SMART ASSISTANCE FOR THE FLORICULTURE INDUSTRY

2023-133

Project Proposal Report

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DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	**Student ID**	**Signature**
Basnayake N.S.N.	IT19994406	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the Supervisor   Date
(Dr. Sanvitha Kasthuriarachchi)

…………………………….   ..………………………

Abstract

This research proposes an innovative system for the floriculture industry in Sri Lanka that can accurately identify nutrient deficiency and mite-affected plants. The system uses imaging and deep learning algorithms to analyze plant images and calculate the affected area of the plant to meet export-level standards. The proposed system can help growers to identify affected plants in the early stages and take necessary action to improve plant health, resulting in increased plant yield and reduced financial losses. The floriculture industry in Sri Lanka faces significant challenges due to the use of inefficient technology and pest attacks and nutrient deficiencies that significantly reduce plant yield. Therefore, the development of an efficient and effective system is essential to identify affected plants in the early stages and improve plant health by using pest control methods and fertilizers. The proposed system aims to address these challenges by utilizing various imaging and analyzing techniques, including deep learning algorithms, to accurately identify nutrient deficiency and mite attack symptoms. To develop this system, the research will review and analyze several studies on floriculture management, machine learning, and deep learning. The proposed system has the potential to revolutionize the floriculture industry by reducing financial losses due to rejected shipments and improving the quality and yield of plants. Overall, this research proposes a valuable contribution to the development of the floriculture industry in Sri Lanka. The proposed system's significant potential lies in its ability to accurately identify nutrient deficiency and mite-affected plants in the early stages and calculate the affected area of the plant to meet export-level standards. The system can help growers to take necessary action to improve plant health, increase plant yield, and reduce financial losses. Therefore, the proposed system can contribute to the growth and development of the floriculture industry in Sri Lanka.

Keywords: floriculture, Sri Lanka, recommendation system, export, nutrient deficiencies, mite attack, deep learning, images, fertilizers, local market, mother plant, mobile application, leaf, affections

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LIST OF ABBREVIATIONS

ANN	Artificial Neural Network
BGR	Blue Green Red
CNN	Convolutional Neural Network
GLCM	Gray-Level Co-Occurrence Matrix
HSV	Herpes Simplex Virus
OpenCV	Open Source Computer Vision Library
RGB	Red Green Blue
SVM	Support Vector Machine
VGG	Visual Geometry Group

LIST OF APPENDICES

1 INTRODUCTION

Sri Lanka is one of the world's leading producers of floriculture, with growers establishing both small and large-scale businesses to meet the growing demand for high-quality plants and flowers. [1] However, many of these growers face various challenges, and there is a significant need for smart assistance systems due to the use of inefficient technology.

Plant cultivation often faces challenges such as pest attacks and nutrient deficiencies that can significantly reduce plant yield. Therefore, it is crucial to identify affected plants in the early stages to take necessary action and improve plant health by using pest control methods and fertilizers. Additionally, there are export-level standards and restrictions that require the assessment of the affected area of plants in percentage terms. Therefore, accurately assessing these parameters is essential to avoid financial losses for growers if their shipments fail to meet these standards and get rejected.

To address these challenges, an efficient and effective system is necessary to accurately identify nutrient deficiency plants and mite-affected plants while also calculating the area of the affected plant. The proposed system will utilize various imaging and analyzing techniques to identify affected plants. It will capture plant images and analyze them using deep learning algorithms to accurately identify nutrient deficiency and mite attack symptoms. The system will also calculate the affected area of a plant to check whether it meets export-level standards.

To develop this system, this research will review and analyze several studies on floriculture management, machine learning, and deep learning. Overall, this proposal aims to contribute to the development of an innovative system that can accurately identify nutrient deficiency plants and mite-affected plants while also calculating the area of the affected plant. The proposed system has the potential to revolutionize the floriculture industry by reducing financial losses and improving the quality and yield of plants.

The following sections will present the background and literature review, research problem, research gap, objectives, methodology, system diagrams, and work breakdown.

1.1 Background & Literature Survey

Numerous studies have been conducted on the floriculture industry, with many focusing on the challenges faced by growers in their daily operations. To address these challenges, researchers have explored various solutions, including the use of modern technologies such as knowledge systems, recommendation systems, and demand forecasting. As a result, a smart assistance agent has been developed to aid growers in their work. [2]

The floriculture sector encompasses a wide variety of flowers, making their identification a significant challenge. However, this problem can be addressed through the use of deep learning technologies. These technologies can not only be applied to identify flowers, but also leaves and other parts of plants. [3]

Pest attacks can significantly reduce plant yield, making it crucial to identify these issues early in order to minimize damage and improve plant health. This research study was conducted in Indonesia to identify pests by uploading images of Black Orchid leaves that were attacked by ladybugs, mites, snails, and caterpillars. [4] This study utilized the traditional machine learning approach of Naïve Bayes. By incorporating advanced techniques, such as those used to identify pests in Sri Lanka, these technologies can be further enhanced.

