Faculty of Computer Science and Information Technology

A Web Based Fruit Classification Platform with Deep Learning Approach

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A WEB BASED FRUIT CLASSIFICATION PLATFORM WITH DEEP LEARNING APPROACH

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This project is submitted in partial fulfilment of the
requirements for the degree of
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2025

PLATFORM KLASIFIKASI BUAH BERBASIS WEB DENGAN PENDEKATAN DEEP LEARNING

MICHELLE CHANG JIA WEN

Project ini merupakan salah satu keperluan untuk
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Fakulti Sains Komputer dan Teknologi Maklumat
UNIVERSITI MALAYSIA SARAWAK
2025

DECLARATION

I hereby declare that the project report, "A Web Based Fruit Classification Platform with Deep Leaning Approach" is entirely original with my work completed to partially fulfil the requirements for the degree of Bachelor of Computer Science with Honours (Computational Science). I declare that this report, in whole or in part, has not been submitted to any other university or institution for consideration of any academic degree or professional certification.

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UNIVERSITI MALAYSIA SARAWAK

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ABSTRACT

Accurate identification of fruit species is made extremely difficult by their global range, especially when it comes to unfamiliar or uncommon kinds. Traditional fruit categorization techniques frequently result in inefficiency and human mistake since they mainly rely on manual observation and experience. To overcome these challenges, a web-based fruit categorization platform that makes use of deep learning technologies is suggested. Through the ability to input fruit images for immediate identification, the proposed solution streamlines the procedure and produces precise and effective outcomes. An agile design process was used to create the system, enabling continuous feedback and incremental improvements while it was being developed. To improve classification performance, a pre-trained EfficientNetB2 model was modified using the Fruits-100 dataset. To further enhance the user experience, the platform also includes a structured database with details fruit information. The final implementation demonstrates high responsiveness and accuracy. Other features, such as the ability to create PDF reports and track history, significantly improve usability. Future enhancements might include expanding the fruit dataset and adding ripeness detection capabilities. By bridging the gap between traditional classification methods and modern AI-driven solutions, this project develops a fruit classification platform that is scalable, effective, and user-friendly.

ABSTRAK

Pengenalpastian spesies buah dengan tepat menjadi amat sukar disebabkan oleh kepelbagaian buah di seluruh dunia, terutamanya apabila melibatkan jenis yang jarang ditemui atau kurang dikenali. Kaedah pengelasan buah secara tradisional sering kali tidak efisien dan mudah terdedah kepada kesilapan manusia kerana ia bergantung sepenuhnya kepada pemerhatian manual dan pengalaman. Bagi mengatasi cabaran ini, satu platform pengelasan buah berasaskan web yang menggunakan teknologi pembelajaran mendalam telah dicadangkan. Platform ini membolehkan pengguna memuat naik imej buah untuk tujuan pengecaman serta-merta, sekali gus memudahkan proses dan menghasilkan keputusan yang tepat dan berkesan. Proses reka bentuk Agile telah digunakan dalam pembangunan sistem ini, yang membolehkan maklum balas berterusan dan penambahbaikan secara berperingkat. Model EfficientNetB2 yang telah dilatih terlebih dahulu telah diubah suai menggunakan set data Fruits-100 bagi meningkatkan prestasi pengelasan. Untuk menambah baik lagi pengalaman pengguna, platform ini turut merangkumi pangkalan data berstruktur yang mengandungi maklumat terperinci mengenai buah. Pelaksanaan akhir menunjukkan tahap ketepatan dan tindak balas yang tinggi. Ciri tambahan seperti penjanaan laporan PDF dan penjejakan sejarah turut meningkatkan kebolehgunaan sistem. Penambahbaikan pada masa hadapan mungkin merangkumi perluasan set data buah serta penambahan keupayaan pengesanan tahap kematangan buah. Projek ini merapatkan jurang antara kaedah pengelasan tradisional dan penyelesaian moden berasaskan AI, sekali gus menghasilkan platform pengelasan buah yang berskala, berkesan dan mesra pengguna.

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LIST OF ABBRIEVATION

AI	Artificial Intelligence
ASD	Agile Software Development
CNN	Convolutional Neural Network
GUI	Graphical User Interface
DFD	Data Flow Diagrams
ERD	Entity Relationship Diagram
RGB	Red, Green, Blue

CHAPTER 1: INTRODUCTION

1.1 Background / Introduction

Fruits are essential components of our daily diets, providing vital vitamins and dietary fibre that benefit our health. Fruits such as apple, orange and banana are easily accessible in supermarkets, making them a convenient choice for daily nutrition. However, there are hundreds of fruit species in the world, and fruit production reached 1 million tons in 2021 according to fruit production data (Mimma et al., 2022). This data shows how much fruit is consumed, but it also poses a problem: correctly identifying different fruit types. Not everyone is familiar with every fruit, and it can be especially challenging to recognize uncommon or rare species. This problem emphasizes the necessity of precise, effective fruit categorization systems that may close the knowledge gap and enable broad fruit identification.

In past, traditional fruit classification methods have many limitations and mainly rely on manual observation and evaluation (None israa, 2020). According to Gulzar (2023), a person needs to have good knowledge to identify and recognizing different type of fruits. To be familiar with the characteristic of fruits, individuals usually rely on morphological features such as shape, colour, size. This process is time-consuming and prone to human error (None israa, 2020). This also poses a challenge to the public, especially for those without prior knowledge, where manual classification may lead to misidentification and missed opportunities to try to identify new or unfamiliar fruits.

