Grenze International Journal of Engineering and Technology, June Issue

Automated Hydroponic Agriculture System

Mr. Keertheswaran M D[1], Mr. Hruday H[2], Mr. M J Jyothish[3], Mr. Kalyan Alladi[4] and Prof. Kanaiya V Kanzaria[5]
[1-4]Students, School of Computer Science and Engineering, REVA University, India
Email: keerthes.md@gmail.com, hrudhay01@gmail.com, jyothishmj99@gmail.com, Kalyanalladi3@gmail.com
[5]Assistant Professor, School of Computer Science and Engineering, REVA University, India
Email: kanaiya.vk@reva.edu.in

***Abstract*—Food is a vital part of all living being's lives on earth. In the modern world, we use a variety of agricultural methods to create food, or the raw materials needed to make food. Hydroponics is one of the modern, widely used techniques of food production. Plants can be grown hydroponically without using dirt. A nutrient-rich solution is used in lieu of soil to replace it, and when plant's roots touch the nutrient solution, they absorb the nutrients. In comparison to conventional soil-based growing methods, hydroponics uses less water and produce plants that develop more quickly and with higher yields. But even this system needs human intervention, and growing the plants takes a lot of time and work on the part of the farmer. Thus, we aim to automate the hydroponics process of growing crops in our project.**

***Index Terms*— Agriculture, Automation, Hydroponics, Nutrient Film Technique (NFT).**

I. INTRODUCTION

Our world runs on a few essential supplies that are required daily, one of which is crucial for the sustenance of all life on this planet is food. Food is abundantly available in developed parts of the world, but only a fraction of the area is considered developed. Whereas the rest of the world is suffering from low availability of food, most of this hunger affected countries import their food from the developed countries for a premium. And that is not sustainable for the country's economy or their future, as they will be completely reliant on the import of goods, rather than being self-sufficient.

One of the main reasons why countries are in such positions where they must import their food supplies from other countries is the lack of arable land with proper water resources. One of the widely accepted and tried and tested methods is the Hydroponic way of agriculture.

Hydroponic way of agriculture is a practice of growing edible crops with the help of water and the nutrients present in it, Without the requirement of cultivable soil. This technique can be seen being used in our own history, farmers have been growing plants in hydroponic gardens for at least 2600 years, beginning with the legendary Hanging Gardens of Babylon built around 600 BC in Babylon or Mesopotamia and situated along the Euphrates River. Egyptian hieroglyphics dating back to several hundred years BC show plants being grown in water along the Nile without soil.

A technique that has such a rich history is still beneficial till date, it enables us to cultivate crops with exceptionally high yield per acre of hydroponic system. But at the same time, it utilizes 98 percent less water than traditional growing methods, this can be especially helpful for drier countries, which motivates us to utilize this technique. But this technique still requires some labor, and for city dwellers or people with multiple jobs or businesses who own agricultural land but do not have the time to do it. This project can be automated for most

Grenze ID: 01.GIJET.9.2.562

parts and enables people to pursue their own career goals while utilizing their agricultural land for the cultivation of agricultural crops.
In this project, to automate the entire system we are using Robotics to actuate the controls of the hydroponic agriculture system. The control system consists of Sensors and actuators that manage the control of the environment like lighting, watering, plant nutrients supply Etc., that are required for the crops. A Mobile App is used by the farmer as a Monitor console and Manual control panel. We have deployed IoT technology to establish communication between the system and the app.

