pumping motor.

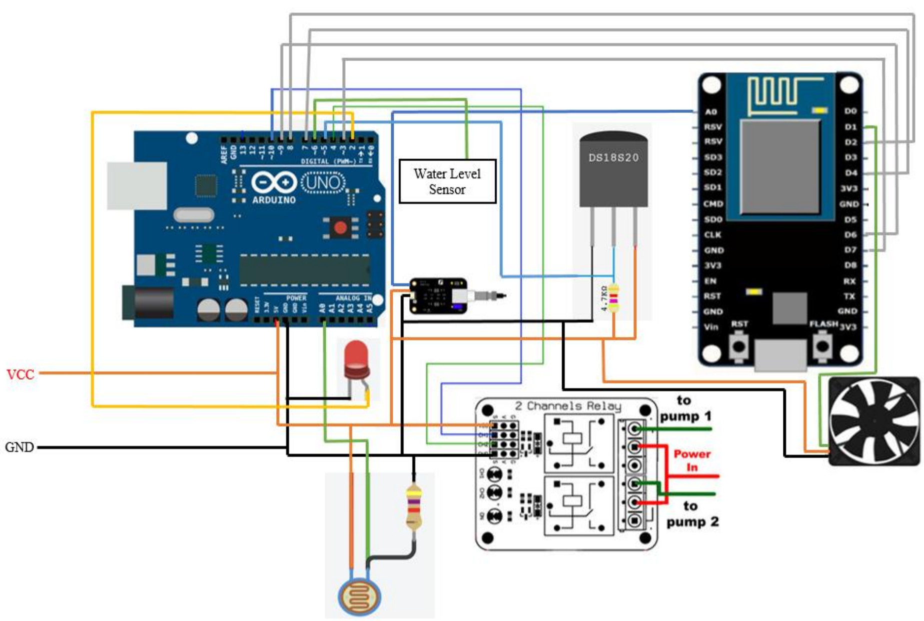

Figure 3: Simulation Circuit Diagram

6. Results and Discussion

6.1 Result:

For controlling and monitoring the smart hydroponic farm method, IoT based API's called Blynk and Thing speak is used. Blynk is a platform which supports with android or ios application to control Arduino, Raspberry Pi modules over the internet. The data such as temperature, humidity, water level and plant growth are received from hydroponic farm by Node MCU module by using various sensors such as Temperature sensor, pH sensor and water flow sensor sent to the blynk application through ESP8266 Wifi module over the internet. Thing speak is also an open source cloud based API for storing and retrieving data from the things using the HTTP protocol over the internet. The method for data received by the Blynk application is same as for receiving in the Thing speak application.