Although plant diseases can sometimes be detected visually, identifying the exact disease and determining the correct fertilizer can be challenging. To address this, numerous research studies have focused on using image recognition techniques to identify plant diseases. [5] One such study utilized convolutional neural networks to detect and classify plant diseases, achieving high accuracy for plant leaves but not for the plant body.

However, manually identifying diseases for a large-scale crop can still be time-consuming. To address this issue, researchers have used OpenCV to analyze aerial images of wheat crops, identifying color changes that indicate disease and providing an exact percentage of the affected area. [6]

For every plant, it is necessary to use nutrient fertilizers; otherwise, nutrient deficiencies can affect plant growth. [7] Additionally, different stages of plant growth require different nutrient fertilizers. For instance, during the flowering stage, plants require more nutrients. [8] That research study was conducted in India focusing on identifying nutrient deficiencies in tomato plants. By uploading an image, nutrient deficiencies were identified using artificial neural networks. Traditional machine learning algorithms such as support vector machines [9] and random forests [10] can also identify nutrient deficiencies in plants.

Calculating the area of an affected plant can be useful for various purposes. In one research study, [11] a convolutional neural network was used to detect the affected area of vegetable crops in Batticaloa. Based on the affected area, the researchers identified the pest count. This technique has significant potential for improving pest management strategies in agriculture.

Overall, several studies have focused on identifying and addressing pest infections and nutrient deficiencies. In this proposed system, all relevant challenges faced by growers due to pests are considered. To build the system, various technologies were employed, some of which have been used before but are used differently in this system. By proposing an innovative system that can improve efficiency and effectiveness in the floriculture industry, this research has significant potential for enhancing crop yield and quality.

1.2 Research Problem

In the floriculture sector, it is common for plants to become infected despite regular fertilizer application. Pest attacks and deficiencies can occur despite our best efforts, and it is crucial to identify and address them promptly. Proper pest control and nutrient management are essential to maintaining healthy plants. To provide the correct fertilizer, it is necessary to accurately identify the plant's ailment. For instance, mistaking a pest attack for a deficiency could pose a significant threat not only to the affected plant but also to the rest of the crop. Pests can quickly spread throughout the growing area, making prompt identification and treatment vital. It is equally essential to identify the correct nutrient deficiency as using the wrong fertilizer can exacerbate the problem. Unfortunately, there is currently no standardized system for distinguishing between pest attacks and deficiencies. Visual inspection alone can be problematic, as shown in a survey of floriculture growers' responses, which are presented in the figure 1-1 and figure 1-2 below. It is equally critical to recommend the appropriate fertilizer once the infection has been identified, ensuring that the plant receives the necessary nutrients to recover fully.