Addressing this issue requires proactive measures to help the public identify various types of fruits. With the advancement of artificial intelligence (AI) and deep learning methods, fruit image classification has become increasingly accurate and efficient (Sinha and Dhanalakshmi, 2024). According to Sinha and Dhanalakshmi (2024), AI-based fruit image classification

systems have many advantages over traditional methods because they can recognize complex patterns and features, quickly process large amounts of data, and adapt to new data. Therefore, by using the state-of-the-art of the deep learning algorithm, it is now possible to identify fruit species accurately, which is suitable for daily use and help public to identify fruits easily.

The aim of the project is to build a web application that will classify out the fruit using a deep learning model. Through the website, users can upload fruit images and immediately receive results with the relevant fruit information. This is achieved by combining advanced image recognition and classification algorithms. Limitations of traditional methods and reduces the possibility of false identification while improving accessibility can be managed through this system. Therefore, public regardless of their age and background can use this system to bridge the gap between difficult identification questions and simple answers.

1.2 Problem Statement

Accurately identifying diverse types of fruits bring significant challenge due to the abundance of fruit species. Traditional methods of fruit classification usually based on manual observation of physical characteristics such as shape, color, and size, are time-consuming and prone to human error (None israa, 2020). Additionally, it also relies on the personal knowledge in identify fruit type (Gulzar, 2023). These methods require knowledge of fruit varieties, which not everyone can recognize, especially for rare or unfamiliar fruits. Therefore, the limitations of manual classification can lead to misidentification.

With the implementation of deep learning technology, this project has demonstrated strong performance in image classification, help to address this issue. This system aims to address the limitation of traditional methods by offering an accessible, efficient, and reliable

solution for fruit classification, suitable for a wide range of users and applications. This problem can be outlined with the following challenges:

(i) Time-Consuming Nature of Manual Classification

Traditional methods for fruit identification like based on manual observation or personal knowledge, are time-consuming and inefficient. Its demand a big block of time to see and compare the physical characteristics of each fruit, which does not scale well for large datasets or real-time applications.

(ii) Prone to Human Error Manual

Classification is strongly dependent on the knowledge and expertise of the classifier. This dependence on a human's judgment introduces an element of error, especially in the classification of the same fruits or rare species that may not be recognized easily.

(iii) Limited Knowledge of Fruit Varieties

Not everyone has the knowledge to recognize all kinds of fruits. For example, less common or exotic fruits may not be known by most people, and therefore, might be identified wrong. It further complicates accurate classification within the diverse or world-class context.

1.3 Aims and Objectives

The goal of this project is to develop a web-based platform that using a deep learning model to efficiently classify and identify fruits, addressing the limitations of traditional fruit classification methods. This platform aims to simplify the identification process for public, offering a user-friendly interface to upload fruit images for instant recognition. By doing these goals, the project looks to improve the accessibility, accuracy, and speed of fruit identification,

helping users gain insights into various fruit species with minimal effort. The specific objective of this project aims:

- To design a web-based fruit classification platform that allows users to upload images for right identification of various fruit species.
- To develop a system that provides the information of the fruit, enhancing user understanding of diverse types of fruits.
- To evaluate the functionality and usability of the proposed web-based platform that enables users to easily upload fruit images for real-time identification and feedback.

1.4 Brief Methodology

Agile method has been chosen for developing the web-based fruit classification platform because it supports iterative progress, flexibility, and continuous user feedback. Agile enables the improvement of the fruit classification system iteratively in small chunks called sprints (Daraojimba et al., 2024). This approach is helpful for any deep learning model as it allows continuous feedback and adjustment.

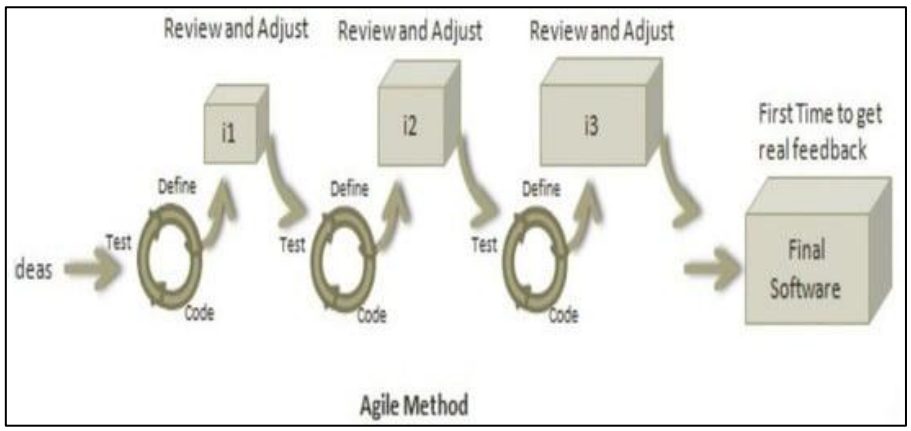

Figure 1.1: Agile Software Development (ASD) Methodology from Wafa et al. (2022)

The deep learning model will be trained with a dataset consisting of a variety of fruit images. A pre-trained Convolutional Neural Network (CNN) will be utilized to enhance the effectiveness of the learning process. This pre-trained model will provide it with best learning in which convergence can be achieved with higher accuracy and speed in fruit identification. For the development of the backend to support deep learning operations, Python will be used to handle model inference and data processing, while for the frontend web development is going to be done with the Python framework Streamlit and custom HTML and CSS, providing an accessible and responsive user interface.

