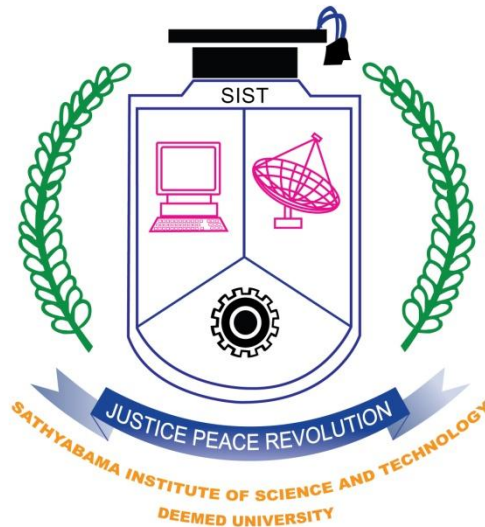


AUTOMATED PH MONITORING AND CONTROLLING SYSTEM FOR HYDROPONICS UNDER GREENHOUSE CONDITION

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by
ANUSHAA A (Register No. 39140003)
HARINI C(Register No. 39140017)



**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

APRIL 2023



SATHYABAMA

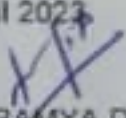
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

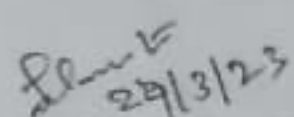
Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
www.sathyabama.ac.in

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
ENGINEERING**

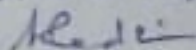
BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
ANUSHAA A (Reg. No. 39140003) and **HARINI C** (Reg. No. 39140017) who carried
out the project entitled "**AUTOMATED PH MONITORING AND CONTROLLING
SYSTEM FOR HYDROPONICS UNDER GREENHOUSE CONDITION**" under our
supervision from November 2022 to April 2023.

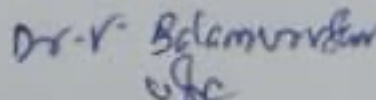

Mrs. RAMYA D
Internal Guide


Dr. V. SIVACHIDAMBARANATHAN
Head of the Department

Submitted for Viva voce Examination held on 26/4/2023

Name: Dr. S. RAOULU
Signature: 

Internal Examiner


Dr. V. Balaraman
External Examiner

DECLARATION

We ANUSHAA A (Reg. No. 39140004) and HARINI C (Reg. No. 39140017) hereby declare that the Project Report entitled "AUTOMATED PH MONITORING AND CONTROLLING SYSTEM FOR HYDROPONICS UNDER GREENHOUSE CONDITION" done by us under the guidance of RAMYA D is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

DATE: 26/04/23.

PLACE: CHENNAI

1. Anushaa A

2. Harini C

SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. N. M. Nandhita., Dean, School of Electrical and Electronics Engineering** and **Dr. V. Sivachidambaranathan, Head of the Department, Dept. of Electrical and Electronics Engineering** for providing us necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project Guide **RAMYA D** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

We wish to express our thanks to all Teaching and Non-teaching staff members of the Department of Electrical and Electronics Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

The automated monitoring and controlling system was developed to monitor the humidity, temperature, conductivity sensor, and identifying the plant disease. The humidity, temperature and plants nature is monitored using, "THING VIEW FREE" app. the nature of the plant is examined by identifying wheather the plant affected by any fungal, bacterial, viral infections with the help of MATLAB software. This abstract provides an overview of an automated pH monitoring and controlling system designed for hydroponics under greenhouse conditions. Hydroponics is a soil-less method of growing plants using water and nutrient solutions, where the pH level of the solution is critical for optimal plant growth. The proposed system uses sensors to monitor the pH level of the nutrient solution and automatically adjusts it using pH adjusters or acid/base solutions. In a greenhouse environment, where growing conditions can vary, an automated pH monitoring and controlling system can provide a stable and controlled environment for plants. The system can save time and labor for hydroponic farmers, reduce the risk of human error, and improve the quality and yield of crops. The design of the system involves selecting appropriate sensors, pH adjusters, and control systems, calibration, testing, and integration with the overall greenhouse control system. Overall, an automated pH monitoring and controlling system can be an effective tool for hydroponic farmers to optimize plant growth and increase yields.

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
	ABSTRACT	lv
	LIST OF FIGURES	Viii
1	INTRODUCTION	
	1.1 GENERAL	1
2	LITERATURE SURVEY AND SUMMARY	
	2.1 MAJOR FINDINGS FROM LITERARURE SURVEY	3
	2.2 IEEE STANDARDS	7
3	EXISITING SYSTEM	
	3.1 EXISTING SYSTEM BLOCK DIAGRAM AND EXPLANATION	9
	3.2 DISADVANTAGE OF EXISTING SYSTEM	10
	3.3 EXISTING METHOD	10
	3.3.1DRIP IRRIGATION IN NORMAL METHOD	10
	3.3.2GREEN HOUSE MONITORING	11
4	PROPOSED SYSTEM	
	4.1SCOPE OF THE PROJECT	13
	4.2OBJECTIVE	13
	4.3METHODOLOGY	13

	4.4CONCEPTUALIZATION OF THE STUDY	15
	4.5THE PODUCTION SYSTEM	15
	4.6AUTOMATION OF PH MONITORING AND CONTROLLING DEVICE	16
	4.7PROPOSED SYSTEM	
	4.7.1 METHODS USED IN PROPOSED SYSTEM	16
	4.7.1.1IDENTIFICTION OF PLANT DISEASE	16
	4.7.1.2DRIP METHOD	25
	4.8 HARDWARE REQUIREMENTS	28
	4.8.1 NODE MCU	27
	4.8.2 SOIL MOISTURE SENSOR	28
	4.8.3 WATER MOTOR	29
	4.8.4 DHT11 SENSOR	29
	4.8.5 MEMBRANE	30
	4.8.6 MOTOR DRIVER	31
	4.9 SOFTWARE DETAILS	31
	4.9.1 ARDUINO IDE	31
	4.9.2 MATLAB	32
5	RESULTS AND OUTPUTS	
	5.1RESULTS	33
	5.1.1IDENTIFICATION OF PLANT DISEASE	33
	5.1.2DRIP METHOD	35
	5.1.3PH SIMULATION	36
	5.2APPLICATION	37
	5.3ADVANTAGE	37

6	CONCLUSION AND REFERENCE	39
----------	---------------------------------	-----------

LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
3.1	BLOCK DIAGRAM OF EXISTING SYSTEM	9
3.2	DRIP IRRIGATION IN NORMAL METHOD	11
3.3	GREEN HOUSE MONITORING SYSTEM	12
4.1	MAIN STAGES OF THE SYSTEM	18
4.2	THE MENU WINDOW	19
4.3	GETTING IMAGES FROM THE DATABASE	20
4.4	LEAF DETECTION	20
4.5	LEAF PRE-PROCESSING	21
4.6	HISTOGRAM EQUALIZATION	21
4.7	FEATURE POINTS RETRIVED FROM FEATURE EXTRACTION	22
4.8	THE IMAGE SELECTION WINDOE-TO SELECT AN IMAGE FOR TESTING	22
4.9	IMAGE SELECTED	23
4.10	IMGAGE CONVERTED TO RGB2GRAY AND THEN SMOOTHING IS PERFORMED	23
4.11	IMAGE AFTER APPLYING EDGE DETECTION	24
4.12	THE RESULT WINDOW	24
4.13	BLOCK DIAGRAM OF DRIP METHOD	25
4.14	SOIL SENSOR	28
4.15	WATER MOTOR	29
4.16	DHT11 SENSOR	29
4.17	MEMBRANE	30
4.18	MOTOR DRIVER	31

5.1	SELECTING SEGMENT	33
5.2	DETECTION OF DISEASE	33
5.3	IDENTIFIED DISEASE	34
5.4	DISPLAYING THE RESULT	34
5.5	OUTPUT OF DRIP METHOD	35
5.7	DISPLAYING TEMPERATURE AND HUMIDITY VALUES	36
5.8	PH SIMULATION	36

CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

Hydroponics is a method of growing plants in a soil-less environment by using water and nutrient solutions. In hydroponic systems, the pH level of the nutrient solution plays a crucial role in the growth and yield of plants. The pH level needs to be constantly monitored and adjusted to ensure optimal plant growth. Automated pH monitoring and controlling systems can help hydroponic farmers to maintain the pH level of the nutrient solution within the desired range. Such systems use sensors to monitor the pH level of the nutrient solution and automatically adjust it using pH adjusters or acid/base solutions.

In a greenhouse environment, where the growing conditions can vary due to changes in temperature, humidity, and light intensity, an automated pH monitoring and controlling system can be particularly beneficial. It can provide a stable and controlled growing environment, which can lead to better plant growth, higher yield, and improved quality.

The design of an automated pH monitoring and controlling system for hydroponics under greenhouse conditions would typically involve selecting appropriate sensors, pH adjusters, and control systems. The system would need to be calibrated and tested to ensure accuracy and reliability. It would also need to be integrated with the overall greenhouse control system to enable seamless operation. Overall, an automated pH monitoring and controlling system can help hydroponic farmers to save time and labor, reduce the risk of human error, and improve the quality and yield of their crops.

Agriculture plays an important part in the growth and development of a country. Having an agricultural industry allows a country to produce its own food which does not necessitate the need for the trade and importation of goods from other countries. In short, agriculture allows for the self-sufficiency of a country in terms of its food supply and other agricultural products (Tagle et al., 2018).

Hydroponics system is a growing plant system that does not use soil but uses water with nutrients to save space planting and not contaminated with chemicals in the soil (Kularbphetpong et al., 2019). The only requirements with the

water culture system is a water reservoir to supply nutrients to the plants, a platform for the plants on top of the nutrient solution. Water culture systems are the systems of leafy lettuce. These are very inexpensive systems which can be utilized in areas with little to no electricity. In the present scenario, almost everything can be controlled and operated automatically, systems become smarter and automatic in that way there is a need of revolution in agriculture industry (Mishra and Jain, 2015).

Arduino uno microcontroller can be used to implement nutritional water flow system and the sensors can well detect and handle the water level in hydroponic tubes (Sihombing et al., 2018). Though, there are several other parameters such as air temperature and humidity, lights, water temperature, etc. which are not controlled or maintained. These parameters are important for a healthy and faster plant growth (Brechtner et al., 2013).

Hence, this study is conceptualized to develop an automated system by monitoring the pH of the nutrient solution in a hydroponic system for optimum plant growth as this factor can greatly affect the growth of lettuce. Specifically, the study aimed to install an automated Ph monitoring and controlling mechanism for the nutrient solution, evaluate the performance of the automated monitoring and controlling device and determine the response of lettuce on the automated monitoring and controlling device.

CHAPTER 2

LITERATURE SURVEY AND SUMMARY

2.1 MAJOR FINDINGS SURVEY

Amy lizabeth jose rico (2018) An automated pH monitoring and controlling system for hydroponic system was developed, calibrated and validated in this study. The automated monitoring and controlling system was developed to monitor and control the pH of nutrient solution in hydroponic system. The greenhouse available at the Center for Hydroponics and Aquaponics Technology (CHAT) and locally available materials and hardware for the hydroponics and automation were used in the development of the system. These devices were designed and assembled based on the conceptual framework of the study. The pH sensor sends signal to the microcontroller which triggers the adding of acid/base solution and turning on/off of the mixer. The instruments used were calibrated prior to the performance evaluation and obtained calibration equation for the pH sensor is $y = 0.91x + 0.91$. Validation of the automated pH monitoring and controlling system was done and the recorded maximum pH is 6.54 and minimum pH of 6.0. The lettuce planted during the validation has an average height of 14.61 cm and the average leaf count of 12 for the lettuce crops during the 4th week after planting. A total of 4.78 kg of lettuce crop was harvested with an average of 20.6 g per lettuce crop was obtained. Based on the performance evaluation and validation done on the automated pH monitoring and controlling system, it was found to be reliable. This system becomes useful in reducing labor cost and allows for real-time monitoring of pH, therefore, increasing farmer's crop productivity and income.

