PREDICTING CARROTS FRESHNESS BY DETECTING CARROT DISEASES USING A MACHINE LEARNING MODEL AND DIGITAL IMAGES

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Declaration

I certify that this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university, and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

Acknowledgment

We worked together to create the proposal that we are submitting today. We have been guided along our road by many helping hands. We seemed to be making good progress while writing this report. It significantly increased our comprehension. A summary of our undergraduate experiences can be found in this publication.

This group project proposal is presented as an initial requirement for the final year research project which is a part of the Bachelor of Information and Communication Technology Honours Degree program offered by the Department of Information and Communication Technology, Faculty of Technology, University of Sri Jayewardenepura.

The final year group research project is a milestone in the degree program that should be completed with the highest contribution of the group members and the support and guidance from many resource persons. Therefore, this page of the project proposal is reserved to acknowledge those valuable people. First of all, we would like to express our deepest gratitude to our supervisor, Dr. Pulasthi Gunawardhana (Senior Lecturer Gr. II, Faculty of Technology, USJ) for filling us with his knowledge and experience in academic research. As beginners in research projects, our biggest strength is having a supportive and experienced supervisor and guidance. And also, we owe a debt of gratitude to the Faculty of Technology's influential lecture panel for encouraging our inventiveness by supporting our research endeavor, as well as for their skillful direction and beneficial ideas.

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Abbreviations

1. AI - Artificial intelligence
2. ICT - Information and Communication Technology
3. GDP - Gross Domestic Products
4. UI/UX - User Interface/User Experience
5. CNN – Convolutional Neural Network
6. PCA - Principle-component analysis
7. YOLO - You Only Look Once
8. RPN - Region Proposal Network
9. SVM - Support Vector Machines
10. R-CNN – Region Based Convolutional Neural Network

1. Introduction and Background

1.1 Overview

Vegetable disease detection is crucial for agricultural industries. Sri Lanka is a heavily agricultural nation where farming is the majority of peoples' jobs. Since the crops are the farmers' main source of income, the crop output is very significant to them. Farmers currently rely on human disease identification capabilities, which are unreliable and lacking in expertise, to identify vegetable diseases. Therefore, a fully automated approach for accurate disease identification of vegetables is required. The diagnosis of vegetable diseases is a skill that necessitates knowledge. controlling and evaluating vegetable quality is a crucial issue for the agricultural sector that produces vegetables since it directly affects both consumer health and the market price of the end product. The basic and distinctive qualities of a vegetable that are deemed acceptable by consumers are referred to as its quality. External elements like appearance (color, shape, and size), texture, and physical damage are examples of qualities. Internal aspects like chemicals, water level, or insecticides.

Farmers are unable to detect the disease early on due to a lack of knowledge and experience. The field of computer vision and image processing technology is quickly advancing, making it feasible to make progress in accurately and effectively diagnosing diseases, such as pathogen identification and early warning. Inadequate identification of the diseases' occurrence, which may be precisely established by machine vision technology, is one of the obstacles to disease detection. Vegetables are a valuable source of vitamins, minerals, nutrients, and antioxidants. Vegetable consumption has greater health advantages. People who consume more fruits and vegetables as part of a balanced

diet will likely have a lower chance of developing various chronic diseases. The most significant agricultural products are vegetables. Among them carrot is a special vegetable. So, in many party occasions, carrots are used in bulk quantities. And carrot is must-order vegetable in hotels, restaurants as well as many food shops. And carrots are now widely used in many products. therefore, the quality of carrots is most important. carrots are widely exported by many nations. It is a root vegetable that comes in a variety of colors, such as yellow, orange, white, and red. It has potassium, beta- carotene, fiber, and other nutrients that are good for human growth. The practice of including these raw veggies in every meal can lessen the risk of cancer and diabetes while boosting immunity. The majority of farmers live in rural regions and lack the technical expertise to speak with agricultural officers and make the appropriate decisions in a timely manner, which causes them to experience economic difficulties. So, it's very appropriate to find out about the diseases that affect them.

common diseases of carrot vegetable,

- Cavity Spot
- Root nematode (Meloidogyne Hapla)
- Black Root Rot
- Sclerotinia Rot (White Mold) (Sasirekha and Suganthy, 2019)

Figure 1

Cavity Spot

Figure 2

Root nematode (Meloidogyne Hapla)

Figure 3

Black Root Rot

Figure 4

Sclerotinia Rot

(White Mold)

1.2 Project scope

The research area focuses on the development of an online predicting quality of the carrots. Develop a machine learning based system as a solution for critical problems of the farmers and buyers while classifying carrots according to the diseases. Our approach smart system involving machine learning for showing classification of the carrots. On that, we expect to develop observable characteristics identification and classifying machine learning models to extract observable characteristics from the carrots.

