UNIVERSITY OF TECHNOLOGY

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

DEPARTMENT OF INFORMATION SCIENCE

REPORT OF PROJECT ON
CROP HEALTH MONITORING SYSTEM FOR REMOTE SENSING AGRICULTURE

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1. Abstract

This project, titled “Crop Health Monitoring System for Remote Sensing Agriculture,” is an innovative smart farming initiative that integrates IoT devices, automation, and sustainable practices to revolutionize agricultural management. This system addresses critical issues such as limited space in urban areas, excessive water and fertilizer usage, and the impact of climate change on crops. Through the use of image recognition, sensors, and automated systems, it provides real-time monitoring and intervention capabilities for crops.

The system empowers users to observe and maintain crops remotely while fostering fish in nutrient water tanks, recycling the nutrient-rich water back to plants. It supports the cultivation of a wide variety of crops, including leafy vegetables like basil, celery, cabbage, lettuce, mustard, medicinal plants and more. In this system, four types of medicinal plants: Chlorophytum Comosum (Spider Plant), Rosemary, Oregano and Vietnamese Coriander (Persicaria Odorata) are cultivated. The whole system can be controlled and monitored by computers, smartphones, and tablets. The specific function is 15 days of collectable historic data by web server.

2. Objectives

This system focuses on achieving four primary outcomes:

- To promote ICT in Myanmar’s Agricultural sector
- To develop a smart aquaponics farming system to improve livelihoods for farmers
- To optimize resource utilization in agriculture by using advanced ICT and remote sensing technologies
- To encourage sustainable agriculture practices while minimizing environmental impacts

3. Introduction

Agriculture faces immense challenges today due to urbanization, resource depletion, and climate change. Traditional farming methods often fall short in addressing these issues, particularly in urban settings with limited space and increasing demand for sustainable practices. This system introduces a smart farming system that combines vertical aquaponics farming with IoT-based monitoring and automation. This system aims to improve resource efficiency, reduce environmental impact, and optimize crop productivity. By leveraging

cutting-edge technologies, the system demonstrates a feasible solution for both urban farming and traditional agricultural landscapes, especially in countries like Myanmar.

4. Problem Statement

The agricultural sector faces several challenges, especially in urban and resource-constrained environments. These challenges include:

Space Constraints in Urban Cities: Limited space for traditional farming, particularly in densely populated areas such as Singapore is facing space constraints for traditional farming, necessitates innovative farming methods.

Excessive Water Usage: Traditional agriculture often consumes significant amounts of water, can lead to water shortage.

Large Amount of Fertilizer Usage: Overuse of fertilizer can lead to soil and water pollution, negatively impacting on ecosystems and human health.

Climate Change Impact on Crops: Changing climate patterns and extreme temperature variations can negatively affect crop health.

