SMART MANGO – DISEASE DETECTION AND DIAGNOSIS SYSTEM FOR MANGO PLANTATION MANAGEMENT

Final Report

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September 2023

DECLARATION

I declare that this is my own work, and this dissertation 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. Also, I hereby grant to Sri Lanka Institute of Information Technology the non-exclusive right to reproduce and distribute my dissertation in whole or part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as article or books) ...

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

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Ms. Hansika Mahaadikara – Supervisor Date

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Ms. Shashika Lokuliyana – Co-Supervisor Date

ABSTRACT

This research introduces an innovative approach utilizing Internet of things (IoT) and machine learning to revolutionize mango cultivation practices. The research employs various machine learning model underscoring the potential of machine learning to revolutionize mango cultivation for more efficient and sustainable practices. Since it is essential to ensuring global food security, proper disease system has garnered a lot of attention. For the efficient use of pesticides in agricultural industry and to increase crop production, a smart system is used. As a result, has less of a negative environmental impact and there is less of a provide pesticide supplies. This project will identify the gaps in the methods in mango cultivation and examine how they affect crop quality, productivity, and usage. It has been demonstrated that by capturing image to gain data and by analyzing them through a machine learning model, the pesticide needs to be provided to the agriculture field can be determined. Therefore, it can prevent the disease spread and preserving crop growth and quality.

ACKNOWLEDGEMENT

I would like to sincerely thank everyone who has helped me to continue 4th year research project. First, I would like to express my sincere gratitude to our project supervisor Ms. Hansika Mahaadikara, who guide us with knowledge and informative commentary to continue this project successfully. I would like to thank our co-supervisor Ms. Shashika Lokuliyana for her valuable advice and encouragement. I would also like to thank the AIMS panel for giving us valuable advice on our project.

I owe a debt of gratitude to my group members, Withanaarachchi S. P., Jayamanne B.D.N., Niroshani A who has helped me to do this project.

Finally, I would like to express my sincere gratitude to my family and friends who has supported me to make this project a success.

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LIST OF ABBREVIATIONS

NGO	Non-Governmental Organization
OpenCV	Open Computer Vision
IoT	Internet of Things
AWS	Amazon Web Services
ML	Machine Learning
RN50	Rest Net 50
MN	Mobil net

1. INTRODUCTION

A country like Sri Lanka, where the economy is built primarily on agriculture and the weather conditions are isotropic, needs to quickly improve its food production technology to meet the constantly rising demand for food. Despite this, we are still unable to fully utilize our farming resources. Moreover, we constantly pollute the ecosystem and misuse a variety of farming components.

mango industry plays a pivotal role in numerous countries, bolstering their economies with substantial annual revenues. Sri Lanka, among these beneficiary nations, relies on the mango industry for economic sustenance. However, mango trees are susceptible to various diseases that adversely affect their growth and yield. The early detection of these diseases becomes imperative to curtail their propagation and minimize crop damage.

One promising avenue to address this challenge is the utilization of algorithms designed to identify diseases in mango trees. By employing machine learning techniques to scrutinize images of mango trees and their leaves, this program aims to detect and classify disease indicators. Additionally, it may factor in environmental elements such as weather and soil conditions to enhance diagnostic accuracy.

The adoption of such an algorithm has the potential to significantly enhance the efficiency and precision of mango disease diagnosis. This, in turn, empowers farmers to respond swiftly to contain disease outbreaks and sustain the health and productivity of their mango orchards. Furthermore, it may mitigate the reliance on labor-intensive manual methods, which can be both costly and time-consuming.

In the ensuing report, we delve into an in-depth examination of the feasibility of developing an algorithm capable of recognizing mango tree diseases and assess the system's efficacy in identifying prevalent mango diseases. Ultimately, the creation and implementation of such an algorithm could wield transformative influence in the mango market, benefiting the interests of both farmers and consumers alike.

The early causes of disease identifying are a dearth of information and very helpful to improve the productivity and cure for the disease.

To help farms save time and money while also improving their quality of life, we are developing an automated method. For changing applications-based image scanning, smart systems are a developing technology. Most of the smart systems present in the market are expensive and cannot be afford by the small-scale mango farmers. This system is made using qualified and sensors with reasonable prices. Therefore, this system can be provided with a reasonable price. The machine learning model used in the system can be used to accurately identify the disease and suggesting the pesticides needed to the plantation. The usage of this system will reduce many tasks that are divided among the employees, and it will help the managers to manage the farm activities efficiently and effectively.

This automated system uses camera to monitor plants health and track, by considering these factors, The optimal amount of pesticides required by each plant will then be determined using a machine learning model. The use of ML model to determine the pesticide usage will help the farmers to increase the mango yield and the money spend on the labor can be reduced. This will help the farmers to manage the mango plantation in a more efficient and effective way.

This research explores a novel approach to revolutionize mango management, driven by the rising demand for this economically significant fruit. By harnessing machine learning and Internet of Things (IoT) technologies, this research enhanced efficiency and better decision-making for both farmers and consumers.

Employing cutting-edge machine learning techniques and leveraging data from Image and IoT sensors, our aim is to identifying the health of mango requirements for mango trees at

various stages of growth. Armed with this understanding, farmers can adopt sustainable practices.