Rahul G . mapari et al., (2022) As the world is moving at a very fast pace in aspects like technology and science, farming methods are also changing. Soil erosion and infertility is a very big issue in traditional farming and so to evade this a soilless farming also known as hydroponics is becoming very popular. Hydroponics is technique for growing plants without the use of soil in a controlled manner by providing necessary nutrients to the crop. The existing systems of farming require regular ploughing and weeding of land, use of large area and an enormous amount of water. All these problems can be eradicated by using the hydroponics system of farming, and reduce the work of the farmer by automating

the watering processes. The idea of proposed hydroponic style vertical farming is to use the Internet of Things (IoT) for sensing and monitoring important factors such as pH, TDS, temperature, and humidity to automate the system. The novelty of the project lies in its feature of automating the irrigation process, displaying all-important factors on an app and notifies the user through email in abnormal conditions.

Gnana yashaswini sriram et al.,sa(2021) Aquaponics is the unification of aquaculture and hydroponics in a single system. The cycle of dispensing fish excreta as supplement food for the plant growth and the nutrient emanated from those plants passing back to the fish in the aquarium as its food will continuously take place. The intention of this project is to develop an aquaponic system with a real time remote monitoring system by using Arduino IDE platform,ESP8266-NodeMCU as a controller and numerous sensors to control various parameters through the Internet of Things. All sensors are combined together to check the temperature, Ph values in the fish tank, while the auto feeder plays a major role to sustain growth and survival. Ultimately, the adjustments are made to maintain the whole process with the help of the controller that acts as a memory bank by collecting the data from all the sensors and taking actions accordingly. An alert and notification unit is integrated with the system to warn the user via an application whenever the values fall off their optimal levels.

Maria C moreno et al., os(2019)Greenhouses are climate-controlled environments that allow maintaining the ideal conditions for plant development. A large proportion of these structures are controlled manually to keep within the range of desired parameters such as temperature, humidity, pH, and heat index, requiring one or more operators to repeatedly visit the greenhouse. Autonomous control and monitoring of these variables through sensors, actuators, and modules that allow the combination of the Internet of Things (IoT) applied to these technologies provide a good performance in plant growth, since it can store and access records in the cloud at any time over platforms such as ThingSpeak and Blynk. This paper is oriented to planning an autonomous deep water culture hydroponic system that saves water resources and produces under limited environmental conditions. For this reason, a prototype has been developed, which includes a Real-Time Clock (RTC) module, a level sensor (9SSE1), and a

temperature and humidity sensor (DHT11), which send the data to the NodeMCU (development board with IoT platform) that will process the information to control the coolers, light bulb, buzzer, and greenhouse lights.

Ma. Jenica rt al.,sji (2020)This paper introduces the development of monitoring and maintaining optimal water quality in an aquaponics system. The design is based on the hydroponics system's Nutrient Film Technique (NFT) in which plant roots are being exposed to a thin layer of nutrient water in a long narrow channel. The design used a developmental and experimental type with the use of microprocessors and sensors for enhanced monitoring and error-correcting within the aquaponics system where standard data was obtained from different reliable sources. Various sensors are calibrated for different measurements to provide accurate and reliable readings of water temperature, pH level, dissolved oxygen, total dissolved solids, water flow, and temperature and humidity. The Arduino Mega reads and analyzes data collected by various sensors, and instructs actuators such as aquarium heater, cooling fan, aerator, grow light, and water pump. The data gathered appears on the built-in LCD screen and will be sent to the owner's mobile phone regarding the condition of the system. Also, the system has a fish feeder that automatically dispenses food at a given time. The device can be controlled wirelessly using a mobile phone and manually using a 4x4 keypad. Also, the owner can monitor the way each actuator was controlled.

Helmy Helmy et al.,da (2020)Hydroponics is a cultivation method where the plants are grown by using water as the growing media. One of the solutions we can choose to end vegetables production quantity problem is by using a hydroponic technique called Nutrient Film Technique (NFT). This method utilizes the nutrient solution, circulating water, and oxygen to hasten plant growth and produce better result. One of the most important parameters to note here is the pH value. We have to maintain the pH value at a stable level. This research discusses the details of an automated pH control system by using multiple linear regression. This control system used Arduino Nano and NodeMCU with pH H-101 sensor. The accuracy result of the multiple linear regression tests with several reservoirs and several set points is 94.84%. For the overall system accuracy test, the result was 89.37%. Based on these results, we can confidently say that the multiple linear regression method can be used to control hydroponic acidity (pH). development of

an automated pH control system for hydroponic greenhouse" by J. Li, C. Yan, and H. Li. This paper presents the design and development of an automated pH control system for hydroponic greenhouses. The system uses a fuzzy logic controller to control "Automated pH and nutrient monitoring system for hydroponic lettuce production" by M.A. Sabah, H. Hashim, and M.Z. Yusoff. This study describes the development of an automated pH and nutrient monitoring system for hydroponic lettuce production in a greenhouse. The system uses a microcontroller-based pH and nutrient sensor to monitor and control the pH and nutrient levels of the hydroponic solution.

"Development of an automatic pH control system for hydroponic lettuce production" by **C.C. Chang, Y.C. Huang, and Y.H. Chen**. This study describes the development of an automatic pH control system for hydroponic lettuce production. The system uses a microcontroller-based pH sensor to monitor and control the pH of the hydroponic solution, and the results show that the system is effective in maintaining the pH within a desired range.

"Design and implementation of a microcontroller-based automated pH control system for hydroponics" by **M. Zarei, S. Saeedi, and M. Tavakoli**. This paper presents the design and implementation of a microcontroller-based automated pH control system for hydroponics. The system uses a pH sensor and a microcontroller to monitor and control the pH of the hydroponic solution, and the results show that the system is effective in maintaining the pH within a desired range.

"Automated pH control for hydroponic crop production" by **R. Savvas and S. Ntatsi**. This article reviews the current state of automated pH control systems for hydroponic crop production. The authors discuss the different types of sensors and controllers used in these systems, as well as the benefits and limitations of automated pH control in hydroponics.

Overall, these studies demonstrate the effectiveness of automated pH monitoring and controlling systems for hydroponics under greenhouse conditions. These systems can help growers maintain optimal pH levels for their crops, which can lead to increased yields and improved crop quality.

2.2 IEEE STANDARDS :

IEEE 802.15.4 is a wireless communication standard for low-rate personal area networks (LR-WPANs). It defines the physical and media access control (MAC) layer protocols for LR-WPANs, including packet format, addressing, and channel access. It is designed to be reliable and energy-efficient, making it ideal for devices with limited power resources. Overall, IEEE 802.15.4 provides a cost-effective and flexible solution for wireless connectivity in LR-WPANs.

IEEE 1451 is a set of standards that defines a standardized interface for sensors and actuators. The interface includes mechanical, electrical, and software characteristics, as well as communication protocols. This standard facilitates interoperability between different types of transducers and measurement and control systems. IEEE 1451 reduces the cost and complexity of integrating sensors and actuators into measurement and control applications. The standard provides a framework for transducer communication that promotes innovation and enables system integration.

IEEE 1588 is a precision clock synchronization protocol for networked measurement and control systems. The protocol enables the synchronization of clocks in devices connected over a network, allowing for accurate and synchronized readings from multiple sensors. IEEE 1588 is designed for use in real-time applications that require high levels of precision, such as industrial automation, power systems, and telecommunications. The standard specifies the synchronization mechanism, message format, and performance requirements for clock synchronization. Overall, IEEE 1588 provides a reliable and cost-effective solution for clock synchronization in networked measurement and control systems.

IEEE 1680.3 is a standard that establishes environmental performance criteria for imaging equipment, including printers, copiers, and scanners. The standard specifies requirements for energy efficiency, material selection, and end-of-life management. It aims to promote sustainability in the design, manufacturing,

and use of imaging equipment, reducing the environmental impact of these devices. IEEE 1680.3 is part of a series of standards that address environmental considerations in electronics, promoting the development of eco-friendly products. Overall, IEEE 1680.3 provides a framework for environmentally responsible practices in the imaging equipment industry.

IEEE 1800 is a standard for electronic design automation (EDA) that defines the SystemVerilog language. The standard provides a unified approach to design, verification, and testing of digital systems. It includes features for hardware and software co-design, testbench development, and assertions. IEEE 1800 is widely used in the semiconductor industry for the design and verification of complex digital systems, such as microprocessors and integrated circuits. Overall, IEEE 1800 provides a comprehensive and standardized framework for digital system design and verification

CHAPTER 3

3.1 EXISITING SYSTEM

BLOCK DIAGRAM

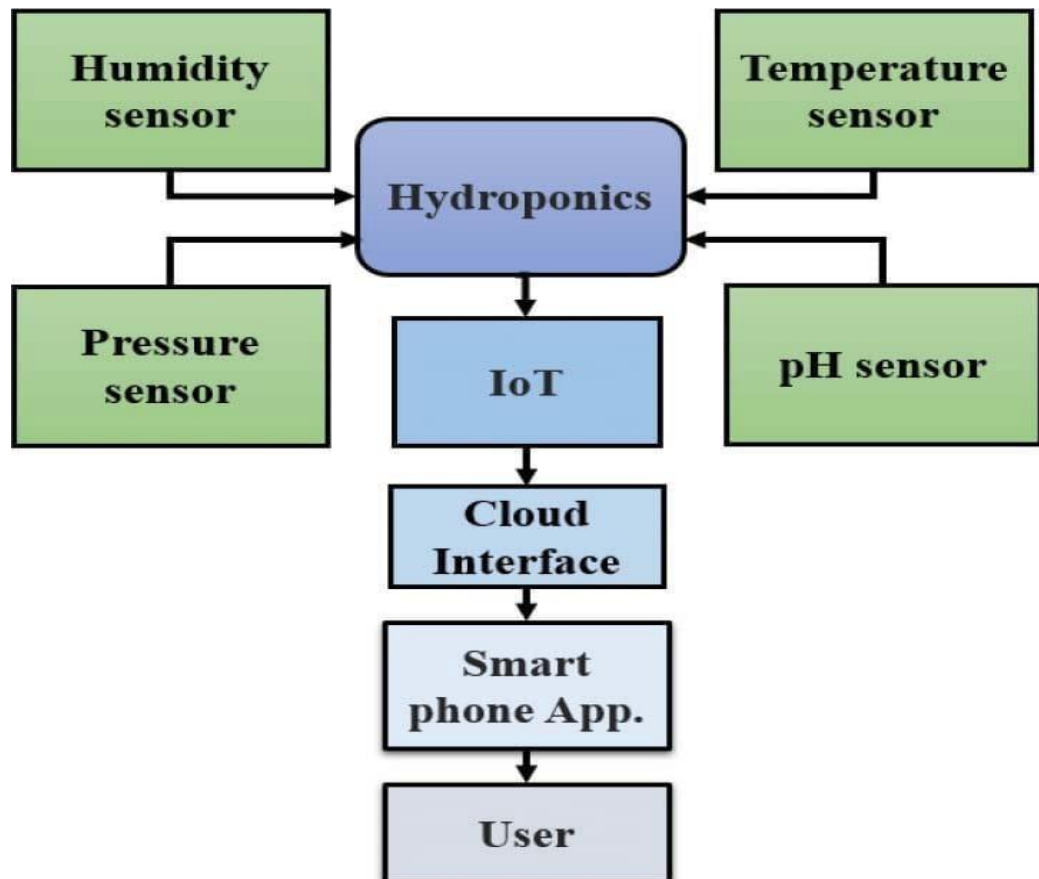


Fig. 3. 1. BLOCK DIAGRAM OF EXISITING SYSTEM

Agriculture plays an important part in the growth and development of a country. Having an agricultural industry allows a country to produce its own food which does not necessitate the need for the trade and importation of goods from other countries. In short, agriculture allows for the self-sufficiency of a country in terms of its food supply and other agricultural products (Tangle et al., 2018). Hydroponics system is a growing plant system that doesn't use soil but uses water with nutrients to save space planting and not contaminated with chemicals in the soil (Kularbphetong et al., 2019). The only requirements with the water culture system is a water reservoir to supply nutrients to the plants, a platform for the

plants on top of the nutrient solution. Water culture systems are the systems of leafy lettuce. These are very expensive systems which can be utilized in areas with little to no electricity. In the present scenario, almost everything can be controlled and operated automatically, systems become smarter and automatic in that way there is a need of revolution in agriculture industry (Mishra and Jain, 2015). Arduino uno microcontroller can be used to implement nutritional water flow system and the sensors can well detect and handle the water level in hydroponic tubes (Sihombing et al., 2018). Though, there are several other parameters such as air temperature and humidity, lights, water temperature, etc. which are not controlled or maintained. These parameters are important for a healthy and faster plant growth (Brechtner et al., 2013). Hence, this study is conceptualized to develop an automated system by monitoring the pH of the nutrient solution in a hydroponic system for optimum plant growth as this factor can greatly affect the growth of lettuce. Specifically, the study aimed to install an automated pH monitoring and controlling mechanism for the nutrient solution, evaluate the performance of the automated monitoring and controlling device and determine the response of lettuce on the automated monitoring and controlling device.