5. Prototype Design

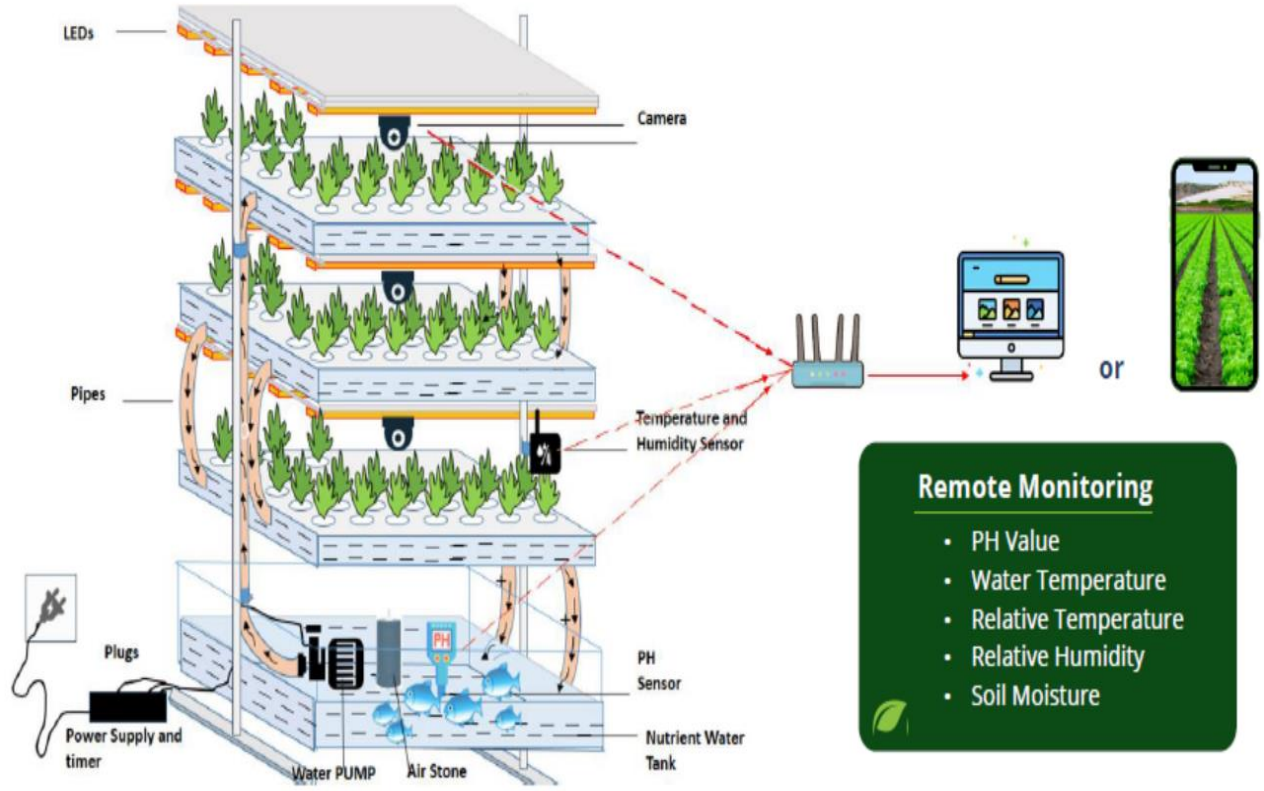


Figure 1. Prototype Design of the System

6. Implementation of Smart Aquaponics System

Smart aquaponics farming system is implemented by using ESP32 microcontroller. Arduino Development Environment (IDE) software is used to develop a program for the microcontroller to communicate with multiple sensors and other hardware. The circuit of pH sensor, temperature sensor, water temperature sensor, relative temperature and humidity sensor, capacitive soil moisture sensor, Liquid Crystal Displays (LCD), submersible pump, oxygen pump, heater and 4G SIM router for Global System for Mobile communication (GSM), Solar Panel and solar controller are constructed and connected to the system.

This system is powered by standard AC 220V 50Hz. In addition, automatic feeder is used to feed the fish for every 12 hours, 24hours or manual mode. The water pump operates on a timed circulatory system or manual mode. The timer allows the pump to work for 5 minutes every 30 minutes. Meanwhile, the information liquid crystal display can indicate the pH value, water temperature, relative temperature and humidity, soil moisture value. The whole system

can be controlled and monitored by computers, smartphones, and tablets. The special function is 15 days of collectable historic data by web server.

Figure 2. Smart Aquaponics System

Technical Parameter

	Parameter Range
Water Temperature Range:	-10°C ~ 85°C
pH Value Range:	0~14
Relative Temperature Range:	-40°C ~ 80°C
Relative Humidity Range:	0~100%
Lighting Lumen:	600lm
Color Temperature	5700K
Resolution Images and Videos	2560 x 1440 (2K)
Communication System	GSM 4G Network
Selectable Automatic Feeding Timer	12 Hours, 24 Hours and Manual Mode
Power Input	110-240V AC
Pump Power	45W, Max 2200 Liters per Hours
AC/DC Air Pump Pressure	2x18 Mpa
Aquarium Water Heater	100 Watt
Boltless Rack UDL	100Kg per Level
Solar Panel	50W
Solar Controller	120 VA
Back Up Battery	12V, 9Ah
Oxygen Pump Continuous Standalone Working Hours	~20 Hours

6.1 Medicinal Plants

Chlorophytum comosum (Spider Plant)

- Family : Asparagaceae
- Binomial name : Chlorophytum comosum
- Its leaves can be dried and used to make a tea that prevents Scurvy.
- Fresh leaves are often used to supplement diets of pregnant and lactating women.
- Roots are used to treat fevers, scorpion stings and arthritis.

Rosemary

- Family : Lamiaceae
- Binomial name : Salvia rosmarinus
- Rosemary is widely used as a spice when cooking, especially in Mediterranean dishes.
- Consuming rosemary regularly can potentially help lower the risk of infection and help the immune system fight any infections that do occur.
- It is also used for fragrance in soaps, cosmetics and medicinally to improve memory.