1.1 Background Literature

There has been lack of research on the use of smart systems for Sri Lankan mango farms, despite these systems have been extensively explored for a variety of crops. Mangos are a significant fruit crop in Sri Lanka, because of the problems with leave disease can have a severe effect on both productivity and quality. The potential advantages of using these systems for mango production have been highlighted in a few studies.

The detection and diagnosis of mango tree diseases is crucial for the management and control of these diseases. In recent years, researchers have explored different methods to identify and classify mango tree diseases using various techniques such as image processing, machine learning, deep learning, fuzzy logic, and computer vision-based algorithms.

Ramani (2017) demonstrated that using image processing techniques can provide a non-invasive [5], efficient, and reliable method for detecting mango tree diseases. Similarly, Devadoss (2019) found that deep learning algorithms can accurately detect and classify different mango tree diseases [2], providing a fast and reliable method for disease diagnosis. Shekhawat (2019) also showed that machine learning algorithms can accurately classify different mango tree diseases [3], providing a cost-effective and efficient method for disease diagnosis.

In addition, Siva (2018) explored the use of fuzzy logic as an effective method for diagnosing mango tree diseases [1], providing accurate and reliable results. Kumar (2020) found that computer vision-based algorithms can provide an efficient and non-invasive method for

detecting mango tree diseases, using image processing algorithms with the OpenCV library and MATLAB software.

Overall, these studies demonstrate that the use of various algorithms can provide promising results for detecting and diagnosing mango tree diseases, with the potential to revolutionize the mango industry [4]. Further research in this field is needed to refine and optimize these methods for real-world applications.

1.2 Research Gap

Despite the significance of mango trees as a crop, there is a lack of thorough and accurate information on the prevalence and geographic distribution of mango tree diseases, particularly at the regional and global levels.

Limited knowledge of the diseases that affect mango trees' underlying mechanisms: Although a significant study has been done on the origins and mechanisms of diseases that affect mango trees, there are still many unanswered questions, especially regarding how various environmental conditions and management techniques combine to affect disease development.

1.3 Research Problem

Mango leaf diseases are a serious hazard to mango plantations around the world, resulting in lower yields, monetary losses, and possibly negative effects on food security. To protect the health of the mango crop and assure sustainable production, the issue is to create effective ways for early detection, accurate diagnosis, and efficient management of these illnesses. This research issue emphasizes the significance of combating mango leaf diseases and the requirement for research to identify solutions that benefit both mango cultivators and international food supply chains, using machine learning algorithms to optimize schedules based on the unique requirements of each mango variety.

1.4 Research Objectives

1.4.1 Main Objectives

To implement a smart management system that provide pesticides to the plantation at the correct time and the correct amount.

The main objective of the system is to implement a smart management system that provide pesticides based on data input by different types of sensors and analyze it through a machine learning model. The amount of data analyzed through the machine learning model is distributed to the farmland through the pipelines. The real time data can be obtained through the website. This will help the users of the system to control and manage remotely. This will make the management functions easier, and the operation cost of the field will be reduced. The maximum yield can be obtained by using a smart system. The wastage of many resources such as energy, labor force, time, and money.

1.4.2 Sub Objectives

The primary goal of diagnosing diseases on mango tree leaves is to enhance the overall health and productivity of mango trees. This goal is achieved through the following specific objectives:

- Early Detection

Identifying diseases at their earliest stages to prevent their spread and reduce damage to mango trees.

- Accurate Diagnosis

Providing precise identification and classification of diseases to implement targeted and effective treatment measures.

- Improved Management

Developing strategies and interventions for managing mango tree diseases, such as the application of appropriate pesticides or cultural practices

- Enhanced Crop Health

Ensuring the long-term well-being of mango trees, which contributes to higher fruit yields and overall sustainability in mango cultivation.

In summary, the specific goals of diagnosing mango tree leaf diseases revolve around early detection, accurate identification, effective management, and ultimately, improving the health and productivity of mango orchards.

