SEMINAR REPORT
ON

HYDROPONICS BASED PRECISION FARMING WITH FEATURE OPTIMIZATION

SUBMITTED BY

JANHAVI BHOR
VARAD CHASKAR
SAHAJ CHAUDHARI

Under the Guidance of
Mr. RAMGOPAL SAHU

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION
P.E.S'S MODERN COLLEGE OF ENGINEERING
PUNE – 411 005.

SAVITRIBAI PHULE PUNE UNIVERSITY
Academic Year: 2023-2024

CERTIFICATE

This is to certify that

JANHAVI JITENDRA BHOR	**Exam No. B190313024**
VARAD VINAYAK CHASKAR	**Exam No. B190313028**
SAHAJ SHEKHAR CHAUDHARI	**Exam No. B190313030**

of B.E. (E&TC) have successfully completed the seminar titled '**Hydroponics Based Precision Farming with Feature Optimization**' during the academic year 2023-2024. This report is submitted as partial fulfillment of the requirement of degree in E&TC Engineering as prescribed by Savitribai Phule Pune University.

Dr. Mrs. K. R. Joshi **Principal** **P.E.S's MCOE, Pune-05.**	**Dr. Mrs. R. S. Kamathe** **Vice Principal,** **H.O.D. (E&TC)**	**Mr. Ramgopal Sahu** **Project Guide**

ACKNOWLEDGEMENT

We would like to express our sincere appreciation to all the individuals who contributed to the success of our project "Hydroponics Based Precision Farming with Feature Optimization".

First and foremost, We would like to thank **Mr. Ramgopal Sahu** for his invaluable guidance and support in PCB design, enclosure design, component choices, and modifications. His expertise and experience played a crucial role in the successful implementation of our project. His suggestions on plant choices were also very helpful in achieving our goals.

We would also like to extend our heartfelt thanks to **Mrs. Shreyasi Watve** for her brilliant ideas on the farm field and modifications in the report. Her contributions have greatly enhanced the quality of our project. Furthermore, we would like to express our gratitude to our HOD **Dr. Mrs. R. S. Kamathe** for her constant support and encouragement throughout the project.

We would also like to thank the industry expert **Mr. Jayesh Ranjare** who provided valuable suggestions for this project. Their insights and knowledge have been immensely helpful in achieving our objectives.

We would also like to express our gratitude to our principal **Dr. Mrs. K. R. Joshi** for provision of state-of-the-art infrastructure, access to necessary resources and college's commitment to fostering an environment that encourages innovation, creativity, and hands-on learning.

Lastly, we would like to thank **Mr. Chandrakanth Bhode**, a certified fertilizer shop owner, for providing us with the best knowledge about fertilizer choices for hydroponics systems. His inputs were very valuable for the success of our project.

- Janhavi Bhor
- Varad Chaskar
- Sahaj Chaudhari

ABSTRACT

The world is changing rapidly, bringing both innovations and problems. As the population grows, land and water resources are shrinking. Conventional farming methods are becoming unsustainable due to climate change and harmful environment. Hydroponics offers an innovative solution that uses less space and water and produces more food with fewer chemicals than soil based farming. Furthermore, hydroponics can grow food in any location and season, providing fresh, local, and nutritious vegetables to consumers. The proposed system aims to enhance the hydroponics concept by not only automates crucial aspects of hydroponic systems such as water and nutrient supply but also incorporates features like machine learning algorithms, IoT, cloud computing, M2M communication, and image analysis and controlling environmental parameters in plant growth but also verifying whether the system functions as intended. The system is in product-ready form that may be used commercially or domestically.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

Agriculture is vital for feeding the world's rising population and stands as a vital lifeline, ensuring sustenance for a fast-changing world. With ever-increasing demand for resources, food and the scarcity of arable land, there is a need to create sustainable and efficient agricultural practices. As the world is facing challenges such as climate change, population growth, and limited natural resources, there is a pressing need for innovative solutions that can maximize crop productivity while minimizing resource consumption. By creating a self-sustaining agriculture automation system we can increase a yield significantly compared to traditional agriculture methods, this project can help meet this demand and ensure a sustainable future for agriculture.

1.1 Objectives

1. To improve efficiency and productivity in farming and reduce labor costs. Using automation to achieve higher yields and profitability for farmers.

2. To reduce environmental impact and promote sustainable farming practices. Implementing and efficient resources management to minimize waste and conserve natural resources.

3. To increase food security and help address food supply issues in the world. Utilize self-sustaining agriculture technologies to improve crop yield and provide more food for a growing population.

4. To collect data from sensors and optimize system operations using machine learning algorithms, including humidity prediction and nutrient level.

1.2 Scopes

1. It encompasses comprehensive research and selection of suitable sensors, modules, and components.

2. It includes the design and development of circuitry, connections, and control mechanisms to integrate the sensors, actuators,microcontrollers, and communication modules effectively.

3. It also involves programming the microcontroller with machine learning algorithms to optimize system operations based on sensor data.

4. Develop a user-friendly website and mobile application that will serve as a centralized platform for remote control, monitoring, and alerts. This interface will enable farmers and agricultural practitioners to conveniently manage and monitor their hydroponic systems, ensuring real time data visualization and timely interventions when necessary.

1.3 Hydroponics NFT Automation

Nutrient Film Technique(NFT), is a popular hydroponic system that involves a continuous flow of a thin film of nutrient solution over the plant roots . This technique allows for efficient nutrient absorption and water conservation, leading to higher crop yields compared to traditional soil-based farming methods. By integrating sensors and control systems, farmers can remotely monitor and manage multiple NFT hydroponic systems simultaneously . Sensors placed in the nutrient solution tanks can measure parameters such as pH, EC, temperature, humidity, and water level . The collected data can be transmitted wirelessly to a central control system, allowing farmers to monitor the conditions of each system and make necessary adjustments as needed .

Automation in NFT hydroponics also enables precise control of nutrient solution flow rates and timing. By automating the nutrient film flow, farmers can ensure a continuous and uniform supply of nutrients to the plant roots, promoting efficient nutrient absorption and preventing nutrient imbalances. Furthermore, automation simplifies the management of multiple NFT hydroponic systems. With centralized control systems, farmers can monitor and control multiple systems simultaneously, reducing the need for manual intervention and saving time and effort.

1.4 Application of Hydroponics NFT Automation

Automating a hydroponic system has wide-ranging applications in various sectors. Firstly, it improves the accuracy and reliability of parameter monitoring and control, minimizing the risk of human error and optimizing plant growth conditions. Secondly, it allows for more efficient resource utilization, such as water and nutrients, as automation systems can precisely deliver the required amounts to the plants. Lastly, automation enables farmers to remotely monitor and manage a NFT hydroponic system, providing flexibility and convenience in system management.

CHAPTER 2

LITERATURE SURVEY

CHAPTER 2
LITERATURE SURVEY

2.1 Literature Survey Of The Reference Papers

"Nutrient Film Technique (NFT) Hydroponic Monitoring System Based on Wireless Sensor Network," by Helmy, Marsha Gresia Mahaidayu, Arif Nursyahid, Thomas Agung Setyawan, Abu Hasan (2017), there are issues related to urban development, such as the conversion of agricultural land to housing and industry, leading to a decrease in agricultural land in cities. As urban food needs are dependent on agricultural production, hydroponic cultivation has emerged as a popular technique. Hydroponics is a method of cultivation using nutrient solutions, with soil functions replaced by water, nutrition, and oxygen which are delivered directly to the plant. The Nutrient Film Technique (NFT) is one such hydroponic technique that uses nutrient solution drained on the root area, which crucially defines success in hydroponic cultivation.

"A Controlled Environment Agriculture with Hydroponics: Variants, Parameters, Methodologies and Challenges for Smart Farming," Srivani P, Yamuna Devi C and Manjula S H (2019), the paper discusses the increasing issues of urbanization, food scarcity, insecurity, and unpredictable climate in agriculture. To fight these problems, Hydroponics, which is a soilless culture, is presented as an alternative to conventional farming. Hydroponics is a sustainable model for controlled environment and precision agriculture. It efficiently uses water and nutrients for optimal growth of plants and is expanding worldwide as a sustainable model. The technology has advanced to automate the agriculture system and efficiently utilize resources. Urban farming with Controlled environment methods can be adapted as it eliminates the use of pesticides and genetically modified organisms (GMO).

"Technological Influences on Monitoring and Automation of the Hydroponics System," by Geetali Saha (2021), this paper undertakes a detailed examination of hydroponics. The paper presents an in-depth review of the key components that constitute an efficient hydroponic system: an extensive atmospheric database capturing detailed data on prevailing weather, a sensor database logging minute details, an integration unit that conducts decision making based on a blend of historical and current readings, automated control systems managing the flow of water and nutrients, data storage, an IoT interface, and remote access capabilities for seamless connectivity.

2.2 Brief Findings From Research Literature

- New technologies are being researched and improvements are being done in areas like nutrients composition, supply, medium as well as effect of light, temperature, humidity and EC/TDS and pH conditions as these have shown to have a linear relation with plant growth.
- Although introduction of automation and AI in hydroponics has been stated for a long long time, most of it has been for simulated environments, either physical or virtual through matlab.
- Even model building of Ai research work exists; most of them are either for simulated environments, and built using data from real life, but their effectiveness in actual farming has not been shown.
- As most work in his domain has not utilized/shown research techniques that will turn this technology(introduction of ai and automation) into a feasible product , showing efficiency, and effectiveness which we intend to do rather than only focusing on plant growth.

2.3 Literature Survey Of Similar Products Available In The Market

2.3.1 Automation kit by Growtronix

The Hydroponic Automation Kit by Growtronix and the Hydroponic Starter Kit by General Hydroponics are two similar products available in the market. The Growtronix kit provides a complete hydroponic automation solution with features such as temperature and humidity sensors, water level sensors, and nutrient dosing systems. The General Hydroponics kit includes a water pump, air pump, and air stone, and is designed for use with a 5-gallon bucket.

Fig: 2.3.1 Automation by Growtronix
Source: growtronix.com/cart/blog/how-growtronix-works-n5

2.3.2 City Greens

City greens provide low cost hydroponic solutions for farmers who are on budget and would like to grow seasonal and local crops, but at the same time enjoy higher yields and improved profits as compared to what is possible in traditional farming. They are currently serving 18+states right now. They provide setup , support and automation to farming systems.

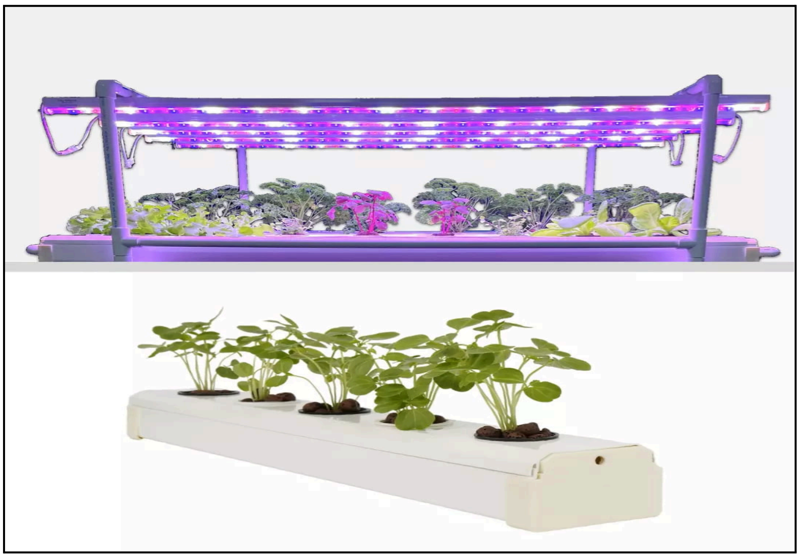


Fig: 2.3.2 Product by City Greens
Source: https://www.citygreens.shop/Images/202211/1080x1080/Kits.webp

2.4 Comparison With Various Technologies Available

Compared to traditional soil-based farming methods, hydroponic systems have several advantages such as higher crop yields and reduced water usage. Automation further enhances the efficiency and effectiveness of hydroponic farming. While several technologies are available for hydroponic automation, each has its own pros and cons. For instance, automated dosing systems provide precise nutrient delivery, but they can be expensive and require regular maintenance. On the other hand, simple systems with a timer and a water pump may be more affordable, but they lack the precision of automated dosing systems.

Also, there is no such system that operates the UV light, fan, air pump, and water pump all 4 at once. Furthermore, there is no such technology invented that verifies whether UV lights and pumps are working or not. Thus, these factors make the project unique.