Oregano

- Family : Lamiaceae
- Binomial name : Origanum vulgare
- Oregano adds flavor to savory dishes.
- It may also have health benefits due to its anti-inflammatory, antioxidant, and antimicrobial properties.
- It may also help reduce the risk of cancer.

Vietnamese Coriander (Persicaria odorata)

- Family : Apiaceae
- Binomial name : Persicaria odorata
- The leaves are used for medicine.
- This plant possesses antioxidant, anti-inflammatory, antimicrobial, and hepatoprotective properties that can boost immunity, aid digestion, and promote overall well-being.
- In food, Vietnamese coriander is used to flavor soups, stews, and salads.

6.2 System Components

This system incorporates IoT devices within a vertical hydroponic framework to maximize efficiency and sustainability.

- **Camera System**

  The camera monitors crop health by identifying the type of crops and weeds, detecting physical damage, and pinpointing areas requiring fertilizer. This system enables precise interventions, ensuring healthier crops and reduced wastage.

-Monitor the crop health
-Classify the plants and weed seedlings, and notify to the users
-Identify the physical damage of plant and inform users exactly where fertilizer is needed.

EZVIZ 360° Camera

EZVIZ Smart Home Camera		
Log in Email	aquaponicsmyanmar@gmail.com	
	Model: CS-H6c (Pro 4MP, W1) 2K+	
	Serial Number	Verification Code
Smart IP Camera 1	BC4951245	WPSDAG
Smart IP Camera 2	BC4997302	VFEQGK
Smart IP Camera 3	BC4951343	NGCMZC

- **LED Lighting**

  LEDs serve as a reliable source of light energy for the plants, ensuring optimal growth conditions irrespective of weather. This feature accelerates photosynthesis and supports year-round farming.

The light will provide the plant with the largest source of light to ensure that plants grow quickly and healthy whatever the outside weather is.

- **Water Pump**

  The water pump operates on a timed circulatory system. The timer allows the pump to work for 5 minutes every 30 minutes. The water pump will pump the water from the nutrient water tank to the uppermost shelf. Like the indicated direction of the arrows in the prototype diagram, the water will flow from the left end of shelf to the other, and then go to the lower shelf. The water will flow continuously from one shelf to another, and then finally the water will go back to the nutrient tank. By this water, we can save the water resources.

Time-able Circulatory System: The timer allows the pump to work for 5 minutes every 30 minutes. Not only make the pump more durable and save nutrient solution, but also make the vegetables grow better.

- **pH Sensor**

  This Potential of Hydrogen(pH) sensors measure the pH levels of plant tissues to assess health and nutrient bioavailability. It is automated adjustments for measuring Conductivity, Calcium, Nitrate, Potassium, Sodium, Salt concentration and pH measurement. If the PH value is more than 0.5 away from the optimal 6.4 value, we can adjust as follows: If the PH is > 0.5 higher than (6.4): add small amount of phosphate fertilizer. If the PH is > 0.5 lower than (6.4): add small amount of calcium/potassium fertilizer.

If the PH value is >0.5 higher than the optimal 6.4 value, add small amount of phosphate fertilizer. If the PH is <0.5 lower than 6.4, add small amount of calcium/ potassium fertilizer.

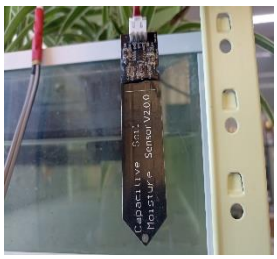
- **Temperature and Humidity Sensor**

  This Temperature and Humidity Sensor DHT11 monitor environmental conditions and notify users when moisture content or temperature deviates from optimal levels, ensuring a stable growth environment for plants.

It is used for monitoring heat and humidity. The device is intended to notify the users when the moisture content drops below a certain value.

- **Soil Moisture Sensor**

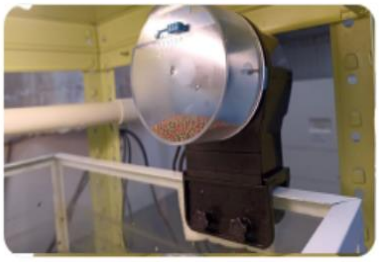
  Measures the moisture levels in the plant-growing medium. Ensures that the plants receive adequate water without overwatering. The sensor's readings alert the system to make irrigation cycles by activating the water pump only when moisture levels drop below a predefined threshold.



