SMART AEROPONICS USING IOT

A Project Report

Submitted by

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to

APJ Abdul Kalam Technological University

in partial fulfillment of the requirements for the award of the Degree of

Bachelor of Technology (B.Tech)

in

MECHATRONICS ENGINEERING

Under the guidance of

MR. SIBIN JOHNY

JYOTHI ENGINEERING COLLEGE
LEAD KINDLY LIGHT
TET
CREATING TECHNOLOGY LEADERS OF TOMORROW
ESTD 2002

DEPARTMENT OF MECHATRONICS ENGINEERING

Jyothi Engineering College
Reaccredited with NAAC (Grade A) and NBA Programmes*
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December 2022

DECLARATION

We the undersigned hereby declare that the project report "Smart Aeroponics Using IoT", submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under supervision of Mr. Sibin Johny. This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources. We also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in this submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously used by anybody as a basis for the award of any degree, diploma or similar title of any other University.

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CERTIFICATE

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VISION OF THE INSTITUTE

Creating eminent and ethical leaders through quality professional education with emphasis on holistic excellence.

MISSION OF THE INSTITUTE

- To emerge as an institution par excellence of global standards by imparting quality Engineering and other professional programmes with state-of-the-art facilities.
- To equip the students with appropriate skills for a meaningful career in the global scenario.
- To inculcate ethical values among students and ignite their passion for holistic excellence through social initiatives.
- To participate in the development of society through technology incubation, entrepreneurship and industry interaction.

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MISSION OF THE DEPARTMENT

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- To provide quality education to create graduates with professional and social commitment.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1: Graduates shall possess fundamental and advanced knowledge in electronics, electrical and mechanical along with fundamental knowledge in mathematics, basic sciences and computer programming to analyze and solve the challenges related to automation.

PEO 2: Graduates shall have ability to design and create novel solutions with modern tool usage which lead to a lifelong learning or higher qualification, making them experts in their profession

PEO 3: Graduates shall have the ability to work in a multidisciplinary environment with good professional and ethical commitment.

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1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
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7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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COs	Description
CO1	Model and solve real world problems by applying knowledge across domains(Cognitive knowledge level: Apply).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: Apply).
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CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: Apply)
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: Analyze).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: Apply).

CO MAPPING TO POs

	POs											
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1
Average	1	1.17	1.17	0.3	1.5	0.83	0.83	1.17	1.5	1.3	1.33	1.33

CO MAPPING TO PSOs

	PSOs	
COs	PSO1	PSO2
CO1	3	3
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3
CO6	3	3
Average	3	3

ABSTRACT

Aeroponics is a type of urban farming that uses air as a growing medium. Aeroponics farming allows for a considerable decrease in water usage with improved production when compared to hydroponic or conventional farming.In aeroponics, plants are grown in an air or mist environment with their roots suspended in air. The plants are regularly misted with a nutrient-rich water solution, providing them with the nutrients they need to grow.

Aeroponics systems can be more complex and require more equipment than other hydroponics systems, but they can also offer a number of benefits, including faster growth and higher yields. However, they can also be more sensitive to changes in temperature and humidity, and require more precise control of nutrient levels.

IoT sensors and devices can be used to gather data on various aspects of the aeroponics system, such as the temperature, humidity, and nutrient levels, and send this data to a central controller or computer. This data can then be used to make adjustments to the system in real-time to optimize growing conditions.In addition to automation and monitoring, IoT technology can also be used to remotely access and control the aeroponics system from a smartphone or other device. This can be particularly useful for commercial growers who need to manage multiple systems in different locations.The design and construction of an aeroponics system using the Internet of Things (IoT) for online and automated monitoring are presented in this project.

