Smart Hydroponics System

Prof.D.M.Yewale[1], Ms. Mansi Sanjay Darwade[2], Ms. Gouravi Atul Mardhekar[3], Ms. Vaishnavi Sandeep Kulkarni[4]

[1]*Professor, Department of Electronics & Telecommunication Engineering, AISSMS IOIT College, Pune, India*

[2,3,4]*U.G student, Department of Electronics & Telecommunication Engineering, AISSMS IOIT College, Pune, India*

Abstract: **Agriculture is extremely important to India's economy. There is an increase in food demand due to the ever-increasing population. But there is a food shortage due to rising labor costs, unfavorable environmental conditions, and reduced agricultural land. This gives rise to the concept of indoor farming known as hydroponic farming. This method is used to employ a water solvent to dissolve mineral nutrient solutions, allowing plants to intake nutrients in a more efficientmanner than soil. The roots receive nourishment from a variety of sources. Keeping in mind the above scenario we propose to develop a closed loop system which will provide the correct amount of nutrients and adjust the pH level. Our method contains a pH sensor, a TDS sensor, as well as temperature and humidity sensors. The pH level, amount of nutrients, temperature, and humidity will be sensed by theanalog pH sensor, analog TDS sensor and DHT11 sensor respectively. These values will be sent to the microcontroller and it will smartly decide whether to release the nutrients or pH buffer solution. The nutrients will be released using a peristaltic pump through relay.**

Index Terms: **Agriculture, Farming, Hydroponics, SoillessFarming**

I. INTRODUCTION

India is an agricultural country that also happens to be the world's largest economy. It is also the main occupation of people in the country. But some factors such as rising labor costs, unfavorable environmental conditions, and reduced agricultural land have hindered the crop yield using traditional methods. There are various types of agriculture, one of which is hydroponics. Hydroponics is a technique for producingplants or vegetables without requiring soil and instead relying on mineral nutrients, mixtures of solutions and water. As this solution will be utilized as a source of nourishment for plants or vegetables, it must be safe, so it is necessary to control or manage many factors in this liquid. In today's environment, where practically all technologies are becoming smarter, there is a strongdesire for automation. This can be accomplished with the help of a closed loop system. In our proposedsystem we are implementing the system on Lettuce crops, which will be grown in the hydroponic setup and will be monitored throughout the cultivation period. Some variables that we have to control are the nutrient solution's pH value or concentration. There will be many devices involved to monitor humidity, nutrient solution, temperature, and pH value. It will be used to manage and analyze data from many interconnected devices and sensors. There are three aspects to the hydroponic farming ecosystem. The first section deals with detection of Temperature, humidity and pH sensors used. The second section focuses onthe system's control system, which may be adjusted to govern it by monitoring the values from the sensors. The last part will look at dynamically adjusting the temperature, humidity, and nutrient concentration so that they are balanced within a given range or threshold. Hydroponic growth located in urbanenvironments can help with maximization of crops per acre. The purpose of this project is to design, install and maintain hydroponics containing different varieties of crops owned by that particular farm.

II. LITERATURE REVIEW

Smart hydroponic farming with IoT-based climate and nutrient manipulation system, Rangga Perwiratama, Yosef Kely Setiadi & Suyoto developed a system using IoT based on controlling different parameters. Hydroponic systems provide increased crop productivity and efficiency, high yield per plant per square meter and fresh produce, regardless of the season or the soil temperature. Methods used for Developing Smart Hydroponics System were using different parameters and manipulating climate and nutrients by automatic computer control.

Applied Internet of Thing for Smart Hydroponic Farming Ecosystem (HFE), Somchoke Ruengittinun, Sitthidech Phongsamsuan & Phasawut Sureeratanakorn Developed Hydroponic Farming Ecosystem (HFE) that uses IoT devices to monitor humidity, nutrient solution temperature, air temperature, pH and electrical Conductivity (EC). They found the challenges while testing the accuracy of the sensors. The application was tested to see if it registers the correct values from the sensors. The values sentto the application included the water flow rate, the water levels and the temperature, in which all were sent with a high accuracy.