3.2. DISADVANTAGES OF EXSISTING SYSTEM :

- Putting together hydroponics system isn't cheap
- Constant monitoring is required
- Hydroponic system are vulnerable to power outages.

3.3 EXISITING METHOD :

3.3.1 Drip irrigation in normal method:

Main line conveys water from the head unit to the sub mains. There is one sub-main for each sub division (part) of the field. In small fields a sub-main may not be required. Laterals are connected to the sub main and carry water to the individual crop rows. Emitter fixed on the lateral delivers the water to individual crops. Pressure gauge, air release valve, flush valves and bypass assembly are other important accessories of the drip system that assist in trouble free functioning of the drip system.

Disadvantages :

- High initial investment requirements;
- Regular capital requirement for replacement of drip irrigation equipment on the surface (damage due to movement of equipment, UV-radiation);
- Drip irrigation emitters are vulnerable to clogging and dysfunction (water filters required, regular flushing of pipe system);
- High skill requirements for irrigation water management in order to achieve optimal water distribution;
- Soil salinity hazard.

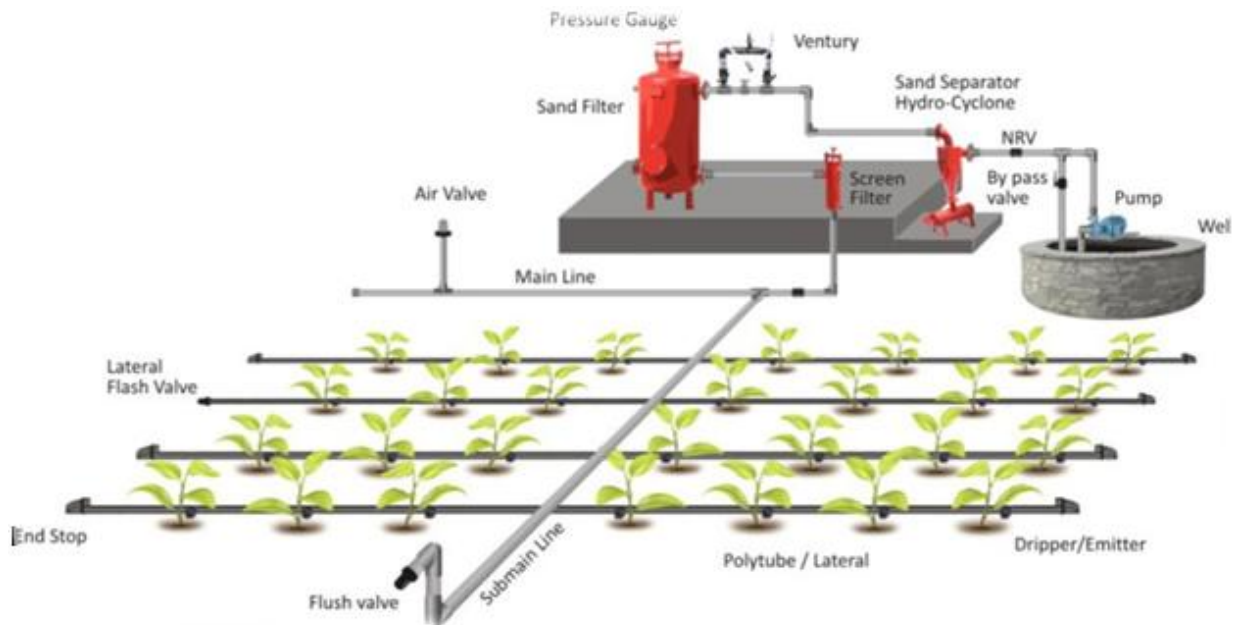


fig 3.2 drip irrigation in normal method

3.3.2 Green house monitoring :

The system deals with monitoring and controlling the environmental conditions like temperature, relative humidity, with sensors and sends the information to the web page and then plot the sensor data as graphical statistics. The data updated from the implemented system can be accessible in the internet from anywhere in the world.

Disadvantages:

- Careful consideration of a proper site for your greenhouse often reveals this primary disadvantage of constructing one.
- Designed to hold in warmth during cold seasons, a greenhouse also becomes a heat trap during warm weather.
- The same barrier that a greenhouse provides to keep out undesirable weather also keeps in pests and diseases.

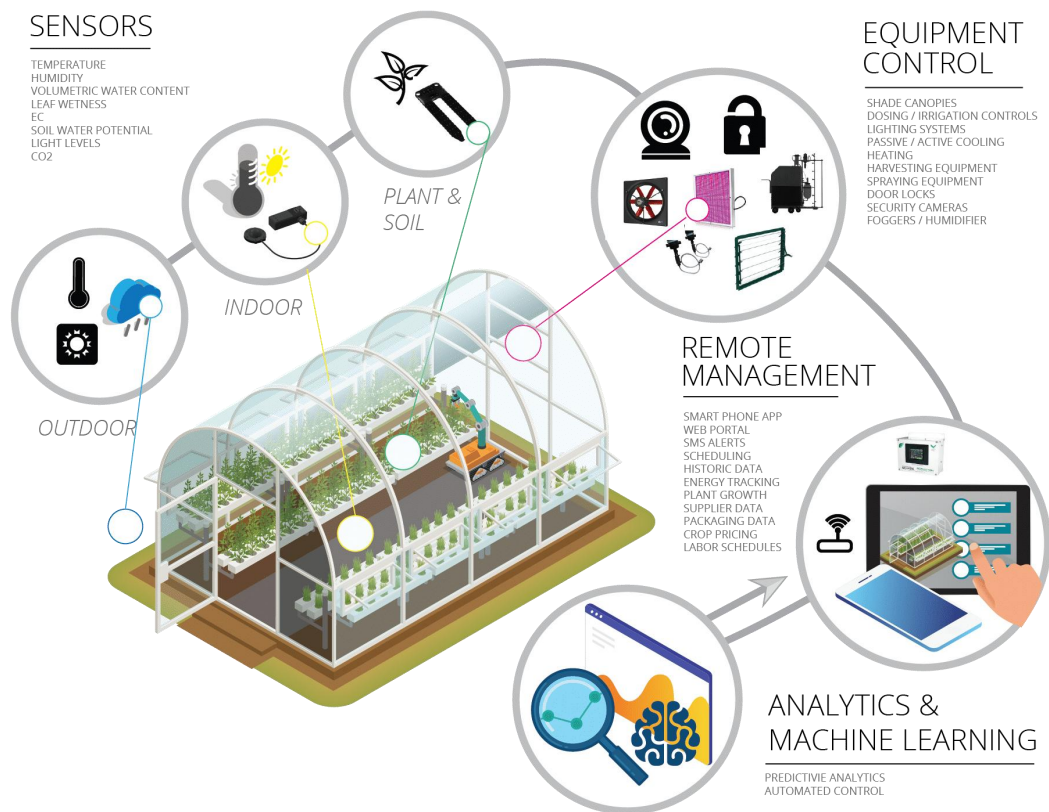


Fig 3.3 Greenhouse monitoring method

CHAPTER 4

4.1 SCOPE OF THE PROJECT

The main scope of the project is,

- Convert green house into usable nutrients.
- The pH of the nutrient solution is tested and maintained at certain level.
- To give plants the essential minerals and nutrients.
- Using this method the green house is been recycled into usable product.

4.2 OBJECTIVE

This study is conceptualized to develop an automated system by monitoring the pH of the nutrient solution in a hydroponic system for optimum plant growth as this factor can greatly affect the growth of lettuce.

Specifically, the study aimed to install an automated pH monitoring and controlling mechanism for the nutrient solution, evaluate the performance of the automated monitoring and controlling device and determine the response of lettuce on the automated monitoring and controlling device.

4.3 METHODOLOGY

Here, the pH of the nutrient solution in the hydroponic system reservoir is sensed using pH sensor. The pH level set point is designated for the plants. The reservoirs having the nutrient solutions also has the acidic/ basic pump.

Based on the pH level the acid or base gets mixed in the reservoir with water and given to the plants. Microcontroller using Arduino is used for programming, controlling and monitoring processes.

Monitoring is provided by the LCD display. If the pH level in reservoir is equal to set limit pump remains in off condition. If the pH value greater than set limit acid pump turns on.

Similarly, if the pH level is lesser than the set value base pump turns on. Thus, corresponding values are indicated and the mixture gets formed resulting in nutritious and productive growth of plants.

The methodology for designing and implementing an automated pH monitoring and controlling system for hydroponics under greenhouse conditions involves the following steps:

System Design:

The first step is to design the system by selecting appropriate sensors, pH adjusters, and control systems. The system must be capable of monitoring the pH level of the nutrient solution and automatically adjusting it within the desired range.

Calibration:

Once the system is designed, it must be calibrated to ensure accuracy and reliability. This involves testing the sensors and pH adjusters to ensure that they are working correctly.

Integration:

The pH monitoring and controlling system must be integrated with the overall greenhouse control system to enable seamless operation.

Real-time pH Monitoring:

The system must monitor the pH level of the nutrient solution in real-time using appropriate sensors. The sensors must be placed in the nutrient solution to detect the pH level accurately.

Automated pH Adjustment:

The system must be programmed to automatically adjust the pH level of the nutrient solution using pH adjusters or acid/base solutions. This can be done using pumps and valves controlled by the system.

System Testing:

The system must be thoroughly tested to ensure that it is working correctly. This involves monitoring the pH level of the nutrient solution and checking that the system is adjusting it within the desired range.

System Optimization:

The system may require optimization to ensure that it is operating at peak performance. This may involve adjusting the pH range, optimizing the control algorithms, or making changes to the system hardware.

Maintenance:

The pH monitoring and controlling system must be regularly maintained to ensure that it continues to operate correctly. This involves checking and replacing sensors and pH adjusters as needed.

Overall, the methodology for designing and implementing an automated pH monitoring and controlling system for hydroponics under greenhouse conditions involves designing the system, calibrating it, integrating it with the greenhouse control system, monitoring and adjusting the pH level in real-time, testing the system, optimizing it, and performing regular maintenance to ensure proper functioning.

4.4 CONCEPTUALIZATION OF THE STUDY:

The study aimed to monitor and control the pH of the nutrient solution using hydroponic system under greenhouse condition. Through this process, time and labour can be saved as well as real time monitoring of the parameters can be achieved.