2.5 Market Survey Based On Economy Literature

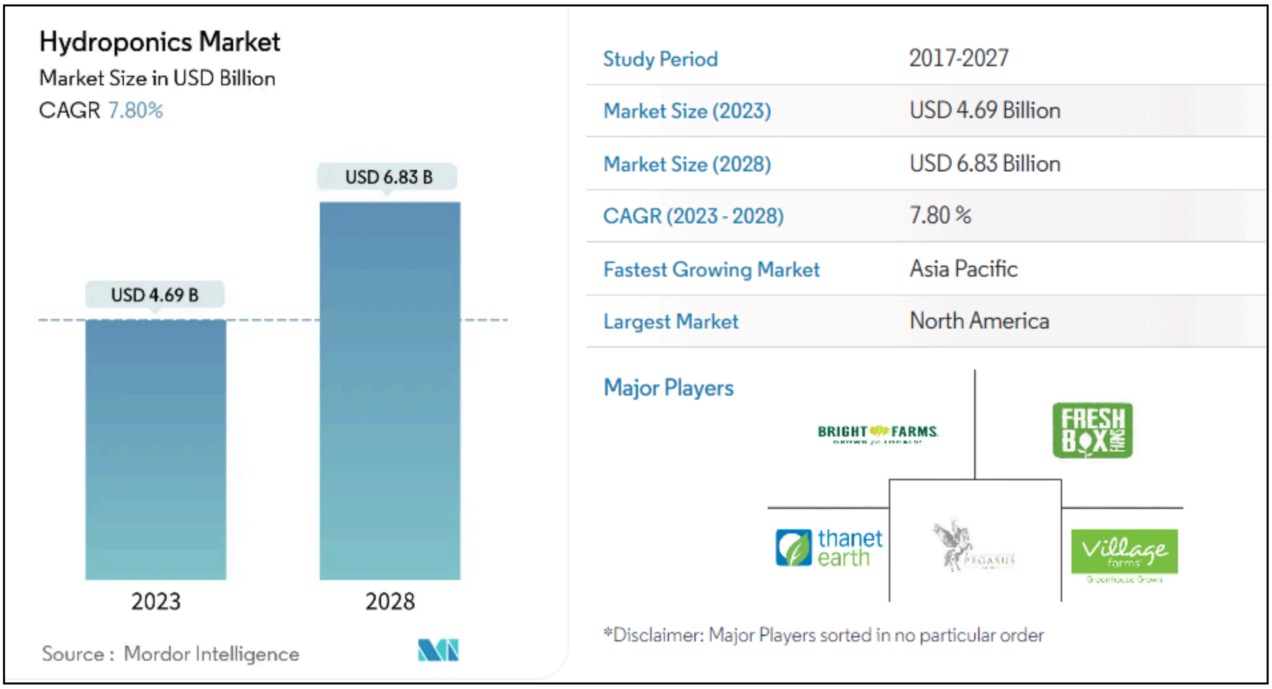


Fig: 2.5 Hydroponics Market Size

Source: https://www.mordorintelligence.com/industry-reports/hydroponics-market

- The Hydroponics Market size is expected to grow from USD 4.69 billion in 2023 to USD 6.83 billion by 2028, at a CAGR of 7.80% during the forecast period (2023-2028).North America Dominates the Market, while asia pacific is fastest growing in market [4].
- It is set to grow rapidly on account of the surging implementation of this agricultural method in Australia, Japan, India, and China [5].
- The global market is highly fragmented with the presence of multiple companies. Most of them are focusing on R&D activities to come up with state-of-the-art techniques for surging sustainability and saving costs [6].
- March 2021: The state government of Ahmedabad announced its plan to accelerate hydroponic farming in cities to encourage households to grow vegetables in their homes. The agriculture department staff will provide hands-on training to residents with DIY videos.
- The key players operating in the hydroponics market are Argus Control Systems Ltd[7].. (Canada), Signify Holding B.V. (Netherlands), The Scotts Miracle-Gro Company (U.S.), Hydroponic Systems International (Spain), Hydrodynamics International Inc (U.S.), AmHydro (U.S.), Emerald Harvest (U.S.), Heliospectra AB (Sweden), Freight Farms, Inc. (U.S.), Logiqs BV (Netherlands), AirLogix (U.S.), and Nutriculture Grow Systems (U.K), among others.

CHAPTER 3

SPECIFICATIONS

CHAPTER 3

SPECIFICATIONS

3.1 General specifications

- Temperature range: 0-50 degree Celsius
- Humidity range: 20% to 90%
- Accuracy: ±2°C and ±5%
- Bluetooth protocol: Bluetooth v2.0+ & EDR
- Frequency: 2.4GHz ISM band
- Core RAM size: 2K

3.2 External system specification

3.2.1 UV light

- Type: USB
- Adjustable intensity
- Adjustable color (red, blue, violet)
- Voltage consumption at Max. Brightness: 5V, DC
- Current consumption at Max. Brightness: 1.45A

3.2.2 Air pump

- Type: USB
- Voltage consumption: 5 – 5.1V, DC
- Current consumption: 0.15A

3.2.3 Fan

- Type: USB
- Voltage consumption at maximum speed: 5V, DC
- Current consumption at maximum speed: 0.91A

3.2.4 Water pump

- Voltage consumption: 5V
- Current consumption: 0.31A

Thus, the whole project runs on 5V DC USB power supply, and at Max. load, the current consumption is 3.03A.

3.3 Technical Specifications

● Microcontroller: ESP 01 (Espressif Systems)
○ ESP8266EX chip
○ 32-bit RISC CPU operating at 80 MHz
○ Integrated TCP/IP stack for internet communication
○ Integrated Wi-Fi (802.11b/g/n)
○ Frequency Bands: 2.4 GHz (Wi-Fi)

● Motor Driver: 2 x L293D Motor Driver IC
○ Capable of driving two DC motors or one stepper motor per L293D
○ 4.5V to 36V supply voltage range with bi-directional drive current up to 600mA.

● Temperature and Humidity Sensor: DHT11
○ Temperature measurement range: 0°C to 50°C
○ Humidity measurement range: 20% to 90%

● Camera: ESP32
○ FPC connector.
○ Support for OV2640 (sold with a board) or OV7670 cameras.
○ Image Format: JPEG(OV2640 support only), BMP, grayscale.
○ LED flashlight.
○ Temperature Range: Operating: -20 ℃ ~ 85 ℃
○ Power Supply: 5V via pin header.
○ External Storage: micro SD card slot up to 4GB.

CHAPTER 4

BLOCK DIAGRAM AND DESCRIPTION

CHAPTER 4

BLOCK DIAGRAM AND DESCRIPTION

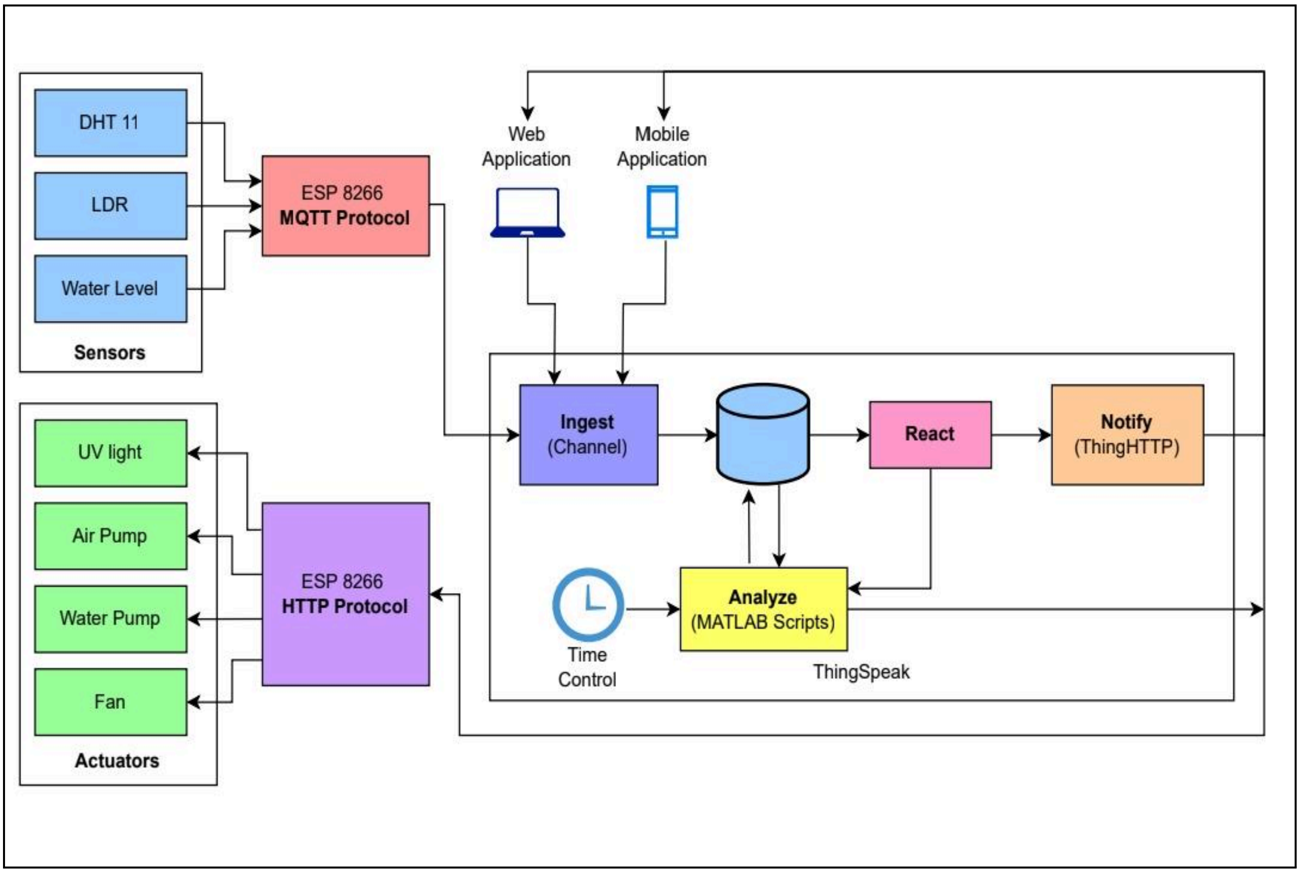


Fig. 4.1: Block diagram of the system

4.1 Description of the block diagram

4.1.1 The working of each block

1. Sensors Block:

● Water Level Sensor: Measures the water level in the hydroponic system to ensure it remains within the desired range and expected setup.

● Temperature Sensor: Monitors the temperature within the hydroponic environment for optimal plant growth. And measures the humidity levels to maintain an ideal atmosphere for plant growth.

● LDR (Light Dependent Resistor): Checks the light status to determine if additional artificial light is needed.

2. Controller Block:

● ESP01 Microcontroller: It is a compact and cost-effective WiFi module based on the ESP8266 microcontroller, enabling wireless connectivity for IoT and embedded systems.

3. IoT + Bluetooth Block:

● IoT Protocols of Communication: Enables communication with external networks or devices, allowing remote monitoring and control.

● Bluetooth Connectivity: Allows for local control and monitoring via a mobile device or Bluetooth-enabled interface.

4. Web/App Block:

● Smartphone UI: Provides a user-friendly interface on a mobile app or web application for users to monitor and control the hydroponics system remotely.

5. Actuator Block:

● LED Light: Controls the artificial lighting system to supplement natural light as needed.

● Fan: Regulates ventilation and air circulation within the hydroponic environment.

● Air Pump: Manages aeration of the nutrient solution for plant roots.

● Water Pump: Controls the flow of nutrient-rich water to the plant roots.

6. Camera Block:

● ESP32 CAM: It is a compact, Wi-Fi and Bluetooth-enabled module with a built-in camera, suitable for various IoT and image capture applications

