Automated Greenhouse for Growing Lettuce

A Capstone Project

Presented to

The committee of Oral Examiners

J.H. CERILLES STATE COLLEGE

DUMINGAG CAMPUS

Dumingag, Zamboanga del sur

In Partial Fulfilment

of the Requirements for the Degree of

BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

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by

Maricar H. Olarte
Chella Mae C. Camus
Riylyn T. Niego
Nelmar Jun C. Tumagna

MELIZA J. CHATTO
Adviser

APPROVAL SHEET

The capstone project study titled, "**AUTOMATED GREENHOUSE FOR GROWING LETTUCE**", prepared and submitted by Tumagna, Nelmar Jun C., Niego, Riylyn T., Camus, Chella Mae C. and Maricar H. Olarte has been examined and is recommended for approval and acceptance.

RECOMMENDED:

MELIZA J. CHATTO
Adviser

APPROVED by the IT Project Defense Panel with a grade of _________ on May 20, 2022.

ZENON A. MATOS, JR., MIT
Chairperson

ROMAFE P. MATOS
Member

VINCENT JOHN L. CHATTO
Member

NIÑOBEL G. CANENCIA
Member

ACCEPTED and APPROVED in partial fulfillment of the requirements for the degree Bachelor of Science in Information Technology.

ZENON A. MATOS, JR., MIT
Dean, School and Engineering and Technology

DATE: ___________________

ABSTRACT

Gardening is one of the popular hobbies among the people in the midst of busy work culture and urban life style. Gardening seems to release the stress, healthy spending of the leisure time effectively. But the apartment living has no free space for gardening. As a result, small scale greenhouse is now the hottest trend in the century. Greenhouse is a structure that the user used to grow the plants. Although it creates a perfect environment for plants, it needs human care to control the optimum status of the house such as ventilation. Automated greenhouse is to ease people when they wish to grow plants. It helps to monitor the situation, when they are not at home. (Thangavel Bhuvaneswari Faculty of Engineering and Technology Multimedia University, 2014).

The aim of the project was to create a prototype for automated greenhouse for growing lettuce that monitored the temperature, humidity, light and water flow inside the greenhouse. When it is so hot, the dynamo motor would directly control the shader. The LDR would control the turn on/off the grow light. The data was stored and be displayed in the web from Thing Speak. Relevant data were gathered and used for the design of the prototype. Several components were used in automated greenhouse for growing lettuce prototype like Arduino Uno, LCD, LDR, DHT11 and wi-fi module.

Testing prototype was done to observe and evaluate whether the objectives set were met and whether it function as it was expected too. Based on the series of testing conducted, the prototype successfully performed its function. Greenhouse status were monitored, DHT11 measured the amount and humidity and the data was sent to the Thing Speak which could be viewed in the webpages.

Keywords: Greenhouse Automation, Sensors, temperature, humidity.

ACKNOWLEDGMENT

Through the trials and obstacles that the researchers have encountered along the way, some people showered their special assistance and never left them behind as they go on the accomplishment of this project.

Grateful appreciation are due to Mr. Zenon A. Matos, Dean, School of Engineering and Technology, Mrs. Meliza J. Chatto, the capstone project adviser; Mr. Vincent I. Chatto Arduino instructor, for sharing their knowledge, never ending support and guidance, generosity and for imparting their expertise which enabled them to have a successful work;

Unending thanks to the panel members, Mrs. Romafe P. Matos, Mr. Niñobel G. Canencia, Mr. Precious Gitalan and Mr. Vicpher D. Garnada for their helpful comments and constructive criticism on the technical aspects of the method and manuscript;

To those people whose names not mentioned but in other way, assisted, encouraged and inspired them in making this work possible, heartfelt gratitude are due;

Above all, thanks and praises to the Almighty Father for giving them blessings, intellect, guidance, strength and protection to survive the four long years of struggle; and for enlightening their mind to pursue this project, for without Him they are nothing.

DEDICATION

This humble project is heartily and profoundly dedicated to the following persons who spend their time with us and show their concern that inspired us a lot.

Our beloved School, J.H. Cerilles State College School of Engineering and Technology.

Our dearest friends, instructions and classmates;

Our beloved parents:

Margie Tumagna and Nilo Tumagna

Elna Camus and Nelson Camus

Teresita Niego and Jose Rolly Niego

Carmelita Olarte and Olmar Olarte

Who gave financial and moral support and encouragement at the course of undertakings,

Above all, the Almighty Father

God Bless and more power!!!

Nelmar Jun

Riylyn

Maricar

Chella Mae

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BACKGROUND OF THE PROBLEM

Introduction

Climate change is one of the causes of good or bad productivity in agriculture, (Yanuar Nurdiansya, 2020). The delay in the rainy season and the progress of the dry season base on climate change and cause the planting calendar to change (Ministry of Agriculture 2015). Uncertain environment factors, especially in terms of temperature and humidity can affect the growth and development of vegetables and fruits.

According to Grubben and Suprakarn, (1994), lettuce vegetable varieties that contain lots of substances are beneficial to human health. The optimum temperature for lettuce growth at 25C to 28C (Darmawan, 1997) and humidity ranges from 80% to 90% (Krisna et al 2017). Lettuce can also grow in cold and tropical regions lettuce marketing increases along with economic growth and population. (Cahyono, 2014).

One way to increase the production of lettuce is to use hydroponic technology and regulating the temperature and humidity inside the greenhouse. Since hydroponic lettuce grows with its roots directly in water, there's no need for soil. Instead, gardeners use a growing medium both to help the seedlings sprout initially and also to provide physically for the roots as the plant continues to growth. For germinating lettuce, stone wool (rockwool) and phenolic foam are commonly used, as well as coconut fiber and perlite. However, problems often arise due to mismatch between the normal environmental conditions of vegetable plants, consequently having an impact on their growth and development. Lettuce is the perfect winter plant for the Greenhouse. This leafy plant like a cool environment. Therefore, for growing lettuce you don't need to heat your Greenhouse because it likes a cool environment. If you are living in an area that is frost-free then a greenhouse is necessary.

In the Philippines, high temperature remains major problems of growing lettuce especially during sunny season. Lettuce is a cool season vegetable; it is sensitive to high temperature and dry soil. Lettuce seeds germinate poorly in warm summer soil since heat may cause seed dormancy. Lettuce may bolt in response to the stress of high temperatures, and the leaves may become bitter as the plant puts its growth into flowering. Leaves wilt, toughen, and get bitter if the plant becomes water stressed in heat. High temperature can be reduced the amount of dissolve oxygen in the solution it also affected the biological processes in the root system.

In tropical environment of the Philippines lettuce can be successfully grown using hydroponics. Greenhouse is important part of agriculture and horticulture sector in the Philippines it can be used to grow plants under controlled climatic condition for optimum produce. These physical factors are hard to control manually inside a greenhouse and a need for automated design arises. All plants and vegetation require certain conditions for their proper growth. Therefore, it is necessary to bring environmental condition under control in order to make those conditions as close to the ideal as possible. To create an optimal environment the main climatic and environmental parameters such as temperature, humidity, light intensity needs to be controlled to create optimal environment.

Thus, proposed study focused on a system prototype that will automate the control of the mentioned parameters (temperature, humidity, water flow, light) to make the greenhouse environment suitable for the growth of the lettuce.

Project Context

Greenhouse is the go-to-option for farmers these days. It is important part in Agriculture and Horticulture because it can be used to grow plants without more soil and it can save space. Greenhouse amplifies the light and also provides a protected place for the plants to grow. Plant needs moisture, warmth and light to grow. A greenhouse stablishes the growing environment by buffering the ambient temperature and protecting the plant from extreme cold. Through the use of Automated Greenhouse, it would be easy to monitor and control greenhouse environment. It would help maintain the temperature, humidity, list and flow of water in the greenhouse which help the lettuce grew.

Purpose and Description

This paper proposed Automated Greenhouse for growing lettuce. It was developed in order to help and create the lettuce farm innovative, unique, relevant and easy to operate and monitor the greenhouse parameters. This system automatically monitored the humidity and temperature of the greenhouse. It has two sensors: the ultra-low-cost Digital Temperature and Humidity (DHT 11) sensor that measure the amount of humidity, temperature; and light Dependent Resistor (LDR) sensor which measure the light intensity of the greenhouse. The project also used Wi-fi module to transmit the data into the cloud storage and be displayed in the webpages. The target user of this study was Mr. Carlito Carcueva, who is the owner of a lettuce farm located in Maralag, Dumingag, Zamboanga Del Sur.

Objectives of the study

The main objective of the study was to develop a prototype that automate a greenhouse for lettuce. Specifically, it aimed to:

- Provide balance temperature and humidity of the greenhouse;
- Directly control the shader to protect the lettuce from the extra heat of the sun;
- Automatically turn on/off the grow lights whenever needed;
- Maintain the flow of water, which is absorb by plants; and
- Send all the data to the cloud database/cloud storage and be displayed to the webpages.

Scope and Limitations

This system would monitor greenhouse status to obtain and maintain the desired climate. A greenhouse has ranges of 2 width and 3 ft long. It focused on one variety of plant only, which was lettuce. It was because lettuce was a common garden vegetable that has a high market potential due to increasing demand for salad vegetables. The size of it was suitable for a small greenhouse used at home. The greenhouse was able to create a microclimate suitable for lettuce plants. In this project the system would monitor temperature, humidity, amount of light and a control loop including exhaust fan of the greenhouse. The optimum temperature inside the greenhouse was at 25˚C to 28˚C and humidity ranges from 80% to 90%.

Significance of the study

The owner would benefit this system because it would give less efforts and reduced time in checking the status of the greenhouse. It is easy to manage and monitor the environmental factors including temperature, humidity and light levels, maintain the growth of plants, monitor the field conditions. It helped the owner to take care of their plants inside the greenhouse. This study would be effective tool to serve as a reference to the future researchers and they can also use this study to widen and enlighten them for the research.

Definition of Terms as used in the Study

In order to have better understanding of this study, the following terms were defined conceptually and operationally.

Arduino uno. It serves as the main board for the connection components such as Light dependent resistor (LDR), Ultra low-cost digital temperature and humidity sensor (DHT11), Relay, Dynamo motor, WIFI Module, Liquid crystal displays.

Greenhouse. Is a structured with walls and roof made of PVC, Plastic Screen, UV Plastic.

Grow light. It gives plant a greener color and it also helps plants to grow bigger and stronger, especially when combined with good nutrition.

Humidity. It is the percentages of the amount of water vapor present in the atmosphere at
temperature, when the air warms, it is able to hold more moisture, which is why greenhouse are so warm and humid.

LCD. Liquid Crystal Display. Display the temperature, humidity and lumens

Lumens. It measures the brightness of the light

Sensors. Key components of greenhouse monitoring system.

Temperature. Greenhouse temperature controls help lower the temperature in your greenhouse during those hot summer months, when an excess of heat can actually lead to heat stress and other-high temperature diseases that can damages the output.

Thing Speak. Its Capability is to store data from the microcontroller which is the Arduino uno through ESP8266 WIFI MODULE.

WI-FI Module. It has the storage capability to be integrated with the sensors and transmitted to Thing Speak and displayed to webpage.

LCD. Liquid Crystal Display. Display the temperature, humidity and lumens.

Chapter 2

REVIEW OF RELATED STUDIES AND SYSTEM

Technical Background

The automated greenhouse was made by using Arduino. In this system Arduino was the heart of whole system which took control over the process like DHT 11 sensor that connected to Arduino to measures the amount of temperature and humidity. When the DHT 11 sensor sense any change in environment the Arduino uno comes in action and process the required operation.

The LDR sensor was also connected to the Arduino uno which measure the amount of light. When the light is high the Arduino takes control and dynamo motor would automatically turn on to carry the shade net. When light intensity is lower than a define level of 900 below, the artificial lights will turn on, and when the light intensity comes in normal range artificial lights will automatically turns off. In this system LCD was used for displaying status for all operations like temperature, humidity and light status.

Hardware specification

The proposed study utilized the following hardware and components to successfully achieve the objectives.

Arduino Uno

The used of this component in the greenhouse is the main of whole system that takes control the process of all components that were used in developing the project.

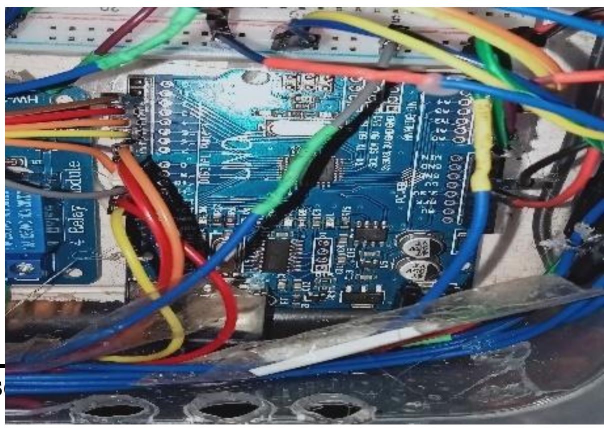


Figure 2.1 Arduino Uno

Bread Board

Is way of constructing electronics without having to use a soldering iron. Components are pushed into the sockets on the Breadboard and then extra jumper wires are used to make connection.