1.3 Motivation for the Study

Technology is being developed and updated every day, and it provides solutions for many problems in all industries. Digital devices, including computers and mobile devices, now

work as solution providers for the problems people face in day-to-day life. In today's world, many researchers and tech enthusiasts develop systems and find innovations using the newest technologies. As undergraduates studying technology who read for conceptual understanding, we are becoming more to investigate novel and difficult problems to create solutions utilizing more advanced technology. Every living thing on the world has benefited from the application of information technology in the medical profession. Additionally, there are many sectors of the agricultural industry some parts that are not currently impacted by information technology but may be adapted in the future. So, in this research as technology undergraduates, we are motivated to apply our knowledge to solve problems that most people faced in the day to day lives with selecting fresh carrots.

1.4 Rationale and Justification

In recent years, the search for a freshness identifying system, have some researches done things, but they have only covered some factors, not covered all factors that affected to the carrot freshness. This study will address the need for an information technology-based solution to assess fresh carrots reducing the workload of farmers and buyers, and giving much more insight into carrot freshness. This system gives them the ability to identify fresh and diseased carrots. This study aims to address these particular issues that earlier studies haven't been able to. In addition to these explanations, this study will be able to advance the expertise of its experts in the disciplines of machine learning. , and, these areas of expertise, this study will help to improve the soft skills of the researchers. This supports the conclusion that conducting a study in this area will be advantageous to all parties concerned, both directly and indirectly.

1.5 Research Problems

In Sri Lanka, growing vegetables has become a major source of income for farmers. The most suitable areas are Walimada, Bandarawela, and Haputhale, because of the climate. 85% of the people living in the area are growing upcountry tea and crops as their primary income sources. The primary crops grown by the villagers are potatoes, beans, cabbage, carrots, leeks, and beets. Due to the increase in stock of vegetables in this area, the tendency of spoilage is increasing.

There are many factors that affect the spoilage of carrots. They are, weather, storage time, physical damages and insecticides. Changes after spoilage are changing color, changing shape, changing texture, changing size and changing water level. And before mentioned diseases improving lack of optimized weather, water and soil.

Due to their similarity in color, texture, and environmental variations, fruits and vegetables are challenging to automatically classify and recognize using machine vision. The system described in this research uses deep learning to classify multiclass fruits and vegetables. It initially identifies the item type in a photo before classifying the object into one of two categories—fresh or rotten using texture and color. (Mukhiddinov, Muminov and Cho, 2022) A new segmentation technique and texture features for carrot detection were developed in the current work. The approach for identifying diseases using photos of carrots is discussed in this research. (Sasirekha and Suganthy, 2019) A digital twin, which can track and predict the state of fresh produce over the length of its lifecycle, (Melesse *et al.*, 2022)

The common problem of recognizing deterioration factors and using causes of deterioration for the freshness of carrots. however, it not solved all factors and causes. This means that, in light of the difficulties raised, it may be possible to develop the best

methodology for evaluating freshness of the carrots by identifying major diseases of the carrots. An automatic carrot disease detection system can aid in the identification of malicious carrots and can offer instructions for curing the illness at an earlier stage, resulting in a less costly loss in the carrot production system.

1.6 Research Objectives

1.6.1 Main objective

The primary objective of conducting this research study is to explore methodologies to develop a machine learning-based model that can identify the major diseases of the carrot.

1.6.2 Specific Objectives

• To identify a suitable and accurate machine learning technique for the identification and classification of carrot diseases.

• To apply digital image analysis techniques to recognize and classify carrot diseases and fresh healthy carrots.

• To develop a user-friendly mobile application

• To make an alternative or supplement to replace the traditional manual method

1.7 The Conceptual and Practical Significance of the Research

Conceptual significance -

The study will expect to compare past researches that developed models for identifying freshness of the carrots. And our expected system how optimizing with finding fresh carrots.

Theoretical significance -

This study will an innovative methodology of combining conversation machine learning-based approach to identifying the diseases of the carrots.