A flexible and iterative approach to software development is emphasized by the Agile methodology, which makes it possible to adjust to changes and take user feedback into account at every stage. Idea collection and project requirements definition are the first steps, followed by several iterations where coding and testing occur. During each iteration, goals are established, features are created, and the program is thoroughly tested to find and fix any bugs. It will then move on to evaluate the findings and modify the project in considering user feedback and testing results. This cycle keeps on, allowing the product to be continuously improved and refined. In the end, the Agile approach ensures a user-centric development process and fosters cooperation by producing a final software solution that represents user demands and expectations.

1.5 Scope

The main goal of the project is to use deep learning to create a fruit classification web-based platform. Users will be able to input fruit photos to the system, and the platform will analyze them to precisely identify the fruit species. The software will give real-time feedback

with the fruit name accurately by using a deep learning model that has been trained on a large dataset. This tool is designed to be user-friendly so that individuals with little technological experience will find this tool easy to use.

The core functional requirements contain image upload feature, allowing users to submit images of fruits for analysis. After the fruit is uploaded, the platform will categorize fruit image using a deep learning model specifically using Transfer Learning. A pre-trained network will be used by the model to extract features from the picture. It will then fine-tune the model to classify the fruit based on these features by using a fruit image dataset. The name of the uploaded fruit along with its information will be displayed once the fruit is identified.

A fully functioning web interface and a trained deep learning model integrated into the system will be the project deliverables. However, the project's goal will not handle non-fruit items and complex characteristics like evaluating the quality and ripeness as well as mobile applications and APIs that are not part of the online platform. Even though the platform is designed to identify a wide range of fruits, its accuracy depends on the quality of the provided images and the amount of the training dataset utilized for the deep learning model. Lastly, only one object can be predicted per image for recognition.

1.6 Significance of Project

The web-based fruit classification using deep learning techniques will be very useful in improving accessibility, accuracy, and efficiency in fruit identification. Traditional identification of types of fruits relies on manual classification based on some physical features of the fruits or referring to expert knowledge, which is time-consuming and prone to errors.

This platform bridges the knowledge gap by making available a tool that is easy to use and allows users instantly to identify various species of fruits through image uploads.

Precisely, this is helpful for users who are not familiar with certain types of fruits and allows a wider section of people to correctly identify fruits. In this framework, the deep learning model has ensured that misidentification rarely happens and quickly helps the identification of fruits by anyone without regard to user background or experience.

The contribution of this general project is to enhance the accuracy and simplicity of fruit identification, promote learning and curiosity about the variety of fruits that exist, and present an effective use of deep learning in solving a practical, everyday challenge.

1.7 Project Schedule

Project Phase / Activities	Start	Finish	Duration (days)
1. Final Year Project 1	**7/10/2024**	**25/1/2025**	**105**
1.1 FYP Brief Proposal	7/10/2024	20/10/2024	14
Milestone 1	20/10/2024	20/10/2024	1
1.2 FYP Feedback and Comment from Reviewer/Examiner	21/10/2024	28/10/2024	8
Milestone 2	28/10/2024	28/10/2024	1
1.3 FYP Full Proposal	29/10/2024	14/11/2024	17
Milestone 3	14/11/2024	14/11/2024	1
1.4 FYP Chapter 1	15/11/2024	21/11/2024	7
Milestone 4	21/11/2024	21/11/2024	1
1.5 FYP Chapter 2	22/11/2024	13/12/2024	22
Milestone 5	13/12/2024	13/12/2024	1
1.6 FYP Chapter 3	14/12/2024	5/1/2025	23
Milestone 6	5/1/2025	5/1/2025	1
1.7 Compilation and Final Check of FYP1	6/1/2025	16/1/2025	11
Milestone 7	16/1/2025	16/1/2025	1
1.8 Submission of FYP 1 Report & Paper for Assessment	17/1/2025	17/1/2025	1
Milestone 8	17/1/2025	17/1/2025	1
1.9 FYP Presentation	24/1/2025	25/1/2025	2
Milestone 9	25/1/2025	25/1/2025	1

Figure 1.2: The Project Schedule of FYP1

The project schedule for a Final Year Project (FYP) 1 from July 10 in 2024, to December 25 in 2025 is shown in Figure 1.2 and the visualization of the project is shown in Figure 1.3. It

lists all the stages and tasks, together with the start and end dates and the amount of time needed for each activity. From October 7 to October 20 in 2024, the project starts with the FYP Brief Proposal. From October 21 to October 28, there is a response period. From October 29 to December 14, the Full Proposal is being developed. The project's subsequent chapters are planned to be finished by November 21 for Chapter 1, December 13 for Chapter 2, and January 5 for Chapter 3. In addition, the timetable comprises a final check from 6 January to 16 January 2025, which is followed by the report submission on 17 January and the presentation on 24 January or 25 January.