CHAPTER 5

HARDWARE SYSTEM DESIGN

Chapter 5

HARDWARE SYSTEM DESIGN

5.1 Schematic Circuit Diagram With 555 IC

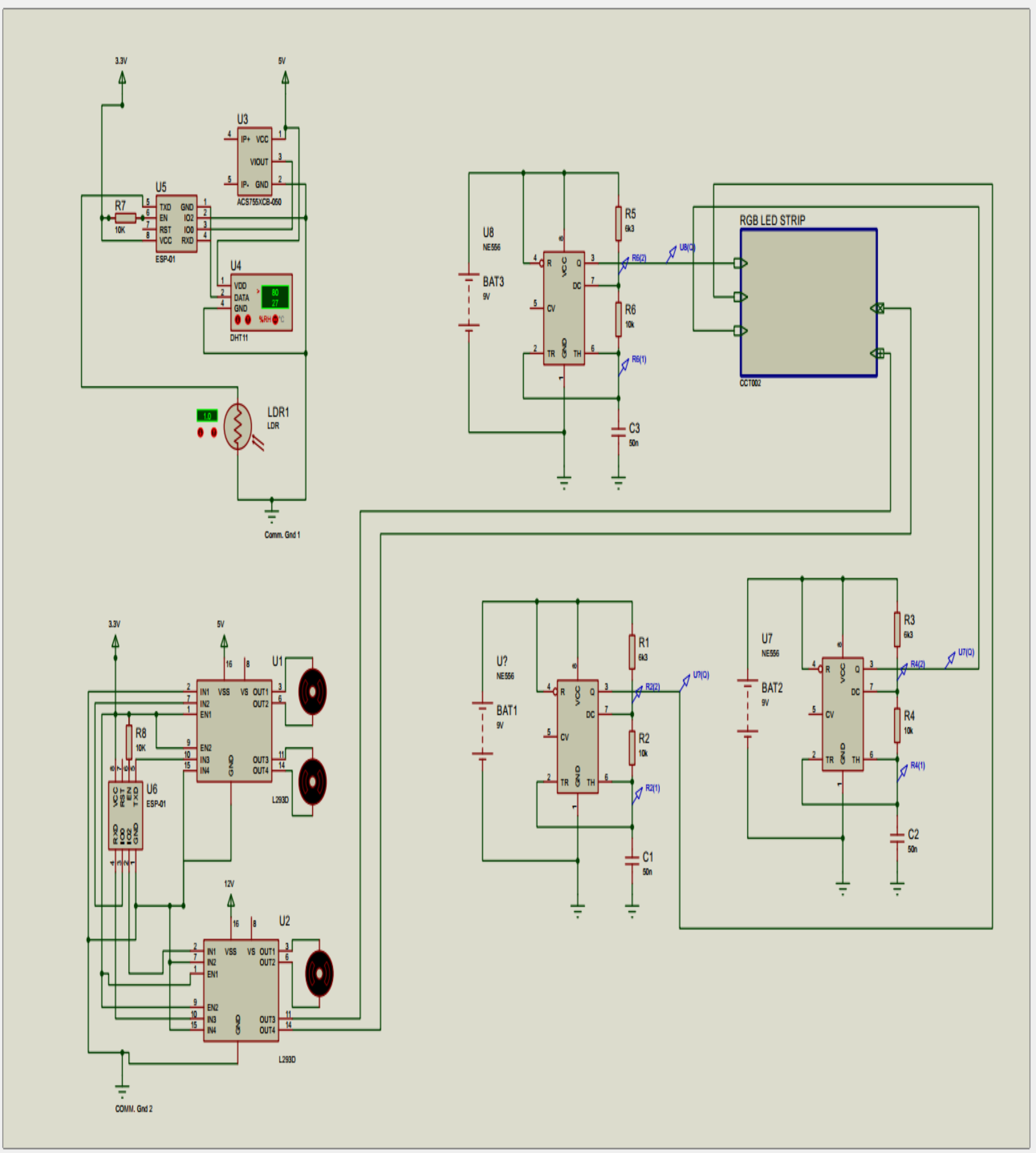


Fig. 5.1: Schematic circuit diagram

5.2. Matlab Simulink Emulation

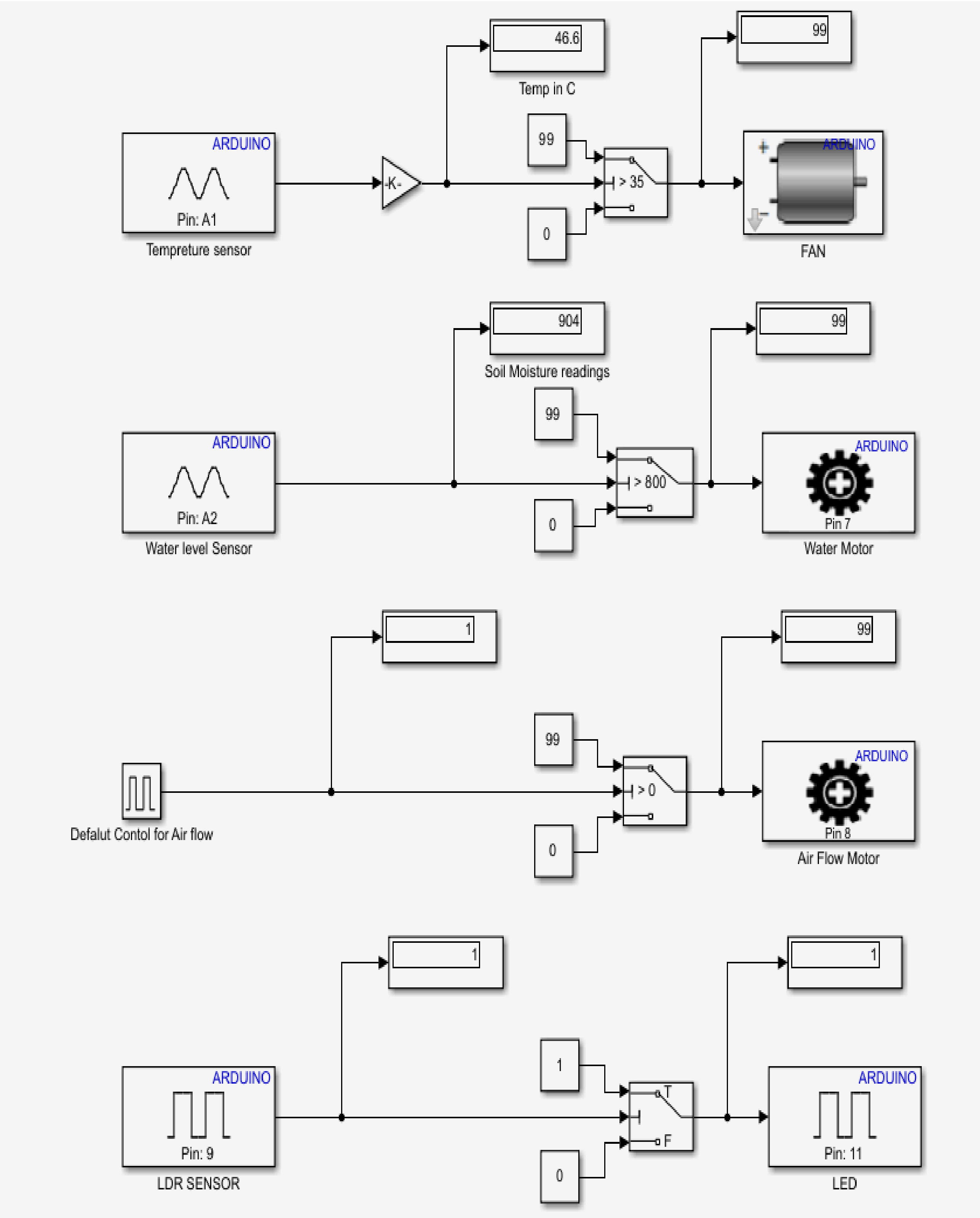
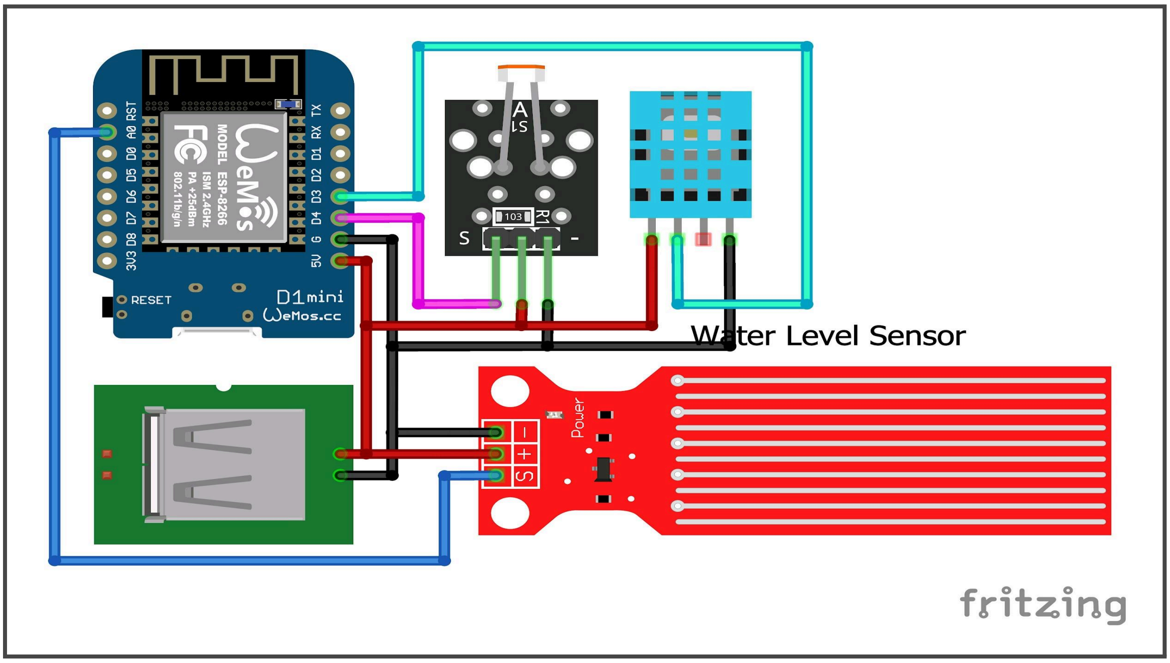


Fig 5.2 : Emulation conducted on matlab Simulink

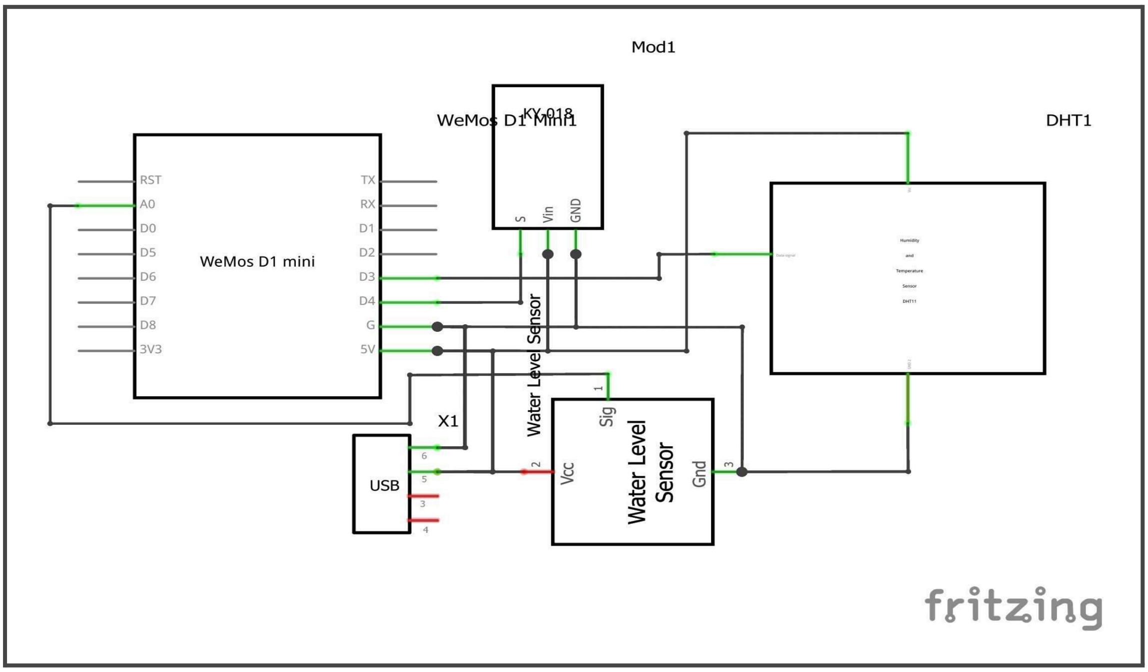
5.3. Breadboard Circuit Diagram and Schematic Diagram.

5.3.1. Breadboard Circuit Diagram of the Sensor Module.



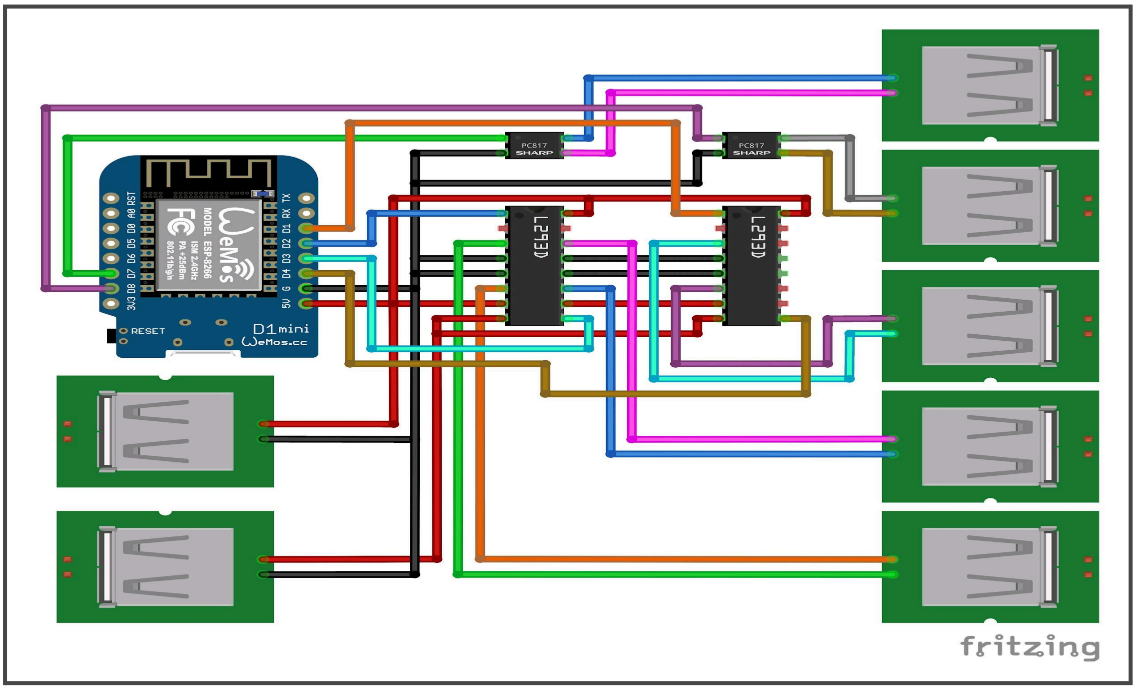
5.3.1 : Breadboard Circuit Diagram of the Sensor Module.

