SMART HYDROPONIC SYSTEM

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A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronic Engineering of BRAC University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

Department of Electrical and Electronic Engineering
BRAC University
February, 2023

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Academic Technical Committee (ATC) Panel Members:

Dr. Md. Mosaddequr Rahman, (Chair)
Professor. and Chairperson,
Department of EEE, BRAC University

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Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is my/our own original work while completing degree at BRAC University.

2. The Final Year Design Project (FYDP) does not contain material previously published or

written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.

4. I/We have acknowledged all main sources of help.

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Approval

The Final Year Design Project (FYDP) titled "Smart Hydroponic System" submitted by

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3. Azmin Akter Nipa (ID- 18121079)
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of Fall,2022 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering on 15th December, 2022.

Examining Committee:

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Dr. Md. Mosaddequr Rahman,
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Final Year Design Project
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Ethics Statement

Plagiarism Boundary is strictly maintained. It was only 14%

Abstract

Agriculture is the key of our countries development and hydroponic system has added up a new scope on that development. Hydroponic system is a new addition of the agriculture industry which has created an immensely enhancement all over the world. Hydroponic is a modern cultivation system where no soil requires. It is basically a cultivation process where no soil use. It has created a big revolution already. Now our ambition was to make it more convenient with the control of some electrical parameters to make it smart. In our project we have developed a hydroponic structure with an electrical part that controls the pH of the nutrient, EC, TDS, Air temperature, Water temperature and the nutrient flow. All in all, it completes all the data that a hydroponic structure requires. Using NFT (nutrient flow technique) system in our hydroponic structure we used the Lettuce as our plant. It took 45 days to grow. Lastly, we connect our system to be stored all the data and also monitored with an IOT based application.

Keywords:

Hydroponic System, Smart Technology, Solar System, Automation, Green Energy

Acknowledgment

We would like to express our sincere appreciation to our Academic Technical Committee (ATC) Chair, Dr. Md. Mosaddequr Rahman, Professor and Chair of the Department of Electrical and Electronic Engineering, BRAC University, as well as to Aldrin Nippon Bobby, Lecturer, Department of Electrical and Electronic Engineering, BRAC University, and last but not the least, Mohaimenul Islam, Lecturer, Department of Electrical and Electronic Engineering, BRAC University. Furthermore, we would like to convey our heartfelt appreciation to Dr. Jahedur Rahman, professor in the department of horticulture with in faculty of agriculture at Shere-Bangla Agricultural University, for his unwavering support and excellent direction throughout our project. We are really appreciative to him. Finally, we would like to express our gratitude to BRAC University for providing us with all the resources required to successfully finish the final year design project.

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List of Acronyms

NFT Nutrient Flow Technique

DFT Deep Flow Technique

EC Electrical Conductivity

PVC Polyvinyl chloride

TDS Total Dissolved Solids

PPM Parts Per Million

GSM Global System for Mobile communication

LCD Liquid-crystal display

LED Light-emitting diode

NREL National Renewable Energy Laboratory

HOMER Hybrid Optimization Model for Multiple Energy Resources

ISO International Organization for Standardization

IEEE Institute of Electrical and Electronics Engineers

Chapter 1: Introduction

1.1 Introduction:

In this chapter we are mainly focused on preliminary topics. In the introductory phase we discuss the problem statement and solution of the problem. Along with that objective, requirements, specifications and criteria have been defined. This chapter focuses on CO1, CO2 and CO10. Therefore, the need of the proposed project is clearly defined here. Also, the requirements of the project and specifications are elaborately discussed.

1.1.1 Problem Statement:

Due to rapid population growth and industrialization trees are cutting simultaneously, the cultivated lands are getting filled up with new industrial or residential buildings. A survey says losing a huge amount of land (3.5-7 billion/year deforestation), constraints from natural calamities and also a proper monitoring system damages the quality & quantity of a typical cultivation system. In this situation we people are having shortage of food. Because our forests are decreasing as a result the animals are dying. However, (3' x 4') of space can grow up to 208 plants, which is the same amount of food as four (8' x 4') outdoor garden beds would produce. Plants also grow up to 2x more quickly with hydroponics versus soil-based gardening.

On the contrary, if we address the population growth and the low consumption of less nutritious food in the citizens, then the implementation of hydroponics farming can have an effective contribution for solving this significant matter. In addition, hydroponic cultivation is using ten times less water than the traditional field crop watering methods. Last but not the least, industry value of this technology is rapidly increasing due to its highly beneficial aspects. This cultivation method gives us an alternative solution to plant vegetables and plants in a very small area but with a huge positive impact.

Hydroponics is basically a unique method to grow plants in a nutrient solution, without using Soil. From two Greek words "Hydro" and "Pons" make the word "Hydroponics" which means water is the labor for the system to produce plants. This cultivation process was introduced first in the nineteenth century (1930) by Professor William Gerick. From that era to this moment Hydroponics technique has proved itself as a remarkable technique as no more traditional methods has been moralized for this cultivation As we know, hydroponics cultivation is a type of hydro culture that ensures to grow healthy plants, crops or micro greens by using mineral and nutrient solutions in water. It can be considered as an art of growing plants in water without soil. While controlling the humidity, temperature, proper pH level of water, water flow of the liquids etc. and many more aspects Now it has become very popular among many of the countries as a new and functional plantation process. Statistics stated that, most hydroponic systems operate automatically to control the amount of water, nutrients and photoperiod based on the requirements of different plants (Resh2013).

1.1.2 Background Study:

To choose the better approach we did different types of analysis

1. Read articles, journals, and research papers

2. Plant visit

3. Survey

1.1.2.1 Read articles, journals, and research papers

We gather knowledge from the articles and from that journal articles and from that we found out the details of the approach's details. And these are:

Here we are using a Drip system to send the nutrient liquid from time to time straight to the roots of the plants while having a right controlled flow through the pump. We have to have a clear eye on the nutrient solution as it is heading straight to the roots of the plants. That is why using a microcontroller-based system that can keep the data of the state of the nutrient liquid via sensors is used here.

As NFT is a continuous cycle of the nutrient water flow here we also have to monitor different aspects of the water. To maintain a healthy environment of the nutrient we need to know how much oxygen, pH, and temperature the water is maintaining. Throughout the cycle and also have to use an air pump to continuously pump air to the tank to keep the cycle ongoing. By adding sensors. NFT (Nutrient Film Technique) based system with a growth chamber is also an NFT system-based approach for a smart hydroponic cultivation system. Here while monitoring for a healthy nutrient solution and water flow. We also want to give the plants a stress-free environment. Therefore, all the sensors for all the aspects of the environment which are needed for plants are added, and also an artificial grow light and humidifier are added to give the plants the necessary light and moisture to have healthy surroundings.

1.1.2.2 Plant Visit

Figure 1.1 NFT Based Hydroponic System

Fig 1.2 Rooftop Hydroponic system

Location: B-1, G-Block, Avenue Road, Mirpur-1

We visit the plant and get ideas from that about the project. Get this information.

1.2.2.3. Data Collection:

Table 1: Data Table

Functional	Non-Functional
* Land	* Pipe (PVC)
* Suitable place	
* 5 types (lettuce, cucumber, tomato, cabbage,)	
* Water pump Motor	
* Sunlight	

* Power source	
* pH level	
* Still Rack	

Table2: Data Table

PVC Pipe	10 feet, 5 feet, 8 feet
Pump	250 watts to 500 watts
Water reservoir, backup battery, Solar panel, shed used	None
Growth Time	90 to 120 days
Plants (lettuce, cucumber, tomato, and cabbage)	Around 300
Plant cap	Height: Width → 1.5'' * 3.0''
Water pump Motor	6 pieces
Area	20-25 feet by 8 feet

1.1.3 Literature Gap:

As for our natural environment, hydroponics farming can prove to be much more efficient in terms of energy-saving and eco-friendliness. Not only does it increase the production of vegetables and plants but also it is efficient for reducing the negative impacts of nature. The hydroponics system has mainly two parts. These are liquid and aggregate systems. Then it has some specific system methods like Water culture system, Ebb and flow system, Deep Flow technique (DFT), Nutrient Film Technique (NFT), Aerologic System.

Here pH level and EC range play an important role for particular crops. To improve vegetable yield and quality (Gouda, 2009) an example has been shown where the yield of tomato under a hydroponic system increased as the EC of the nutrient solution increased from 0 to 3 dSm-1 and decreased as the EC increased from 3 to 5 ds m-1 due to increase of water stress (Zhang et al., 2016). Levels of EC, 1.5, 2, and 3 ds m-1 at vegetative, middle vegetative, and generative phases, respectively, had increased crop height, fruit number, and pepper fresh weight.

1.1.4 Relevance to current and future Industry:

High possibility that says hydroponic advancements will play a role in the field of agriculture by becoming sources of flavorful and fresh product in “food deserts” and making farms, restaurants and cuisine because production growth is huge even in urban areas.

This is the potential promise of hydroponics for the soil-less cultivation of crops in controlled environments. It’s a growing industry. About $9.5 billion in sales is expected to nearly double in the next five years. From concerns about growing food to feed a worldwide population expected to hit 10 billion in the next 30 years. In 2016 the global Hydroponics Market was estimated to cross USD 21203.5 million. Crop like tomato, cucurbits, lettuce & leafy vegetables, peppers, strawberries are mainly being cultivated in hydroponic systems. Hydroponics is becoming more popular option for commercial agriculture, as its technology develop. It uses less land and fewer resources, so the farmers who do not have a huge space can also cultivate as the land requirement is very less. Though hydroponics is water based it uses 90% less water than the traditional methods. It is easy to use with controlled environment agriculture (CEA) technology, which allows the crops to be grown in a controlled and ideal environment. Consumers are becoming increasingly aware of the superiority of quality greenhouse-grown vegetables, and the demand for hydroponics culture is rising in Europe and Asia-Pacific. Weight. Europe is traditionally the largest market that is implementing advanced techniques in hydroponics. Asia Pacific forms the second largest market. Besides, countries that are extremely expert in hydroponic technology are Netherland, Australia, France, England, Israel, Canada and USA.

To attain the most relevant phenomena, we set sort of questions and did a survey. The motive was to have a clear view of what people think about the new idea.

Survey Questions

1. Do you believe hydroponic technology can reduce our county's nutrient food problems?
2. Which design will you choose?
3. How much will you rate the system for handling ease?
4. How much will you rate the system for growing quality crops?
5. How much will you rate the stand and shed for the project?
6. How much will you rate the water reservoir for the project?
7. How much would you rate for a power source (backup) for the project?
8. How much will you rate for a growth light for the project?
9. Is there any procedure you would like to mention?

Survey Results

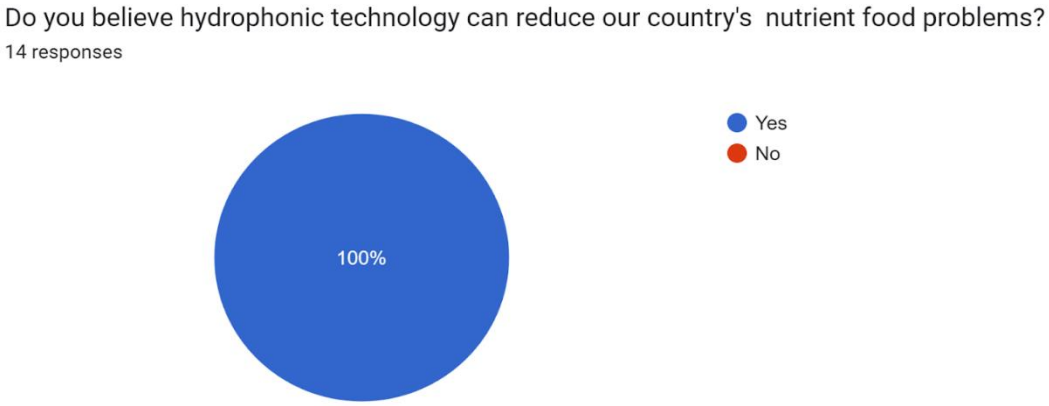

Figure 1.3: Results of hydroponic technology results

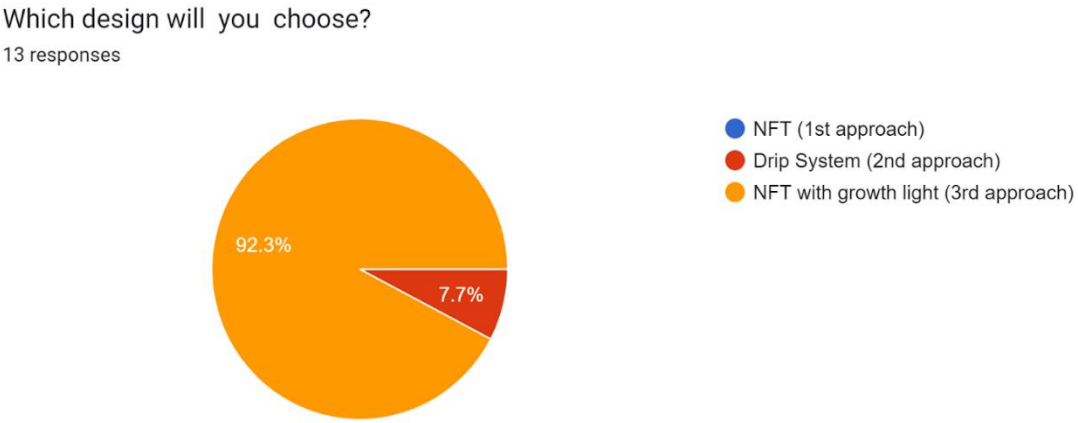

Figure 1.4: Results for system choice

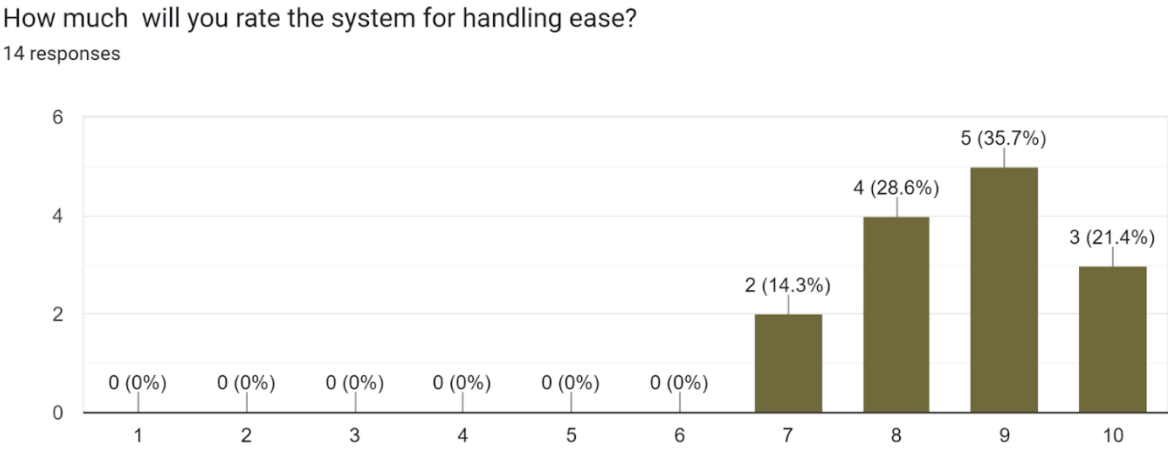

Figure 1.5: Results of system handling easy

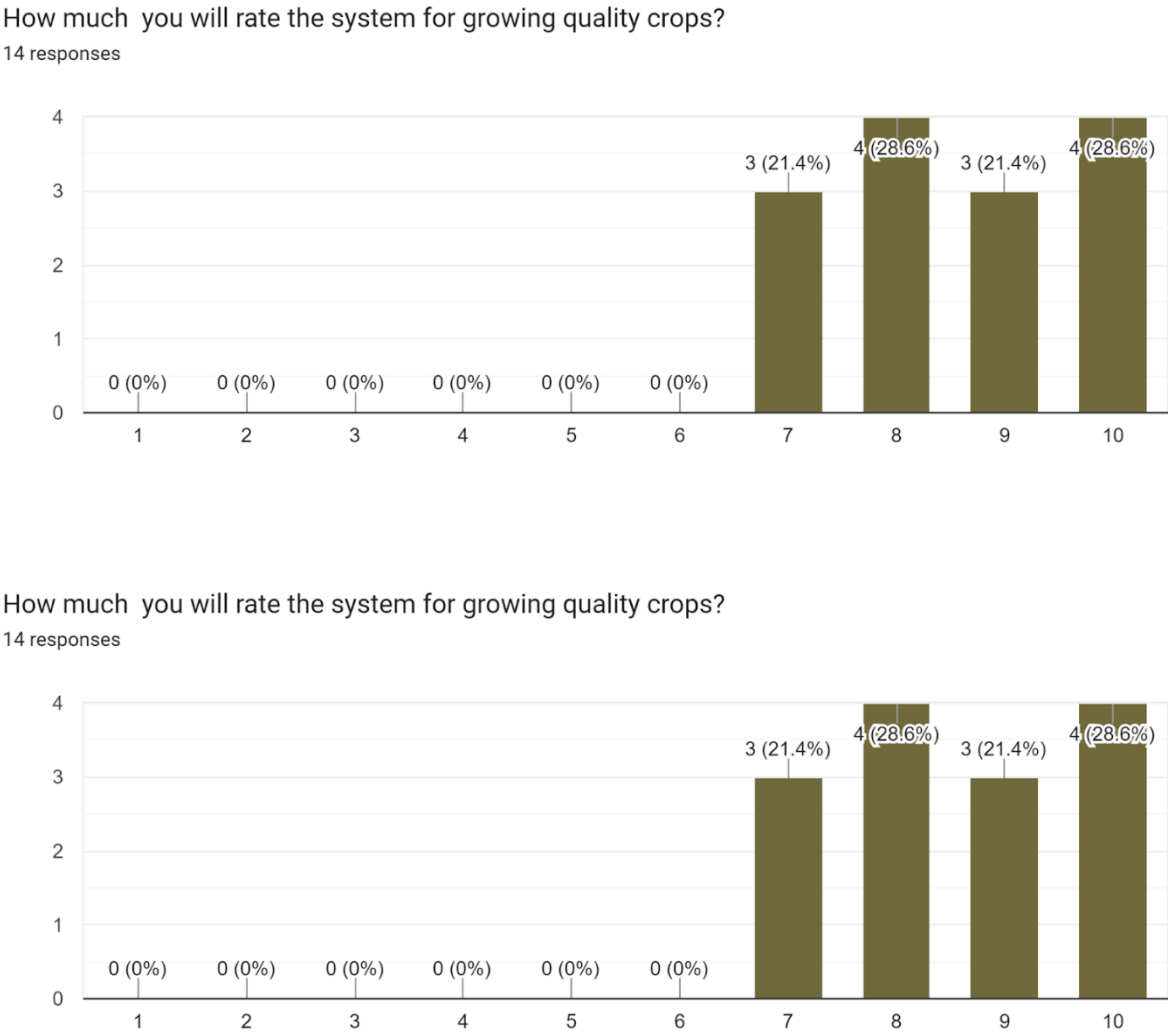

Figure 1.6: Results of growing quality crops.