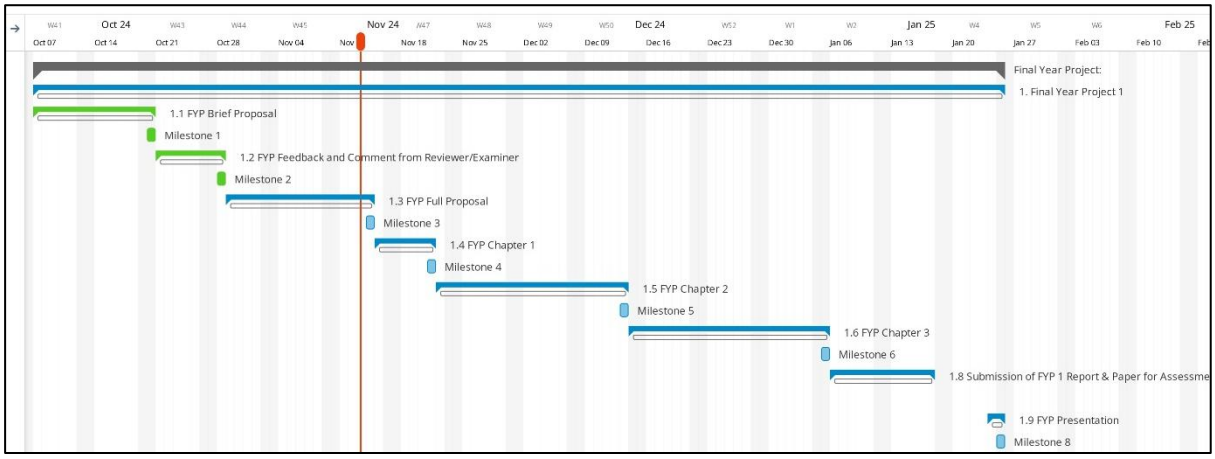

Figure 1.3: Gantt Chart of FYP1

Figure 1.3 shows the visualisation of Final Year Project (FYP) 1 Gantt chart which runs from October 2024 to January 2025. It clearly shows the beginning and ending dates of each activity while highlighting different stages and milestones. The project begins with the FYP Brief Proposal, start from October 7 and October 20. After that, there is a feedback process that continues until October 28. From October 29 to November 14, the Full Proposal is being developed. Chapters 1 through 3 are expected to be finished by in the end of January 5. Before the FYP 1 Report is submitted on January 17, 2025, a final check is scheduled to be finished by January 16, 2025.

Project Phase / Activities	Start	Finish	Duration (days)
2. Final Year Porject 2	**17/3/2025**	**28/7/2025**	**127**
2.1 Submission of the proposed/revised structire of FYP report, Title and gantt ch	17/3/2025	1/4/2025	16
Milestone 1	1/4/2025	1/4/2025	1
2.2 Submission of First Draft for Chapter 4	2/4/2025	15/5/2025	44
2.2.1 Development of the Fruit Classification Web-Based System	2/4/2025	8/5/2025	37
Milestone 2	7/5/2025	7/5/2025	1
2.2.2 FYP Chapter 4	9/5/2025	15/5/2025	7
Milestone 3	15/5/2025	15/5/2025	1
2.3 Submisson of First Draft for Chapter 5, 6 & Abstract of Paper	16/5/2025	31/5/2025	16
2.3.1 Testing of the Web-Based System	16/5/2025	19/5/2025	4
Milestone 4	19/5/2025	19/5/2025	1
2.3.2 Evaluation of the Web-Based System	20/5/2025	22/5/2025	3
Milestone 5	22/5/2025	22/5/2025	1
2.3.3 FYP Chapter 5	23/5/2025	25/5/2025	3
Milestone 6	25/5/2025	25/5/2025	1
2.3.4 FYP Chapter 6	26/5/2025	28/5/2025	3
Milestone 7	28/5/2025	28/5/2025	1
2.3.5 Abstract of Paper	29/5/2025	31/5/2025	3
Milestone 8	31/5/2025	31/5/2025	1
2.4 Submission of First Draft for FYP 2 Full Report & Paper	1/6/2025	10/6/2025	10
Milestone 9	10/6/2025	10/6/2025	1
2.5 Submission of Final Report, source code, installation kits, user manual and Paper for Assessment	11/6/2025	23/6/2025	13
Milestone 10	23/6/2025	23/6/2025	1
2.6 FYP Symposium	1/7/2025	2/7/2025	2
Milestone 11	2/7/2025	2/7/2025	1
2.7 Amendment and Modification Period for FYP	3/7/2025	18/7/2025	16
Milestone 12	18/7/2025	18/7/2025	1
2.8 Submission of Final Report	19/7/2025	28/7/2025	10
Milestone 13	28/7/2025	28/7/2025	1

Figure 1.4: The Project Schedule of FYP2

Figure 1.4 outlines a comprehensive schedule for the Final Year Project 2 from March 17 to July 28, 2025. The project is broken down into several stages, such as developing a web-based system, submitting reports, testing, evaluating, and final evaluations. Important dates, such finishing different report drafts, system evaluation, and symposium participation, are stated throughout the timeline. Besides of that, the initial drafts of Chapters 4, 5, and 6 are considered major submissions followed by the full report and final submission. Lastly, an amendment and modification time is also included in the schedule to guarantee that any necessary changes are made before the final report is submitted.