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CHAPTER 1

INTRODUCTION

1.1 Overview

The desire for eating freshly, locally and organically produced vegetables and herbs has become a major topic in this day and time. It is good, if seasonal vegetables can be produced all year round, with the use of soil, but here in Nigeria, challenges of climatic condition and the need for land use for social economic activities such as: Shelter, Transportation, Urbanization and Industrialization, hinders this project. Another issue that we have, is insecurity such as: Kidnapping, Animal rustling, Boko haram, Gun men attacks to lack of relevant agricultural technology appreciation and application by stakeholders (Farmers, Government and Extension Agents). There is also a general problem of Soil infertility. Unguided resources allocation and utilization. Crops get contaminated by certain chemicals underground and could be harmful to consumers .[1]

In aeroponics, the plants are never submerged in the water. The nutrients from the water solutions are delivered to the plants by spraying the water to their lower stem and roots. The main advantage of this technique is that the plant will grow healthier because the disease that may spread from plant to plant can be prevented. However, there still exists a problem in aeroponic, i.e. any failure of the nutrient distribution (including water) can lead to the rapid death of the plants. Therefore, to prevent the failure in aeroponic farming, indicators, i.e. humidity and temperature, that are crucial for the cultivation environment must be carefully and continuously monitored and controlled . There are some previous reports on the implementation of aeroponic systems. An aeroponic system was built for a seed-potato development . This system was capable of monitoring the root chamber temperature and humidity onsite. Humidity was created by using mistmaker and fan which was controlled by a timer without any feedback from any sensors. Another system was developed with the capability to monitor the parameters in real time and online [2].

CHAPTER 2

LITERATURE SURVEY

2.1 Modern Plant Cultivation Technologies In Agriculture Under Controlled Environment: A Review On Aeroponics

This paper describes a novel approach to plant cultivation under soil-less culture. At present, global climate change is expected to raise the risk of frequent drought. Agriculture is in a phase of major change around the world and dealing with serious problems. In future, it would be difficult task to provide a fresh and clean food supply for the fast-growing population using traditional agriculture. Under such circumstances, the soil-less cultivation is the alternative technology to adapt effectively. The soil-less system associated with the Hydroponic and Aeroponics system. In the aeroponics system, plant roots are hanging in the artificially provided plastic holder and foam material replacement of the soil under controlled conditions. The roots are allowed to dangle freely and openly in the air. However, the nutrient rich-water deliver with atomization nozzles. The nozzles create a fine spray mist of different droplet size at intermittently or continuously. This review concludes that aeroponics system is considered the best plant growing method for food security and sustainable development. The system has shown some promising returns in various countries and recommended as the most efficient, useful, significant, economical and convenient plant growing system then soil and other soil-less methods.[3]

2.2 Internet of Things Hydroponics Agriculture (IoTHA) Using Web/Mobile Applications

In this proposal, our concern is innovating an automation system for hydroponics agriculture based on internet of things (IoT) technology. The programming logic control that is used in the proposed system is consisted of six input from the sensors: namely, potential hydrogen (PH) value, electrical conductivity (EC) value, water temperature value, air temperature value, light value, motion sensor value. All of these values will be communicated to the microcontroller (ESP32) by the sensors. The microcontroller will transmit all the values (data) received through Wi-Fi to the internet on ThingSpeak and Blynk platforms for analysis and visualization. Hydroponics as an advanced technique for vegetable production: An overview. Various hydroponics structures such as wick, ebb and flow, drip, deep water culture and Nutrient Film Technique (NFT) system, their operations, benefits, limitations, performance of different crops like tomato, cucumber, pepper and leafy greens and water conservations have been discussed. [4]

2.3 Design and Implementation of IoT System for Aeroponic Chamber Temperature Monitoring

The aeroponic system in this work consists of two separate chambers. The chamber on the upper side is called the growth chamber where the stem, leaves, or fruits grows. This site is exposed to light. The chamber on the lower side is called the root chamber. The root chamber contains the roots hanging upside-down in the air. It is sealed from light to provide an environment similar to that of the soil. This system employed mist maker for the distribution of water and nutrient in the form of mist. The root chamber temperature and light intensity are monitored online, continuously. Some actuators are placed to control the temperature to realize an ideal condition for plant growth, i.e. water spinach (Ipomea Reptans).

The aeroponic system consists of a temperature control subsystem (red dashed block), a humidity nutrient distribution subsystem (blue dashed box), and a light intensity sensor. These subsystems and light sensors were connected to Wemos D1 Mini microcontroller which has an integrated WiFi module. The connection established by Wemos D1 Mini allowed the parameters, i.e. temperature, humidity, and light intensity, to be monitored in real-time via the internet.