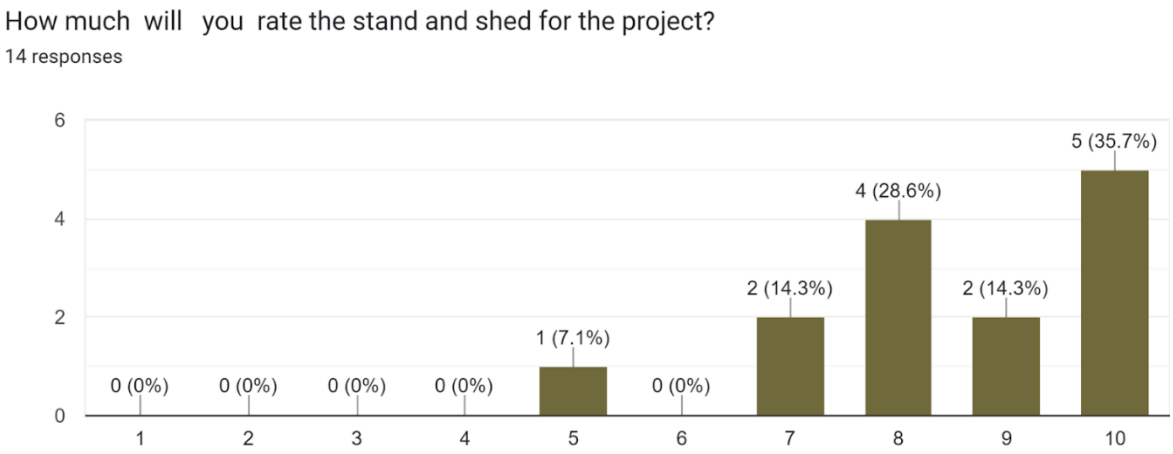

Figure 1.7: Results of the importance of the shed

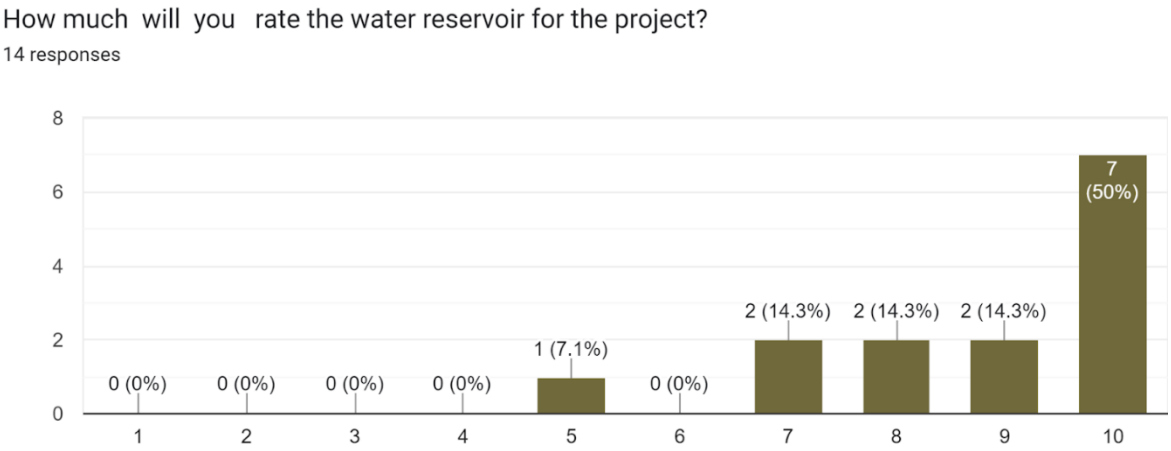

Figure 1.8: Results of having a water reservoir in the project

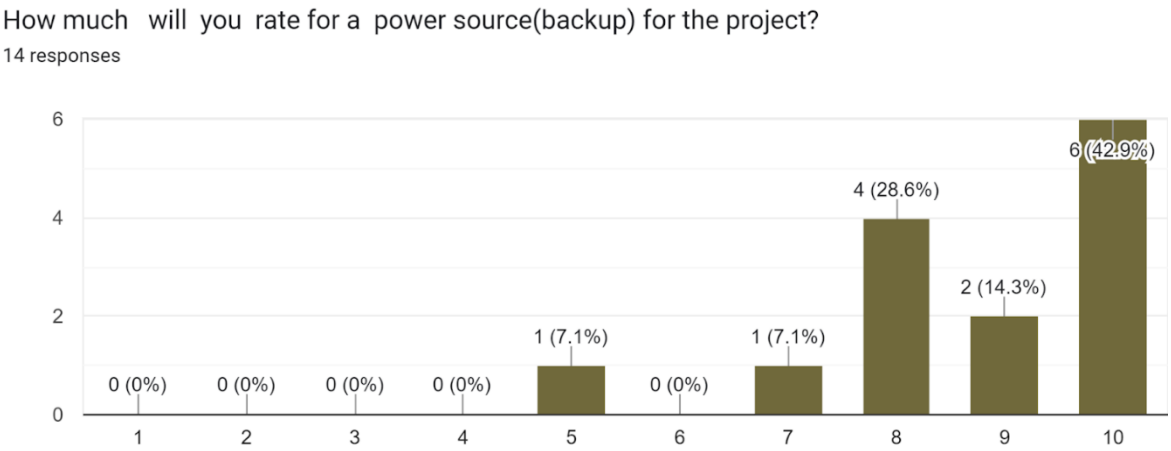

Figure 1.9: Results of the importance of backup power.

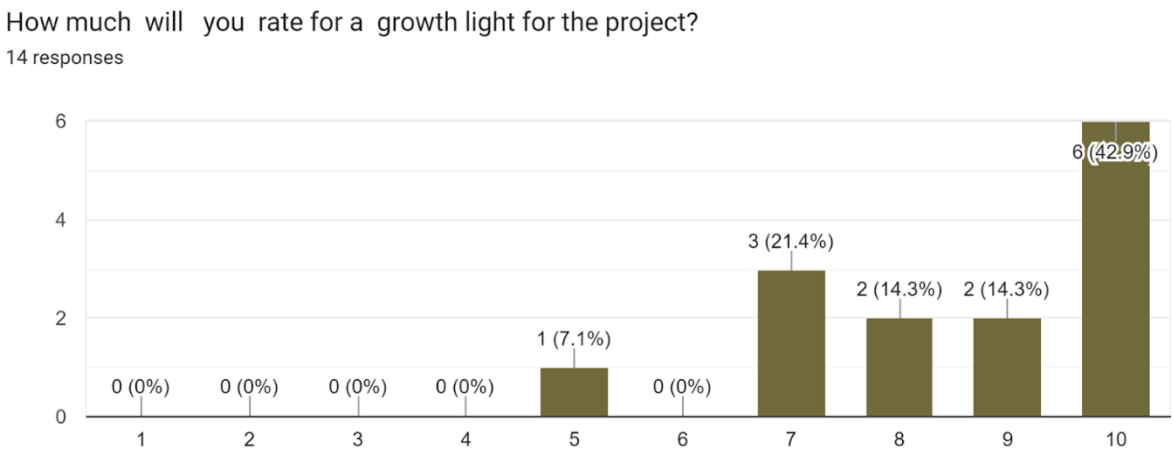

Figure 1.10: Results of having a growth light.

Then, out of all the options, we choose the best one. The methods are: NFT, Drip system, NFT (Nutrient Film Technique) based system with growth chamber. And among all of the options, we chose the NFT (Nutrient Film Technique) based system with a growth chamber as the best option, with which we may proceed.

With this we can see people have ideas about it and also it is relevant with the new generation. Also, they are eagerly accepting the fact to obtain a new solution.

1.2 Objectives, Requirements, Specification and constant:

1.2.1. Objectives:

Our objective is to develop a smart hydroponic system that can omit the need for a traditional Cultivation system. In this project, we want the automatic detection of temperature, EC level, pH level, and humidity. Moreover, we want to analyze the needs of the system project and meet every requirement. Also want to make the project more feasible and more economically friendly. Last but not least the project will be more environmentally friendly and also ensure the safety of the natural environment as the use of pesticides and harsh chemicals is zero here.

1.2.2 Functional and Nonfunctional Requirements:

Table – 3

Functional	Non-Functional
* Land	* Styrofoam
* Suitable place	* Pipe (PVC)
* Seeds (Strawberry, lettuce)	* Digital Storage System.

* Water pump and reservoir	
* Sunlight	
* Power source	
* pH level	
* Water Temperature (20-25°C)	
* Water flow rate (1 to 2 liters per minute)	
* TDS (600 ppm-1000 ppm)	

1.2.2 Specifications:

Table-4:

Area	'9* 7.5'
Sunlight	12 to 13 hours a day
Installation space	Farm
Plants (Lettuce)	45 pieces
PVC Pipe	Different Measurement
Pump	65 watts
Solar panel	20 watts
Growth Time	45 to 60 days

The area is required about ('9* 7.5') for this cultivation process. A great advantage in this process is that we need less area than the traditional system. About 12 feet area of any land will be enough for the construction of the system. As it requires less area, we can also do hydroponics on our rooftop, balcony or in a farm. For the project design, we must require some lettuce plants. We assume 45 pieces of the lettuce plant. We need a pump of about 65 watts. For the water supply we need a pipe of about ½''. We need a solar panel for an effective and efficient purpose as electricity efficiency is a must for this system. For the cultivation of lettuce, we need approximately 45 to 60 days.

1.2.3 Technical and Non-technical consideration and constraint in design process:

Table 05:

Technical	Non-Technical
Electricity supply: To build up hydroponics on the rooftop may face electricity problems as our rooftop may not have electricity facilities.	**High-cost budget:** This cultivation process is very costly. For the design of this system and applying the smart storage system, a high budget is required.
	Restrictions on space: As hydroponics requires less area and can build up on rooftops or balconies a restriction can be introduced by the owner. So, for the cultivation of rooftop permission should be taken from the owner.

1.2.4 Applicable compliance, standards, and codes:

Table 06:

No	Standard Name	Definition
IEEE 2778-2020	IEEE Guide for Solar Power Plant Grounding for Personnel Protection	This guide is primarily concerned with the grounding system design for photovoltaic solar power plants that are utility-owned and/or utility-scale (5 MW or greater). The focus of the guide is on differences in practices from substation grounding as provided in IEEE Stud 80. This guide is not intended for the substations to interconnect the plant; however, if the substation is included within the plant, portions of this guide may be applicable. Similarly, this guide does not directly cover small-scale solar power plants (such as rooftop type systems), substation grounding, or lightning protection.[13]
ISO 22000	FOOD SAFETY MANAGEMENT	Whatever their size, or product, all food producers have a responsibility to manage the safety of their products and the well-being of their consumers.[14]
ISO 65.020.20	PLANT GROWING	INCLUDING HORTICULTURE, FLORICULTURE, SEEDS, AND PLANT DISEASES.[15]
ISO 5526:1986	Cereals, pulses, and other food grains — Nomenclature	Lists the botanical names of 59 main species. It also lists their common names in English, French, and Russian. The common names are listed alphabetically in the index. 21 most commonly met synonyms of the botanical names are indicated in an annex.[16]
FSSC 22000	FSMS and Quality	The Food Safety System Certification 22000 (FSSC 22000) offers a complete certification Scheme for the auditing and certification of Food Safety Management Systems (FSMS).[17]

1.3 Summary of the proposed project:

Our project has the motive to enlarge the area in electrical and electronic concepts in the area of agricultural field. It lightens up the modern cultivation system more efficiently. The effectiveness of the functionality of the systems are many and reliable. With the project we can connect to modernization with a vast new scope.

1.4 Conclusion:

Hydroponic is definitely a promising strategy because of its unique feature. It has a high intention to enlarge the modernization. Undoubtedly, it has the effectiveness to be the future cultivation system as it is very much popular in the commercial industry.

Chapter 2: Project design Approach

2.1 Introduction

In this chapter, we will describe how we selected our approaches for the project. Basically, after doing lots of research, survey, collecting data we select the techniques. Then we develop our approaches.

2.2 Identify multiple design approach

We identify three approaches from our background research. And they are:

1. NFT System
2. Drip system
3. Deep cultured water-based system.

2.3 Describe multiple design approach

Approach 1:

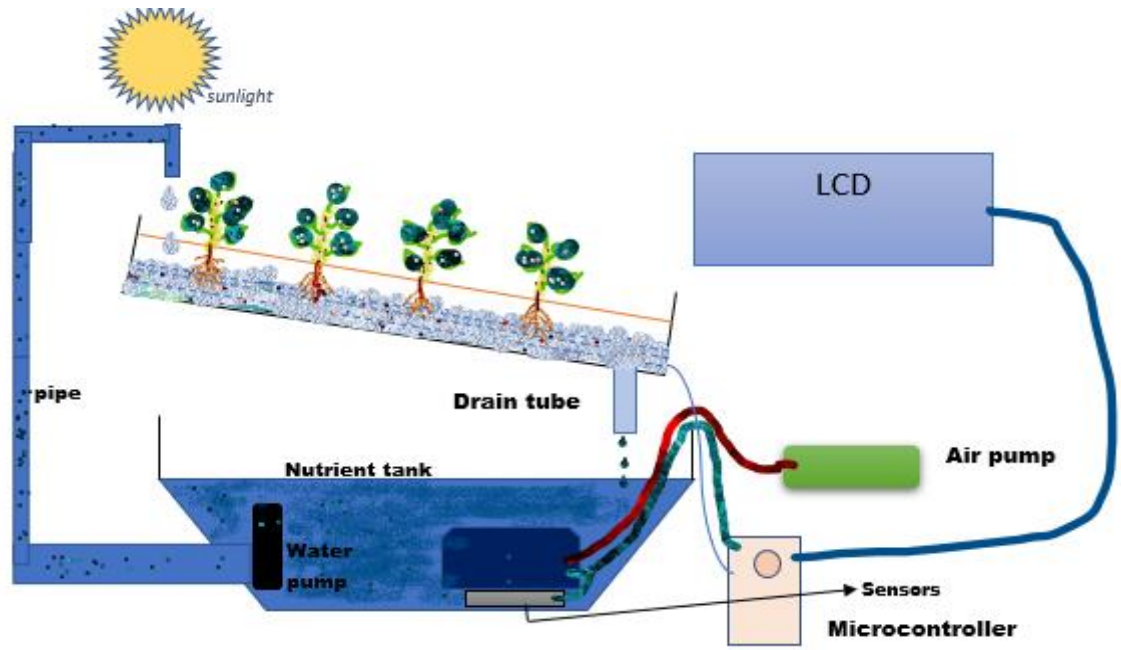

Figure 2.1.1: NFT (Nutrient Film Technique) based hydroponic system

As NFT is a continuous cycle of the nutrient water flow here we also have to monitor different aspects of the water. To maintain a healthy environment of the nutrient we need to know how much oxygen, pH, and temperature the water is maintaining. throughout the cycle and also have to use an air pump to continuously pump air to the tank to keep the cycle ongoing. By adding sensors and having the data and knowing the current state of the water health, we can also control the air pump to have suitable water flow, time to time as needed by using a microcontroller.

Approach 2:

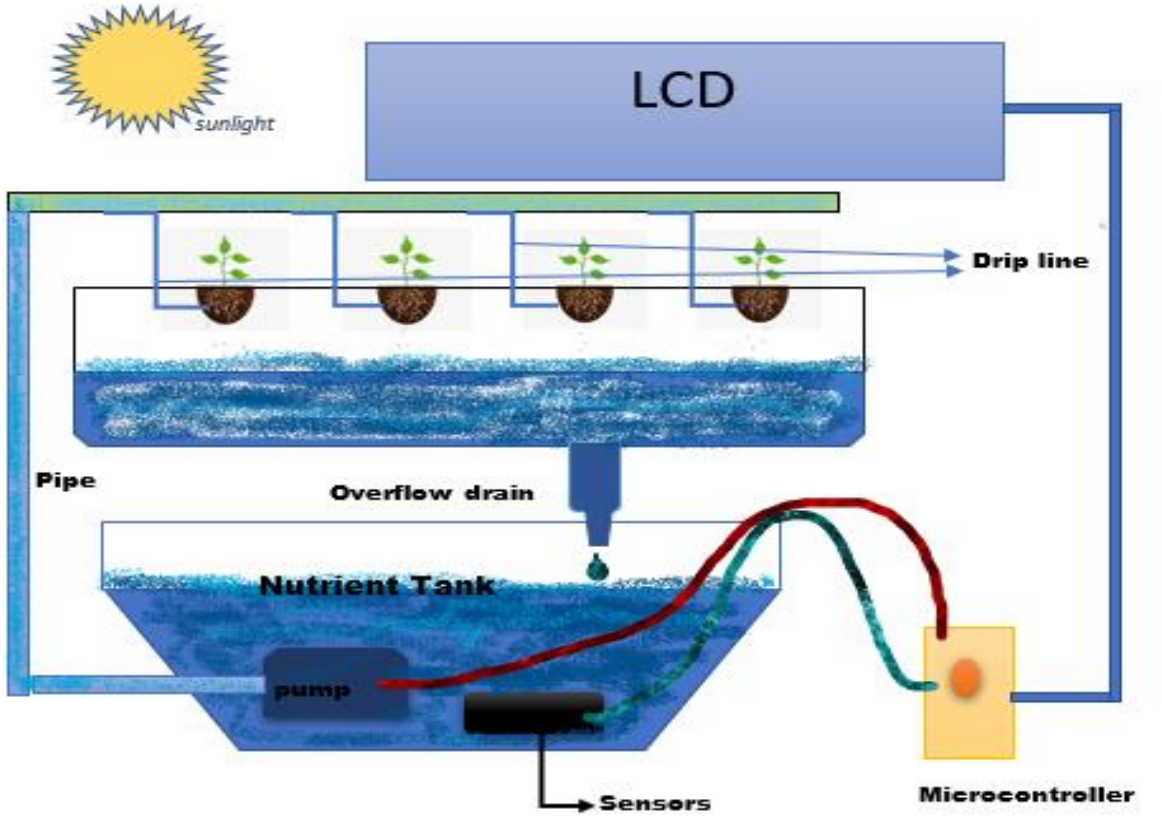

Figure 2.2.2: Drip System-based hydroponic system.

Here we are using a drip system to send the nutrient liquid from time to time straight to the roots of the plants while having a right controlled flow through the pump. We have to have a clear eye on the nutrient solution as it is heading straight to the roots of the plants. That is why using a microcontroller-based system that can keep the data of the state of the nutrient liquid via sensors is used here.