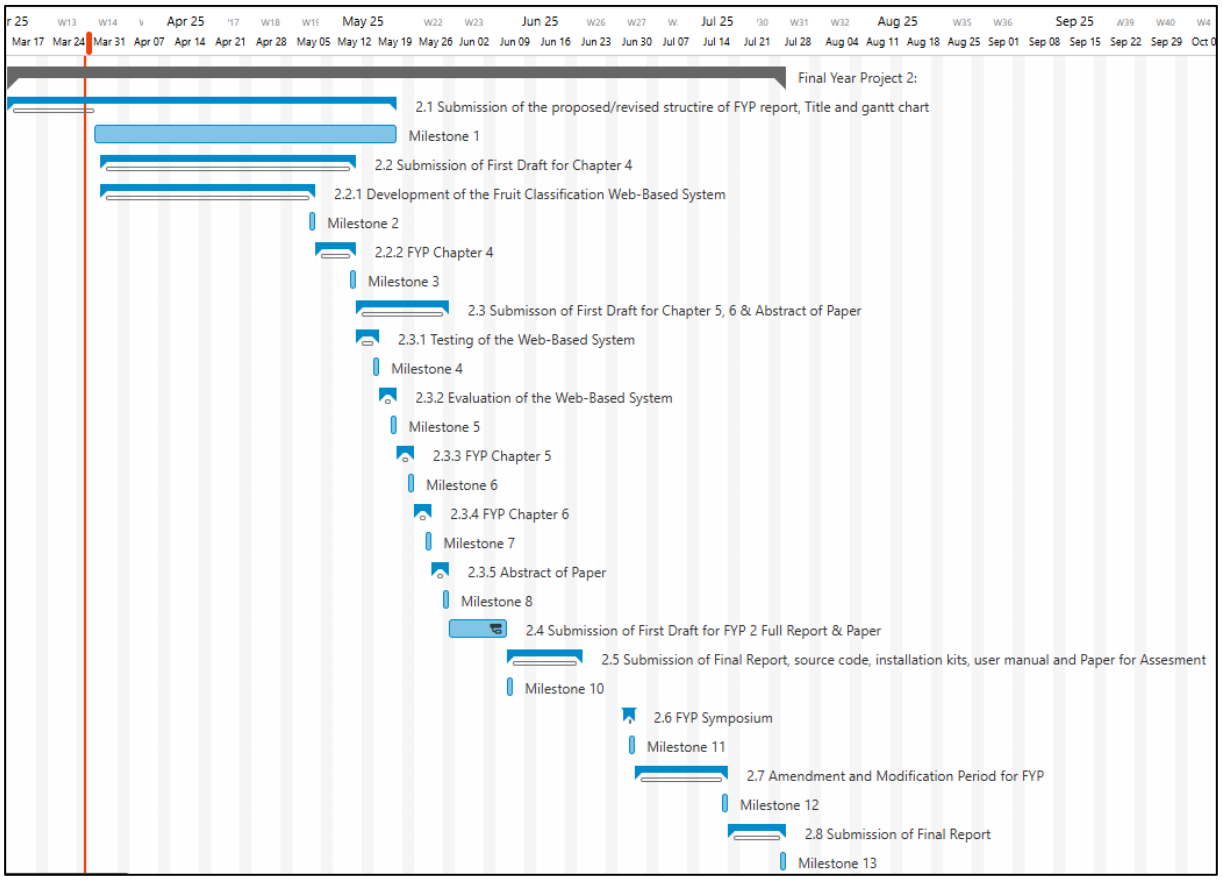

Figure 1.5: Gantt Chart of FYP2

Figure 1.5 shows the visualisation of Final Year Project (FYP) 2 Gantt chart which runs from March 17, 2025, to July 28, 2025, is shown in Figure 1.5. It clearly shows the orderly completion of significant activities, such as submission of various report drafts, the development and evaluation of the web-based system, and milestone achievements. The timetable also highlights important due dates, including the initial drafts of several chapters, the final report along with the final submission. It also identifies important events such as the FYP symposium, system testing, and a period for modifications and changes to improve the final report before to submission.

1.8 Expected Outcome

The expected outcomes of this project are as follows:

- Deliver a fully functional web application that accurately classifies various fruit species using deep learning models, providing fast and reliable results immediately after image upload.
- The platform minimizes human error and ensures consistent, precise identification across a wide range of fruit species.

1.9 Project Report Outline

This project consists of 6 chapters which are introduction, literature review, requirement analysis and design, implementation, testing and conclusion and future work.

Chapter 1: Introduction provides an overview of the project including its background, problem statement, objectives, methodology, project scope, significance of project, project schedule, expected outcome, and project outline.

Chapter 2: Literature Review reviews existing systems related to fruit classification and web integration. It analyses their functionalities with respect to the proposed system. This review is expected to add value to the design of a solution to address identified limitations and, thus, enhance the effectiveness of the web-based fruit classification platform.

Chapter 3: Requirement Analysis and Design outlines the requirements and specifications of the project, focused on the use of the Agile methodology for flexibility and iteration. Visual representation will also be discussed in this chapter In Agile, these designs can be refined incrementally. Additionally, data collection methods, such as utilizing a

Google Form questionnaire, are discussed to ensure thorough preparation for meeting user needs and improving system functionality throughout the development cycle.

Chapter 4: Implementation covers the phases of the fruit classification platform's development. The implementation process describes how the deep learning model is integrated into the web-based system, ensuring ease of use and that it works seamlessly. To achieve the platform objectives, measures will be taken to optimize system functionality and usability.

Chapter 5: Testing process is conducted to check the reliability and accuracy of the system. Each feature will be evaluated and any issues founded are fixed in the process to make sure that the platform is ready to use and performs well in the classification and identification of fruits.

Chapter 6: Conclusion and Future Work provides an overview of the main points and makes recommendations for additional developments.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing systems that are relevant to the development of the proposed web-based fruit categorization platform. It starts with a thorough analysis of the features, strength, and limitations of the three existing systems, pointing out any functional gaps that the proposed system seeks to fill. In addition, the evaluation explores the technology and tools used to develop the proposed system to identify key strategies for developing a platform that is both efficient and easy to use. By evaluating these systems thoroughly, the literature research provides the foundation for creating a solid solution that meets user requirements.