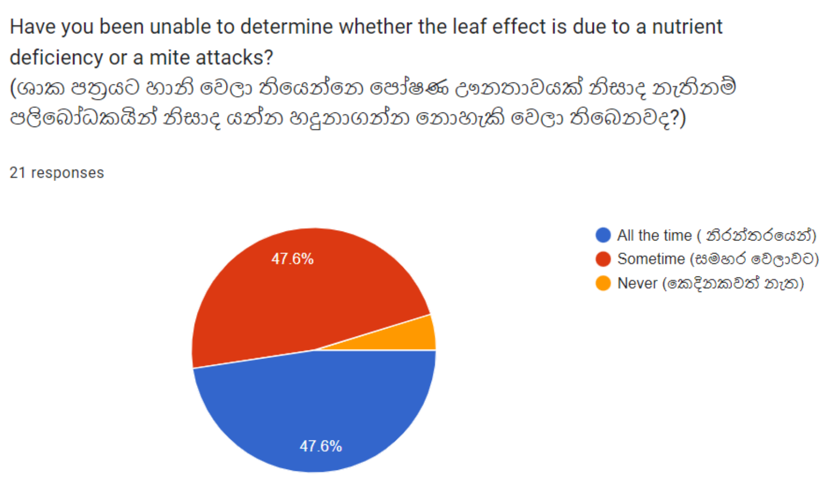

Figure 1-1 Survey to find difficulties for visual inspections

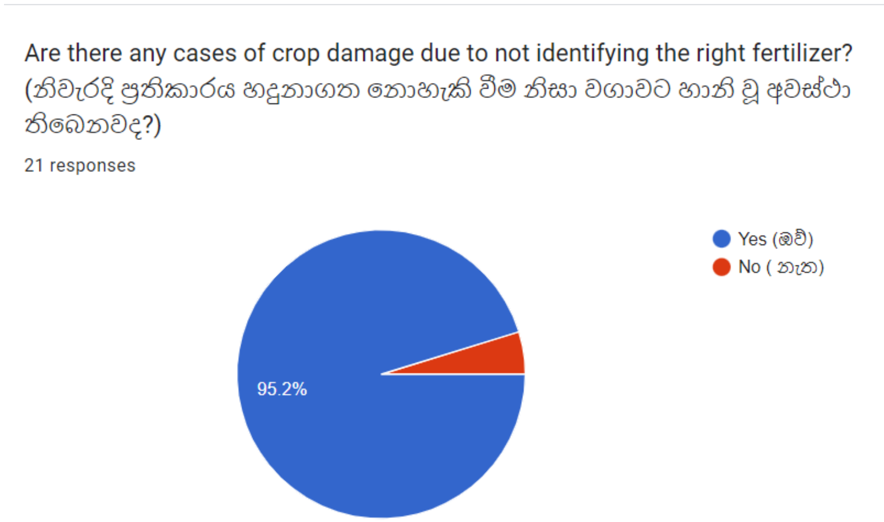

Figure 1-2 Survey to find difficulties for identifying the fertilizer

Exporting plants to other countries comes with numerous restrictions, and growers must comply with all requirements to avoid rejection. One such requirement is providing exact percentages of any plant afflictions, including a report on whether the plant was previously affected, and the spread is now under control. However, restrictions often include specific remarks, such as the maximum percentage of the affliction allowed, and the exact area of the problem. Unfortunately, visually inspecting the plants is not always sufficient to provide accurate measurements, as growers have reported in the figure 1-3 below.

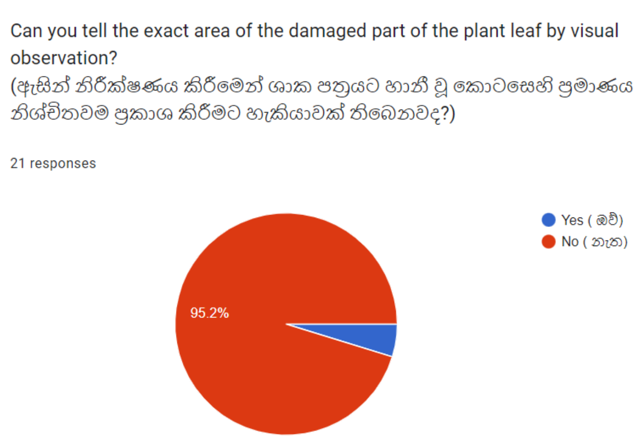

Figure 1-3 Survey to find difficulties for calculating the leaf area

To address these challenges, we propose implementing a system that provides accurate measurements and ensures that plants meet all requirements before shipment. By doing so, growers can avoid the costly rejection of a shipment that fails to meet import restrictions. If the requirements are not met, the grower can consider selling the plant in the local market. However, if even the local market rejects the plant, it can still be used as a mother plant.

So, as mentioned before, visually inspecting plants for afflictions has a high chance of producing inaccurate results, as shown in the survey responses below in figure 1-4.

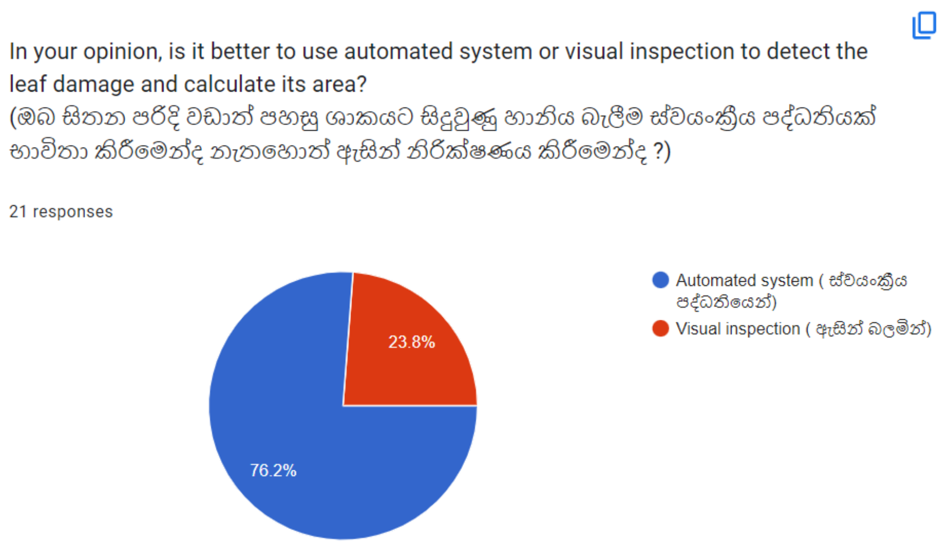

Figure 1-4 Survey to get the opinions of growers

In my proposed system, growers can accurately identify deficiencies and pest attacks and use the appropriate fertilizer. Furthermore, they can precisely identify the affected area and determine whether the plants are suitable for export, local sales, or use as mother plants.