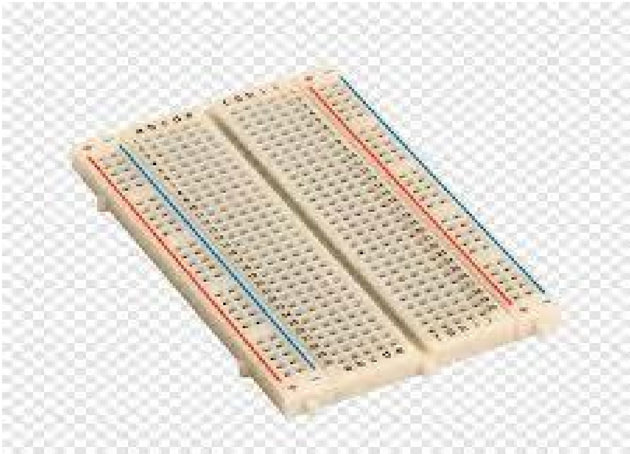


Figure 2.2 Bread board

Dynamo Motor

The Dynamo Motor the one who push and pull of the shade net when the sun is too much heat.

Figure 2.3 Dynamo Motor

Diaphragm Pump

The use of this component is to control the water to the misting line. The water drives the diaphragm up and down frictionlessly and no internal leakage that let the pump starts at very low flow rate and pressure

Figure 2.4 Diaphragm Pump

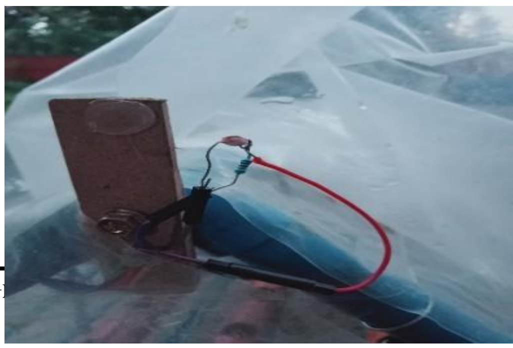
Light bulb

It provides a high intense quality of light in the greenhouse, the heat produced from light let the Lettuce stay warm naturally.


Figure 2.5 Light Bulb

Light Dependent Resistor

The Light Dependent Resistor (LDR) used to detect or to measure the light intensity



of the greenhouse parameters and also to indicate the presence or absence of light.

Figure 2.6Light Dependent Resistor

LCD

The LCD (Liquid Crystal Display) is a type of display that uses the liquid crystal for its operation it will display the amount of Temperature, Humidity and Lumens.

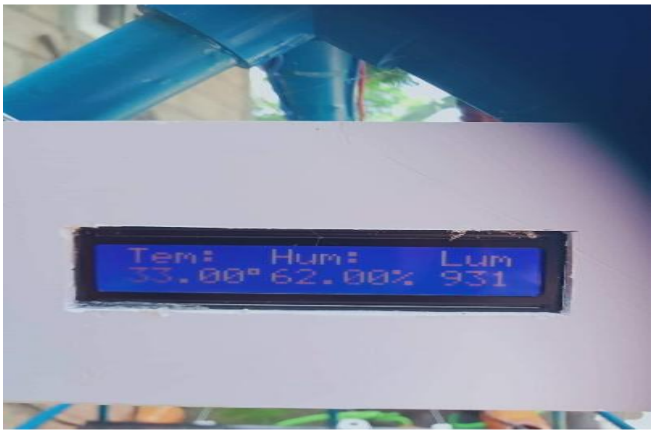


Figure 2.7 LCD

Misting

It produced tiny water droplets in the form of fog inside greenhouse and to avoid over watering, to keep the right temperature and humidity. When the humidity is 80 percent below the misting is automatically mist the Lettuce.

Figure 2.8 Misting

Power Supply

. Power supply is used to provide electricity to the system, it converts one type of electrical power to another, but it may convert a different form of energy.

Figure 2.9 Power Supply

Relay

It is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 5V provided by the Arduino pins.

Figure 3 Relay

Shade Net

The used of the shade net it can regulate the entry of sunlight to reduced sunburn it can protect also for the lettuce from the extra heat of the sun.

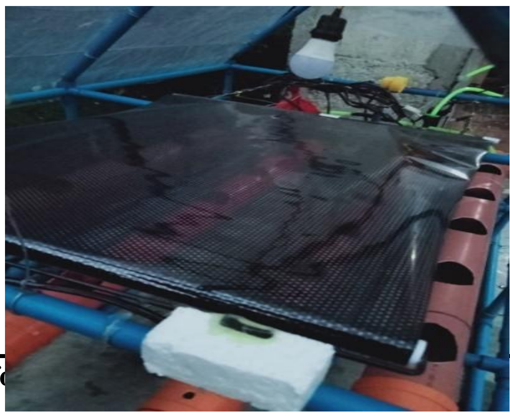


Figure 3.1 Shade Net

Ultra-low-cost Digital Temperature and Humidity Sensor

The used of the DHT11 in the greenhouse is to detect or measure the temperature and humidity.

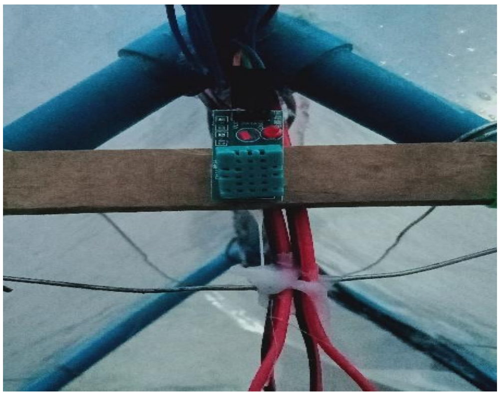


Figure 3.2 DHT11

Water Pump

A water pump operates the water pumping machine and ensures that is running effectively and it can circulate the whole volume of water in the entire system. A water pump is a transporting the water in the system from water tank to the plants and back to water tank again.

Figure 3.3 Water Pump

Programming Environment

This software contained a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It was connected to the Arduino and hardware to upload programs. It is easy to write code and upload to the board.

The environment was written in Java that based on processing and other open-source software.

Related studies

Foreign studies

The study of Krishna Nemali (2017) titled Growing Hydroponic Lettuce it used heated nutrient solution under cooler air temperature, Lettuce is one of the major leafy greens grown in hydroponic greenhouses. They used Stone Wool (rockwool) and phenolic foam as well as coconut fiber and perlite.

(Smith) claimed that lettuce is a cool-season crop with distinct temperature requirements. The optimal growing temperatures are 73ºF (23ºC) during the day and 45ºF (7ºC) at night. Most California growing regions have daytime temperatures from 63º to 83ºF (17º to 28ºC) and night temperatures from 37º to 53ºF (3º to 12ºC). At the high end of the temperature range, lettuce may bolt, causing bitterness and loose, fluffy heads. At temperatures near freezing, young plants are not damaged, but growth is slowed. Freezing can damage the outer leaves of mature lettuce, leading to decay in handling and storage.

This system was made and design an implemented a microcontroller-based system that automatically monitors and control greenhouse parameters such as, Ph of soil, soil moisture, light intensity, relative humidity and temperature to maintain the predefined optimum ranges.

The Bluetooth and GSM based remote wireless automatic monitoring system provide mobility during the monitoring and control process. Greenhouse could be automated by utilizing microcontroller based-system. One possible solution to achieving food security is to use greenhouse, which enable the farmer to control the growth condition thereby ensuring maximum crop yield throughout the year.

Local Studies

In the Philippines lettuce are normally grown in areas with relatively low temperatures. High temperatures can cause them to flower and turn bitter sooner. In tropical environment of the Philippines Lettuce can be successfully grown using hydroponics. The biggest a hydroponics grower encounters in the summer of course the heat. The ambient temperatures can easily go over 35 degrees Celsius (90 Fahrenheit to Celsius). A locally developed smart greenhouse hydroponics project in Iloilo now benefits a farm enterprise.

It applies the internet of things (IOT) technologies to automate the monitoring and control of growth parameters for lettuce grown in a nutrient-film-Technique (NFT) hydroponics system. Dr. Mucas, describe the smart greenhouse hydroponics as equipped with sensors and communication technologies that automatically captures data on essential parameters such as temperature, acidity or PH, electrical conductivity, and water flow. The collected data goes to through an IOT platform for monitoring analysis, and control. Aside from monitoring from a personal computer, the used of Android App enables a farm manager to remotely monitor the system status or control specific actuators for water flow, fertigation, and water cooling.

Synthesis

Based on the studies read, the proposed automated greenhouse for growing lettuce has similarities, they are both hydroponics and grown in a cool environment. The biggest hydroponics growers encountered during summer because of high temperature. The researchers designed automated greenhouse that monitor the environment inside the greenhouse using sensors and displayed the amount of temperature, humidity and lumens. The proposed system has capabilities of these components which was reliable to monitor the greenhouse parameters. The difference of researcher's study to Nemali 2017 their prototype designed using an implemented Micro controller – based system and used Bluetooth and GSM based remote wireless automatic monitoring system to provide their mobility during the monitoring and control process. However, the researcher's study used multiple technologies such as DHT11 sensor for measuring the amount of temperature / humidity and LDR sensor for measuring the light intensity.

Chapter 3

DESIGN AND METHODOLOGY

Researchers used waterfall model. A waterfall method is made to show quickly the requirements appear visually as what researchers did in the prototype of the Automated Greenhouse for growing lettuce. A prototype was built or developed following the phases. Shown in Figure.3.1.

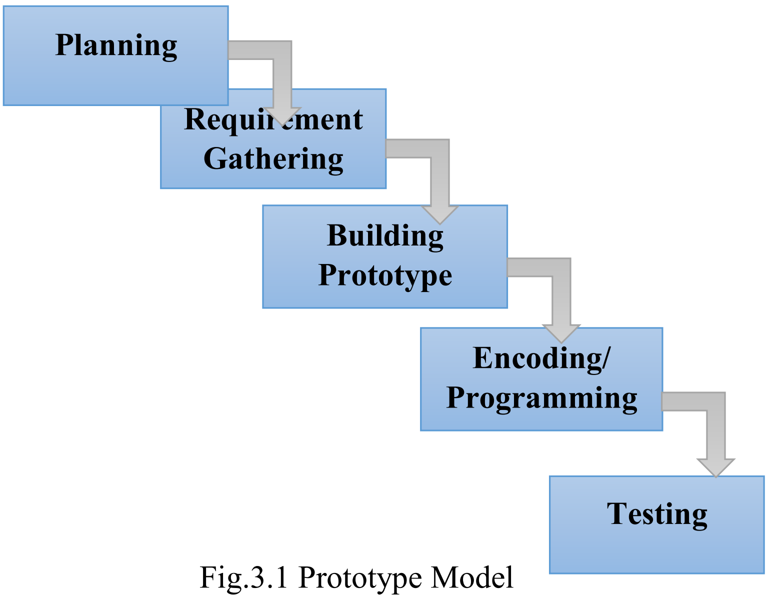


Fig.3.1 Prototype Model

Requirement Gathering

them, because lettuce is not a tropical plant it does not like hot weather. In tropical you can only grow lettuce during the cooler months it prefers moist Relevant data were gathered by conducting interview with the concerned persons and reading related studies in articles about growing lettuce in the lowland where the normal environment is not suitable for growing and cool condition. In fact, these plants grow best when the optimum temperature was 25Ċ and 28Ċ and the humidity rages was 80% to 90%. This data was used in designing appropriate solutions and strategies on Automated Greenhouse for growing lettuce would be achieved.

Planning

After gathering information, the researchers have already ideas, views and plans on what they are going to do and how to start, organized the proposed project. This was done in order to make work easy and efficient in order to cater and answer needs of the Automated Greenhouse for growing lettuce.

Building Prototype

In this phase, the researchers designated the Automated Greenhouse for growing lettuce. The system design illustrated in Figure 3.2 shows the flow of the proposed system.

Referring to the figure 3.2 the Arduino Uno is placed inside the Tupperware. It takes control on the process of all components used in developing the project: The LDR sensor measure the light intensity, DHT11 sensor measures the amount of temperature and humidity, L298N control the direction and speed of dynamo motor, Dynamo used to automatically drag the shade net, Shade net was used to protect the lettuce from the heat of sun, Relay which control the on and off process, UV light provided a high intense quality of light in the greenhouse, Exhaust fan to help decrease the temperature, Power Supply provide electricity to the system, Misting pump would force water through misting lines at high pressure, Misting would apply water to increase humidity around a plant and to keep the plants cool and growing, Water pump to increase the pressure of water and Water Tank used to provide storage of water.