The system consists of two separate chambers, i.e. the growth and the root chamber. The plants are to be placed in the six available netpots such that the upper side of the plants (stem and leaves) is in the growth chamber while the lower part of the plants (roots) is in the root chamber. The growth chamber was designed for the plants to be exposed by the sunlight. The root chamber was designed as a closed and dark space resembling that of the soil. For cooling of temperatures[1]

CHAPTER 3

METHODOLOGY

3.1 Overview

Automated aeroponic system by controlling the humidity, temperature, and light cycles automatically. By automating humidity, wastage of water can be prevented to a great extent. We are also incorporating the concept of Internet of Things for uploading data related to system onto a cloud network. These data will be useful for others who are performing similar cultivations. Also through IoT, the user can monitor the health of plants from anywhere. This section first introduces the hardware components used for our implementation followed with the control algorithm. We construct individual sensor nodes which then communicate to a Central HUB over a Personal Area Network), which then communicates to data to a cloud. Initially, we proceeded with the design of a grow bed for our experimental setup. Multiple LED strip lighting was used to compensate for the ambient light. Aluminum foil was used to enhance the retention of light, temperature, and humidity.

3.2 Hardware Components

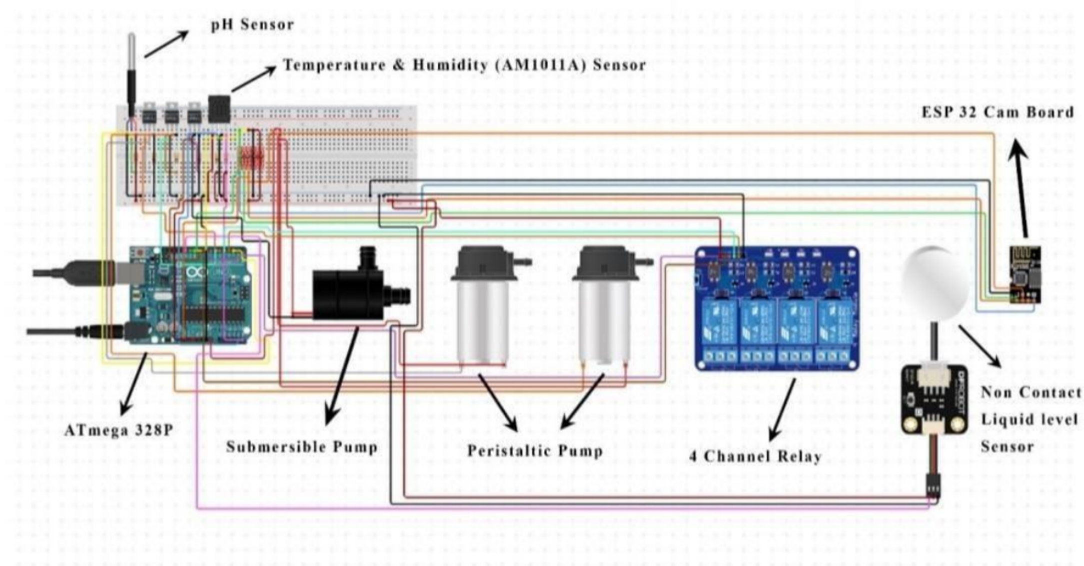

Figure 3.1: Circuit Diagram with Components

3.2.1 ATmega 328P

Arduino UNO We make use of an Adruino Uno R3 microcontroller board. The choice of the microcontroller was based on the availability of extensive sensor and interfacing libraries and the presence of an active online support community. The Arduino Uno uses an ATMega328P 8-bit microcontroller with 32 kB flash memory for program and data storage.

3.2.2 Relays

Relays are often used in electronic circuits to control the flow of electricity to devices such as motors, pumps, and lights. They are particularly useful in situations where it is not practical or safe to use a direct electrical connection between the controlling circuit and the controlled device.