Practical significance -

The proposed our system can output freshness of the carrots by detecting major diseases of the carrots

1.8 Expected Outcomes

- The main expected outcome is a develop a machine learning-based model that can identify the diseases of the carrot.
- To get fresh carrots for peoples' meals.
- Provide User friendly mobile application.
- introduce a machine-learning model that can detect carrot diseases..

2. Literature Review

(Ni *et al.*, 2020) research article said, the most important indicator of fruit quality is freshness because it has a direct impact on consumers' physical health and buying intentions. Researching the method for assessing fruit freshness is essential. In this study, we used transfer learning to examine the process of freshness deterioration and developed a relationship between freshness and storage dates using bananas as an example. The classifier module employed the Google Neural Network model to automatically extract the qualities of the banana photos, which were then categorized.

(Kaya *et al.*, 2020) research article said, the fragrance of the product is one of the primary characteristics that may be used to determine the quality of the food. Sensors sometimes fail to deliver accurate measurements because of things like physical aging or environmental variables. Researchers suggest machine learning-based failure tolerance that disregards malfunctioning sensors. Machine olfaction, or the automated replication of the sense of smell using an "electronic nose" or "e-nose," is a key trend in this domain.

(Mukhiddinov, Muminov and Cho, 2022) said, Freshness is a crucial determinant of fruit and vegetable quality that directly affects consumers' physical health and propensity to buy. Due to their similarity in color, texture, and environmental variations, fruits and vegetables are challenging to automatically classify and recognize using machine vision. The system described in this research uses deep learning to classify multiclass fruits and vegetables. It initially identifies the item type in a photo before classifying the object into one of two categories—fresh or rotten. The system is based on a yolov4 model improvement. When compared to the previous YOLO series, the suggested method may

obtain a larger average precision than the original yolov4 and yolov3, with 50.4%, 49.3%, and 41.7%, respectively.

(Koyama *et al.*, 2021) said, People consider a number of important variables when purchasing fruits and vegetables, including the appearance of freshness. Panel testing costs money and takes a lot of time to evaluate food goods. Here, a non-destructive method for identifying the freshness of spinach based on image processing was evaluated. With the help of the feature combinations selected from the spinach images, machine-learning models were trained to distinguish between various degrees of freshness.

(Kulkarni and Gupta, 2022) said, Fruits and vegetables are categorized based on their quality, which has a big impact on their pricing, consumers, and industries. We may use iot machines to categorize various fruits and vegetables according to their quality in the real world.

(Bi, Xue and Zhang, 2021) reviewed, the fundamental ideas of computer vision and machine learning are introduced in this chapter. It explains crucial picture preprocessing techniques and image descriptors used in the classification of images. The fundamental ideas of machine learning are covered, including feature learning, ensemble learning, classification, and transfer learning. Additionally, it covers the fundamentals of convolutional neural networks.

(Sasirekha and Suganthy, 2019) found, about 17% of India's GDP is contributed by the agricultural sector. Manual health monitoring of the carrot is essential. Images constitute a key source of data and information. A new segmentation technique and texture features for carrot detection were developed in the current work. The approach for identifying diseases using photos of carrots is discussed in this research.

(Melesse *et al.*, 2022) said, Due to a gap in the food supply chain's capacity to monitor fruit quality progression, a sizable percentage of fruit is wasted. A digital twin, which can track and predict the state of fresh produce over the length of its lifecycle, is a potential tool for lowering fruit waste.

.Vegetables must be swiftly and precisely identified or categorized in accordance with the agriculture industry's quality criteria. The classification and object detection challenges have seen some extremely encouraging results from machine learning and deep learning techniques. In total, the image collection contains 6850 pictures of vegetables. The dataset contains four vegetable folders, including bell pepper, tomato, chili pepper, and New Mexico chili. Each vegetable folder has five subfolders: unripe, ripe, old, dried, and damaged.

(Kaya *et al.*, 2020) found, one of the key elements that may be utilized to assess the food's quality is the aroma of the product. Because of things like physical age or environmental factors, sensors can occasionally fail to produce correct measurements. This paper proposes a failure tolerance based on machine learning that ignores broken sensors.

According to our comprehensive review, the majority of researchers used color, size, shape, texture, water level and physical damages to measure the freshness. There is an opportunity to detect and monitor the diseases of the carrots using digital images.

