Arab American University

Faculty of Engineering and Information Technology

Computer Systems Engineering

SENIOR PROJECT (I)

“Plantie” Smart Image Processing for Plant Diseases Detection and Farmer Assistant

Academic Year:

2023/2024

Students Statement

We the undersigned students, certify and confirm that the contents and work submitted in this project report are entirely our own and have not been copied from any other source. Any material that has been used from other sources has been properly cited and acknowledged in the report.

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Submitted in partial fulfillment of the requirements of B.Sc. Degree in Computer System Engineering

Supervisor Certification

This is to certify that the work presented in this senior year project manuscript was carried out under my supervision, which is entitled:

Plantie App

"Smart Image Processing for Plant Diseases Detection and Farmer Assistant"

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I hereby that the students have successfully finished their senior year project and by submitting this report they have fulfilled in partial the requirements of B.Sc. Degree in Computer Systems Engineering.

I also, hereby that I have read, reviewed, and corrected the technical content of this report and I believe that it is adequate in scope, quality, and content and it is in alignment with the ABET requirements and the department guidelines.

Prof. Mohammed Awad,

ACKNOWLEDGMENT

Praise be to God, Lord of the worlds, and prayers and peace be upon the most honorable of the prophets and messengers, our master Muhammad, his family, and companions, and those who followed them in goodness until the Day of Judgment.

First and foremost, we thank God for His blessings on us, and on our behalf, we succeeded in this endeavor. We also pray for the knowledge we gain to be useful to the rest of the world, especially to Palestine.

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To all those and others who have supported us through thick and thin, we offer a big "thank you" straight from our hearts, we bring to you this report and project.

ABSTRACT

In the realm of agriculture, where the importance of sustainable practices looms large, the timely detection of diseases in crop production emerges as a critical factor for increasing productivity. However, Due to the scarcity of technologies used in crops, the diagnosis of diseases and pests is largely supported by human inspection, generating errors caused by the subjectivity of individuals. Even if disease is detected, finding the optimal treatment among the thousands of fertilizers and agricultural medicines is a challenging task. Our goal is to develop a plant disease detection system that utilizes a subfield of artificial intelligence known as Computer Vision to solve this issue. This system can predict plant disease by comparing the images of plants and those in the dataset and then recommending the best treatment. The system utilizes an algorithm to analyze and process the captured image to classify the plant disease The diagnostic system is composed of image acquisition, image preprocessing, segmentation, feature extraction, feature selection, and subsequent classification of disease. The system can recognize the condition by utilizing deep computer vision with convolutional neural networks (CNN) which is particularly well-suited for image recognition and processing tasks. By utilizing a smartphone camera or a captured image, recommendations can be made to the agricultural shop where they will be available. on the other hand, the application will help the farmers with the information needed to treat the detected diseases produced by the image processing model. This solution aims to provide a versatile, scalable, approach to plant disease. Overall, the system promises to enhance the process of detecting plant diseases and pests, while also providing farmers with information to enhance crop productivity, which will lead to a decrease in financial losses.

Keywords: *Smart Plant Disease Detection, Pests, Farmer, Plant, Smartphone Camera, CNN, Mobile Application.*

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LIST OF SYMBOLS	
LIST OF ABBREVIATIONS	
ABET	Accreditation Board for Engineering and Technology
ReLU	rectified linear unit.
CNN	Convolutional Neural Networks
ANN	Artificial Neural Network
NaCRRI	National Crops Resources Research Institute
VCS	Version Control System
AI	Artificial Intelligence
AR	Augmented Reality
MVC	Model-View-Controller
Rest	Representational State Transfer
API	Application Programming Interface
N-P-K	Nitrogen (N), Phosphorus(P_2O_5), and Potassium (K_2O)
Ha^{-1}	Hectare

1 CHAPTER 1: INTRODUCTION

Throughout history, humans have been developing tools and techniques to enhance agricultural productivity. From simple farm tools and organic fertilizers to greenhouses, tractors, chemical fertilizers, and other inventions made by humans. The most important part of the process of increasing agricultural productivity is maintaining the health of crops and providing farmers with the best treatment. The process of maintaining plant health includes appropriate fertilizers and medications. The detection of plant disease and its treatment is not an easy process, it needs an experienced agronomist who knows all aspects of plants.

With the help of machine learning and deep learning, the agricultural industry has become more advanced. Machine learning and deep learning have become one of the most important subfields of artificial intelligence through which systems are developed that do not need humans to perform their assigned tasks. Not to mention the speed and accuracy of the results possessed by these modern technologies, the results may not be as accurate if the person performed them himself. These technologies came trying to replace human work to reduce effort, budget, and time and increase productivity.

So, why deep learning in plant disease detection? Because the traditional way of predicting plant diseases requires full knowledge of plants. Human inspection can make mistakes in predicting many diseases and providing the best treatment that is needed. On the other hand, the process of detection and prediction of the disease is much faster and more accurate when using deep learning and computer vision. All you need is a camera to predict the disease and provide treatment in less than a minute. In dealing with this issue, the system will use a sub-field of Artificial Neural Network (ANN) called Convolutional Neural Network (CNN) which is particularly well-suited for image recognition and processing tasks. The process includes image acquisition, image preprocessing, image segmentation, feature extraction, feature selection, and subsequent classification of disease. Anyway, plant disease is a huge impact on humans around the world, Our yield loss (range) As shown in figure 1-1 estimates at a global level and per hotspot for wheat (21.5% (10.1–28.1%)), rice (30.0% (24.6–40.9%)), maize (22.5% (19.5–41.1%)), potato (17.2% (8.1–21.0%)) and soybean (21.4% (11.0–32.4%)) suggest that the highest losses are associated with food-deficit regions with fast-growing populations, and frequently with emerging or reemerging pests and diseases [1].

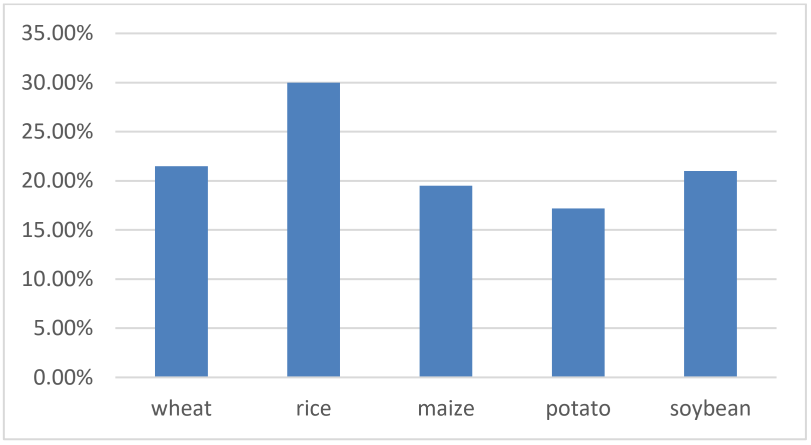


Figure 1-1 The number of losses in the agriculture field cause plant diseases.

1.1 Problem Statement and Purpose

The process of plant diagnosis through observation of the symptoms on plant leaves is full of complexity. Experienced agronomists and plant pathologists struggle to diagnose specific diseases, and that leads to making mistakes in predictions of the plant treatment process. Without the use of advanced diagnostic tools and automated computational systems for the detection and diagnosis of plant diseases, errors are more likely to occur. These technologies play an important role for agronomists and pathologists to assist them in the process of detecting plant pests and diseases.

Traditional methods often rely on human experts like agronomists and pathologists to diagnose plant pests and diseases, and that could be a long-time process and can lead to errors due to variations in human judgment. The time an expert spends predicting the disease could lead to an increase in the spread of diseases. Moreover, when dealing with a diverse range of plant species and potential issues, manual inspection may result in inaccuracies. In Addition, the process of manual diagnosis of the plant needs a laboratory analysis and this process may require substantial time, manpower, and equipment.

Building a mobile application that detects plant diseases could be a valuable tool for farmers. It helps the farmers to reduce the expected time of diagnosis and saves them money. The application employs image processing to extract visual features, including color, texture, and patterns, from plant images that are taken from a phone camera or a gallery. Then a pre-trained CNN model is used to analyze these features and classify plant diseases.

1.2 Project and Design Objectives

We aim to develop an application that helps farmers develop their crops by detecting plant diseases using modern AI technologies. In addition, providing them with tools and techniques to help them in the farming process:

- Build/design a user-friendly mobile application.
- Support the Mobile app with a design scalable and extendable system.
- Support the Mobile app with suggestions based on Weather conditions.
- Support the Mobile app with a community System for mutual information between users.
- Support the Mobile app with the Fertilizer Calculation System.
- Support the Mobile app with information to Find the nearest plant shop to the user.

1.3 Intended Outcomes and Deliverables

The desired outcome from this project is a mobile application that provides farmers the ability to detect plant disease, which saves time, effort, and money. In addition, the application will provide the farmers the common treatment for specific plant diseases. The application is an assistant for the farmers which reduces the need for experts there's no need to waste much time in trying to predict the desired disease within the possibility of errors occurring with associated documentation that describes the project requirements and project features in advance.

1.4 Summary of Report Structure

The senior project design document is divided into several chapters to ensure that technical experts can read it easily. The following describes each chapter's content:

In Chapter 1, you will find an overview of intended outcomes and deliverables, as well as an introduction to the project, the problem statement, and the purpose of the project.

Chapter 2 provides background information, which includes a project overview, relevant statistics, and previous research and projects that have explored similar ideas.

In Chapter 3, the document outlines the main components of the project and then provides an extensive explanation of the system design, which includes design specifications, related standards, and any constraints. The chapter focuses on design alternatives, system analysis, and optimization, and ends with simulation or experimental tests.

Chapter 4 presents the project's findings and conclusions.

Chapter 5 concentrates on project management, which encompasses tasks, schedules, milestones, resource management, and cost management. The project lessons learned are included in this chapter.

In Chapter 6, the impact of the engineering solution on the environment, economy, society, and other relevant issues is discussed.

The document ends in Chapter 7 with the team's final thoughts on the project, the skills they acquired during the process, and recommendations for future work.

2 CHAPTER 2: BACKGROUND

2.1 Overview

A plant disease detection system that utilizes deep learning algorithms allows farmers to use a mobile application to handle the recognition process of plant diseases through infected plant leaf images. After the system recognizes the specific disease, it provides the optimal treatment that the plant needs. In Plantie, the system will detect many diseases for different plants. The common plants that the system must handle are the tomato, grape, olive, potato, and cucumber. The flow of this process follows some steps. The first step is image acquisition, image acquisition is the process of capturing the image through the smartphone camera. After we capture the image and convert it to the digital version, the image must go through the preprocessing step. Preprocessing means making some changes in the image to prepare them for analysis. This step may include Noise reduction, Color space conversion, Normalization, and Segmentation. Finally, the image is ready to be inserted in the pre-trained CNN model. Figure 2-1 show that tools such as Plantix and Farm Beats, farmers can reduce herbicide and fertilizer consumption by 25% to 35% as well as increase yields by up to 4% [2].

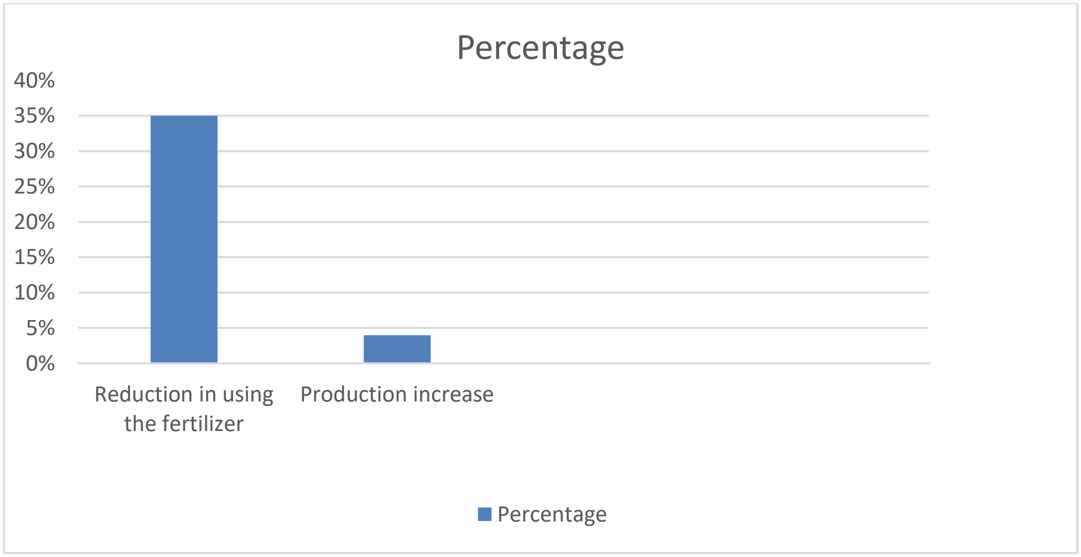


Figure 2-1 The production increase and the reduction in using fertilizer

2.2 Related works

2.2.1 Plant village Nuru

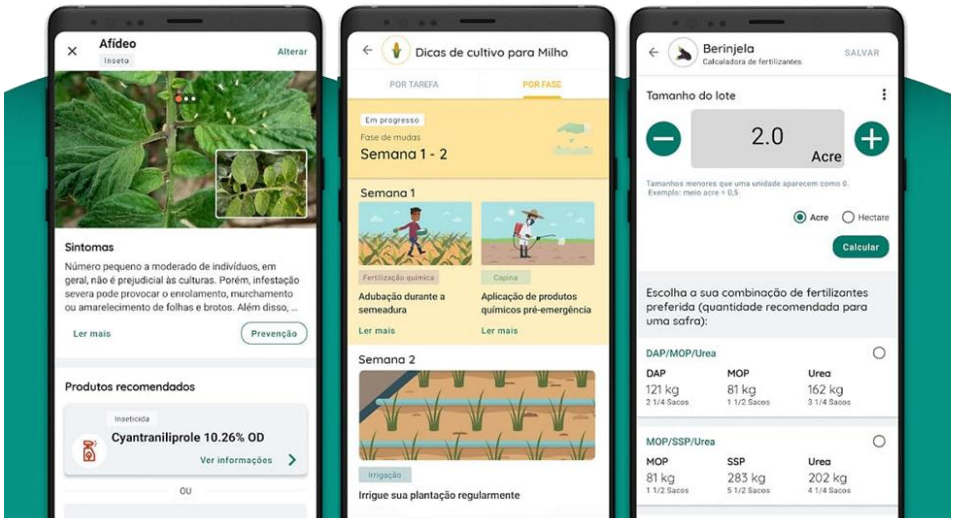
PlantVillage Nuru is a publicly supported, and publicly developed application that uses a digital assistant to help farmers diagnose crop disease in the field, without an internet connection [3]. Plant Village Nuru is a mobile app that uses CNN to detect and diagnose plant diseases. Plant village Nuru provides many features such as diagnosing plant diseases, a community for farmers, and a chatbot called Cassava AI. The application uses CNN architecture called Inception-v3 which is developed by Google. The Plant Village Nuru uses its dataset called PlantVillage. PlantVillage dataset is the most common dataset for plant disease recognition which provides many diseases for different plants.

PLANT VILLAGE NARU
PlantVillage Nuru
Immediate diagnosis for Cassava, Potato or Fall armyworm
Send your image to a Human expert
Ask a Question
Check out our Knowledge library

Figure 2-2 Plant Village Nuru

2.2.2 Plantix

Plantix is a mobile application that helps farmers to take control of their crop health. The application provides features such as plant disease and pest identification, crop advisory, community platform, and offline functionality. Plantix helps farmers diagnose and treat crop problems, improve productivity, and provide farming knowledge. Achieve your farming goals and improve your agricultural experience with Plantix [4]. The application allows you to choose a specific plant to provide you with the information that you need within the possibility of predicting the disease from the image. Unfortunately, there's not enough information about the architecture of this system. Plantix is one of the most common mobile applications in plant disease recognition. The app shows the weather status and then provides if the current day and the next day are good for applying pesticides or weeding. In addition, the application provides fertilizer calculation and cultivation tips for a specific plant.



Número pequeno a moderado de indivíduos, em geral, não é prejudicial às culturas. Porém, infestação severa pode provocar o enrolamento, murchamento ou amarelecimento de folhas e brotos. Além disso, ...

Adubação durante a semeadura

Aplicação de produtos químicos pré-emergência

Irrigue sua plantação regularmente

Tamanhos menores que uma unidade aparecem como 0. Exemplo: meio acre = 0,5

Escolha a sua combinação de fertilizantes preferida (quantidade recomendada para uma safra):

DAP/MOP/Urea

DAP	MOP	Urea
121 kg 2 1/4 Sacos	81 kg 1 1/2 Sacos	162 kg 3 1/4 Sacos

MOP/SSP/Urea

MOP	SSP	Urea
81 kg 1 1/2 Sacos	283 kg 5 1/2 Sacos	202 kg 4 1/4 Sacos

Figure 2-3 Plantix - Related works.

2.2.3 Potato Disease Classification

It's a potato disease detection system that utilizes the CNN model inside a backend within a Website and mobile connection. The system detects and recognizes a potato disease in a fast API server to handle the prediction process. The system uses Custom CNN architecture which uses 5 Convolution layers with several filters: 32, 64, 64, 64, 64 in row, Max Pool layers which are applied after each convolutional layer with a pool size of 2x2 [5]. The system CNN model applies the preprocessing inside the model itself as layers that make resizing, rescaling, and augmentation. The result of the architecture is 1 layer for resizing to 220x220 shape, 1 layer for rescaling, 2 layers for augmentation which apply the rotation and flipping, and a series of convolutions layers and Max pool layers. Figure 2-4 shows the system flow of Potato Disease System:

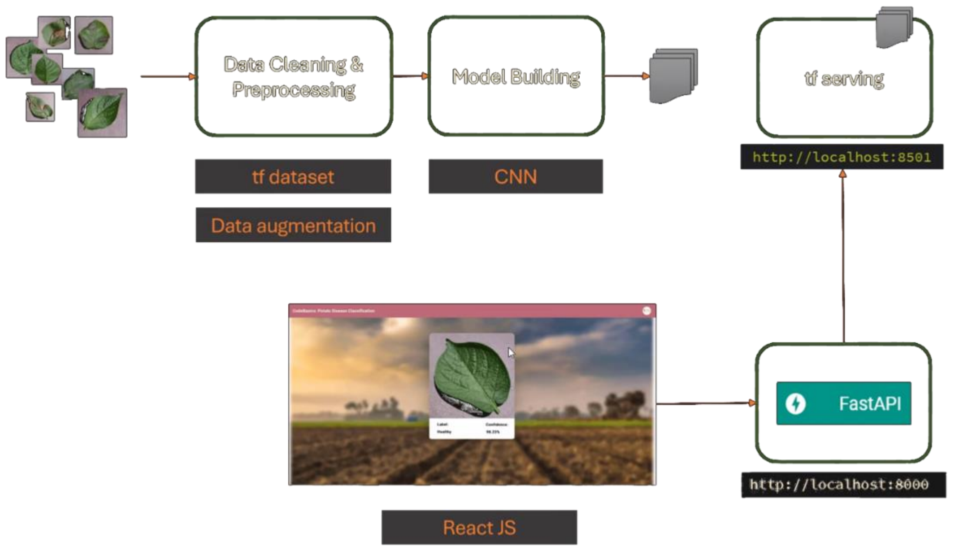


Figure 2-4 Potato Disease Detection system flow.