Approach 3:

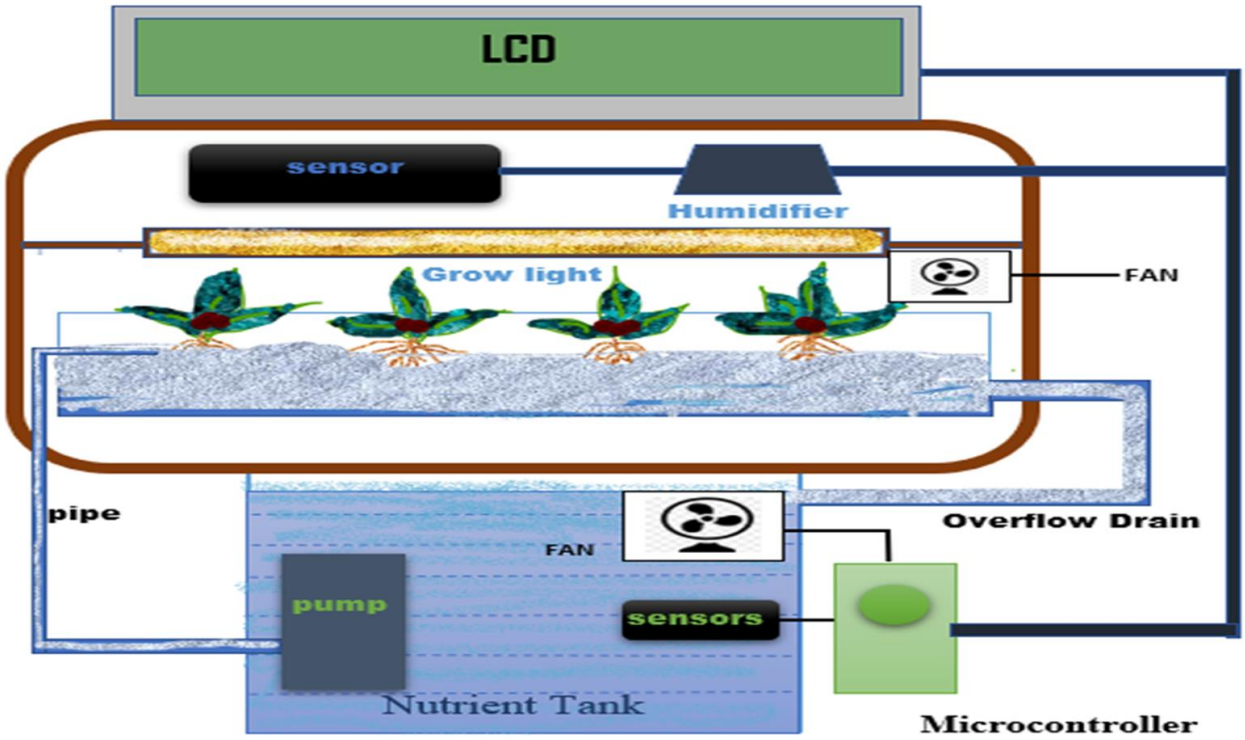

Figure 2.2.3: NFT (Nutrient Film Technique) based system

In this approach, we are having an NFT-based hydroponic system that will have an additional growth chamber. Firstly, in the nutrient tank, we have a pH, turbidity, and temperature sensor that will update the situation of the nutrient continuously through LCD. Moreover, the temperature will be kept from 25-20°C by a Fan. As NFT is a continuous cycle it is crucial to have a clean and prominent nutrient flow to the plant's roots. Then in the growth chamber, we have a growth light for the popper light amount for the plant, a fan to keep the environment cool, and also a humidifier which will keep 75% to 55% humidity percentage for the plants to have a prominent environment.

2.4 Analysis of multiple design approach

Here we are using a Drip system to send the nutrient liquid from time to time straight to the roots of the plants while having a right controlled flow through the pump. We have to have a clear eye on the nutrient solution as it is heading straight to the roots of the plants. That is why using a microcontroller-based system that can keep the data of the state of the nutrient liquid via sensors is used here.

As NFT is a continuous cycle of the nutrient water flow here we also have to monitor different aspects of the water. To maintain a healthy environment of the nutrient we need to know how much oxygen, pH, and temperature the water is maintaining. Throughout the cycle and also have to use an air pump to continuously pump air to the tank to keep the cycle ongoing. By adding sensors

NFT (Nutrient Film Technique) based system with a growth chamber is also an NFT system-based approach for a smart hydroponic cultivation system. Here while monitoring for a healthy nutrient solution and water flow. We also want to give the plants a stress-free environment. Therefore, all the sensors for all the aspects of the environment which are needed for plants are added, and also an artificial grow light and humidifier are added to give the plants the necessary light and moisture to have healthy surroundings.

2.5 Conclusion:

In this chapter we discuss our multiple approaches. We design our approaches block diagram and describe its working functions.

Chapter 3: Use of Modern Engineering and IT Tool. [CO9]

3.1 Introduction:

In this part of our discussions, we have stated the IT tools of our simulations. We have developed the multiple approaches for the design simulations as well as the approach simulations. Firstly, we have chosen the IT software by putting them in some criteria. After that we see the use of the IT tools.

3.2 Select appropriate engineering and IT tools:

Designing Tools:

The objective of project design is to give different ways of thinking from a real perspective

Table-07: Design tools comparison

Functions/ Tools name	Illustrator	Blender	SketchUp Pro 2021
Software Skills and training	High	Medium	Low
Design Model Availability	High	Medium	High
3D Design Perspective	Hard	Below Average	Most User Friendly
Storage Capacity	High	Medium	Very Low
Installation Process	Hard	Average	Easy

In the contemporary age, we have the ability to employ a variety of design tools to obtain the actual scenario of our project, which aids in its development in accordance with our plan. Most excitingly, this tool selection procedure makes it simple to validate both our calculations and our project.

For our design work, we used a variety of technologies, including Illustrator, Blender, and SketchUp Pro 2021. Although all of these programs are adept at design, we must choose the one that will serve our needs the best. First of all, compared to Blender, Illustrator's software abilities and initial training are fairly difficult, whereas SketchUp Pro 2021 is quite simple to understand after watching a brief tutorial lesson. Moreover, SketchUp Pro 2021 has the most design model availability as per our requirements which is another important factor in choosing this program for design. Additionally, 3D designs always offer a superior viewpoint from all angles, and if we approach a design from a 3D perspective, we can create it in Sketchup Pro, notably the 2021 version, which is the most user-friendly of the other two applications for 3D designing.

However, Illustrator and Blender require a lot of storage space because of their typically big size in terms of software and other library resources, whereas SketchUp offers the global "3D

DESIGN WAREHOUSE" library that is widely accessible. We only needed to look for a design model when we wanted one, such as a fan, motor, tank, etc., in the warehouse, download the 2021 version file, and then import it into the software to scale or design as necessary. The final point is that, in comparison to other processes, installation is fairly simple in SketchUp Pro.

Based on the aforementioned factors, we choose SketchUp Pro 2021 as our preferred design tool for the tool selection phase. Here are also some of the snapshots of our design.

Coding tools:

1. MATLAB
2. Code vision AVR
3. Arduino IDE

Table-8: Code tools comparison

Functions /Tools	Python	Code vision AVR	Arduino IDE	Selected tool
Low-cost board	**	*	***	Arduino IDE
Easy to learn	*	**	***	
Open source in both hardware and software	*	**	***	
Wide array of sensors	**	*	***	
Ease of application	**	**	***	

Arduino IDE is an open source for both hardware and software. It designs a variety of microprocessors and controllers. It can be occupied by both digital and analog as input and output for the work interphase.

The microcontroller can be programmed by the C, and C++ language, and the processing language can be used by the modified version of IDE. In our project, we have been contracting an Arduino-based smart system. That is why Arduino IDE is preferable to the other programming tools.

Besides, Arduino is easier to learn as the programming language can be processed. AVR and Python are also very suitable but they have more functions that make them complex. Arduino has the bootloader for that it has a better memory than the AVR. Apart from that, it has an excellent array of sensors in the workspace. Whereas, AVR has the minimum array of sensors. Python is easy but for the project, Arduino meets up the maximum workspace.

Moreover, Arduino is simple and comparatively fast than AVR. So, ease of application also supports Arduino IDE for programming.

Simulation tools:

1. Proteus
2. MATLAB Simulink
3. Autodesk EAGLE

Table 9: Simulation tools comparison

Functions/ Tools name	Proteus	MATLAB Simulink	Eagle	Selected Tools
Knowledge and Experience	***	**	N/A	Proteus
Vast Library of Components	***	*	**	
Easy Code Interfacing	**	*	***	
Addition of new library	**	**	**	
Reliability	***	**	**	
Installation Process	***	*	*	

The Proteus Design Set is a proprietary software toolset suite that is mostly used to automate electrical design. As our project is a microcontroller and sensor-based, we choose to use an Arduino. That is why most of the components can be found with a built-in library in Proteus. Though some of the components can be foreign to it, we can collect the library for it and can add that. Moreover, the uploading of the code can be very easy in this software and it is quite available on our computers. For code, we can use any tools like Arduino IDE, python, or Code vision AVR. The components' design is much more prominent than others. From our previous experience, we have always used proteus for simulation and interfacing with the two tools mentioned above. Lastly, we can say, it is intended for making interactive projects.

MATLAB Simulink is a block diagram environment for designing multi-domain systems, simulating them before going to hardware, and deploying them without writing code. The components are not prominent to see. For interfacing, we need to use MATLAB other than any other tools for code.

EAGLE is a scriptable electrical design automation tool that includes functions such as schematic capture, printed circuit board layout, auto-routing, and computer-aided manufacturing. It is mainly used for its PCB designing and printed circuit board. For us, it is quite new to use in our project. All in all, other than simulation it is most suitable for PCB designing and printing circuit boards.

For calculation purposes from our background research, we select three software and they are:

1. Homer
2. PV planner
3. PVsyst

HOMER stands for Hybrid Optimization Model for Multiple Energy Resources. It was developed by NREL (National Renewable Energy Laboratory) in the USA. Homer is a model that combines optimization, simulation, and sensitivity analysis methods. A project wizard makes it possible to calculate CAPEX and OPEX. Along with this, we can simulate many forms of energy, and add several loads. But it cannot determine whether solar PV neither produces IV curve data nor carries out shading analysis. Additionally, the report on PV electricity generation is less thorough and in-depth because of the scarcity of meteorological data and module information. Numerous loss factors experienced during PV power generation are not taken into account. Not easy to use and requires adding too many parameters manually.

PV planner software is from SolarGis and it is a cloud-based software. From this software solar radiation and PV, the power potential of a location can be determined by accurate satellite data.

This software can make reports in 14 types of languages. It has three-step-based simulations. Although the terrain shading is automatically calculated, there are no options for surrounding structures or close shading analysis. There is just an online version accessible. It is claimed the variation in most modules is not more than 1.22% which is less than the variation in solar radiation.

The most popular solar simulation tool for estimating energy yield and determining the best layout for solar power plants is called PVsyst. This software was created by electrical engineer Michel Villoz and Swiss physicist Andre Mermoud are widely regarded as the industry standard for PV system design and simulation. Its primary characteristics include hourly estimating, extensive analysis, size, quick production estimation at the project planning stage, and report generating. useful design tool for estimating and designing PV systems generates a thorough simulation report by simulating the majority of the parameters needed by PV system builders.

Table-10: Calculation tools comparison

Functions /Tools	Homer	PV planner	PVsyst	Selected tool
Availability	**	*	***	PVsyst
Easy to learn	*	**	***	
Easy to use	*	**	***	
Determine PV Solar	**	*	***	
Analysis Data Collection	**	**	***	

From our analysis, we found that PVsyst is the better software for our project.

Here,

"*" denotes the performance of tools:

* = Average

** = Better

*** = Best

3.3 Use of modern engineering and IT tools:

In the beginning we set up the 3D model to have a visual expression. As mentioned, to build up the 3D model we have chosen SKETCH UP. In the interface of SKETCH UP we have firstly, we set up the hydroponic rack with a proper height and width. Furthermore, we had to draw a solar panel to have a view of our main power source. In order to do that we had to have a library where we can have the solar panel with a proper 3D view. After that we set up the water pump and other staff as we need to have a continuous water supply in our main demonstration. Also, we show a jar having all our required sensors such as pH, TDS, DHT11 and Water temperature sensor. All the sensors were submerged in the nutrient tank. Onwards, we mentioned a nutrient tank having a continuous water supply all over the pipe. Also, the nutrient is being replaced when it is required. We try to have a clear idea by the 3D model of our main construction which is similar.

As we were required to function our system we had to build up with coding and simulating. We have used Arduino IDE for our programming section as mentioned earlier. We have a huge division of sections in order to build up this system. Firstly, we have introduced our project having a built-in command. Later on, we have divided every section for the application of every sensor. Firstly, we work with the pH sensor, TDS sensor, Humidity and air temperature sensor and water temperature sensor. For the sensor of TDS and pH we had to find the library as it was not available for the Arduino interface. Onwards, we built up a smart system which ensures smart communication. We need to add up the libraries for that also. Therefore, we programmed for the GSM module and IOT system. We use the Blynk.iot app for the IOT system.

At the point of simulation, we have selected Proteus for our software simulation section of our system. Here again, we have added the libraries for the pH and TDS sensors. As a controller we used the Arduino. Motors were installed in order to flow the nutrient in the nutrient tank and throughout the plants. Put on two LED lights to ensure the safety also as an indicator. After that, as we need to have a smart system, we introduced a GSM module to have a message for any emergency communication.

As our expected system was large and requires continuous power supply, we chose a solar panel for a constant power supply. Likewise, we store a certain amount of energy using a battery. Calculating the powers of every component and every device we got our expected solar calculation. In order to calculate PVSYST was the help. We set up all the values that were mentioned such as tilt angle, power consumption of every component, selected motor power consumption and their time of run per day. After selecting all the data PVSYST gave us the solar panel of 1KW.

3.4 Conclusion:

In the chapter on modern engineering tools, we have done with programming tools, simulation tools, power calculation tools, and 3D design tools. All the tools were efficiently effective to obtain accuracy and have proper guidelines for the hardware part.

Chapter 4: Optimization of Multiple Designs and Finding the Optimal Solution.

4.1 Introduction

We found three approaches from our background research and from those we selected our best option one by the concept matrix and pros and cons. Then we did the 3D simulation and we also did the proteus simulation on our optimum design and based on its performances we did changes.

4.2 Optimization of multiple design approach

4.2.1 Concept Matrix:

We build the concept matrix based on our research.

Table 11:

Concept Matrix:

	Multiple Design Approach						
Selection Criteria	**Drip System**		**NFT**		**NFT with growth chamber**		**Weights**
	R	**Score**	**R**	**Score**	**R**	**Score**	
Handling ease	2.5	0.125	2.5	0.125	4.125	0.20	5%
Quality crops	2.75	0.69	2	0.5	4.5	1.125	25%
Stand and Shed	1.5	0.225	1	0.15	4.5	0.675	15%
Water reservoir	4	0.2	4.25	0.21	4.5	0.225	5%
Ease of Manufacture	3.25	0.48	2.25	0.34	4	0.6	15%
Power source (backup)	2.25	0.34	2.25	0.34	4	0.6	15%
Ease of use	2	0.2	2.25	0.225	4.25	0.425	10%
Growth light	0.5	0.05	0.75	0. 075	4.75	0.75	10%
Total Score	**2.31**		**1.965**		**4.6**		
Rank	**2**		**3**		**1**		
Continue	**No**		**No**		**Develop**		

4.2.2 3D design Simulation:

Approach 1:

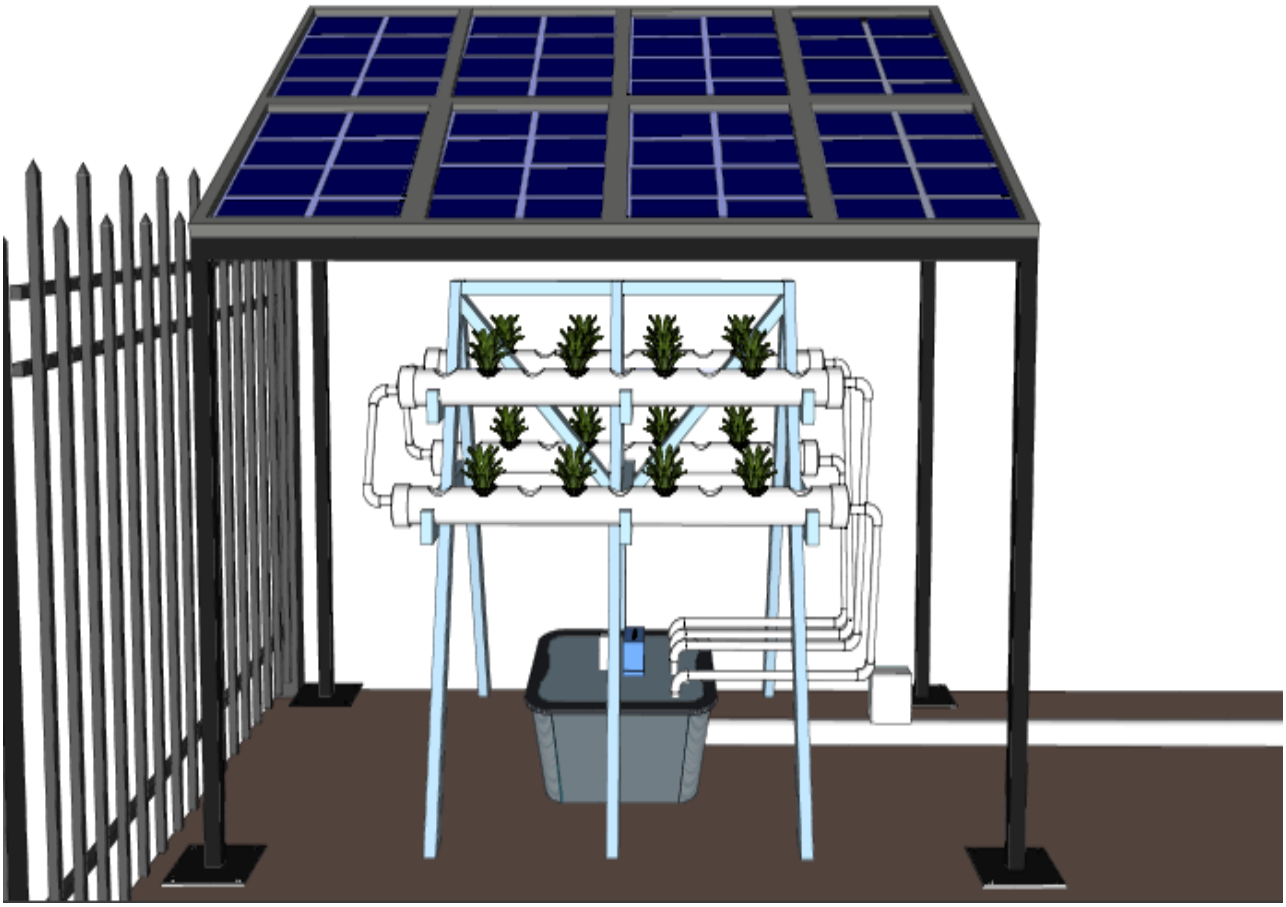

Fig 4.2.2.1: Hydroponic System with Solar Panel at top

Approach 2:

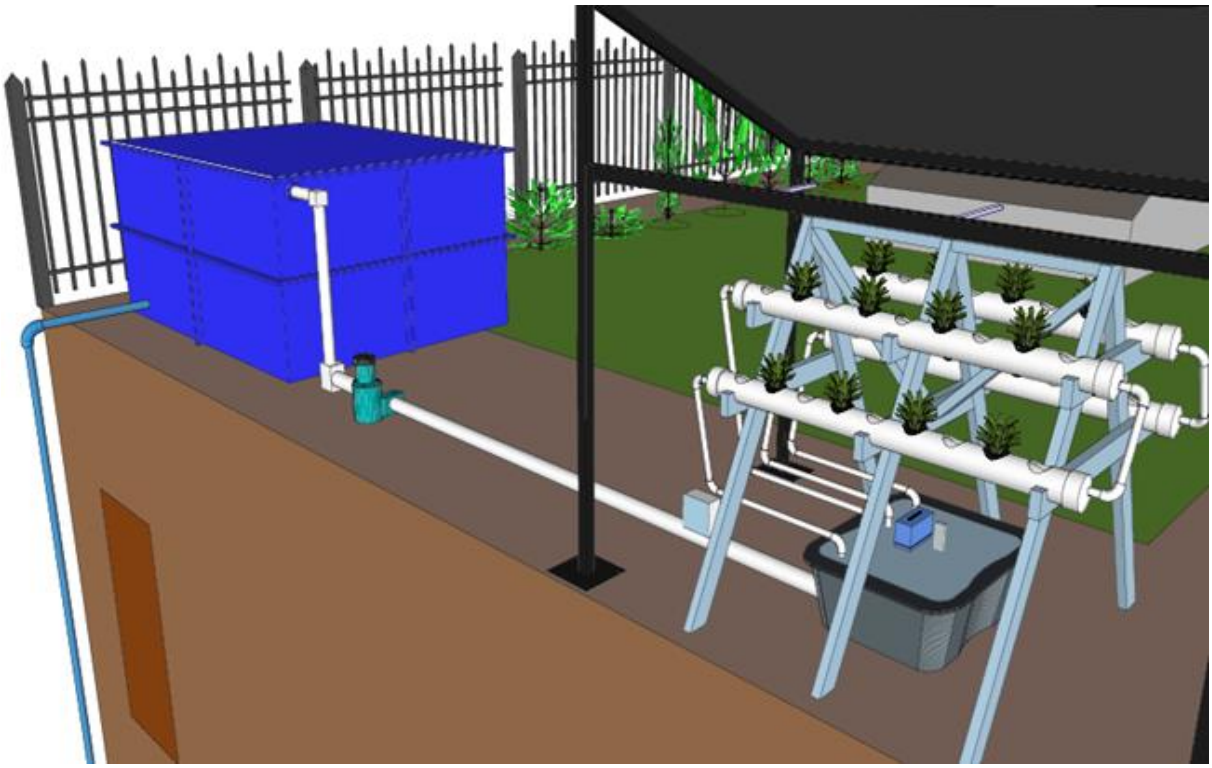

Fig 4.2.2.2: Rear view of the proposed preliminary design

Approach 03:

Fig 4.2.2.3 Transparent Glass all around the plant rack

4.3 Identify optimal design approach:

To identify the optimum solution, we did the proteus simulation

4.3.2. Final Approach Proteus Simulation:

For smart hydroponic system, the goal is to make this system as handy as possible. Therefore, the circuit simulation in Proteus that has been done to ensure the utmost convenience for the user. The circuit simulation is done based on the third approach introduced in this project.