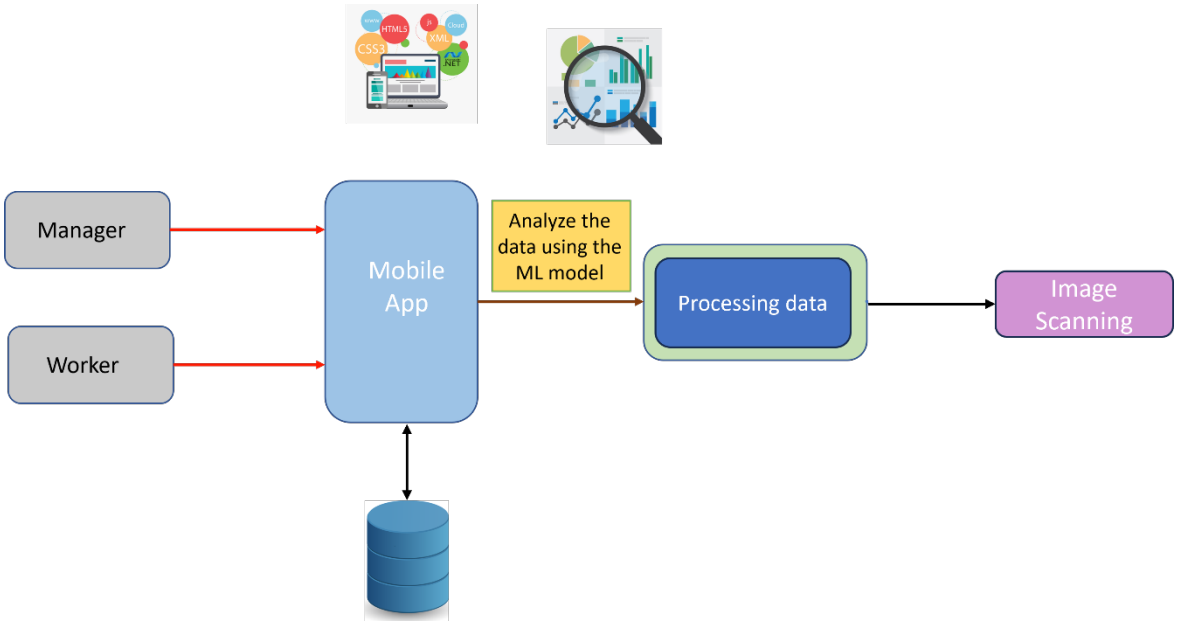
2. Methodology

In this research, we have employed several machine learning technologies to address the different objectives of grading mangoes based on weight and color, predicting mango yield, determining the required mango water level, and predicting mango diseases as depicted. Each technology was chosen based on its suitability for the specific task and the nature of the data available. Below, we elaborate on the technology used and the reasons behind their selection: Transfer Learning with VGG16 and ResNet50 Models. Transfer learning is a popular technique in the field of deep learning that involves leveraging pre-trained models on large datasets to address specific tasks. In our research, we used transfer learning with both the VGG16 and ResNet50 models for different purposes.

Machine learning-based image analysis: Used method for spotting diseases of mango tree leaves is to analyze photographs of the leaves and look for patterns that correspond to various diseases. To construct a predictive model for disease identification, the system trained a large dataset of images of both healthy and diseased mango leaves.

accordingly. A report will be provided to the management within certain periods according to the requirement.

2.1 System Diagram



2.2 Commercialization of the product

2.2.1 Target Audience

The target audience of the product is mango farmers specifically in Sri Lanka. But our future plan is to make this system to be used by mango farmers worldwide.

2.2.2 Demand

The demand for this product is very high as there is a lack of smart systems for the mango plantation is Sri Lanka. As we have discussed with few mango planters in Sri Lanka, they are always willing to find a method decrease their expense and increase their income. By using a smart system made by using ML and IoT identifying disease can be used in a more efficient manner. As most of the mango plantations in Sri Lanka is in insects' areas and semi-arid areas this system will be very helpful to prevent spreading the disease. And by using this automated system it will help the mango planters to provide the perfect pesticides to plantation in the correct time without any human intervention therefore it may help to avoid mistakes made by workers. Therefore, this system will have a high demand among the mango planters in Sri Lanka.

2.2.3 Marketing Strategy

We plan to sell this system as a product through the agriculture department in Sri Lanka. The new buyers will have a free trial period and if they are not satisfied with the system, they can return the product within the given time period. The small-scale farmers who cannot afford the system are given a monthly based paying method. The people who cannot afford the system are distributed through the NGO's

2.2.4 Social Media Marketing

The social media marketing is the most current trend in marketing. Even though you do not have a customer base still, you can make people aware of the product through the social media marketing like Instagram, Facebook, YouTube etc.

2.3 Testing & Implementation

Software Specifications, Research Review or Design Components

Test ID	Test Description	Status
001	Testing of the ML model by varying the input values	Pass
002	Testing image using inputted data	Pass
003	Testing of the Database	Pass
004	Testing of the mobile application	Pass