1.3 Research Gap

Based on my research problem, the research gap will be shown as follows.

Research A:

The research [4] is related to identifying pests. It was conducted for the black orchid species in Indonesia. After uploading an image, the type of pest that attacked the leaf will be identified, such as ladybugs, mites, snails, or caterpillars. This was achieved using the Naïve Bayes algorithm for image processing, and the GLCM method was used for leaf texture feature extraction.

Research B:

The research [5] is related to detecting plant diseases in leaves using machine learning. For this purpose, they used a CNN model. After training the model on affected and healthy plants, the diseases were classified according to the models. However, this approach was only applicable to leaves and not to the plant body.

Research C:

The research [8] is related to detecting nutrient deficiencies in plants using machine learning. In India, this was done for the tomato crop using an ANN model. After examining the leaves, the correct nutrient deficiency was identified. The final output was a mobile app that could take and upload photos of the plant and provide information on the deficiency. It was observed that different fertilizers were used for different tomato plants, for instance, more nutrients were used during the flowering period.

Research D:

The research [9] is related to detecting nutrient deficiencies in corn leaves. The corn leaf image data was pre-processed, and RGB and HSV were used to finalize the data. Then, the data was trained with an SVM model and classified. Based on the classification, the appropriate nutrient fertilizer was recommended for the particular plant.

Research E:

The research [11] is related to calculating the affected area in a leaf. This was done in Sri Lanka for vegetable crops grown in Batticaloa to control pests after identifying the threat. First, the RGB images were converted to HSV. Then, the necessary steps were taken to detect the affected region, and based on that, the number of counts in that particular leaf was obtained. A classification model was created using a CNN model to identify the type of pest.

Research F:

The research [6] is related to detecting diseases in wheat crops. When there are large-scale crops, it is difficult to identify diseases by inspecting them one by one. Therefore, this research found a solution by obtaining aerial images using drone cameras. Using OpenCV, the BGR images were converted to the RGB format, and the necessary steps were taken to detect the affected area. After obtaining location-wise results, growers can take necessary actions to stop or prevent the spread of the disease.

Table 1-1 shows simply comparison between my proposed system and the past research that I mentioned earlier.

Table 1-1 Comparison between past research and proposed system

Research / **Features**	A	B	C	D	E	F	Proposed system
Identification difference between mite's attack & deficiency for the plant	-	-	-	-	-	-	✓
Recommending the nutrient fertilizer	-	-	✓	✓	-	-	✓
Calculated the affected area of a leaf in percentage	-	-	-	-	✓	-	✓
Recommendation system shipment	-	-	-	-	-	-	✓
Mobile application	-	-	✓	-	-	-	✓

2 OBJECTIVES

2.1 Main Objective

Differentiate nutrient deficiencies from mite attacks and recommend plants for shipment

2.2 Specific Objectives

- Identification difference between mite’s attack & deficiency for the plant
- Predict Recommending the nutrient fertilizer
- Calculated the affected area of a leaf in percentage
- Recommendation system for shipment
- Create a smart mobile-based identification

3 METHODOLOGY

3.1 Overall System Architecture

Figure 3-1 shows the overall system diagram comprising four main components.