IOT Hydroponics Management System, this method used for integrating systems based on Internet of Things (IoT) for monitoring and management of a hydroponics garden is proposed. With the rising trend of IoT and through automation, the problems of managing these resources will be solved. Chris Jordan G. Aliac', Elmer Maravillas tested sensor Data Acquisition Time Results. Effect of the Fan and the Sprinkler to Relative Humidity & Air Temperature. Using Hydroponics System, Firebase and Web Application Connectivity.

IoT based hydroponics system using Deep Neural Networks, Development of IoT based Hydroponics Control System prototype for tomato plant with sensors interfaced to Arduino and Raspberry Pi3 acting as Edge. Development of Intelligence at the edge by deploying Deep Neural Network model towards providing appropriate control action to hydroponics systems in real time with higher accuracy. Implementation of Deep Neural Network at the cloud towards the classification of control action based on parameters collected from hydroponics systems. Manav Mehra, Sameer Saxena, Suresh Sankaranarayanan, Rijo Jackson Tom found the challenges where 5 parameters were taken as input for controlling the hydroponic environment which is pH, temperature, humidity, level, lighting. These parameters are trained using Deep Neural network towards providing the appropriate control action which is labeled. The predicted control action for the real-time data is storedin the cloud. Shreya Tembe, Sahar Khan, and Rujuta Acharekar developed an Arduino-based project in which the plant will be grown indoors and parameters like pH, temperature, and humidity electrical conductivity will be measured. The automated section contains insect sprinklers, humidity adjustment unit, and pH up/down pump based on the monitored data. This is also connected to a Wi-Fi module, allowing for convenient data monitoring. The system automatically supplies nutrients and nutrients can be monitored. Pest detection and connectivity to Wi-Fi modules (IoT) are necessary to make the automated model more adaptive. When compared to the soil system, this technology saves water and fertilizer while improving yields.

III. ABBREVATIONS AND ACRONYMS

TDS – Total Dissolved Solids, DHT – Digital Humidity and Temperature, LCD – Liquid Crystal Display, PPM – Parts Per Million, IDE – Integrated DevelopmentEnvironment, IOT – Internet of Things.

IV. HYDROPONICS

A. What is Hydroponics?

Hydroponics is a type of horticulture and a subset of hydro culture which involves growing plants, usually crops, without soil, by using water-based mineral nutrients solutions in aqueous solvents.

B. Why Hydroponics?

Higher fields can be obtained by using hydroponics farming. Plants that are grown in well-managed hydroponic systems are thriving. Plants spend more time growing upward and less time and energy downwards that is establishing huge root systems to gather nutrients since theirroots are drenched in all the nutrients they require. As there is no use of soil there is no harm from pests that survive on plants. Growth rates vary depending on the type of system and level of care provided in the traditional farming, but hydroponic plants can grow up to 25% faster than plants grown in soil, with higher crop yields. This is because closed systems used in hydroponics do not have the same evaporation rates as higher as that of open systems. Plus, the water used in hydroponic systems can be purified, re- circulated with nutrients, and supplied back to the plants, ensuring that water is not wasted.

C. Basic requirements for Hydroponics

Table 1: Basic Requirements

Parameters	Value
pH requirement	5.8-6.5
Temperature requirement	20- 30ºC
Light requirements	14-16 hours per day
TDS Requirements	560-1260ppm

V. METHODOLOGY

The pH sensor and TDS sensor is interfaced with Arduino UNO to collect the instantaneous data of the nutrient solution. Water has pH 7, but ideal pH of lettuce is between 5.5 - 6.5, so whenever the pH is above 6 the pH down pump will switch on to maintain the ph. The ideal TDS for lettuce is 560 - 840, so when it goes below 800, the nutrient pumps will switch on and release the nutrients. The temperature and humidity sensor will also send the data. This data will be sent to the Arduino. The Peristaltic pumps are interfaced with Arduino through relay. The Arduino willsmartly decide which pump to start according to the data received. The peristaltic pump will accordingly release the nutrient or pH up/down. The LCD will display theparameters or output which is given by the Arduino.