(Tsukahara *et al.*, 2020) Our goal was to create a technique for assessing lettuce freshness variations during storage using just the surface color.In the first experiment, one lettuce's surface color was continuously monitored for six days. Lettuce's external hue could influence its inside quality, and it is claimed that lettuce freshness can be measured and forecast. Researchers have used X-ray fluorescence analysis, mid-infrared spectroscopy,

and oven drying to determine the moisture levels, composition, and organic matter of lettuce leaves.

(Tata *et al.*, 2022) Principle-component analysis (PCA) and deep learning (CNN) are utilized. We chose a high-performance Android app for faster deployment in order to improve identification and usability over current manual systems, such as a person verifying every fruit and vegetable to grade, which takes more time and energy. We created a program that will categorize fruits and assign grades to them based on their quality. Size, shape, look, and other factors will be used to determine a vegetable or fruit's grade. Image pre-processing techniques, including data augmentation and normalization, are utilized.

(Ameethajunaina *et al.*, 2020) In India, agriculture has always been the foundation of the economy. Techniques for quickly and accurately determining the quality of fruits and vegetables are needed for the export market. Traditional manual quality assessment is laborious, time-consuming, and prone to mistakes. Research is being conducted in a number of fields to create an automated method for quickly grading the quality of fruits.

(Li *et al.*, 2022) A total of 4,790 photos of freshly cut cauliflower were gathered and divided into four groups: infected, browning, mildewed, and healthy. When the learning rate was set to 0.001, the Mobile Net model's loss value was 0.033 and its accuracy was 99.27%.

(Fu, 2020) Images of fruits are given to YOLO as an object for segmentation and regression before being graded for freshness. The outcomes show that our method performs better than the linear predictive model and highlight its unique advantage over a linear model, according to this thesis.

(Jayasinghe and Sammani, 2022) Sensors were used to track changes in CO2 emission, water vapor release, and oxygen absorption after papaya and watermelon had been harvested. The information gathered was used to create a machine learning model (Keras Sequential Model) for predicting the freshness of fruits.

(Kaya *et al.*, 2020) Using solely the surface color, we intended to create a method for assessing how lettuce freshness varies during storage. Using the oven drying method, X-ray fluorescence analysis, and mid-infrared spectroscopy, respectively, the lettuce leaves' moisture contents, elemental composition, and organic matter were all determined at the same time.

Reference	Problem Domain	Object	Total Size of Dataset	Segmentation Algorithm	Classifier	No of features detected	Accuracy	Country
A. Majumder et al. (2019)	Disease Detection and Classification	Carrot	202	k-means clustering	SVM	11	96%	Bangladesh
G. C. Khadabadi et al. (2015)	Disease Detection and Classification	Carrot	50	Not mentioned	PNN	4	88.0%	India
(Methun *et al.*, 2021)	Disease Detection and Classification	Carrot	2131	Not mentioned	CNN	Not mentioned	97.4%	Japan