4.3.2.1. Circuit 1: (Primary Simulation)

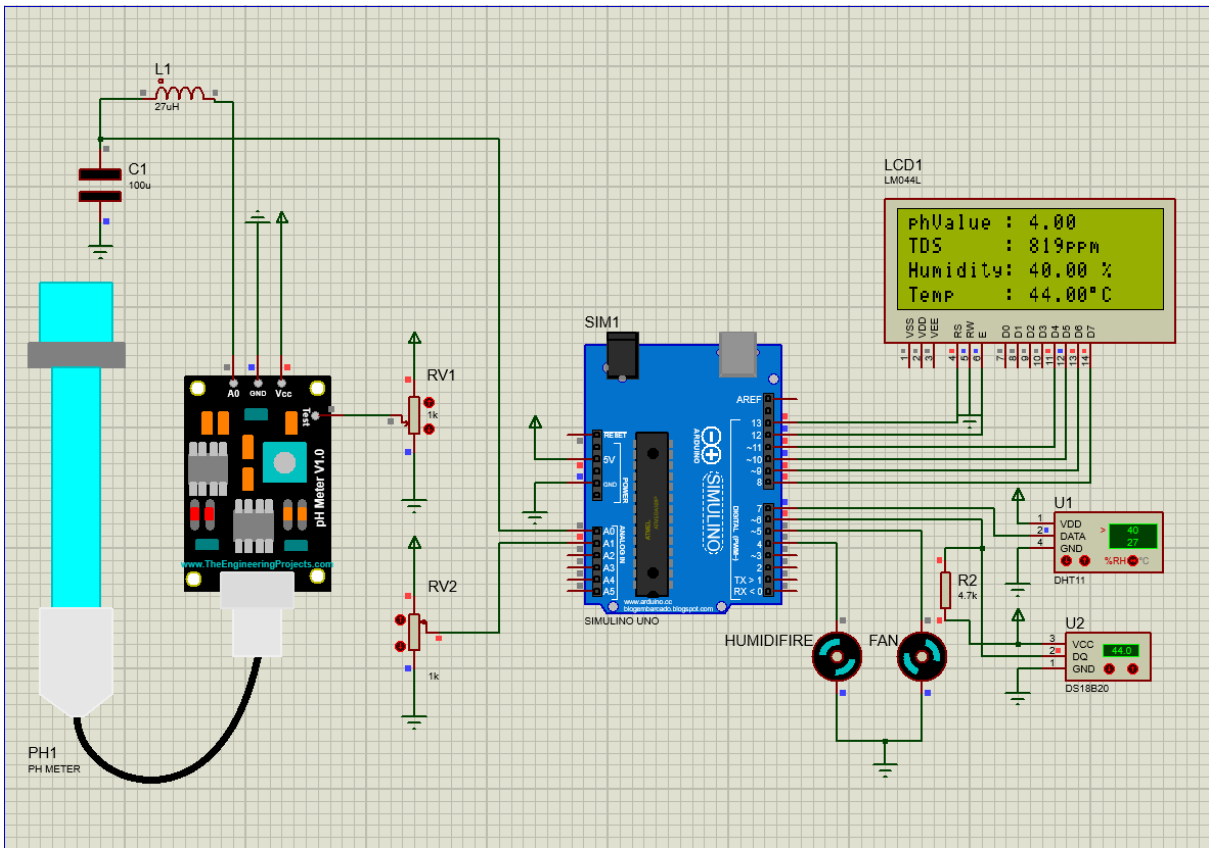

Fig 4.3.1: circuit simulation for a hydroponic system

Here we can see that an Arduino Uno is used as a microcontroller. Whereas ph. sensor, tads sensor, humidity sensor, and a waterproof temperature sensor is controlled. When the temperature is higher than 25 degree Celsius a fan will turn on to control the temperature of the water reservoir, then whenever the temperature has reached 20 degree Celsius the fan will turn off immediately, the motor in the protest simulation resembles the fan. Moreover, when the humidity is sensed to be lesser than 55% then a humidifier in the plant growth section will turn on and when it will reach 75% humidity the humidifier will turn off. Then again, a humidifier is also shown as a motor in the circuit.

4.3.2.2. Circuit 02: (Modified Final Simulation)

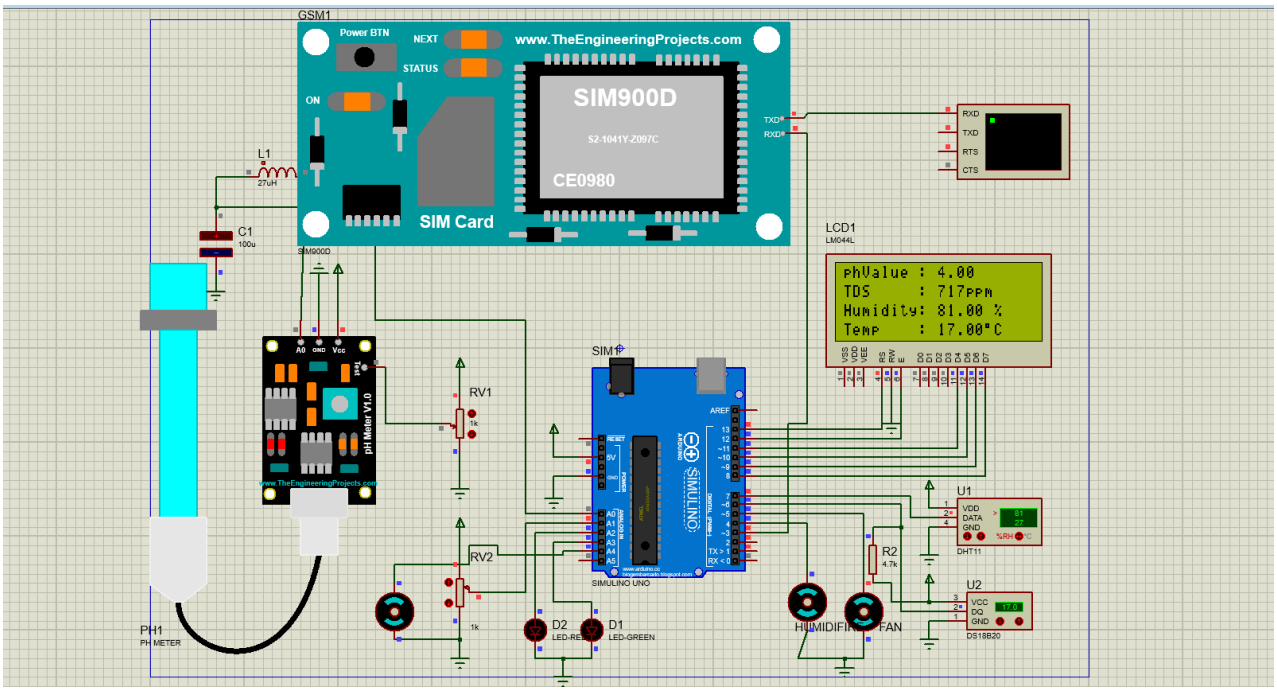

Fig 4.3.2: The circuit simulation for a smart hydroponic system.

In this circuit simulation, it is seen that there are some additions to it. Here when the TDS is less than 600 ppm or more than 1000 ppm and led light will turn on as a signal as the TDS of the nutrient solution is not ideal. On the other hand, it will send a notification on the. Equivalently, when the pH of the nutrient solution is less than 5 or more than 6 another led light (red) will turn on and also a notification will be received about the imbalance pH of the nutrient solution. Other than that, when the TDS is less than 600 ppm a pump will turn on and mix a certain amount nutrient to meet the ideal TDS level. Lastly all of threading for these sensors will be shown in the LCD.

4.3.3. Different condition of the circuit simulation:

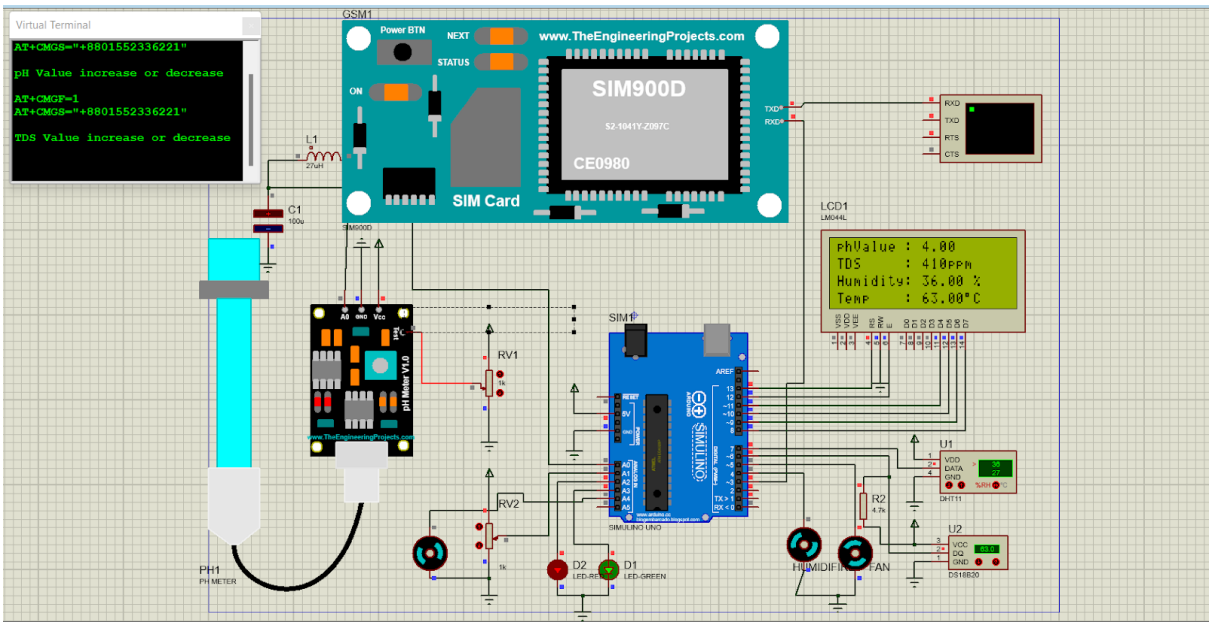

Fig 4.3.3: The circuit simulation for a smart hydroponic system.

Here the pH is less than 5 TDS is less than 600 ppm that is why the two led is on and the one motor to the left is turned on. Also, two notifications are received which are shown in the virtual display. On the other hand, as the humidity is less than 55% and temperature is more than 20 degrees Celsius both the motor at the right is turned on.

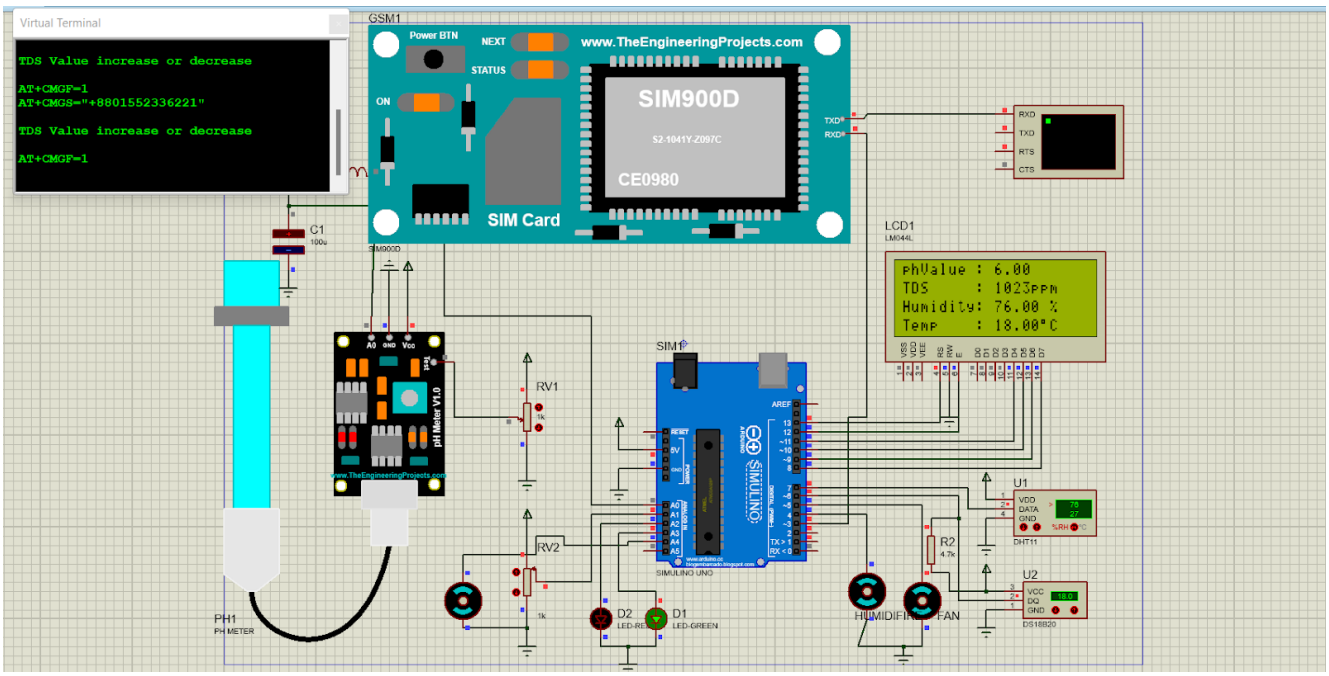

Fig 4.3.4: The circuit simulation for a smart hydroponic system.

Here as the pH is ideal that is why the LED is off but as the TDS value is more than 1000 ppm only the green led is on and a notification is sent.

PVsyst Simulation Report:

Solar energy is a type of renewable energy or clean energy; it is obtained by electromagnetic radiation from the Sun that falls on the earth's surface. Photovoltaic solar energy is a clean renewable energy source that allows obtaining electricity directly from solar radiation through semiconductor devices called photovoltaic cells. For the development of our project, the PVsyst software (*PVsyst, 2021*) is used as a methodology for pre-dimensioning. Additionally, to evaluate the outcomes of the program, we also employ the most recent version which can examine both qualitative and quantitative approaches.

The project is named "SMART HYDROPONIC". Firstly, we choose a stand-alone system with batteries. The PV field orientation is the fixed plane with a 23° Tilt/Azimuth angle. The PVsyst report shows that as per our total load demand we need almost 288 kWh/year and we have the available energy of 338 kWh/year from the solar panel. The total unit of nominal power is 260 Wp and 1 unit of PV module. In this project, we will use a Lithium-ion battery with a 3 parallel section which has 13 vol and a nominal capacity of 309 Ah. The daily use of energy is almost 0.8 kWh/day.

Table-:12 Load Calculation:

	Number	Power	Use	Energy
		W	Hour/Day	Wh/Day
Sobo Water Pump	2	5W/pump	24.0	240
Arduino	1	5W	24.0	120
Fan	1	8W	12.0	96
Humidifier	1	4W	15	60
Growth Light	1	20W	12	240
TDS Sensor	1	5W	24.0	120
PH + Temperature	1	6W	24.0	144
Stand-by consumers			24.0	24
Total daily energy				1098Wh/day

The primary findings indicate that the entire amount of energy available is almost 338.0 kWh/year, although we have estimated our energy use to be almost 290 kWh/year. As a result, we will receive an additional ~ 39 kWh of backup each year.

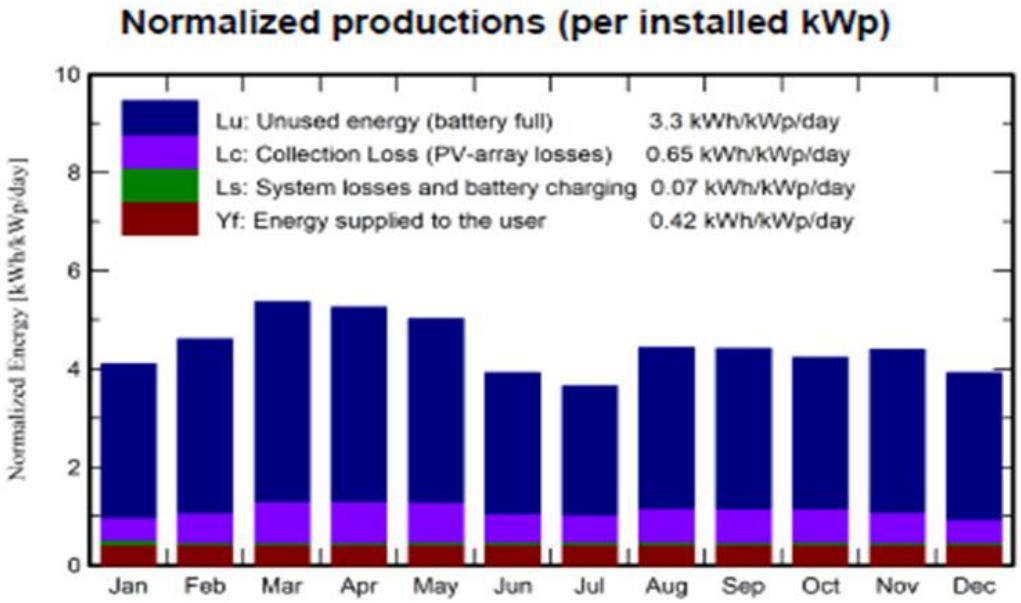

Fig 4.3.5: Normalized Energy vs. Year (PVsyst report)

The normalized energy vs. months' chart demonstrates that all of the year's planned milestones, including battery full (0.42 kWh/kWp/day), collection loss (0.73 kWh/kWp/day), and Yf (3.03 kWh/kWp/day) system losses and battery charging (0.26 kWh/kWp/day) and battery charging percentage, as well as PV array loss, were achieved. Here, we were given a year-in-review. The total amount of lost energy was 4 kWh each year. Additionally, we obtained a loss diagram (Fig:4.3.6), which details all losses and the energy required to power our load.