II. Literature Studies

In some texts, hydroponics is a good option compared to terrestrial farming. In recent years, numerous articles have been published in several journals about hydroponic systems, the following papers can be seen trying to automate the hydroponic method of agriculture.
IoT Hydroponics Management System [1], Author: Chris Jordan G. Aliac & Elmer Maravillas Year: 2019. The authors propose an unified system based on the IoT for keeping track of and managing hydroponic gardens. The ever-growing IoT and automation advances solve the problem of using these resources wisely. The purpose of this system is to ensure a healthy place for crops to flourish and it is a system that continuously controls water level, relative humidity, temperature, and pH level. In addition, the controlled irrigation system provides water nutrient absorption with a simple mechanism. Using data collected by sensors and cloud as backup, users manage, store, utilize and share data over the net. Keeping the positive progress seen and results obtained by the study, resource management in hydroponic setup will become simpler and worth the investment.
IoT-Based Hydroponic System [2], Author : Ruaa Suliman Al-Gharibi, Year: 2021, The author focuses on the development of a hydroponic system based on IoT to provide a flourishing growth environment. The author presents an advanced system for keeping track of a lot of factors that affect the growth of the crop. It gives a way to grow a variety of crops year-round without the constraints of weather. A Lot of work has been done in this using various technologies and techniques. Tests have been performed to evaluate capacity and compatibility of growth. It has been seen that Greek basil grown in this system achieved the highest growth rate for the three samples. Hence the finding of this paper by the author can be accepted to be good progress. But more work and more tests need to be executed in order to understand the full potential.
Automated hydroponics nutrition plants systems using Arduino uno microcontroller based on android [3], Author: P Sihombing et a, Year: 2018. In this paper, the author discusses how today's technological advances have made the combination of computer science and science, including agriculture, so common that both sciences need each other. The aim of the author is to build a tool for automatic control of nutrient flow in hydroponic plants using an Arduino MCU and controlled by smartphone. Logic automatically controls nutrient flow using an Arduino Uno microcontroller. The microcontroller can also send the data of current status of crops to the Android smartphone of the hydroponic plant owner. The quantity of water left in the tank is detected by the HC-SR04 ultrasonic sensor and the temperature is detected by the LM35 temperature sensor. The sensor data is transferred to the Arduino and outputted on the LCD. After that, the ESP8266 module transmits the amount of solution left and the status of the plant's environment wirelessly (WIFI) to your Android smartphone.
From the above papers, we can observe in [3] that the system from a general user’s perspective looks complex and all the data collected from the sensors is only displayed as an output value. Simplification of the system can be achieved by making it compact and concise with a portable design and it can be made user friendly with the help of a mobile application.
Another paper [2] can be seen with a good physical system design although it lacks a good medium of communication between the user and the physical system. Whereas this paper [1] has an application which displays all the data extracted from the physical system, however in this paper we can further automate it by enabling the application to ask for the nitrogen phosphorus and potassium values to general user and automate the addition of those N.P.K quantities per liter every time the reservoir runs out of nutrient solution.

III. Motivation

Farming has always been one of the basic occupations of human beings since 10,000 BCE or more, and there have been many forms of agriculture across the globe spanning from the Mayans, Aztec, Indus valley civilization and Egyptians. One of the forms of agriculture that can be seen throughout history in various civilizations was hydroponics, or some variation of the same kind.

In today's world, we have been facing global warming, pollution and other natural or man-made calamities. With all these problems on our planet, we as humans must act now to try and fix our planet. One of the ways is to enhance the way we do agriculture, and a proven and practiced form of agriculture is hydroponics.
Hydroponics has many benefits like the usage of water is just 2 to 10 % of the water required for regular forms of agriculture, the amount of yield is said to be 4 times that of regular agriculture per acre if undertaken with proper planning, the quality of crops is also seen to increase as the crops are grown in a controlled environment. All these benefits can lead to a profitable and environmentally friendly conduct of food production.
Seeing these benefits, it felt as though it's too good to be true. Which kindled our curiosity to see what it takes to get started and to our surprise we found this form of agriculture to be quite expensive and at the same time demands more monitoring and regulating efforts from a farmer who wants to implement it. This becomes a tedious task which requires one to keep an eye on all aspects of the hydroponic system, which is always not possible. These problems were visible after research and implementation of a basic non-automated system.
To come up with a solution to this problem a desire to try an automate this system arose, we could see a solution that motivated us to build a system that can control the factors like pH, Temperature, Nutrient content and many more on its own and at the same time update the farmer with the status of his crops and the environment they are in.

IV. Problem Domain

Our project is built and researched with an intention to automate the process of a highly advantageous form of agriculture (Hydroponics) and make it easily accessible to all the farmers who want to get started with this form of cultivation by providing a control system that comprises both hardware and software elements, which fall under the domain of this technology.

V. Problem Definition

The automated system we envision to build here to enable a farmer to easily practice hydroponics consists of two parts i.e., physical system and software system. The physical system comprises two systems within which are the reservoir control system and environment control system and these systems controlled and monitored by actuators and sensors. The software system acts as a bridge between the farmer or user and the physical system by providing an easy-to-use graphical user interface i.e., an app that can enable a farmer to control and monitor the system from the comfort of his home or office.

VI. Statement

A highly profitable and eco-friendly form of agriculture that has been around for centuries but has not been in wide practice because of its strenuousness and demand of meticulous labor which over-time has resulted in a decline of the adoption and use of this practice. To enable the people to adopt and use hydroponics with ease and precision, we aim to automate the meticulous parts of the practice and make the whole process of farming using hydroponics simpler by building a system that can be monitored and managed with less hands-on involvement.

VII. Innovative Content

A. IoT Hydroponics Management System [1]

The project by the above paper has implemented the system at a intermediate level and all the necessary sensors and actuators have been implemented like pH, temperature, humidity and water level are monitored and with simple mechanisms they have made possible to control irrigation of water and nutrient solution addition and use a cloud based technology as backend to monitor the crops

B. IoT-Based Hydroponic System [2]

The paper presented by this author has given an in-depth insight of what their result was, they have monitored TDS, pH and light-intensity among others like water level, temperature of environment and humidity. They have used Blynk and ESP12F Wi-Fi modules as the medium to communicate between the physical system and the app. They have used an LDR sensor to detect light intensity and ultrasound atomizer to control humidity levels. Overall, the system has a lot of different monitoring sensors and devices along with control mechanisms.