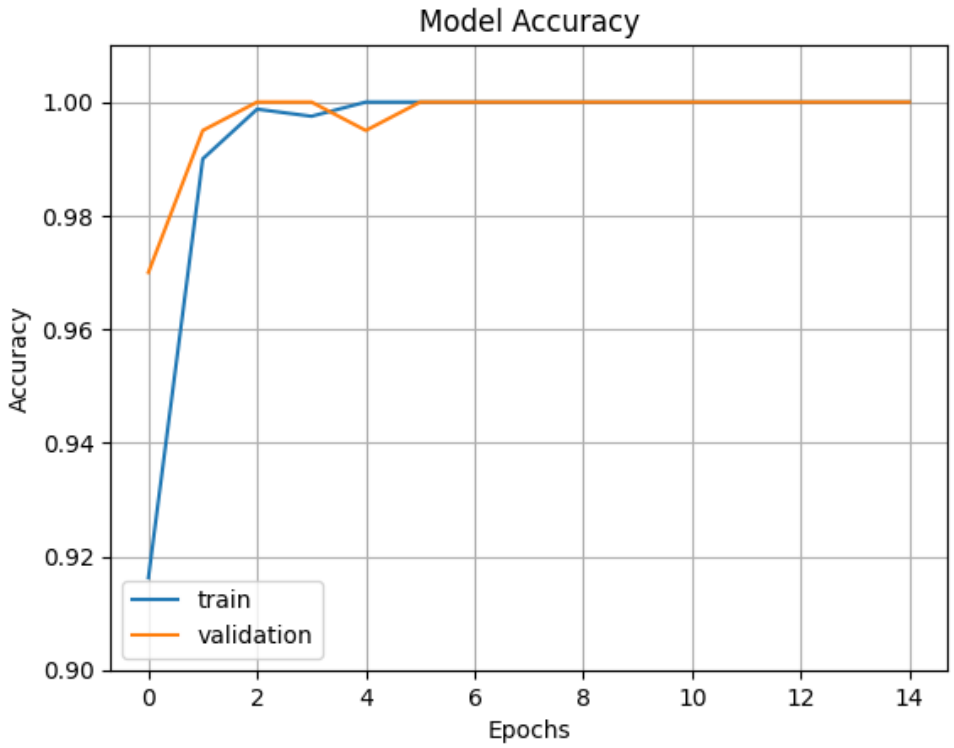
2.4 Budget and Budget Justification

Component	USD	LKR
Mobile APP	34	10960.55
Virtual Machine	12	3868.43
Mongo DB	6	1934.21
AWS	5	1611.85
Total	57	18375.03

*Used 1 USD to LKR conversion rate of 322 Rs. on 9/10/2023

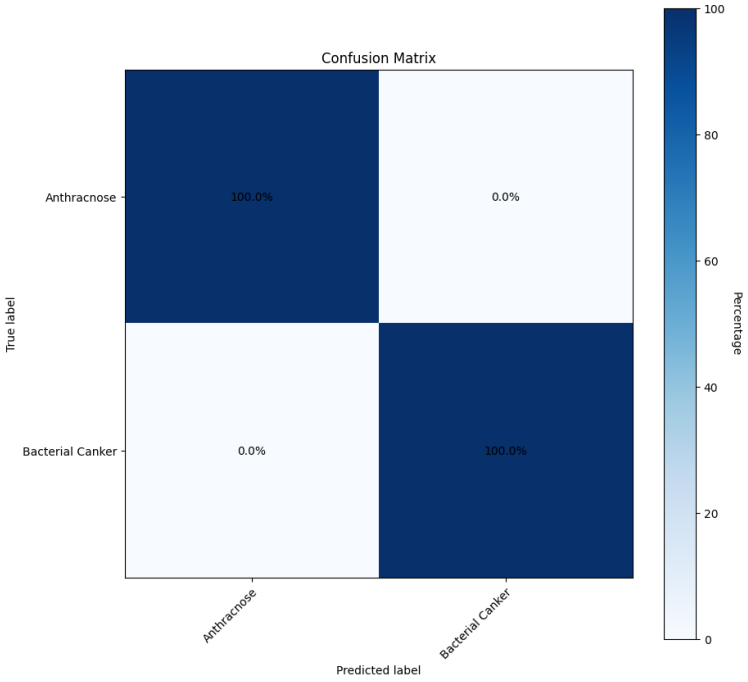
3. Results and Discussion

3.1 Results



ResNet50 Model for Mango Disease Prediction:

A ResNet50 model, another deep CNN architecture, was used for detecting mango diseases from images. Mango diseases often exhibit specific patterns and visual cues that can be difficult to capture with traditional image processing techniques. Transfer learning with ResNet50 allowed us to benefit from the model's understanding of general image features and patterns, which helped in accurate disease prediction. Fine-tuning the ResNet50 model on our mango disease dataset made it proficient at identifying disease related patterns and distinguishing healthy from infected mangoes. The dataset included 1000 of images belongs to two classes which are Anthracnose, Bacterial Canker. 80% of data were used for training and 20% of data were used for validation.



3.2 Research Findings

This research has help to identify the mango leave disease using Integrating advanced image recognition and pattern detection algorithms with real-time. data from IoT systems, we seek to develop a disease detection system capable of identifying early signs of illnesses in mango trees. Timely disease detection empowers swift intervention, averting disease spread, and minimizing crop losses.

3.3 Discussion

The use of IoT and machine learning for system optimization is becoming increasingly important due to the real-time monitoring of several parameters and the generation of large amounts of data. To ensure that the data is managed and controlled effectively, eliminating useless data, implementing clustering techniques, utilizing efficient algorithms, and utilizing sustainable resources are some of the recommendations. Artificial intelligence (AI) and fuzzy logic are used to evaluate the data gathered from the sensors to carry out the disease - related actions, and machine learning is used to make predictions. These methods enable the process to be improved by predicting any difficulties that can arise and how the risks must be addressed to guarantee maximum work efficiency. Machine learning can be used to reduce the disease spreading and pesticides use, more earnings, and improved agricultural yields.