4.5 THE PRODUCTION SYSTEM:

The automated hydroponic system used in the study is composed of the structural system, the hydroponic system and the automation system. The automated pH monitoring and controlling was tested in one of the greenhouse facilities located at the Center for Hydroponics and Aquaponics Technology (CHAT) measuring 3.0 m in width, 4.0 m in length and 3.5 m in height. The frames of the greenhouse are made from 2.54 cm galvanized iron pipes bended and welded together to form a quonset-type structure. The structure is provided with three roof covers: the insect-proof net in the inner side, the ultraviolet-resistant plastic film in the middle and the gray woven net shade on the outer side that offers strength and improve the ventilation in the system. The recirculating tube culture system was used in hydroponic system. The hydroponic system was enclosed in the structural system. The grow pipes used was 300.0 cm in length and 0.075 cm diameter. A slope of 1 cm/100 cm of the pipe length was employed for the water to flow through the pipe with ease. The PVC pipes were drilled with 5.08 cm diameter holes and were spaced at 16.5 cm between holes (center to center) and made in 2-layer and 4-column pipe layout. A 150 L reservoir served as the source of water in the hydroponics system where the water was pumped to each growing tubes.

The water flow in the hydroponic system was run by a 65 W submersible pump, 1-2 L-1min flow for each growing tube that lifts the water to the upper layer

of the growing tubes. A mixer inside the reservoir was installed to equally dispense the nutrient solution to the reservoir water.

4.6 AUTOMATION OF THE pH MONITORING AND CONTROLLING DEVICE:

The automated pH monitoring and controlling device basically monitor and control the parameters such as pH of the nutrient solution in a hydroponic system under greenhouse condition. Sensors were used to determine the pH in the reservoir. A microcontroller using the Arduino platform was used in programming the automation of the Ph monitoring and controlling device. Using this data, the microcontroller adjusts the pH level of the water in the system by adding acid and base solution and turning the mixer on. The LCD is initialized when the automation system is turned on. The pH range of 6.0-6.8 for the nutrient solution was entered in the system. These ranges determine when the acid/base solutions will be added and the mixer will be turned on and determined using the pH level sensor submersed into the reservoir. If the pH level reading is below 6.0, the sensor sends signal to the microcontroller to trigger the peristaltic pumps to add base solution as well as to turn on the mixer. On the other hand if the pH level of the nutrient solution is above 6.8, the sensor sends signal to the microcontroller which triggers the peristaltic pumps to add acid solution and turn on the mixer. When the entered pH range is attained, the sensors send signal the microcontroller to turn off the mixer and the addition of base/acid solution in the reservoir.

4.7 PROPOSED SYSTEM

4.7.1 METHODS USED IN PROPOSED SYSTEM

4.7.1.1 IDENTIFICATION PLANT DISEASE

There are 4 stages to identify the plant disease

INPUT

Here the RGB images of the plant is given as the input.

PREPROCESS

Black dot noise(BDN) depending on time and season the functionality and darkness differs with eachother, so BDN is used to enhance the quality of the image.

SEGMENTATION

It operates on concept region of interest where it divides the image into 3 slices of layers. The one we evaluate will conclude either the plant is affected or not.

CLASSIFICATION

It concludes the disease of the plant using DCNN deep convolutional neural network.

The state-of-the-art of leaf/plant/tree recognition is nowadays used by botanists. However, the program developed in that case is specific for one task and is of no use in more general applications. Actually, these simple techniques focus only on a few features (like color), and are not efficient in a more general purpose.

Consequently more general image classification methods are used, because it is a widespread topic, and there are a lot of well-known features (such as color histogram, SIFT (Scale invariant feature transform), HOG (Histogram of oriented gradient), Shape descriptors, OCR (Optical Character Recognition)). In order to focus on the main structure of the program, the MATLAB implementation, the database retrieving and specific feature creation, we will take benefit of the built functions available in MATLAB for Digital Image Processing. The final program as provided a segmentation algorithm. In addition, like in most of the image recognition programs, a database of plant or leaf picture has to be done, as well as a learning method to extract the features for the database, and a matching method to retrieve the best match from the database. Several additional small programs have been implemented to gather information for results.

A unique set of features are extracted from the leaves by slicing across the major axis and parallel to the minor axis. Then the feature points are normalized by taking the ratio of the slice lengths and leaf lengths (major axis). These features are used as inputs to the SVM.

The SVM Classifier was trained with few simple leaves from a different plant species.

INPUT DATA PREPARATION: Once the feature extraction was complete, two files were obtained. They were: (1) Training texture feature data and (2) Test texture feature data.

Classification using Support Vector Machine based on Hyper plane classifier A software routine was written in MATLAB that would take in .mat files

representing the training and test data, train the classifier using the train files and then use the test file to perform the classification task on the test data.

Consequently, a MATLAB routine would load all the data files (training and test data files) and make modifications to the data according to the proposed model chosen.

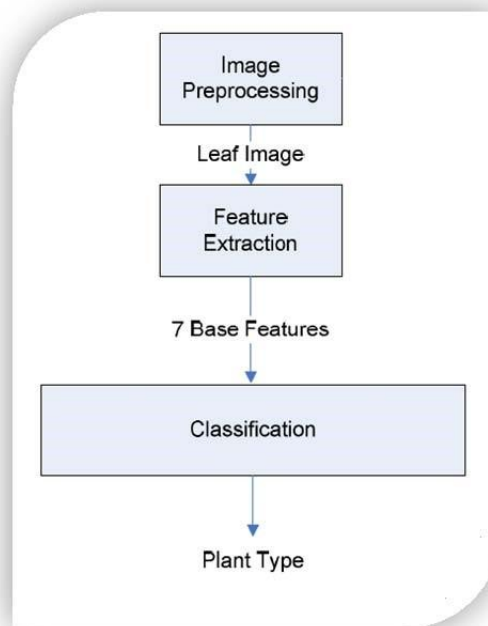


Fig 4.1 . Main stages of the system.



Fig 4.2. The menu window.

The Menu window displays all the image processing steps that has to be carried out on a leaf image. Here we obtain all the leaf images converted to grayscale from RGB which is stored in the database to display.

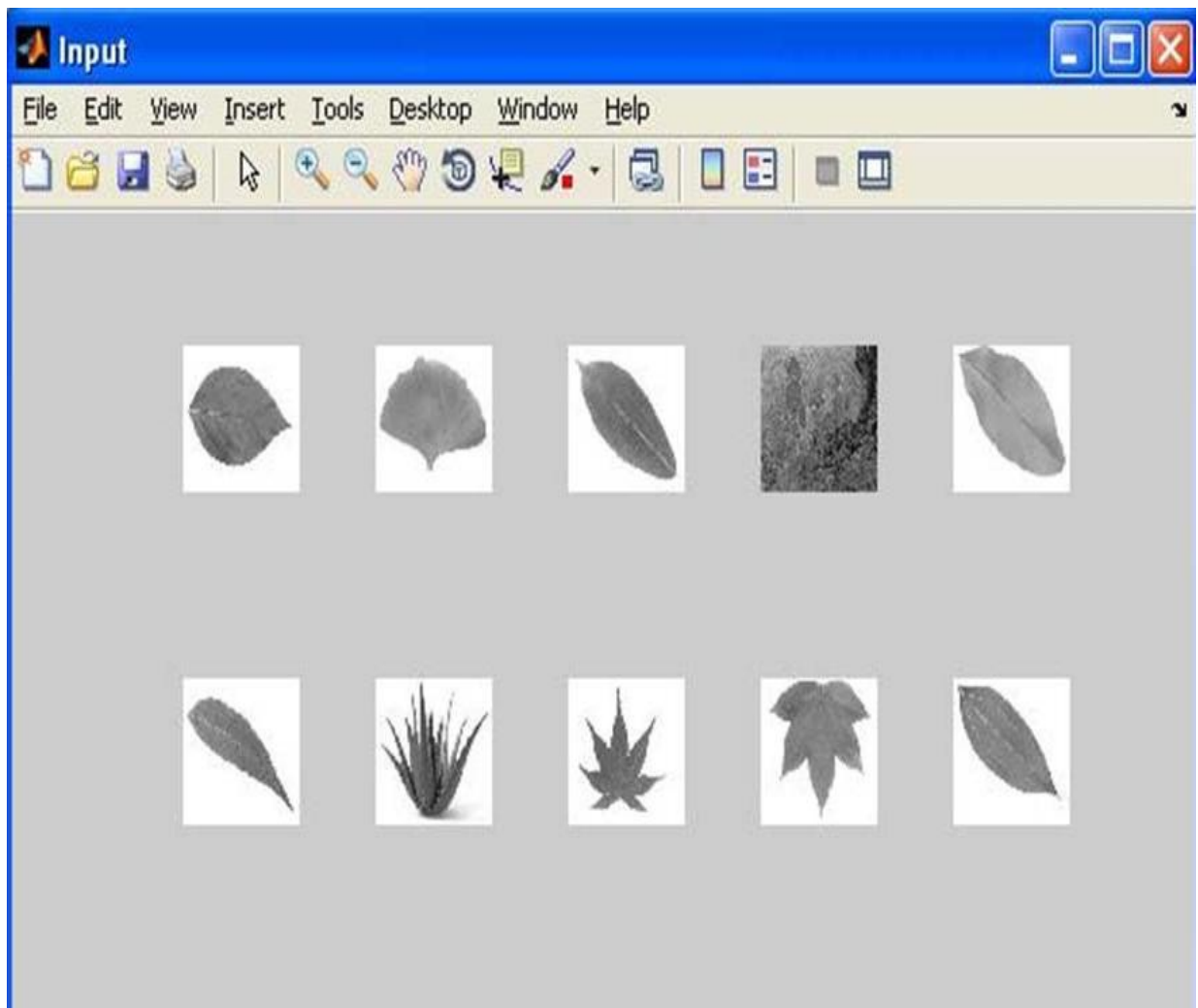


Fig 4.3 Getting images from the database

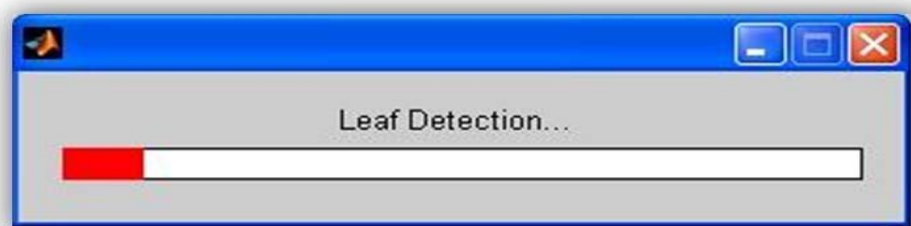


Fig 4.4 leaf detection.

Leaf process uses the image and performs smoothing on the leaf image. The histogram equalization is performed on the image.



Fig 4.5 leaf pre-processing.



Fig 4.6 histogram equalization.

FEATURE EXTRACTION: The Feature points are extracted from the leaf image.

TESTING: Selection of input leaf image upon which RGB2gray and then smoothing is performed.

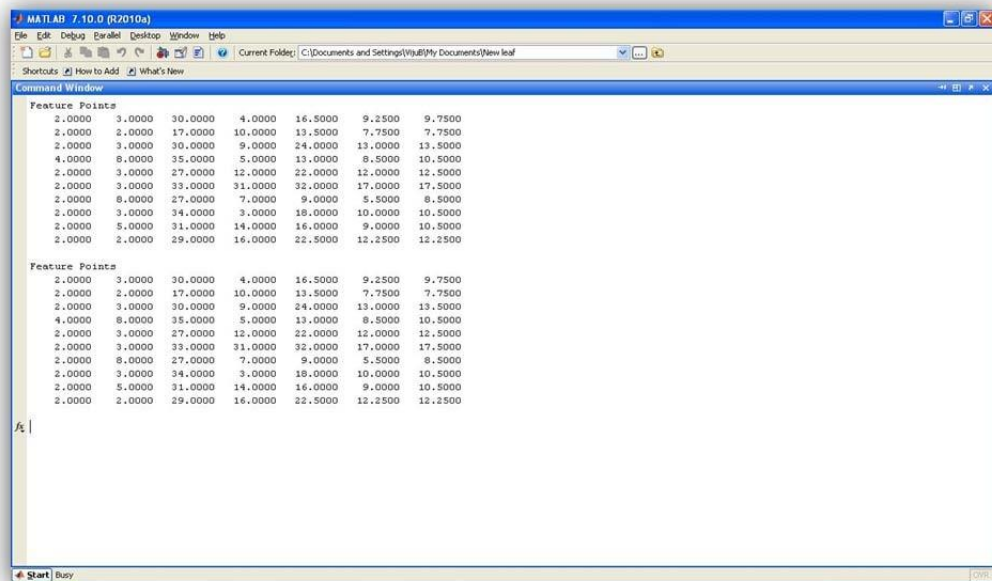


Fig 4.7 feature points retrieved from feature extraction.