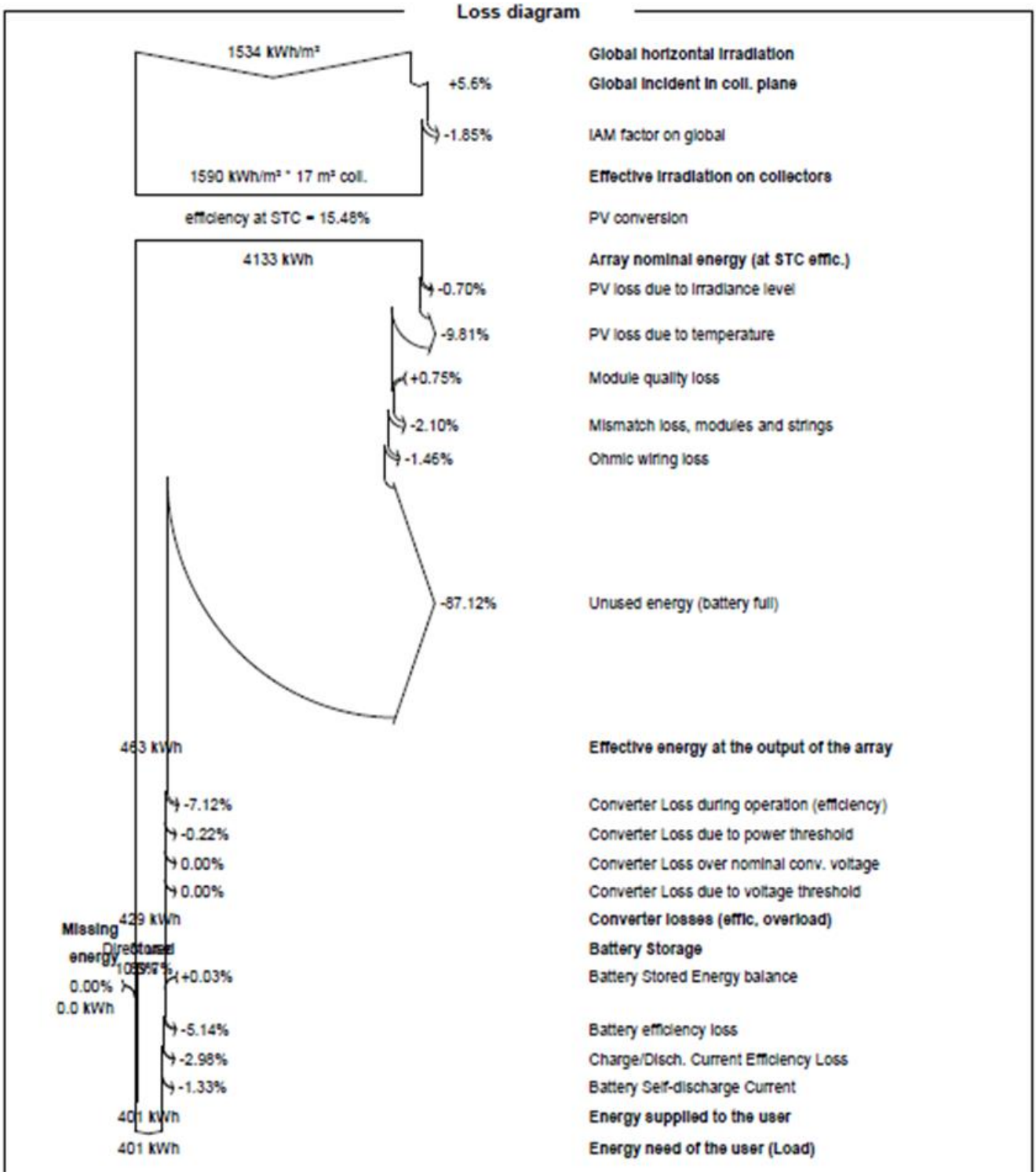

Fig 4.3.6: Loss Diagram

4.4 Performance evaluation of developed solution:

After selecting the approach on which we determine to work on we try to find the most convenient solution for the use by creating different types of proteus simulation.

In the system, the main goal is to culture healthy plants for which maintaining pH level, water temperature, and perfect nutrient availability is important. For this reason, we need to find a better proteus solution on which we may work. To find the solution we set some test cases based on the plant's need and identify the better process on which we may work.

4.4.1 Circuit 1:(Primary Simulation)

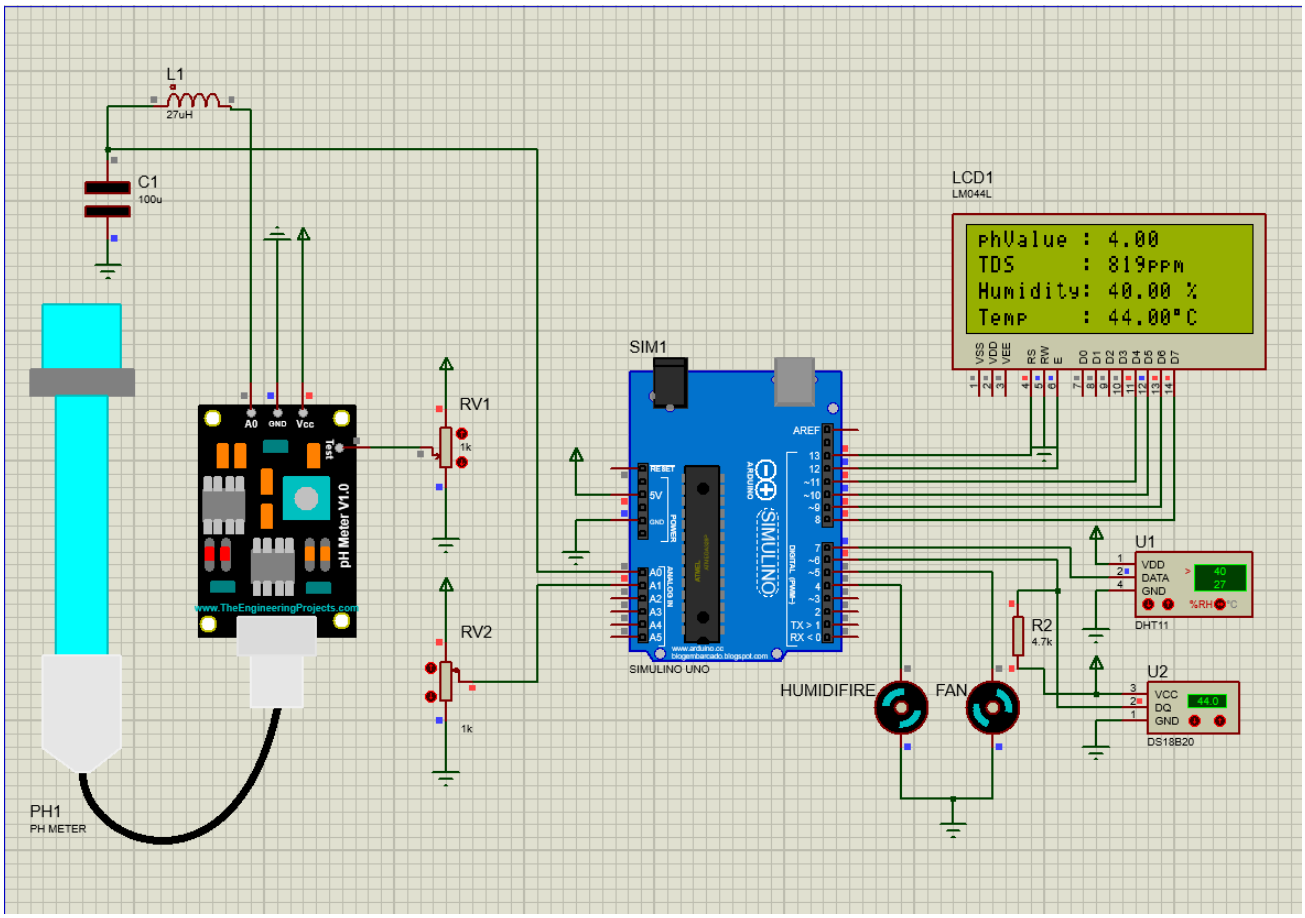

Figure 4.4.1: The circuit simulation for a smart hydroponic system.

Table 13:

Test Case 1:

Test Case	Scenario	Expected Outcome	Comments
1	TDS<600	No Change	Not Validate
2	TDS>1000	No Changes	Not Validate
3	pH<5	No Changes	Not Validate

4	pH>6	No changes	Not Validate
5	Humidity>55%	Fan turn on	Validate

4.4.2. Circuit 2 :(Modified Final Simulation):

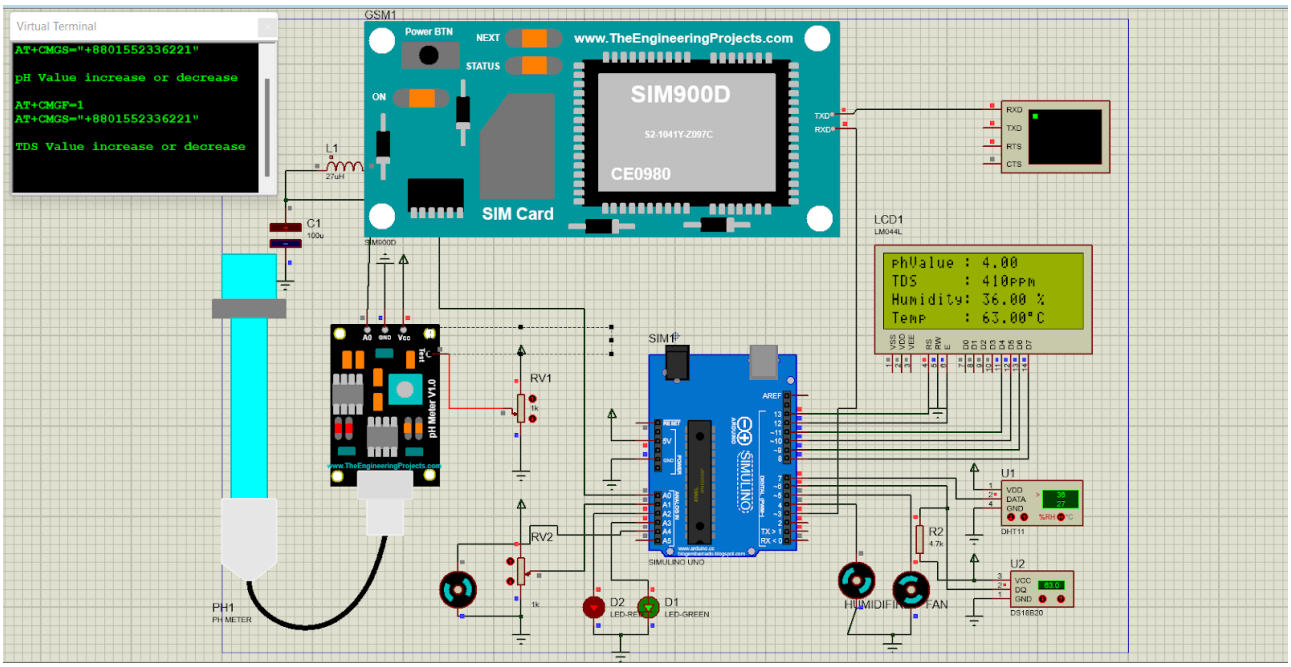

Figure 4.4.2: The circuit simulation for a smart hydroponic system.

Table 14:

Test Case 02:

Test Case	Scenario	Expected Outcome	Comments
1	TDS<600	Green Light on and message notification (Nutrient will be mixed)	Validate
2	TDS>1000	Green Light on and message notification	Validate
3	pH<5	Red Light on and message notification	Validate
4	pH>6	Red Light on and message notification	Validate
5	Humidity>55%	Fan will turn on	Validate

Among these two circuit simulations we found out that the second circuit is more convenient and automated. For that reason, we may be working on the second circuit.

4.5 Conclusion

Throughout the procedure of simulation, we made so many changes in our designs and we finally selected the best one based on our software performance. And after that we did our hardware simulation.

Chapter 5: Completion of Final Design and Validation.

5.1 Introduction

The completion of the Smart Hydroponic System depends on the fulfillment of all the conditions we proposed. By considering the electrical part and the structural part our motive was to ensure the compilation of our project. On the other hand, as we need to validate this project's different aspects, to have it satisfied all the essentials. That is why, the completion of final design and validation is elaborated.

5.2 Completion of final design

In the Smart Hydroponic System, we have constructed a five-platform structure for the plants to be mounted. Where 45 plants were planted with a cup underneath. The pipe in the structure had cut out for the plants to be placed and inside them a flow of nutrient solution is streaming continuously. Five pvc pipes had been used for this task. The structure is 62 inches where the diameter of the pipe is 4.2 inches. Then the continuous nutrient solution flow is ensured by the A motor.

Fig 5.5.1: measurement of the whole structure.

In the electrical part we have the esp32 as the microcontroller, we have controlled some sensors via this which was very crucial for the health of the nutrient solution. To ensure that the nutrient solution is in good condition we are continuously measuring pH, EC, TDS, water temperature. As well as the air temperature and the humidity of the plant's atmosphere. Then again, the pH is imbalanced, a green led light will turn on and the GSM module that is introduced will notify us. Moreover, when EC value is imbalanced a red led light will be turned on and again the GSM module will notify us via message. Then when the Ec is lower a motor will turn on to have a nutrient flow to the solution to balance out the EC. Moreover, when the water temperature is very high the cooler fans will turn on to cool down the temperature of the

solution. In the meantime, all of the data will be saved and shown to the LCD as well as through an application also as we have introduced IOT in this project.

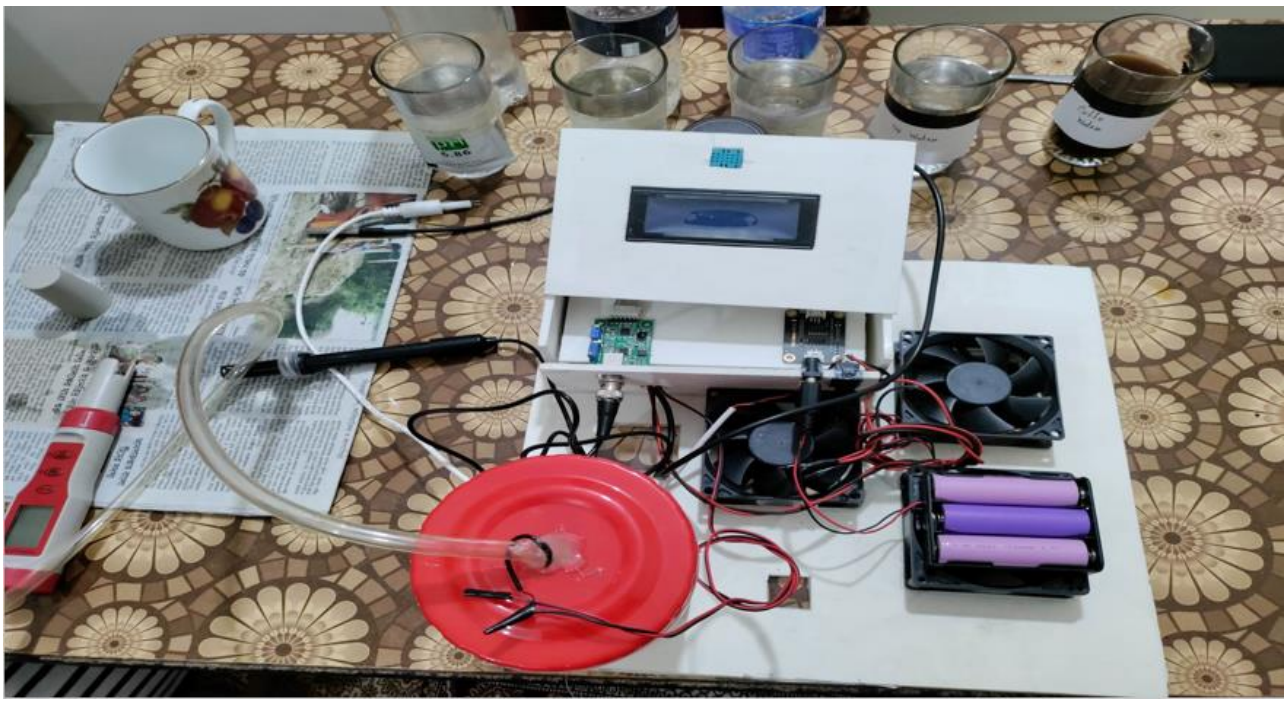

Fig 5.2.2: circuit system

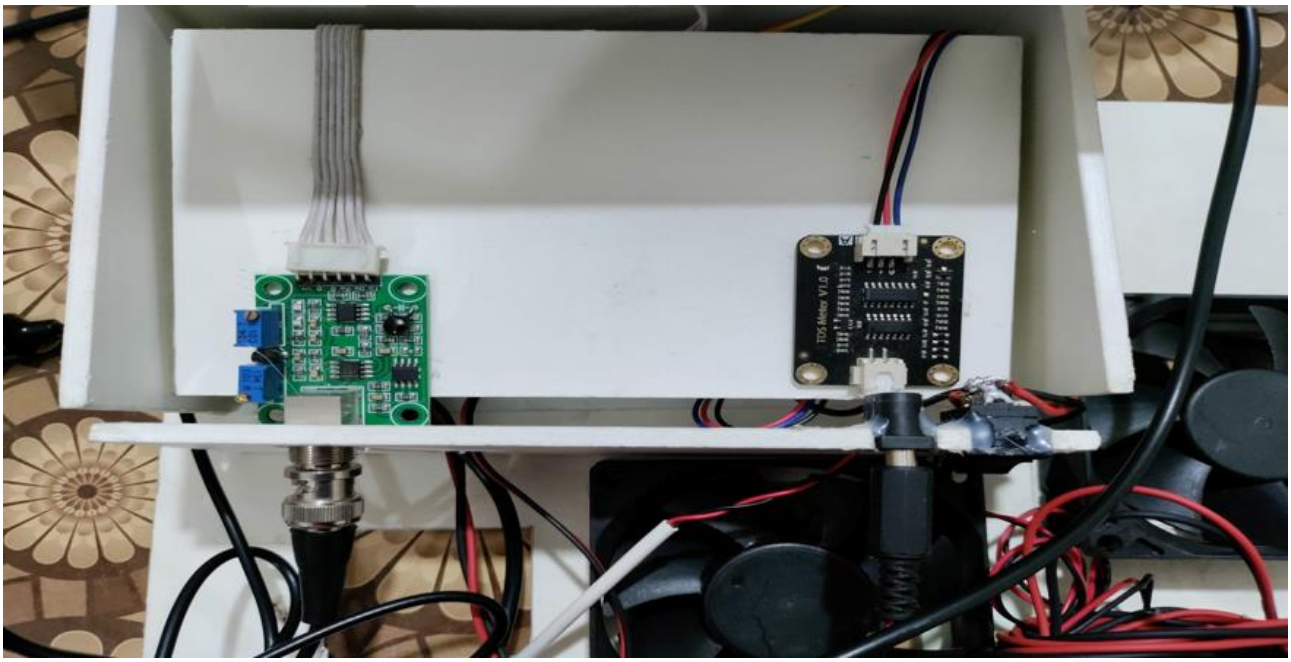

Fig 5.2.3: circuit system

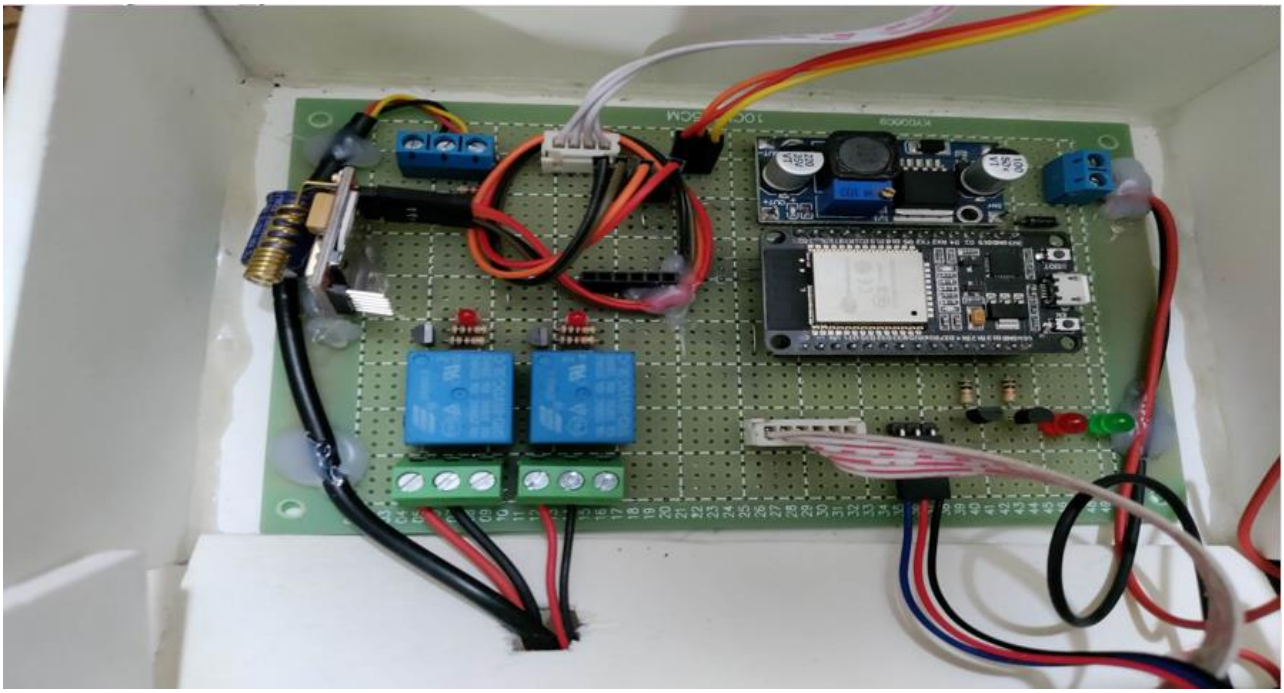

Fig5.2.4: circuit system

Then again in our project we had some changes from earlier firstly as we have proposed to do it in Drip hydroponic system but as for our environment and the availability, we decided to go with the NFT hydroponic system. Secondly, we are also changing our plant choice from strawberry to lettuce according to the fact that lettuce takes a very small amount of time to grow other than strawberry and lettuce can be a low maintenance plant. Then in the electrical part with the microcontroller as an Arduino but esp32 has some built in pins for the iot system. For this reason, as we also wanted to receive data through our mobile devices, we used esp32 as our microcontroller. Then again as our system was supposed to be fully powered by solar panels but as for the NFT hydroponics system we need continued water flow so we decided to have the AC motor to be powered the traditional way. Other than that, for cooling down the water we are not using any chiller rather we are using cooling fans. Because the cooler can turn the water way colder than needed.