It can also manage irrigation-related hazards, such as crop diseases, inadequate storage management, pesticide control, weed management, inadequate irrigation, and inadequate management. AI approaches and smart system have been presented by Bannerjee et al., Chlingaryan et al., and Elavarasan et al., and precision systems can be utilized to adaptably regulate the environment's changing conditions. Sustainability is a crucial factor that is connected to systems, and a balance between the three sustainability pillars must be maintained for any system to be sustainable. Organizations engaged in the specific sector and associated operations must take these factors into account since the components of sustainability might be evaluated in various situations and media. The most important details in this text are related to system and sustainability.

Multi-agent architectures are renowned in management and its IoT solutions. The general design and layout of sensory systems based on IoT is based on multi-agent architectures. Most architectures are broken up into functional blocks that reflect the many tasks and activities that need to be completed. The Internet of Things (IoT) systems are made up of

several gadgets that are positioned to carry out a wide range of diverse tasks, including control, monitoring, detection, and action.

These gadgets also have interfaces via which connections may be made with other devices to send the necessary data. IoT architecture has traditionally been composed of three main levels: application, network, and perception. However, a new layer known as the service layer has been introduced to store and analyze data using cloud computing and fog. Fernández-Pastor's four-layered structures have been proposed, with the edge layer chosen to find crucial applications and carry out fundamental control operations. Different tiered techniques have been developed and deployed in relation to IoT systems for Diseases, with varying degrees of success.

4. Summary of each student

Member	Task	Contribution
Withanaarachchi S.P. (IT20466008)	Implementation of the Smart Watering System	Implementation the IoT device used to gather data from the plantation. Designing of the pipe system used to distribute water in the plantation. Deployment of the ML model used to decide the water required to the plantation based on the data collected from the IoT device.
Jayamanne B.D.N (IT20276928)	Implementation of the IoT Based Mango Grading Model	Designing of the weighting model used to measure the weight of mangoes. Implementation of the model used to
Niroshani A. (IT20103354)	Implementation of the Mango Yield Prediction Model	Designing the UI/UX of the mobile application.

Aksham M.Z.M. (IT20280260)	Implementation of the Mango leaf disease identification system	Creating the Mongo DB database and host the server on cloud and creating Virtual Machine.

5. Conclusions

This research examines the advantages and drawbacks of the currently used methodologies in order to develop a disease detection system. Using the data provided by the image as input, the machine learning model will be used to identify the disease in early stage and suggest the pesticide needed for the plantation and to distribute it via mobile app. The system uses Image data to calculate how much disease effected and treatment should be applied to the plant, which may be increase the productivity. To follow the procedure, farm owners can use the website. This study has shown how the Internet of Things and automation might significantly improve agriculture. The device offers a workable solution to the problems associated with the present manual and tiresome strategy by enabling efficient utilization of resources.

In summary, the research underlines the significant role of machine learning in enhancing mango management practices.

Technology developments are now crucial in the present business environment, and its applications may be improved to deliver the maximum degree of operational efficiency while achieving the desired performance goals. Farmers have used sensory systems to get a

better understanding of their crops, minimize their influence on the environment, and preserve resources, while the Internet of Things has been linked to the automation of all agricultural practices and elements to make the whole process much more effective and efficient. Businesses have been looking for strategies to protect the resource while also improving the efficiency of their operations due to the major challenge. To achieve their performance goals, smart systems are now required, and recommendations for implementing to identify the current inefficiencies in procedures and methods and develop a better strategy for improved results. More consideration should be given to management and security issues, and effective communication infrastructure is necessary to guarantee that the nodes do the required duties.