2.2 Review on Similar Existing System

A review on 3 similar existing systems is given in this section. To find areas for development and create a more effective web-based fruit classification platform, it is crucial to comprehend the strengths and weaknesses of these systems. The chosen existing systems for examination are:

- Glean Machine
- Fruit Identifier
- Image Recognize

2.2.1 Glean Machine

The Glean Machine mobile application is a helpful tool for local farmers' markets since it is made to help identify a broad range of food. It makes it easier to identify fruits and

vegetables from across the globe by comparing user-uploaded images to a database of more than 300 different kinds of food (App Store, 2024). This provides rapid and precise identification, removing uncertainty and improving the buying experience. Below will show the Glean Machines interface:

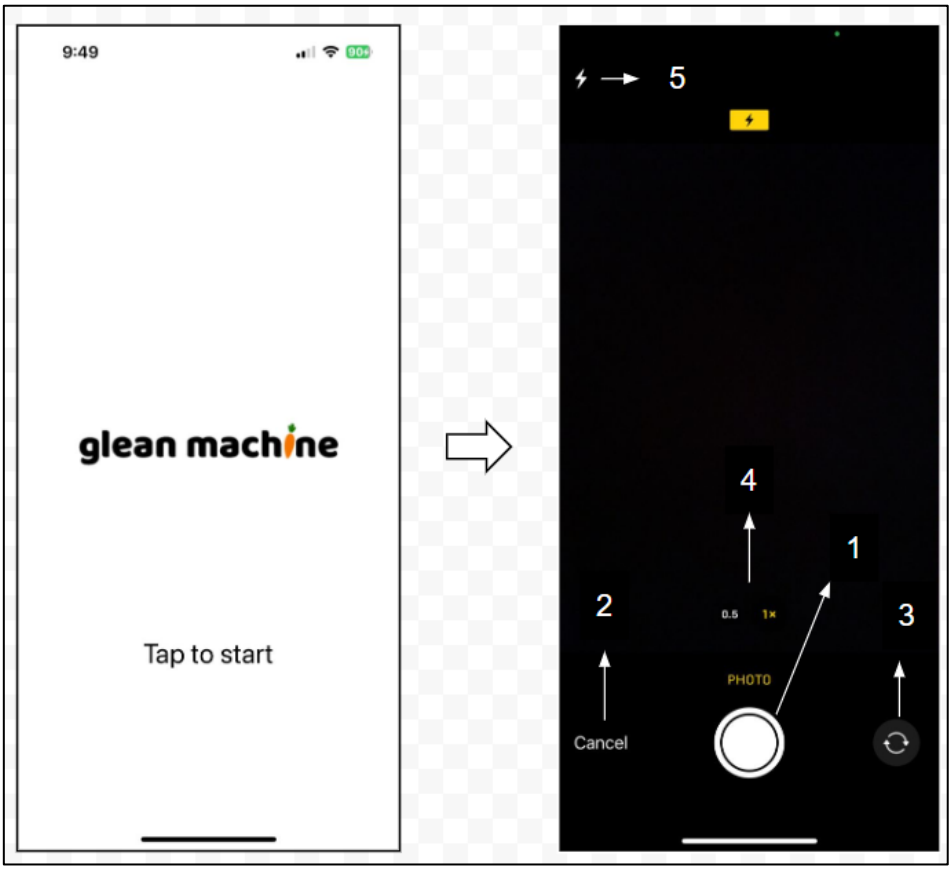

Figure 2.1: Interface of Glean Machine

Figure 2.1 shows the Glean Machine interface. The first screen shown on the left side displays the welcome page of the app with a "glean machine" logo and a “Tap to start” button. After tapping it, it will move to the second screen displayed on the right, showing the camera interface that allows the user to take a fruit photo for identification. The functions and the description of the camera interface in Glean Machine are outlined in Table 2.1 below:

Table 2.1: Functions in Glean Machine

Functions		**Description**
1	Photo Capture Button	User can click the camera button to capture a picture of the fruit.
2	Cancel Button	User can click the cancel button to exit the photo mode without taking a picture.
3	Camera Switch Button	User can choose to switch front and rear camera based on their preferences.
4	Zoom Control (0.5x/1x)	User can adjust the zoom level by choosing between a wider field of view (0.5x) or closer focus (1x) to capture more detail.
5	Flash Toggle	User can choose to turn “On” or “Off” the camera light.

Strength of Glean Machine

- **Ease of Use:** Provide a user-friendly interface, allowing the user to easily identify the object by using the camera, and enhance the accessibility for users of all experience levels.
- **Real Time Processing:** Provides fast detection to identify objects, enhancing usability and convenience.

Weakness of Glean Machine

- **Lack of Fruit Information:** The lack of comprehensive details on the selected fruits limits the system's use for practical or educational reasons.
- **Unable Upload Images:** Unable to upload previously taken images for classification, reducing its flexibility compared to the similar app.

The Glean Machine mobile application is a great tool for recognizing a large range of fruits and vegetables. Real-time object identification and a user-friendly interface allowing users to quickly and accurately identify items with little effort. However, there are still certain things the app might do better, including introducing an image upload tool to provide users with greater flexibility, addition introducing fruit detail to enhance user experience. Overall, the Glean Machine is still a useful tool for identifying items since it provides accurate and timely results.