System Design

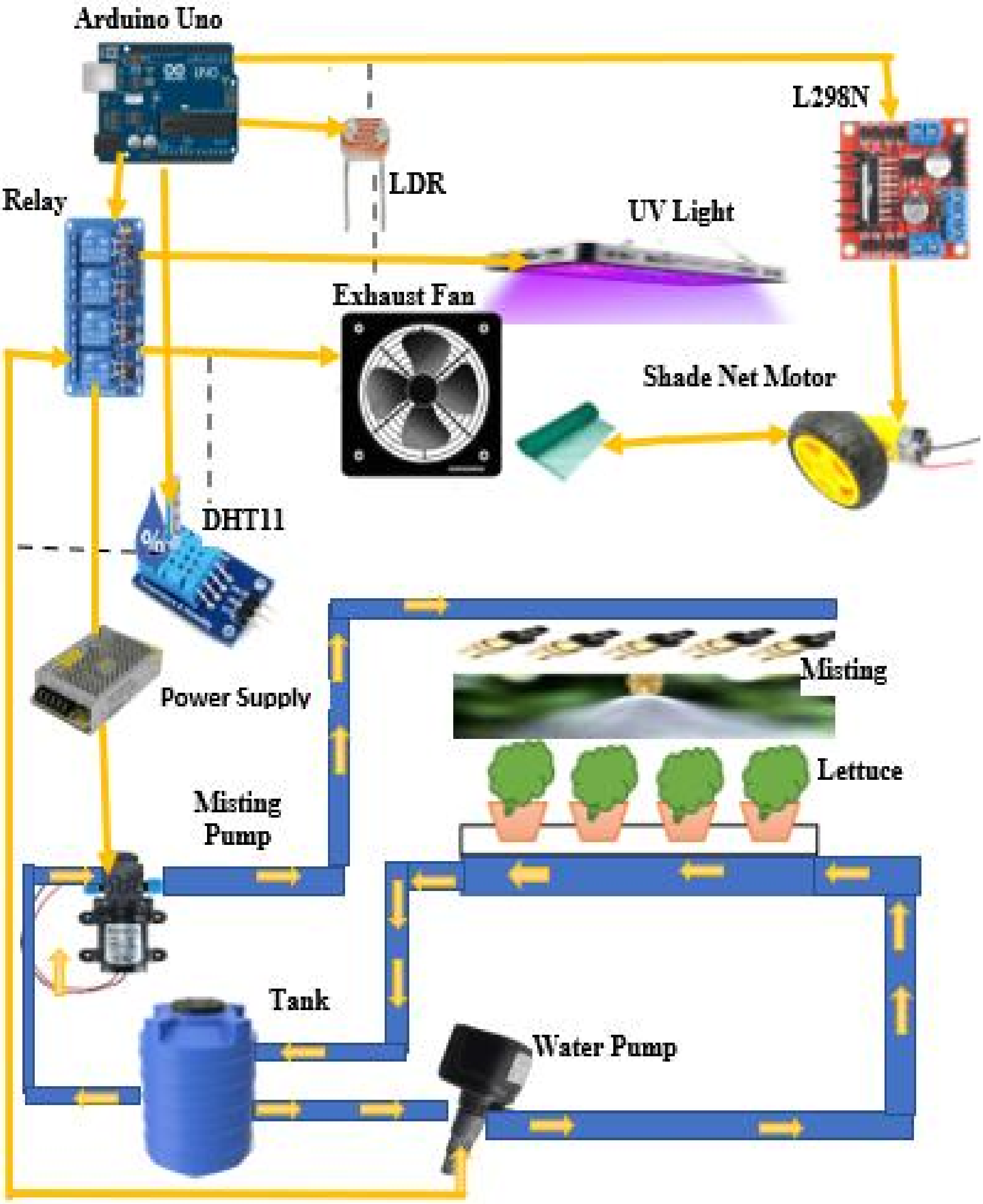
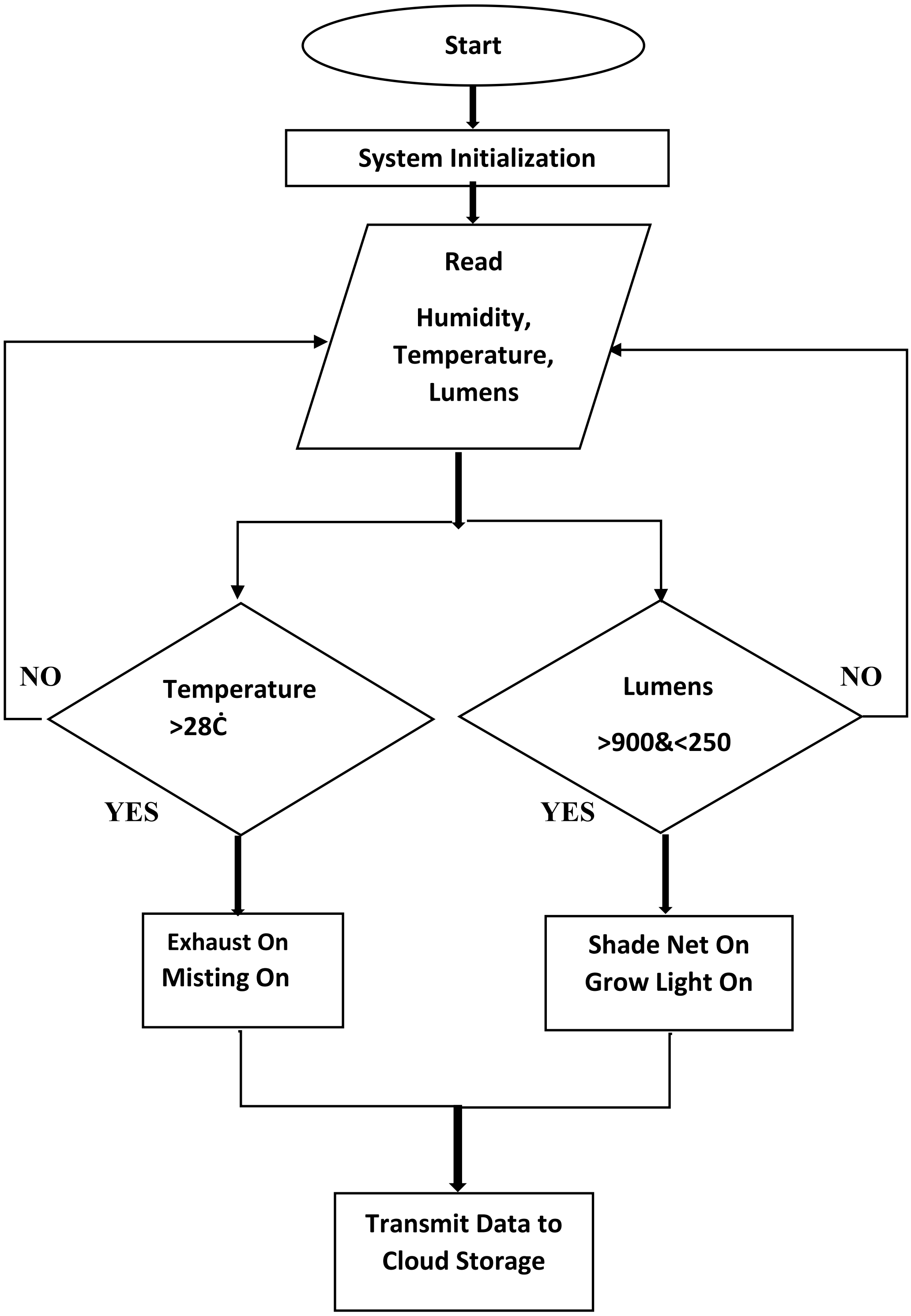


Figure 3.2 System Design

Flow Chart

In Figure 3.3 shows the flow chart of the automated greenhouse for growing lettuce using Arduino. It displayed the environment inside the greenhouse. To determine the maximum value, the temperature of the lettuce was assumed to be 28˚C.

Referring to the figure, DHT 11 sensor measures the amount of temperature and humidity of the greenhouse, if the temperature is >28˚C and the humidity is <80% the exhaust fan and misting will automatically turn on. The LDR will detect the amount of light inside the greenhouse, it is important factor for the lettuce growth. If the lumens >900 the shade net motor automatically on and if the lumens<900 the grow light will turn on. The Wi-Fi transmit the data into the cloud storage and be displayed in the webpage then end.


Start
System Initialization
Read
Humidity,
Temperature,
Lumens
NO
Temperature
>28Ċ
YES
Lumens
>900&<250
NO
YES
Exhaust On
Misting On
Shade Net On
Grow Light On
Transmit Data to
Cloud Storage

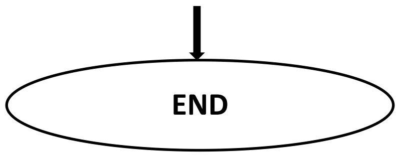


Figure 3.3 Flow Chart

Encoding/Programming

In this phase, the researchers made and wrote set of instructions for the system to function as expected. Encoding codes for automation was also done in this phase. Moreover, writing the source code of the program and debugging it were the main activities during this phase

Testing

After writing the source code, the program was uploaded to the Arduino Uno microcontroller to see if it could work based on the objectives set. By this time the prototype of the project was finally built, integrating all components (Arduino, LDR, DHT11, RTC, Relay, Wamp, Misting, Exhaust, Wires) into one. Testing the functionality of the prototype was the main concern of this phase to make sure that it functioned and worked accurately as expected. This project was successful when the DHT11 sensor detected and measure the amount temperature and humidity inside the greenhouse and also when the LDR sensor measured the light intensity. The data displayed in the web page, and the LCD screen displayed the amount of Temperature, Humidity and Lumens.

Chapter 4

DEVELOPMENT, TESTING AND IMPLEMENTATION

Description of the Prototype

The automated greenhouse was made up of PVC pipe, UV plastic, plastic screen. The UV plastic was used in roofing to absorb UV radiation and prevent it from being transmitted through the film and into the greenhouse, while the plastic screen was used to covered the wall of the greenhouse. At the middle of the greenhouse, ultra-low-cost digital temperature and humidity sensor (DHT11) for humidity and temperature measurement was placed. At the back side of the greenhouse the Light dependent resistor (LDR, was the light sensor used in the project, its main function was to monitor the intensity of light. It turns off the light when it needs to save the power and turn on the light if it is required in the greenhouse. When the lumens were 900 above, the dynamo motor automatically drag the shade net in order to protect the lettuce from the heat of the sun. At the front of the greenhouse the Liquid crystal displays (LCD) was placed, to display the percentage on how much the temperature, humidity and lumens. At the back, the exhaust fan was placed to help to eliminate drying of foliage from a direct air stream and also to help decrease the temperature. Power supply was used to provide electricity to the system. The Micro Diaphragm pump would force water through misting lines at high pressure and the other one of the water-pump used to increase the pressure of water in order to move it from one print to another. At the front side of the greenhouse was the plasticware, where wires and other components were kept.

Figure 4.1 Actual prototype

Development

The schematic diagram of the system is shown in Figure 4.3. the Digital Humidity Temperature (DHT 11) sensor were placed at the center of the greenhouse to monitor the climate changes inside the greenhouse. The Light Dependent Resistor (LDR) sensor were placed at the back of the greenhouse which measure the light intensity. The two sensors stated above were communicated to the Arduino Uno, and the results it was displayed on the LCD screen. At the same time data were transmitted to Thingspeak.com and stored to the cloud-based database through ESP8266 Wi-Fi module and displayed on a webpage.

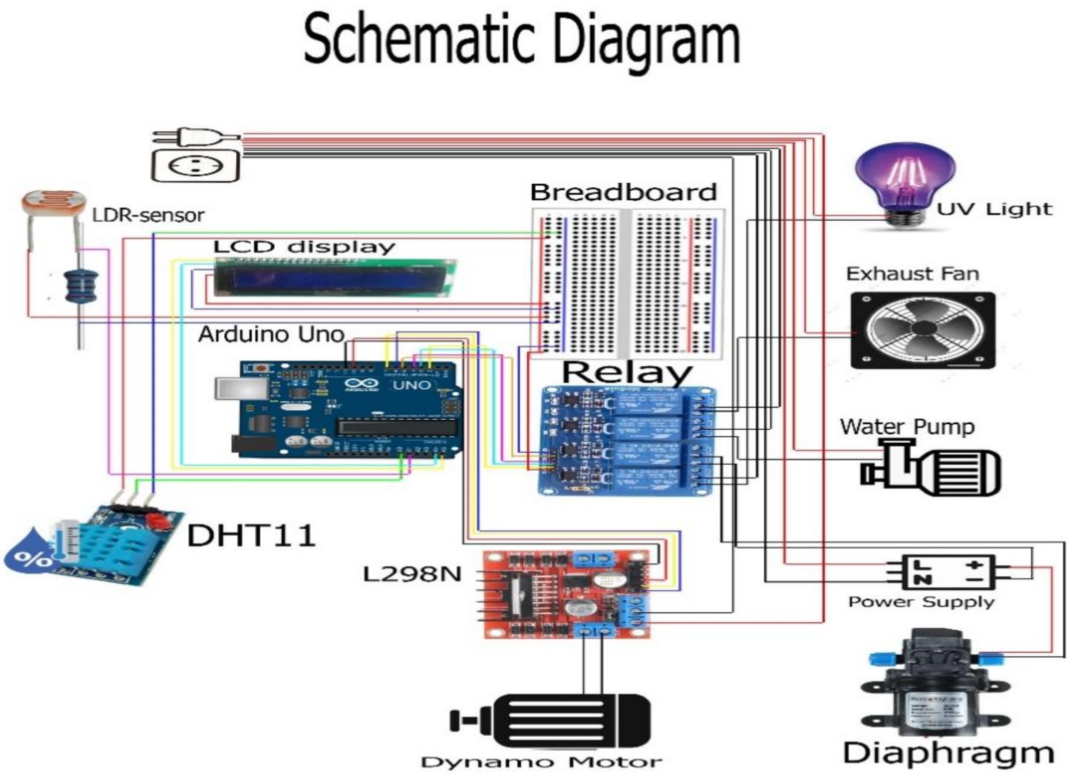


Figure 4.3 Schematic Diagram

On the other hand, webpage was developed utilizing JavaScript programming language which was supported by jQuery and bootstrap to have a responsive and use friendly page. Figure 4.4 below shows the data displayed in the web.