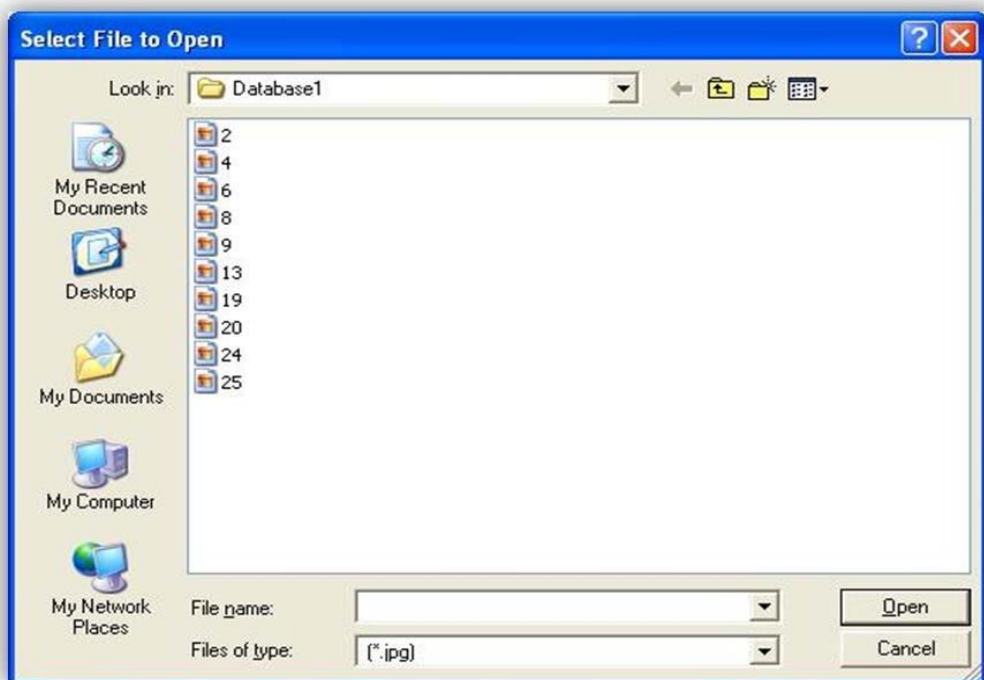


Fig 4.8 the image selection window – To select an image for testing.

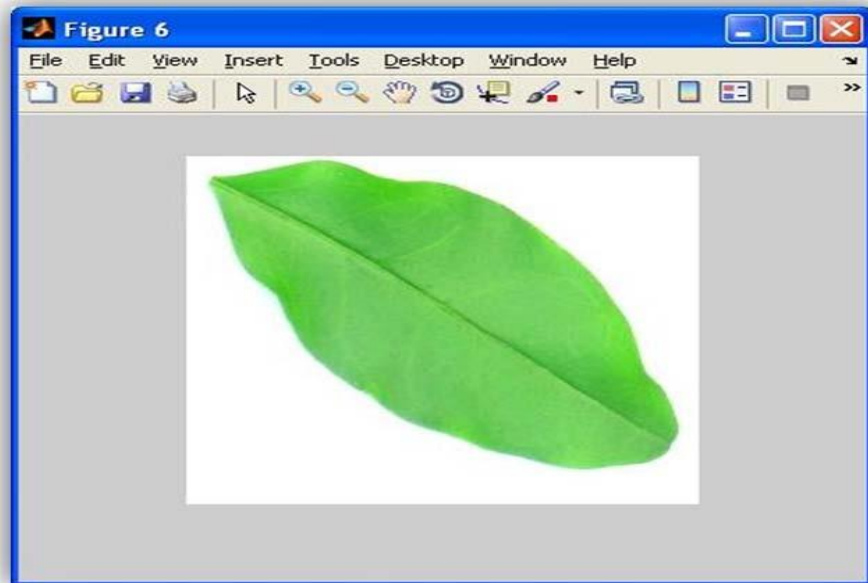


Fig 4.9 image selected.

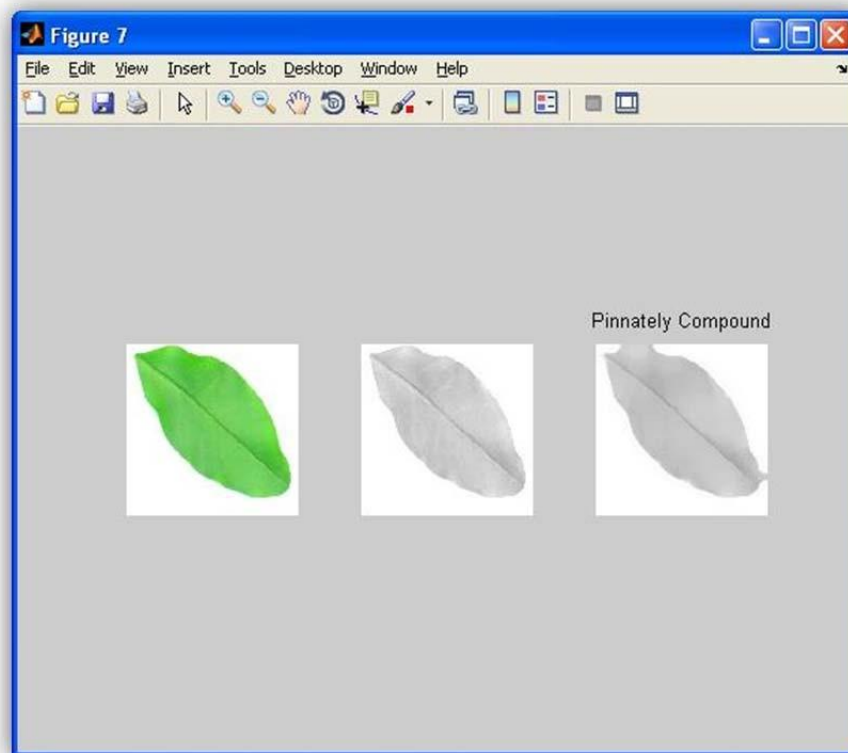


Fig 4.10 images where the image is converted to RGB2GRAY and then smoothing is performed.

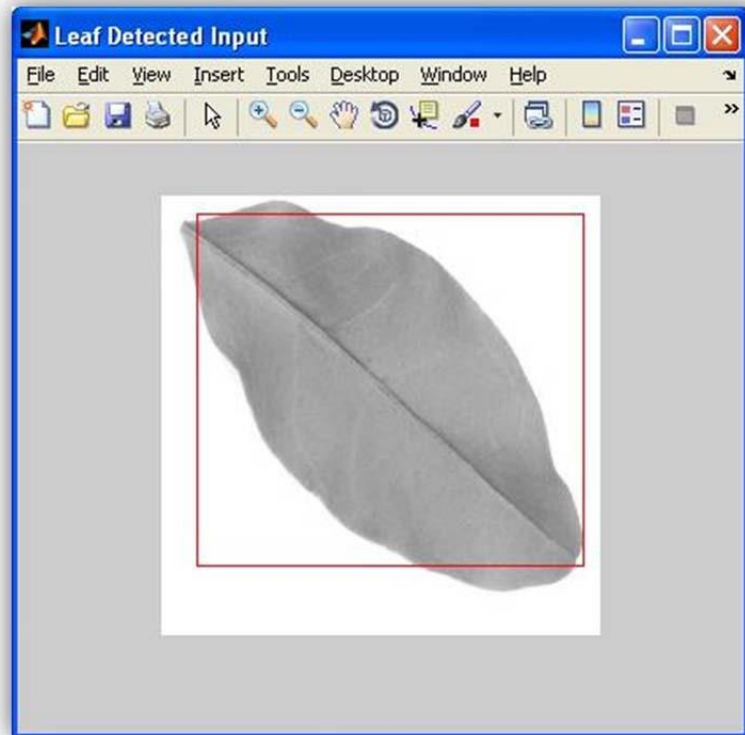


Fig 4.11 image after applying edge detection.



Fig 4.12 the result window.

LEAF INPUT DETECTED: The input leaf is detected against the leaf image in the database. MATCHING : Matching displays the result.

4.7.1.2.DRIP METHOD

BLOCK DIAGRAM

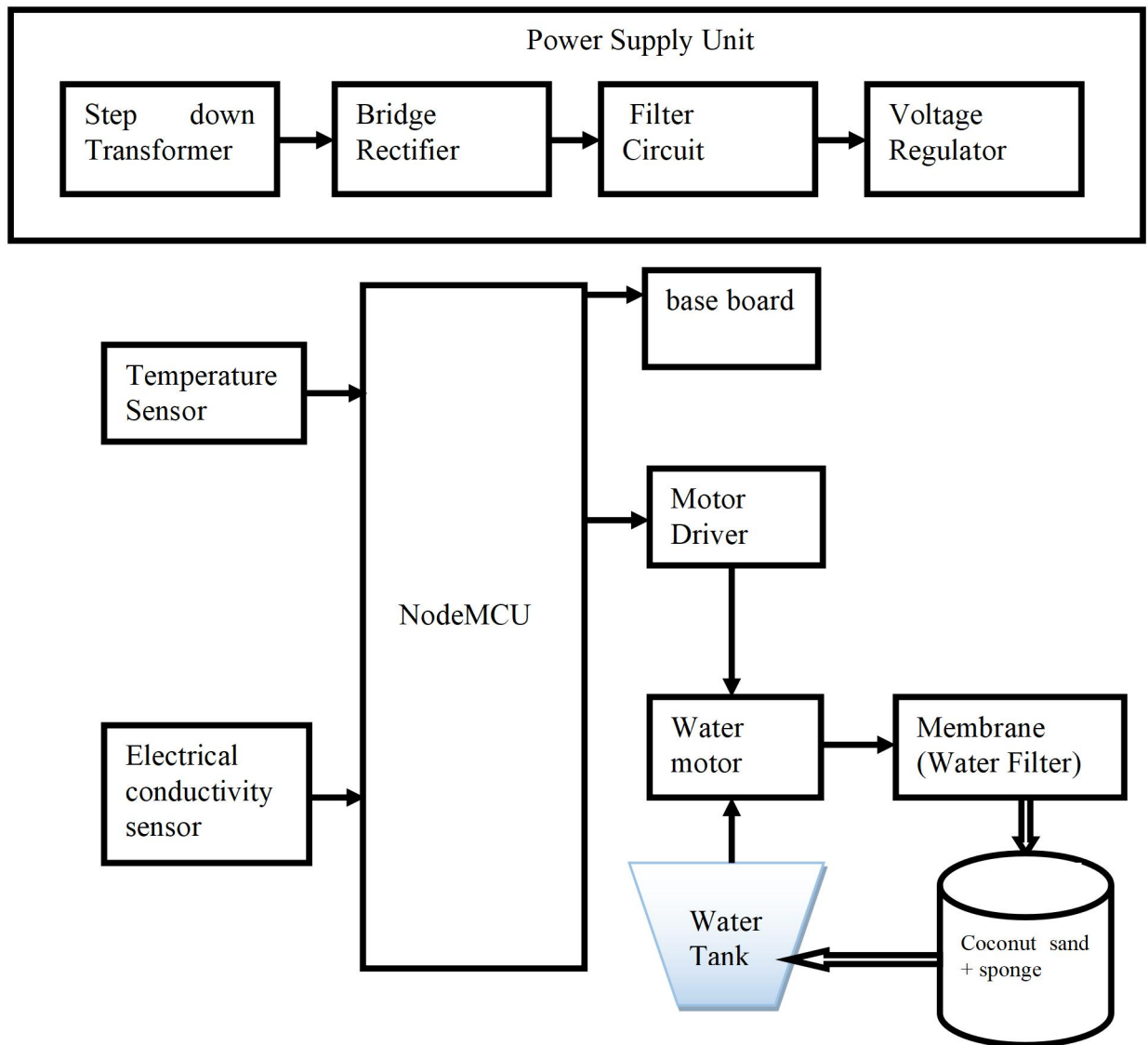


Fig 4.13 Block diagram of drip method

- Here temperature ,conductivity sensor is used to monitor the PH, temperature, Humidity.
- Using Node MCU the data will update to IOT automatically.
- With the help of “Thingview free” app the value are displayed.
- With the help of motor which contains membrane will manage the PH.
- water to flow through tube with has drip emits that controls the flow to the coconut sponge.