2.2.4 Intelligent System for Cucumber Leaf Disease Diagnosis

In a paper on December 2, 2022, Saman M. Omer, Kayhan Z. Ghafoor, and Shavan K. Askar discuss the plant disease detection for the cucumber plant. The paper discusses an architecture built by the authors to show the comparison between the common architecture and the proposed architecture, and these architectures are Inception-V3 architecture, AlexNet architecture, and ResNet-50 architecture. The paper shows that the proposed model for detecting 5 cucumber diseases for 200 epochs, was better than the rest of the architecture. The recognition accuracy was 98.19%, 97.77%, 97.53, 96.69%, and 96.14%, respectively on 1-CNN (proposed model), Inception-V3, and ResNet-50 [6]. In the context of the paper, it shows that the Data Argumentation to make balance in the dataset is an efficient approach for cucumber disease detection, especially when the data is unbalanced. In this context, we noticed that all related works came together to detect the disease first, and there were differences in how they implemented this process. The Plantix can predict a lot of different plants for different diseases, and as shown in his site it's the top free app for crop diagnosis. The key difference between them is the side features like the community, fertilizer calculator, suggestions based on weather, and the variety of plants that the system can predict. Our project meets all these features plus the finding nearest plant shop.

2.3 Comparison

Table 1 System Comparison

	Plant Village Nuru	Plantix	Potato Disease Detection	Cucumber Disease Detection	Proposed Project
Disease Detection	✓	✓	✓	✓	✓
The number of plants Can Detect	Many	Many	One plant	One plant	5 or more
Community	☒	✓	☒	☒	✓
Fertilizer Calculator	☒	✓	☒	☒	✓
Find the Nearest Plant Shop	☒	☒	☒	☒	✓
Disease Treatment	✓	✓	☒	☒	✓
Suggestions based on weather conditions	☒	✓	☒	☒	✓
Target	Africa	Indian	For education purpose	For education purpose	Palestine

3 CHAPTER 3: METHOD AND MATERIALS

In the previous chapters, it has been talking about what the purpose and objectives of the project and how it will help the farmers to keep the crops healthy. In this chapter, we will discover the system architecture design, the system modeling diagram, the specification, and the functional and non-functional requirements of the proposed system within the standards and constraints that will be followed during the process of developing the system.

3.1 System Algorithms

The system design and algorithms are an important process to provide a clear requirement specification for our development process. The maintainability of the system will be easier if we well understand the system design and algorithms. The system design and what algorithms it used, give us a clear knowledge of system flow. Moreover, system design provides the audience with a roadmap for understanding how the system works. This translates to improved maintainability and a robust foundation for future system enhancements. Figure 3-1 shows the architectural design of the system.

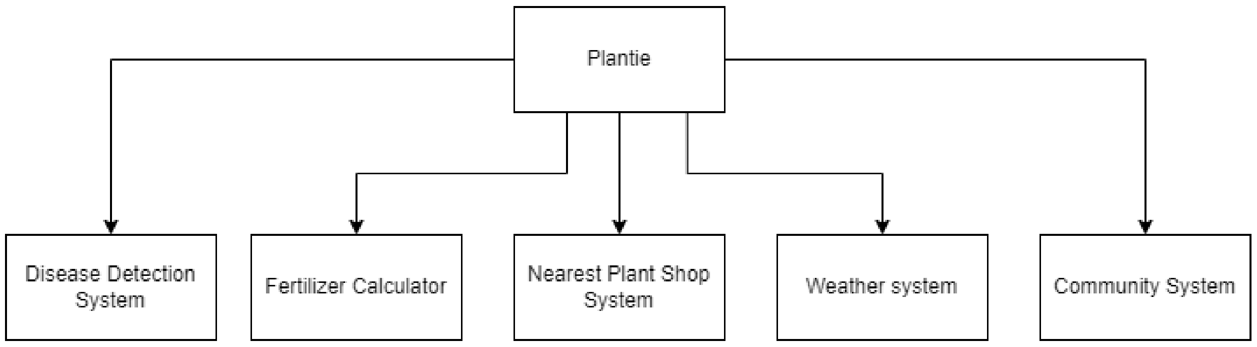


Figure 3-1 Algorithm Architecture

3.1.1 Plant Diagnosis System

The process of plant disease detection includes the dataset collection for the training model process and the evaluation of the model accuracy, image acquisition to convert the plant leaf into digital representation, and image preprocessing to apply some changes to enhance the image quality for our purpose. After these steps, now the image is ready to be inserted into the pre-train CNN model which is trained with the previously collected dataset. The model will classify and make predictions of plant disease. Figure 3-2 shows the plant disease recognition flow:

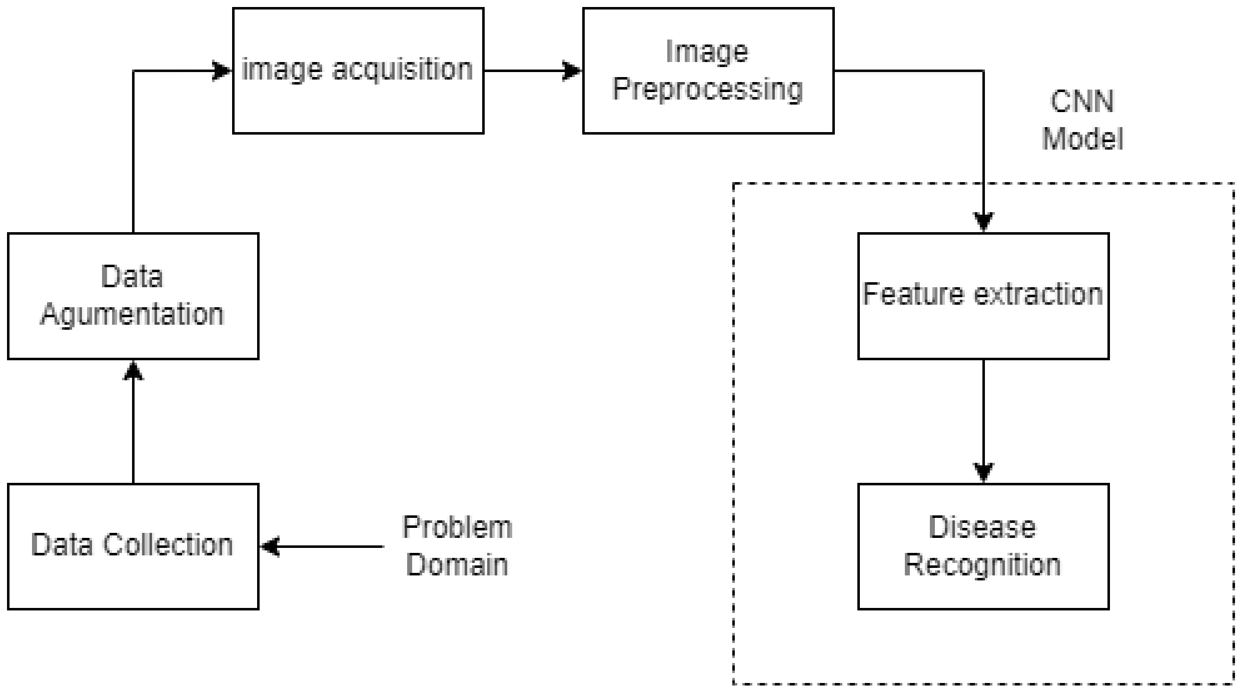


Figure 3-2 Plant Disease Detection Algorithm Architecture

3.1.1.1 Data Collection

As we mentioned before the dataset is an important requirement in the training process. The quality, diversity, and quantity of data affect the accuracy of prediction and the training process time. Also, part of the dataset is used in the testing and evaluation process. We need to test and evaluate the process to determine the effectiveness and of our trained model.

The proposed project uses different datasets and combines them. Dataset-1. PlantVillage: PlantVillage is the most common dataset in the realm of plant disease detection. The PlantVillage contains many types of plants and diseases. The plants include apples, corn, potato, tomato, pepper, and more plants with different diseases. Dataset-2. olive dataset is a dataset in GitHub collected from Denizli city of Turkey during spring and summer [7]. Dataset-3. ibeans dataset is a dataset in GitHub collected by the Makerere AI lab in collaboration with the National Crops Resources

Research Institute (NaCRRI), the national body in charge of research in agriculture in Uganda [8]. Figure 3-3 shows some samples from the pre-collected dataset:

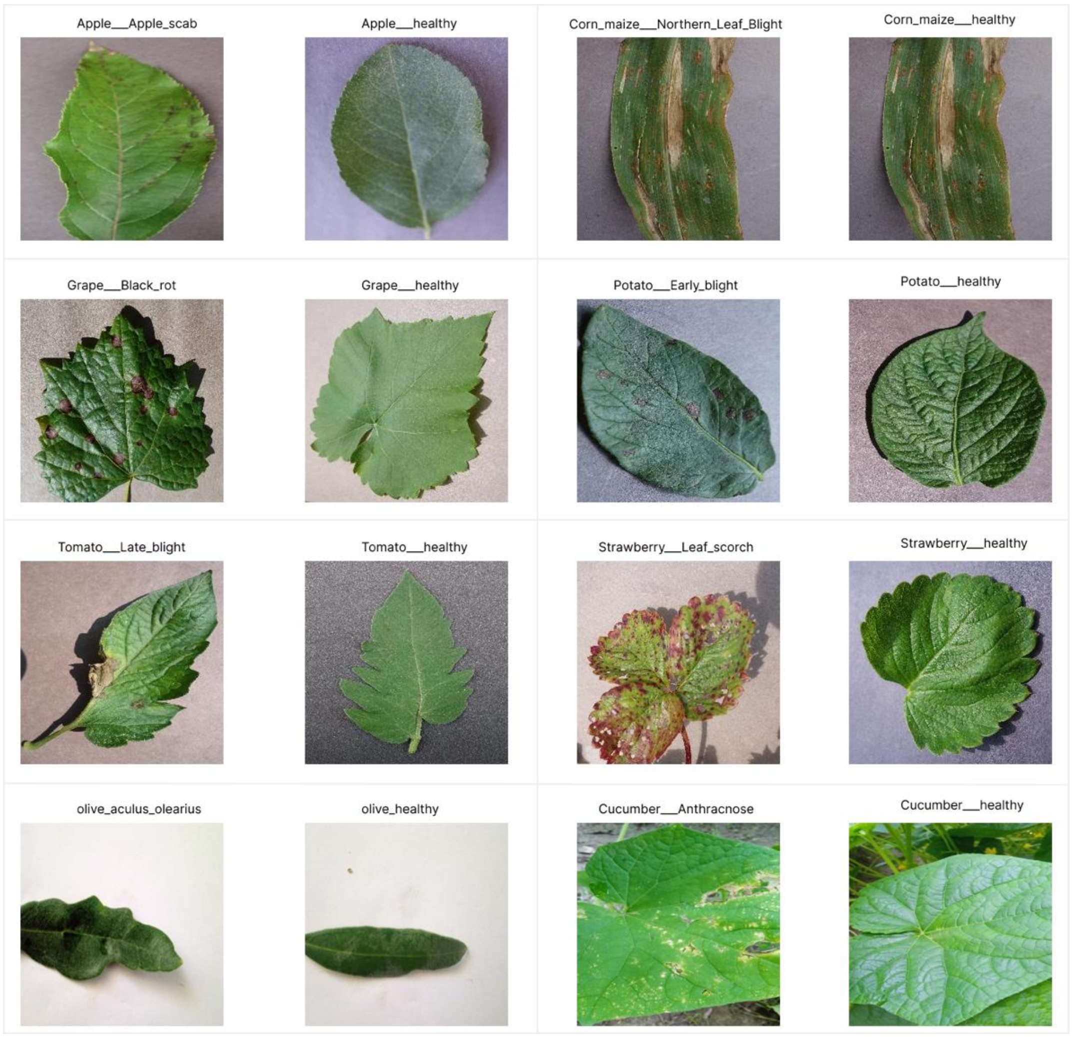


Figure 3-3 Samples from the pre-collected dataset.

3.1.1.2 Imbalanced Data and Data Augmentation

Another factor in model accuracy is the data balance factor. The data is called, but it is not balanced when the number of images of each class is not close to the number of images for the rest of the classes. For example, when we have a dataset of 1200 images of 3 different classes. Let's say the data includes 400 images for tomatoes, 200 for potatoes, and 600 for olives, then the dataset is called an unbalanced dataset. So how does the unbalanced data affect prediction accuracy? The model tends to prioritize learning to predict the class that has a higher number of images, and this led to high accuracy in general, but poor performance for the classes that have fewer images. The Figure 3-4 describe the 3 methods to achieve the balance:

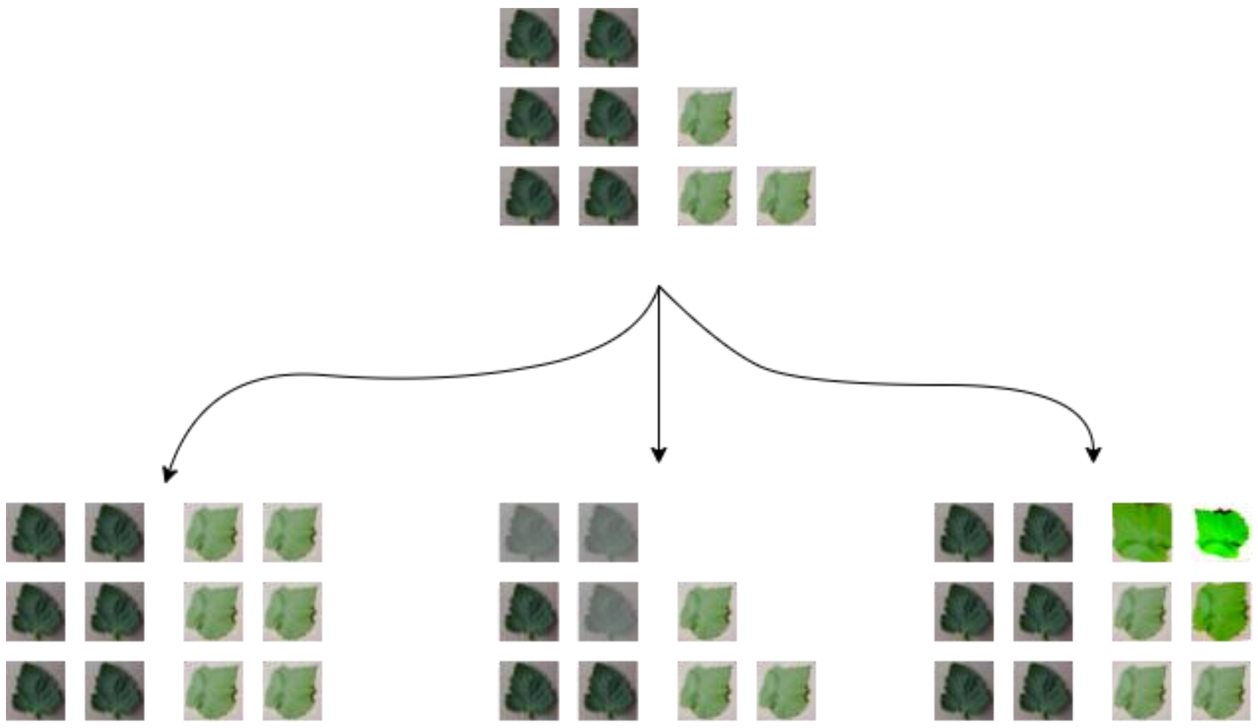


Figure 3-4 3 methods solving the imbalanced data.

However, there are different ways to solve the unbalanced data problem like oversampling, Undersampling, and Data Augmentation:

1. Oversampling: It is a technique which the data will be repeated many times to achieve balance. In the previous example, both the number of tomato and potato will be increased into 500-600 which is the maximum number of images in one class.

2. Undersampling: It is a technique in which the data will be decreased to achieve the balance. In the previous example, both the number of olives and tomatoes will be decreased to 200-300 which is the minimum number of images in one class.

3. Data Augmentation: Data augmentation is a technique in machine learning, that increases the training set by creating modified copies of a dataset using existing data [9]. It includes making minor changes to the dataset or using deep learning to generate new data points. Augmented data is driven from original data with some minor changes. Plantie application used image augmentation techniques, that make geometric and color space transformations to increase the size and diversity of the dataset. In plant disease detection using deep

learning, rotation, flipping, re-sizing, brightness, contrast, and cropping are common image augmentation techniques. image augmentation techniques have several advantages as reduced overfitting, improved model accuracy, and enhanced model generalization.

3.1.1.3 Image Preprocessing

Image preprocessing is the steps taken to format images before they are used by model training [10]. As shown in figure 3-5, The image preprocessing includes Resizing, Normalization, Contrast enhancement, and Noise reduction. This process leads to faster training and better performance.

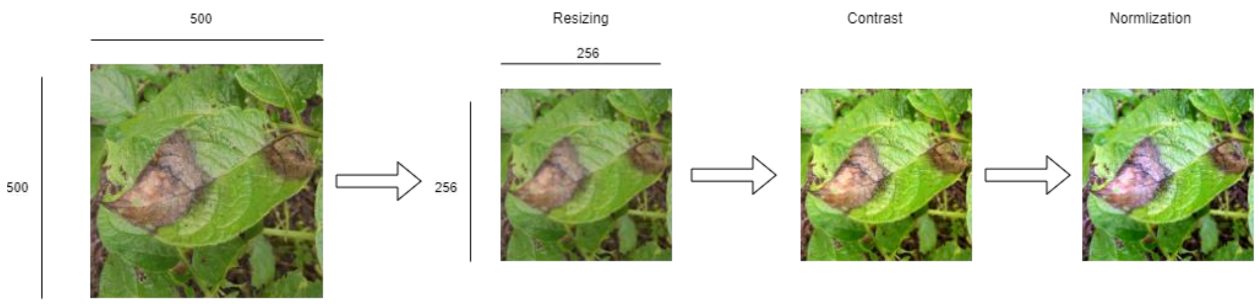


Figure 3-5 Applying image preprocessing.