Measures the moisture levels in the plant-growing medium. The plants receive adequate water without overwatering.

- **Fish Feeder**

  Automates the feeding of fish for every 12 hours, 24 hours or manual, ensuring they receive food at regular intervals. Prevents overfeeding, which could harm fish health and degrade water quality.



Automatic Fish Feeder can be controlled by web application or mobile application with 12 hr, 24 hr or custom timing.

- **Solar Panel**

  Provide renewable energy to power the entire system, making it more sustainable. Solar panels generate electricity during the day, which is either used immediately or stored in batteries for nighttime operation (for oxygen pump and fish feeder).

A 50W Solar Panel and 12V 9Ah Battery was installed to work air stone for fishes.

- **Water Temperature Sensor**

  Measures the temperature of the water in the fish tank and nutrient reservoir. Helps maintain the ideal temperature for aquatic life and nutrient absorption in the hydroponic system. Activates the heater to warm the water in colder conditions or issues alerts if the water temperature exceeds safe levels for the fish.

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- **Air Stone and Oxygen Pump**

  Oxygenate the water in the fish tank to maintain adequate dissolved oxygen levels for aquatic life. The pump forces air through the air stone, creating bubbles that dissolve oxygen into the water. Automatic Smart Oxygen pumping system can use any power supply System such as AC or DC or Solar powering. It also has uninterrupted power supply system with build in internal battery. Oxygen Pump Continuous Standalone Working Hours is about 20 Hours.

The pump forces air through the air stone, creating bubbles that dissolve oxygen into the water. Oxygen Pump Continuous Standalone Working Hours is about 20 Hours.

- **Aquarium Heater**

  Regulates the water temperature in the fish tank to ensure a stable environment for aquatic life. Activates automatically when water temperature drops below the ideal range for the specific fish species being raised.

Activates automatically when water temperature drops below the ideal range for the specific fish species being raised.

- **4G SIM Router**

  Provides internet connectivity for remote system monitoring and control. Sends sensor data and system alerts to a cloud server or mobile application for real-time updates. Allows users to make adjustments to system parameters remotely via GSM technology.

Sends sensor data and system alerts to a cloud server or mobile application for real-time updates.

6.3 Sensor Monitoring

- Temperature Chart: Displays the real-time air temperature readings from the temperature sensor. It allows users to monitor and ensure the environmental conditions are within the optimal range for plant growth.
- Humidity Chart: Tracks the humidity levels, which is crucial for maintaining the health of the plants and ensuring a suitable microclimate.
- Soil Moisture Chart: Shows live data from the soil moisture sensor, helping to maintain the appropriate water levels in the soil for plant growth.
- pH Value Chart: Displays real-time pH readings of the water from the pH sensor. This is essential for maintaining a stable and healthy environment for both plants and aquatic organisms. The pH levels must be adjusted to fall within the acceptable range for optimal plant growth and fish health.
- Water Temperature Chart: Displays real-time water temperature readings from the water temperature sensor. This ensures that the water used in the aquaponics system is at a temperature conducive to both plants and aquatic life.