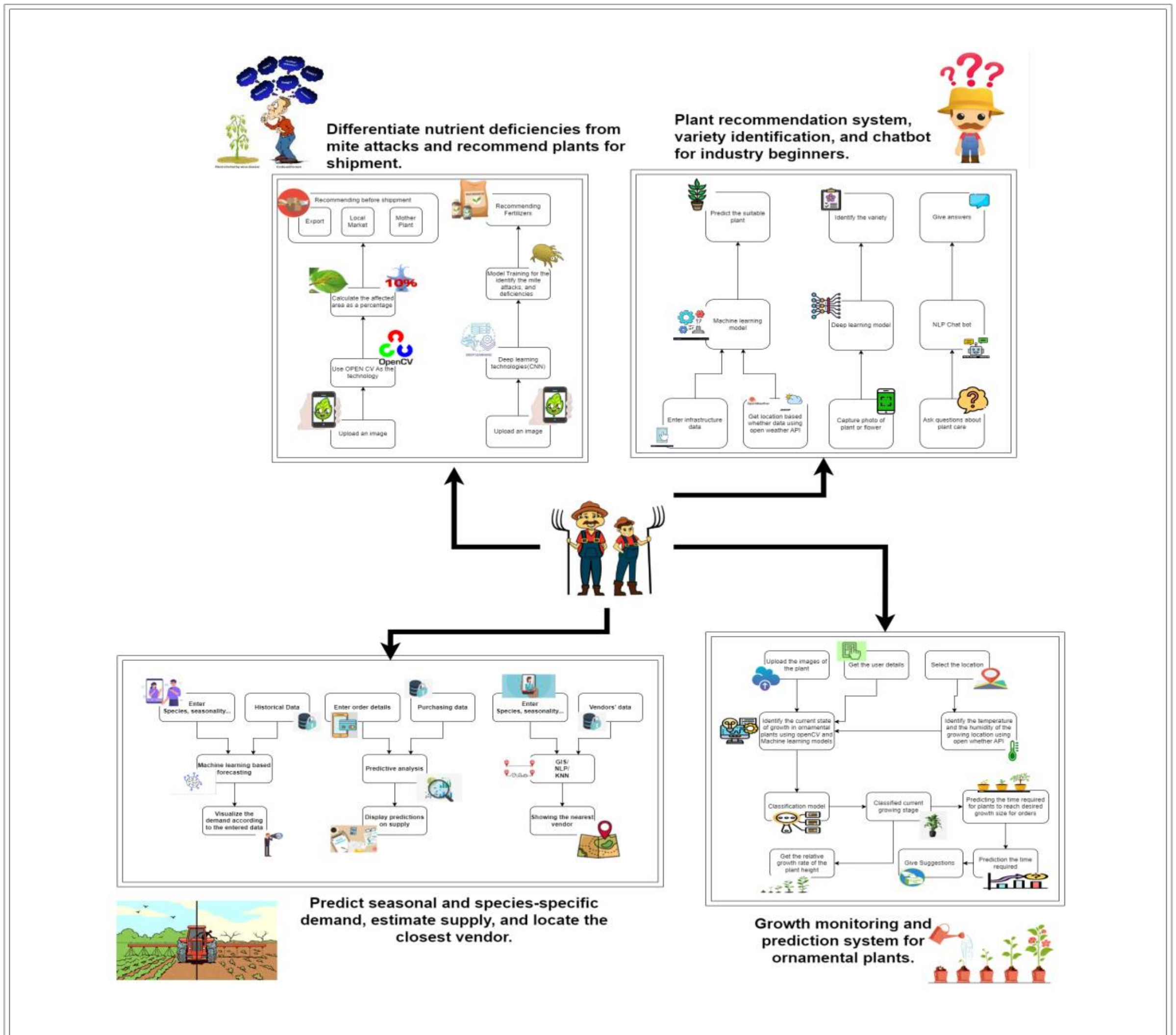

Figure 3-1 Overall system diagram

3.2 Individual System Architecture

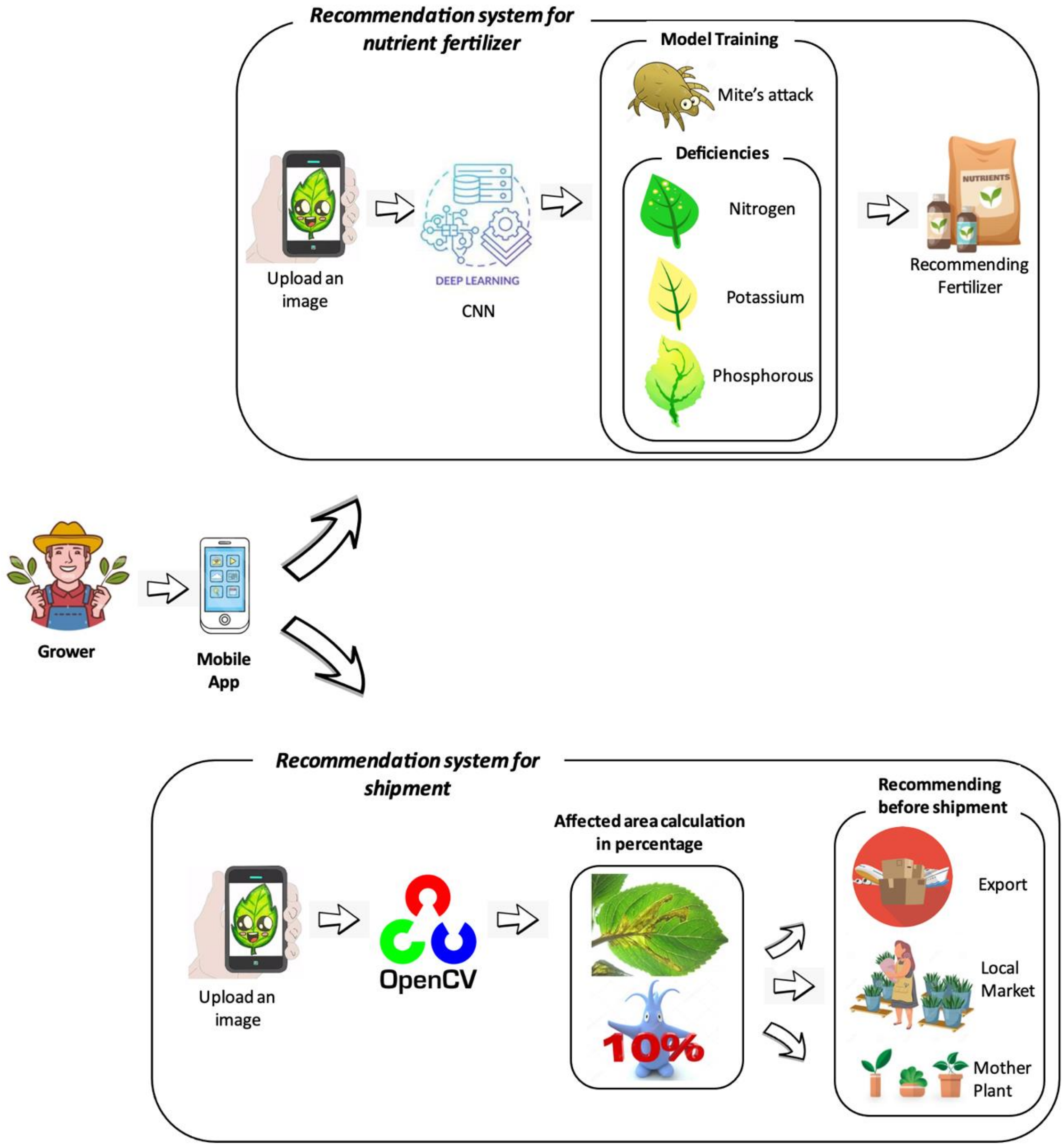

Figure 3-2 Individual system diagram

Figure 3-2 shows the simple architecture of the system, which has two main parts for recommendations. The first part involves identifying the cause of the plant's affections, whether it be a mite attack or a deficiency. To achieve this, the grower can upload an image of the affected plant leaf and receive a correct diagnosis, along with a recommendation for which fertilizer to use. To accomplish this, a CNN model will be trained for leaf classification.

The second part involves recommending where to sell the plant based on the affected leaf percentage. If the percentage meets the required export or local market requirements, the system will recommend the appropriate market. If the plant is badly affected, it will be recommended to use it as a mother plant. Leaf segmentation for this part will be performed using OpenCV.

To develop this system, I will be employing an Agile methodology, as illustrated in Figure 3-3.

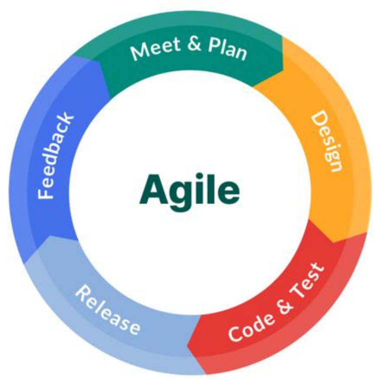

Figure 3-3 Agile Methodology

To develop this system, I will use the following technologies, algorithms, architectures, and techniques shows below in the table 3-1.

Table 3-1 Technologies, Algorithms and Techniques for the proposed system

Technologies	Algorithms & architectures	Techniques
Flask Python Tensorflow Keras OpenCV Scipy Numpy React Native	Algorithms • CNN Architecture • VGG	Data preprocessing Feature engineering Transfer learning Data augmentation Image thresholding Contour detection

3.2.1 Recommending the fertilizer

- Collecting data