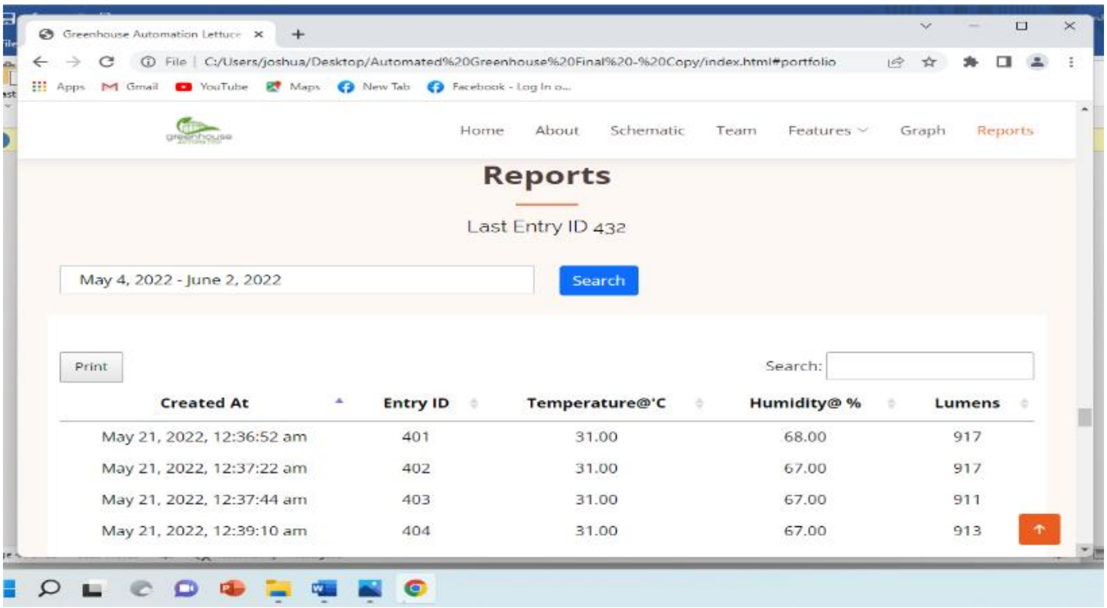


Figure 4.4 Reports Display in the Web

Gantt Chart

During the development of the system, our groups gathered to set a schedule and assign task to keep our work well organized. In figure 4.2 the table shows the length of work and the task performed which are planning, research, content, proposal, initial design and order of components, construction, programming Arduino, continuous testing and

documentation and presentation.

Figure 4.2 Gantt Chart

Testing

During the development of the project, certain issues arised, such as errors of programming, malfunction of misting hose, cable, and also the internet signals. Were also change the LDR sensor because of low detection. After resolving such issues, the prototype was put to test its functionality. The automated greenhouse measured the amount of humidity and temperature. When the temperature was >28˚c and the humidity was<80% the exhaust fan, misting and water pump automatically turned on. It also measured the light intensity, when the lumens >900% the shade net motor automatically turned on and when the lumens <9000 the grow light also turned on. Farther, the amount of humidity, temperature and lumens was displayed on the LCD screen. Meanwhile the Wi-Fi module transmitted data to things speak that can be viewed in the web page.

All data collected by the sensors were sent immediately to the Thing speak and was displayed in the webpages where graphs and other reports such as humidity, temperature and lumens can be viewed as shown in the Figure 4.5 and 4.6.

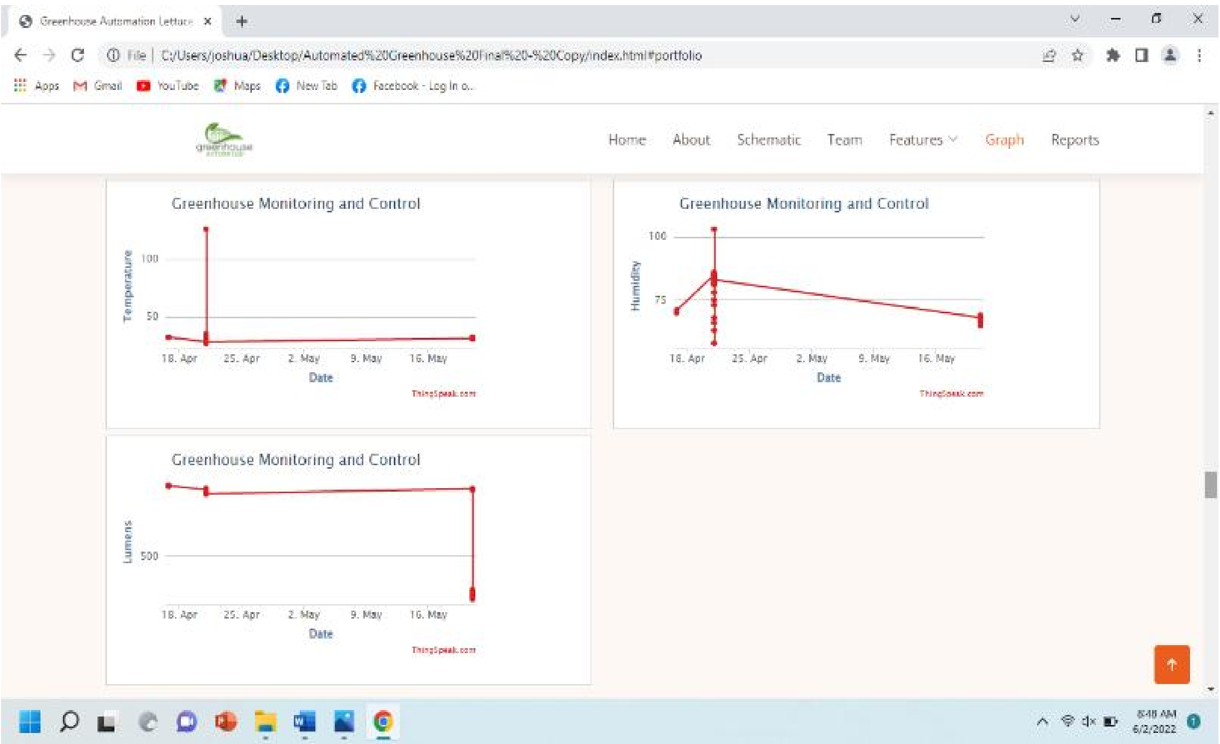


Figure 4.5 Graph

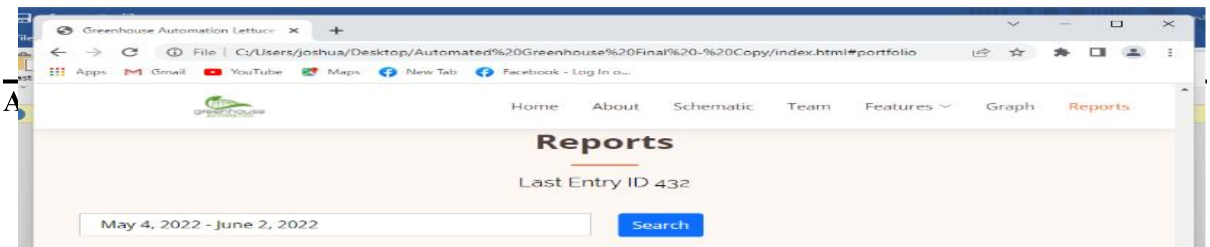


Figure 4.6 Reports

Implementation Plan

Approval from the owner of the greenhouse, system installation and distribution of manuals the strategies that the researchers planned in implementing the said project. The established system may be presented to Mr. Carlito Carcueva. If he decided to accept and use the project, the researchers would hand over the project as well as the documentation, which acted as a reference for the greenhouse.

Strategy	**Activities**	**Persons Involved**	**Duration**
Approval from the owner of the Greenhouse		Researchers, Owner of the Greenhouse, Automated Greenhouse	4 days
System Installation	Installation of the required software/hardware	Researchers, Owner of the Greenhouse, Automated Greenhouse	3 days
Information Distribution	Distribution of manual information	Researchers	6 days

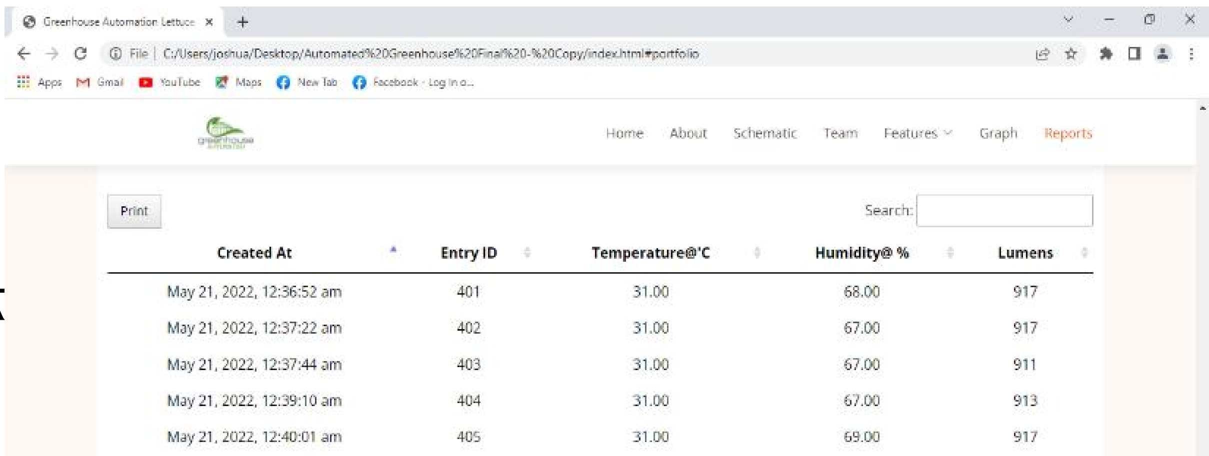
Figure 4.3 Implementation plan

Chapter 5

RESULTS, DISCUSSIONS, AND RECOMMENDATION

Provide balance temperature and humidity of the greenhouse

The Digital Humidity Temperature (DHT 11) sensor was the one used to detect or to measure the temperature and relative humidity inside the greenhouse. When temperature is greater than 28 degrees Celsius which means the sun is too hot, the dynamo motor would automatically drag the shade net to cover the lettuce to protect the extra heat of the sun to avoid tendency of plants damages. If the humidity is less than 80 percent, the exhaust fan and misting would automatically turn on to regulate humidity by bringing a cool air and blowing out warm air, to give plants thrive in a moist environment. It maintained an ideal greenhouse temperature by proper draining, proper circulation of water inside the greenhouse. It helped to maintain the right balance between temperature and humidity. In addition, humidity, temperature and lumens was also displayed on the LCD as shown Figure 4.5.



Created At	Entry ID	Temperature@'C	Humidity@ %	Lumens
May 21, 2022, 12:36:52 am	401	31.00	68.00	917
May 21, 2022, 12:37:22 am	402	31.00	67.00	917
May 21, 2022, 12:37:44 am	403	31.00	67.00	911
May 21, 2022, 12:39:10 am	404	31.00	67.00	913
May 21, 2022, 12:40:01 am	405	31.00	69.00	917

A

Figure 4.4 Data on the Webpages

Figure 4.5 Temperature, Humidity and lumens

Directly control the shader to protect the lettuce from the extra heat of the sun

The Dynamo motor directly control the shader to protect the lettuce from the extra heat of the sun through the use of shade net. When the lumens was >900, the dynamo motor automatically drag the shade net to cover the lettuce and if the lumens was <900, the dynamo motor will force out the shade net.

Figure 4.6 Shade net

Automatically turn on/off the grow lights whenever needed

The light dependent resistor (LDR) is the one to hold or to control the light intensity of the greenhouse. When the lumens is less than 900, the grow light will turn on, specially in cloudy weather or during night time to give plants light. It would measure also the amount of light received. The lumens greater than 900, which means the sun is too hot, the light will automatically turn off to avoid plants damages.