Fig 5.2.5: Implementation of the project

5.3 Evaluate the solution to meet desired need

Table15:

Test Case 03:

Sl. No.	Scenario	Expected Outcome
1	EC< 2us/m	Green Light on and message notification DC motor will turn on
2	EC>2.5 us/m	Green Light on and message notification
3	pH<5.5	Red Light on and message notification
4	pH>6.4	Red Light on and message notification
5	Water temperature> 24	Fan will turn on

for validating our claims of the system, we have done some testing such as for validating the when the EC is less that 2us/m in the coffee water the motor will not turn on and it remain still.

But as soon as we dip it into the normal water the EC drops and the motor turns on so as the Green LED light. Then again in pH solution when it is 4.00 the pH sensor will sense it and turn on the Red LED light. Then by using body heat from hand we also demonstrate the turning on of the fans while the temperature is higher than 24 degrees Celsius.

Fig: 5.3.1 from the above figures we can see the validation of the pH sensor of our system. The pH of the coffee solution is showing 5.41 and, in the LCD, it is 5.82.

Fig: 5.3.2 TDS value of the LCD IS 1170 where the meter is showing 1260

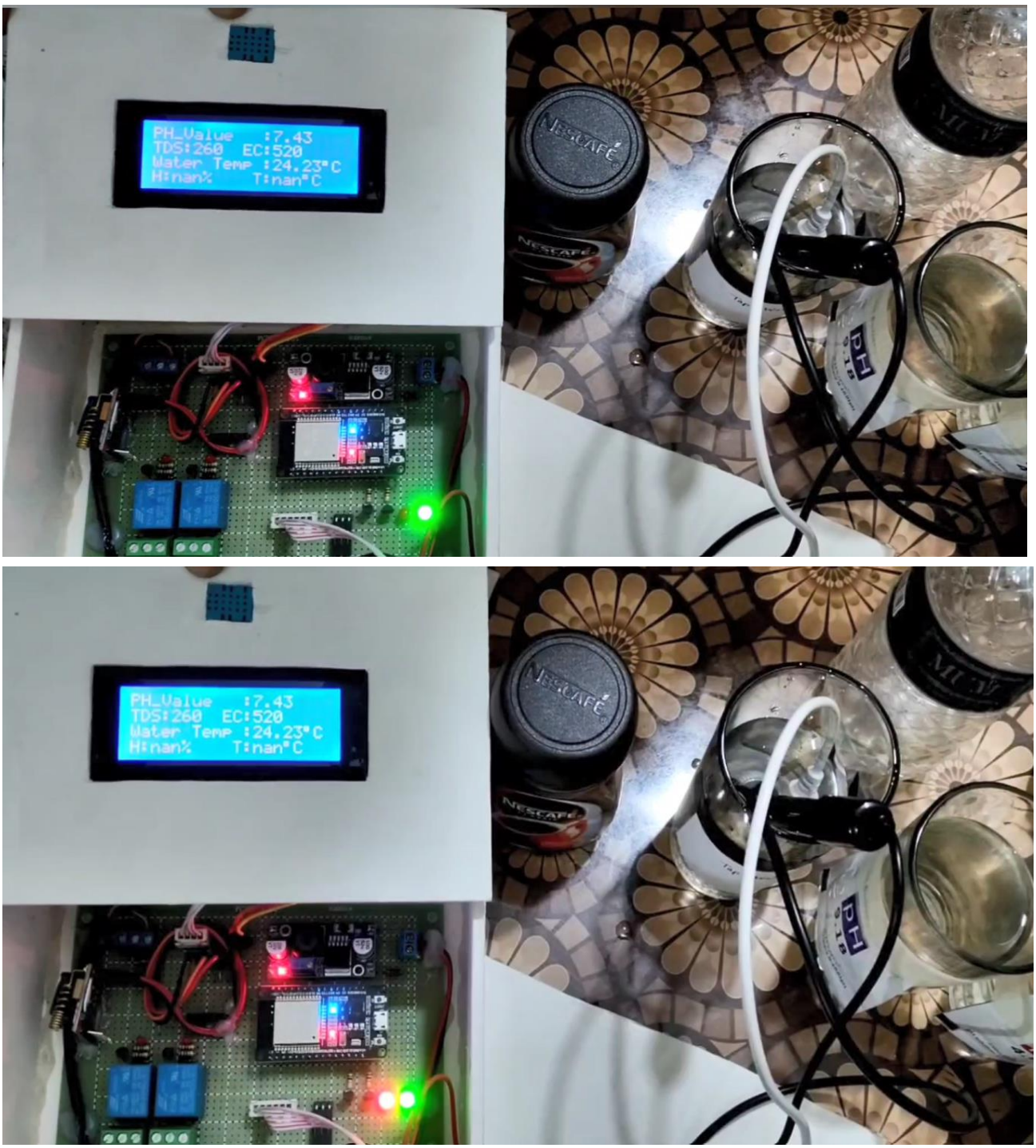

Fig: 5.3.3 when pH and EC is imbalanced simultaneously red and green led light will turn on

Fig: 5.3.4 we can also observe the data through the application

Here are the stored data from some particular day,

Table 16:

Table of the stored data:

Date	pH	EC (us)	TDS (ppm)	Water Temp (°C)	Air Temp (°C)	Air Humidity (%)
12/9/2022	7.16	0	0	24.69	20	45
12/9/2022	7.64	0	0	23.44	20	45
12/9/2022	7.91	0	0	24.12	23.8	39
12/9/2022	7.91	2323	1161	23.81	23.8	39
12/9/2022	7.86	804	402	24.19	24.5	39
12/9/2022	7.87	832	416	24	24.8	38
12/9/2022	7.86	926	463	23.69	24.8	39
12/9/2022	7.88	2300	1150	23.44	24.8	38
12/9/2022	10.94	2267	1133	22.56	24.8	38
12/9/2022	9.26	2267	1133	23.31	26.2	44
12/9/2022	5.61	510	255	23.87	26.7	46
12/9/2022	1.25	1767	883	23.31	27.1	47
12/9/2022	4.95	1360	680	24.5	27.1	47
12/9/2022	6.78	0	0	25.5	26	51

12/9/2022	4.37	0	0	25.31	26	51
12/9/2022	6.06	1710	855	25.88	25	52
12/9/2022	5.66	427	213	24.75	25	52
12/9/2022	5.64	430	215	24.81	25	53
12/9/2022	4.71	387	193	24.91	25	53
12/9/2022	0.66	405	202	24.79	25	53
12/9/2022	8.29	386	193	24.73	25	53
12/9/2022	6.62	400	200	24.79	25	53
12/9/2022	6.27	396	198	24.79	25	52
12/9/2022	6.19	401	200	24.73	25	52
12/9/2022	10.06	412	206	24.73	25	53
12/9/2022	9.73	420	210	24.6	25	54
12/9/2022	7.66	414	207	24.54	25	54
12/9/2022	8.73	429	214	24.48	25	53
12/9/2022	3.85	432	216	24.48	25	54
12/9/2022	8.53	1778	889	24.1	25	53
12/10/2022	9.15	1779	889	24.1	25	52
12/10/2022	9.17	1775	887	24.1	25	52
12/10/2022	6.62	596	298	23.1	24	48
12/10/2022	3.8	1797	898	23.41	26	47
12/10/2022	9.23	1712	856	24.35	26.2	46
12/10/2022	9.22	645	322	23.73	26.2	46
12/10/2022	8.37	1752	876	24.48	26	48
12/10/2022	7.36	606	303	23.85	26.2	47
12/10/2022	7.1	655	327	23.91	26.4	47
12/10/2022	6.78	140	70	24.04	26.7	47
12/10/2022	9.29	619	309	24.04	26.7	48
12/10/2022	9.23	600	300	23.98	26.2	48
12/12/2022	6.99	0	0	24.41	24.8	61
12/13/2022	8.47	2285	1142	25.98	23.4	62