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7. Appendices

7.1 Intrface of the mobile application

Figure 7:1Interface 1

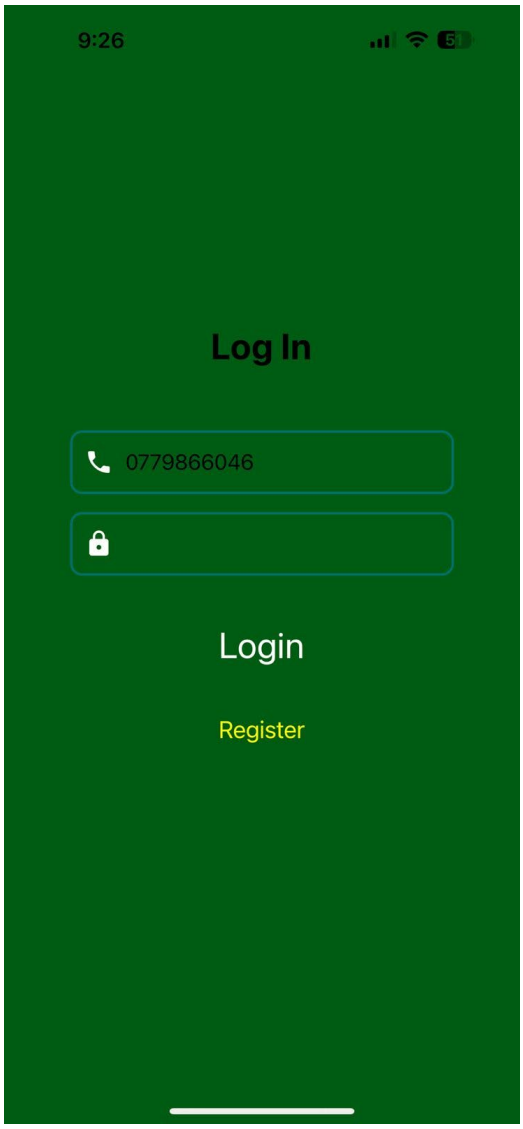

Figure 7:2 Interface 2