5.3.2. Schematic Diagram of Sensor Module.



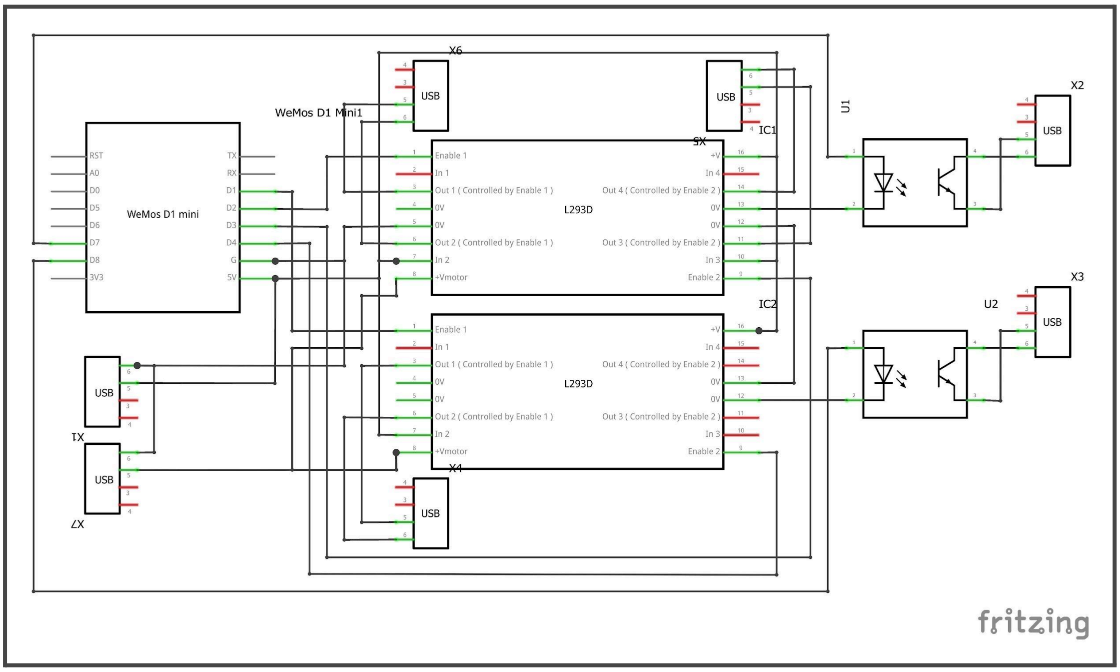
5.3.2 : Schematic Diagram of Sensor Module.

5.3.3. Breadboard Circuit Diagram of the Actuator Module.



5.3.3 : Breadboard Circuit Diagram of the Actuator Module.

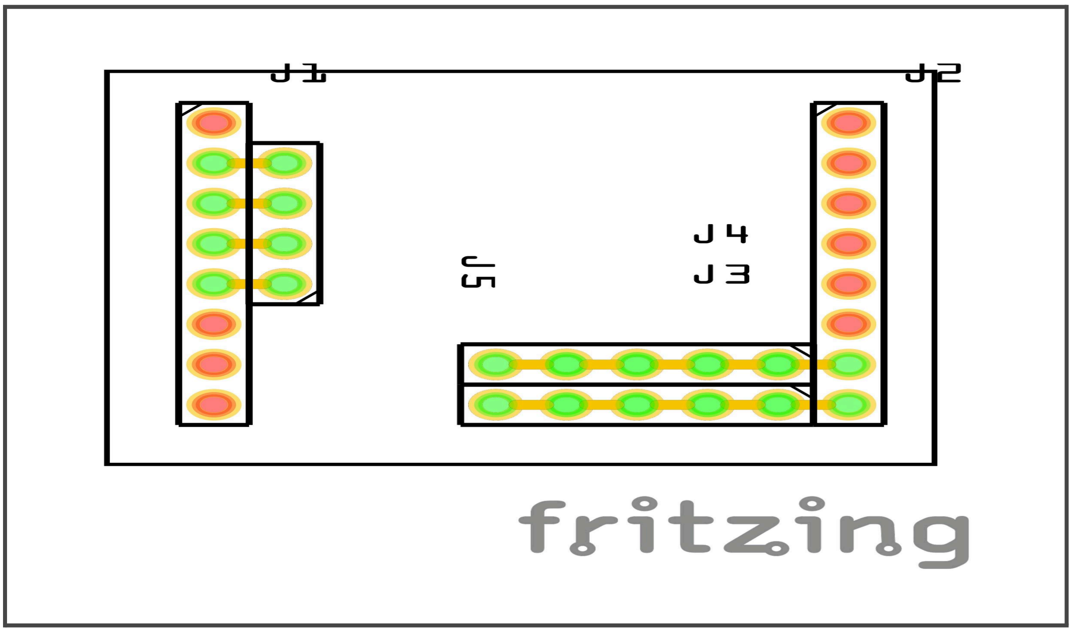
5.3.4. Schematic Diagram of Actuator Module.



5.3.4 : Schematic Diagram of Actuator Module.

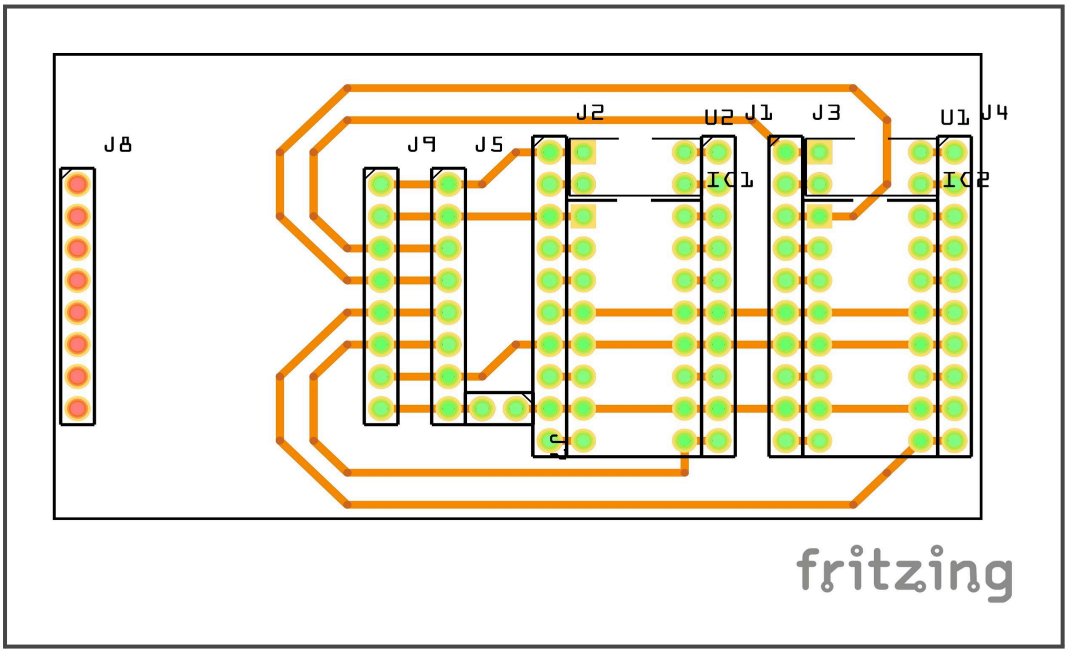
5.4. PCB Layout Design on Fritzing

5.4.1 PCB Designing of Sensor Module



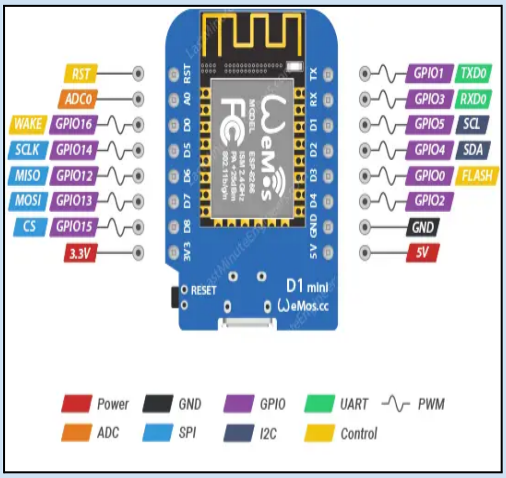
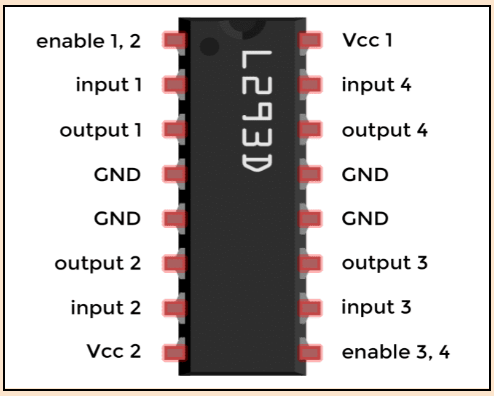
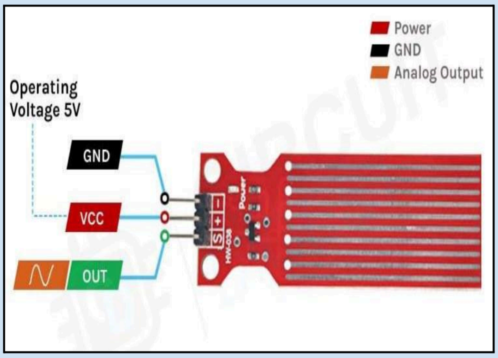
5.4.1 : PCB Designing of Sensor Module

5.4.2 PCB Designing of Actuator Module



5.4.2 : PCB Designing of Actuator Module

5.5. Specifications of components

Sr. No.	Specifications of Components	Hardware Design
1.	**Wemos D1 mini** **Microcontroller:** ESP8266EX **Operating Voltage:** 3.3V **Digital I/O Pins:** 11 (can be used as GPIO, PWM, I2C, and more) **Analog Input Pins:** 1 (3.2V max) **Flash Memory:** 4 MB **Clock Speed:** 80 MHz **Wi-Fi:** 802.11 b/g/n (2.4 GHz) **Integrated Antenna:** Yes **USB-to-Serial Converter:** CH340G **Built-in LED:** GPIO 2 **Reset Button:** Yes **Temperature Range:** -40°C to +125°C **Dimensions:** 34.2mm x 25.6mm	
2.	**L293D Motor Driver** **Motor Supply Voltage (VS):** 4.5V to 36V **Logic Supply Voltage (VSS):** 4.5V to 7V **Output Current (per channel):** 600 mA (1.2A peak for short durations) **Total Output Current (all channels combined):** 1.2A (2.4A peak) **Number of Channels:** 4 (two H-bridges) **Enable/Disable Feature:** Yes (enable pin for each H-bridge) **Operating Temperature Range:** 0°C to 70°C	
3.	**Water Level Sensor** **Operating Voltage:** 3.3 V to 5V **Operating current:** 4-20mA **Temperature Range:** -10°C to 30°C **Humidity Range:** 10% to 90% **Detection Area:** 40mmx16mm **Size:** 65 mm x 20 mm x 8 mm **Manufacturing Process:** FR4 double spray tin **Optional Accessories:** 3 pin sensor connecting line,Arduino 328 controller, Sensor relay shield	

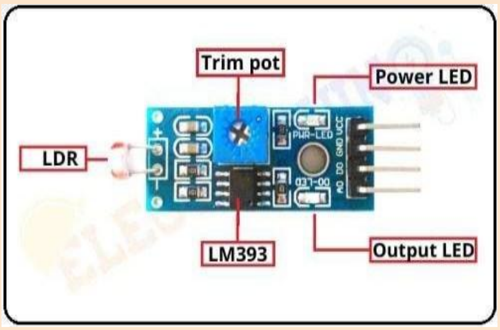
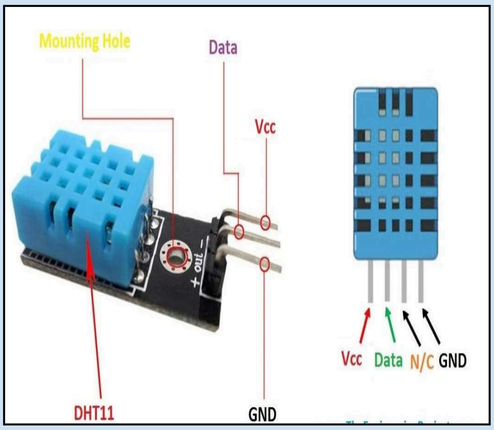
Sr. No.	Specifications of Components	Hardware Design
4.	**LDR Sensor** **Operating Voltage:** 5V to 3.3V **Operating current:** 5mA **Temperature Range:** -25°C to +75°C **Module Pins:** 3 pins **PCB size:** 3cm * 1.6cm **Weight:** 50 grams **Dimensions:** 5 x 4 x 3cms	
5.	**DHT11 Sensor** **Operating Voltage:** 3.3V to 5.5V **Temperature Range:** 0°C to 50°C **Temperature Accuracy:** ±2°C **Humidity Range:** 20% to 80% **Humidity Accuracy:** ±5% **Communication Protocol:** Single-wire digital signal **Response Time:** 2 seconds (for temperature and humidity) **Calibration:** Factory calibrated **Low Power Consumption:** 0.5 mA (average during active sensing) **Dimensions:** 15.5mm x 12mm x 5.5mm	