3.1.1.4 ANN Algorithm

An artificial neural network is a powerful tool in the world of machine learning. An artificial neural network is several nodes connected that form a network like the one found in the human brain. Each interconnection has a weight, and this weight is useful in the process of activating the neuron. An activation function is a function that uses weight to decide which interconnection to take to provide a transit path for another interconnection. The core feature of ANNs is that the ANNs use the interconnected nodes to process information and learn from experience, and this process of learning from experience is called training, the ANNs model trains from the dataset and it will make changes to the weight of each interconnection. ANNs employ 3 layers called the fully connected layers, and these layers consist of the input layer, hidden layers, and the output layer. The figure 3-6 shows how the 3 layers are connected.

- Input Layer: This layer receives input data, usually, referring to the dataset features.
- Hidden Layers: These layers are a set of layers that relate to the input layer and output layer.
- Output Layer: refers to the last neurons that represent the final prediction (label).

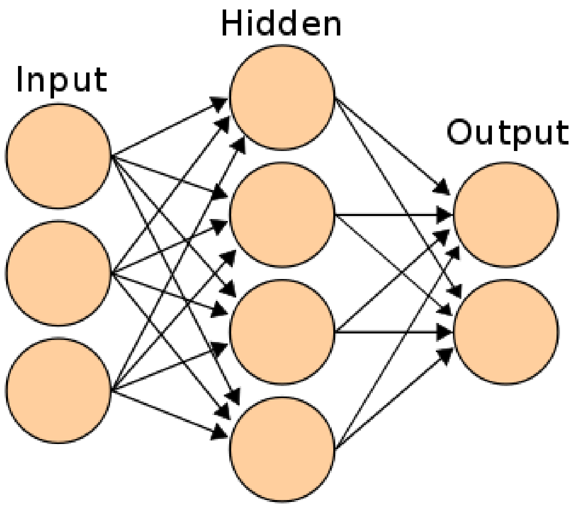


Figure 3-6 ANN Algorithm layers.

3.1.1.5 CNN Algorithm

CNN is a category of machine learning model, namely a type of deep learning algorithm [11]. As mentioned before, CNN is the most suitable algorithm for object detection and recognition. Like ANN, CNN has 3 layers (input layer, hidden layers, output layer) plus some layers for handling images called convolution layers and pooling layers. In turn, the convolution layers work together to extract features from the image. Followed by pooling layers to reduce the dimensionality of the extracted features. This process will result in a set of features to be inserted into the ANN to make predictions. Figure 3-7 shows the general form architecture for the CNN algorithm.

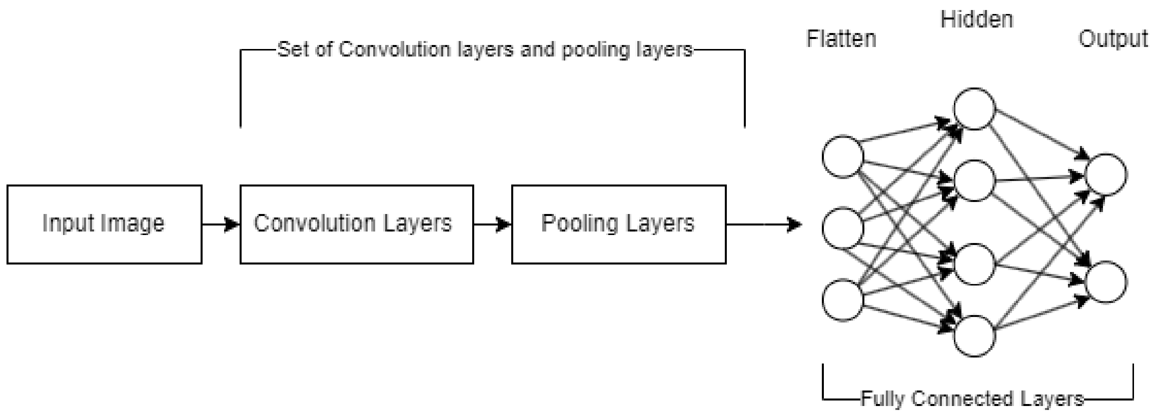


Figure 3-7 CNN Layers

CNN Pseudocode

```
create_model()
# Convolutional layers with subsampling (pooling):
add_convolutional_layer(number_of_filters,filter_size,stride,activation='tanh')
add_average_pooling_layer(pool_size)
add_convolutional_layer(number_of_filters, filter_size, stride, activation='tanh')
add_average_pooling_layer(pool_size)

# Fully connected layers:
flatten_layers()
add_fully_connected_layer(number_of_neurons, activation='tanh')
add_fully_connected_layer(number_of_neurons, activation='tanh')

# Output layer (number of output neurons depends on the task):
add_output_layer(num_classes, activation='softmax')
```

Convolution Layers

The convolutional layer is the core building block of a CNN algorithm which employs multiple filters stacked together to extract features from images, each filter has a specific(n x m)size to extract a specific feature. To understand more about the filters, imagine that there's a human face image, the human face has some features like ears, eyes, mouth, and so on. Each filter tries to extract one of these features. In the end, the output of a convolution layer is a set of feature maps. The feature map is a 2D array that stores the feature result of each filter. Moreover, the filter will slide among the image input and then store the data in the feature map array. Figure 3-8 show how the filters will slide and fill the feature map.

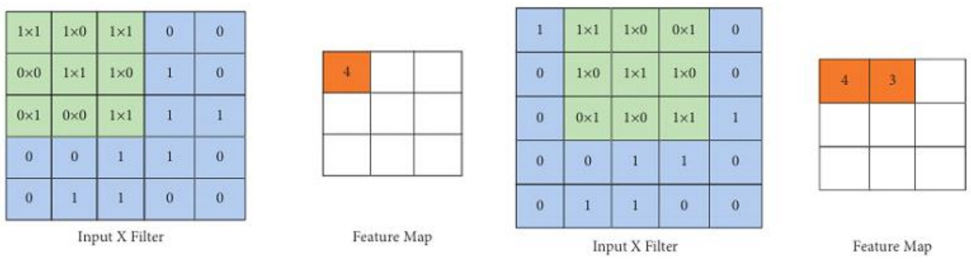


Figure 3-8 Generating feature map for a single filter.

Notice that the numbers within a feature map represent the activations of a particular filter at different spatial locations in the input image.

Pooling Layers

Pooling layers play a crucial role in reducing the dimensionality of feature maps by applying operations like Max pooling and Average pooling. The pooling operation involves sliding a two-dimensional filter over each channel of the feature map and summarizing the features lying within the region covered by the filter [12]. The pooling uses a sliding window with ($n\ x$ m) size to calculate the average or max of the pixels within the rectangular region of the window. The result is a downsampling of the feature map. Figure 3-9 shows how the filters work and how the sliding windows are sliding to fetch and collect the features from the image:

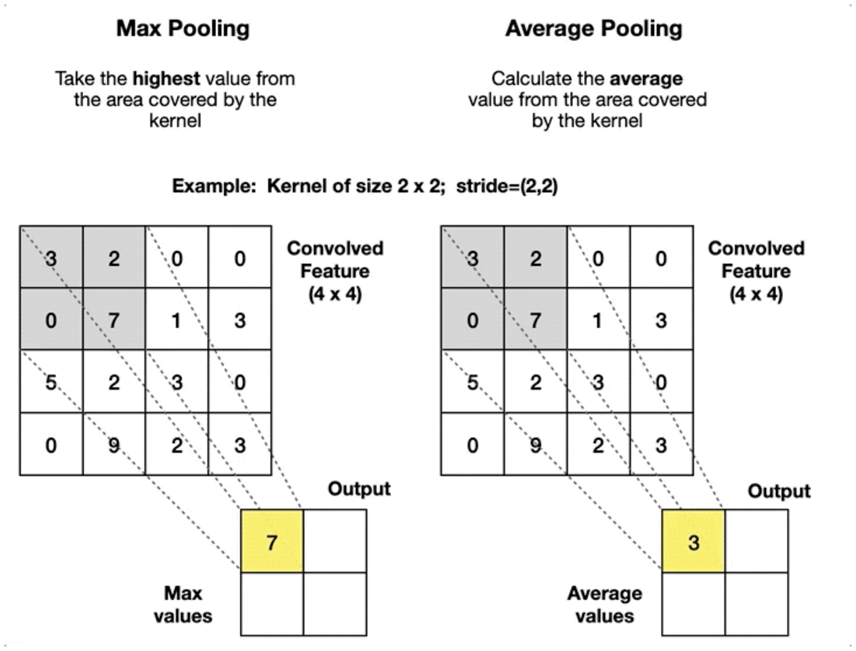

Max Pooling
Take the highest value from the area covered by the kernel
Average Pooling
Calculate the average value from the area covered by the kernel
Example: Kernel of size 2 x 2; stride=(2,2)
3 2 0 0
0 7 1 3
5 2 3 0
0 9 2 3
Convolved Feature (4 x 4)
Output
7
Max values
3
Average values

Figure 3-9 Max and Average Pooling

Fully Connected Layers

The fully connected layers refer to the traditional neural network layers which take the input from the previous feature maps, they combine the extracted feature repairing to the final output. The input layer is called flatten, from its name the image input will be represented into a 1D array to be ready to go as an input in the ANN. As the ANN there are hidden layers and output layers, the operation here is the same as those in the ANN.

Proposed Model Architecture

The Figure below is the basic architecture of the CNN and it’s called leNet. LeNet-5 was one of the earliest convolutional neural networks and promoted the development of deep learning [13]. In the context of CNN, many different architectures exist, and each one has advantages. As we mention in the related works the plant disease detection projects used different architecture, and some of them used their architecture like the “Potato disease detection”, and the “Cucumber diseases detection”. The CNN architecture that we used in this project is the basic CNN model as shown in Figure 3-10:

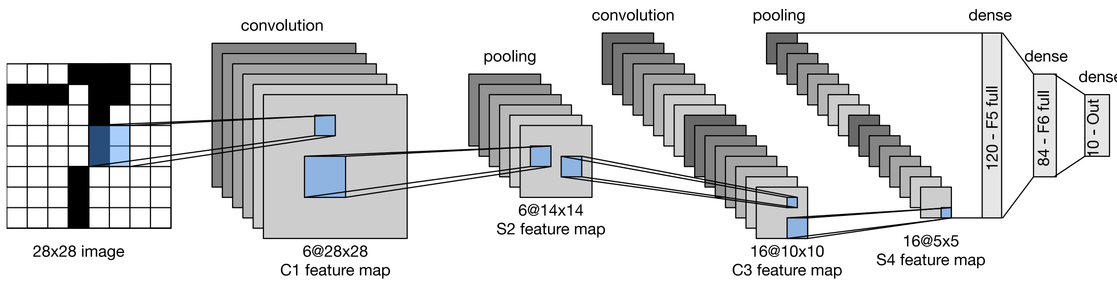


Figure 3-10 LeNet architecture

3.1.2 Fertilizer Calculator

Fertilizer is important in the process of plant growth. The new farmers may struggle with the calculation of several fertilizers. When we want to calculate the number of fertilizers that should be applied to the plant, we must know that 2 things must be known, the N-P-K, and the land size. The letters "NPK" on a fertilizer label stand for nitrogen, phosphorus, and potassium, the three primary nutrients plants need to grow [14]. The N-P-K rate refers to nitrogen (N), phosphorus(P_2O_5), and potassium (K_2O), and these refer to how much nitrogen, phosphorus, and potassium the plant needs. On the other hand, there some kinds of fertilizers contain a specific amount of these compounds, for instance, the Urea fertilizer contains 46% nitrogen which can be represented as 46-0-0 in the N-P-K form, the MOP contains 60% Potassium, and the SSP contains

16-18% of phosphorus [15]. We can calculate the amount of fertilizer for each of these fertilizers by the following equation:

For example, if we know that the average N-P-K of the cucumber is (150-75-50), then the required amount of each fertilizer is like the following:

$$\textit{The required amount of Urea} = (100*150) / 46 = 320 \text{ kg ha}^{-1}$$

$$\textit{The required amount of SSP} = (100*75)/16 = 468.75 \text{ kg ha}^{-1}$$

$$\textit{The required amount of MOP} = (100*50)/60 = 83.3 \text{ kg ha}^{-1}$$

All the results here are measured by kilogram per hectare (ha^{-1}), the one hectare equals 100*100 meters (m). If the size of the land is more or less than that, then the number of fertilizers will be different. Suppose that land is 2 ha^{-1} In the previous example, then the result will multiply by 2. However, the fertilizer calculator will calculate the amount of fertilizer that the plant needs and will show you how much N-P-K the plant needs. In addition, the process of calculating the amount of fertilizer is not sufficient, as the amount of fertilizer must be shown for each week. Because all these numbers of fertilizers are not applied immediately when the plant is in the early growth stage. The calculator should show how you divide the amount of fertilizer by weeks.

3.1.3 Find the Nearest Plant Shop

Plantie’s "Find Nearest Plant Shop" feature improves user experience by assisting users in finding the closest plant shop concerning their present location. Map services such as Google Maps or Mapbox are used by the app, which makes use of the device's location capabilities and a variety of plant shops containing names, addresses, and maps. By considering road networks, the system determines the journey times and distances between each plant shop and the user's location while maintaining accuracy. Iteratively measuring the minimum trip distance, the app finds the closest shop after filtering the list of plant shops depending on the user's city or surrounding cities. An easy-to-use interface gives users access to information about the shop, including its name, address, estimated trip time, and any other pertinent characteristics.

```
function findNearestPlantShop(userLocation):
    # get the array of plant shops with names, addresses, and coordinates
    plantShops = getPlantShops()
    # Filter plant shops based on the user's city or nearby cities
    nearbyShops = filterShopsByCity(plantShops, userCity)

    # Initialize variables for tracking the nearest shop
    nearestShop = nil  ,   minDistance = maxInt (infinity)

    # Loop through each nearby shop
    for shop in nearbyShops:
        # Calculate travel distance and time from user location to the shop
        travelInfo = calculateTravelInfo(userLocation, shop.location)
        # get the nearest shop
        if travelInfo.distance < minDistance:
            minDistance = travelInfo.distance
            nearestShop = shop

    # Display the details of the nearest shop to the user
    displayShopDetails(nearestShop)

# Helper function to calculate travel distance and time using mapping services
function calculateTravelInfo(userLocation, shopLocation):
    # Use mapping services (Google Maps or Mapbox) to get distance and time
    # This involve API calls to the mapping service
```

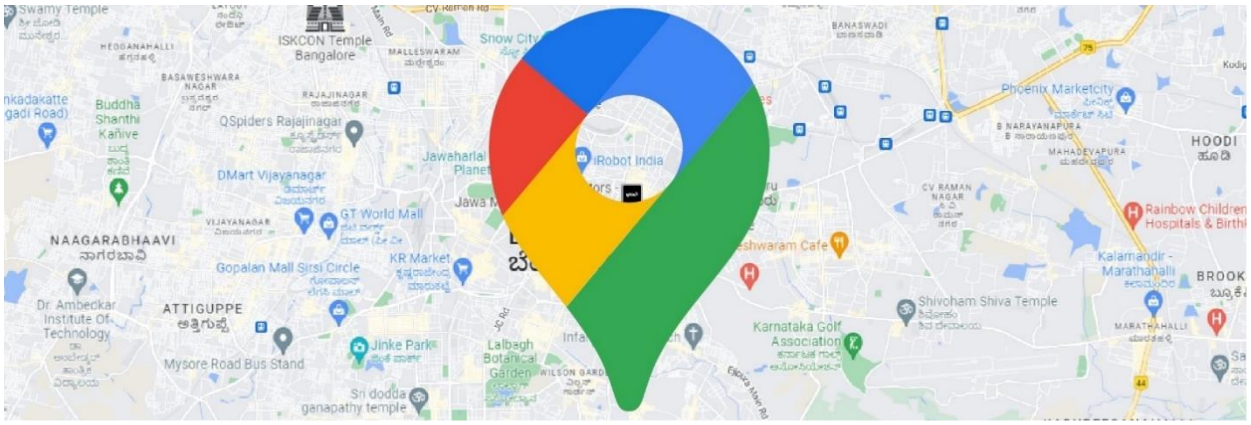


Figure 3-11 Google map.

3.1.4 Weather System

Another feature to help farmers is the weather system. Knowing the weather conditions will help farmers in the farming process. The system will provide the farmer with best practices or suggestions based on weather conditions. For instance, if the weather is rainy, it is a good idea for the farmer to supply fertilizer on that day. The system will use an API to provide it the real-time weather status and will detect what is better to be done based on the status. The following pseudocode explains how the suggestion works:

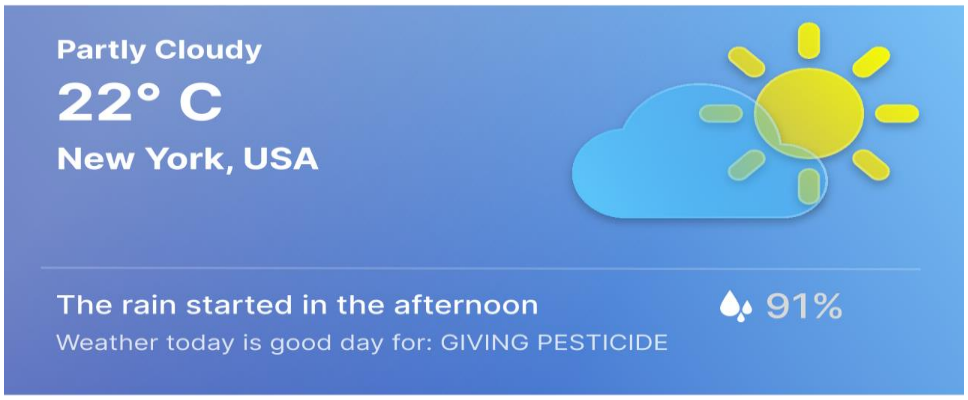
```
status, temperature, humidity = GoogleWeatherAPi()


if status == 'Sunny' and temperature > 30:
    send_data('The Day is good for framing')

if status == 'Cloudy' and temperature < 25 and humidity < 50%:
    send_data('The Day is good for Applying Irrigation')

if status == 'Rainy' and temperature < 15:
    send_data('The Day is for Giving Pesticide')
```

The system connects with an API let's say a Google Weather API to provide the status, temperature, humidity, and more details based on the user's location. Then the system will search in the knowledge base to retrieve the optimal suggestion based on this information. After the detection what the suggestion the system will show it in the UI. Figure 3-12 shows the weather condition status and the optimal Suggestion:



The rain started in the afternoon
Weather today is good day for: GIVING PESTICIDE

Figure 3-12 Weather conditions.