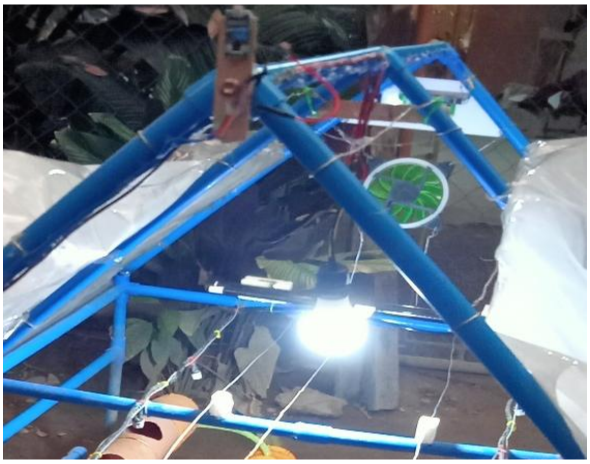


Figure 4.7 The grow light

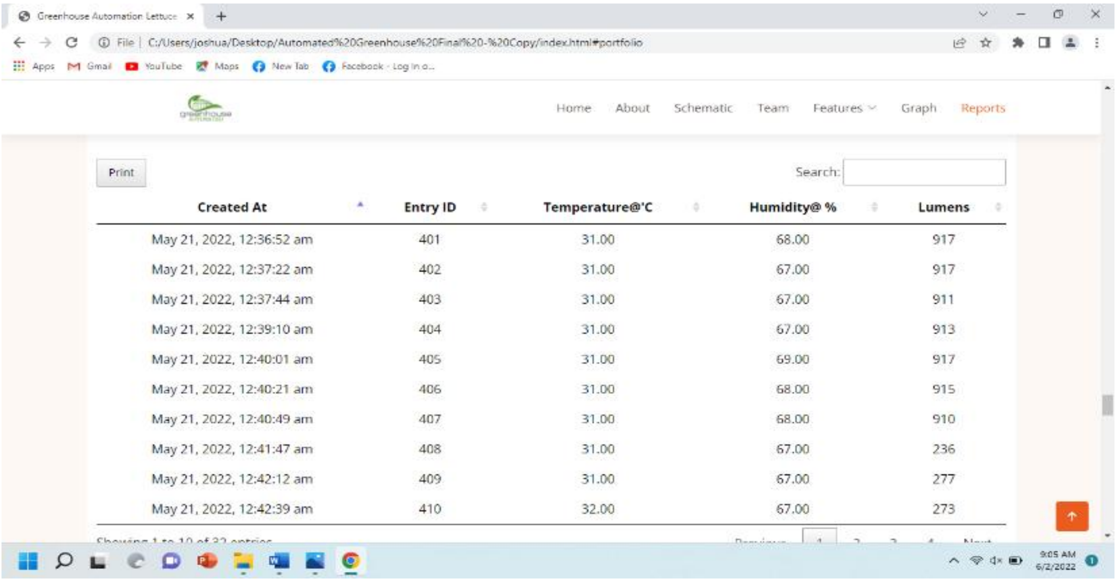
Maintain the flow of water which is absorb by plants

Through the use of water pumped it can maintain the flow of water to move from one area to another which is absorb by plants. A water pump operates the water pumping machine and ensures that is running effectively and it can circulate the whole volume of water in the entire system. A water pump is a transporting the water in the system from water tank to the plants and back to water tank again.

Figure 4.8 The water pump

Send all the data to the cloud database/cloud storage and be displayed to the webpages.

All data sent by Wi-Fi module were sent to the Thing speak. Data stored in the Thing speak was also displayed in the web pages with the use of HTML codes provided by the Things speak.



Created At	Entry ID	Temperature@'C	Humidity@ %	Lumens
May 21, 2022, 12:36:52 am	401	31.00	68.00	917
May 21, 2022, 12:37:22 am	402	31.00	67.00	917
May 21, 2022, 12:37:44 am	403	31.00	67.00	911
May 21, 2022, 12:39:10 am	404	31.00	67.00	913
May 21, 2022, 12:40:01 am	405	31.00	69.00	917
May 21, 2022, 12:40:21 am	406	31.00	68.00	915
May 21, 2022, 12:40:49 am	407	31.00	68.00	910
May 21, 2022, 12:41:47 am	408	31.00	67.00	236
May 21, 2022, 12:42:12 am	409	31.00	67.00	277
May 21, 2022, 12:42:39 am	410	32.00	67.00	273

Figure 4.9 Data on the web pages

Conclusion

The developed automated greenhouse was suitable for small area, it could easily monitor and control the temperature, humidity, water flow and light of the greenhouse with the help ultra-low-cost digital sensors such as DHT 11 and LDR. Shade net motor directly control the shader to protect the lettuce from the extra heat of the sun. A water pump was also used to automatically maintain the flow of water because overflowing water should be restricted to avoid plant damages.

The system was automatic and so, does not require human intervention. It is very tough for human to measure actual light intensity, temperature and humidity while this proposed system can do them all. It eliminated risk of human errors to maintain a greenhouse specific environmental condition. Moreover, it was also eco-friendly. In addition, all data of automated greenhouse were saved to the databased/cloud storages to access either through the public internet or a dedicated private connection.

Recommendation

For further research on the designed prototype greenhouse system, this study recommends the following:

1. A website can be incorporated in the designed system to monitor the actual greenhouse values and save the data in an online database for future reference.

2. The designed prototype greenhouse can be applied in the agricultural sector to design and implement smart greenhouses.

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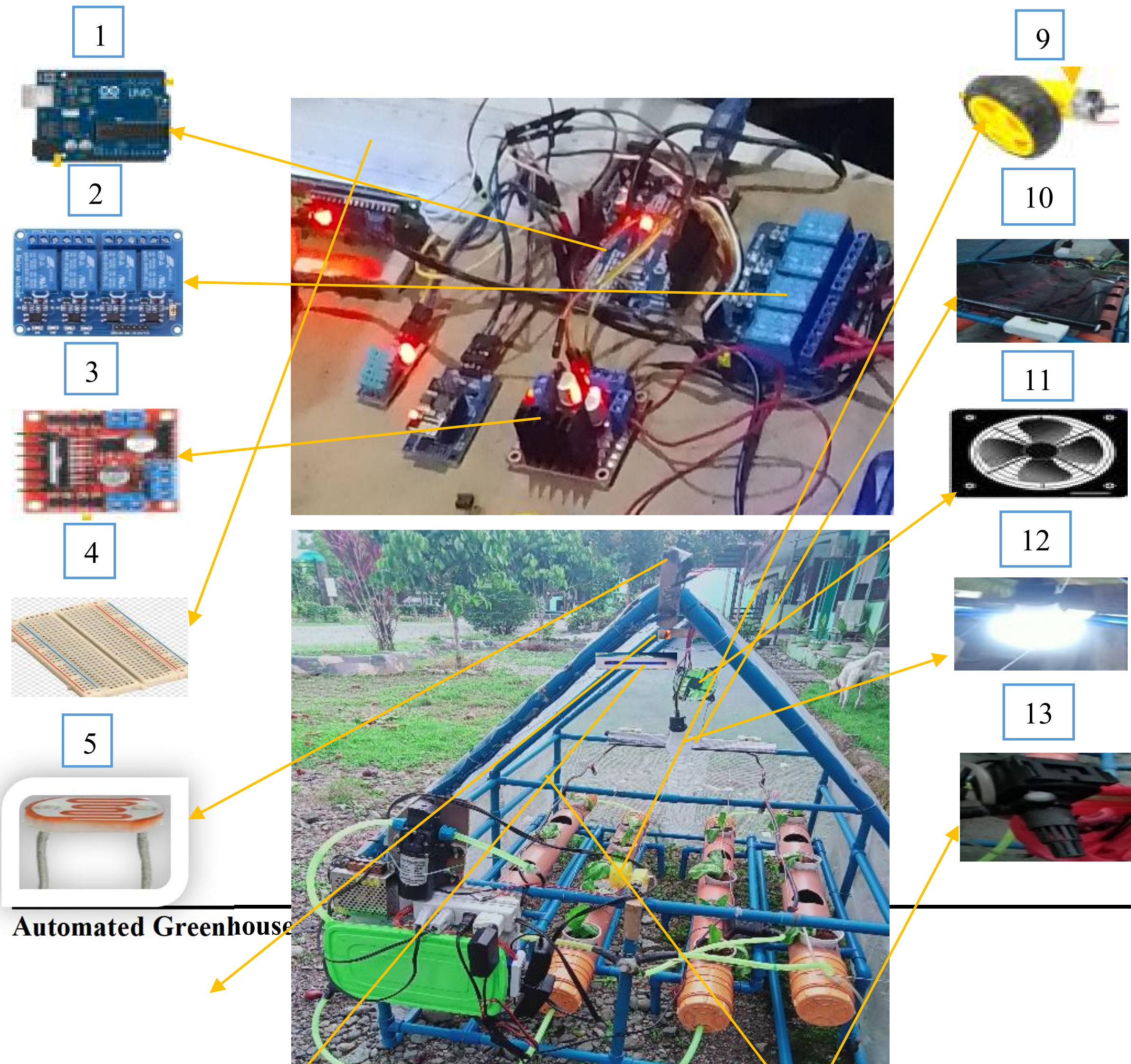
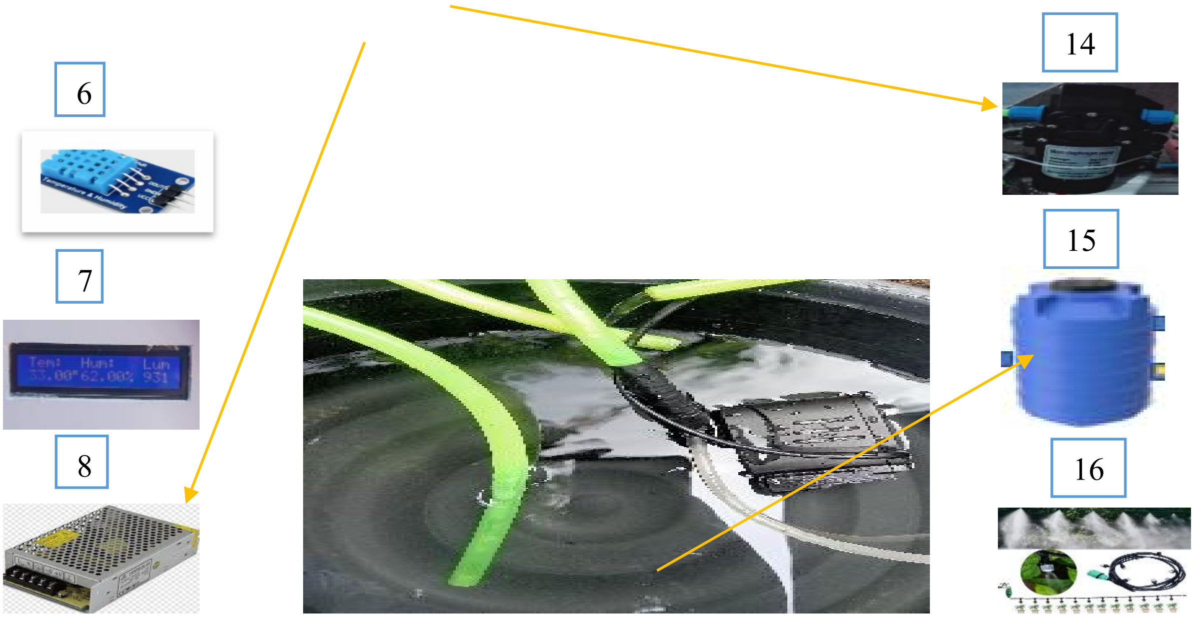
APPENDIX “A”

User’s Manual

GENERAL INFORMATION





1. Arduino Uno	The main microcontroller board
2. Relay Module	Is an electrically operated switch that can be turned on or off, letting the current go through or not.
3. L298N	To turn the motor on, to turn it off and to control its speed.
4. Breadboard	Is way of constructing electronics without having to use a soldering iron. Components are pushed into the socket on the breadboard and then the extra jumper wires are used to make connection.
5. LDR	To detect or to measure the light intensity of the greenhouse parameters and also to indicate the presence or absence of light.
6. DHT11	To detect or to measure the temperature and humidity.
7. LCD	To display the amount of temperature, humidity and lumens.
8. Power Supply	To provide electricity to the system, it converts one type of electrical power to another, but it converts a different form of energy.
9. Dynamo Motor	The Dynamo motor the one who push and pull of the shade net when the sun is too much heat.
10. Shade net	To regulate the entry of sunlight to reduced sunburn it can protects for the lettuce from the extra heat of the sun.

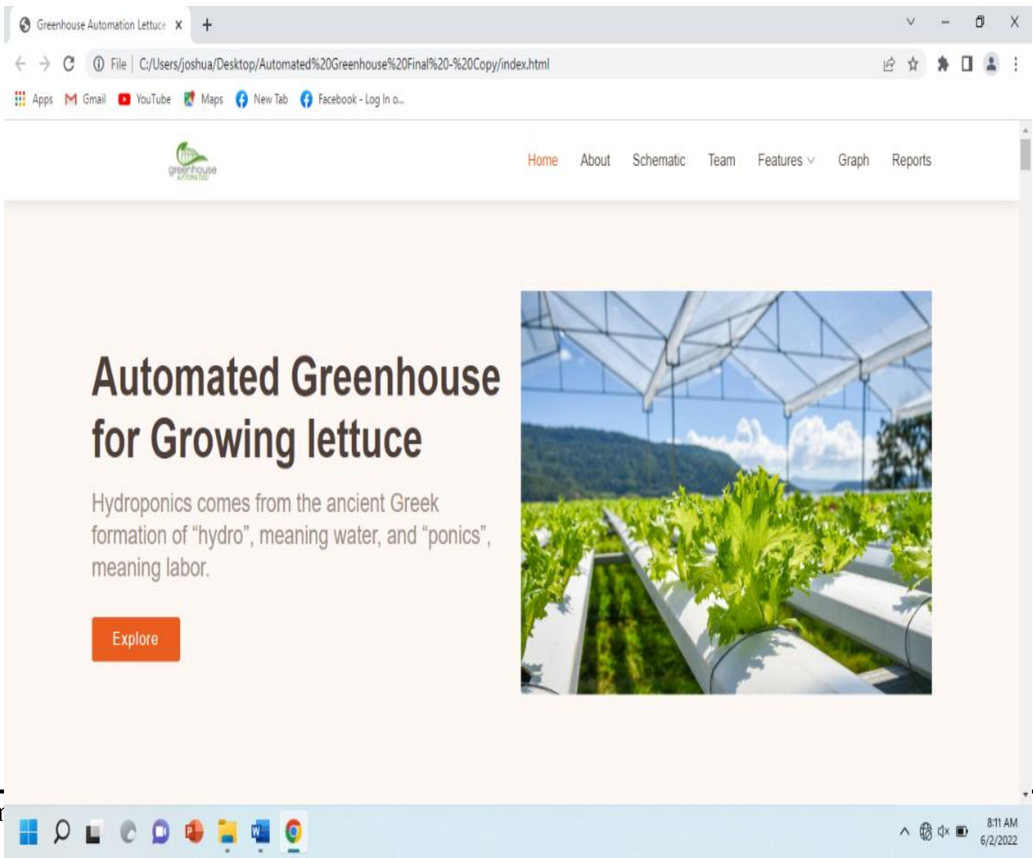
11. Exhaust Fan	To bringing a cool air and blowing warm air to give plants in a moist environment,
12. Bulb	It provides a high intensity quality of light in the greenhouse, the heat produced from light let the lettuce stay warm and naturally.
13. Water Pump	It operates the water pumping machine and ensures that is running effectively and it can regulate the whole volume of water in the entire system.
14. Diaphragm	To control the water to the misting line.
15. Water Tunk	To provide storage of water.
16. Misting Hose	It produced tiny water droplets in the form of fogs inside the greenhouse and to avoid overwatering, to kept the right temperature and humidity.