C. Automated hydroponics nutrition plants systems using Arduino uno microcontroller based on android [3]

The author of this paper has managed to make the system locally monitorable using an LCD display and over the network using an app on a smartphone. They have used LM35 temperature sensor and have used Arduino Uno as the controlling unit and ESP8266 to connect to the internet via which the results can be seen on a mobile application. They have utilized an Ultrasonic sensor to measure the depth of the reservoir and find the water level and present it on the application.

VIII. Problem Formulation and Design

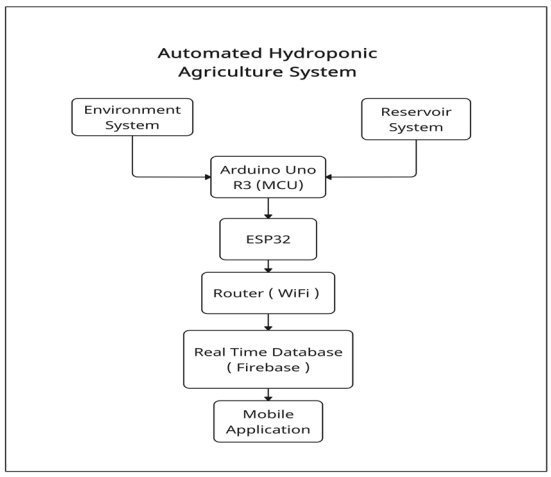

Figure 1: System Schema

1. The above system portrays the high-level descriptions of the components of our system, the actuator part of the system has two parts of its own i.e., Environment System & Reservoir System.
2. Each individual system contains their own circuitry and actuation based on the input of the user and the other optimal settings that have been set by default.
3. These systems are then connected accordingly to Arduino Uno, which controls the circuitry and enables them to & fro transference of data and control.
4. This transfer of data is done over Wi-Fi's SSID and password which are input into ESP32. ESP32 enables Wi-Fi and Bluetooth communication between devices and servers.
5. The ESP32 transfers data via the router to the Real Time Database present in Firebase BaaS.
6. Firebase RTDB is linked to mobile applications where operations on the physical system are performed.

IX. Solution Methodology

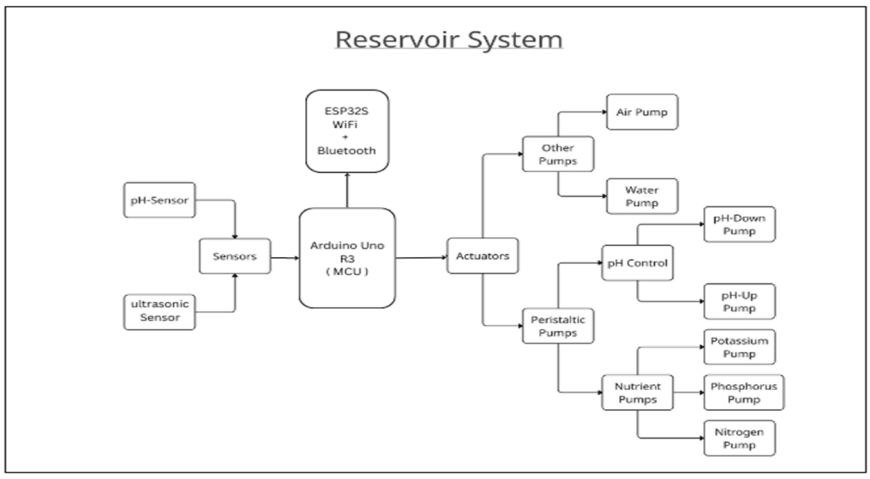

Figure 2: Reservoir System

1. The Reservoir System contains all the actuators & sensors required for successful automation. It has sensors like pH & ultrasound/float which give valuable data to ensure the smooth operation of the actuators.
2. The actuators of the system are Peristaltic pumps which fill liquids in measurable quantities, and other pumps to keep water and oxygen flowing.