3.1.5 Community System

Sharing the experience between farmers is an efficient thing, especially for those who are new in the agriculture field. In any application, the community makes it more interactive and keeps farmers up to date with new features in this field. Give the farmers the ability to ask about the plants, new fertilizers, and the best practices. Plantie is not just a tool that allows you to predict the disease, it also provides you the ability to gain more experience from other farmers. The community system allows you to post questions, like, and comment on other posts. Rather than searching or asking in other places, all you need is one hub.

Moreover, the community system helps us to improve the application in the long term by keeping track of the feedback of the users. This user feedback allows us to be knowledgeable about the up-to-date features that the system should provide it. Like any generic software application, feedback is the key point of improving the system any measure of the acceptance between the users. Figure 3-13 shows the functionalities of the community system:

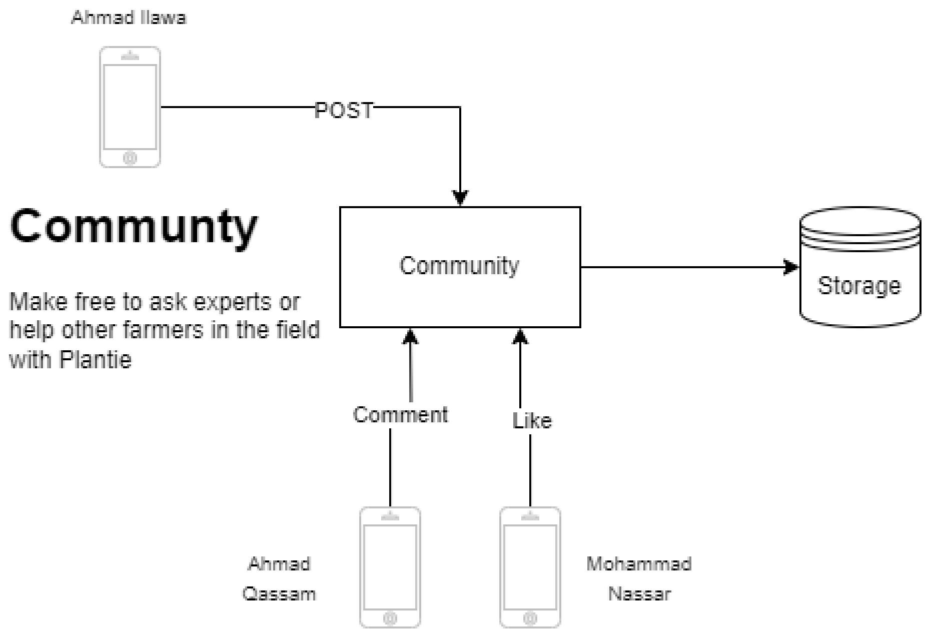


Figure 3-13 Community System

When we talk about a community system, we assume that there are users and there are authorization and authentication systems. Anyway, the community system provides features including:

- Post Questions: the users can ask the community about the field.
- Post Preview: All posts will be shown to all users to communicate with them
- Comment: users can comment/replay to the posts to help them find the solution to their problems
- Like: The user can like or dislike posts, which helps to increase the reach of this post.

3.2 System design

System design includes important abstraction models like Sequence Diagrams, Database Designs, and Architecture Designs, which together provide a thorough representation of the project's organization. These models offer a blueprint for efficient development and implementation in addition to describing the elements and interactions of the system. The system design process guarantees a well-organized and planned approach to developing a reliable and scalable solution by using these design features.

3.2.1 Architectural Design

As shown in Figure 3-14, the application will send an image to the server and the server will predict the pre-trained model and then will retrieve the prediction. Also, the server can make queries in the database.

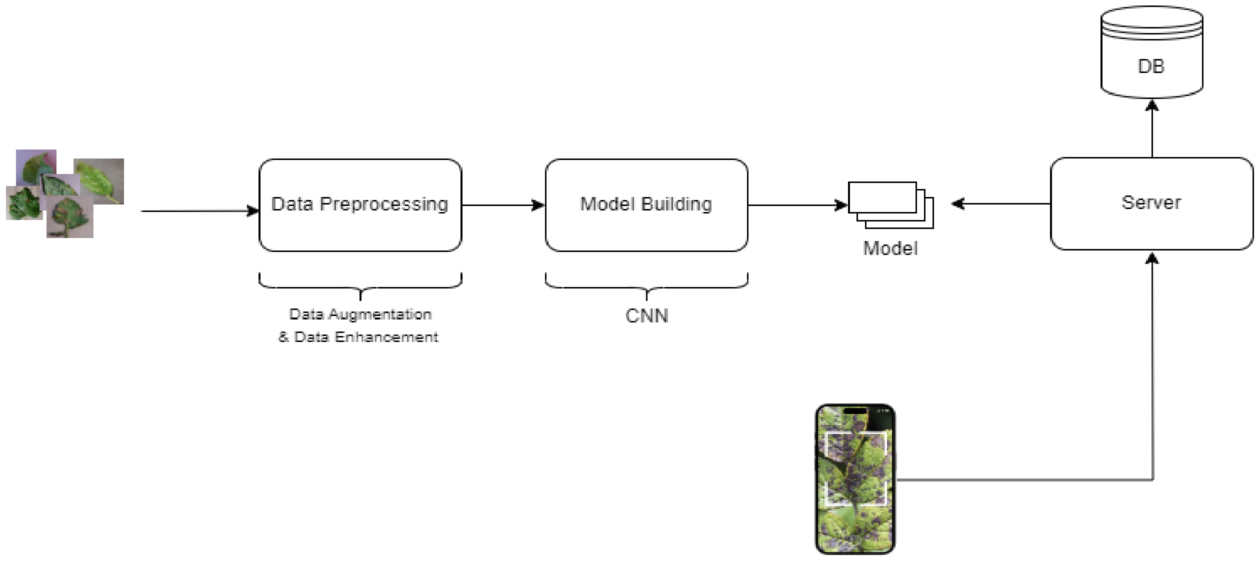


Figure 3-14 System Architecture

Model-View-Controller (MVC) and REST API (Representational State Transfer) are smoothly integrated to create a strong architectural framework in the Plantie App. In this design, the Controller serves as the go-between, the View controls the user interface, and the Model contains the data and business logic. The use of the REST API makes communication easier. The Plantie App can offer a dynamic and responsive user experience because of its improved scalability, maintainability, and flexibility, which also ensures adaptability for upcoming improvements and external integrations.

3.2.2 Database Design & UML Diagram

The database architecture of the Plantie App is set up to effectively manage various app features. The Users table contains the user's data, including login credentials and profile information. Information on different plants and related diseases is kept in the Plants and Plant Diseases tables. Users can interact with individual plants they've dealt with by using the User Plants table, which also notes diseases, photos, and detection details. The posts table manages user-generated material and keeps track of favorites and dislikes. By using foreign keys to connect the user and the post, the "Comments" table collects user-generated comments on postings. Environmental data about user locations is captured by the Weather table. Well-defined foreign key constraints and data integrity are the foundation for establishing relationships between tables.

The UML as shown in Figure 3-15 describes the database schema and the main tables and entities of the Plantie application. The tables are the user table for the authentication and authorization process, the User Plants which contains all plants of the user, the Plant Disease table which contains the details about the disease itself, the plant's table which contains information for each plant, and the last 3 tables are for the community which include the post, comment, and likes.

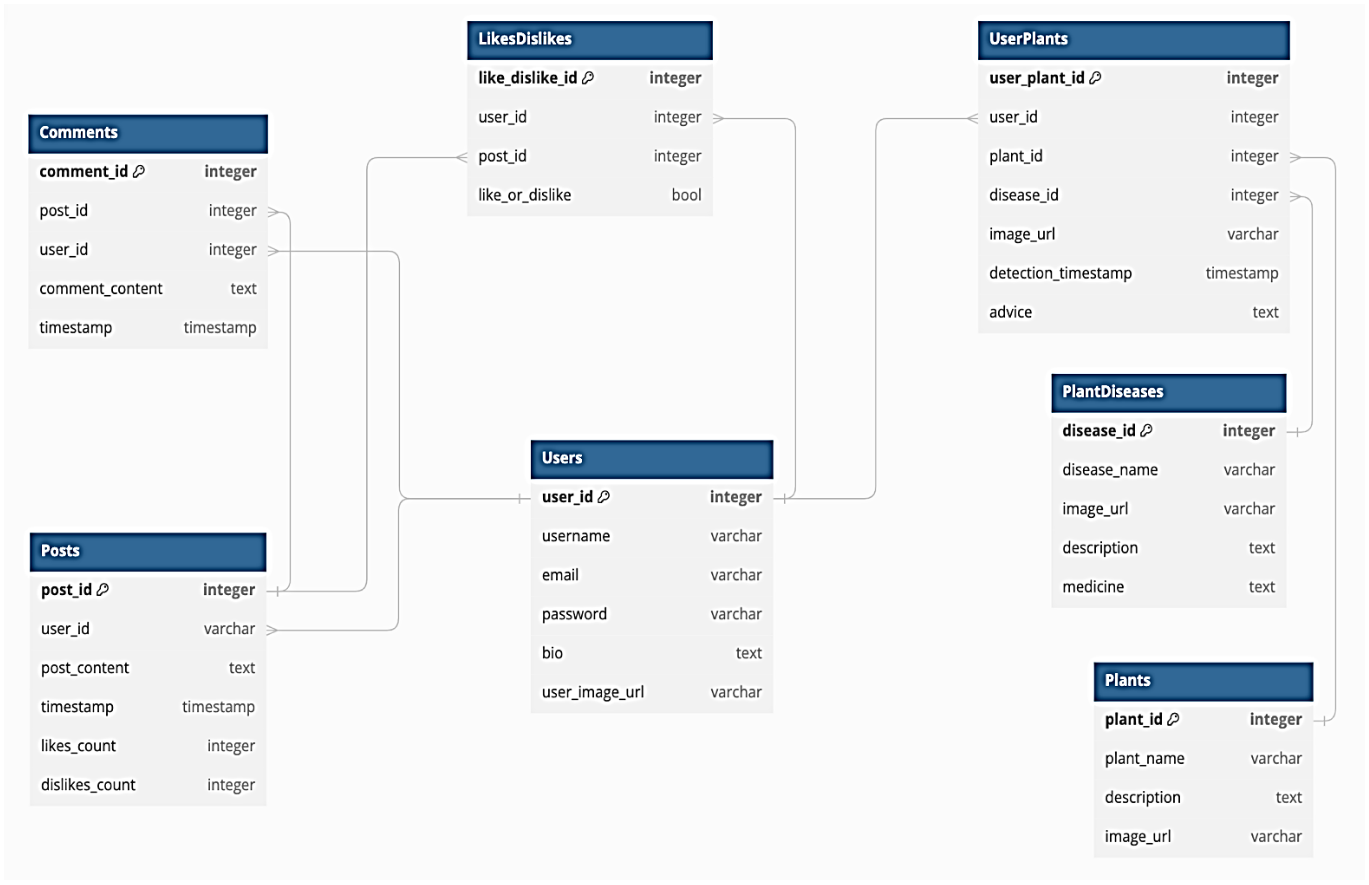


Figure 3-15 Proposed system database UML Diagram

3.2.3 User Scenarios

1. Scenario - User Registration via Email:
    a. The user receives an email prompting them to register.
    b. The user gives their username.
    c. The user generates a strong password.
    d. The database contains the verified registration data.
    e. The user is taken to the profile page after completing the registration process.
2. Scenario - User Registration via Gmail:
    a. The user chooses to sign up with their Gmail address.
    b. The application asks for authorization to use the Gmail account.
    c. After the user verifies access, pertinent data is retrieved.
    d. The application verifies and saves the user's data.

    e. The user is taken to the profile page after completing the registration process.
3. Scenario - User Registration via Facebook:
    a. The user decides to sign up with their Facebook credentials.
    b. The application asks permission to access user information on Facebook.
    c. The user allows access, and the required data is obtained.
    d. The application verifies and stores the user's information.
    e. Following a successful registration, the user is taken to the page featuring their profile.
4. Scenario: User logs in:
    a. The user is asked for their email address.
    b. The user is asked for their username.
    c. The user is prompted for a password.
    d. The profile page opens, and the user is successfully logged in if his credentials match those in the database.
5. Scenario: The user is unable to log in.
    a. An email request is made to the user.
    b. A password request is made to the user.
    c. If the user's credentials do not match those in the database, the user is not logged in.
    d. There will be a prompt displayed.
    e. He'll have to submit his information again.
6. Scenario: The user modifies his profile. He can do the following:
    a. Change his name.
    b. Modify his bio and user image.
    c. Modify his password.
7. Scenario - User Posts in Community View:
    a. The user opens the community view.
    b. The user writes and/or uploads images to a new post.
    c. After verifying the post, the program saves it in the database.
    d. The post is viewable and interactable by other users.
    e. The user receives notifications when other people engage with the post.

8. Scenario - User Comments in Community View:
    a. The user chooses a post after gaining access to the community view.
    b. The user comments on the post they have chosen.
    c. The application verifies and logs the feedback.
    d. Other users can view the comment by scrolling down below the post.
    e. The original poster of the post and other participants in the discussion receive notifications.
9. Scenario: User Makes Disease Detection:
    a. The user opens the detection view.
    b. The user photographs a plant that might be ill. b. The software analyses the image using a machine-learning model.
    c. The user gets immediate feedback regarding the illness that was identified.
    d. The app might offer suggestions for managing diseases.
10. Scenario: User Accesses Plants View with Weather and Fertilizer Calculations:
    a. The user views the plants.
    b. The user chooses a certain plant from the list.
    c. The application shows the user's location's current weather information.
    d. Based on the type of plant, the app determines and recommends the amount of fertilizer needed.
    e. The user gets thorough guidance on how to take care of their plants.
11. Scenario: User Accesses Map:
    a. The user views the disease detection result view.
    b. The user presses the button to navigate to the Map.
    c. The user shows the nearest plant shop.

3.2.4 Use Case Diagram

3.2.4.1 Login

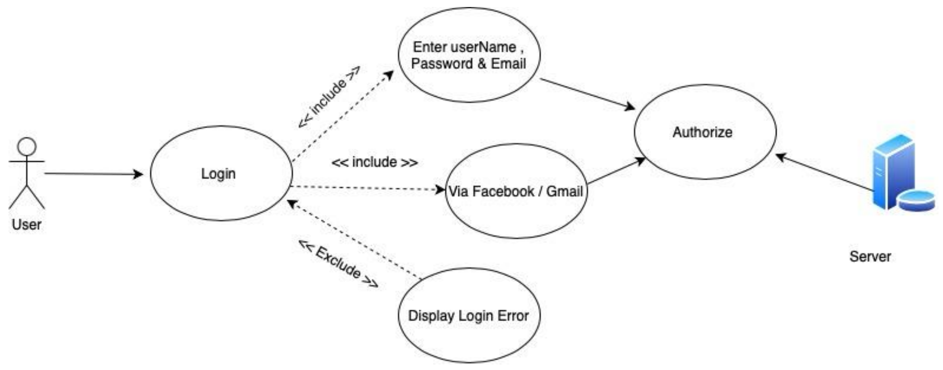


Figure 3-16 Login Use Case Diagram.

3.2.4.2 Register

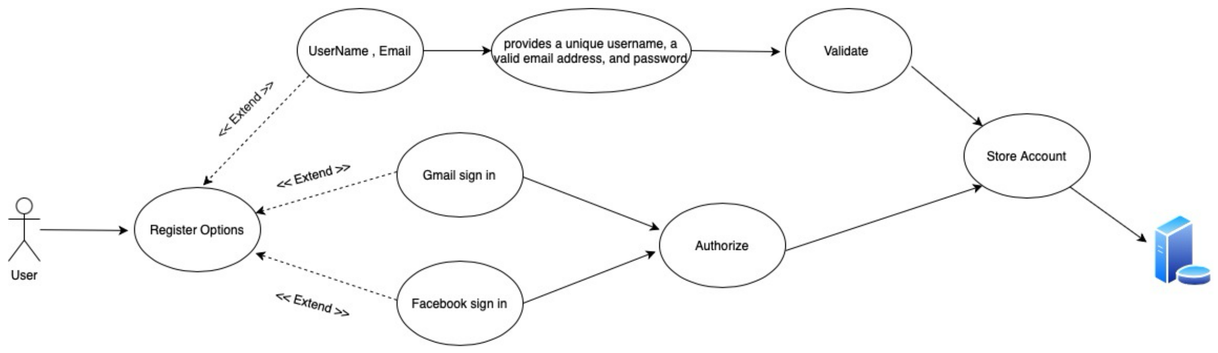


Figure 3-17 Register Use Case Diagram.

3.2.4.3 Profile

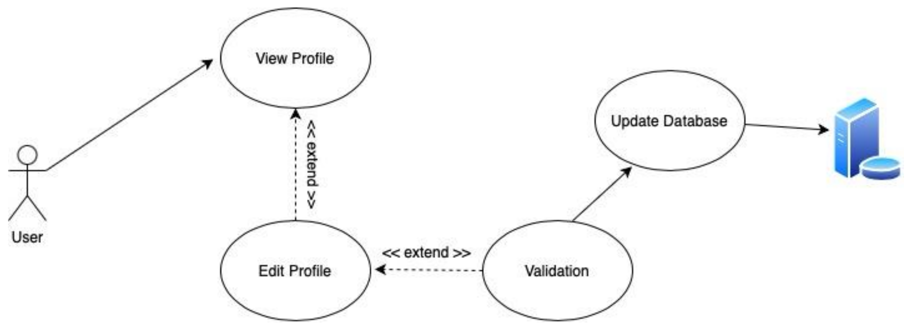


Figure 3-18 Profile Use Case Diagram.