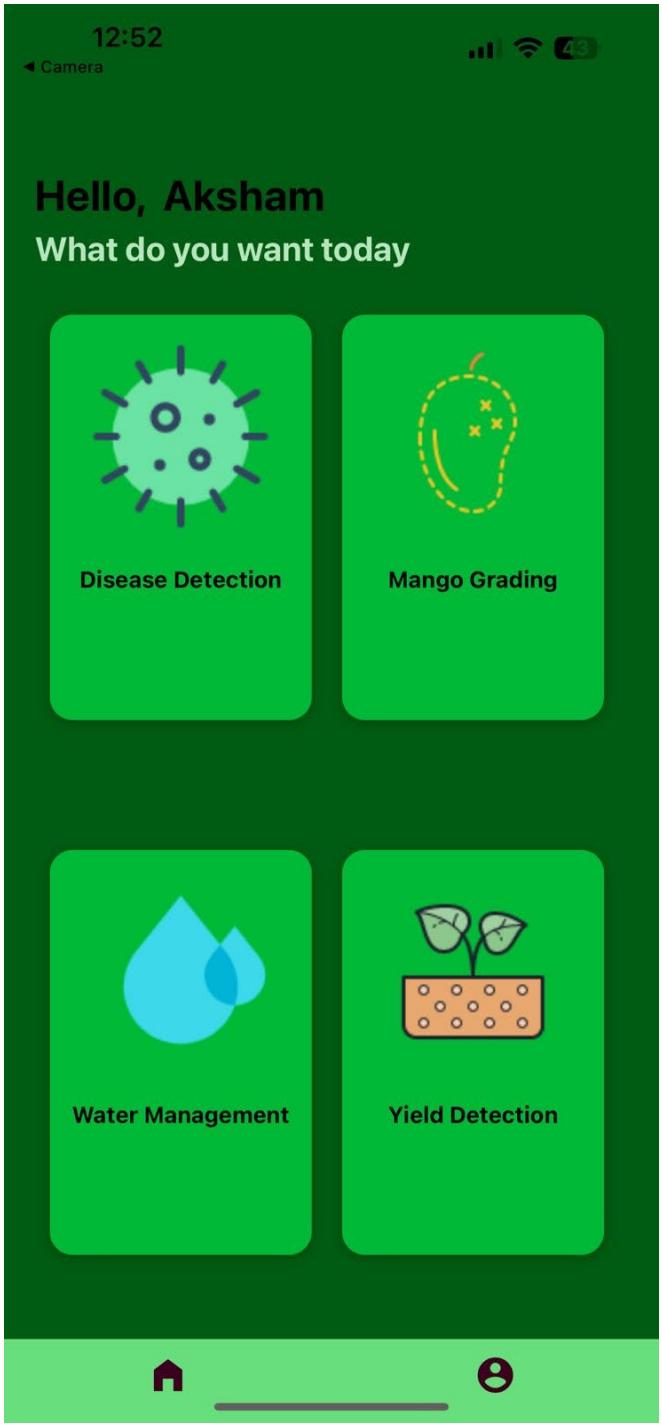

Figure 7:3 Interface 3

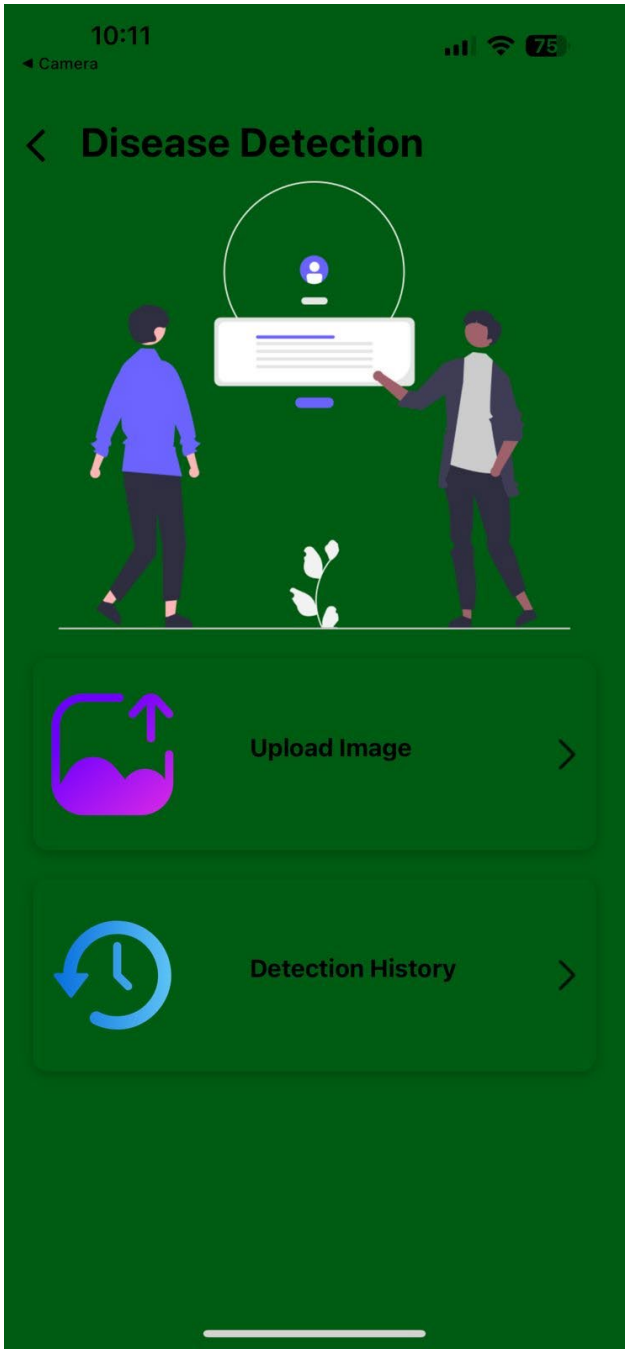

Figure 7:4 Detect Disease System Interface

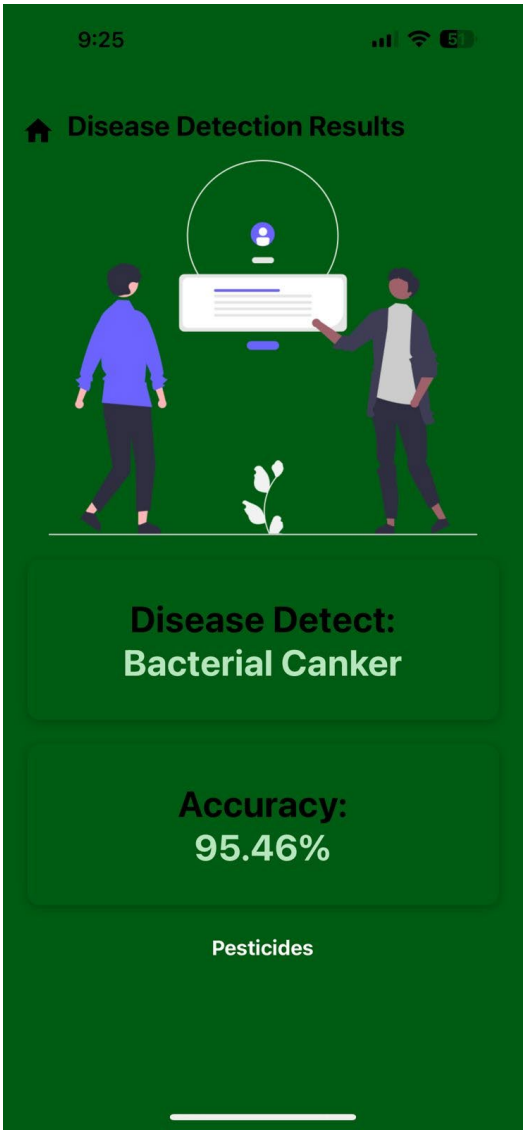