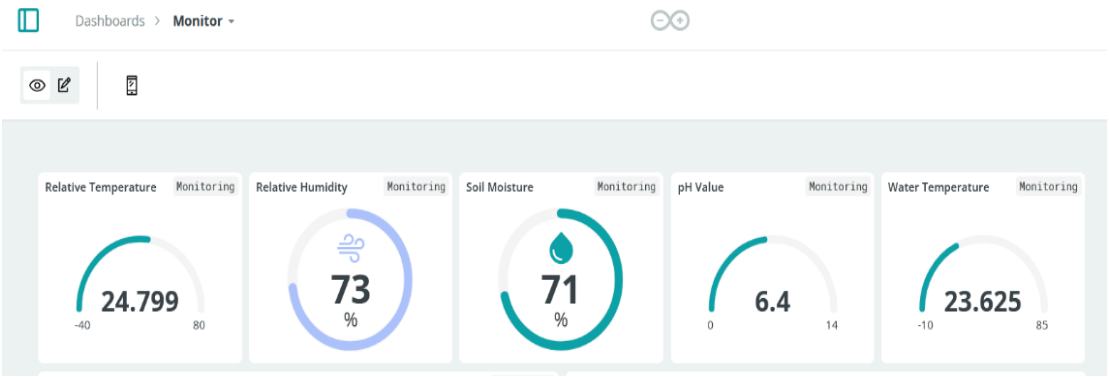
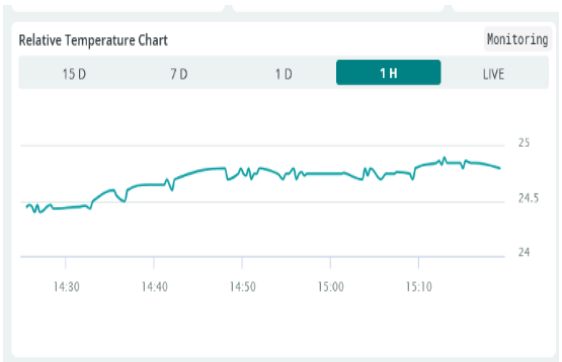
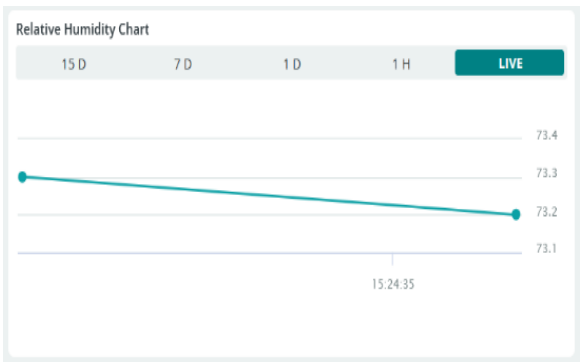


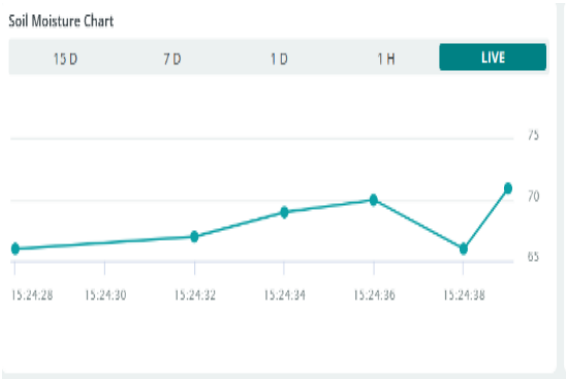
Figure 3. Live Sensor Monitoring for Temperature, Humidity, Soil Moisture, pH Value and Water Temperature

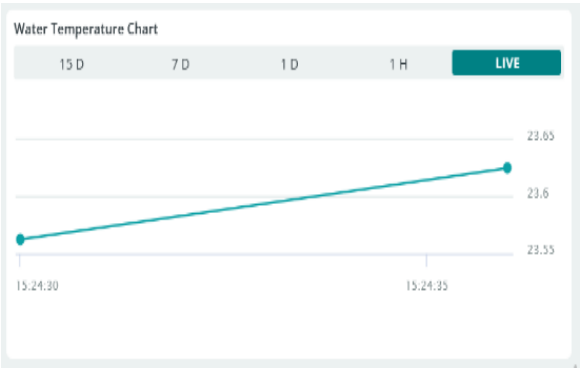


4.(a) Data Visualization for Temperature



4.(b) Data Visualization for Humidity





4.(c) Data Visualization for Soil Moisture **4.(d) Data Visualization for Water Temperature**

Figure 4. Data Visualization Chat

6.4 Remote Control Features

- Fish Feeder Activation: Enables remote feeding of fish, ensuring they receive food on time without manual intervention.
- Water Pump Control: Users can switch the water pump on or off remotely to regulate water flow in the aquaponics system.
- Light Control: Users can control the LED grow lights to provide the necessary illumination for plant photosynthesis, even in low-light conditions.
- Oxygen Pump Management: Users can activate or deactivate these devices to maintain the oxygen levels required for fish health.