3.2.4.4 Post on the community/Comment on the post:

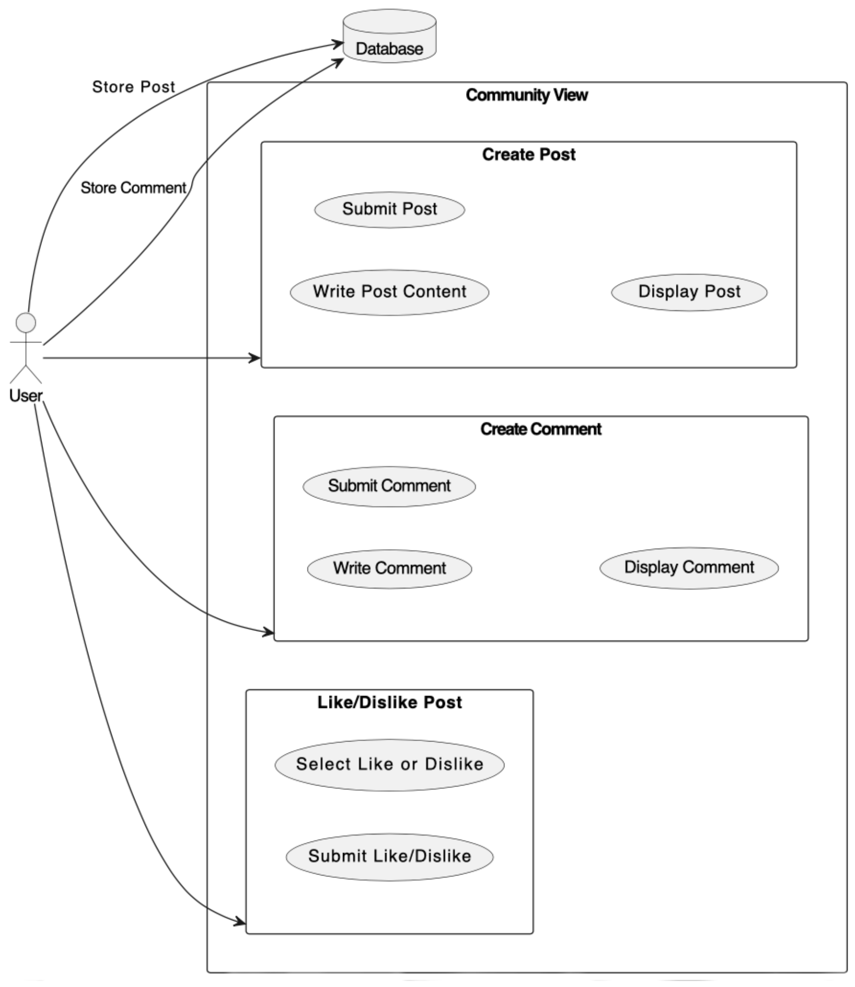


Figure 3-19 Community Use Case Diagram.

3.2.4.5 Plant’s view:

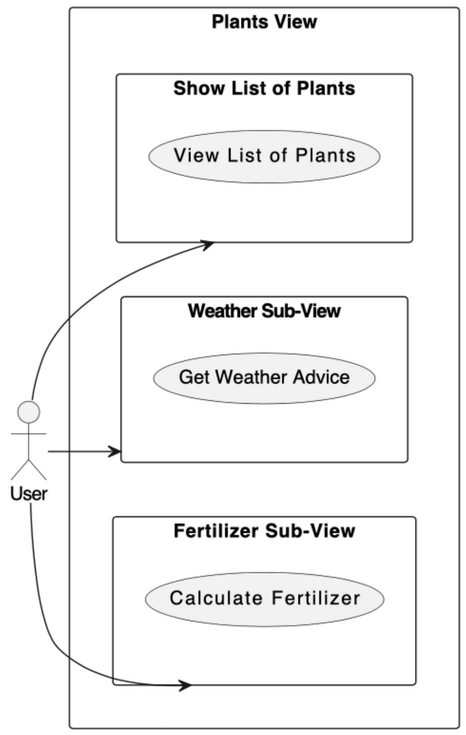


Figure 3-20 Plant use case Diagram.

3.2.4.6 Detection:

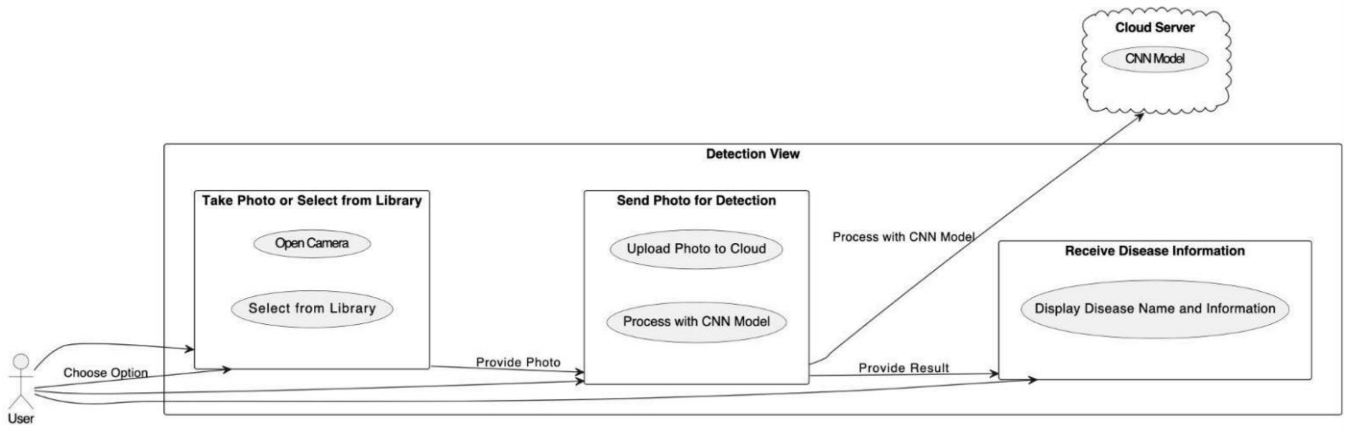


Figure 3-21 Detection Use case Diagram Sequence Diagram

3.2.5 Sequence Diagram

3.2.5.1 Login/Register:

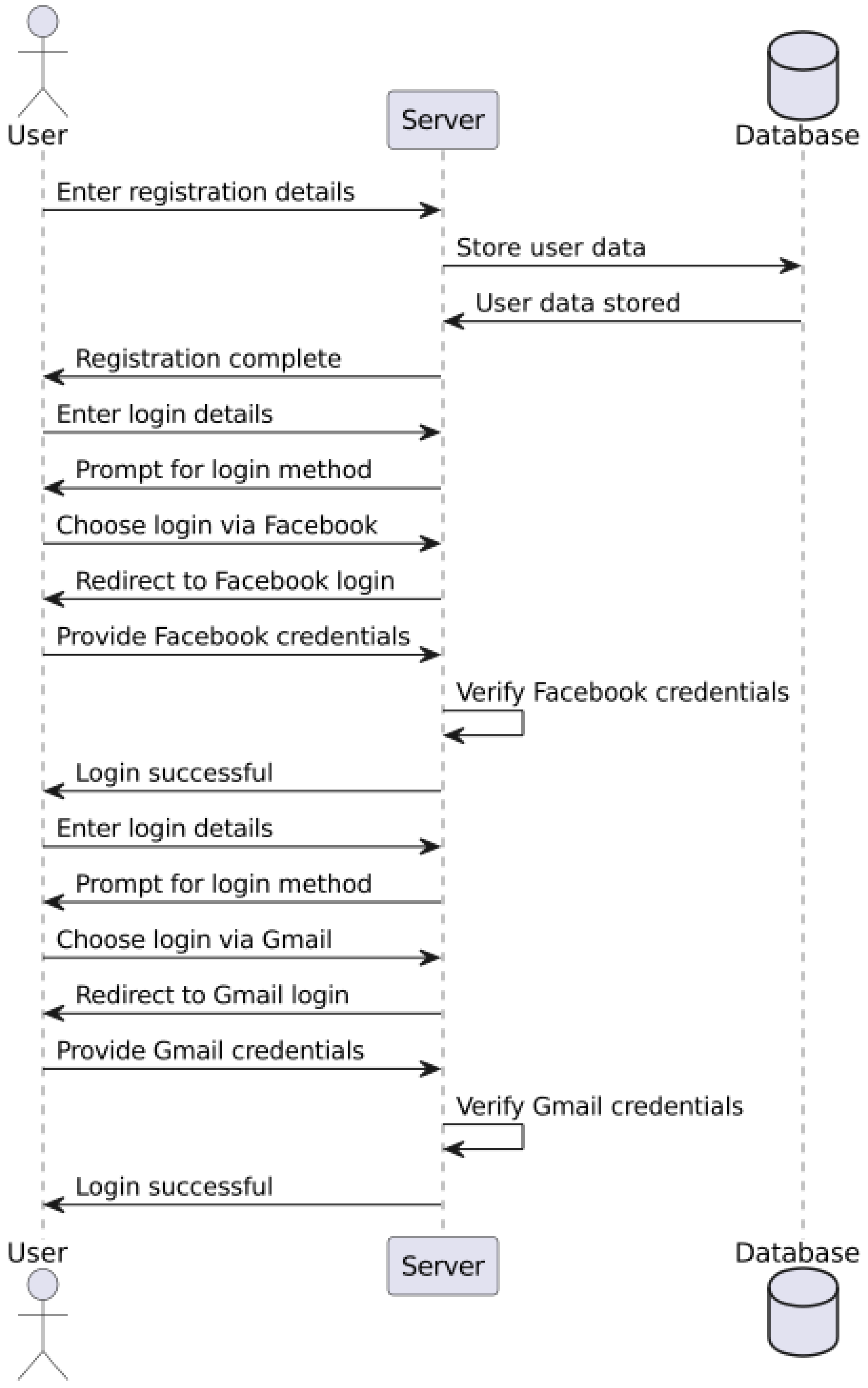


Figure 3-3 Login/Register Sequence Diagram

3.2.5.2 Post on the community/Comment on the post:

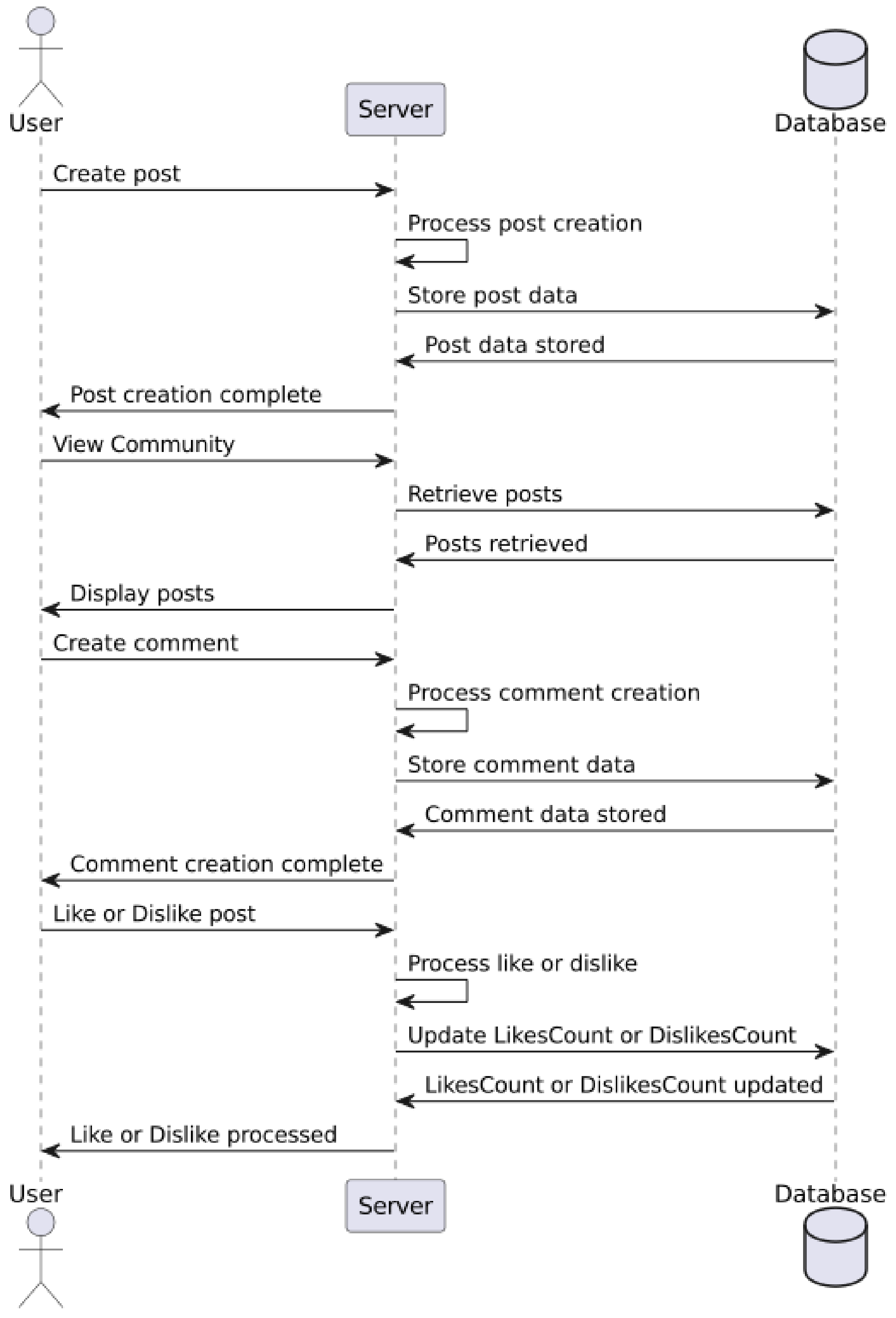


Figure 3-22 Post on community/Comment on the post Sequence Diagram

3.2.5.3 List view

- This view contains two sub-views the first for a list of plants, and the second for showing the real-time weather based on user location.
- When clicking on a plant, a sub-view appears behind the information of the plant for calculating fertilizer.