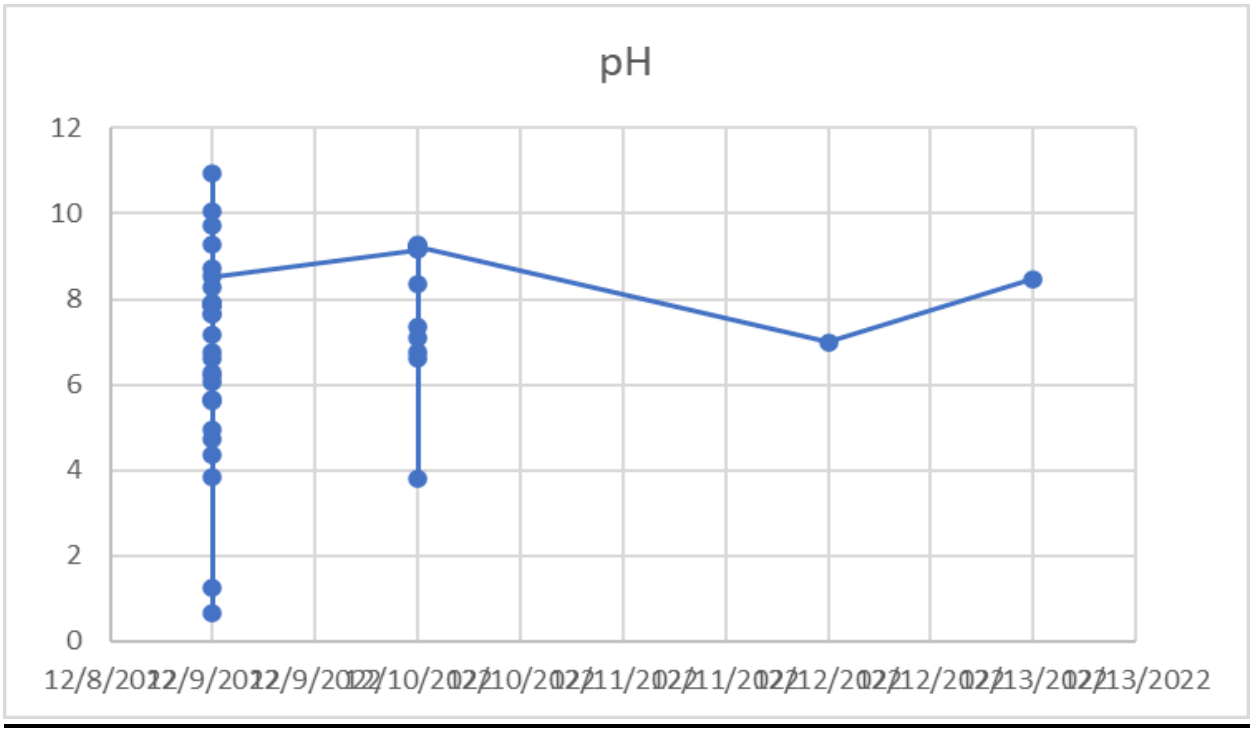

Fig: 5.3.5 Timeline vs. pH

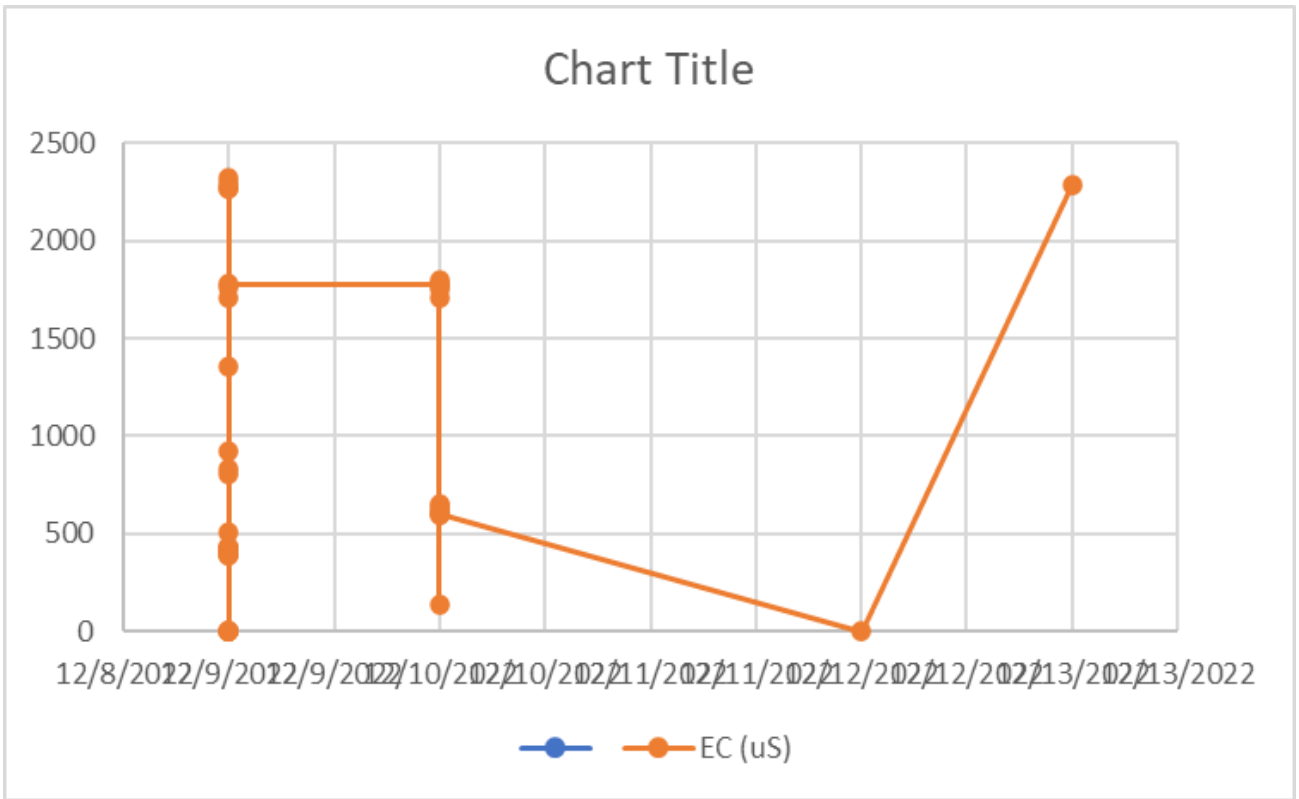

Fig: 5.3.6 Timeline vs. EC

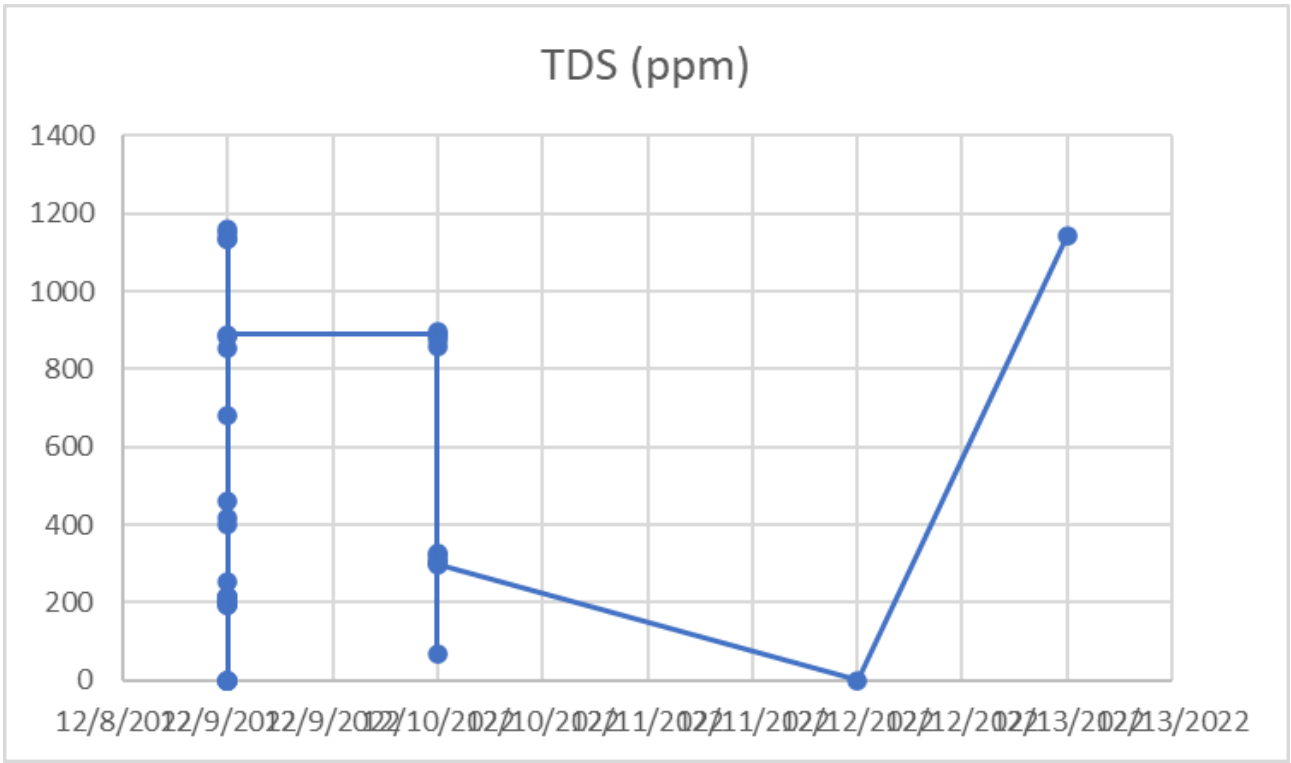

Fig: 5.3.7 Timeline vs. TDS

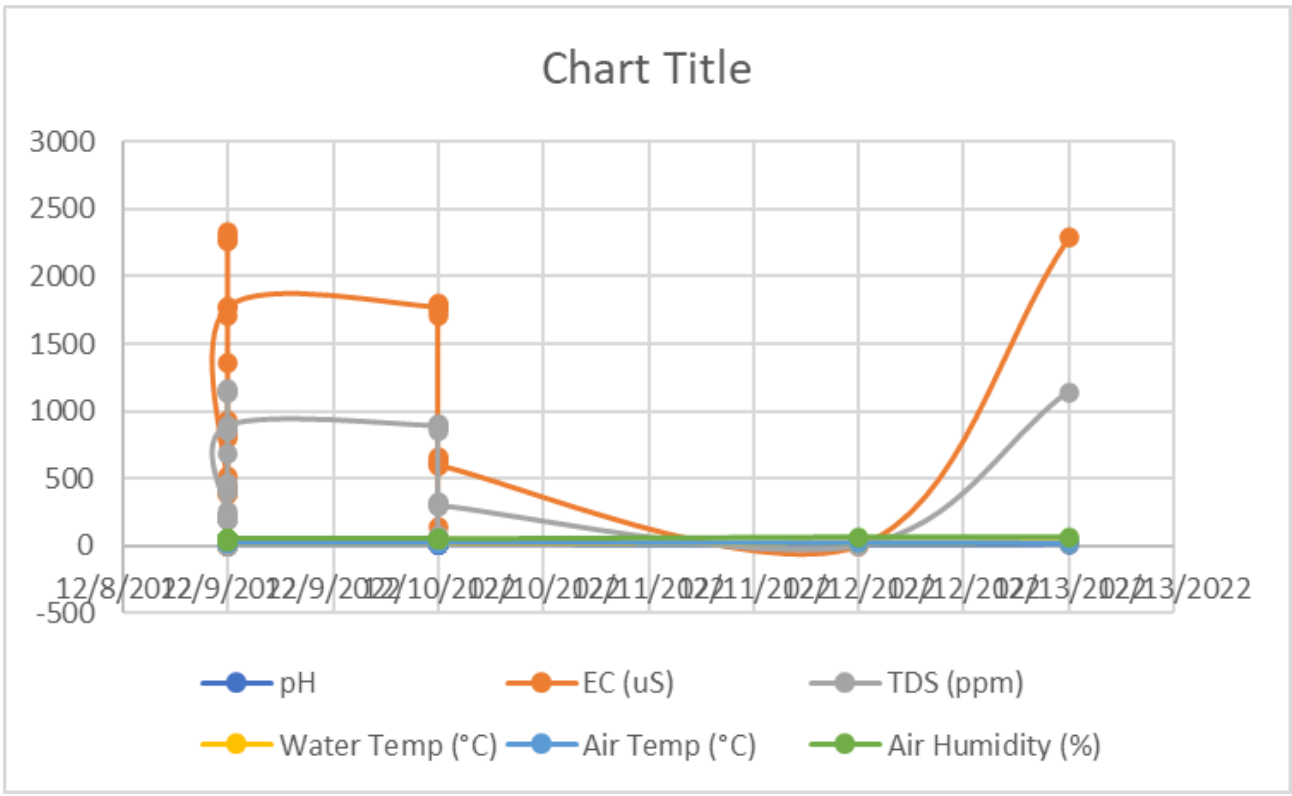

Fig: 5.3.8 Timeline vs. data

5.4 Conclusion:

In conclusion we can say that the considered conditions are being fulfilled by the project. Though it might have some shortcomings as we made some adjustments to overcome them. All in all, it can be proven to be a very environmentally friendly sustainable system for the coming time.

Chapter 6: Impact Analysis and Project Sustainability:

6.1. Introduction

While building a project the major aspect of it is to acknowledge the impact and sustainability of that project. Whether to have a good outcome and positive consequences or to avoid harm of any kind. Therefore, it is obliged to ensure that the project has worthwhile effects on our social, health, safety, legal, culture and environment. On the other hand, for any project it is an utmost requirement for it to ensure sustainability. When a project is sustainable it is considered to fulfill all the motives in the absence of compromising the necessity of the next generation as well as the present.

6.2. Assess the impact of solution

SOCIAL:

When it comes to the social impact of constructing the smart hydroponics system it will be quite noticeable. As for the urban area, the system can mostly have positive feedback. The reason for this is having easy access to electricity, the flexibility of this system to be inside or outside the house, and the need for fresh produce and gardening. Though, a wide range of people in the residential area are used to terrace and balcony farming to build a smart system for plants can seem queer. Nevertheless, the conveniences of this system can attract people if they are well informed and if it is well publicized. This can partially solve the demand for fresh produce for the urban people and can be a hassle less farming, and gardening inside and outside houses like the terrace and balcony basement within small spaces. Therefore, will be influenced by smart hydroponic gardening and give their plants a stress-free environment to grow while living in suburban areas.

On the other hand, while a vast area is used for smart hydroponics systems, it is able to produce more eco-friendlier procedures for farming. In rural areas, people are very much used to traditional farming. Smart Hydroponics can step up the process much more. It will influence the farmer to use a hydroponics system which is an easy way to produce more vegetables, decreasing the hassle they normally face. When the farmers are starting to become comfortable with the process it can inspire them to cultivate and be creative with their process to have modified local vegetables or fruits in a good way. Just like the Japanese are producing luxury fruits like Yubari melon, Ruby Roman grapes, white jewel strawberry, etc. It can be beneficial to the agriculture industry of our country and can be a positive contribution to our economy too.

HEALTH:

Smart hydroponics can be a huge step toward creating a healthy community throughout the country. While being convenient to use wherever you live in urban or rural areas. One of the reasons for that is eating locally. If the smart hydroponics system is embraced both privately and on an industrial level either way, it will be beneficial for the health of the consumer. When

a community is consuming their food locally, they are instantly reducing their carbon footprint. While using smart hydroponics systems we don't require any kind of pesticides or high doses of chemical fertilizations also the water is continuously purifying so the contamination of the solution is very much low to null. Additionally, as for its user-oriented ability, it will encourage citizens to produce vegetables and fruits locally as it is quite convenient. As people will be more conscious about what they are putting on their plates and being healthier.

Other than that, as for using it on an industrial level the need for foreign exotic vegetables and fruits can be fulfilled to a certain extent. Most of the vegetables are produced thoroughly in our country. Even so, recently the number of imported fruits was 1.7 million kg [12]. By not fully depending on traditional farming we can produce suitable nutritional vegetables and fruits by using a smart hydroponics system. Which can step up the process of fulfilling the nutritional needs of the people proportionally.

SAFETY:

The system's safety measures are very important to have a successful project. For the safety of the system, we need to have daily monitoring. Because of some malfunction it can be damaged which can prove to be harmful for the plants. For instance, if the turbidity sensor is harmed, the microcontroller might not know if the turbidites need to be on or not. Like this, the harmony of all the sensors and the corresponding devices needs to be assured through daily monitoring and maintenance if needed. Moreover, the devices and the platform for the plants need to be situated in a well-built structure and also have proper insulators where needed so that it might not be a cause of harm for anyone near it. Also, assuming any malfunction in the devices, the conducting wire used in this project as well as the solution need to only be handled by experts with proper protection as they can conduct electricity.

LEGAL:

The legal aspects of conducting a smart Hydroponics system could face challenges such as the regulation and status of land use, then about the zoning, and also about the price rate of the goods produced by it from wholesale to retail distributors. Firstly, there is a necessity to have permission from the land owner for the installation of the system and project. Therefore, we need legal permission from the landowner and with the terms and conditions. Secondly, the regulations about zoning need to be considered carefully as some areas may not allow the installation of this system because it may have the potential to become an industry that the zoning rules might not allow in that area. Lastly, as a smart hydroponics system encourages to produce and eat locally. Therefore, the price rate might have the potential to be out of hand without a fixed rate given. [11] As there is a reputation for having extra charges on organic produce.

CULTURE:

Smart hydroponics systems also have the potential to have an impact on cultural aspects. We can say that the vast use of this handy system can open the door to cultivating foreign plants in

their suitable environment. It can even create a tropical tree greenhouse. As a result, we can have different types of western and unique products that can be introduced to our cuisines. It can fully fill the need for nutrition among residents, and also can create new food habits. Also, people will be more eager to have overseas plants.

ENVIRONMENTAL:

The good environmental impact of hydroponics is lots. The smart hydroponics system takes it to another level. The soilless cultivation is less polluting to the land and the food is much fresher and less contaminated. One of the great aspects is that it requires 70%-90% less water than regular farming and is reused. There is no use for pesticides is another great side as the plants are strong enough. Additionally, the carbon footprint is way less food this system as most of the food can be produced locally, less usage of irrigation pump as well as tractor plowing.

At the same time, there needs to be strict regulation on the cultivation of any foreign plant that may be an invasive species to our ecological environment. Plants like Water hyacinth. Billy goat weed, Lantana, Centella Asiatica are some existing invasive plants in Bangladesh. [10] Therefore, we should have the proper knowledge to prevent any invasive species and have rules and policies to prevent them from being cultivated through this system.

6.3 Evaluate the sustainability:

STRENGTH:

In hydroponic technology the rate for the plant production rate is much higher than the regular farming system, which is the biggest strength of the hydroponic cultivation system. As we are using proper nutrients, the quality of the plants will be good enough and healthier. Moreover, this nutrient can be used after one product as it is recycled through the pipe from the mini reservoir. If we consider farming water is one of the main tools to produce. Nonetheless, we can ensure less use of water and proper maintenance of water level where the control system will automatically detect the level of water and take as much as it needs. In addition, hydroponic cultivation takes less space and produces even more plants. Last but not the least, we can produce plants all year.

WEAKNESS:

Thinking on the other side, Hydroponic cultivation technology has some weaknesses as well. First of all, we've to spend a good amount of money to build the setup for growing the plant. As this is a highly monitored system, some of the expensive sensors and instruments will be used, which is a highly investing project. Then again, considering the quality of the seeds we've to take the best quality of seeds as there are several grades of seeds throughout the market. It's a big problem to overcome the quality of the seeds. If we're using it once, we won't be able to change the seeds. This is why it's a big deal in hydroponic systems. Moreover, by investing a high amount of money it's very difficult to bring the profit unless it's a big project indeed.

OPPORTUNITIES:

It's a big opportunity for hydroponic cultivation to give proper nutrients to the plant as per requirement. There are myths that some plants need to be specific soil to produce good quality plants or crops. Interestingly, this system is controlled and monitored by the water and nutrient mixture, so that there are no restrictions or barriers in the soil. There could be an individual measurement for each type of plant which could be monitored and may control automatically for further cultivation.

THREATS:

Nonetheless, the Hydroponic cultivation system has carried most of the positive side which led this technology to some high potential threats. Firstly, there could be a chance of getting more sunlight to the plants which are in the initial condition and this heat could make high water temperature through the pipeline. That may not carry the actual nutrient to the roots of the plant as a result it won't support getting good quality plants. As we've discussed before, this technology is using many sensors and microcontroller-based equipment which may get damaged due to its internal issue. Therefore, our full system will get error results and can't be properly monitored. Most importantly, the hydroponic cultivation system is rapidly increasing in the industrial sector as a result there's high competition to run this business. Moreover, many stakeholders want to make their industry even bigger to compete with the running industries, unless they are going to face a big threat to their business.

Table 17:

SWOT ANALYSIS:

STRENGTH	WEAKNESS
Faster rate of production	High investment at the initial stage
Healthy crops	Hard to get good seeds
Less water	Less profit except for bigger industry
Minimum space and maximum growth	
Yearly yield capability	

OPPORTUNITIES	THREATS
Proper nutrients to the plant	Excessive sunlight may drop the plant's quality.
No barrier to soil restrictions	Internal damage to one sensor may bring about system failure.
Control system technology for individual plant	Competition is high

Table 18:

Impact Matrix:

Impact criteria/ Features	Social (10)	Health (10)	Safety (10)	Legal (10)	Cultural (10)	Environmental (10)	Weighted Sum (60)
Eco Friendless	9.33	9	7	4	4.33	10	43.66
Reduced Carbon Footprint	7.67	9.33	7.67	1.33	1.33	10	37.33
Convenience	8.167	3	6.67	3.67	4.67	5	31.177
Safety/ Security	6.67	8.33	9.67	5.67	2.67	8	40.98
legislation	6.33	1.33	2.33	10	3.33	4	27.32
Diversity	8.33	5	1.33	5.33	9.33	8.67	37.99
Economically beneficial	9.33	3.67	1.33	5.67	2.67	3	25.67
Nutritional benefit	8.67	10	5.33	1	4	4.33	33.33

6.4 Conclusion:

All in all, Smart Hydroponic System has its own ways of very practical and constructive impact. This project has some incredible benefits added to many aspects of our life while might have few minor cons in its way. All things considered, this project has some pragmatic impact and also fulfilled the principal parameters to be a sustainable project.

Chapter 7: Engineering Project Management:

7.1 Introduction:

Knowledge of engineering project management is as important as gathering knowledge of basic engineering. It's leadership skills that will help an engineer to proceed with any project perfectly followed by time and quality. Nowadays, project management is required almost in every professional career which needs to be fulfilled before becoming an engineer. Therefore, it is advantageous to understand engineering project management, complete complex projects, and correctly resolve them.

7.2 Define plan and manage engineering project:

An engineering project is based on any critical problems that is solved by some methods along with critical steps. Along with solving complex projects, engineers should have to bring the solution which will be beneficial for our world as well. As a result, managing any projects and tackling the unwanted situation during solving the projects is also important for an engineer.

The startup, development, and implementation phases of our engineering project were separated into three separate phases. These three stages are assigned to three different courses which are EEE 400P (initialization), EEE-400D (development), and EEE-400C (implementation). A logbook has been kept track of the meetings and agendas to manage our project. Each stage's tasks were distributed equally among the group members. Gantt charts for each of the three stages were created in order to monitor the progress of our project. Our progress in the project is maintained by the Gantt chart and a log book. We have prepared the Gantt chart according to our task for each course and divided it according to our group members so that the tasks can be solved by different people.

Moreover, we've obtained how much we have done in each task and kept notes regarding this. Therefore, it's easier to move to the next task and find the revision if needed. We prepared the Gantt chart for EEE400P at the very beginning of our project and also, made an estimated chart for the future work of EEE400D and EEE400C. As a result, we can follow upon our next target and come to an end to our project. Most importantly, we can maintain our timeline through this plan and manage all the tasks which are really helpful for all the three phases. However, the Gantt chart that was updated in accordance with the timeline is used to manage and maintain the project advancement of the implementation stage. Some of our assigned tasks or the Gantt chart may have been modified, altered, or postponed during this semester as a result of various circumstance

7.3 Evaluate Project Progress:

1	EEE400P						
1.1	Researched Complex Engineering Problem	ALL	C01	10/2/2022	12/2/2022	2	90%
1.1.1	Literature Review, Justification	ALL		12/2/2022	14/2/2022	2	100%
1.1.2	Problem Statement	Saikat		14/2/2022	28/2/2022	14	90%
1.1.3	Prepare Gantt Chart	Saikat		10/2/2022	12/2/2022	2	100%
1.2	Project Objetive, Specification, Requierments and relatvent informations for the specifide project.	Azmin	C02	13/2/2022	28/2/2022	15	100%
1.3	Impact of the solution	Rokaia	C03	23/2/2022	1/3/2022	8	80%
1.4	Sustainability and environmental impact	Saikat Rokaia	C04	23/3/2022	30/3/2022	7	100%
1.5	Project Managment Skills		C011	-	-	-	80%
1.5.1	Final Specifiaction	Azmin		25/3/2022	28/3/2022	3	100%
1.5.2	Methodology and applicable resources	Nowshin		23/3/2022	10/4/2022	17	80%
1.5.3	Attributes of Complex EP & EA	Nowshin		11/3/2022	23/3/2022	12	80%
1.5.4	Project Budget Risk Management	Saikat Nowshin Azmin		10/4/2022	17/4/2022	7	100%
1.6	Ethical Issues and Design Soltuion	Rokaia	C013	5/4/2022	10/4/2022	5	90%
1.7	Completion of the Project		C015	-	-	-	80%
1.7.1	Reviewed appropritae stakeholders	Rokaia Nowshin		10/4/2022	13/4/2022	3	100%
1.7.2	Prepare problem concept notes	ALL		17/4/2022	20/4/2022	3	100%

Fig 7.3.1: Project plan for 400P

WBS NUMBER	TASK TITLE	TASK OWNER	COURSE OUTCOME	START DATE	DUE DATE	DURATION	PCT OF TASK COMPLETE
2							
EEE 400D							
2.1	Design Multiple Engineering Solutions	Saikat	CO5	29/05/2022	10/05/2022	11	100%
2.1.1	Background Research & Servey	Rokaia		29/05/2022	01/06/2022	4	90%
2.1.2	Selection tools with justification	Saikat		02/06/2022	02/06/2022	2	100%
2.1.3	Design multiple basic structure	Saikat		02/06/2022	10/05/2022	5	100%
2.2	Analyze Alternative Design	Azmin	CO6	13/06/2022	19/06/2022	7	100%
2.2.1	Functional verification	Rokaia		13/06/2022	16/06/2022	3	90%
2.2.2	Finding different components for design from design warehouse	Nowshin		16/06/2022	19/06/2022	4	80%
2.3	Rearrange multiple mordern tools	Nowshin	CO9	20/06/2022	22/	12	90%
2.3.1	PVsyst Simulation	Saikat		20/06/2022	28/06/2022	8	100%
2.3.2	Load Calculation	Saikat & Nowshin		22/06/2022	22/07/2022	1	100%

2.3.3	Proteus Simulation	Saikat & Rokaia		20/06/2022	02/07/2022	12	100%
2.4	Design and validation of the solution	Rokaia & Azmin	CO10	04/07/2022	08/07/2022	5	100%
2.4.1	Test design and calculation verification	Azmin		09/07/2022	12/07/2022	4	80%
2.4.2	Updated Design with Optimal solution	Saikat		04/07/2022	12/07/2022	9	100%
2.5	Evaluation of Project Progress by estimated project plan	ALL	CO11	15/07/2022	17/07/2022	3	90%
2.5.1	Change the design as per advisor instruction	ALL		16/07/2022	22/07/2022	5	100%
2.6	Ethical Issues and Design Solution	Azmin & Nowshin	CO13	15/07/2022	18/07/2022	3	80%
2.6.1	Discussion and Update all report	ALL		16/07/2022	20/07/2022	5	80%
2.6.2	Ensure all the literature reviewer's reference	ALL		20/07/2022	21/07/2022	2	80%
2.7	Prepare Design Reports Deliver Oral Presentation	-	CO15	-	-	-	0%
2.7.1	Prepare Final Presentation Slide	-					0%

2.7.2	Ready for the final presentation of EEE400D						0%

Fig 7.3.2 project plan for 400D

EEE 400C							
3.1	**Implementation, testing and evaluate The solution**	**-**	**CO7**	**-**	**-**	**-**	**0%**
3.2	**Develop solution as per final design**	**-**	**CO8**	**-**	**-**	**-**	**0%**
3.2.1	**Prepare final prototype using IT tools**	**-**	**CO9**	**-**	**-**	**-**	**0%**
3.2.2	**Research proper information, skill, materials Resources to validate the final prototype**	**-**	**CO10**	**-**	**-**	**-**	**0%**
3.3	**Economic Analysis Cost-benefit Estimation**	**-**	**CO12**	**-**	**-**	**-**	**0%**
3.3.1	**Final Demonstration**	**-**	**CO15**	**-**	**-**	**-**	**0%**

Fig 7.3.3: Project plan for 400C

This is our revised project progress for the last phase to complete our tasks. We ensured to do our project according to our course outcome (CO). We conduct our last phase in the month of October, November & December of 2022. Accordingly, in the first month we did our preliminary implementation and testing followed by our project design that was covered in the design (EEE400D) part. After that, we develop the solution and prepare the final prototype.