Table 5.5: Specifications of components

5.6. Enclosure Design

5.6.1 Enclosure design of whole system

Material Used: Steel-Satin, Color Used: Metallic Brown

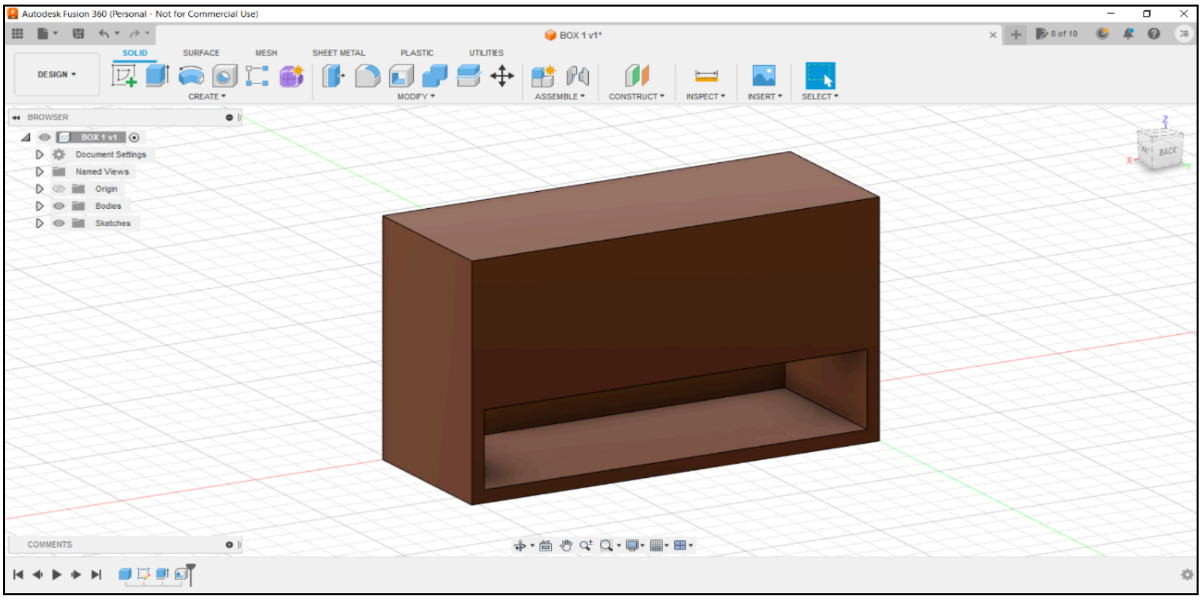


Fig 5.6.1: Enclosure design of whole system on fusion 360

5.6.2 Enclosure design for controller

Material Used: Steel-Satin, Color Used: Metallic Red

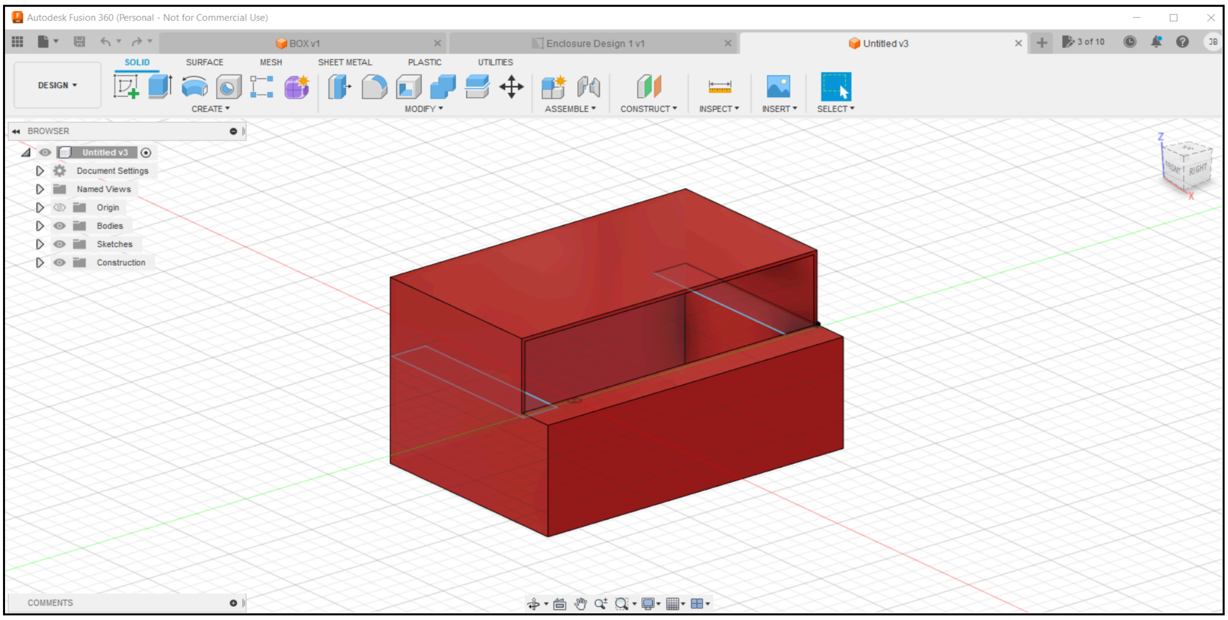


Fig 5.6.2: Enclosure design for controller on fusion 360

5.6.3 Enclosure design for NetPot

Material Used: Steel-Satin ,   Color Used: Metallic Black

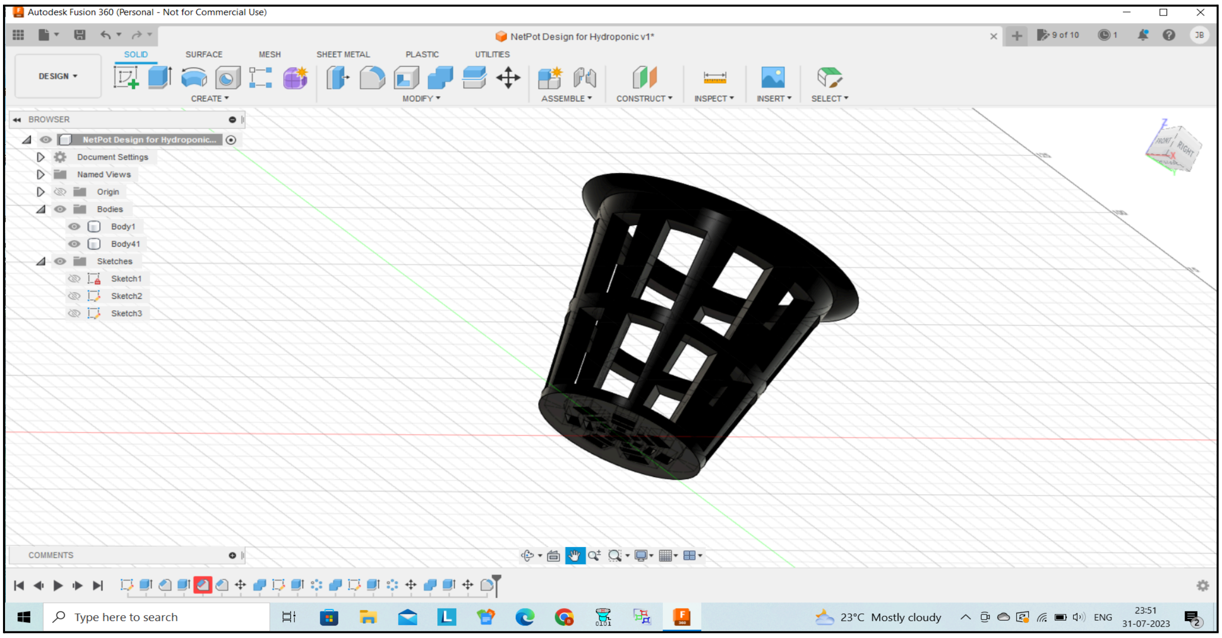


Fig 5.6.3: Enclosure design for NetPot on fusion 360

5.6.4 Enclosure design for NFT Channel

Material Used: Steel-Satin ,   Color Used: Metallic White

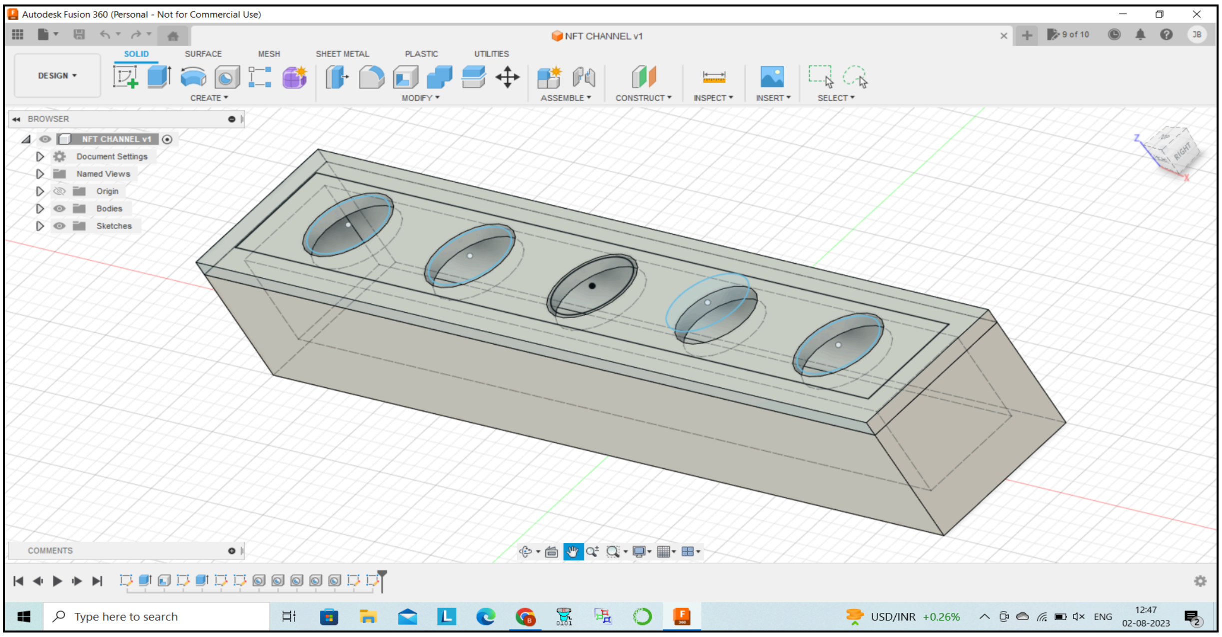
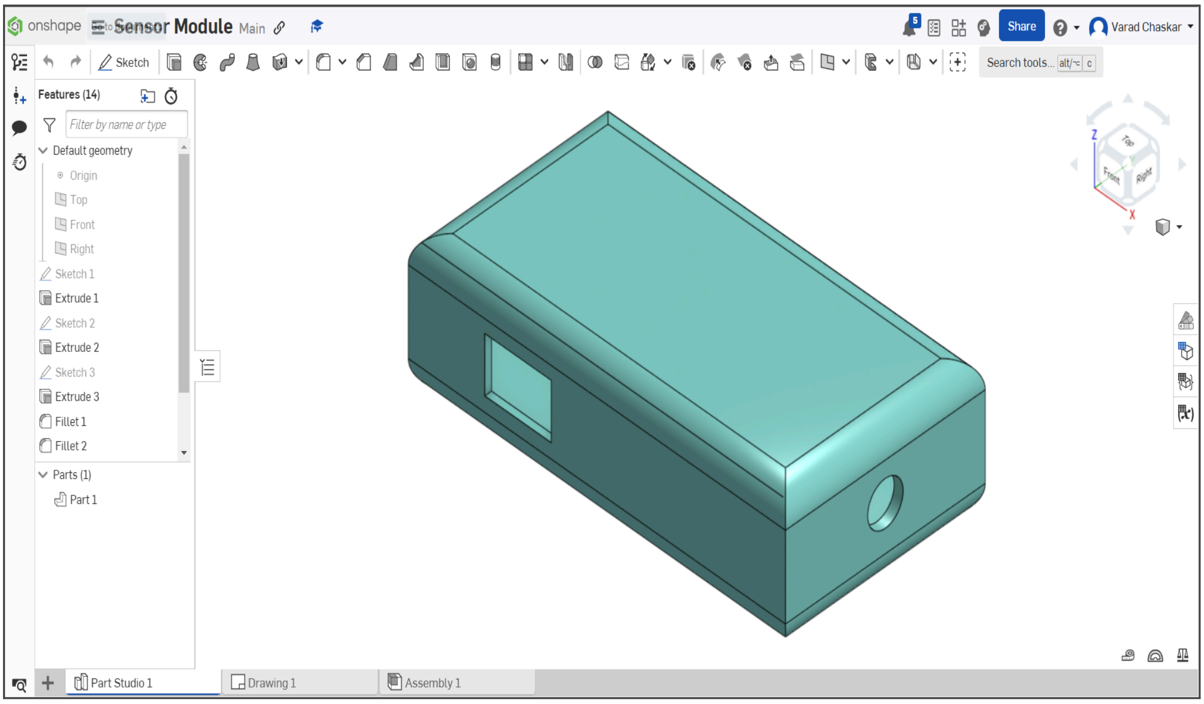