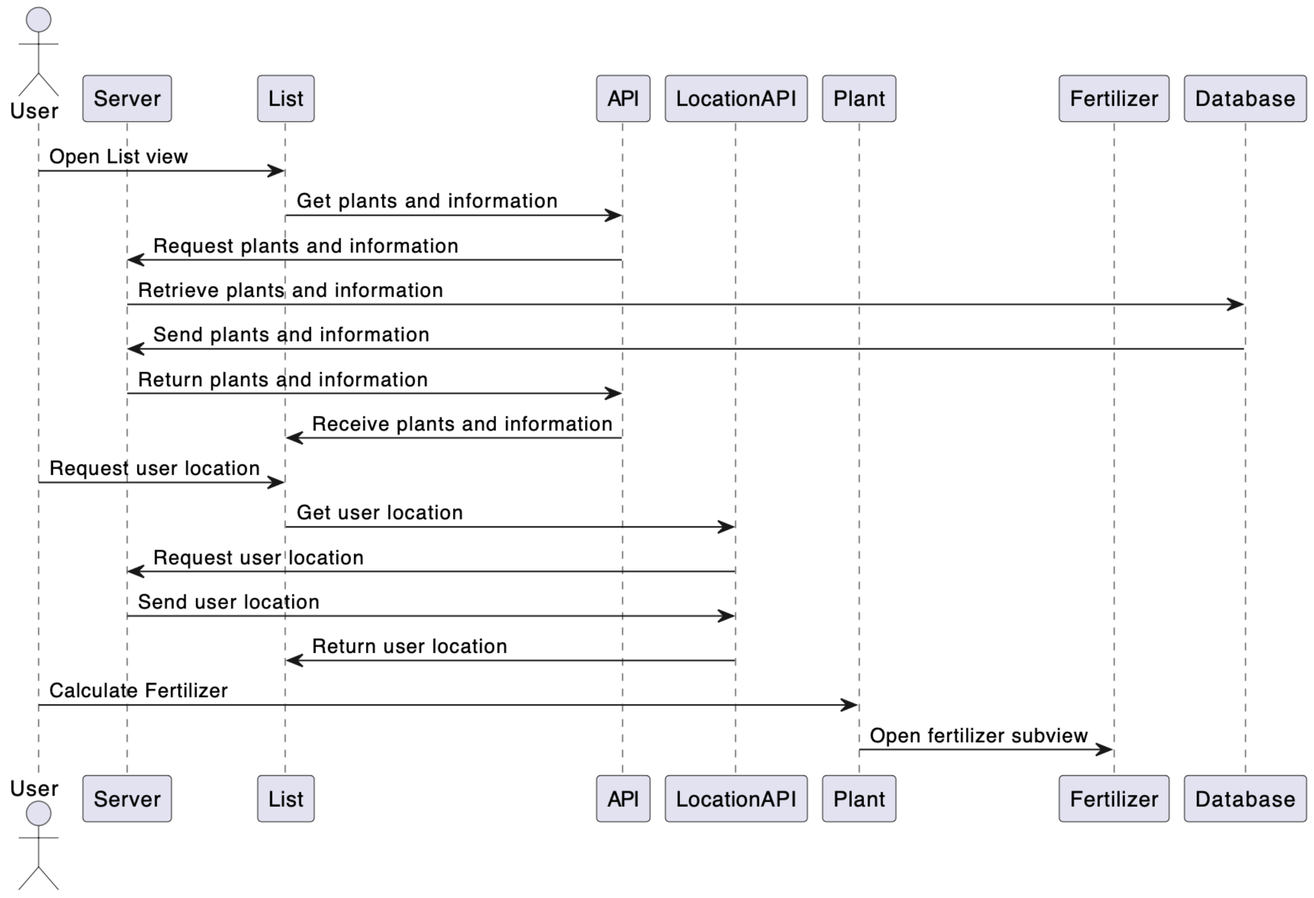


Figure 3-23 List View Sequence Diagram

3.2.5.4 Detection of the plant disease using the ML Model:

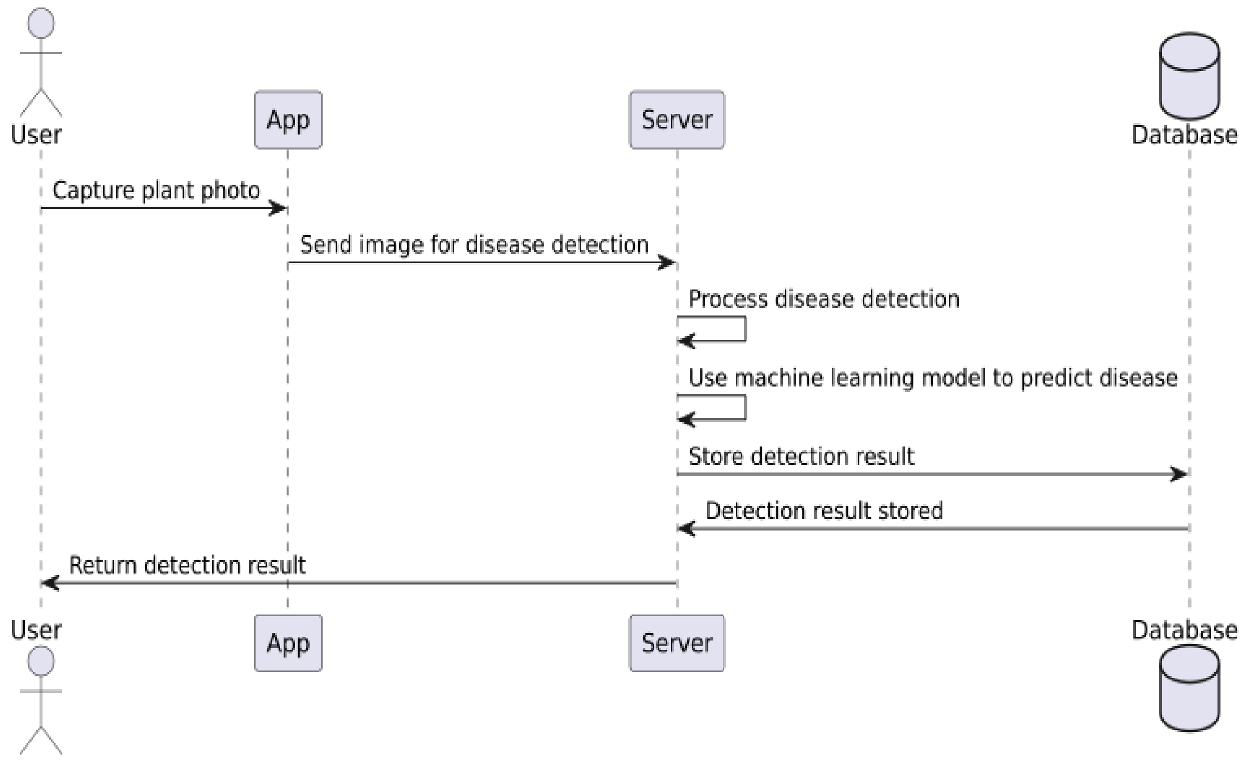


Figure 3-24 Detection of the plant disease using the ML Model Sequence Diagram

3.2.6 ER Diagram

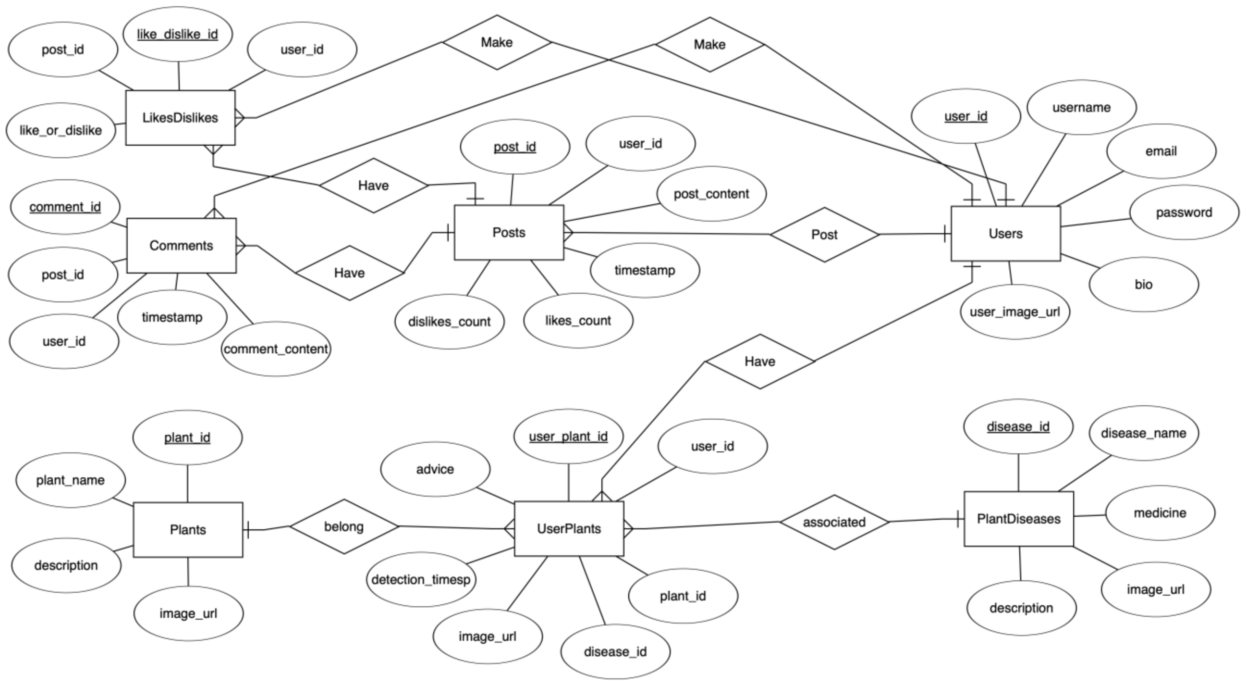


Figure 3-25 ER Diagram

3.3 Software and Tools

3.3.1 GitHub

GitHub provides hosting and review for the source code which helps us to collaborate in the development process. Also, we used GitHub for uploading agendas and Meeting Reports for each meeting we had. The GitHub and any Version Control System (VCS) is a core tool for developers to work together remotely and reflect the different changes in one hub. GitHub allows creating an organization to work within the group with the ability to customize and control the team members' roles.

3.3.2 Kaggle

Kaggle is a data science competition platform and online community of data scientists and machine learning practitioners under Google LLC [16]. We used the Kaggle for shared testing to test our models together in one place. Kaggle gives the ability to execute the Python code within the important libraries for building, training, and testing the models. It is a great tool to provide an environment within the team. Kaggle provides a community that allows users to share their projects and datasets with others which is helpful to users to make them familiar in areas of similar interest. This community helps us to test some models and code from others and compare it with our models.

3.3.3 Draw.io

Draw.io is a web platform that allows us to create diagrams such as flowcharts, wireframes, UML diagrams, organizational charts, and network diagrams. With the rich full features that Draw.io you can manage all these much easier. All of that is web-based which gives the ability to work with teams. Tool rich in features and templates that provide the ability to do the diagram comfortably. Don’t forget that the offline version of Draw.io has all the features of the online version, except saving to the cloud and sharing online.

3.3.4 Figma

Figma is a web application for interface design. We used Figma to design our application UI. Figma provides a community that helps us to find people's works and designs which help us so much in our UI design process, you can copy any design-available in Fig and apply your changes as well. Unlike Adobe XD, Figma is free with the ability to create an infinite number of private designs. Figma allows you to work with the team and reflect on the changes in the design.

3.3.5 Trello

Trello is a project management tool that we used to manage the tickets and tasks. Trello is suitable for small teams like ours, with the ability to provide many useful features such as automation and a simple user interface.

3.3.6 Dropbox

Dropbox is a file hosting service that allows us to synchronize files between us. Also, we use it as storage to store the papers and some related works that could help us in one place. Dropbox provides file version history which allows us to restore any version when want whatever we want.

3.4 Design Specifications, Standards, and Constraints

3.4.1 Functional Requirements

Table 2 System Requirement Table

Req#	Requirement	Comments	Priority	Date	Reviewed / Approved
R_0_1	User registration and authentication.	Users can register with a unique username and email.	1	23/12/2023	Team
R_0_2	Option to log in via Facebook or Gmail.	-	2	23/12/2023	Team
R_0_3	Users can edit their profile information.	- Validation of user inputs.	1	23/12/2023	Team

		- let users store and retrieve information securely.			
R_0_4	Community Page.	To let users communicate with each other’s and exchange information for the plants.	1	23/12/2023	Team
R_0_5	Users can create posts.	let users create posts on the community and make comments as likes/dislikes.	1	23/12/2023	Team
R_0_6	List of plants with information.	Fetch the information via API to get up-to-date information.	1	23/12/2023	Team
R_0_7	Plant detection with machine learning model.	- Let users take photos or choose a photo from a library of plants for disease detection. - Utilize a machine learning model to detect diseases. - Provide a simple-to-use interface for taking or uploading pictures of plants.	1	23/12/2023	Team
R_0_8	Weather Integration and give advice based on the state of the weather.	- Fetch and display real-time weather information based on the location of the user. - Give general advice for plants based on the state of the weather.	1	23/12/2023	Team

R_0_9	Fertilizer calculator.	- Provide a simple-to-use interface for the Fertilizer calculator.	2	23/12/2023	Team

3.4.2 Non-Functional Requirements

3.4.2.1 User Interface Requirements

1. Different screen resolutions and appearances are based on devices.
2. Tap the bar controller for the App for simple moves between views.
3. Responsive simple design.

3.4.2.2 Usability

➢ Accessibility

❖ The app should be easy to always access. This app should be easy to access only with your name and email or via Facebook/Gmail.

➢ Responsiveness

❖ The app shall be responsive both in data transactions, especially because of the reliance on the servers.

➢ Flexibility

❖ The app shall be easy to update to accommodate new requirements.

❖ The app shall be designed in such a way that allows us to make changes without starting from the beginning.

➢ Efficiency

❖ The performance of the application will be influenced by how well the server and REST API work.

❖ As the software is planned to be fast, there should be an internet connection of at least 20 dedicated Megabytes of internet.

3.4.2.3 Performance

➢ Capacity

- Several users at Once: During periods of high demand, the server should be able to manage several users at once with efficiency. Strive for scalability to handle expansion.
- Concurrent API queries: To ensure responsiveness and minimal latency, design the REST API to support a sizable number of concurrent queries.
- Database Scalability: To handle the growing amount of user and plant data, the database should scale horizontally. Use partitioning or sharing techniques as necessary.

➢ Availability

- The app will be live 24/7.
- It has a very low probability of downtime.
- Monitoring and Alerting: Keep tabs on API performance, server health, and other important data by utilizing monitoring tools. Configure automated notifications to receive instant alerts, when possible, problems arise.

3.4.2.4 Maintainability

- The application is simpler to update and maintain when its components are separated.
- Principles of RESTful design encourage a modular and easily maintainable codebase.

3.4.2.5 Security

➢ Specify the factors that will protect the system from malicious or accidental access, modification, disclosure, destruction, or misuse. For example:

  - Encryption.
  - Activity logging.
  - The application should also include a list of modules and components that will be required to be accessed from the application, as known as permissions.

3.4.2.6 Data Management

Careful procedures are needed at every stage of the data lifecycle to ensure proper data handling for the Plantie app. This entails the limited and safe gathering of user data, the use of strong encryption techniques for data in transit and storage, and the implementation of an organized, safe database design with suitable access controls. User privacy and data processing efficiency are improved by asynchronous processing and adherence to API security requirements.

3.4.2.7 Standards Compliance

By utilizing strong system encryption for increased safety and security, the Plantie app makes sure that legal requirements are met.

3.4.2.8 Portability

- To improve accessibility and user reach, the Plantie app must be portable to adapt and work flawlessly across a range of platforms and devices so, we use Flutter cross-platform.
- Real-time updates.

3.4.2.9 Domain Requirements

Everything about the domain that could be required for the project will be covered in this section. It is possible to consider the domain requirements to be a component of either non-functional or functional requirements at times.

3.5 Programming languages and frameworks

3.5.1 Flutter

Flutter is a cross-platform framework that allows developers to use a single codebase for both Android and iOS app development, saving time and resources. It offers a wide range of customization widgets that can be styled to match the design of the app. Flutter has an active and vibrant community of developers who actively contribute to the framework's development and share their knowledge. It is widely regarded as a suitable option for creating a Minimum Viable Product (MVP) as it enables developers to quickly build and deploy an app without spending excessive amounts of time and resources. Community feedback can also be utilized to improve the system [17].

3.5.2 Python

Python is a popular high-level, interpreted, and general-purpose programming language widely used in the field of machine learning and artificial intelligence. It comes equipped with various libraries and frameworks like TensorFlow, PyTorch, scikit-learn, Keras, etc. These pre-built functions and tools can be used to develop, train, and deploy machine learning models, making it easier for developers to focus on the modeling part without worrying about implementation details.

3.5.3 Firebase

Firebase is a collection of tools and services that developers can use to create mobile and web applications [18]. It has several features such as real-time data synchronization, user authentication, and machine learning services. Firebase is renowned for its user-friendliness and speed, making it the ideal choice for developing real-time collaborative applications. It is a Google-owned product that provides developers with a complete set of tools to create robust and scalable mobile apps. One of its primary features is authentication, which simplifies the process of user registration and login. This significantly speeds up the authentication process for

3.6 Design Alternatives

3.6.1 Offline Detection Application

In this alternative, the model will be included in the application. The detection process will be within the mobile phone resources, with no need for Wi-Fi to make predictions for the infected plant leaf image. The only thing that needs the use of the Wi-fi in this application is the other features like the map of the closest shop and the access to the community. Other than that, the process of detection and finding the treatment will be within the mobile application (No need to connect with the backend).

Advantages:

- No connection to prediction: this process provides a great advantage to users who do not have a connection at any time or who have a bad connection to the internet.
- Portability: when the process of prediction is a standalone application that means there's no limitation on the area of the process.

Disadvantages:

- lack of resources for the mobile application
- Extendibility: any development and changes to the model or the treatment tables lead to the need to download the new version of the model from the store

3.6.2 Online Detection Alternative

In this alternative, the whole process is within the need of Wi-Fi. The system will be connected to the backend and the backend will do all entire services which include plant detection, finding the treatment, accessibility to the community, and providing the description of the plant.

Advantages:

- The power of server resources: the prediction within the connection with the server leads to more accuracy and more efficiently
- Scalability: no need to be up to date to use the new versions of the model

Disentangles:

- Wi-Fi limitation: cannot use any feature or service without the need for Wi-Fi.

3.6.3 Hybrid Approach Alternative

In this alternative, we combine the 2 previous alternatives. By adding the ability to download the model and use it offline. This approach provides the capability to let the user choose whatever the prediction of the model is online or offline. So, the application will be online by default with the ability to download the model and make predictions offline.

3.7 System Analysis and optimization

We will discuss this section in senior project II, after implementation.

3.8 Simulation and/or Experimental Test

This section will be discussed in Senior Project II.

4 CHAPTER 4: RESULT AND DISCUSSIONS

4.1 Result

The Visual Result refers to the UI and the prototype of the application, which show the clear initial specification. The UI design is an efficient way to describe what the application looks like and how the application must be done. The following shows the Main Pages/Views of the “Plantie”.

4.1.1 Authentication Views

The authentication system is important to be part of the Plantie community. The authentication system gives you the ability to register either manually by using email, password, and username or through social media accounts like Gmail and Facebook. Figure 4-1 shows the login and register views with the landing view:

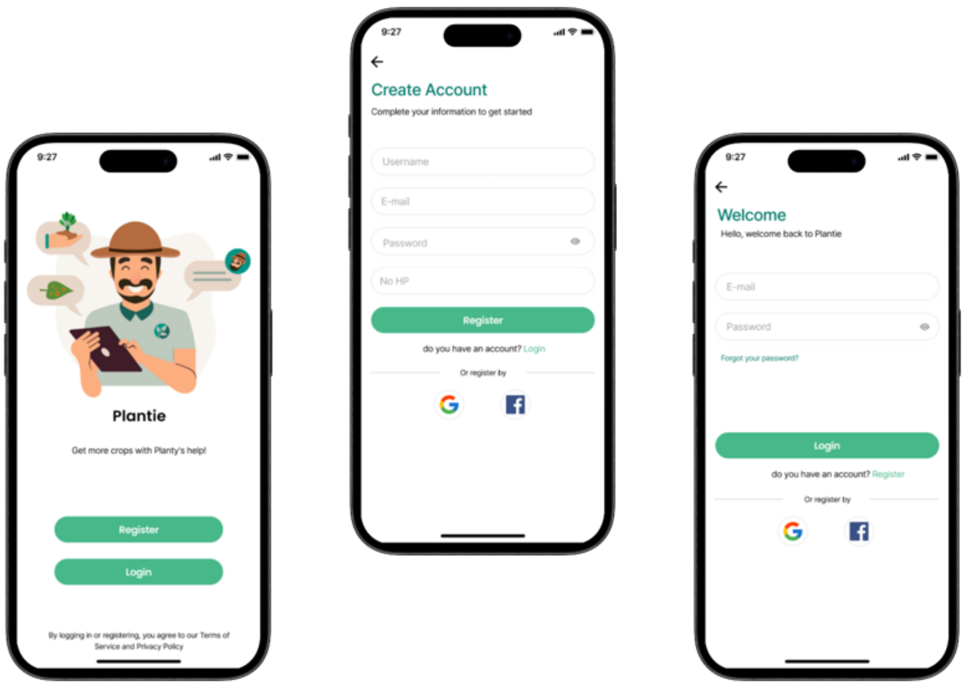

9:27
Plantie
Get more crops with Planty's help!
Register
Login
By logging in or registering, you agree to our Terms of Service and Privacy Policy
9:27
Create Account
Complete your information to get started
Username
E-mail
Password
No HP
Register
do you have an account? Login
Or register by
9:27
Welcome
Hello, welcome back to Plantie
E-mail
Password
Forgot your password?
Login
do you have an account? Register
Or register by

Figure 4-1 Authentication Views

4.1.2 Plants/Home View

The main view of Plantie includes the weather system section which provides the weather conditions, and the temperature based on the user location, and the lower part of the section gives suggestions. The second section of the view includes the horizontally scrollable list which contains the plants with its description and some details like the amount of water that plants need and when the plant grows. Within this section, there’s a button that navigates you to the fertilizer calculator as shown at the left of the figure 4-2.