POWERING THE PROTOTYPE

1. Connect the 12V connector to the Arduino Uno female connector.

Accessing Data To Webpage

1. Open the webpage through clicking the link then homepage would displayed in the screen.

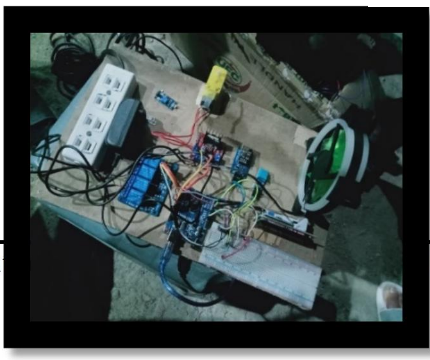
2. 

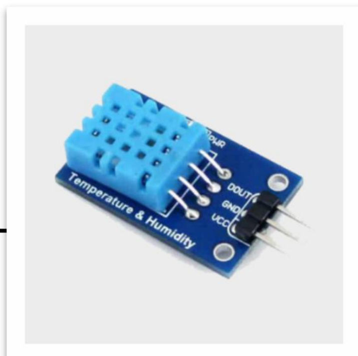
All the data would be seen in the webpage.

Actual Prototype

Greenhouse Prototype

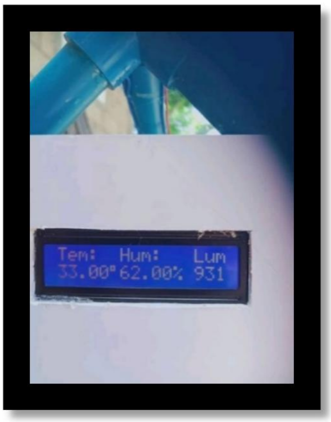
It was built with the use of PVC pipe, UV plastic and plastic screen, greenhouse used to grow plants like lettuce and other tropical plants.



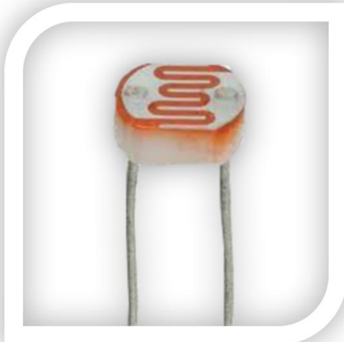


Inside the component DHT11

LCD



LDR

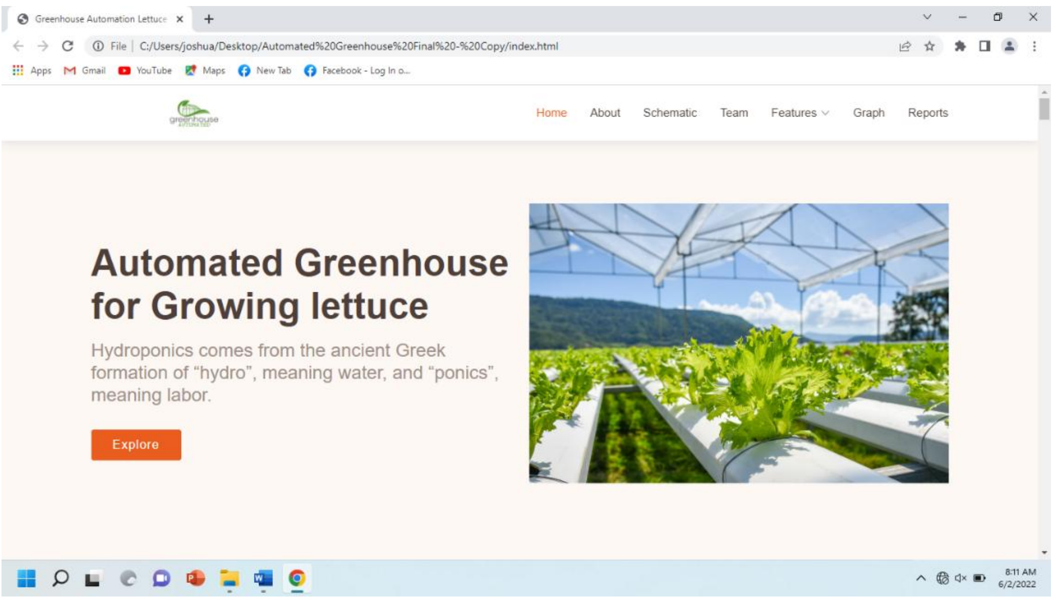


APPENDIX "B"

Screenshots of the web pages

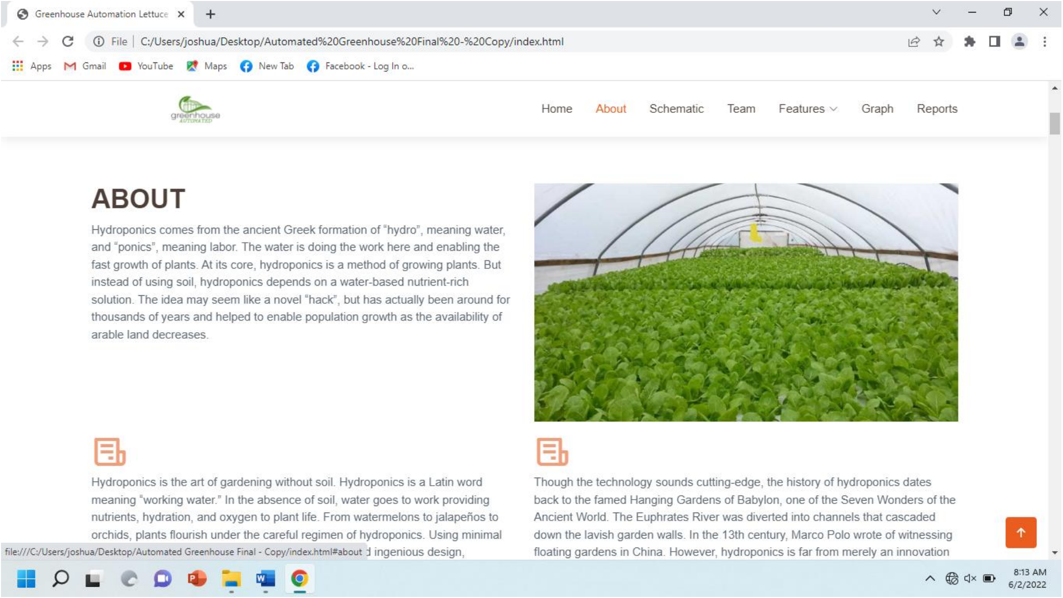
Home pages

This is the home page of the system where users can view the title of the project Automated Greenhouse for growing Lettuce.



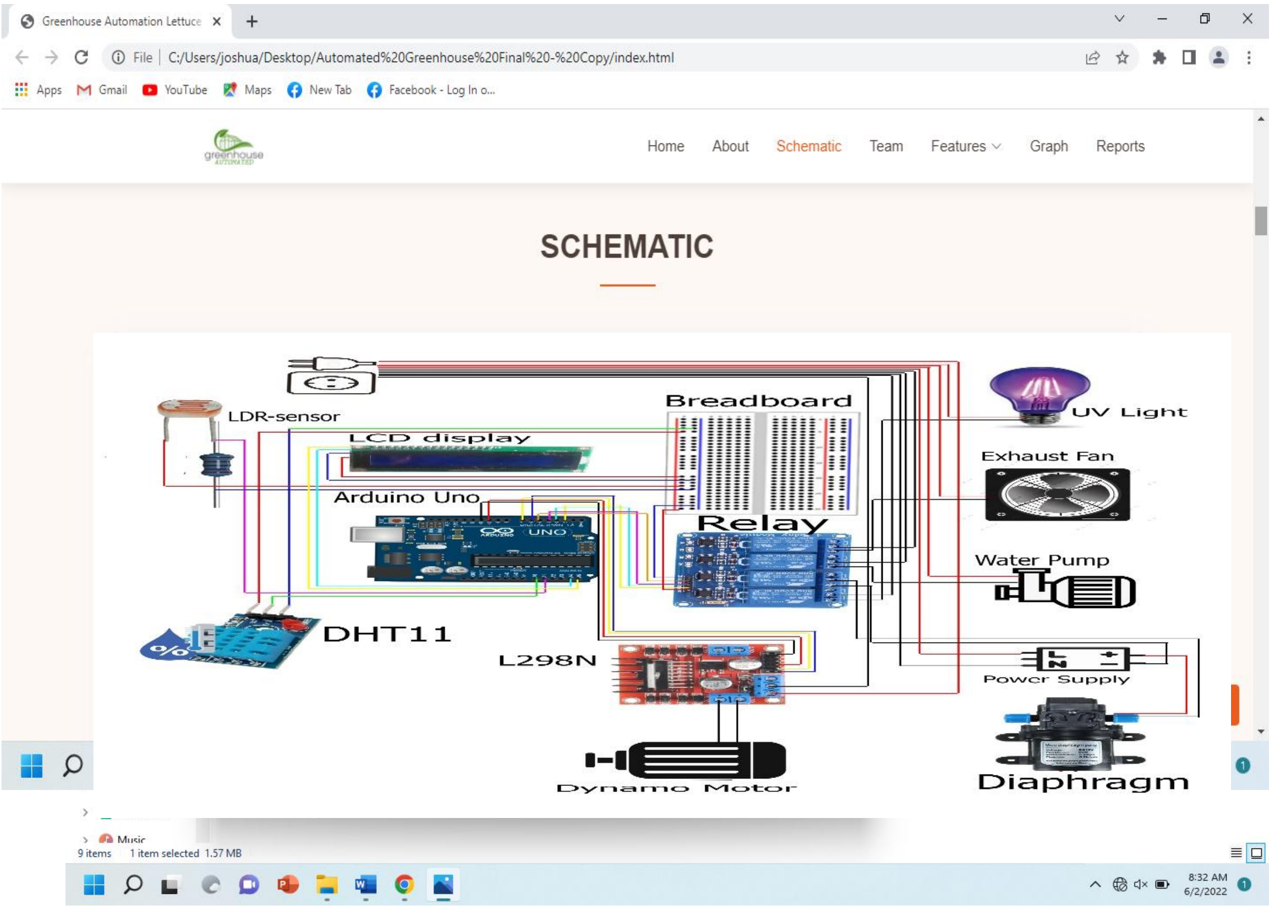
About

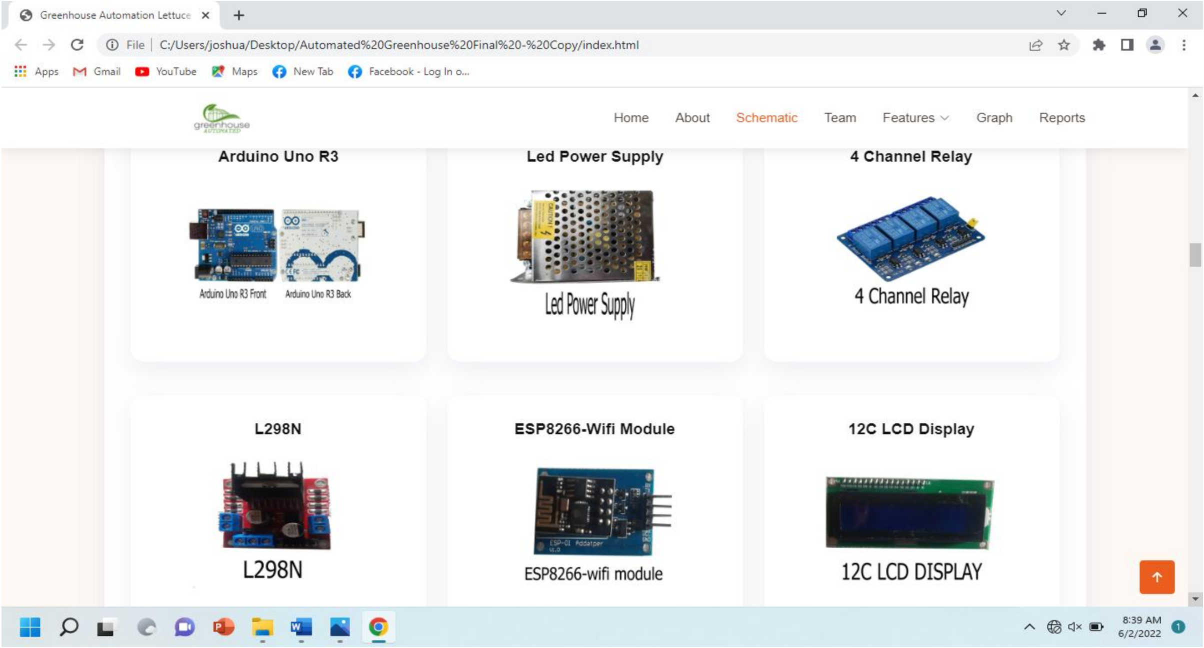
In the about page, users were able to view the overview of the project.