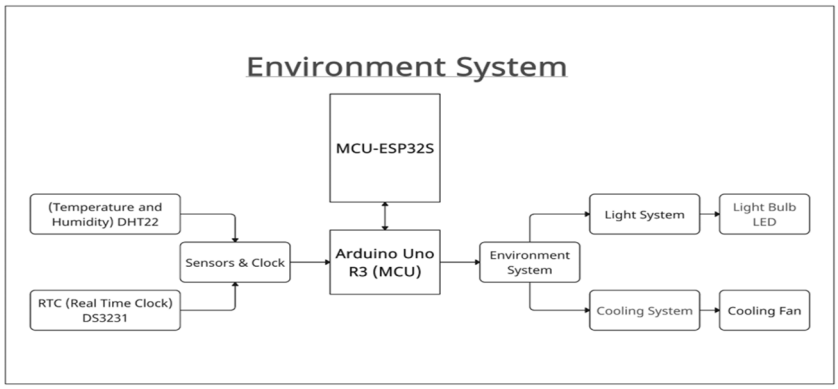

Figure 3: Environment System

1. The Environment System contains all the actuators and sensors required to ensure a well-conditioned environment for the crops to grow. It contains sensors & modules which provide important data like; temperature, humidity and time.
2. The actuators of the system perform tasks like; turning the Light On & Off and Turning the fan ON when the temperature exceeds the optimum limit.

X. RESULTS

Upon conducting the necessary experiments, we have found out and concluded with a system that can ingest sensory data and send it via the internet using firebase real-time database to the application and display it and at the same time take necessary actions based on that data to ensure the continuous operation of the system.
The farmer can input the values of nitrogen, phosphorus and potassium that are specific to the kind of crops he wants to grow, and the system ensures that the exact quantity of those nutrients is delivered into the reservoir as required for one liter of water.
The other factors of the system are controlled on their own like the optimal temperature of most basic crops lie within a similar range so the system will turn the cooling fan on/off based on the current temperature, the pH level is also automatically controlled based on the optimal pH level required for most crops, along with an Ultrasonic Sensor to detect the amount of liquid present in the reservoir. Additionally, an auto set 12-hour clock i.e., in our case an RTC module that will help the microcontroller to turn the lights on/off in a fashion like the sunrise and the sunset.
Talking about the whole system on a higher level, we have seen it grow some beans, tomatoes, lettuce etc. but the crop which we found to be successful during our experiments was beans. The system is designed to produce a variety of crops that fall under the same category of nutrient ratios, temperature, humidity, and light at the same time. The functionalities, individual features and their flow of commands and data are portrayed in the following data model.

XI. CONCLUSION

Our proposed system, Automated Hydroponic Agriculture System automates the practice of hydroponics form of agriculture, specifically nutrient film technique. It ensures that the system runs at an optimal capacity with the help of various factors that have been controlled and monitored continuously. We have used all the necessary components that have a major effect on the growth and health of the crops like temperature, humidity, pH, Oxygen content in water, nutrients etc. This enables us to build a cost-effective system which can be accessed by a wide variety of users and farmers with different financial backgrounds. Overall, the system provides a simple yet powerful means to implement hydroponics which consists of a physical system with automated controls and a mobile application that can be used for control, management, and monitoring of the whole system.

REFERENCE

[1] Chris Jordan G. Aliac & Elmer Maravillas, “IoT Hydroponics Management System ”,DOI: 10.1109/HNICEM.2018.8666372, 14 March 2019. https://ieeexplore.ieee.org/document/8666372

[2] Ruaa Suliman Al-Gharibi, “IoT-Based Hydroponic System ”,DOI: 10.1109/ICSCAN53069.2021.9526391, 06 September 2021. https://ieeexplore.ieee.org/document/9526391

[3] P Sihombing et a, “Automated hydroponics nutrition plants systems using Arduino uno microcontroller based on android ”, DOI :10.1088/1742-6596/978/1/012014, 2018 https://iopscience.iop.org/article/10.1088/1742-6596/978/1/012014/pdf

[4] Dr. Asawari Dudwadkar1, Tarit Das, Sakshi Suryawanshi, Rajeshwari Dolas, Tejas Kothawade,“ Automated Hydroponics with Remote Monitoring and Control Using IoT”, DOI:10.17577/IJERTV9IS060677,Vol. 9 Issue 06, June-2020
https://www.researchgate.net/publication/342537801_Automated_Hydroponics_with_Remote_Monitoring_and_Control_using_IoT

[5] Prof. Smita Pawar, Shreya Tembe, Rujuta Acharekar, Sahar Khan, Sheetal Yadav, “Design of an IoT enabled Automated Hydroponics system using NodeMCU and Blynk”, DOI: 10.1109/I2CT45611.2019.9033544, 29-31 March 2019 https://ieeexplore.ieee.org/document/9033544

[6] Dr.D.Saraswathi, P. Manibharathy, R. Gokulnath, E.Sureshkumar, K.Karthikeyan “Automation of Hydroponics GreenHouse Farming using IOT”, DOI: 10.1109/ICSCAN.2018.8541251, 06-07 July 2018
https://ieeexplore.ieee.org/document/8541251