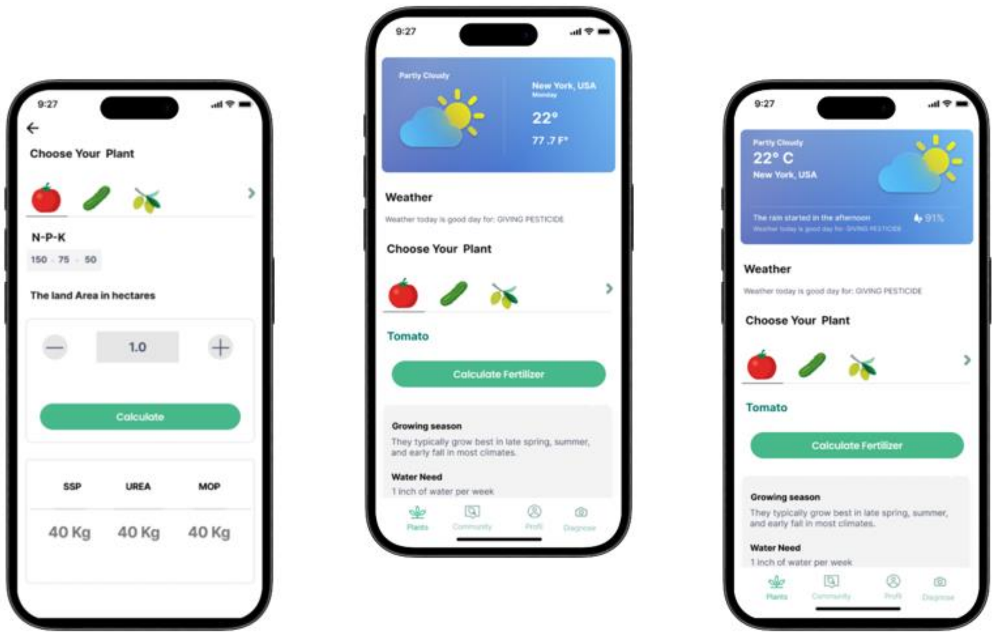
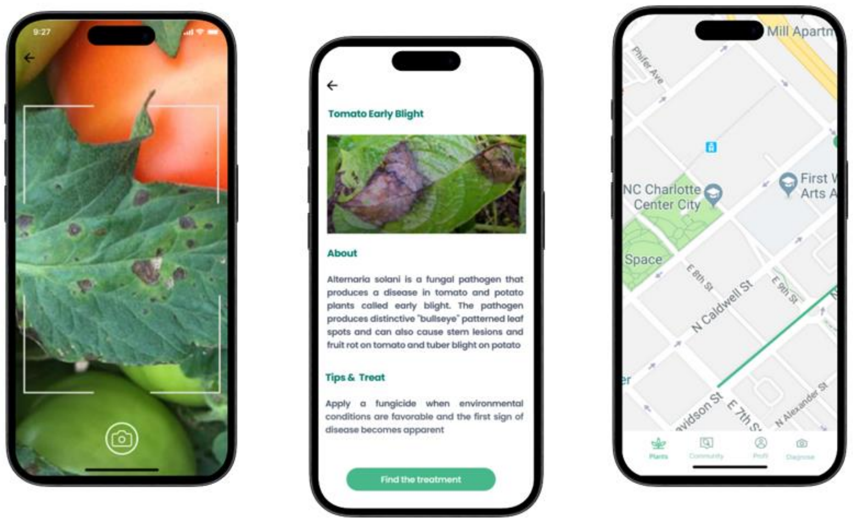


Figure 4-2 Plants/Home View

4.1.3 Disease Detection Views

The disease detection view consists of 3 processes, plant disease prediction, treatment/advice, and the process of finding medicine if necessary. Once when you press on the camera icon in the navigation bottom bar, it will navigate you to the left screen in the figure below to allow you to take a picture or load a picture. After that, the picture will be sent to the server to be processed and the server will retrieve the prediction to show the result as shown at the screen at the middle. This screen includes the disease, its description, the tip or how to threat, and a button that can navigate you to a map to locate the nearest plant shop.


Tomato Early Blight

About

Alternaria solani is a fungal pathogen that produces a disease in tomato and potato plants called early blight. The pathogen produces distinctive "bullseye" patterned leaf spots and can also cause stem lesions and fruit rot on tomato and tuber blight on potato

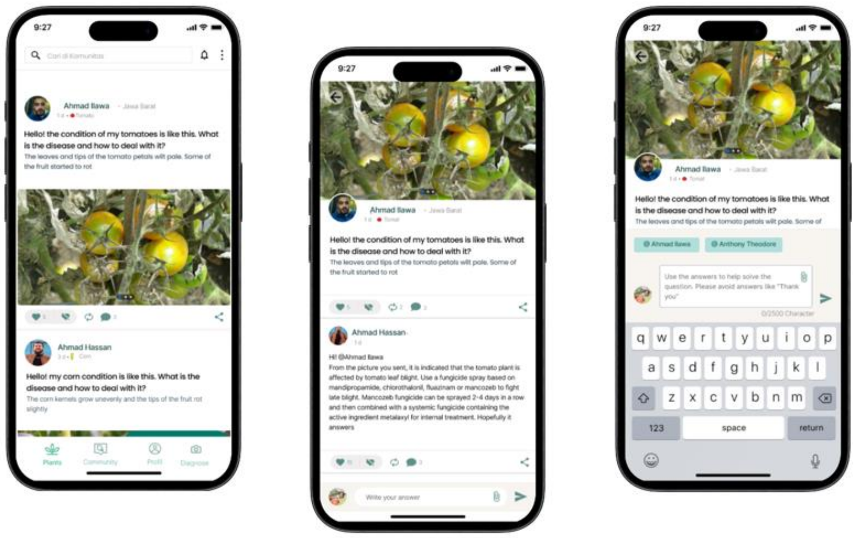
Tips & Treat

Apply a fungicide when environmental conditions are favorable and the first sign of disease becomes apparent

Figure 4-3 Disease Detection View

4.1.4 Community Views

As shown in the figure below, the 3 views show the community view and how the process of posting, and commenting in the post. Figure 4-4 shows the some of Community views:


Ahmad Ilawa

Hello! the condition of my tomatoes is like this. What is the disease and how to deal with it?

The leaves and tips of the tomato petals wilt pale. Some of the fruit started to rot

Ahmad Hassan

Hello! my corn condition is like this. What is the disease and how to deal with it?

The corn kernels grow unevenly and the tips of the fruit rot slightly

Ahmad Hassan

Hi! @Ahmad Ilawa

From the picture you sent, it is indicated that the tomato plant is affected by tomato leaf blight. Use a fungicide spray based on mandipropamide, chlorothalonil, fluazinam or mancozeb to fight late blight. Mancozeb fungicide can be sprayed 2-4 days in a row and then combined with a systemic fungicide containing the active ingredient metalaxyl for internal treatment. Hopefully it answers

Use the answers to help solve the question. Please avoid answers like "Thank you"

Figure 4-4 Community View

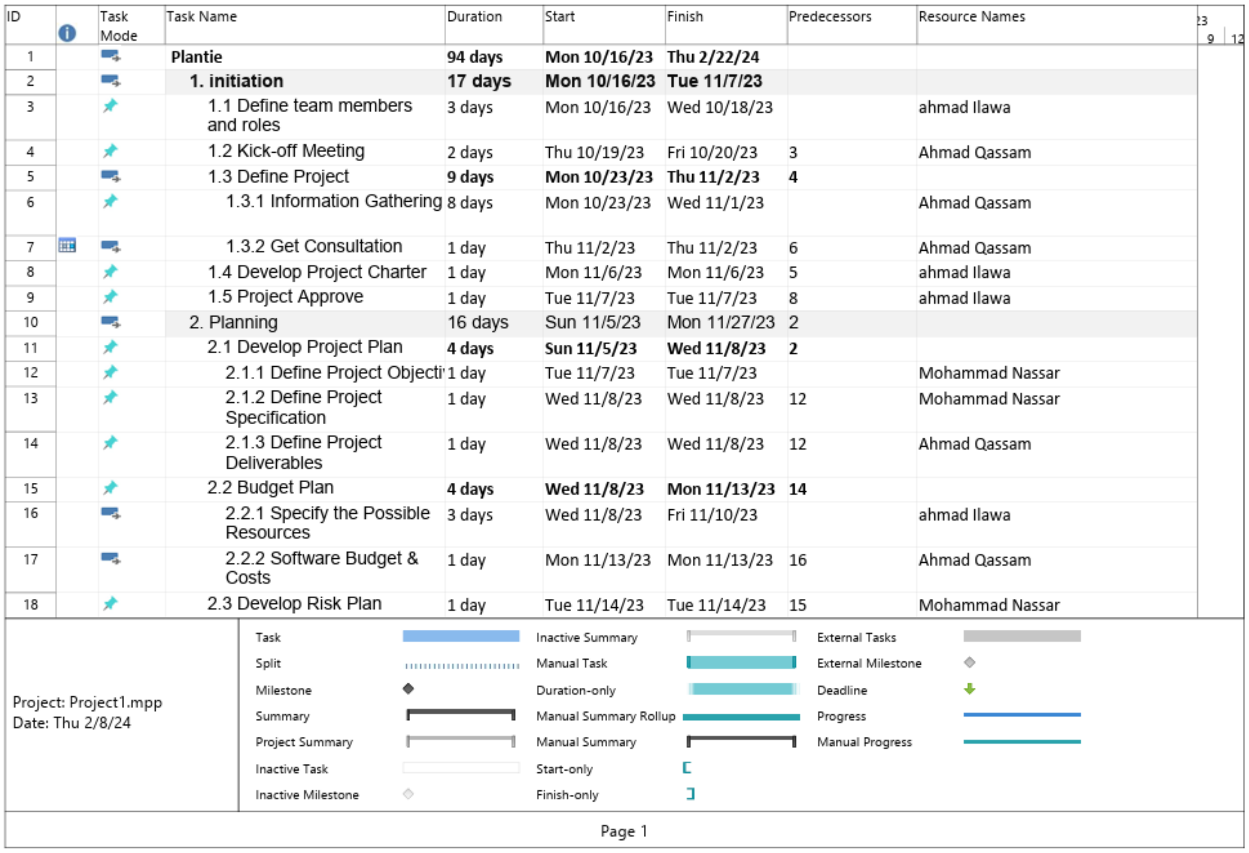
4.2 Discussions

We will discuss our results after implementing the prototype.

5 CHAPTER 5: PROJECT MANAGEMENT

5.1 Tasks, Schedule, and Milestones

The figures below show the project schedule, how the tasks are being done, and how we divided our time and made full use of our time, on another hand, the right side includes a Gantt chart that describes the process we have done.



ID	ℹ	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		▬	**Plantie**	**94 days**	**Mon 10/16/23**	**Thu 2/22/24**		
2		▬	**1. initiation**	**17 days**	**Mon 10/16/23**	**Tue 11/7/23**		
3		📌	1.1 Define team members and roles	3 days	Mon 10/16/23	Wed 10/18/23		ahmad Ilawa
4		📌	1.2 Kick-off Meeting	2 days	Thu 10/19/23	Fri 10/20/23	3	Ahmad Qassam
5		▬	1.3 Define Project	**9 days**	**Mon 10/23/23**	**Thu 11/2/23**	**4**	
6		📌	1.3.1 Information Gathering	8 days	Mon 10/23/23	Wed 11/1/23		Ahmad Qassam
7	▦	▬	1.3.2 Get Consultation	1 day	Thu 11/2/23	Thu 11/2/23	6	Ahmad Qassam
8		📌	1.4 Develop Project Charter	1 day	Mon 11/6/23	Mon 11/6/23	5	ahmad Ilawa
9		📌	1.5 Project Approve	1 day	Tue 11/7/23	Tue 11/7/23	8	ahmad Ilawa
10		▬	2. Planning	16 days	Sun 11/5/23	Mon 11/27/23	2	
11		📌	2.1 Develop Project Plan	**4 days**	**Sun 11/5/23**	**Wed 11/8/23**	**2**	
12		📌	2.1.1 Define Project Objecti	1 day	Tue 11/7/23	Tue 11/7/23		Mohammad Nassar
13		📌	2.1.2 Define Project Specification	1 day	Wed 11/8/23	Wed 11/8/23	12	Mohammad Nassar
14		📌	2.1.3 Define Project Deliverables	1 day	Wed 11/8/23	Wed 11/8/23	12	Ahmad Qassam
15		📌	2.2 Budget Plan	**4 days**	**Wed 11/8/23**	**Mon 11/13/23**	**14**	
16		▬	2.2.1 Specify the Possible Resources	3 days	Wed 11/8/23	Fri 11/10/23		ahmad Ilawa
17		▬	2.2.2 Software Budget & Costs	1 day	Mon 11/13/23	Mon 11/13/23	16	Ahmad Qassam
18		📌	2.3 Develop Risk Plan	1 day	Tue 11/14/23	Tue 11/14/23	15	Mohammad Nassar

Project: Project1.mpp
Date: Thu 2/8/24

Task	▬	Inactive Summary	▭	External Tasks	▬
Split	┈	Manual Task	▬	External Milestone	◇
Milestone	◆	Duration-only	▬	Deadline	⬇
Summary	▬	Manual Summary Rollup	▬	Progress	▬
Project Summary	▭	Manual Summary	▬	Manual Progress	▬
Inactive Task	▭	Start-only	[		
Inactive Milestone	◇	Finish-only	]		

Page 1

Figure 5-1 Project Schedule with Gantt-Chart 1

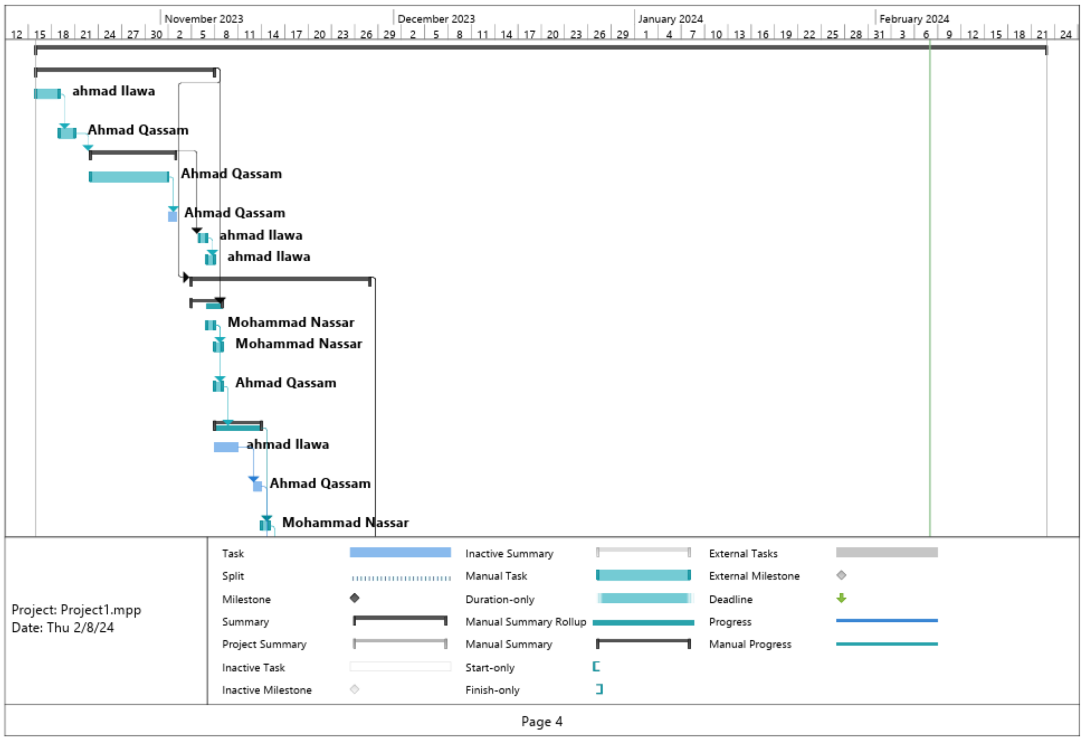
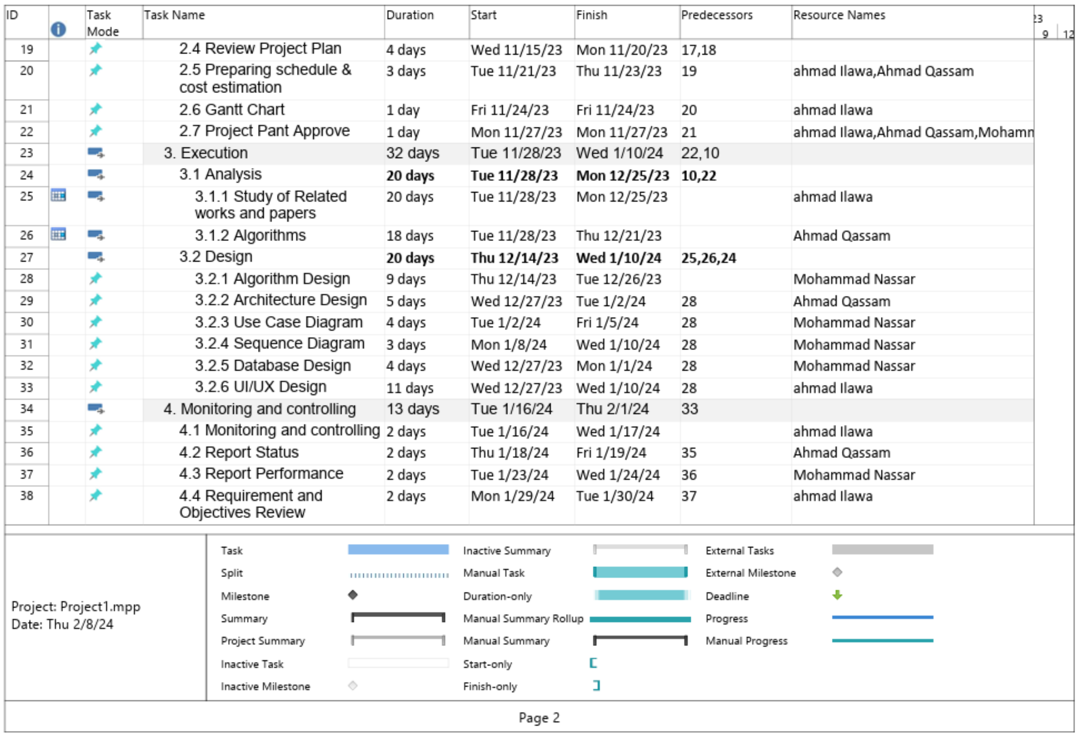