Prototype

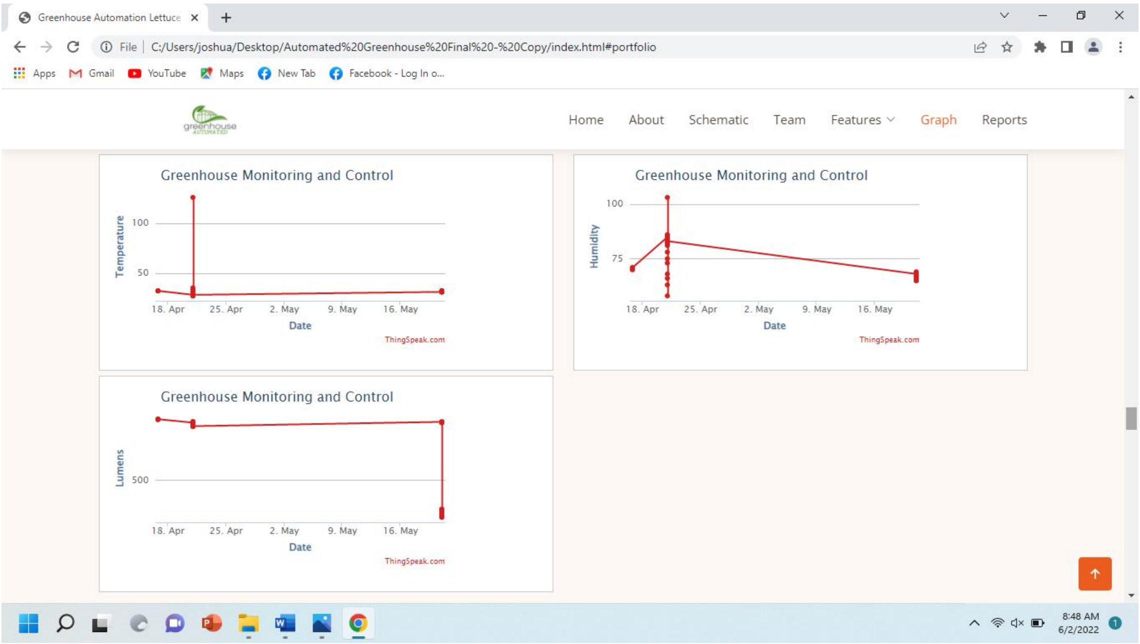
This prototype page contain schematic Diagram and the components used in the system





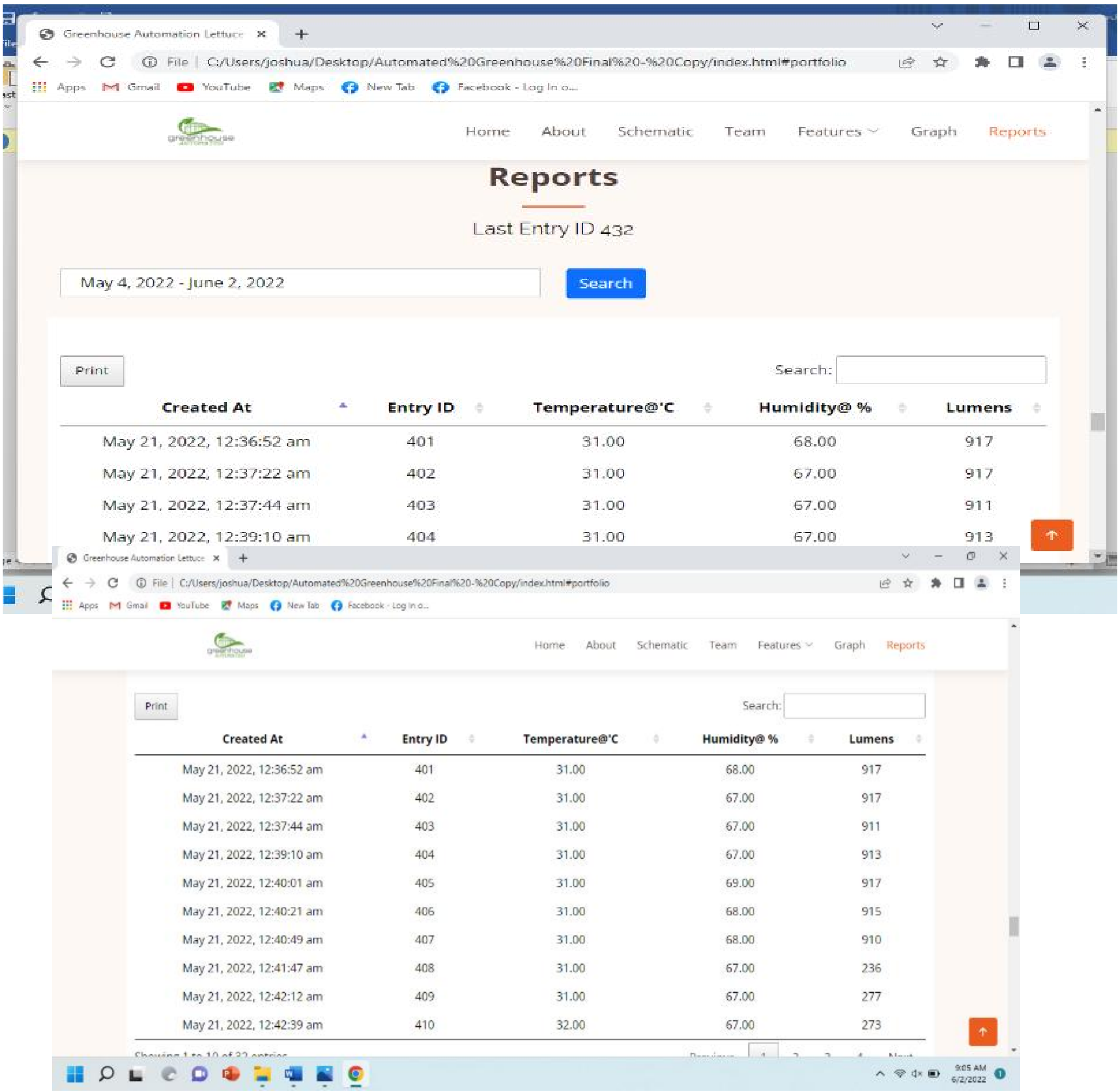
Graph

In this page, users can view the graph regarding the temperature and humidity



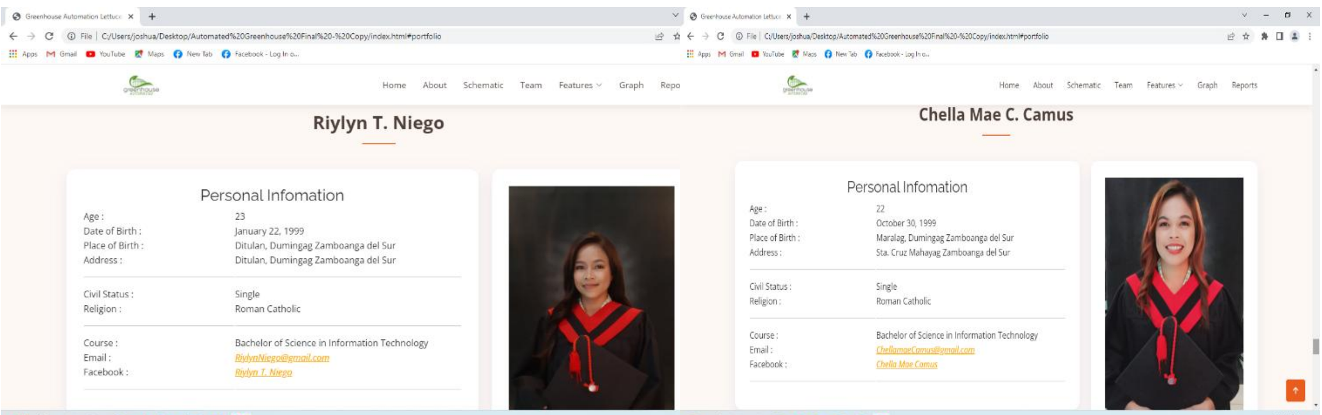
Report

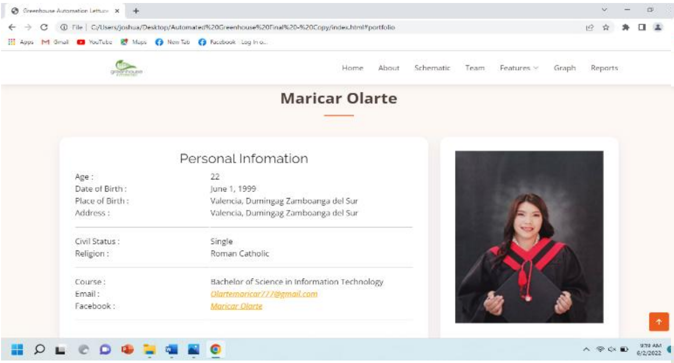
This is the report page where users can view reports regarding humidity, lumens and temperature.

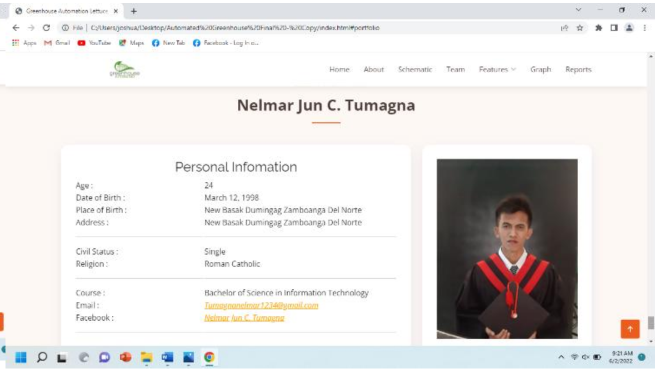


Contact

This contact page contains the researcher's information.







APPENDIX “C”

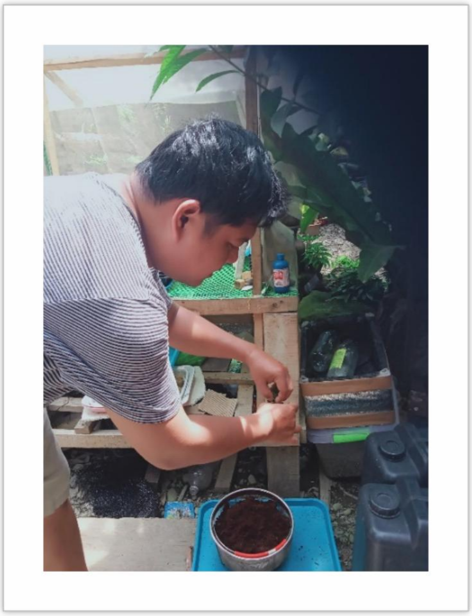
Photo Documentation

The researchers during the title proposal

Photo Documentation

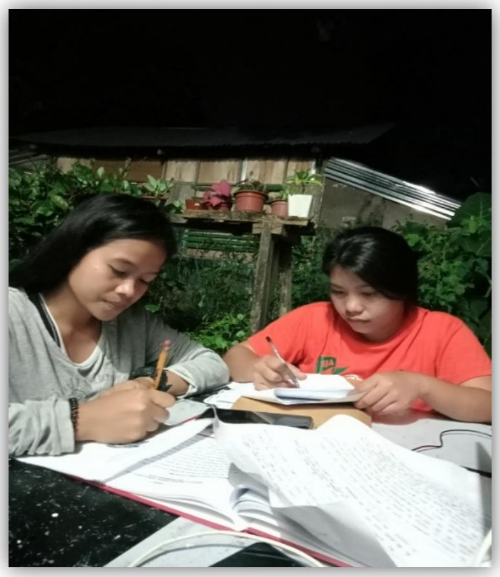
The researchers making the prototype

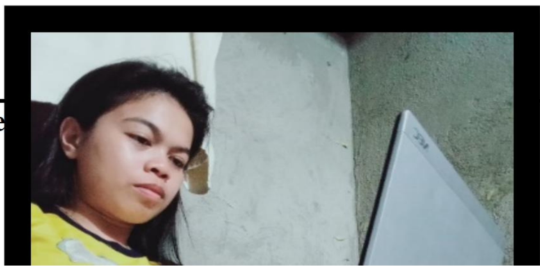
Photo Documentation



The researchers interviewing the owner of the Greenhouse

Photo Documentation





The researchers researching and encoding the documentation of the propose project