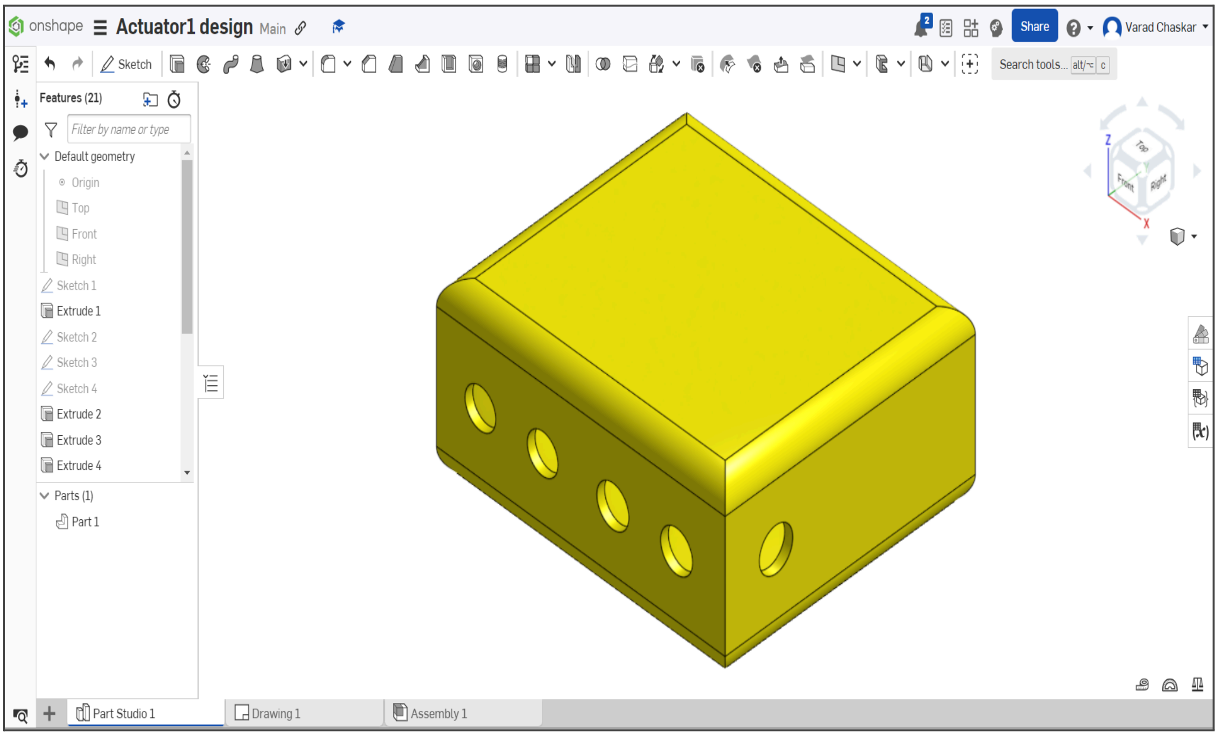
Fig 5.6.4: Enclosure design for NFT Channel on fusion 360

5.6.5 Enclosure design for Sensor Module



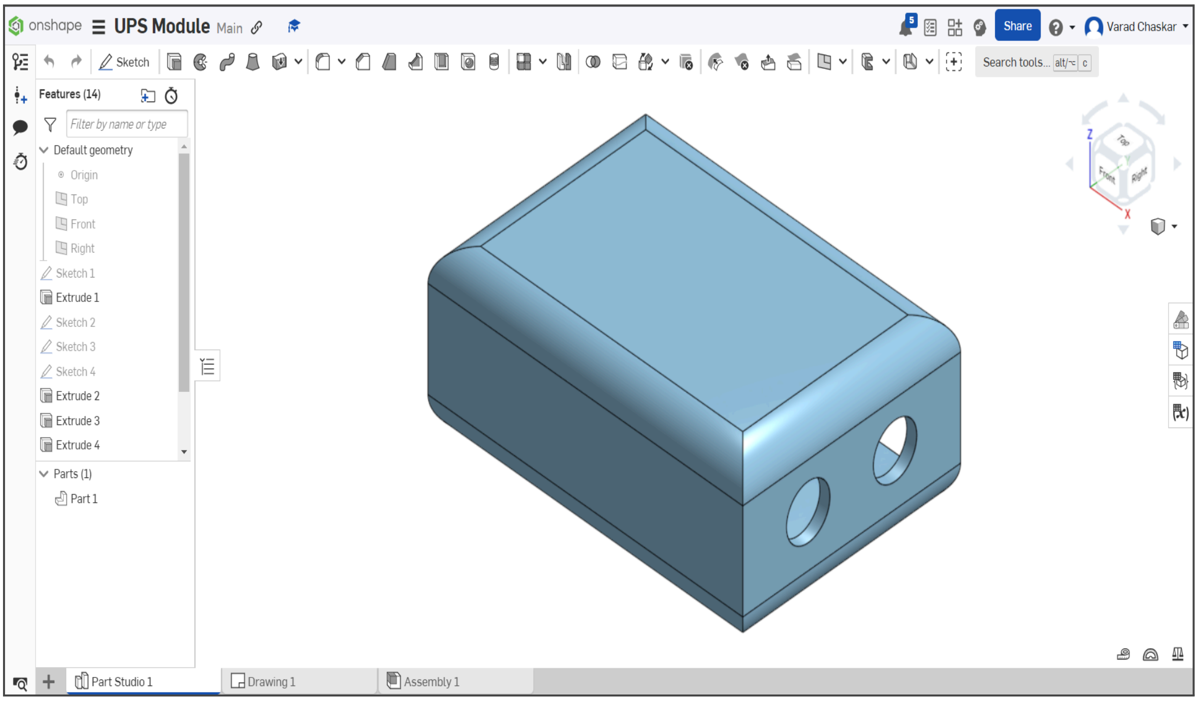
5.6.5 Enclosure design for Sensor Module on OnShape

5.6.6 Enclosure design for Actuator Module



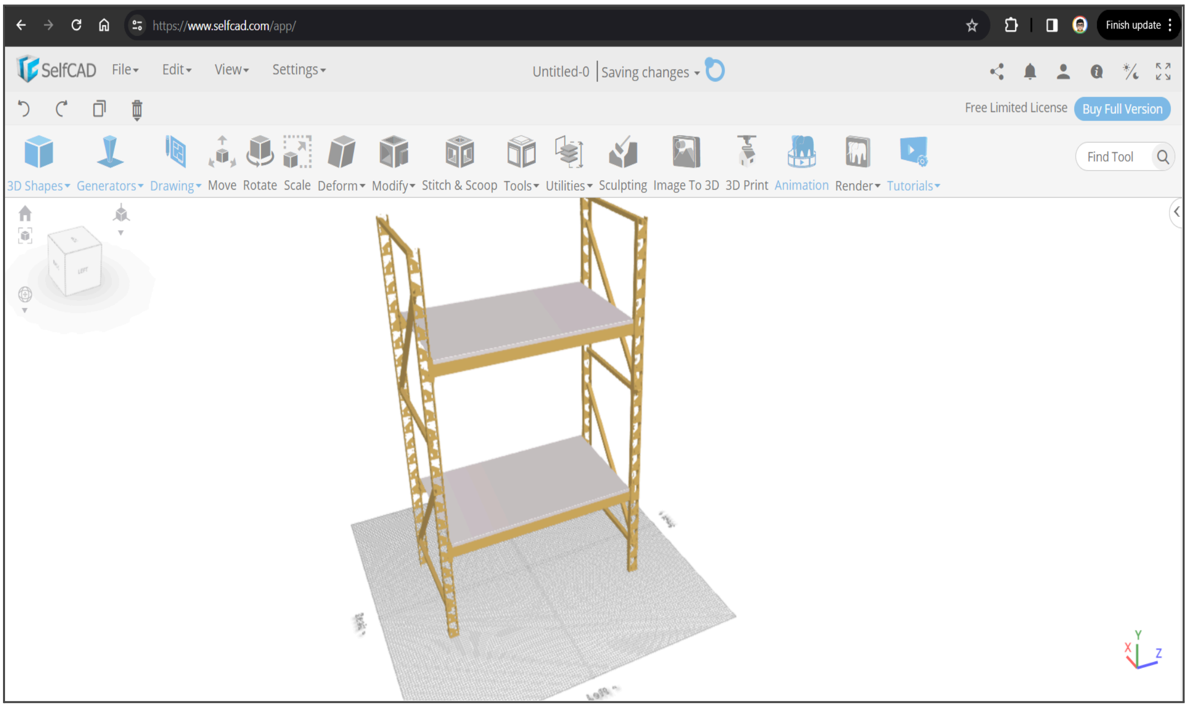
5.6.6 Enclosure design for Actuator Module on OnShape

5.6.7 Enclosure design for UPS Module



5.6.7 Enclosure design for UPS Module on OnShape

5.6.8 Enclosure design for Stack



5.6.8 Enclosure design for Stack on SelfCAD

5.7 Bill of Materials

Sr. No.	Label	Part Type	Part Description	Qty/ Set	Unit Price (INR)	Total Price (INR)
1	R1	KY-018 Photoresistor Module	output type analog; pins 3;	1	22	22
2	U1	Humidity and Temperature Sensor DHT11	±5%RH ±2°C; 20-95%RH; 3.3-5.5V DC;	1	58	58
3	U2	Water Level Sensor	-	1	21	21
4	U3, U4	WeMos D1 Mini	no headers; ESP-8266EX	2	152	304
5	U5, U6	L293D	L293D; package THT	2	21	42
6	U7, U8	Sharp PC817	package THT	2	6.5	13
7	U9	ESP 32 CAM	OV2640 Module 2MP	1	439	439
8	U10	1 channel Relay Module	5V SPDT	1	33	33
9	X1 to X12	USB Connectors	target USB-A;	12	5	60
		Hardware Cost				**992**

5.7.1. Bill of the Setup

Sr. No.	Components	Qty	Unit Price	Total Price
1	UV light	1	1799	1799
2	Air Pump	1	499	499
3	Water Pump	1	90	90
4	Fan	1	240	240
5	Hydroponic Starter Kit	2	1599	3198
	Setup Cost			**5826**
	Total Cost			**6818**

CHAPTER 6

SOFTWARE SYSTEM DESIGN

CHAPTER 6

SOFTWARE SYSTEM DESIGN

6.1 Flow Chart of Whole System

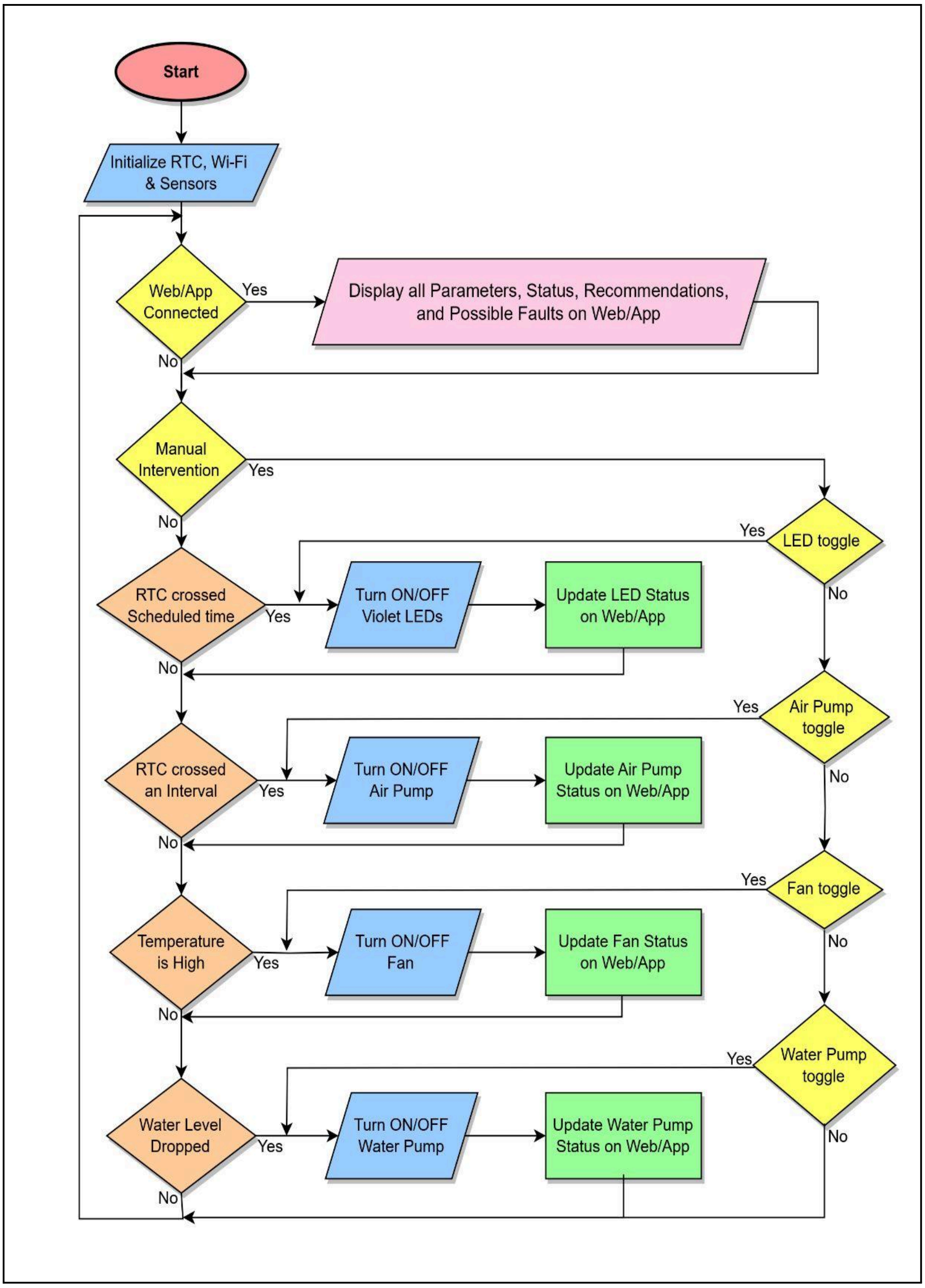
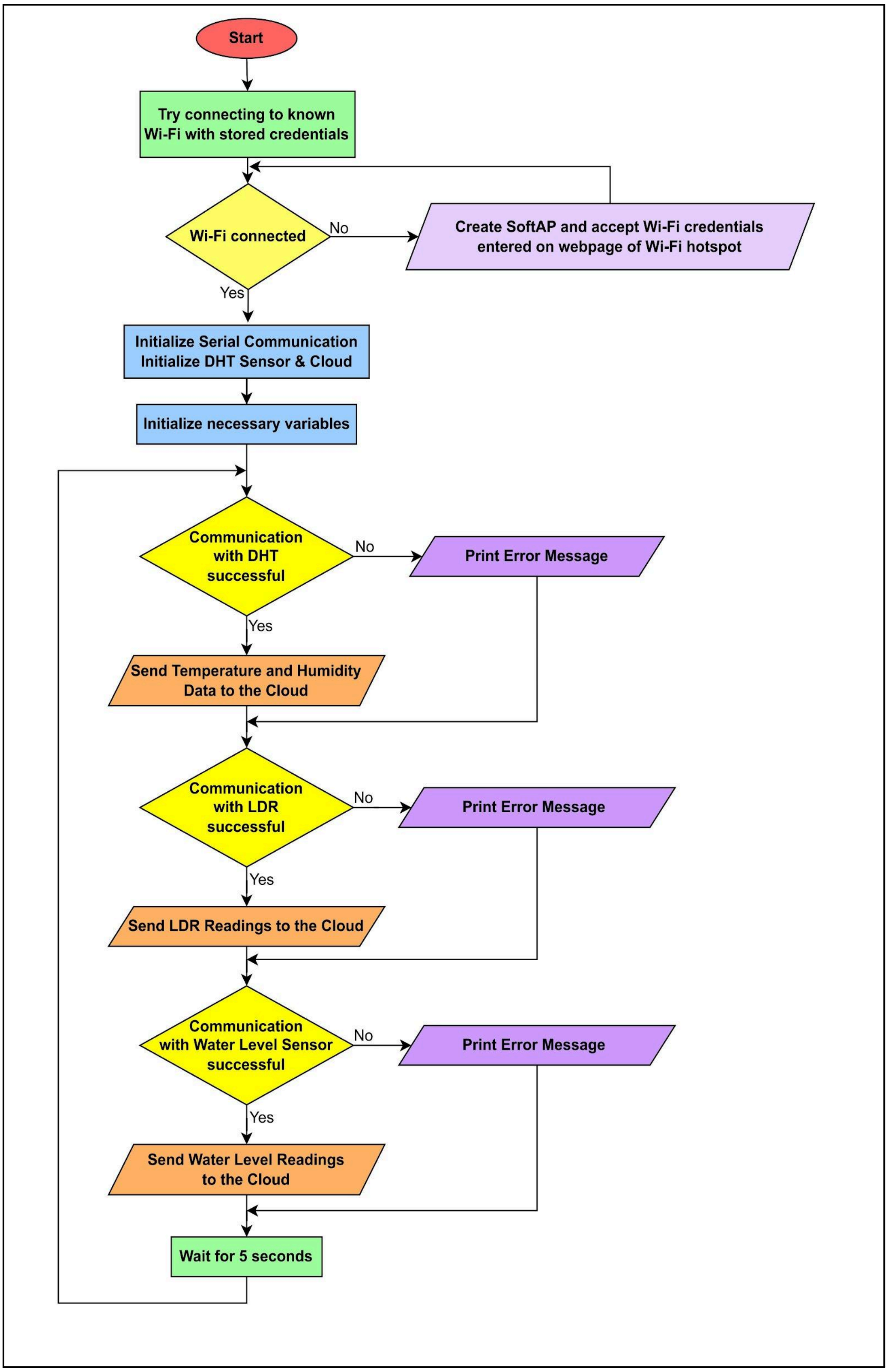