Hydroponics is a soilless method of growing plants where the plant roots are suspended in a nutrient-rich water solution. The success of hydroponic systems relies heavily on maintaining a stable pH level within the nutrient solution. In greenhouse hydroponic systems that utilize the drip method, maintaining an optimal pH level is critical to the health and growth of plants.

An automated pH monitoring and controlling system can help to ensure that the pH level of the nutrient solution remains within the optimal range. The system typically consists of a pH sensor probe that is placed in the nutrient solution, a microcontroller that collects data from the probe, and a set of control algorithms that adjust the nutrient solution's pH level as necessary.

The pH sensor probe continuously measures the pH level of the nutrient solution, and the microcontroller collects this data and compares it to the desired pH range for the plant species being grown. If the pH level falls outside the optimal range, the control algorithms activate a dosing pump that adds the necessary amount of pH adjuster solution to bring the pH level back into the desired range. This process is repeated continuously, ensuring that the pH level of the nutrient solution remains stable.

The benefits of an automated pH monitoring and controlling system for hydroponics under greenhouse conditions using the drip method are numerous. First, it eliminates the need for manual pH monitoring and adjustments, saving time and labor costs. It also ensures that the nutrient solution remains within the optimal pH range, which can increase plant growth and yield. Additionally, by maintaining a stable pH level, the system reduces the risk of nutrient imbalances, which can lead to plant stress, disease, and death.

Overall, an automated pH monitoring and controlling system is a valuable tool for hydroponic growers using the drip method in greenhouse conditions. It

provides a reliable and efficient way to maintain optimal pH levels in the nutrient solution, ensuring healthy and productive plants.

4.8 HARDWARE REQUIREMENTS

- NodeMCU
- Power supply unit
- DHT11 sensor
- Electrical conductivity sensor
- Motor driver (L293D)
- Water motor
- Membrane (Water purifier)

4.8.1 NODE MCU

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware, which is based on the ESP-12 module. The term “NodeMCU” by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as Lua-cjs on and spiffs. LUA based interactive firmware for Espressif ESP8266 Wi-Fi SoC, as well as an open source hardware board that contrary to the \$3 ESP8266 Wi-Fi modules includes a CP2102 TTL to USB chip for programming and debugging, is breadboard-friendly, and can simply be powered via its micro USB port.

FEATURES

- Wi-Fi Module – ESP-12E module similar to ESP-12 module but with 6 extra GPIOs.
- USB – micro USB port for power, programming and debugging
- Headers – 2x 2.54mm 15-pin header with access to GPIOs, SPI, UART, ADC, and power pins Misc – Reset and Flash buttons
- Power – 5V via micro USB port

4.8.2 SOIL MOISTURE SENSOR

Soil moisture sensors measure the water content in soil. A soil moisture probe is made up of multiple soil moisture sensors. This Soil Moisture Sensor can be used to detect the moisture of soil or judge if there is water around the sensor, let the plants in your garden reach out for human help. Insert this module into the soil and then adjust the on-board potentiometer to adjust the sensitivity. The sensor would outputs logic HIGH/LOW when the moisture is higher/lower than the threshold set by the potentiometer.

APPLICATION

- Botanical gardening
- Water monitoring

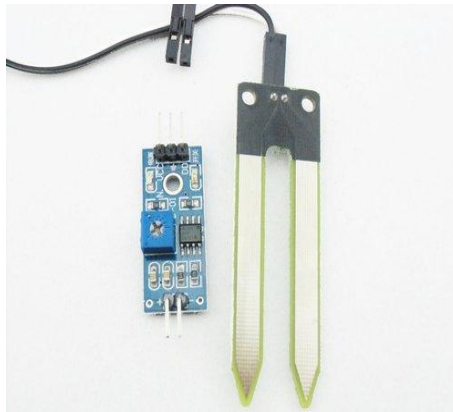


Fig 4.14 Soil moisture sensor

FEATURES

- Digital output, easy to adjust
- Nickel plating to avoid corrosion
- Working voltage: 3.3V-5V
- On-board LM393 chip
- Dimension of the board: 3.2cm * 1.4cm

4.8.3 WATER MOTOR

- DC 3-6V 120L/H Low Mini Submersible Motor Pump New Water Pumps Item Type
- Electronics Specification:
 - DC Voltage: 2.5-6V
 - Maximum lift:40-110cm / 15.75"-43.4"
 - Flow rate:80-120L/H
 - Outside diameter of water outlet: 7.5mm / 0.3"
 - Material : engineering plastic
 - Driving mode: brushless dc design, magnetic driving
 - Continuous working life of 500 hours

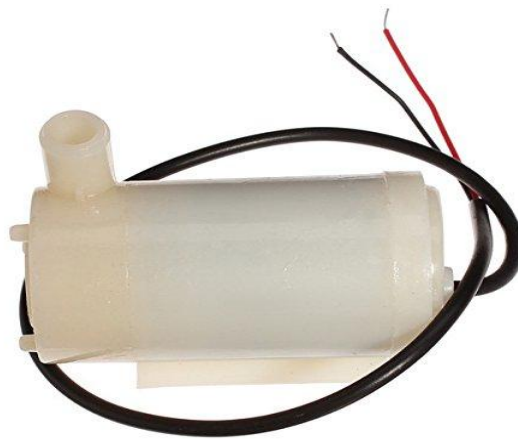


Fig 4.15 water motor

4.8.4 DHT11 sensor

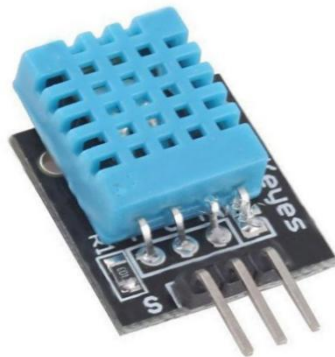


Fig 4.16 DHT11 Sensor

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the

surrounding air and spits out a digital signal on the data pin (no analog input pins needed). This sensor is used in various applications such as measuring humidity and temperature values in heating, ventilation and air conditioning systems. Weather stations also use these sensors to predict weather conditions. The humidity sensor is used as a preventive measure in homes where people are affected by humidity.

4.8.5 MEMBRANE(WATER PURIFIER)



Fig 4.17 Membrane

An RO water purifier has various filters that eliminate different types of impurities found in tap water through multiple stages of filtration. The most important of these filters is the RO membrane. This membrane is a thin, semi-permeable layer that has minute pores on it to allow only pure water to pass through it. Membrane filters act as a barrier to separate contaminants from water, or they remove the particles contaminating the water. Reverse osmosis, ultrafiltration, and nanofiltration all use a membrane in their different filtration processes.

4.8.6 MOTOR DRIVER



Fig 4.18 Motor driver

A motor is an electronic device that assists in the conversion of electrical energy to mechanical energy. As a result, a motor driver enables you to perform automatic tasks using electrical power. A motor driver takes the low-current signal from the controller circuit and amps it up into a high-current signal, to correctly drive the motor. It basically controls a high-current signal using a low-current signal. There are different types of motor drivers available in the market, in the form of ICs.

4.9 SOFTWARE DETAILS

- Arduino IDE
- Embedded C
- Proteus software
- MAT LAB

4.9.1 Arduino IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the

sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino'

4.9.2 MATLAB

Matlab is a commercial "Matrix Laboratory" package which operates as an interactive programming environment. It is a mainstay of the Mathematics Department software lineup and is also available for PC's and Macintoshes and may be found on the CIRCA VAX's. Mat lab is well adapted to numerical experiments since the underlying algorithms for Mat lab's built-in functions and supplied m-files are based on the standard libraries LINPACK and EISPACK .Mat lab program and script files always have filenames ending with ".m"; the programming language is exceptionally straightforward since almost every data object is assumed to be an array. Graphical output is available to supplement numerical results.

KEY FEATURES OF MATLAB

- High-level language for technical computing
- Development environment for managing code, files, and data
- Interactive tools for iterative exploration, design, and problem solving
- Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, and numerical integration
- 2-D and 3-D graphics functions for visualizing data
- Tools for building custom graphical user interfaces
- Functions for integrating MATLAB based algorithms with external applications and languages, such as C, C++, Fortran, Java, COM, and Microsoft® Excel®