APPENDIX "E"

Consultation Log form

Automated Greenhouse for Growing Lettuce

Date	Time	Concern/Issue	Signature
March 15	**9:00-11:30 A.M**	**Consult prototype**	
March 18	**1:00-4:00 P.M**	**Consult prototype**	
March 22	**9:30-11:30 A.M**	**Consult prototype**	
March 23	**9:00-11:00 A.M**	**Consult documentation**	
March 25	**1:00-4:00 P.M**	**Consult documentation**	
April 5	**9:00-11:00 A.M**	**Consult prototype**	
April 10	**1:00-5:00 P.M**	**Consult web page**	
April 15	**1:00-5:00 P.M**	**Consult documentation, Prototype and webpages**	

April 17	**1:00-5:00 P.M**	**Consult documentation, Prototype and webpages**	
April 20	**9:00-11:00 A.M**	**Consult documentation, Prototype and webpages**	
April 22	**9:00-11:00 A.M**	**Consult documentation, Prototype and webpages**	
April 25	**9:00-11:00 A.M**	**Consult documentation, Prototype and webpages**	

MELIZA J. CHATTO
Adviser

CURRICULUM VITAE

Personal Information:

Name : Nelmar Jun C. Tumagna

Date of Birth : March 12, 1998

Place of Birth : New Basak, Dumingag, Zamboanga Del Sur

Address : New Basak, Dumingag, Zamboanga Del Sur

Civil Status : Single

Religion : Roman Catholic

Name of Parents:

Father : Nilo M. Tumagna

Mother : Margie C. Tumagna

Educational Background:

Tertiary : J.H. Cerilles State College-Dumingag Campus,

Dumingag, Zamboanga Del Sur

2021-2022

Degree	: Bachelor of Science in Information Technology
Senior High School	: Dumingag, Technological Training School San Pablo, Dumingag, Zamboanga Del Sur 2016-2018
Secondary	: Dumingag National High School Lo. Landing, Dumingag, Zamboanga Del Sur 2015-2016
Elementary	: Dumingag SPED Center Duminagag, Zamboanga Del Sur 2011-2012

CURRICULUM VITAE

Personal Information:

Name	: Riylyn T. Niego
Date of Birth	: January 22, 1999
Place of Birth	: Ditulan, Dumingag, Zamboanga Del Sur
Address	: Ditulan, Zamboanga Del Sur
Civil Status	: Single
Religion	: Roman Catholic
Name of Parents:	
Father	: Jose Rolly G. Niego
Mother	: Teresita T. Niego

Educational Background:

Tertiary	: J.H. Cerilles State College-Dumingag Campus,

Dumingag, Zamboanga Del Sur

2021-2022

Degree : Bachelor of Science in Information Technology

Senior High School : Dumingag Senior High School

Lo. Landing, Dumingag, Zamboanga Del Sur

2016-2018

Secondary : Dumingag National High School

Low. Landing, Dumingag, Zamboanga Del Sur

2015-2016

Elementary : Ditulan Elementary School

Ditulan, Zamboanga Del Sur

2011-2012

CURRICULUM VITAE

Personal Information:

Name : Maricar H. Olarte

Date of Birth : June 01, 1999

Place of Birth : Bag-ong Valencia, Dumingag, Zamboanga Del Sur

Address :Bag-ong Valencia, Dumingag, Zamboanga Del Sur

Civil Status : Single

Religion : Roman Catholic

Name of Parents:

Father : Olmar S. Olarte

Mother : Carmelita H. Olarte

Educational Background:

Tertiary : J.H. Cerilles State College-Dumingag Campus,

Dumingag, Zamboanga Del Sur

2021-2022

Degree	: Bachelor of Science in Information Technology
Senior High School	: Dumingag Senior High School Lo. Landing, Dumingag, Zamboanga Del Sur 2016-2018
Secondary	: Dumingag National High School Dumingag, Zamboanga Del Sur 2015-2016
Elementary	:Bag-ong Valencia Elementary School Bag-ong Valencia, Dumingag, Zamboanga Del Sur 2011-2012

CURRICULUM VITAE

Personal Information:

Name	: Chella Mae C. Camus
Date of Birth	: October 30, 1999
Place of Birth	: Maralag, Dumingag, Zamboanga Del Sur
Address	: Sta. Cruz, Mahayag, Zamboanga Del Sur
Civil Status	: Single
Religion	: Roman Catholic
Name of Parents:	
Father	: Nelson G. Camus
Mother	: Elna C. Camus

Educational Background:

Tertiary	: J.H. Cerilles State College-Dumingag Campus, Dumingag, Zamboanga Del Sur 2021-2022
Degree	: Bachelor of Science in Information Technology
Senior High School	: Dumingag Senior High School Lo. Landing, Dumingag, Zamboanga Del Sur 2016-2018
Secondary	: Boniao National High School Boniao, Mahayag, Zamboanga Del Sur 2015-2016
Elementary	: Sebastian Lobitaña Elementary School Sta. Cruz, Mahayag, Zamboanga Del Sur 2011-2012

```
#include <SoftwareSerial.h>
#include <dht.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
dht DHT;
#define RX 8
#define TX 9
#define DHTPIN A0
 int uv_light = 2;
 int sump = 3;
 int mist_pump = 4;
```

```
 int fan = 5;

 int ldr=A1;

 int value=0;

int enA = 10;

int enB = 11;

int in1 = 6;

int in2 = 7;

String AP = "VENZOI";       // AP NAME

String PASS = "P@ssw0rd112902"; // AP PASSWORD

String API = "P0BVC7SR09E8GFES";   // Write API KEY

String HOST = "api.thingspeak.com";

String PORT = "80";

int countTrueCommand;

int countTimeCommand;

boolean found = false;

SoftwareSerial esp8266(RX,TX);


void setup(){

  esp8266.begin(115200);

   sendCommand("AT",5,"OK");

   sendCommand("AT+CWMODE=1",5,"OK");

   sendCommand("AT+CWJAP=\""+ AP +"\",\""+ PASS +"\"",20,"OK");


LiquidCrystal_I2C begin();
```

```
lcd.init();
 lcd.backlight();


 pinMode(fan, OUTPUT);
  digitalWrite(fan, HIGH);
  pinMode(mist_pump, OUTPUT);
 digitalWrite(mist_pump, HIGH);
  pinMode(sump, OUTPUT);
 digitalWrite(sump, HIGH);
  pinMode(uv_light, OUTPUT);
 digitalWrite(uv_light, HIGH);
 pinMode(enA, OUTPUT);
  pinMode(enB, OUTPUT);
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  digitalWrite(in1, LOW);
  digitalWrite(in2, LOW);
     Serial.begin(9600);


}
void loop()
{
int chk = DHT.read11(DHTPIN);
 float temp=(DHT.temperature);
```

```
float Hum=(DHT.humidity);
 lcd.setCursor(0,0);
 lcd.print("Tem: ");
 Serial.print("Temp: ");
 lcd.setCursor(0,1);
 lcd.print(temp);
 Serial.println(temp);
 lcd.print((char)223);
 //lcd.print("C");
 lcd.setCursor(6,0);
 lcd.print("Hum: ");
 Serial.print("Humidity: ");
 lcd.setCursor(6,1);
 lcd.print(Hum);
 Serial.println(Hum);
 lcd.print("%");
  lcd.setCursor(13,0);
 lcd.print("Lum: ");
  lcd.setCursor(13,1);
  lcd.print(value);
   Serial.print("Lum: ");
  Serial.println(value);
/*
```

```
  if(DHT.humidity>=80)
  {
   digitalWrite(mist_pump, HIGH);
   digitalWrite(fan, HIGH);
  delay(1000);
}
else
{
 digitalWrite(mist_pump, LOW);
  digitalWrite(fan, LOW);
  delay(1000);
}*/
if (Hum > 80.00)
    {
      digitalWrite(fan,HIGH);// Fan is OFF
    }
    if (Hum <= 79.00)
    {
      digitalWrite(fan,LOW); // Fan is ON
      digitalWrite(mist_pump,LOW);//mist pump is ON
    }
   // if (temp > 25.00)
    if (temp > 28.00)
    {
```

```
    digitalWrite(fan,LOW); //Fan is ON
    digitalWrite(sump,LOW);//HEATER is ON
   }
    // if (temp == 22.00 && temp <= 25.00 )



      if (temp <= 26.00 && Hum >= 80.00 )
   {
    digitalWrite(fan,HIGH);//Fan is OFF
    digitalWrite(mist_pump,HIGH);//HEATER is OFF
    digitalWrite(sump,HIGH);
   }
   value=analogRead(ldr);
if(value>=900)
{
  digitalWrite(uv_light, HIGH);
  delay(1000);
  analogWrite(enA, 255);
  digitalWrite(in1, HIGH);
   delay(1500);
   digitalWrite(in1, LOW);
     delay(1000);
   }
else
```

```
{
  digitalWrite(uv_light, LOW);
}
 // delay(1000);
 //}
  //delay(500);
//ldr1();
//ldr2();
sendtothingspeak();
}
 /*---------------------------------------------------------------*/

void ldr1()
{
 value=analogRead(ldr);
if(value <=300){
  digitalWrite(uv_light, LOW);
  delay(1000);
 analogWrite(enB, 255);
  digitalWrite(in2, HIGH);
   delay(1500);
    digitalWrite(in2, LOW);
       }
}
```

```
/*--------------------------------------------------------------*/
void ldr2()
{
 value=analogRead(ldr);
if(value>=900)
{
  digitalWrite(uv_light, HIGH);
  delay(1000);
  analogWrite(enA, 255);
  digitalWrite(in1, HIGH);
   delay(1500);
   digitalWrite(in1, LOW);
     delay(1000);
   }
else
{
 digitalWrite(uv_light, LOW);


  delay(1000);
 analogWrite(enB, 255);
  digitalWrite(in2, HIGH);
   delay(1500);
    digitalWrite(in2, LOW);
   // delay(1000);
```

```
}
delay(1000);
}
 /*---------------------------------------------------------------*/
 void temp_hum()
 {
int chk = DHT.read11(DHTPIN);
 float temp=(DHT.temperature);
 float Hum=(DHT.humidity);
  lcd.setCursor(0,0);
  lcd.print("Tem: ");
  Serial.print("Temp: ");
  lcd.setCursor(0,1);
  lcd.print(temp);
  Serial.println(temp);
  lcd.print((char)223);
  //lcd.print("C");
  lcd.setCursor(6,0);
  lcd.print("Hum: ");
  Serial.print("Humidity: ");
  lcd.setCursor(6,1);


  lcd.print(Hum);
```

```
  Serial.println(Hum);
  lcd.print("%");
/*
  if(DHT.humidity>=80)
  {
   digitalWrite(mist_pump, HIGH);
   digitalWrite(fan, HIGH);
  delay(1000);
}
else
{
 digitalWrite(mist_pump, LOW);
  digitalWrite(fan, LOW);
  delay(1000);
}*/
if (Hum > 80.00)
    {
      digitalWrite(fan,HIGH);// Fan is OFF
    }
    if (Hum < 79.00)
    {
      digitalWrite(fan,LOW); // Fan is ON
      digitalWrite(mist_pump,LOW);//mist pump is ON
    }
```

```
 // if (temp > 25.00)
  if (temp > 28.00)
  {


    digitalWrite(fan,LOW); //Fan is ON
    digitalWrite(sump,LOW);//HEATER is ON
  }
    // if (temp == 22.00 && temp <= 25.00 )
      if (temp == 26.00 && Hum >= 80.00 )
  {
    digitalWrite(fan,HIGH);//Fan is OFF
    digitalWrite(mist_pump,HIGH);//HEATER is OFF
    digitalWrite(sump,HIGH);
  }
delay(1500);
}
/*--------------------------------------------------------------------*/
void sendCommand(String command, int maxTime, char readReplay[]) {
Serial.print(countTrueCommand);
Serial.print(". at command => ");
Serial.print(command);
Serial.print(" ");
while(countTimeCommand < (maxTime*1))
{
```

```
  esp8266.println(command);//at+cipsend
  if(esp8266.find(readReplay))//ok
  {
    found = true;
    break;
  }
 countTimeCommand++;
 }
 if(found == true)

 {
  Serial.println("OK");
  countTrueCommand++;
  countTimeCommand = 0;
 }
 if(found == false)
 {
  Serial.println("Fail");
  countTrueCommand = 0;
  countTimeCommand = 0;
 }
 found = false;
}
/*-------------------------------------------------------------*/
```

```
void sendtothingspeak() {
 float temp=(DHT.temperature);
float Hum=(DHT.humidity);
 esp8266.begin(115200);
    // esp8266.begin(9600);
   String getData = "GET /update?api_key="+ API
+"&field1="+temp+"&field2="+Hum+"&field3="+value;
    sendCommand("AT+CIPMUX=1",5,"OK");
    sendCommand("AT+CIPSTART=0,\"TCP\",\""+ HOST +"\","+ PORT,15,"OK");
    sendCommand("AT+CIPSEND=0," +String(getData.length()+4),4,">");
    esp8266.println(getData);
    delay(1500);
    countTrueCommand++;
    sendCommand("AT+CIPCLOSE=0",5,"OK");
  }
```