VI. HARDWARE DESIGN

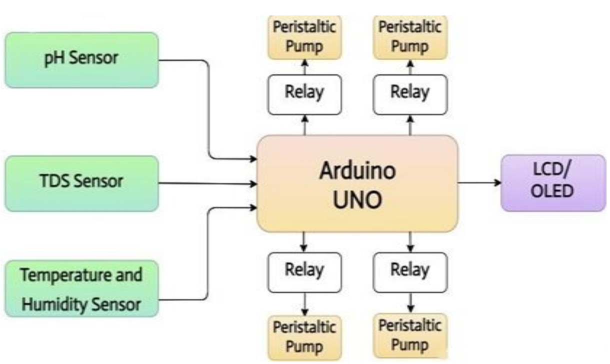

FIGURE 2: BLOCK DIAGRAM

Hardware Requirements

Arduino UNO

The Arduino is used as the microcontroller, which accepts input and outputs according to the program saved in it. The Arduino UNO has an AVR microcontroller Atmega328, six analogue input pins, and fourteen digital I/O pins, six of which are used for PWM output.

PH Sensor

There are various pH sensors available in the market. We decided to use this analog PH sensor due to its accuracy and high sensitivity. It is used to measure the PH of the nutrient tank and adjust the PH level of the solution.

Analog TDS sensor

It is used to calculate total dissolved solids, or the amount of solution in a nutrient solution. It accepts 3.3 5.5V wide voltage input and outputs 0 2.3V analogue voltages, making it compatible with a 5V or 3.3V control system or board.

DHT 11 Sensor

Temperature and humidity sensor used to measure the atmospheric temperature. It producescalibrated digital output. It uses a capacitive humidity sensor and a thermistor to monitor the ambient air and delivers a digital signal on the data pin.

4-Way Relay Module

The Arduino board will send a signal to the relay, which will activate the peristaltic pumps. It is a 4-channel isolated 5V 10A relay module that can be controlled by a variety of microcontrollers like Arduino, AVR, PIC, ARM, and others.

Peristaltic Pump

The peristaltic pumps which will release the nutrients, pH up/down solutions.

LCD

To display the parameters measured by the sensors.

Table 2: Sensing Ranges of the Sensors

pH sensor range	0.00 to 14.00
Temperature Sensor	0 to 90 Degree Celsius
Humidity Sensor	20% to 90 %
Relay Operating Voltage	3.3V to 5V
Peristaltic Pump	Flow Rate up to 100mL/min

VII.SOFTWARE DESIGN

- We have used the Arduino IDE for programming the Arduino UNO board, compile and upload it to the board.

- Proteus 8.1, for simulation of the project and circuit designing. Fig. 3 shows the flowchart of the system.
- In a hydroponic system, various crops can be produced twice as quickly.
- The nutritional value of the product increases as the time between harvest and consumption is decreased.
- Indoor farming in a climate-controlled environment allows these farms to thrive in locations where the weather and soil conditions are unsuitable for traditional food production.
- In a hydroponic system, no chemical, weed or insect management is required.

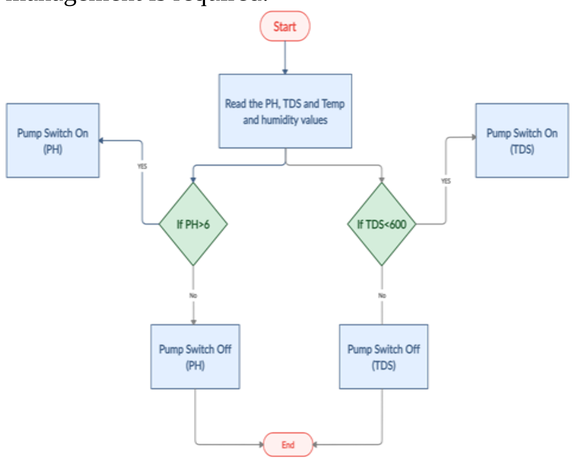

FIGURE 3: FLOWCHART

DISADVANTAGES OF HYDROPONICS

• Higher initial capital expenditure.

• The system needs to be monitored regularly for the supply of sufficient amount of nutrients and light.

• Requires some expertise in hydroponics farming.