3.2.3 ESP 32 Wi-Fi Module

The ESP 32 Wi-Fi Module is a microcontroller developed by Espressif Systems. It is based on the popular ESP 8266 Wi-Fi module and offers improved performance, a larger memory, and a wider range of features. Some of the key features of the ESP 32 Wi-Fi module include:

- Dual-core 32-bit processor
- 4 MB of flash memory for storing programs and data
- Wi-Fi and Bluetooth connectivity
- On-chip ADC and DAC
- Multiple UART, I2C, and SPI interfaces
- Low-power consumption

3.2.4 pH sensor

pH sensor is used to measure the pH value in the water and maintain it as neutral point. If pH value is changed it will be normalized by activating pH low solution using peristaltic pump.

3.2.5 DHT-11 Humidity and Temperature Sensor

Typically, for precision agriculture, sensors like the SHT1x are used. SHT1x is designed to prevent rusting and for increased precision, but at the same time expensive (*25$). However, in the proposed aeroponics system, we make use of a DHT-11—ambient temperature and humidity sensor. This sensor costs less than 2$, measures only the ambient temperature and humidity and is not specific to agriculture. But since the roots are suspended in air, such a sensor is sufficient in making decisions with regard to root temperature and moisture.

3.2.6 Submersible pump

Submersible pump is used for pumping of solution nutrient to roots of the plants using PVC pipe Structure at certain time interval.

3.2.7 Li-ion Battery

Li-ion Battery is the source energy of the project. Its used to power up the system for take placing there actions.

3.2.8 Liquid Sensor

Liquid Level sensor is used to maintain the water level in the tank without direct contact to the water. If there is any changes occur, with the help of peristaltic pump it will be maintained its level.

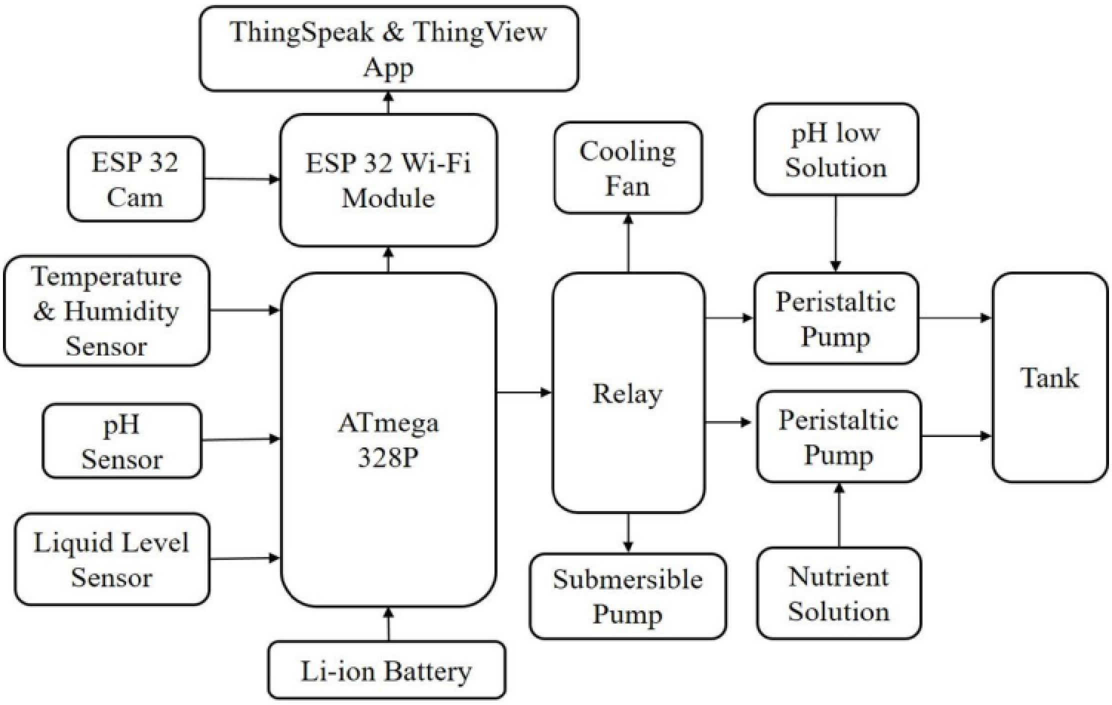

Figure 3.2: Blockdiagram for the project

3.3 Software Components

3.3.1 Arduino IDE (Integrated Development Environment)

Arduino Integrated Development Environment (IDE) is a software application that is used to develop and upload programs (called sketches) to Arduino boards. It is a free, open-source application that is available for Windows, macOS, and Linux.