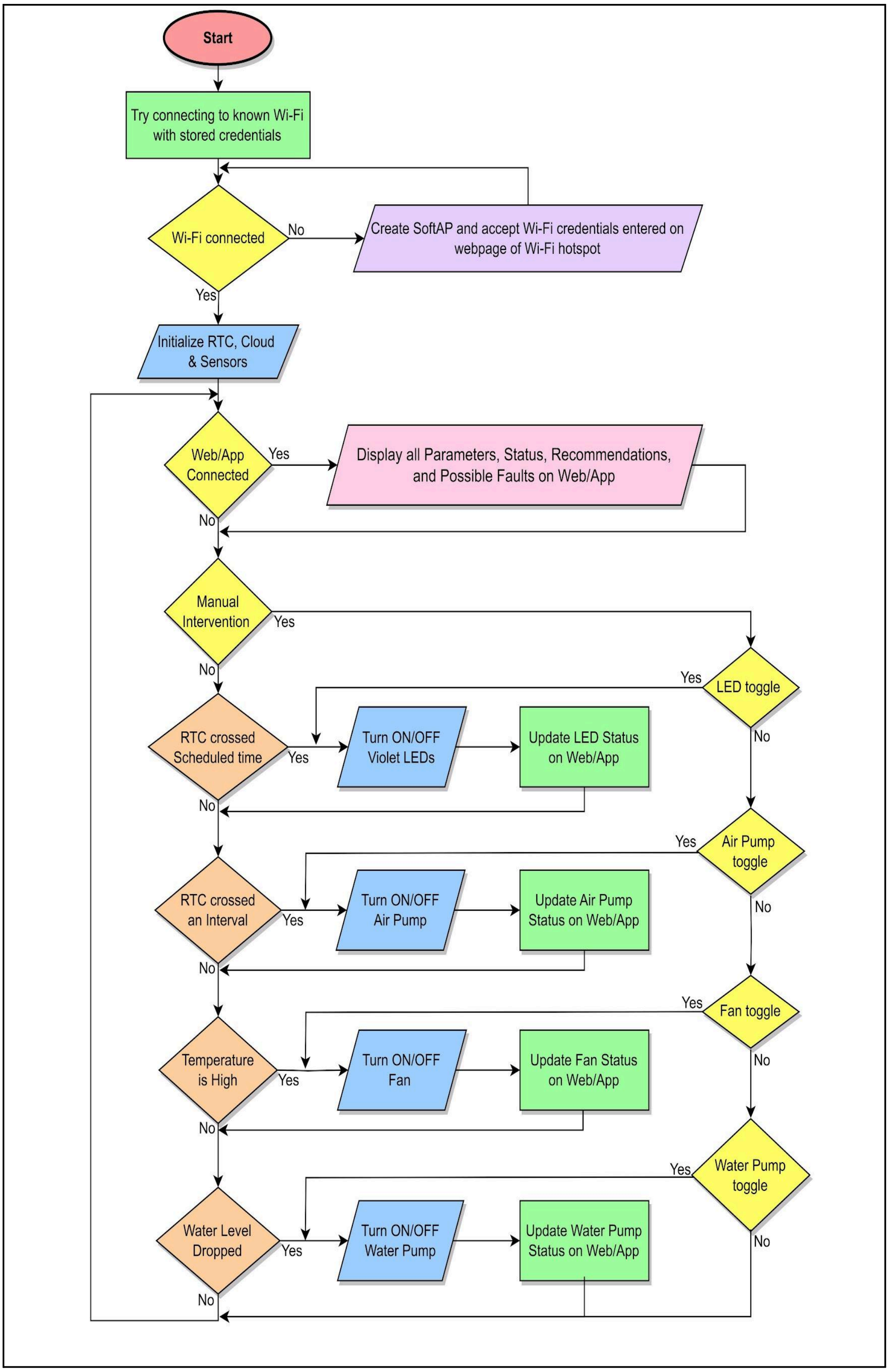
Fig. 6.1: Flowchart of the system

6.2. Flow Chart of the Sensor module



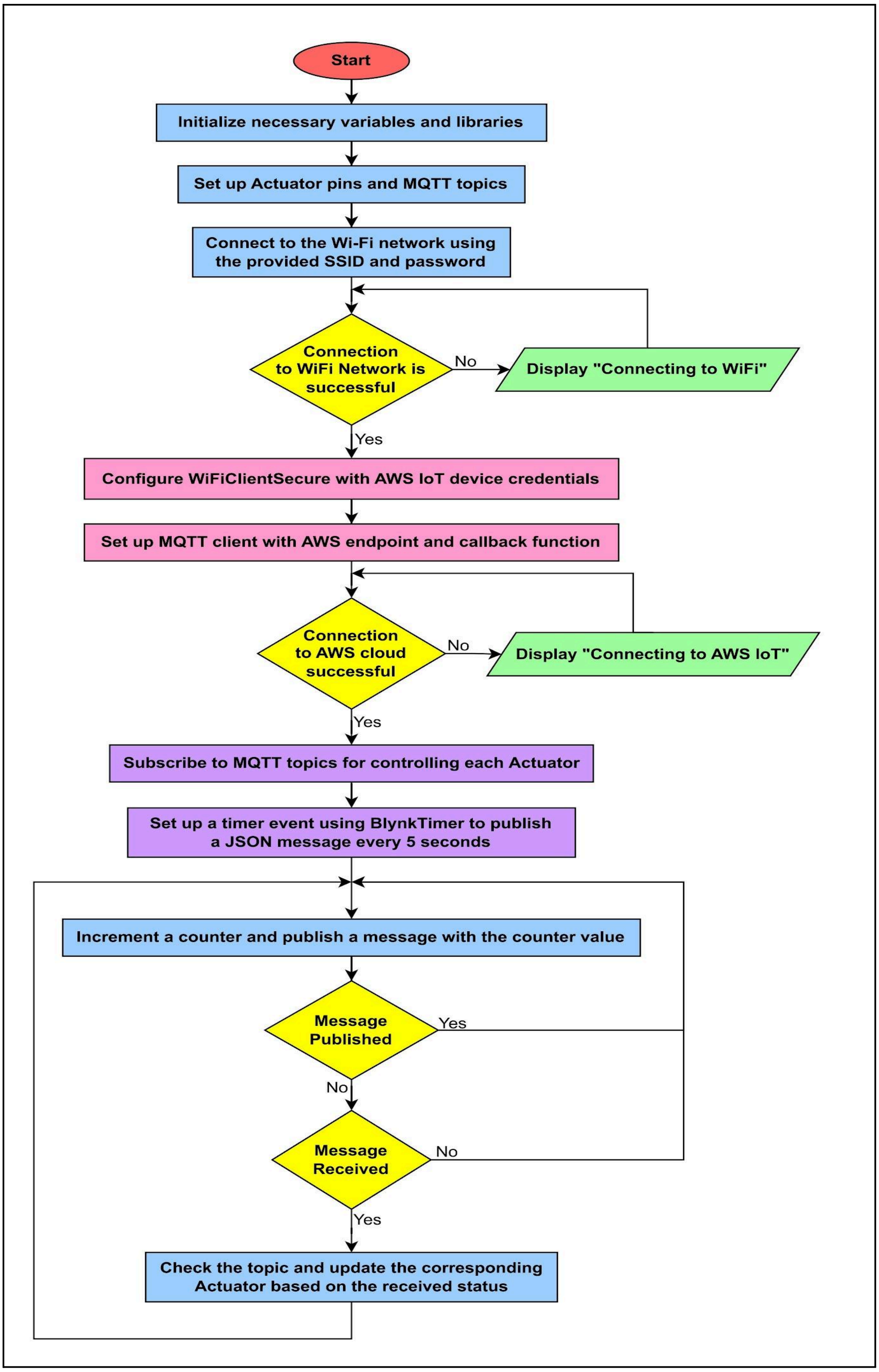
6.2. Flowchart of the Sensor module

6.3. Flow Chart of the Actuator Module



6.3. Flowchart of the Actuator Module

6.4. Flow Chart of AWS MQTT IOT Core



6.4. Flowchart of AWS MQTT IOT Core

CHAPTER 7

EXPECTED RESULTS

CHAPTER 7

EXPECTED RESULTS

1. The Hydroponics Based Precision Farming With Feature Optimization effectively monitors and controls environmental factors, leading to **improved plant growth, health, and yield.**

2. The **system operates reliably and accurately, ensuring minimal manual intervention** and reduced human effort.

3. The user interface, including the website and mobile application, enables **easy and intuitive remote control, monitoring, and alerts.**

4. The machine learning algorithms **optimize system operations based on collected data,** improving resource management and productivity.

5. The research findings provide **insights into the effects of TDS on plant growth, air pump duration, UV light duration, and water tank refill time prediction, contributing to knowledge in the field.**

6. The project is completed within the defined **timeline and budget.**

7. Documentation and **user instructions** provide comprehensive guidance for system operation, maintenance, and data optimization.

APPLICATIONS

- **Home gardening**: NFT hydroponics is an ideal method for home gardening, as it allows for year-round cultivation of fresh herbs, vegetables, and fruits. The system can be set up in a small space and can be easily maintained, making it a convenient and cost-effective option for home gardeners.

- **Commercial agriculture**: NFT hydroponics is also used in commercial agriculture for growing crops such as lettuce, herbs, and strawberries. The system is highly efficient, as it requires less water and space compared to traditional farming methods, leading to higher yields and reduced costs.

- **Urban farming**: NFT hydroponics is becoming increasingly popular in urban farming, as it allows for the cultivation of fresh produce in urban areas with limited space. The system can be set up in rooftops, balconies, or indoor spaces, providing a sustainable and efficient method for urban farming.

- **Research and education**: NFT hydroponics is used in research and education to study plant growth and development in a controlled environment. The system allows researchers and students to manipulate the nutrient composition and environmental factors to study the effects on plant growth and development.

Overall, the NFT hydroponics system has a wide range of applications in home gardening, commercial agriculture, urban farming, research and education, and medical cannabis cultivation, making it a versatile and efficient method for indoor plant growth.

CONCLUSION

The Hydroponics Based Precision Farming With Feature Optimization, based on indoor farming with temperature, UV light, water level, and air pump control, has several benefits in addition to faster growth and reduced water consumption. Firstly, the system eliminates the need for large land areas, making it ideal for urban and suburban regions where space is limited. By precisely controlling temperature, light, and water levels, plants receive optimal growing conditions, leading to higher yields and healthier crops. Furthermore, automation reduces the risk of human error, ensuring consistent production to the highest standards.