RESULTS AND MEASUREMENTS

The following table shows the pH and TDS values required for different crops:

Table 3: pH and TDS values required for different crops

Type	Crop	pH	TDS (ppm)
	Lettuce	5.5 – 6.5	560 – 1260
	Spinach	6.0 – 7.0	1260 – 1610
	Leak	6.5 – 7.0	980 - 1260
Leafy	Cabbage	6.5 – 7.0	1750 – 2100
	Basil	5.5 – 6.5	700 – 1121
	Mint	6.5 – 7.0	1400 - 1680
	Carrot	6.3	1120 – 1400
	Cucumber	5.5	1190 – 1750
	Strawberry	6.0	1260 - 1540
	Tomato	6.0 – 6.5	1400 - 3500
	Radish	6.0 – 7.0	840 – 1540
Fruity	Sweet Potato	5.5 – 6.0	1400 - 1750

The proposed system was designed and tested for the Lettuce Plant. The system is maintaining the pH between 5.5 – 6.5 and TDS between 560 – 1260 ppm.

The below given table compares the expected and tested values.

Sr No	Sample Solution	Expected Result	Actual Result
1	pH	5.5 - 6.5	5.09
2	Temperature (°C)	30	30
3	Humidity (%)	59	59
4	TDS (PPM)	560-260	988

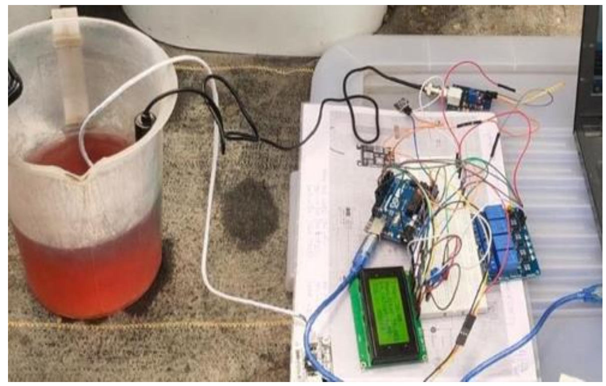

Figure 4: Circuit Tested with The Nutrients

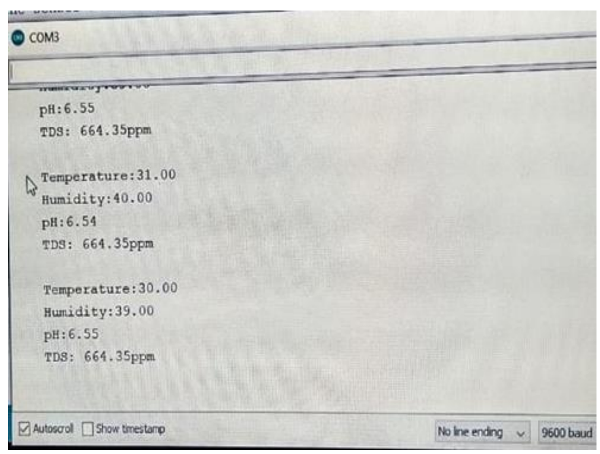

Figure 5: Output Displayed on ARDUINO IDE

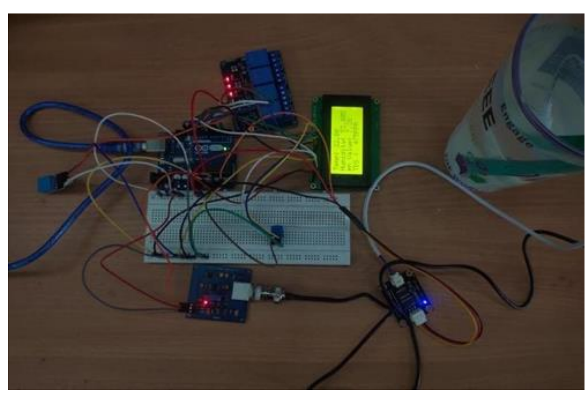

Figure 6: Lcd Display

VIII. CONCLUSION

The hydroponics system is designed in such a way that it will regulate the PH and TDS that is the amount of nutrients with the help of sensors which are interfaced with a microcontroller, according to the requirement of the crop selected. The system will work regardless of the place where the crop is grown and without any human intervention. All the values like temperature, pH, Humidity and TDS will be displayed on the LCD which will be easily monitored.

IX. FUTURE SCOPE

- The system can be implemented on other crops irrespective of any season.
- The system can be implemented using IOT to store thedata and analyze the faults in the system.
- It can be implemented in both automatic and manualmode using an app.

X. ACKNOWLEDGEMENT

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