The Arduino IDE includes a text editor for writing code, a compiler for converting the code into a format that can be understood by the microcontroller on the Arduino board, and a debugger for identifying and fixing errors in the code. It also includes a library of functions and example sketches that can be used as a starting point for new projects.

To use the Arduino IDE, you will need to install it on your computer and connect your Arduino board to your computer via a USB cable. Once the board is connected, you can use the IDE to write and upload code to the board. The Arduino IDE supports a wide range of microcontrollers and development boards, making it a popular choice for many Arduino enthusiasts and professional developers.

3.3.2 ThingSpeak Web Platform

ThingSpeak is a cloud-based Internet of Things (IoT) platform that allows users to collect and store data from sensors, devices, and applications in the cloud, and to create visualizations and perform analysis on the data. It is a web-based platform that is accessed through a web browser.

Some of the key features of ThingSpeak include:

- Data storage: ThingSpeak allows users to store and retrieve data from sensors, devices, and applications in the cloud. The data is stored in channels, which are essentially containers for a specific type of data.
- Data visualization: ThingSpeak provides a variety of tools for visualizing and analyzing data, including line graphs, bar charts, and maps.
- Integration with other applications: ThingSpeak can be integrated with a wide range of applications, including MATLAB, Excel, and Node-RED, allowing users to analyze and manipulate data in a variety of ways.
- API (Application Programming Interface): ThingSpeak provides an API that allows users to access and manipulate data from the platform using programming languages such as Python, Java, and C++.

3.3.3 ThingView App

ThingView is a mobile application that allows users to access and visualize data from the ThingSpeak Internet of Things (IoT) platform. It is available for Android and iOS devices, and it provides a convenient way for users to monitor and control their IoT devices and systems remotely.

Some of the key features of ThingView include:

- Data visualization: ThingView allows users to view data from their ThingSpeak channels in the form of graphs, charts, and maps.

- Remote control: ThingView provides a user interface for controlling the outputs of the user's IoT devices and systems.

- Alerts: ThingView can send alerts to the user's mobile device when certain conditions are met, such as when a sensor exceeds a certain threshold or when a device fails.

- Customization: ThingView allows users to customize the appearance and behavior of the app, including the layout and the types of data that are displayed.

Overall, ThingView is a useful tool for users who want to monitor and control their IoT devices and systems remotely. It provides an easy-to-use interface for accessing and visualizing data from the ThingSpeak platform, and it allows users to stay connected to their devices and systems even when they are away.

3.3.4 Cloud

The ThingSpeak cloud service is used in this project to allow for remote data monitoring over the internet. ThingSpeak is a free cloud service that is specifically designed for implementing IoT (Internet of Things) applications. It allows users to send and receive data from devices and sensor networks to the cloud, where it can be accessed and analyzed from anywhere with an internet connection. In this project, the ThingSpeak cloud is used to communicate with the Raspberry Pi HUB through HTTP POST and GET requests. These requests allow the system to send data to the cloud and receive commands or updates from the cloud. By using ThingSpeak, it is possible to remotely monitor the conditions in the grow chamber and make adjustments as needed, even if the user is not physically present.

3.4 Working

The Arduino Uno board is interfaced with temperature and humidity sensor DHT-11. The data from the sensor are read using the analog pins in Arduino. If the temperature and humidity value falls below the threshold value, the fan and pump will work accordingly. Similarly, if the sensor values are beyond the threshold, then the fan and pump will be shutdown. To further expand on the functions of the water and nutrient distribution system in the aeroponic growing chamber, it is important to understand how the system uses the data from the temperature and humidity sensor to control the fan and pump. The threshold values for the temperature and humidity are preset by the user, and the system monitors the sensor data continuously to determine whether the current conditions are within these thresholds. If the temperature or humidity falls below the set threshold, the system will activate the fan and pump to adjust the conditions in the grow chamber. On the other hand, if the sensor values are above the threshold, the system will deactivate the fan and pump to prevent over-humidification or overheating.