Figure 5-2 Project Schedule with Gantt-Chart 2



ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
19			2.4 Review Project Plan	4 days	Wed 11/15/23	Mon 11/20/23	17,18	
20			2.5 Preparing schedule & cost estimation	3 days	Tue 11/21/23	Thu 11/23/23	19	ahmad Ilawa,Ahmad Qassam
21			2.6 Gantt Chart	1 day	Fri 11/24/23	Fri 11/24/23	20	ahmad Ilawa
22			2.7 Project Pant Approve	1 day	Mon 11/27/23	Mon 11/27/23	21	ahmad Ilawa,Ahmad Qassam,Mohamn
23			3. Execution	32 days	Tue 11/28/23	Wed 1/10/24	22,10	
24			3.1 Analysis	**20 days**	**Tue 11/28/23**	**Mon 12/25/23**	**10,22**	
25			3.1.1 Study of Related works and papers	20 days	Tue 11/28/23	Mon 12/25/23		ahmad Ilawa
26			3.1.2 Algorithms	18 days	Tue 11/28/23	Thu 12/21/23		Ahmad Qassam
27			3.2 Design	**20 days**	**Thu 12/14/23**	**Wed 1/10/24**	**25,26,24**	
28			3.2.1 Algorithm Design	9 days	Thu 12/14/23	Tue 12/26/23		Mohammad Nassar
29			3.2.2 Architecture Design	5 days	Wed 12/27/23	Tue 1/2/24	28	Ahmad Qassam
30			3.2.3 Use Case Diagram	4 days	Tue 1/2/24	Fri 1/5/24	28	Mohammad Nassar
31			3.2.4 Sequence Diagram	3 days	Mon 1/8/24	Wed 1/10/24	28	Mohammad Nassar
32			3.2.5 Database Design	4 days	Wed 12/27/23	Mon 1/1/24	28	Mohammad Nassar
33			3.2.6 UI/UX Design	11 days	Wed 12/27/23	Wed 1/10/24	28	ahmad Ilawa
34			4. Monitoring and controlling	13 days	Tue 1/16/24	Thu 2/1/24	33	
35			4.1 Monitoring and controlling	2 days	Tue 1/16/24	Wed 1/17/24		ahmad Ilawa
36			4.2 Report Status	2 days	Thu 1/18/24	Fri 1/19/24	35	Ahmad Qassam
37			4.3 Report Performance	2 days	Tue 1/23/24	Wed 1/24/24	36	Mohammad Nassar
38			4.4 Requirement and Objectives Review	2 days	Mon 1/29/24	Tue 1/30/24	37	ahmad Ilawa

Project: Project1.mpp
Date: Thu 2/8/24

Task		Inactive Summary		External Tasks	
Split		Manual Task		External Milestone	◆
Milestone	◆	Duration-only		Deadline	⬇
Summary		Manual Summary Rollup		Progress	
Project Summary		Manual Summary		Manual Progress	
Inactive Task		Start-only	[		
Inactive Milestone	◇	Finish-only	]		

Page 2

Figure 5-3 Project Schedule with Gantt-Chart 3

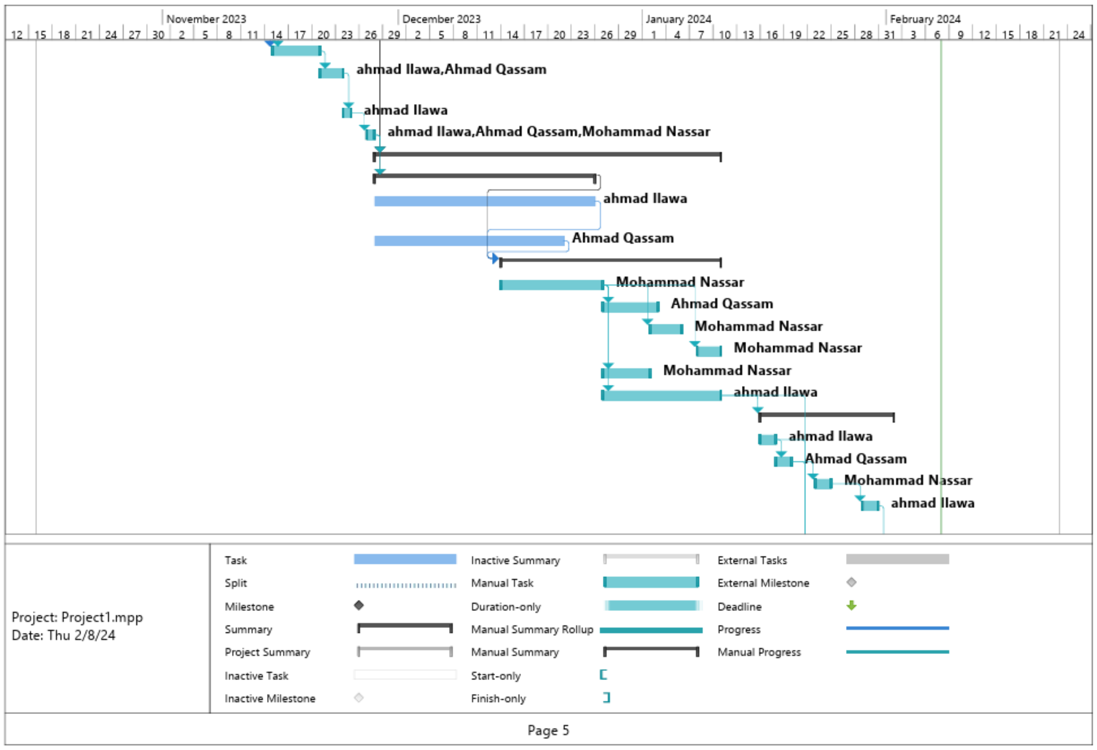
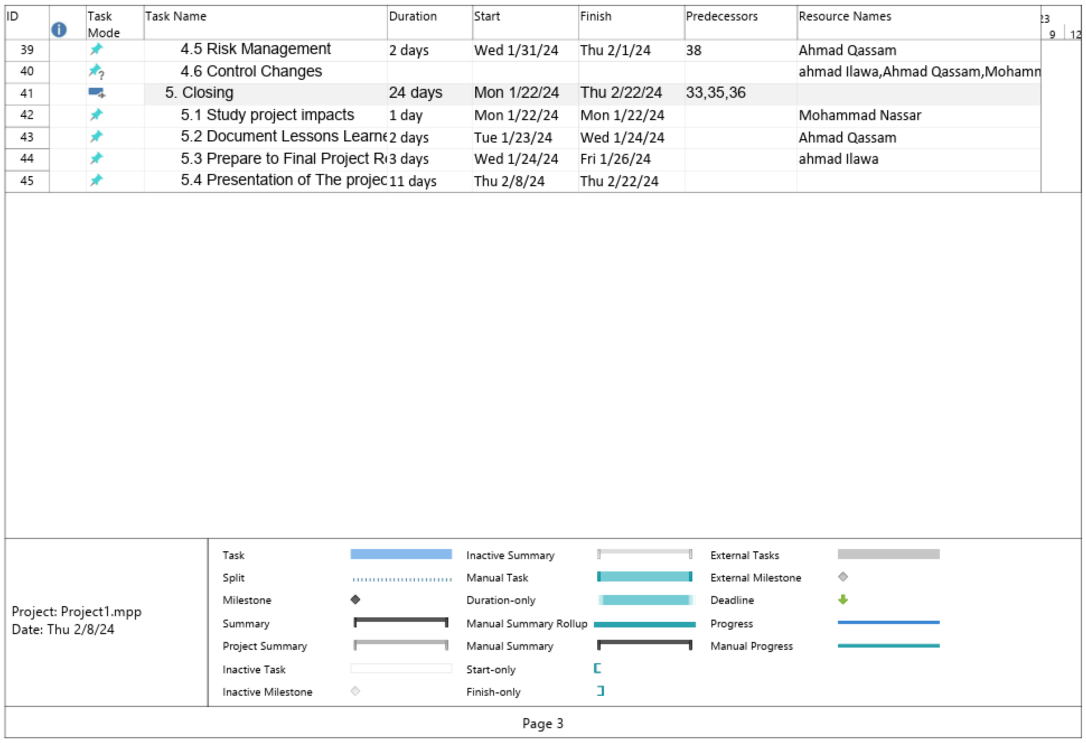


Figure 5-4 Project Schedule with Gantt-Chart 4



ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
39			4.5 Risk Management	2 days	Wed 1/31/24	Thu 2/1/24	38	Ahmad Qassam
40			4.6 Control Changes					ahmad Ilawa,Ahmad Qassam,Mohamn
41			5. Closing	24 days	Mon 1/22/24	Thu 2/22/24	33,35,36	
42			5.1 Study project impacts	1 day	Mon 1/22/24	Mon 1/22/24		Mohammad Nassar
43			5.2 Document Lessons Learne	2 days	Tue 1/23/24	Wed 1/24/24		Ahmad Qassam
44			5.3 Prepare to Final Project R	3 days	Wed 1/24/24	Fri 1/26/24		ahmad Ilawa
45			5.4 Presentation of The projec	11 days	Thu 2/8/24	Thu 2/22/24		

Figure 5-5 Project Schedule with Gantt-Chart 5

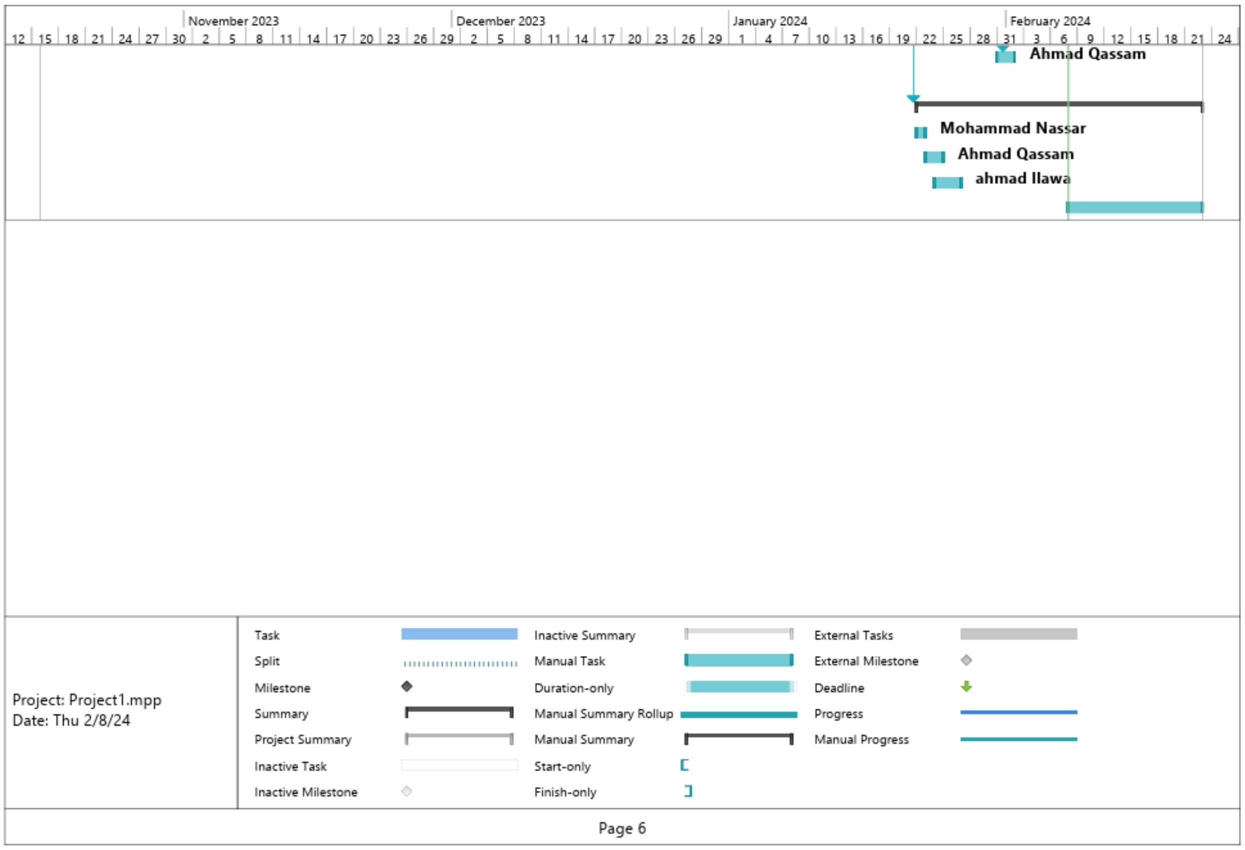


Figure 5-6 Project Schedule with Gantt-Chart 6

5.2 Resources and Cost Management

The table below shows the estimated cost of the project as a whole. All of these numbers are estimates and personal judgments and are not 100% accurate.

Table 3 Resources and Cost Management

	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	WBS Level 1 Total	% of Total
WBS Items					
1. Project Management				$28,700	32.3%
1.1 Project manager	100 hours	$150	$15,000		
1.2 Project team members	235 hours	$40	$9,400		

Contractors (10% of software development and testing)			$4,300		
2. Hardware				$6,900	0.7%
2.1 Handheld devices	30 devices	$130	$3,900		
2.2 Servers	2 servers	$1500	$3,000		
3. Software				$40,000	45%
3.1 Licensed Software		$1300	$1300		
3.2 Software development*			$38,000		
4. Testing (10% of total hardware and software costs)			$4,690	$4,690	0.5%
5. Training and Support				$15,400	17.3%
5.1 Trainee cost	100 Hours	$60	$6000		
5.2 Travel cost	2	$70	$140		
5.3 Project team members	463	$20	$9,260		
Total project cost estimate				$88,790	

5.3 Lessons Learned

During the project, we acquired valuable skills such as time management, task delegation among team members, and monitoring the project plan. We also came to understand the importance of clear requirements to prevent unnecessary changes and delays in project completion. Furthermore, we gained knowledge on new technologies in the field of Deep Learning, specifically CNN, and their workings.

6 CHAPTER 6: IMPACT OF ENGINEERING

The "Plantie" smartphone app, which is intended to help farmers detect plant diseases, has the potential to have a big impact on a lot of different areas of agriculture and society. Using cloud-based model storage and a deep learning algorithm based on CNN, the app seeks to transform plant disease management and farmer-to-farmer communication.

6.1 Economical, Societal and Global

Economic Impact: Farmers can benefit financially from the app in a big way by increasing agricultural productivity, reducing crop loss, and saving money by using targeted disease management. The program provides farmers with trustworthy information on disease diagnosis and management, enabling them to make well-informed decisions that can lead to increased productivity and profitability. The app's affordability and accessibility also play a part in its economic impact. It removes financial obstacles to entry by being a free and easy-to-use tool, guaranteeing that farmers can receive vital disease management knowledge and improve their farming methods regardless of their financial situation.

Social Impact: By giving farmers, the tools to make knowledgeable decisions about their crops, the "Plantie" app can empower them and possibly enhance their standard of living and food security. Farmers may communicate, exchange expertise, and aid one another through the app's community feature, which fosters a sense of belonging and teamwork.

Global Impact: The “Plantie” app demonstrates significant global impact by fostering collaboration and knowledge exchange among farmers worldwide. Through the app's platform for exchanging knowledge and creative approaches, it adds to an international network of agricultural resilience. Its focus on environmentally friendly agricultural methods also helps to conserve the environment and reduces the effects of issues such as plant diseases and climate change. The app becomes an engine for positive change on a worldwide scale, supporting food security and resilience in the face of changing agricultural landscapes, through technology transfer and farmer empowerment.

6.2 Environmental

Environmental Impact: By decreasing the needless use of pesticides through early illness diagnosis, the "Plantie" app can help maintain a sustainable ecosystem. Early disease detection allows farmers to control diseases with customized treatments, minimizing the need for environmentally hazardous broad-spectrum pesticides.

6.3 Other Issues

Assurance of Health and Food Safety: The "Plantie" app is essential for guaranteeing the safety and health of food that is produced. The software helps produce healthier crops by enabling farmers to diagnose and control diseases better, which lowers the possibility of hazardous toxins entering the food supply chain. This focus on food safety is online with customer expectations and international norms, which promotes trust in the agricultural goods that are grown with the app's help.

Empowering Smallholder Farmers: Smallholder farmers, who frequently struggle to obtain access to contemporary agricultural technologies, are greatly assisted by the app. The "Plantie" app supports small-scale farmers by overcoming the technology gap. This allows them to compete in the larger agricultural scene and may even improve their socioeconomic circumstances.

User Engagement and Community Building: The community aspect of the "Plantie" app allows farmers to actively participate in debates, knowledge exchanges, and mutual support, hence fostering user engagement. The software can improve social interaction among farmers, encourage best practices, and empower individuals through shared expertise by fostering a collaborative farming community.

Empowerment through Education: The app serves as a central location for education, offering farmers chances for ongoing education beyond the diagnosis of illnesses. Using educational materials, guides, and updates on contemporary farming techniques, the application transforms into a platform for exchanging knowledge, encouraging a mindset of ongoing enhancement and creativity among farmers.

Accessibility and Inclusivity: The "Plantie" app was created with inclusivity in mind, considering the varied demands of farmers, particularly those who live in isolated locations with poor internet or smartphone access. The goal of the app is to target neglected farming areas and develop offline functionality strategies so that all users, regardless of technological limitations, may continue to use the vital features.

Long-Term Effect and Sustainable Agriculture: The "Plantie" app hopes to have a long-term influence on farming methods and the overall agricultural environment, going beyond quick disease identification. Through the promotion of environmentally conscious farming practices, accurate disease control information, and community building, the app hopes to further agricultural technological advancements and the uptake of sustainable farming approaches.

In conclusion, by empowering farmers, encouraging knowledge exchange, and improving the sustainability of farming operations, the "Plantie" app has the potential to have a significant impact on agriculture and society. The app aims to transform farmer-to-farmer interactions, education, and crop cultivation through its novel approach to disease detection, community development, and inclusivity. This will ultimately contribute to a more robust and interconnected agricultural ecosystem.

7 CHAPTER 7: CONCLUSION AND RECOMMENDATION

7.1 Summary of Achievements of the Project Objectives

Even with the modern level technology, we have today, the traditional method of diagnosing plants is still widely utilized. Diagnosing plants is a crucial aspect of keeping plants healthy, and having a plant system would simplify the diagnosis procedure. Additionally, this application would recommend appropriate treatment for any disease and provide directions to the nearest pharmacy, saving time. Therefore, our project is extremely important, and we aim to propose a prototype to achieve these goals.

7.2 New Skills and Experiences Learn

The ability to split the work between us and efficiently manage our time was the most important skill we learned. We acquired new skills in designing algorithms using the Draw.io application to understand how system components communicate with each other and identify any conflicts or delays. Additionally, learned to design application master pages using Figma, which helped us understand how main pages work. also acquired knowledge about CNN algorithms and image processing, as well as principles of coordination, report writing, and finding similar systems to our own. In senior project 2, will build on these skills and develop new skills like building ML models, testing, and implementation.

7.3 Recommendations for Future Work

In future works, can integrate our project with agricultural environments using hardware components such as Raspberry Pi for real-time diagnosis. That provides a faster way to diagnose plants. Additionally, can integrate Augmented Reality (AR) technology that increases interaction and engagement, so providing a great user experience for users. Using AR in Plantie provides an easy and rich application interface to the user that increases the perceived value of the product. Finally, can also integrate a guide system that provides information about growing the plants and the suitable time to grow plants.

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