Lastly, in all steps our LOGBOOK helps us to keep track of our project progress.

Chapter 8: Economical Analysis. [CO12]

8.1 Introduction

A project's costs and advantages are evaluated by economic analysis. We can estimate the profit, or return, that can be reasonably expected from the project with respect to the investment using this method to establish the project's economic viability. Moreover, it will help in analyzing the welfare impact of a project and better resource allocation. Last but not the least, the following section discusses the economic analysis of our project.

8.2 Economic analysis

Project economic analysis aims to ensure that scarce resources are allocated efficiently, and investment brings benefits to a country and raises the welfare of its citizens. Similarly, our project's costs and advantages are evaluated through economic analysis. We can estimate the profit, or return, that can be reasonably expected from the project with respect to the investment using this method to establish the project's economic viability. Additionally, it will help in analyzing the welfare impact of a project and better resource allocation.

8.3 Cost benefit analysis:

A hydroponic rack often lasts up to 10 years before needing any repairs. Approximately 180 new plants should bud out each season. Lettuce needs 45 days to grow in a healthy state each season.

Each lettuce leaf weighs 8.5g on average. We can make between 1550gm to 1.5kg. 100g of lettuce costing about 65 BDT. It is anticipated to generate 1007.5 BDT in 45 days. Thus, we may receive about 672 BDT each month. This project has an annual output capacity of 8060.4 BDT.

We can anticipate receiving a return on our investment in 3.5 years given that our initial investment was approximately 25550 BDT. The remainder of our earnings will subsequently be considered project profit.

Total Project Budget:

Table 19:

Serial No	Item Name	Per Unit Cost	Number of Item	Total Cost
1	Plant seeds	2	45	90
2	Plant cap	5	45	225
3	Foam	45	1	45
4	Rack	4080	1	4080
5	Rack Repair	1630	1	1630
6	Pipe, L bow, Glue	2600	1	2600
7	4*2 Pipe	800	1	800
8	Wifi Modem	1500	1	1500
9	Data Pack	550	1	550
10	Wire	500	1	500
11	Coffee for pH mesuarement	250	1	250
12	One time glass	5	10	50
13	Power jack and Cable	100	1	100
14	Battery	1800	1	1800
15	Microprocessor, Electrical Compon	5105	1	6590
16	Transportation & Others			1000
17	Solar Charge Controller	300	1	300
18	PVC Board	300	1	300
19	Plastic jar	90	1	90
20	Anti Cutter	85	1	85
21	Super Glue	35	1	35
22	AC Inverter	930	1	930
23	Extras	2000	1	2000
			In total cost =	25550

We can anticipate receiving a return on our investment in 3.5 years given that our initial investment was approximately 25550 BDT.

8.4 Evaluate economic and financial aspects:

Finally, the costs and advantages of this project are contrasted to see if the advantages outweigh the disadvantages. As we've already stated, the advantages—both monetary and intangible far exceed the drawbacks. The economy and society will both benefit greatly from this project. Additionally, we compare several plants. While we may plant 45 plants of strawberries, we can proceed with up to 180 plants of lettuce in a rack. Though strawberries are somewhat more

expensive than lettuces, we can't expect to make more money from their long-term cultivation because they do best in the winter. A strawberry seeds packet (50 pieces) costs 150 BDT. Moreover, it takes a lot of time to grow compared to lettuce. By payback calculations and cost analysis.
To ensure financial aspects we considered the quality of products and maintain the price as cheap as possible with ensuring a good product.

8.5 Conclusion

To conclude, we have examined how the project's implementation would impact the economy in this section. In order to achieve this, an economic study was conducted in which we examined various expenses related to the product, including direct costs, contingency costs, etc. Additionally, we considered the different advantages that this project may have, such as smart technology at a reasonable price and maintaining healthy crops as well.

Chapter 9: Ethics and Professional Responsibilities CO13, CO2

9.1 Introduction:

To develop a project, we need to consider some important parameters to ensure its safety and acceptability. In our case, we also determined some parameters and made sure to fulfill those requirements to ensure our project's safety. In addition, we have to develop things to consider our morals and values. We consider that fully satisfies our values, morals and laws.

9.2 Identify ethical issues and professional responsibility:

Here in the project, we are building a smart system for the plants to grow soilless with way less water. From this, we are trying this system to be beneficial to the environment as much as possible. If no harsh fertilization is used, then there is only a small amount of Carbon dioxide just from the respiration of the plants. The system is quite eco-friendly and the water used here is always recycled.

In our project, the group members are free to choose whether they want to conduct the project after knowing and deciding about the topic with their voluntary participation. The work and responsibilities were given to each member and we had to report it within a certain time.

We all are informed about the purpose, impact, and estimated budget of the project.

All the members reported their work on time and maintained confidentiality about the project as well as about the information of any other members. The potential harm is ensured to be none. Also, we are making plagiarism-free reports.

9.3 Apply ethical issues and professional responsibility:

- Avoid anything harmful for the environment and humans: We are responsible to our system. To obtain the best solution we have avoided any sort of harmful pesticides like Met aldehyde, Boric Acid, Diazinon, Durban, DDT, Malathion, etc.

- Have to consider laws of planting invasive and illegal plants: It is strictly forbidden to plant or grow any kind of invasive plant in Bangladesh according to law. We are absolutely considering these things. Also, in our system, we are trying to maintain the policy which is advised to follow in the agriculture industry.

- Need permission from stockholders: As the system is large in size, the area was an issue. Our stockholder has managed that and considered us to set up the rack as well as the electrical part under his supervision.

To have the consent we have also prepared a consent paper which is attached below,`

OFFICIAL CONSENT

This Official Consent was made on 20th, April 2022 by and between Sahid Alam who consent to the following: To build a smart Hydroponic system on their property.

The Consenter agrees to hold Rokaia Rahman, Azmin Akter Nipa, Saikat Rahut, and Nowshin Sadia harmless of all legal, financial, and any other liability that includes their agents, employees, successors and assigns, and their respective heirs, personal representatives, affiliates, successors and assigns, and any and all persons, firms or corporations liable or who might be claimed to be liable, whether or not herein named, none of whom admit any liability to the undersigned, but all expressly denying liability, from any and all claims, demands, damages, actions, causes of action or suits of any kind or nature whatsoever, which have or may hereafter have, arising out of or in any way relating to any and all injuries and damages of any and every kind, to both person and property, and also any and all injuries and damages that may develop in the future, as a result of or in any way relating to the Consenting Acts.

It is understood and agreed that this Agreement is made and received in the full and complete settlement and satisfaction of the causes of action, claims, and demands mentioned herein; that this Consent contains the entire Agreement between the parties; and that the terms of this Agreement are contractual and not merely a recital.

Furthermore, this Consent shall be binding upon the undersigned, and his respective heirs, executors, administrators, personal representatives, successors, and assigns.

This Consent shall be governed by the laws of the State of Bangladesh.

This Consent has been read and fully understood by the undersigned and has been explained to me.

Consenter's Signature: Shahid Alam Date: 20/04/22

Print Name: Sahid Alam

Releasee's Signature: Rokaia Rahman Date:20/04/22

Azmin Akter Date:20/04/22

Nowshin Sadia Date:20/04/22

Saikat Rahut Date:20/04/22

Print Name: Rokaia Rahman, Azmin Akter Nipa, Nowshin Sadia, and Saikat Rahut.

OFFICIAL CONSENT

This Official Consent made on 20th, April 2022 by and between Sahid Alam who consents to the following: To built a smart Hydroponic system on their property.

The Consenter agrees to hold Rokaia Rahman, Azmin Akter Nipa, Saikat Rahut and Nowshin Sadia harmless of all legal, financial, and any other liability that includes their agents, employees, successors and assigns, and their respective heirs, personal representatives, affiliates, successors and assigns, and any and all persons, firms or corporations liable or who might be claimed to be liable, whether or not herein named, none of whom admit any liability to the undersigned, but all expressly denying liability, from any and all claims, demands, damages, actions, causes of action or suits of any kind or nature whatsoever, which have or may hereafter have, arising out of or in any way relating to any and all injuries and damages of any and every kind, to both person and property, and also any and all injuries and damages that may develop in the future, as a result of or in any way relating to the Consenting Acts.

It is understood and agreed that this Agreement is made and received in full and complete settlement and satisfaction the causes of action, claims and demands mentioned herein, that this Consent contains the entire Agreement between the parties, and that the terms of this Agreement are contractual and not merely a recital.
Furthermore, this Consent shall be binding upon the undersigned, and his respective heirs, executors, administrators, personal representatives, successors and assigns.

This Consent shall be governed by the laws of the State of Bangladesh.

This Consent has been read and fully understood by the undersigned and has been explained to me.

Consenter's Signature _____ Date: 20/04/2022

Print Name: Sahid Alam

Releasee's Signature Rokaia Rahman Date: 20/04/2022

Azmin Akter Nipa Date: 20/04/2022

1

Saikat Rahut Date: 20/04/2022

Nowshin Sadia Date: 20/04/2022

Print Name: Rokaia Rahman, Azmin Akter Nipa, Saikat Rahut and Nowshin Sadia

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9.4 Conclusion:

In this chapter, we have mentioned all the moral values that we have followed till the project completion. Also, the stock holder involvement was defined with the consent paper. Along with that the plants we are using are being chosen by seeing the laws and our social culture.

Chapter 10: Conclusion and Future Work

10.1 Project summary/conclusion:

Our main goal is growing enough food or maintaining food quality through the Smart Hydroponic System. For that reason, we did background research and surveys. The NFT (Nutrient Film Technique) based system with the growth chamber technique. In this method, we use an NFT system to provide nutritional liquid to the plants' roots on a regular basis while maintaining a steady, regulated flow through the pump. We need to keep a close check on the fertilizer solution since it is going straight to the plant roots. As a result, a microcontroller-based system is utilized here to save data on the status of the nutritional liquid via sensors. Here, we're keeping an eye on the nutritional solution and water flow. We also wish to provide a stress-free environment for the plants. As a result, all of the sensors for all parts of the environment that plants require have been incorporated, as well as an artificial grow light and humidifier, to provide the plants with the light and moisture they require to thrive. And it is in this manner that our hydroponics plants will develop.

10.2Future work:

- Measuring plant growth.
- Applying the module on the various plants.
- Better control on the electrical devices.
- Plant growth on the seasonal varieties.
- Protection shields for the electrical device and the nutrient tank.
- Applying growth light.

In future our main intention will be to look after the plant growth of lettuce. Apart from that doing the same module on different kinds of plants such as Tomato, Strawberry, Onion etc. Also, we want to assure our electrical system control with the best accuracy. Introducing a new control system for the plant such as measuring every concentration of the ingredient of the nutrient. Controlling nutrients for the various plants with its required parameters such as for strawberries we want to measure the pH and EC value manually first then controlling the nutrients parameters as per the manual values. Furthermore, we want to look after the plant growth in terms of seasonal varieties. Collecting the data for the individual growth of plants from summer, rainy day and heavy winter we can see the similarities or the differences. Applying growth light, we can measure the fruit size and can see the differences with the fruit who has grown without growth light. Also set up a protection shield for the electrical devices and nutrient tank to avoid unavoidable odds like rain, thunder, sunlight.

Chapter 11: Identification of Complex Engineering Problems and Activities.

11.1: Identify the attribute of complex engineering problem (EP)

Table 20:

Attributes of Complex Engineering Problems (EP)

	Attributes	Put a tick (√) as appropriate
P1	Depth of knowledge required	√
P2	Range of conflicting requirements	√
P3	Depth of analysis required	√
P4	Familiarity of issues	√
P5	The extent of applicable codes	
P6	The extent of stakeholder involvement and needs	
P7	Interdependence	√

11.2: Provide reasoning how the project address selected attribute (EP):

P1. Depth of knowledge:

In our project, we need to gather knowledge about the technique of "Hydroponic Cultivation", from previous publications, articles, journals, and books to acquire every detailed method and process regarding this topic.

P2. Range of Conflicting Requirements:

Our project is costly if we use the power source from the grid. For this reason, we make our project low-cost by using solar power.

P3. Depth of analysis:

We need to analyze and model our project by the depth of our knowledge regarding the techniques. By reading publications, research papers, and recent works we can have a clear idea of how the project should be modeled in our country which is effective and efficient for both the environment and the economic way.

P4. Familiarity issues:

Worldwide Hydroponic Cultivation is not new, rather it is a very popular and desired way of cultivation. There are many hydroponic cultivations going on around our country. One of them was introduced by Sher-E-Bangla Agriculture University, Dhaka, Bangladesh.

P7. Interdependence:

Our project also has interdependence because in our project we included sub-projects such as Solar system, Water pumping, and Software system.

11.3 Identify the attribute of complex engineering activities (EA)

Attributes of Complex Engineering Activities (EA)

Table 21:

	Attributes	**Put a tick (√) as appropriate**
A1	Range of resource	√
A2	Level of interaction	
A3	Innovation	
A4	Consequences for society and the environment	√
A5	Familiarity	√

11.4 Provide reasoning how the project address selected attribute (EA)

A1. Range of Resources:

Our project completes the Range of resources because it is an IoT-based project besides, we use a GSM module for notification and, we also have stakeholder involvement. We use Shere-Bangla-Agriculture University land for our project settlement Besides, we get nutrients for plants from our stakeholders. Along with this we also make a budget plan and we use a proper workflow to complete our project on time.

A4. Consequences for society and the environment

Our project has consequences in the environment because it will fulfill the nutritious food issues. We can grow more quality of crops by our project. As our project is solar energy based, we can reduce the pressure of grid load. We also don't need cultivate land for our project to grow nutritious food. In our project no harmful pesticides will use so the crops are organic.

A5. Familiarity

Our project has familiarity. Hydroponic technology is not new. In our project we developed it in a way where no human touch is required, we make it that much easy that crops can easily grow on their own and if maintenance is needed it can be notified by the notification or can be controlled by the application.

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13. Appendix:

13.1 Log Book:

We've made our project in Sher-e-Bangla Agriculture University, Dhaka. Here, we build our project as per proper materials which took a little bit more time than usual. However, we also have done the economic analysis of the cost benefit estimation before the final project. This analysis evaluates the validation of our project. Last week, we took preparation for real time simulation and project completion which is very helpful to demonstrate our project in the final term. Lastly, in all steps our LOGBOOK helps us to keep track of our project progress.

400P:

Date	**A Attendees**	**Date/Time/Plac Summary of Meeting Minutes**	**Responsible**	**Comment by ATC**
12/02/2022	1. Rokaia 2. Azmin 3. Nowshin 4.Saikat	1. Review of project concepts 2. Need to define the problem statement. 3. Assigned to prepare a draft concept note 4. Implementation	Task 1: Rokaia & Azmin Task 2: Saikat & Nowshin Task 3: All Task 4: All	Discussed project problems. Suggestions regarding new ideas. Help out to do research. Advised to come up with new concepts.
28/02/2022	1. Rokaia 2. Azmin 3.Nowshin 4. Saikat	1. Rearrange the requirements 2. Elaborate problem statement 3. Convert in the concept note 4. Add constraints	Task 1: All Task 2: All Task 3: All Task 4: All	Task 1: completed. Task 2: partially completed. Task 3: completed Task 4: canceled.
03/02/2022	1.Rokaia 2. Azmin 3.Nowshin 4.Saikat	Discussion on, Impact, sustainability, methodology, Applicable standers and codes Ethical consideration, and risk management	Task 1: All Task 2: All Task 3: All Task 4: All	Task completed partially
23.3.22	1. Rokaia 2. Azmin 3.Nowshin	Discussion on methodology, Expected Outcome, Impact, sustainability, Applicable standers and codes Ethical consideration, and risk management	Task 1: All Task 2: All Task 3: All	,,
24.4.22	1. Rokaia 2. Azmin 4. Saikat	Discussion on, Ethical consideration, and risk management, budget, Ethical consideration, and risk management	Task 1: All Task 2: All Task 3: All	Task completed

400D:

Date	Attendee	Summary of the meeting	Responsible	Comment by ATC
29/5/22	1. Saikat 2. Azmin 3. Rokaia 4. Nowshin	1. Selection of tools with justification. 2. 3D design. 3 Verify the optimal solution.	Task 1: All Task 2: All Task 3: All	Discussed selection of the tools. Suggestions regarding new ideas. Help out to do research. Multiple solutions with functional verifications.
13/6/22	1. Saikat 2. Azmin 3. Rokaia 4. Nowshin	1. Functional verification of the design solutions. 2. Selected tools for the simulation. 3. Background research and survey.	Task 1: All Task 2: All Task 3: All	Suggestions about the 3D design. Discussion about the simulation. Discussion about the library of the sensors
5/7/22	1. Saikat 2. Azmin 3. Rokaia 4. Nowshin	1. Rearrange the multiple design approaches 2. Elaborate the selected tools 3. Discussion about the 3D design	Task 1: All Task 2: All Task 3: All	Task 1: completed. Task 2: Partially completed. Task 3: Completed
7/8/22	1. Saikat 2. Azmin 3. Rokaia 4. Nowshin	1. Adding test case multiple design approaches 2. Adding switch and notification in the system. 3.Background research and survey.	Task 1: All Task 2: All Task 3: All	Task1: Partially completed. Task2: Completed. Task3: Completed.

16/8/22	1. Saikat 2. Azmin 3. Rokaia 4. Nowshin	1. Discussion about the expected impact of the optimal solution. 2. Analyzing the optimal solution. 3. Solar calculation in PVSYST	Task 1: All Task 2: All Task 3: All	Task 1: Completed. Task 2: Completed. Task 3: CompletedDate

400C:

Date	Attendee	Summary of the meeting	Responsible	Comment by ATC
26/9/22	1. Saikat 2. Azmin 3. Rokaia 4. Nowshin	1. Selection of hardware tools with justification. 2. 3D design modification. 3 Structure of hydroponic Rack.	Task 1: All Task 2: All Task 3: All	Discussed selection of the Hardware tools. Suggestions regarding new ideas. Help out to do research.
31/10/22	1. Azmin 3. Rokaia 4. Nowshin	1. Specification of the Rack 2. Selected hardware tools. 3. Background research and survey.	Task 1: All Task 2: All Task 3: All	Discussion about the hardware circuit.. Discussion about the library of the sensors in the Arduino IDE
14/11/22	1. Azmin 2. Nowshin	1. Writing Of the report. 2. Power calculation in terms of all the load	Task 1: All Task 2: All Task 3: All	Task 1: Partially completed. Task 2: Partially completed.
28/10/22	1. Azmin 2. Rokaia 3. Nowshin	1. Selection of the PV Panel 2.Discussion about the IOT progress 3.Idea about the project showcasing	Task 1: All Task 2: All Task 3: All	Task1: completed. Task2: Partially Completed. Task3: Partially Completed.
5/12/22	1. Saikat 2. Azmin 3. Rokaia 4. Nowshin	1. Discussion about the IOT and GSM. 2. Analyzing the validations 3. Discussion about the stored Data	Task 1: All Task 2: All Task 3: All	Task 1: Completed. Task 2: Completed. Task 3: Completed