The smart lighting system in the grow chamber is designed to adjust the light level inside the chamber based on the ambient light level. This allows for more natural growth conditions for the plants, as they would receive a similar amount of light as they would in their natural environment. The light cycle can be set manually or controlled remotely through a cloud service, depending on the needs of the plants. For example, if the plants are in the growth phase, they may require a longer light cycle, while plants in the flowering phase may need a shorter light cycle. The RTC module, called the DS1307, is used to set the time intervals for these different light cycles, ensuring that the plants receive the appropriate amount of light at the right times.

The system also includes an IoT cloud service called ThingSpeak, which allows for remote data monitoring and control over the internet. By using HTTP POST and GET requests, the system can send data to the ThingSpeak cloud and receive updates or commands from the cloud. This enables the user to remotely monitor the conditions in the grow chamber and make adjustments as needed. The ThingSpeak cloud service is particularly useful for this application because it is tailored specifically for implementing IoT applications and allows for easy integration with a wide range of devices and sensor networks. Overall, the combination of the temperature and humidity sensor, the fan and pump control system, the smart lighting system, and the ThingSpeak cloud service work together to create a comprehensive system for controlling and optimizing the growing conditions in the aeroponic chamber.[5]

Additionally, the data acquisition nodes in the system allow for precise measurement of various environmental factors, including temperature, humidity, pH, and ambient light. This enables the user to have a clear understanding of the conditions within the grow chamber and make informed decisions about how to adjust the system to optimize plant growth. The system also has the ability to store data and track changes over time, providing valuable insights into the long-term performance of the aeroponic system and the impact of different growing conditions on plant growth. Overall, the combination of accurate data measurement and flexible control options makes the water and nutrient distribution system a powerful tool for supporting the growth and health of plants in an aeroponic environment.