Figure 7:5 Disease Results System Interface

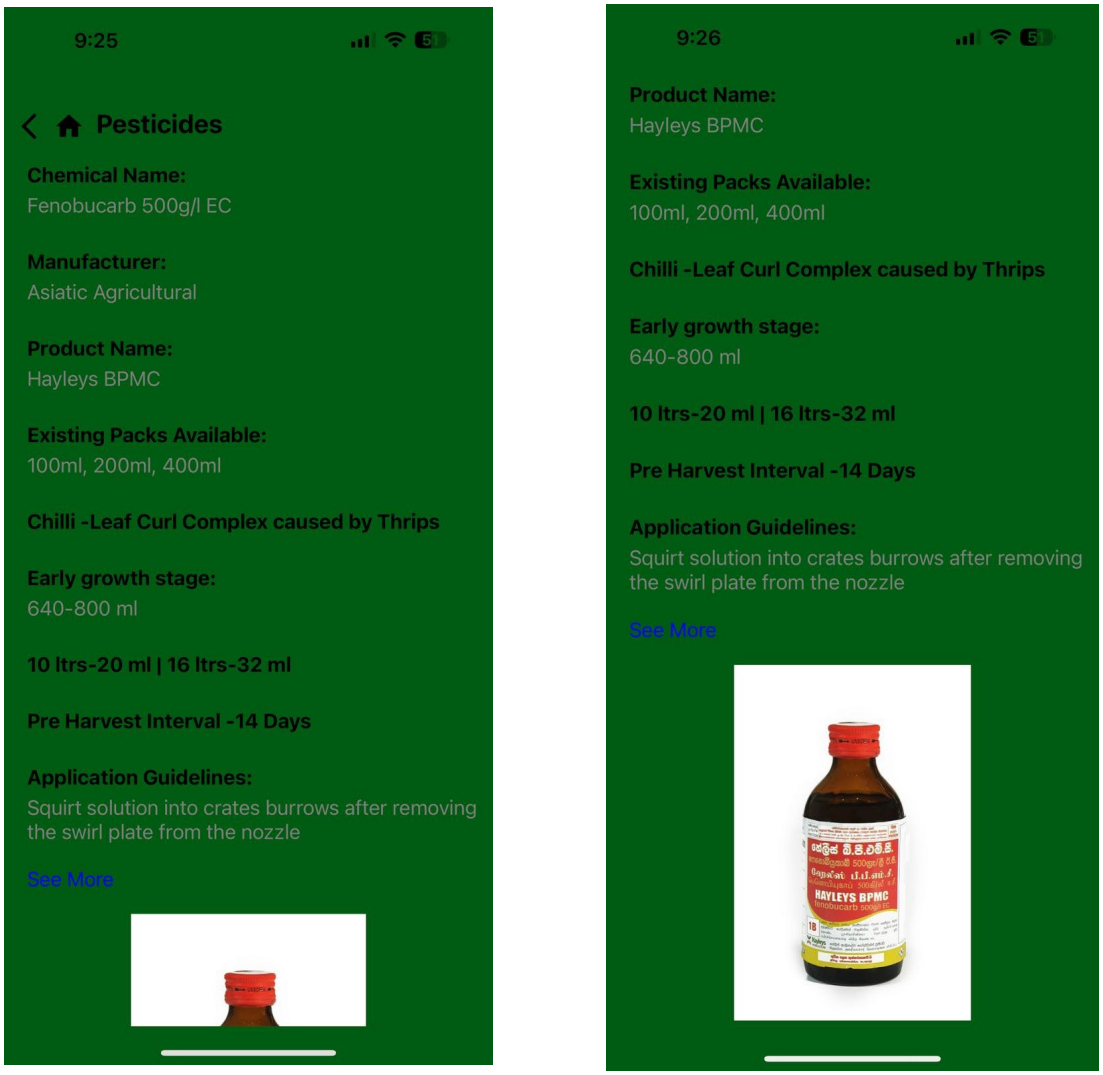

Figure 7:5 Pesticide Suggested System Interface

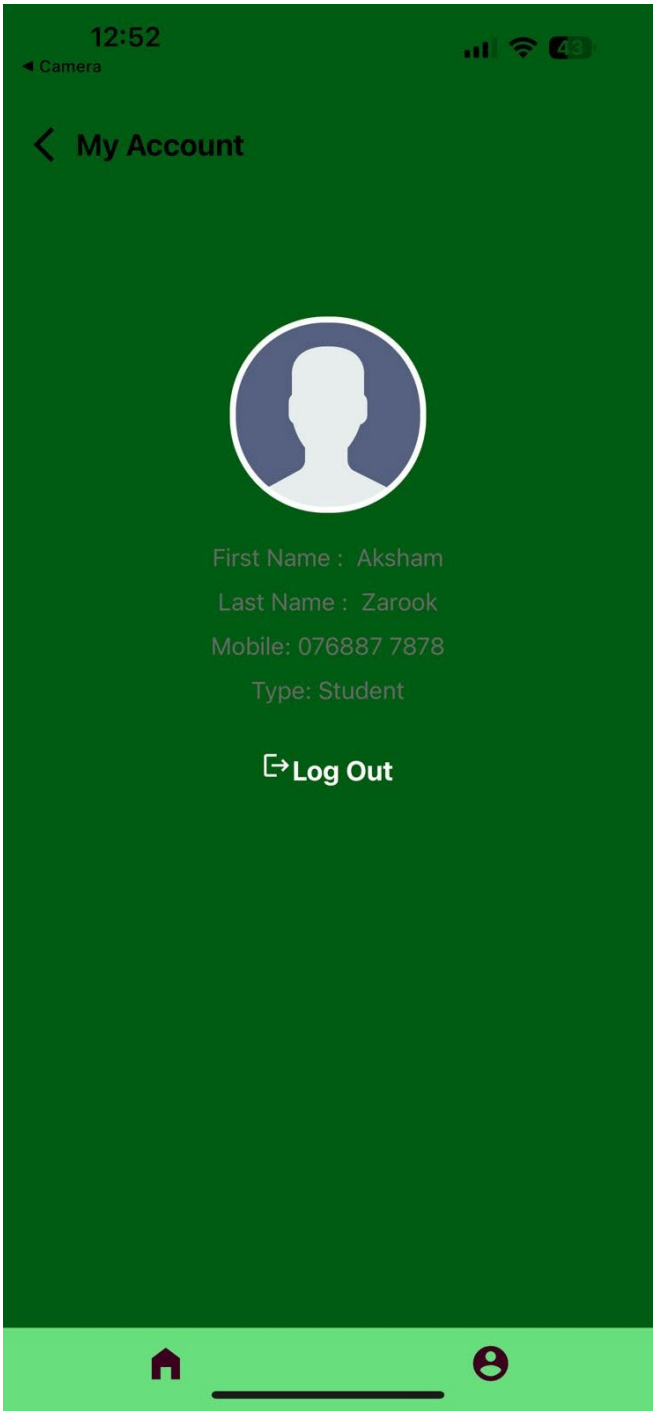

Figure 7:7 Logged Account Interface