CHAPTER 5

5.1 RESULTS

5.1.1 Identification plant disease

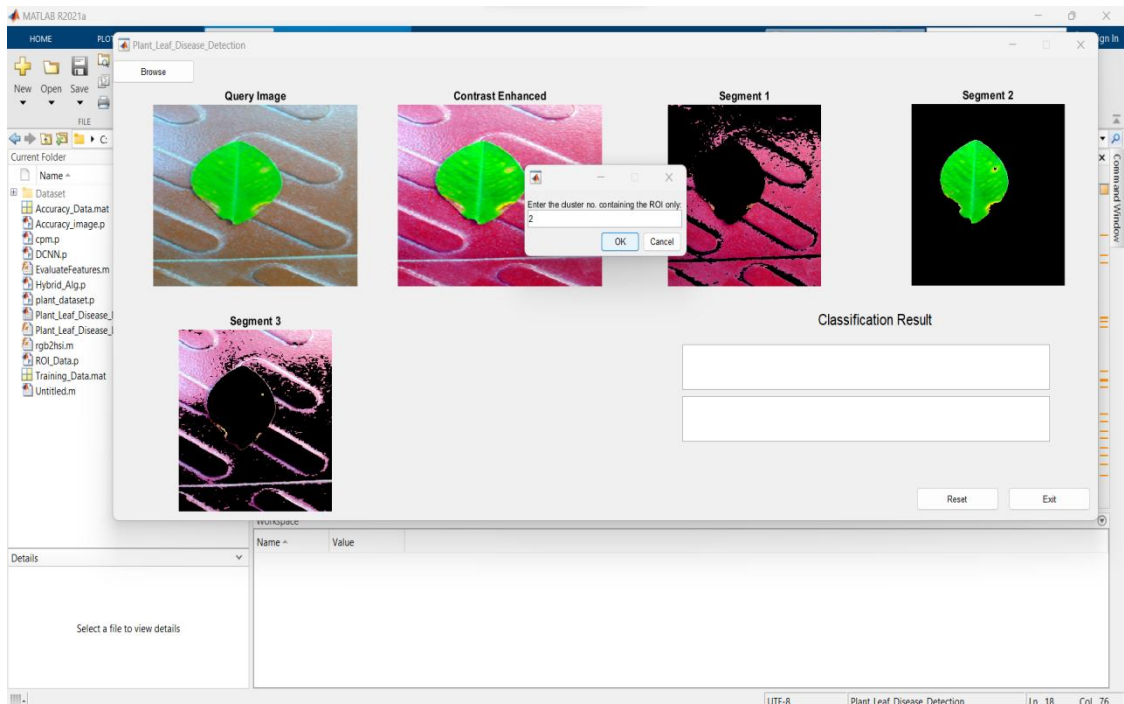


Fig 5.1 Selecting segment

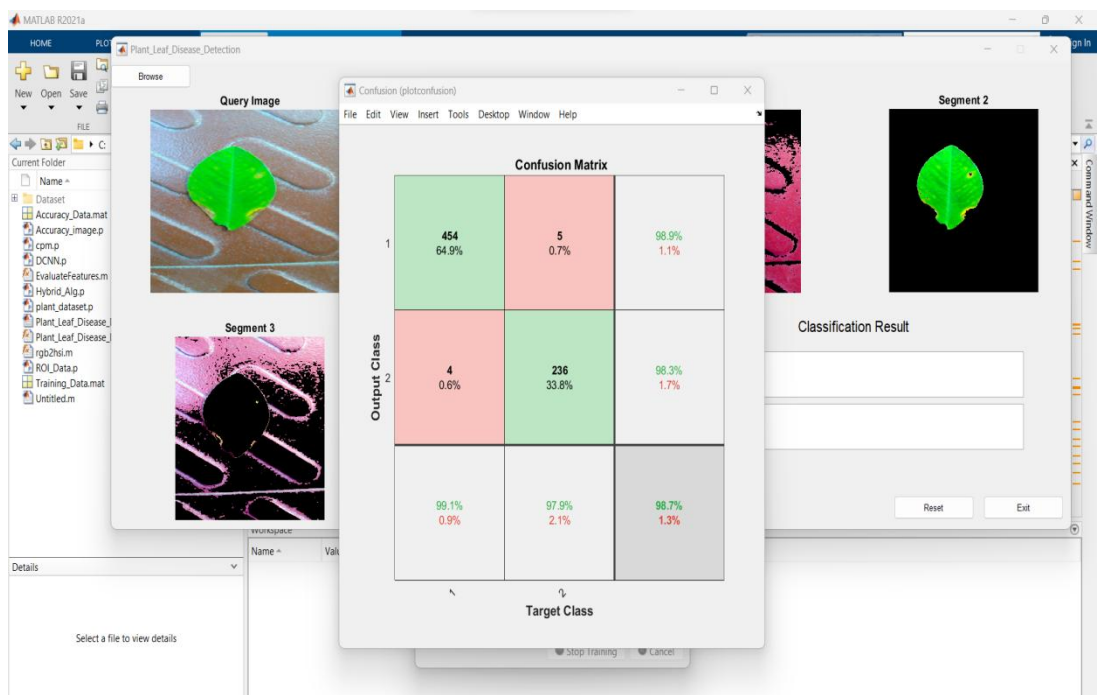


Fig 5.2 Detection of disease

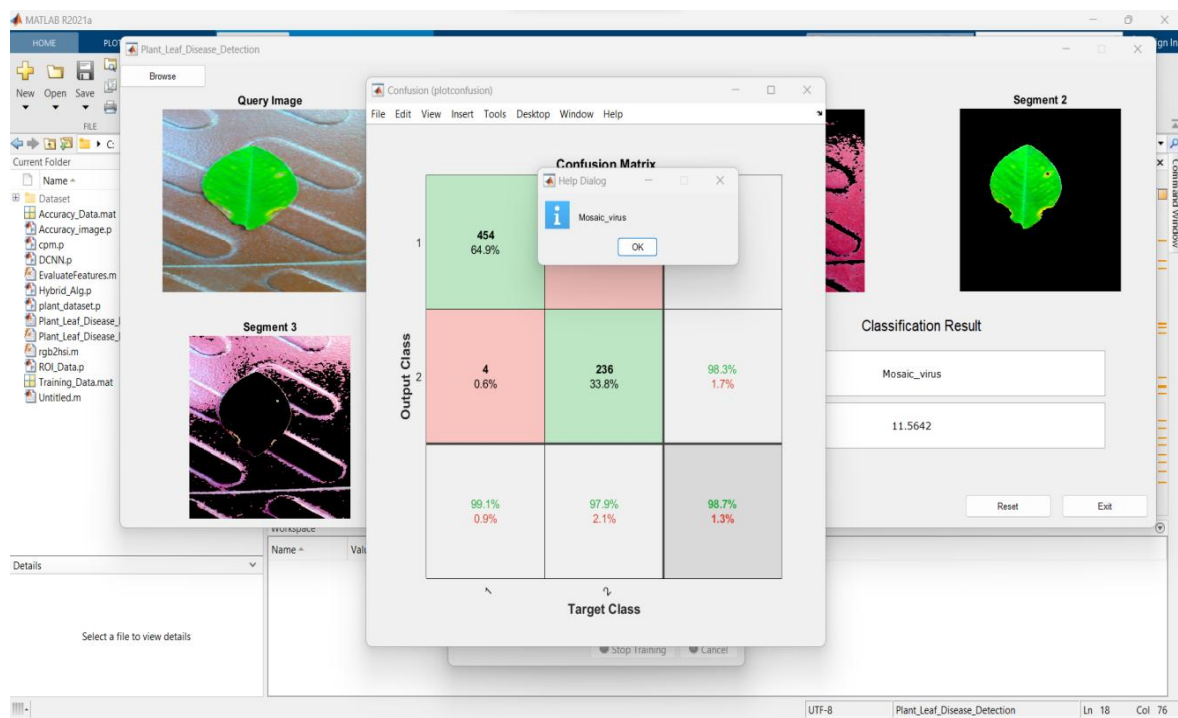


Fig 5.3 Identified disease

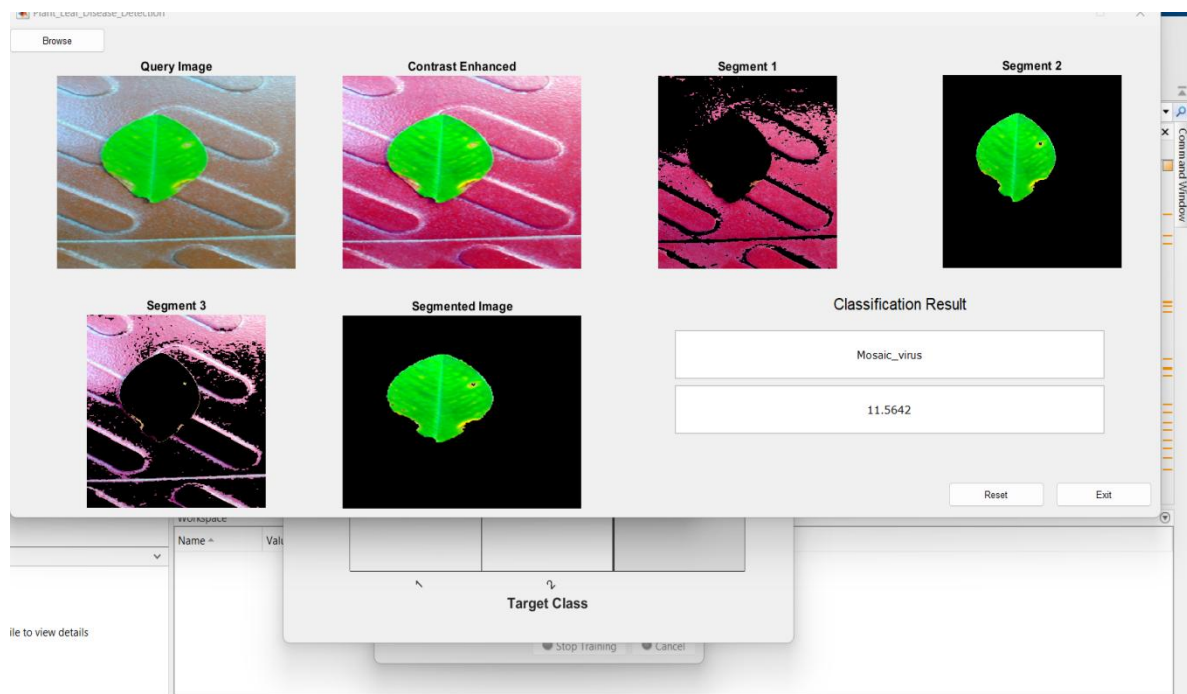


Fig 5.4 Displaying the result

5.1.2 DRIP METHOD

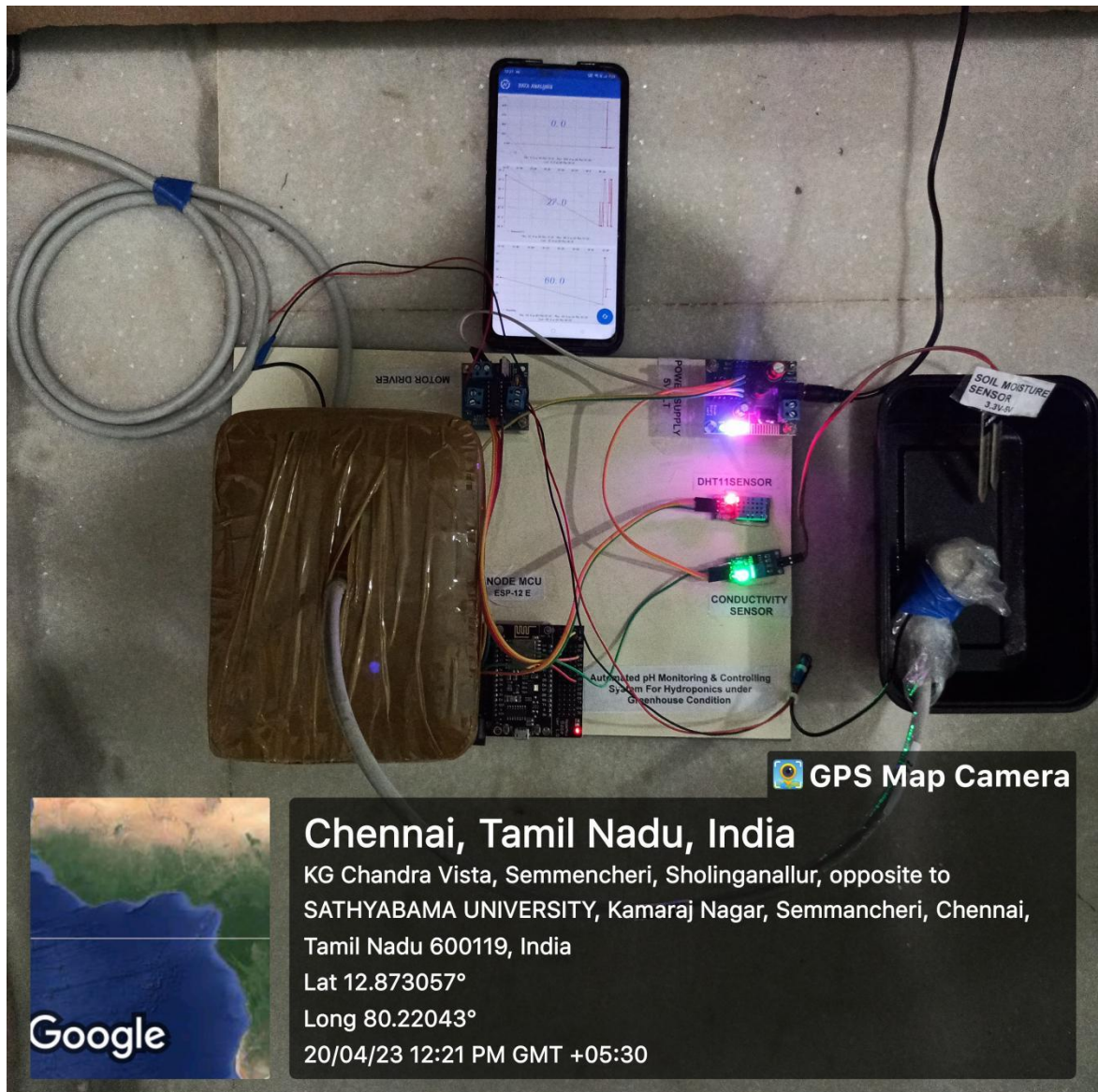


Fig 5.5 output of the drip method

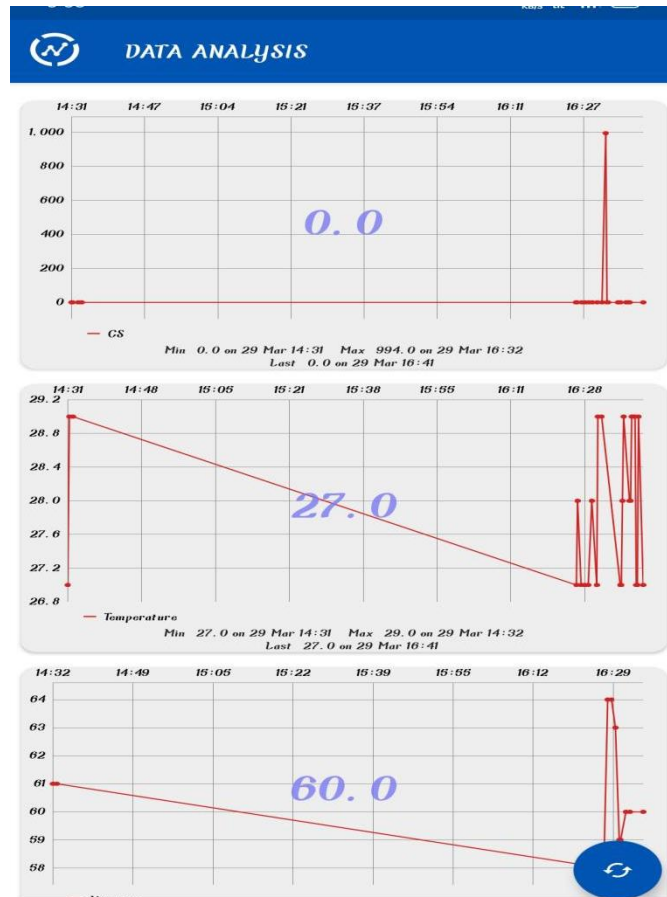


Fig 5.6 Displaying temperature and Humidity values

5.1.3 PH SIMULATION

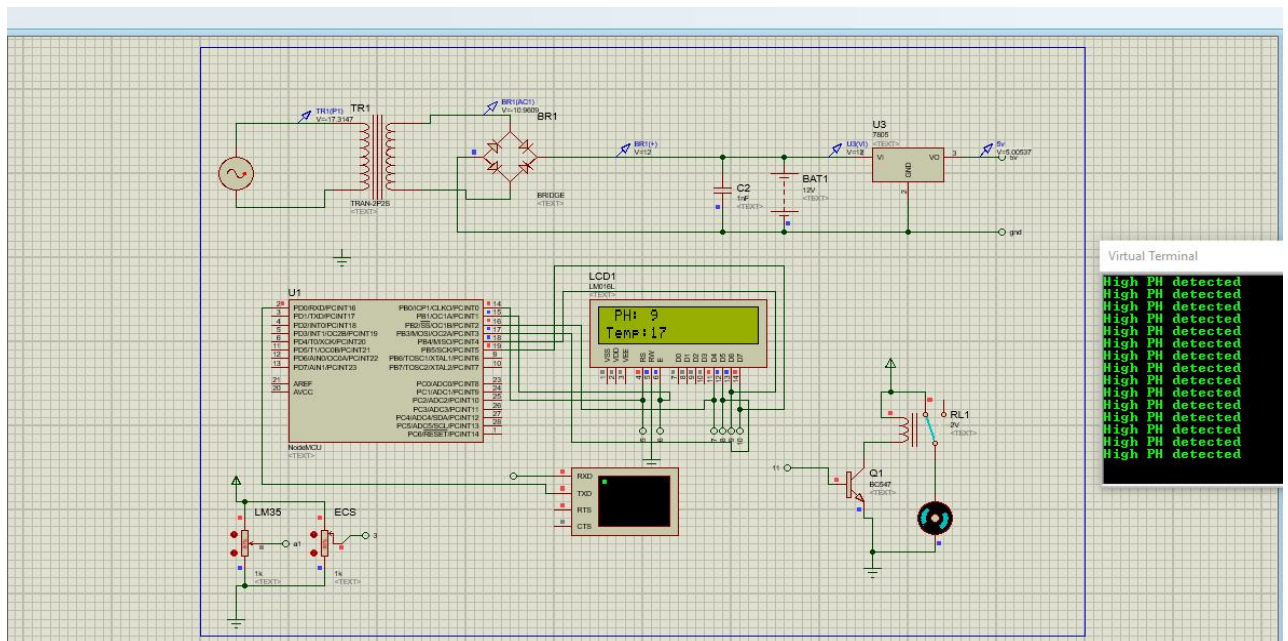


FIG 5.7 PH simulation

5.2 APPLICATION :

The automated pH monitoring and controlling system for hydroponics under greenhouse conditions has several applications in the agriculture industry, including:

- **Hydroponic Crop Production:** The system can be used in hydroponic crop production to monitor and maintain the pH level of the nutrient solution in real-time.
- **Greenhouse Vegetable Production:** The system can be used in greenhouse vegetable production to maintain the pH level of the nutrient solution and provide a stable and controlled environment for plant growth.
- **Vertical Farming:** The system can be used in vertical farming to monitor and maintain the pH level of the nutrient solution in multiple layers of the system.
- **Research and Development:** The system can be used in research and development to study the effects of different pH levels on plant growth and development.
- In conclusion, the automated pH monitoring and controlling system for hydroponics under greenhouse conditions has a wide range of applications in the agriculture industry.

5.3 ADVANTAGES :

The automated pH monitoring and controlling system for hydroponics under greenhouse conditions offers several advantages over manual pH control, including:

- **Precision and Accuracy:** The system provides precise and accurate pH control, which helps to maintain the optimal pH level of the nutrient solution. This improves crop yield, quality, and consistency, and reduces the risk of plant stress and nutrient deficiencies.
- **Real-time Monitoring:** The system provides real-time monitoring of the pH level of the nutrient solution, which allows for prompt adjustments to be made in response to changes in the system. This helps to ensure that the pH level remains within the optimal range and reduces the risk of plant damage.
- **Reduced Labor Costs:** The system automates the pH control process, which reduces the need for manual labor and monitoring. This saves time and money and allows for more efficient use of resources.

- **Customizable Settings:** The system allows for customizable pH range settings, which allows for the optimization of the pH level for different plant species or growth stages. This helps to improve crop yield and quality and ensures that the plants receive the optimal nutrients.
- **Integration with Greenhouse Control System:** The system can be seamlessly integrated with the overall greenhouse control system, which allows for centralized monitoring and control of all aspects of the greenhouse environment. This increases efficiency and reduces the risk of errors.
- In conclusion, the automated pH monitoring and controlling system for hydroponics under greenhouse conditions offers several advantages over manual pH control. The system provides precise and accurate pH control, real-time monitoring, reduced labor costs, customizable settings, and integration with the greenhouse control system. These advantages help to improve crop yield, quality, and consistency and ensure optimal plant growth and level.

CHAPTER 6

6.1 CONCLUSION:

Based on the objectives, the following conclusions were drawn: the installed automated pH controller was able to maintain the desired condition for the hydroponic system based on the observed successes and failures in monitoring the pH, the performance of the developed automated pH controller was found to be reliable and the automated pH controlling and monitoring device was able to grow lettuce with yield and responses similar to normal growing conditions.