3.5 Design

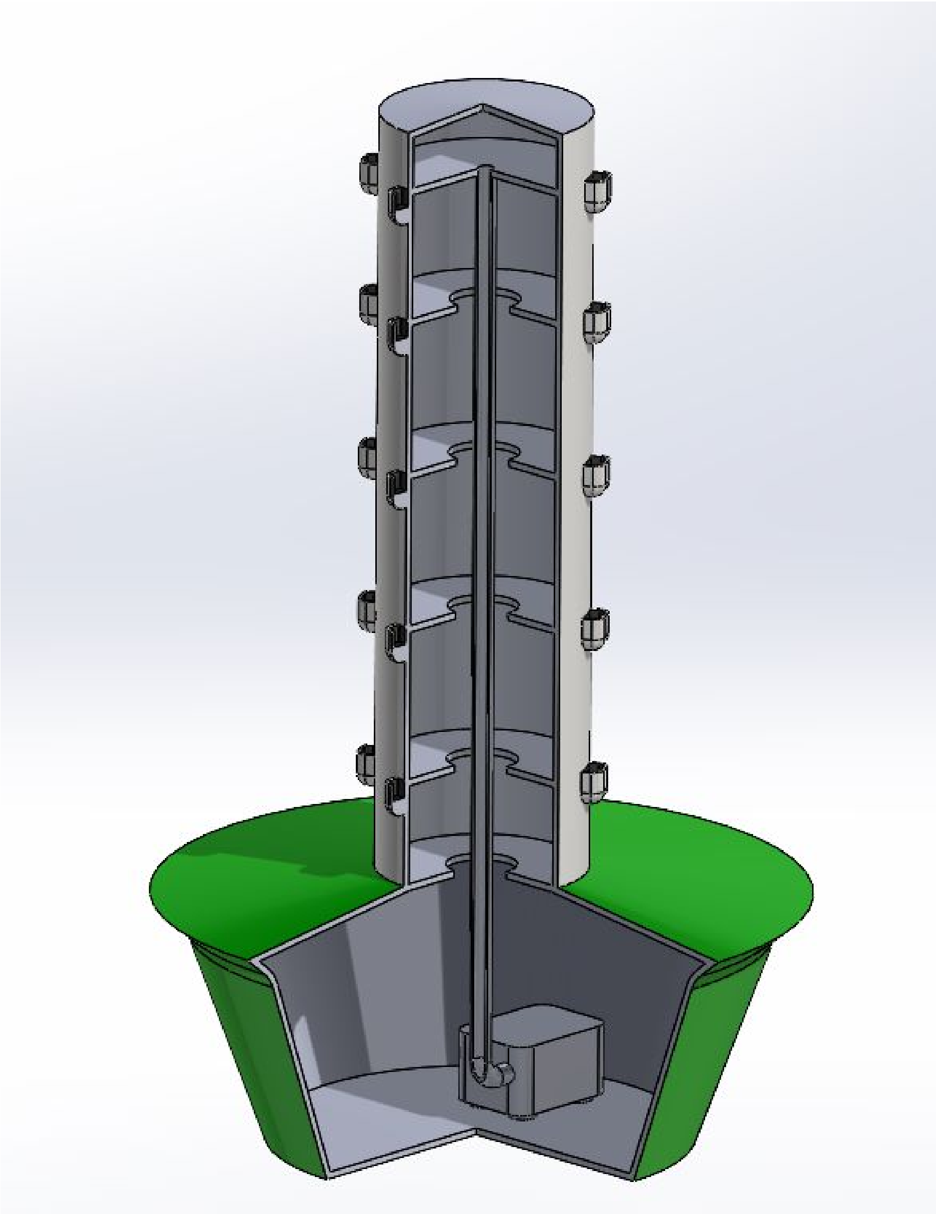

Figure 3.3: Design

CHAPTER 4

CONCLUSION

The monitoring and control system for distribution of water and nutrients in aeroponic, a growing chamber/grow bed, has been successfully designed . The system features individual data acquisition nodes to measure temperature, moisture, pH, and ambient light in order to control the parameters for optimal plant growth. The threshold values and light cycles can be set manual or over the IoT cloud service set up for the purpose of remote data monitoring.

- The non-contact liquid level sensor operates admirably as well. Using a peristaltic pump, it replenishes the water level based on the lack of water.
- The AM1011A sensor performs better at detecting temperature and humidity, and when the temperature rises too high, it activates the cooling fan.
- The monitoring of the plants, pH level, Temperature-Humidity level and water level are all done using Esp32 camera, ThingSpeak platform and ThingView App

It features data acquisition nodes that measure various environmental factors, including temperature, moisture, pH, and ambient light, to ensure optimal conditions for plant growth. The system allows for manual adjustment of threshold values and light cycles, as well as remote monitoring through an IoT cloud service. This allows for precise control over the growing environment and enables effective management of the plants within the aeroponic system.

The system performed real-time, online monitoring of key parameters, i.e. humidity, temperature, and light intensity. Without any control, the root chamber temperature reached 32.9 °C. The control of root chamber temperature was properly carried out resulting in an average value of 28.8 °C which is well within the ideal plant growth temperature. The system was tested by using water spinach and results showed that the plants grew in the aeroponic chamber.

REFERENCES

[1] C. A. Jamhari, W. K. Wibowo, A. R. Annisa, and T. M. Roffi, “Design and implementation of iot system for aeroponic chamber temperature monitoring,” pp. 1–4, 2020.

[2] M. Ahmed, A. Farrukh, M. I. Shah, S. Jamil, I. H. Kalwar, and A. Kamran, *Design and Development of IoT Based Aeroponics Growbox*. 2021.

[3] I. A. Lakhiar, J. Gao, T. N. Syed, F. A. Chandio, and N. A. Buttar, “Modern plant cultivation technologies in agriculture under controlled environment: a review on aeroponics,” *Journal of Plant Interactions*, vol. 13, no. 1, pp. 338–352, 2018.

[4] D. E. Adache Paul, Dr. Aminat Ajibola, “Internet of things hydroponics agriculture using web/mobile application,” *International Research Journal Of Engineering And Technology*, vol. 9, 2022.

[5] M. S. Gour, V. Reddy, V. M., S. N., Vishuvardhan, and V. T. Ram, “Iot based farming techniques in indoor environment: A brief survey,” pp. 790–795, 2020.