To differentiate between plant deficiencies and mite attacks, I need to obtain images of plants affected by various deficiencies and mite attacks. Additionally, to recommend the appropriate fertilizer, I will require information about the type of plant and the desired type of fertilizer. I plan to collect this data, as well as the images, from Omega Green Pvt Ltd. As previously discussed, the owner of the company has granted me permission to obtain these images, and the agricultural experts working there will provide the necessary expertise.

- Preprocessing data

Before using the collected images for the CNN model, they need to be cleaned and resized. Data augmentation techniques such as adding noise, rotations, and other transformations can also be applied. Additionally, the data on the type of plant also needs to be formatted so that it can be used by the model.

- Splitting data

Once the preprocessing stage is complete, the final dataset containing the images must be divided into two subsets: one for training the model and the other for testing it. The training dataset will be used to train the model, while the testing dataset will be used to evaluate its performance.

- Building the model

Deep learning frameworks such as TensorFlow and Keras can be used to build a CNN model. Transfer learning techniques can also be applied by utilizing pre-trained CNN models like VGG.

- Training the model

Once the model has been built, it can be trained using the preprocessed data. By utilizing a dataset of labeled images, the model can be trained to identify the type of deficiency or mite attack based on input images.

- Evaluate the model

After the training phase, various metrics such as accuracy, precision, recall, and F1-score can be calculated to evaluate the performance of the testing data. These metrics provide a comprehensive assessment of the model's ability to correctly identify the presence of a deficiency or mite attack in the input images.