Due to the use of a constant feeding of nutrients and water, the hydroponic plants have grown much taller and produced more leaves quicker than the plants growing in normal soil. Because of this, the null hypothesis is rejected since the data does not support its reasoning.

REFERENCES

1. Mishra, R.L. and P. Jain, 2015. Design and implementation of automatic hydroponics system using ARM processor. *Int. J. Adv. Res. Electr. Electron. Instrum. Eng.*, 4: 6935-6940.
2. Sihombing, P., N.A. Karina, J.T. Tarigan and M.I. Syarif, 2018. Automated hydroponics nutrition plants systems using Arduino UNO Microcontroller based on android. *J. Phys. Conf. Ser.*, Vol. 978,
3. Tagle, S., H. Benozza, R. Pena and A. Oblea, 2018. Development of an indoor hydroponic tower for Urban farming. *Proceedings of the 6th DLSU International Conference on Innovation and Technology Fair*, November 22-23, 2018, De La Salle University, Manila, Philippines, pp: 1-7.
4. S. Wu, F. Bao, E. Xu, Y. Wang, Y. Chang, and Q. Xiang. A leaf recognition algorithm for plant classification using probabilistic neural network. In *7th IEEE International Symposium on Signal Processing and Information Technology*, Cairo, Egypt, 2017.
5. Z. Wang, Z. Chi, and D. Feng. Shape based leaf image retrieval. *IEEE P-Vis Image Sign.* 150:34–43, 2013.
6. H. Fu, Z. Chi, D. Feng, and J. Song. Machine learning techniques for ontology-based leaf classification. In *8th IEEE International Conference on Control, Automation, Robotics and Vision*, Kunming, China, 2014.
7. M. D. Dassanayake, editor. *A revised handbook to the flora of Ceylon*, volume 4. CRC Press, Boca Raton, 2013.
8. M. Ashton, S. Gunathilleke, N. Zoysa, M. D. Dassanayake, N. Gunathilleke, and S. Wijesundera. *A field guide to the common trees and shrubs of Sri Lanka*. Wildlife Heritage Trust Publications, Sri Lanka, 2017.
9. L. K. Senarathne. *A checklist of the flowering plants of Sri Lanka*. National Science Foundation Publishers, Sri Lanka, 2015.
10. R. C. Gonzalez and R. E. Woods. *Digital image processing*, 2nd edition. Prentice Hall, Upper Saddle River, NJ, 2014.

11. M. Sonka, V. Hlavac, and R. Boyle. *Image processing, analysis, and machine vision*, 2nd edition. Cengage Learning, Stamford, CT, 2013.
12. Otsu, N. A threshold selection method from gray-level histograms. *IEEE T. Syst. Man. Cyb.* 9:62–66, 2018.
13. P.-E. Danielsson and O. Seger. Generalized and separable Sobel operators. In H. Freeman, editor, *Machine vision for three-dimensional scenes*, pages 347-380. Academic Press, CA, 2000.
14. Y.-Y. Wan, J.-X. Du, D. S. Huang, Z. Chi, Y.-M. Cheung, X.-F. Wang, and G.-J. Zhang. *Bark texture feature extraction based on statistical texture analysis*. In Proceedings of the 2004 International Symposium on Intelligent Multimedia, Video and Speech Processing, pages 482–485, Hong Kong, 2014.
15. D. S. Huang. *Systematic theory of neural networks for pattern recognition*. Publishing House of Electronic Industry, Beijing, 2016.
16. D. S. Huang. The local minima free condition of feedforward neural networks for outer-supervised learning. *IEEE T. Syst. Man. Cy. B.* 28:477–480, 2018.
17. B. V. Dasarathy. *Nearest neighbor NN norms: NN pattern classification techniques*. IEEE Computer Society Press, Washington, DC, 2018.
18. T. M. Cover and P. E. Hart. Nearest neighbor pattern classification. *IEEE. T. Inform. Theory* 13:21–27, 2017.
19. P. E. Hart. The condensed nearest neighbor rule. *IEEE. T. Inform. Theory* 14:515–516, 2017.
20. F. F. Lei, M. Andreetto, and M. A. Ranzato. Caltech 101, 2016.
http://www.vision.caltech.edu/Image_Datasets/Caltech101/, accessed Jun. 2013.
21. New York State Department of Economic Development. Leaf Identifier, 2013.
http://fallgetaways.iloveny.com/landing_leaf_identifier.html, accessed Aug. 2013.
22. Math Works Inc. Matlab R2012a documentation, 2014.
23. <http://www.mathworks.com/help/index.html>, accessed May 2013.
24. Kularbphetong, K., U. Ampant and N. Kongrodj, 2019. An automated hydroponics system based on mobile application. *Int. J. Inf. Educ. Technol.*, 9: 548-552.