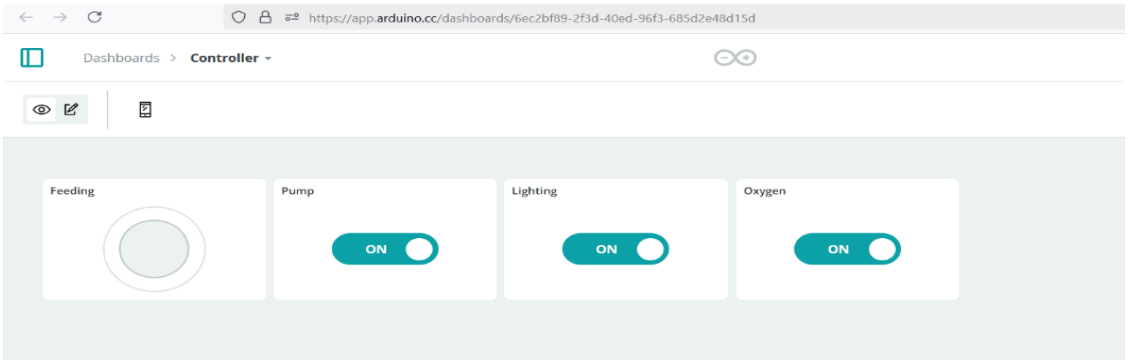


Figure 5. IoT Dashboard for Remote Monitoring and Control via IoT Remote

6.5 Results

This system demonstrates significant improvements in crop management and resource efficiency. Key outcomes include:

- Accurate Crop and Weed Identification: Image recognition successfully distinguishes between crops and weeds, reducing manual effort.
- Efficient Resource Usage: Water recycling reduces consumption by up to 50%, while targeted nutrient delivery minimizes fertilizer use.
- Improved Crop Health: Real-time monitoring ensures optimal growth conditions, leading to higher yields.
- Environmental Benefits: The system reduces soil degradation, greenhouse gas emissions, and deforestation.

6.6 Benefits

- Space Efficiency: Enables farming in compact urban spaces.
- Resource Conservation: Reduces water and fertilizer usage. Water substrate in aquaponics can easily and quickly distributed nutrients uniformly throughout to all plants in the system.
- Pest and Weed Management: Simplifies control through advanced monitoring and aquaponics design. Weeds are easily dealt with and can be removed easily since their roots are suspended in water.
- Productivity Enhancement: Supports simultaneous cultivation of plants and fish, maximizing returns.
- Weather Resilience: Ensures consistent crop growth irrespective of external weather conditions.

7. Sustainable Development Goals (SDGs)

Among United Nation's 17 Sustainable Development Goal (SDGs), "Crop Health Monitoring: Remote Sensing Agriculture" can support these three "Sustainable Development Goals".

Goal 11: Sustainable Cities and Communities

By reducing reliance on traditional soil-based agriculture, it minimizes land degradation and promotes efficient land use. Sustainable practices such as water conservation and organic pest management align with efforts to mitigate climate change and protect urban ecosystems. These initiatives contribute to reducing disaster risk, promoting sustainable energy consumption, and building resilience within urban communities.

Goal 12: Responsible Consumption and Production

This project promotes responsible consumption and production by implementing efficient resource management practices, including precise monitoring of water usage, fertilizer application, and pest control. By minimizing resource wastage and environmental impact, this fosters a more sustainable and resilient agricultural system.

Goal 13: Climate Action

This project contributes to climate action by implementing sustainable farming practices that reduce greenhouse gas emissions and mitigate climate change impacts. Through the promotion of vertical hydroponic systems and nutrient recycling, the project minimizes land degradation and reduces deforestation associated with traditional agriculture.

8. Impact on Myanmar

Agriculture is the backbone of Myanmar's economy, yet it faces challenges from resource depletion, inefficiencies, and climate change. This project provides a transformative solution, offering:

- Increased Productivity: Higher crop yields through optimized farming practices.
- Sustainability: Reduced resource consumption and environmental impact.
- Economic Growth: Improved livelihoods for farmers through modern agricultural techniques.

By adopting this system, Myanmar can modernize its agricultural sector, enhance food security, and contribute to global sustainability efforts.

9. Conclusion

The "Crop Health Monitoring System for Remote Sensing Agriculture" integrates IoT technologies and sustainable practices to address critical agricultural challenges. By enabling real-time monitoring, precise interventions, and efficient resource use, this system provides a scalable solution for modern farming. Its relevance to urban and traditional agricultural contexts, particularly in Myanmar, underscores its potential as a transformative innovation.

10. Future Plan

The project has significant potential for future development, including:

- Currently, plant images are being captured via video. As a further step, the obtained plant images will be analyzed using image processing techniques to determine whether the plants are infested with pests or not.
- The Crop Health Monitoring System project will be showcased at national-level and university-level exhibitions. By providing advice to farmers, it will also contribute to the advancement of agriculture.
- There are issues with access to electricity in Myanmar. The solar system currently in use is designed solely to operate the fish pond motor. As a future plan, we aim to make the entire system operate using solar power.