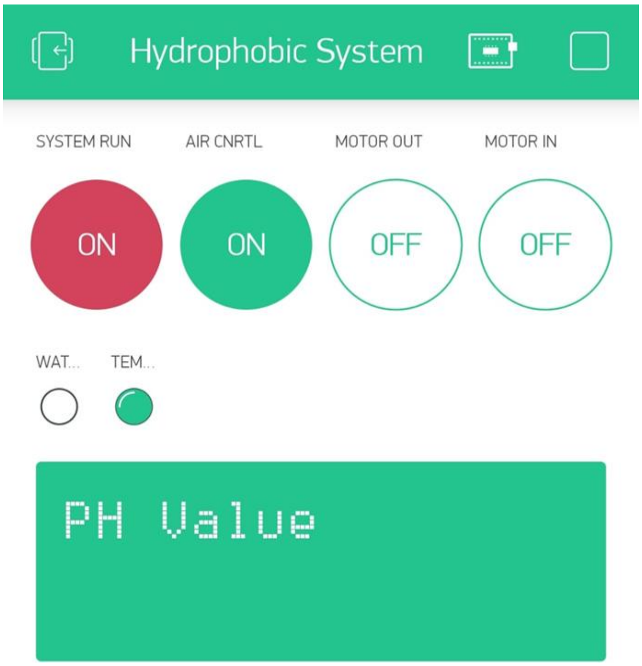

Figure 4(a):Blynk App for Controlling

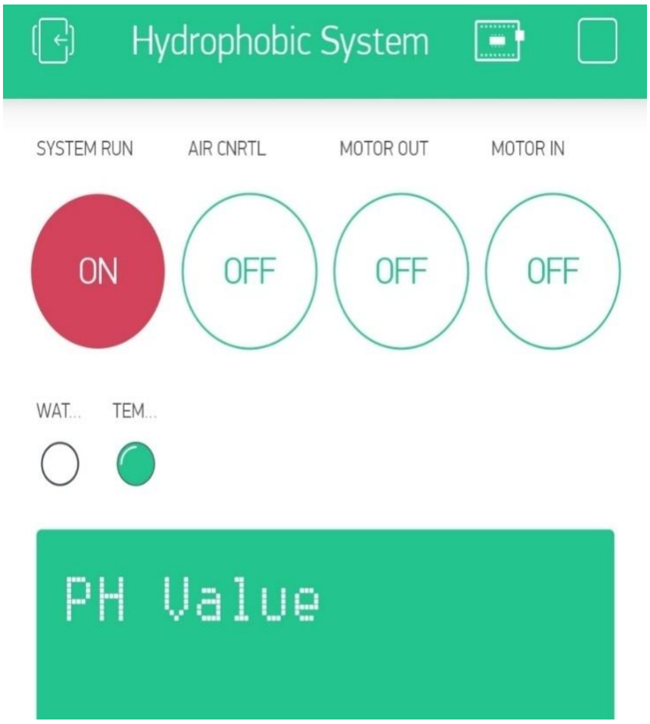

Figure 4 (b):Blynk App for Controlling

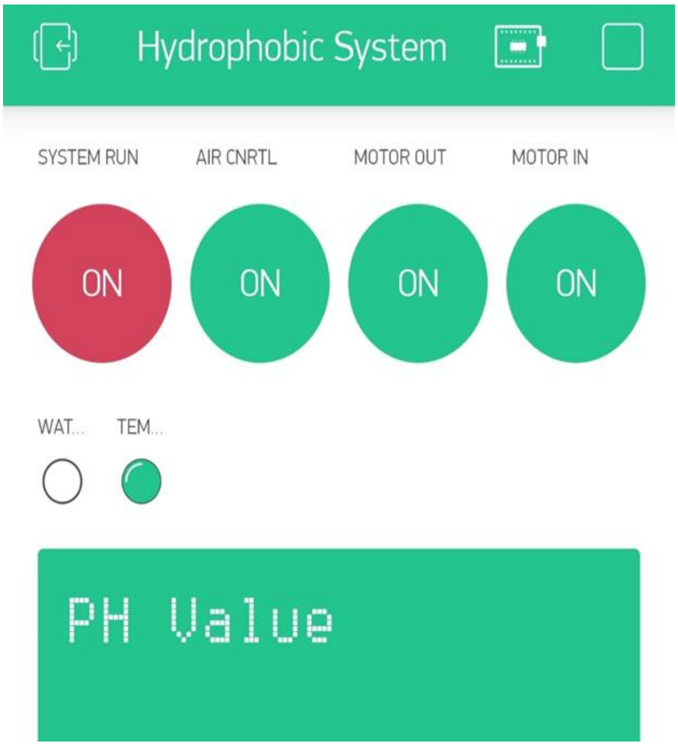

Figure 4(c):Blynk App for Controlling

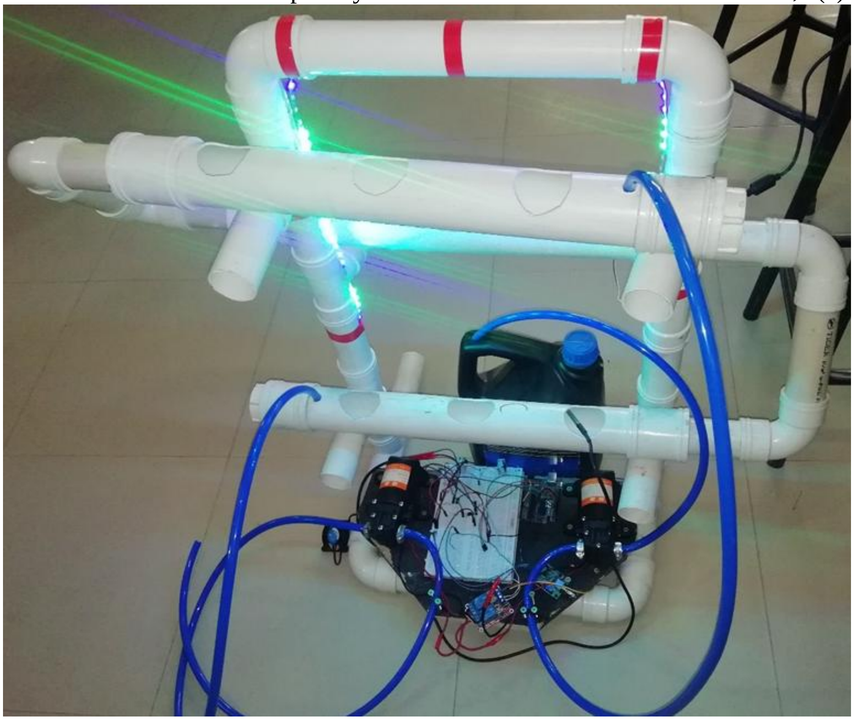

Figure 5:Implemented Circuit

Table 1: System Action Plan

SL No.	Description	Action
01	If pH value >5.5 &<6.5 this water not suitable for plant	System will through me mail
02	If pH value <5.5 &>6.5 this suitable water for plant	System will through me mail
03	If Water temperature >65F &<80F this water recycle	System will indicate on Blynk Apps
04	If Water temperature <65F &>80F this water not recycle	System will indicate on Blynk Apps
05	If LDR value more than 200	System Automatic
06	If LDR value less than 200	System Automatic

7. Conclusion

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. The two main advantages of this type of system soil-less cultivation and hydroponics can be used in places where the gardening is not possible. Thus not only is it a profitable undertaking, but one which has proved of great benefit to humanity. People living in crowded city streets, without gardens, can grow fresh vegetables and fruits in household gardens or in small discarded containers. By means of hydroponics, a regular and abundant supply of fresh greens vegetables, fruits can be produced in poor production areas and clean areas can be made productive at relatively low cost.

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