- Fine-tuning the model

If the performance of the model is unsatisfactory, hyperparameters can be adjusted and transfer learning techniques can be employed to fine-tune the model. This can help to improve the accuracy, precision, recall, and F1-score of the model.

- Recommending the fertilizer

Finally, the system displays the specific deficiency or mite attack present in the plant. Based on this information, the system recommends which fertilizer to use to treat the problem.

3.2.2 Recommending for export

- Collecting data

To calculate the affected area, I will collect images of plant leaves with various types of affections. These images will be obtained from Omega Green Pvt Ltd and will include different types of plants to ensure a diverse dataset.

- Preprocessing data

Before providing images for the calculation, I will preprocess the images by resizing and cropping them to isolate the plant leaves. I will also apply a filter to remove any noise and use thresholding to convert the images into binary format.

- Calculating the affected area:

After the preprocessing stage, I will use OpenCV to calculate the affected area of the plant. Techniques such as edge detection, color segmentation, and grayscale conversion will be employed for this purpose. The best technique will be selected based on its accuracy and will be used for further implementations.

- Recommending the plant leaves

Once the affected area in percentage is determined, the system will check if it meets the required export level. If the percentage meets the requirement, the system will recommend exporting the plant. If the percentage does not meet the export level, the system will check the local market percentage. If the percentage falls within the acceptable range, the system will recommend selling the plant in the local market. If the plant is badly affected, the system will recommend using it as a mother plant.

3.3 Commercialization & Business Plan

This app is developing two versions of a platform for the floriculture industry, a commodity version and a premium version. The commodity version will provide growers with the ability to predict the current state of growth in ornamental plants, identify the relative growth rate of plant height, distinguish nutrient deficiencies from mite attacks, identify the most suitable floriculture plant to grow based on weather and resource factors, and forecast the demand for local and international markets. This will help growers make informed decisions about what to grow and when to sell their products.

The premium version, on the other hand, will offer growers more advanced features, such as predicting the time it will take for a plant to reach the required growth size for an order, providing suggestions to promote growth and advance the ornamental plant to the next level, identifying various floriculture crop varieties, and incorporating a chatbot as a resource for guidance on growing multiple plants. The premium version will also provide growers with recommendations for plants that are suitable for shipments, predict the optimal supply strategy for meeting the required output quantity based on geographical areas, and find the nearest vendor. Additionally, the platform will provide packaging recommendations based on the plant's lifespan, ensuring that plants arrive in optimal condition.

Overall, these features will help growers optimize their production processes, increase efficiency, and make informed decisions about which plants to grow and how to sell them. By providing growers with a range of tools and resources, our platform aims to revolutionize the floriculture industry, making it more efficient, sustainable, and profitable.

4 PROJECT REQUIREMENTS

4.1 Functional Requirements

- The system should be able to classify plant leaves as either deficient or infected with mites based on input images.
- The system should be able to recommend a fertilizer to be added to the plant based on the classification results.
- The system should be able to identify the affected area of the leaf and provide the percentage of the leaf that is affected.
- The system should be able to recommend whether or not to export the plant based on the percentage of the leaf that is affected.

4.2 Non-Functional Requirements

- The system should be accurate in its classifications and provide reliable recommendations.
- The system should be able to process images quickly and efficiently.
- The system should be able to handle large amounts of data and scale as necessary.
- The system should be easy to use and have a user-friendly interface.

4.3 System Requirements

- Tensorflow, and Keras will be used to train a CNN to recognize the different types of leaf deficiencies and mite attacks.
- OpenCV will be used for image processing and leaf segmentation, to identify and isolate the plant leaves from images.
- The programming language will be used Python, due to its compatibility with both TensorFlow/Keras and OpenCV.
- Flask can be used to create a server-side application that can receive requests and respond with recommendations for fertilizer and export decisions.

- NumPy and SciPy will be used for data manipulation and analysis, to preprocess the image data and generate features for the CNN model.
- React Native will be used to create a mobile application that can take pictures of plant leaves and send them to the server for analysis.
- VGG will be used as a pre-trained CNN for feature extraction, which can be used to improve the accuracy of the CNN.
- VS code and Jupyter notebook can be used as integrated development environments (IDEs) for writing and testing the code.

4.4 User Requirements

- The user should be able to capture photos of plant leaves using their smartphone camera.
- The user should be able to upload images of plant leaves to the app for analysis and identification of nutrient deficiencies or pest attacks.
- Once the system has identified a nutrient deficiency, it should provide the user with a recommendation for the appropriate fertilizer to add to the affected plant.
- User should be able to get the affected area in percentage of the leaf.
- User should be able to get the recommendation on whether the affected plant should be exported or not.

5 GANTT CHART

Figure 5-1 displays the Gantt chart outlining the project timeline and task dependencies.