Table 1. Research Analysis table

3. Methodology

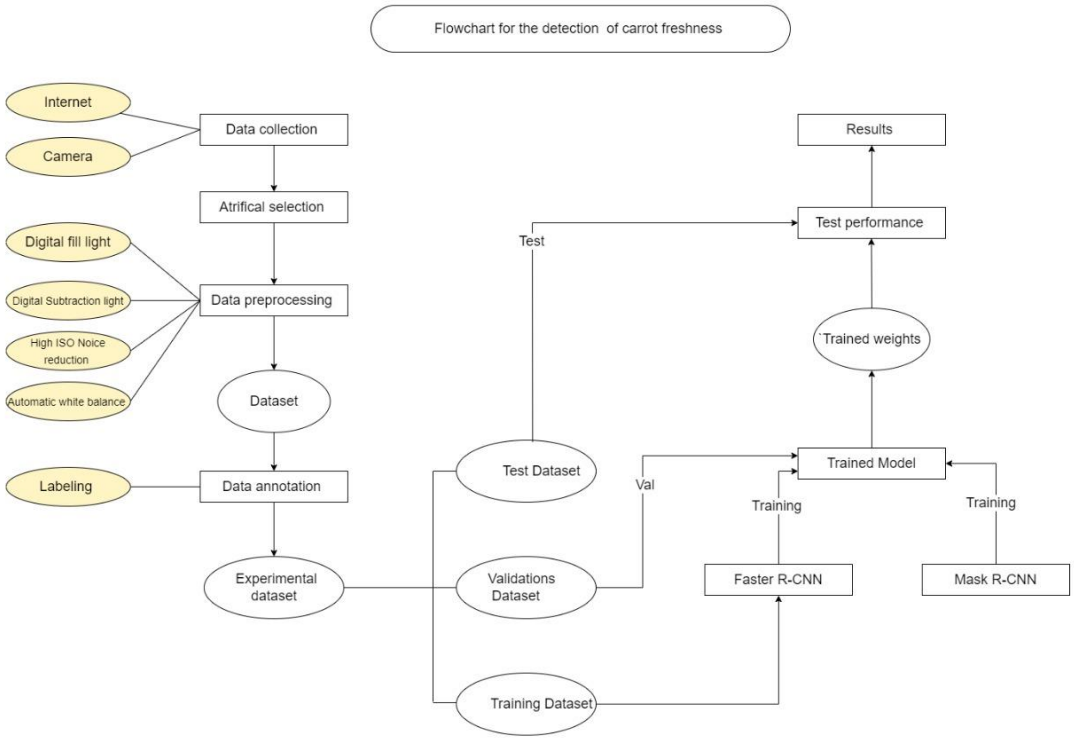

Figure 5 – Diagram of the carrot diseases detecting process

- Data Collection

This step involves capturing the images of carrot vegetable of good quality and diseased carrot (Root nematode, Sclerotinia Rot, Black Root Rot, Cavity Spot.) with high clarity, with good brightness and contrast. The first stage starts with talking a collection of carrot images. The dataset was created by the images captured using mobile phone camera.

And also, to know about these diseases collect the information from farmers in the hilly areas (Bandarawela, Walimada, Badulla, NuwaraEliya).

- Data Preprocessing

Image preprocessing takes place on the images at the lower level wherever image information consists of distortion and the noise, and enhancement of the image is done for further processing.

- Data Annotation

  Labeling and adding additional information to a dataset. And get experimental dataset. The algorithm is learned to spot patterns and generate predictions using labeled data. In active learning, a subset of the dataset is automatically identified and labeled using machine learning techniques, and the labels are subsequently reviewed and corrected by human annotators. This can facilitate the annotation process and enhance annotation quality.

- Training Dataset

  The machine learning model will be trained using the dataset that labeling. training a model on the dataset using a machine learning technique, convolutional neural network (CNN). Based on the patterns and features in the photos, the model will eventually learn to identify the various diseases.

Mask R-CNN

A deep learning approach for object detection and instance segmentation is called Mask R-CNN. It is a development of the well-known Faster R-CNN technique, which classifies and fine-tunes the object bounding boxes using a separate network and a Region Proposal Network (RPN) to locate potential object placements in an image. R-CNN Mask gives

the Faster R-CNN architecture, which is used to forecast a binary mask for each instance of an item in the picture, a new branch. The algorithm can precisely pinpoint the object

in the image and distinguish it from other objects and background pixels thanks to this mask, which segments the object at the pixel level.

Fast R-CNN

In order to create suggestions for the final object bounding boxes, the RPN is trained to predict a set of anchor boxes for each point in the image. The proposals are then categorized, improved, and output as the final item detections by the detection network.

Overall, the object detection approach known as Faster R-CNN (FR-CNN) has been extensively used and researched in the field of computer vision. Later methods, like Mask R-CNN, which adds the capacity to produce pixel-level masks for each instance of an object, have expanded and improved upon it.

- Test Dataset

  Assemble a test dataset of photos of carrot that have been annotated to reflect the various diseases that impact them. The machine learning model's performance will be assessed using this dataset.

  Classify the photos in the test dataset automatically using the machine learning model that has been trained. The model will produce forecasts for the diseases visible in each image.

To assess the model's performance, compare the model's predictions to the test dataset's ground truth labels. Metrics like accuracy, precision, recall, and F1 score can be used to do this.

Examine the evaluation's findings to find any mistakes or weaknesses in the model's operation. This might assist in identifying the model's flaws and potential areas for improvement.

- Validation Dataset

Examine the evaluation's findings to find any mistakes or weaknesses in the model's operation. This might assist in identifying the model's flaws and potential areas for improvement.

Make any necessary modifications to the machine learning model, such as modifying the training parameters or including new data, using the insights from the evaluation.

After the model has been improved, test it on a different test dataset to gauge how well it performs with unknown data. Then judge the model's capacity to generalize to new data with greater accuracy.