The Hydroponics Based Precision Farming With Feature Optimization project is a highly effective and efficient system for growing plants. The system can lead to 30 to 50% faster growth than soil-based farming while reducing water consumption by 70-85%. With the entire system operating on its own, there is no need for human intervention, making it an ideal solution for individuals or businesses seeking to maximize crop yields while minimizing labor and resource costs. Moreover, it has been designed for Scaling by utilizing M2M and cloud. Overall, the Hydroponics Based Precision Farming With Feature Optimization project represents a significant advancement in sustainable farming practices, and its potential to revolutionize the agriculture industry cannot be overstated.

REFERENCES

[1] P. Srivani, Y. Devi C. and S. H. Manjula, "A Controlled Environment Agriculture with Hydroponics: Variants, Parameters, Methodologies and Challenges for Smart Farming," 2019 Fifteenth International Conference on Information Processing (ICINPRO), Bengaluru, India, 2019, pp. 1-8, doi: 10.1109/ICInPro47689.2019.9092043.

[2] S. Adhau, R. Surwase and K. H. Kowdiki, "Design of fully automated low cost hydroponic system using LabVIEW and AVR microcontroller," 2017 IEEE International Conference on Intelligent Techniques in Control, Optimization and Signal Processing (INCOS), Srivilliputtur, India, 2017, pp. 1-4, doi: 10.1109/ITCOSP.2017.8303091.

[3] P Sihombing, N A Karina, J T Tarigan and M I Syarif, Automated hydroponics nutrition plants systems using arduino uno microcontroller based on android, 2nd International Conference on Computing and Applied Informatics 2017.Doi :10.1088/1742- 6596/978/1/012014.

[4] M. Fuangthong and P. Pramokchon, "Automatic control of electrical conductivity and PH using fuzzy logic for hydroponics system," 2018 International Conference on Digital Arts, Media and Technology (ICDAMT), Phayao, Thailand, 2018, pp. 65-70, doi: 10.1109/ICDAMT.2018.8376497.

[5] Baddadi, Sara, Salwa Bouadila, Wahid Ghorbel, and AmenAllah Guizani. "Autonomous greenhouse microclimate through hydroponic design and refurbished thermal energy by phase change material." Journal of Cleaner Production 211 (2019): 360-379.

[6] Kaewwiset, T. and T. Yooyativong (2017). Estimation of electrical conductivity and pH in hydroponic nutrient mixing system using Linear Regression algorithm. 2017 14th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)

[7] M. F. Saaid, A. Sanuddin, M. Ali and M. S. A. I. M. Yassin, "Automated pH controller system for hydroponic cultivation," 2015 IEEE Symposium on Computer Applications & Industrial Electronics (ISCAIE), Langkawi, Malaysia, 2015, pp. 186-190, doi: 10.1109/ISCAIE.2015.7298353.

[8] Wheeler, Raymond M. "NASA's controlled environment agriculture testing for space habitats." (2014).

[9] G. Dbritto and S. Hamdare, "An AI Based System Design to Develop and Monitor a Hydroponic Farm," 2018 International Conference on Smart City and Emerging Technology (ICSCET), Mumbai, India, 2018, pp. 1-5, doi: 10.1109/ICSCET.2018.8537317.

[10] Helmy, M. G. Mahaidayu, A. Nursyahid, T. A. Setyawan and A. Hasan, "Nutrient Film Technique (NFT) hydroponic monitoring system based on wireless sensor network," 2017 IEEE International Conference on Communication, Networks and Satellite (Comnetsat), Semarang, Indonesia, 2017, pp. 81-84, doi: 10.1109/COMNETSAT.2017.8263577.

[11] A. Phutthisathian, "Ontology-Based Nutrient Solution Control System for Hydroponics," no. 1, pp. 258–261, 2011.

[12] J. A. Asumadu, B. Smith, N. S. Dogan, P. A. Loretan, and H. Aglan, "Microprocessor-based instrument for hydroponic growth chambers used in ecological life support systems," in Instrumentation and Measurement Technology Conference, 1996. IMTC-96. Conference Proceedings. Quality Measurements: The Indispensable Bridge between Theory and Reality., IEEE, 1996, pp. 325-329 vol.1.

[13] Desta Yolanda, "Implementation of Real-Time Fuzzy Logic Control for NFT-Based Hydroponic System on Internet of Things Environment", Institut Teknologi Bandung, 2016.

[14] Harun, Ahmad Nizar, Robiah Ahmad, and Norliza Mohamed. "Plant growth optimization using variable intensity and Far Red LED treatment in indoor farming." In Smart Sensors and Application (ICSSA), 2015 International Conference on, pp. 92-97. IEEE, 2015.

[15] G. Saha, "Technological Influences on Monitoring and Automation of the Hydroponics System," 2021 Innovations in Power and Advanced Computing Technologies (i-PACT), Kuala Lumpur, Malaysia, 2021, pp. 1-8, doi: 10.1109/i-PACT52855.2021.9696519.

[16] S. Fourside. Top-Fed DWC Cannabis Setup Guide - Bubbleponics. Available: http://growweedeasy.com/high-yieldbubbleponics-technique

[17] Kaewwiset, T. and T. Yooyativong (2017). Estimation of electrical conductivity and pH in hydroponic nutrient mixing system using Linear Regression algorithm. 2017 International Conference on Digital Arts, Media and Technology (ICDAMT).

[18] Nwosisi, Sochinwechi, and Dilip Nandwani. "Urban Horticulture: Overview of Recent Developments." In Urban Horticulture, pp. 3-29. Springer, Cham, 2018.

[19] H. Helmy, A. Nursyahid, T. A. Setyawan, and A. Hasan, "Nutrient Film Technique (NFT) Hydroponic Monitoring System," J. Appl. Inf. Commun. Technol., vol. 1, no. 1, pp. 1–6, 2016.

[20] J. A. Asumadu, B. Smith, N. S. Dogan, P. A. Loretan, and H. Aglan, "Microprocessor-based instrument for hydroponic growth chambers used in ecological life support systems," in Instrumentation and Measurement Technology Conference, 1996. IMTC-96. Conference Proceedings. Quality Measurements: The Indispensable Bridge between Theory and Reality., IEEE, 1996, pp. 325-329 vol.1.

[21] T. Nishimura, Y. Okuyama, A. Matsushita, H. Ikeda and A. Satoh, "A compact hardware design of a sensor module for hydroponics," 2017 IEEE 6th Global Conference on Consumer Electronics (GCCE), Nagoya, Japan, 2017, pp. 1-4, doi: 10.1109/GCCE.2017.8229255

[22] F. L. Valiente et al., "Internet of Things (IOT)-Based Mobile Application for Monitoring of Automated Aquaponics System," 2018 IEEE 10th International Conference on Humanoid, Nanotechnology, Information Technology,Communication and Control, Environment and Management (HNICEM), Baguio City, Philippines, 2018, pp. 1-6, doi: 10.1109/HNICEM.2018.8666439.

[23] H. K. Srinidhi, H. S. Shreenidhi and G. S. Vishnu, "Smart Hydroponics system integrating with IoT and Machine learning algorithm,"2020 International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT), Bangalore, India, 2020, pp. 261-264, doi: 10.1109/RTEICT49044.2020.9315549.

[24] Ryu, M.-J. et al. (2014) "Spatial, Vertical, and Temporal Variability of Ambient Environments in Strawberry and Tomato Greenhouses in Winter," Journal of Biosystems Engineering. 한국농업기계학회, 39(1), pp. 47–56. doi: 10.5307/JBE.2014.39.1.047.
http://koreascience.or.kr/article/JAKO201409972440252.pdf

[25] Lee, Chan Kyu, Mo Chung, Ki-Yeol Shin, Yong-Hoon Im, and Si-Won Yoon. 2019. "A Study of the Effects of Enhanced Uniformity Control of Greenhouse Environment Variables on Crop Growth" Energies 12, no. 9: 1749. https://doi.org/10.3390/en12091749
https://www.mdpi.com/1996-1073/12/9/1749

[26] Lee CK, Chung M, Shin K-Y, Im Y-H, Yoon S-W. A Study of the Effects of Enhanced Uniformity Control of Greenhouse Environment Variables on Crop Growth. Energies. 2019; 12(9):1749. https://doi.org/10.3390/en12091749
https://www.mdpi.com/1996-1073/12/9/1749
https://mospi.gov.in/97-environment-statistics.

[27] Khudoyberdiev, A.; Ahmad, S.; Ullah, I.; Kim, D. An Optimization Scheme Based on Fuzzy Logic Control for Efficient Energy Consumption in Hydroponics Environment. Energies 2020, 13, 289. https://doi.org/10.3390/en13020289

[28] Yamaguchi, Satoru, Takuya Motosugi, and Yoshihiko Takahashi. "Battery \ Management for Small Hydroponic Systems and Cultivation Experiments," International Journal of Manufacturing, Materials, and Mechanical Engineering (IJMMME) 11, no.3: 21-36. http://doi.org/10.4018/IJMMME.2021070102 [no need for paper , most taken form abstract

[29] A. Chakraborti, A. Jain, S. Menon and K. Samdani, "A Review of Security Challenges in Home Automation Systems," 2019 IEEE International Conference on System, Computation, Automation and Networking (ICSCAN), Pondicherry, India, 2019, pp. 1-6, doi: 10.1109/ICSCAN.2019.8878722. https://sci-hub.se/10.1109/ICSCAN.2019.8878722

[30] Tyson, R. V., Treadwell, D. D., & Simonne, E. H. (2011). Opportunities and Challenges to Sustainability in Aquaponic Systems. HortTechnology hortte, 21(1), 6-13. Retrieved Sep 15, 2023, from https://doi.org/10.21273/HORTTECH.21.1.6

[31] De Rijck, G., and Schrevens, E. (1998b). Elemental bioavailability in nutrient solutions in relation to precipitation reactions. J. Plant Nutr. 21, 2103–2113. doi: 10.1080/01904169809365547 [no need for this paper, doing a reference of its ref]

[32] Khan, S., Purohit, A., & Vadsaria, N. (2020). Hydroponics: current and future state of the art in farming. Journal of Plant Nutrition, 44(10),1515–1538.doi:10.1080/01904167.2020.1860217
10.1080/01904167.2020.1860217
https://sci-hub.se/https://doi.org/10.1080/01904167.2020.1860217

[33] Brooks, C. 2000. Development of a Semi-automated System for Production of Salad Vegetables for use on Space Station Freedom. In Proceedings of the 13th Annual Conference on Hydroponics. Hydroponic Society of America. San Ramon. CA. ed. D. Schact, 72–6.

[34] Drysdale, A. E., A. J. Hanford. 2002. Advanced Life Support systems modeling and analysis project: Baseline values and assumptions document. NASA-Johnson Space Center F Document No. JSC-47787 (CTSD-ADV-482)

[35] Santos, A. N., E. F. de F. e Silva, G. F. d Silva, J. M. C. Barnab ^ e, M. M. Rolim, and D. d C. Dantas. 2016. Yield of cherry tomatoes as a function of water salinity and irrigation frequency. Revista Brasileira de Engenharia Agrıcola e Ambiental 20 (2):107–12. doi: 10.1590/1807-1929/agriambi.v20n2p107-112

[36] Sevostianov, I., & Melnik, O. (2021). IMPROVEMENT OF HYDROPON INSTALLATIONS. ENGINEERING, ENERGY, TRANSPORT AIC.DOI: 10.37128/2520-6168-2021-4-13
http://tetapk.vsau.org/storage/articles/December2021/yWW9YLhBOPqY4czAYJBO.pdf

[37] Lakshmanan, R., Djama, M., Perumal, S.K., & Abdulla, R.M. (2020). Automated smart hydroponics system using internet of things. International Journal of Electrical and Computer Engineering (IJECE). DOI:10.11591/IJECE.V10I6.PP6389-6398 Corpus ID: 226192620 https://ijece.iaescore.com/index.php/IJECE/article/download/20870/14427

[38] Saha, Geetali. “Technological Influences on Monitoring and Automation of the Hydroponics System.” 2021 Innovations in Power and Advanced Computing Technologies (i-PACT) (2021): 1-8. DOI:10.1109/i-PACT52855.2021.9696519 Corpus ID: 246683063 [link not found, info taken from abstract]

[39] A. Ani and P. Gopalakirishnan, "Automated Hydroponic Drip Irrigation Using Big Data," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 370-375, doi: 10.1109/ICIRCA48905.2020.9182908.

[40] S. M et al., "Analysis of Hydroponic System Crop Yield Prediction and Crop IoT-based monitoring system for precision agriculture," 2022 International Conference on Edge Computing and Applications (ICECAA), Tamilnadu, India, 2022, pp. 575-578, doi: 10.1109/ICECAA55415.2022.9936473.
[need to get this from library]

[41] H. K. Srinidhi, H. S. Shreenidhi and G. S. Vishnu, "Smart Hydroponics system integrating with IoT and Machine learning algorithm," 2020 International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT), Bangalore, India, 2020, pp. 261-264, doi: 10.1109/RTEICT49044.2020.9315549.

[42] Susanto, F. ., Suryani, N. K. ., Darmawan, P., Prasiani, K., & Ramayu, I. M. S. (2021). Comprehensive Review on Automation in Hydroponic Agriculture Using Machine Learning and IoT. RSF Conference Series: Engineering and Technology, 1(2), 86–95. https://doi.org/10.31098/cset.v1i2.479 https://proceeding.researchsynergypress.com/index.php/cset/article/download/479/529