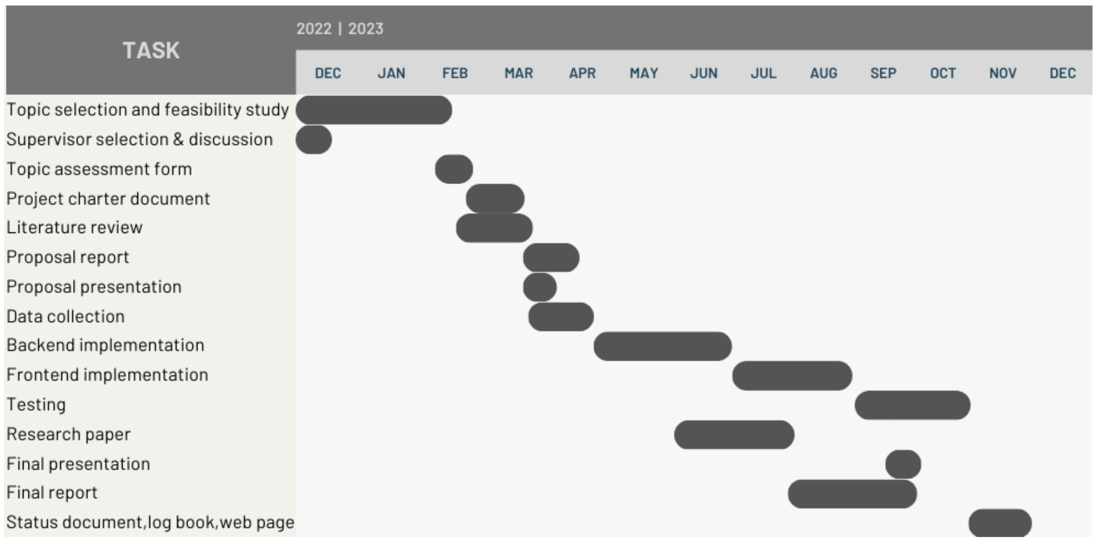

Figure 5-1 Gantt chart

6 WORK BREAKDOWN STRUCTURE

Figure 6-1 demonstrates the WBS for the project, which details the tasks and subtasks required to accomplish the project objectives.

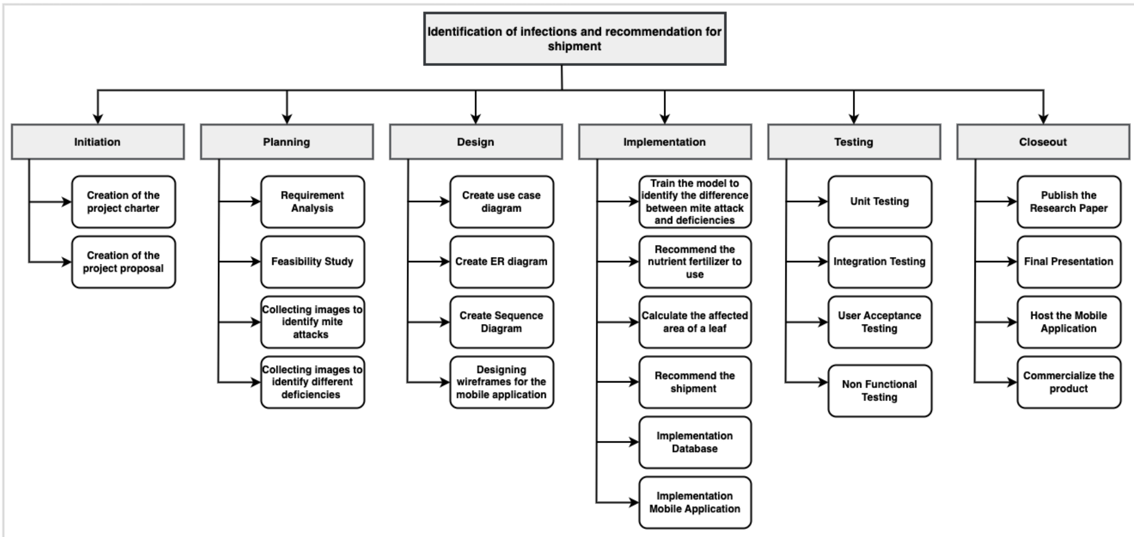

Figure 6-1 Individual work breakdown structure

7 BUDGET AND BUGET JUSTIFICATION

The overall estimated budget for the proposed system is shown in Table 7-1 below.

Table 7-1 Budget estimation

Component	Price
To collect data	
Travelling cost for Omega Green in Badalgama	Rs. 20000
Other expenses	Rs. 10000
To deploy	
Monthly cost for the deploying	Rs. 8000
To host the mobile app	
On play store monthly	Rs. 8075
On app store monthly	Rs. 22610

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APPENDICES

Appendix 1 Survey on Floriculture

https://forms.gle/mknPpztYp63e2wJE8