3.1 Functional, and non-functional requirements

Functional:

- The user shall be able to add image on the system
- The user shall be able to get details of diseases
- The user shall be able to get information to avoid the diseases

Non - functional:

- Use a User-friendly interface (UI/UX)
- Detecting speed.
- Web application loading speed

3.2Used Technologies

- To gather Primary data, using a structured questionnaire survey.
- Digital images will be used.
- Star UML will use as a diagramming tool. helps to design ER diagrams, use case diagrams, and user flow diagrams. Designing user-friendly interfaces using Figma Technology.
- To develop the smart mobile application, hope to use the Ionic framework.
- Visual studio code is used as a text editor.
- Use Database and backend service as the firebase.
- The collaboration tool is GitHub. Managing the tasks will use Trello boards.

4. Project Timeline

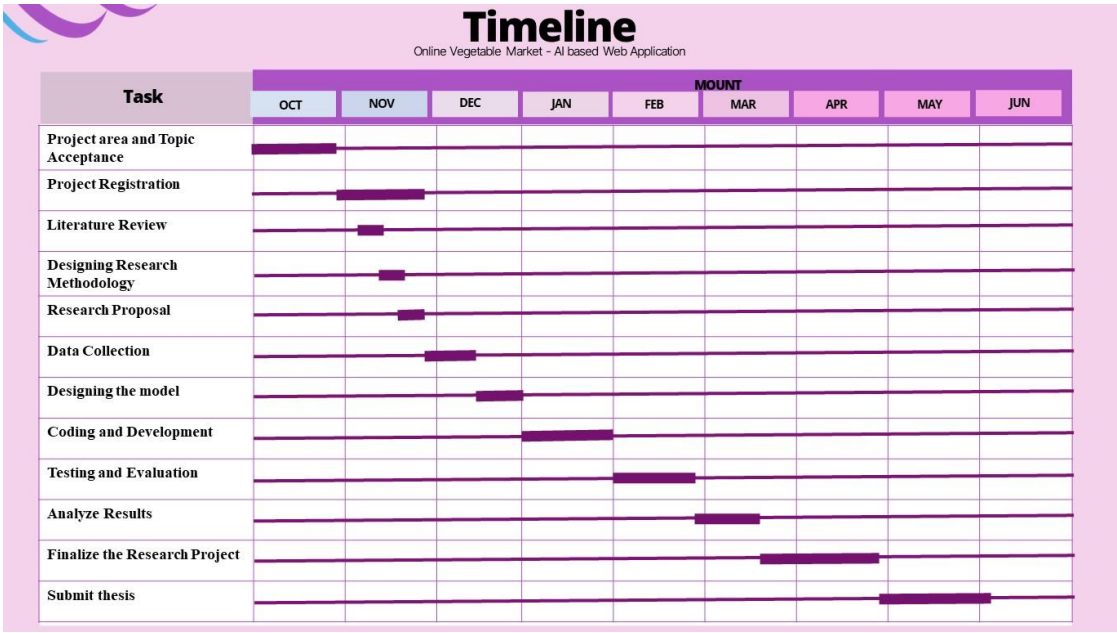

Table 2. Project Timeline

5. System Design Overview

Our study mainly required data for analysis. We hope to collect those using questionnaires from farmers. For this meeting and questionnaire hope to select all 50 people and 25 people to meet. Using those answers, can analyze and make information for our study.

- Camera - During the eye observation time, capture some images in the diseases carrots.
- Laptop – To gather data and analyze all data sets, develop the solution, and also make all documents.
- Smartphones - For software testing parts.

And also, for our study, we want the following software tools to get the best outcomes.

- Mendeley Desktop Application - This application is used for importing others' studies easily and getting access to and reading them. Also, can get ideas from those. And also, for adding reference use this.
- Microsoft Office Word – this application is mostly used for making our documentation part of the study.
- Google Forms tool – to create a questionnaire and analyze those responses.
- Microsoft Office Excel – To save data sets.
- Microsoft Office PowerPoint – Present study and outcomes and also used to create timeline.
- Canva Application – To create form heading covers and other graphic things.
- Zoom app - used for getting research group meetings to share updates on the study.

In the development part used,

- GitHub, Trello boards

- Visual Studio
- draw.io, Figma, Firebase

6. Conclusion

In conclusion, we intend to create a model that can be used as a platform for identifying carrots diseases. Our specific objective is to build a mobile app and after capturing image, identify fresh or not. According to the literature study, agriculture and crop cultivation are broad concepts in Sri Lanka. And in this research we are investigating on our web platform solution can be used for the vegetable market and farmers' problems. The expected outcome would be a successful user-friendly mobile application for detect diseases.

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