2.2.2 Fruit Identifier

Fruit Identifier is a machine learning application created by Kevin Tang that can recognize 40 different fruit types from uploaded fruit images or a camera input (Tang, n.d.). Users can upload a fruit photo to identify types of fruit. It uses photo recognition technology to help users identify fruits they may not be familiar with. Below will show the Fruit Identifier interface:

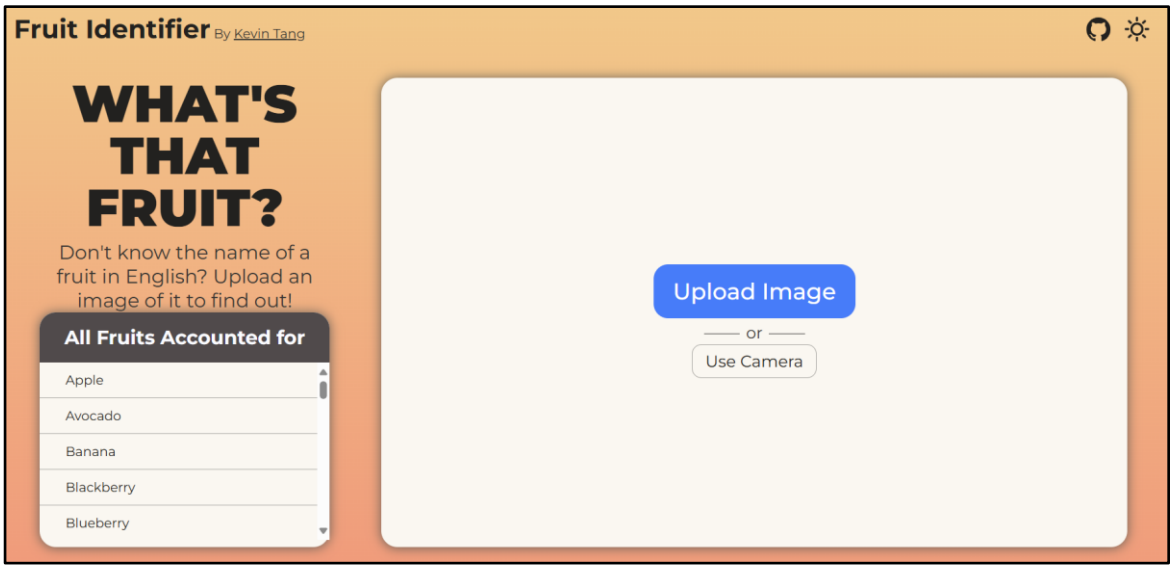

Figure 2.2: Interface of Fruit Identifier

Figure 2.2 shows the web interface of Fruit Identifier. Users can upload a fruit image by selecting the “Upload Image” button or using the “Use Camera” button to capture a fruit photo directly. Once the image is uploaded or captured, the result of the possible fruit will be displayed to the user. On the left side, there is a table with the title "All Fruits Accounted For", listing the fruit that the program has previously identified. While at the top-corner side, there is a “Dark Mode” option, enabling users to choose darker or lighter themes based on their preferences. The description of the function of Fruit Identifier will be outlined in Table 2.2 below:

Table 2.2: Functions in Fruit Identifier

Functions	**Descriptions**
Upload Image	User can click the upload image button to upload previously taken fruit pictures from their device.
Use Camera	User can click the camera button to capture a picture of the fruit in real time.
Dark Mode Option	User can choose to select darker or lighter themes at the dark mode option.

Strength of Fruit Identifier

- **Ease of Use:** Allowing the user to easily identify the object by taking pictures with the camera or uploading ones that already exist. A user-friendly interface improves the accessibility for users of all experience levels.
- **Real Time Processing:** Enhances usability and user convenience by providing quick and effective detection and instant item identification.
- **Offer Dark Mode Settings:** Enabling users to choose between a darker and brighter UI based on their preferences.

Weakness of Fruit Identifier

- **Lack of Fruit Information:** The lack of comprehensive details on the selected fruits limits the system's use for practical or educational reasons.

The Fruit Identifier website is an easy-to-use tool that makes fruit identification simpler. It has features including real-time processing for fast and effective detection, a dark mode option for an adjustable user interface, and simplicity of usage through camera capture or picture upload. These features help to improve its accessibility and usability, making it easy for users to use. However, the lack of fruit detail limits user to get more information about the identified fruit. Despite this, the website application is still a very useful and easy way to effectively identify fruits.

2.2.3 Image Recognize

A website called ImageRecognize.com performs image identification jobs using machine learning technologies. It has tools for specifically identifying things in uploaded fruit images (Image Recognize, 2022). Users can interact with the system by uploading an image, adjusting minimum confidence levels or limiting the maximum object detection. Below will show the Image Recognize interface:

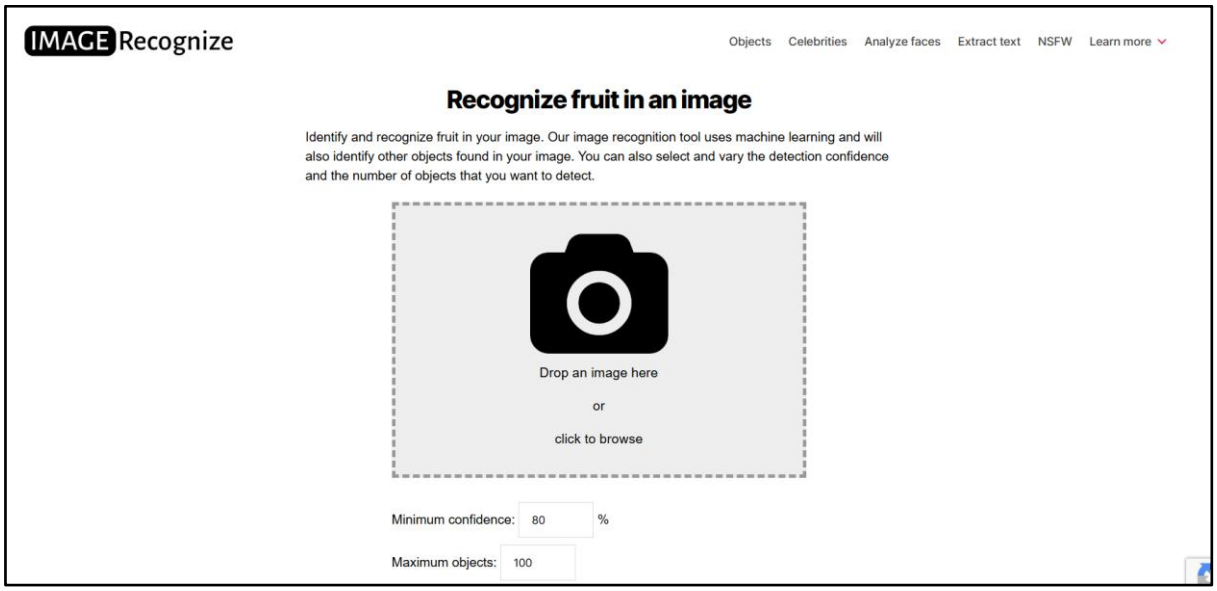

Figure 2.3: Interface of Image Recognize

Figure 2.3 shows the Image Recognize web interface. Users can upload a fruit image by either selecting the “Click to Browse” button or “Drop an Image” into the layout. After the image is uploaded, the possible fruit result is displayed to the user. Apart from that, user can change the result display by modifying the "Maximum objects" field and the "Minimum confidence" slider. Each of the functions that display in the Image Recognize interface will be explained in Table 2.3 below:

Table 2.3: Functions in Image Recognize

Functions	**Descriptions**
Click to Browse	User can upload previously taken fruit pictures from their device by clicking the click to browse button.
Drop an Image	Users can drag and drop fruit image from their devices directly onto the interface for detection.
Minimum Confidence Level	User can choose to select the amount of confidence needed for detections. Higher confidence shows more accuracy in identifying fruit images, while lower confidence shows less accurate identification.

Maximum Objects Detection	User can limit the number of objects classified in one single image by adjusting the maximum object field.

Strengths of Image Recognize

- **Ease of Use:** Users can upload images directly or use drag-and-drop functionality, making it easier for the users to use the system.
- **Real Time Processing:** It provides fast detection to classify objects, giving users an instant result.
- **Ability to Identify Multiple Items:** Ability to recognize and categorize many things in a single image, providing flexibility in simultaneously identifying a variety of items

Weakness of Image Recognize

- **Lack of Fruit Information:** The lack of comprehensive details on the selected fruits limits the system's use for practical or educational reasons.

The Image Recognize website provides users quickly classifying objects in photos. Features like simplicity of use, drag-and-drop capabilities or direct picture uploading, real-time processing and the ability to identify multiple items are among the system's strengths. However, the lack of fruit information prevents user from learning more about the fruit. Excluding this limitation, the platform remains an effective and useful option for object classification.

2.3 Comparison of the Features in the Reviewed Existing System

Table 2.4: Comparison of the Features of Three Existing Systems and the Proposed System.

Features	**Existing System**			**Proposed System**
	Glean Machine	Fruit Identifier	Image Recognize	
Web Application	✗	✓	✓	✓
Mobile Application	✓	✗	✗	✗
Upload Image	✗	✓	✓	✓
Camera Support	✓	✓	✗	✗
Drop an Image	✓	✗	✓	✓
Real Time Feedback	✓	✓	✓	✓
Dark Mode Option	✗	✓	✗	✓
Minimum Confidence Level	✗	✗	✓	✗
Maximum Object Detection	✗	✗	✓	✗
Fruit Detail	✗	✗	✗	✓

A comparison of the features of the proposed system and the existing systems is shown in Table 2.4, highlighting both their main differences and similarities. Based on table 2.4, it shows that Glean Machine is a mobile app, but other systems, including the proposed system, are web-based applications. For the upload image feature, it is not supported by Glean Machine, while Fruit Identifier, Image Recognize, and the proposed system have this feature. In reference

to the camera support feature, Glean Machine and Fruit Identifier includes this functionality, although Image Recognize, and the proposed system does not. While dropping an image feature, both Glean Machine and Image Recognize, along with the proposed system offer this function but Fruit Identifier does not.

Additionally, all systems have real-time feedback features that guarantee users get accurate results in a timely manner. Among these features, only the Fruit Identifier and the proposed system have the dark mode option while Glean Machine and Image Recognize do not. Features like minimum confidence level and maximum object detection, Image Recognize system is the only one that supports both features but other systems, including the proposed system, do not.

Along with that, none of the three existing systems have include fruit detail features. Therefore, the proposed system defines itself by being the only system that supports this feature, addressing the limitation of providing detailed fruit information. Overall, the proposed system aims to address the limitation of the existing system and improve the functionality overall, providing a user-friendly and flexible fruit categorization platform.

2.4 Technology and Tools Used to Develop the Proposed System

2.4.1 Deep Learning

Deep learning is a branch of artificial intelligence and machine learning that employs artificial neural networks in response to human decision-making. To identify trends and generate predictions, it involves training models on huge datasets. Besides, it works especially well for applications like image identification and classification since it can automatically extract characteristics from raw data without human intervention. By using deep learning, the

project can accurately recognize a variety of fruits, guaranteeing the implementation's scalability and dependability (Holdsworth & Scapicchio, 2024).

2.4.2 Kaggle

The well-known online platform Kaggle provides a huge selection of datasets, code notebooks, and contests that are mostly focused on machine learning and data science (Staff, 2025). It is a useful resource for academics and developers looking for high-quality datasets for testing and model building. To assess the effectiveness of the fruit classification model, model training was conducted using Kaggle's integrated code notebooks, and the dataset will be sourced from Kaggle.

2.4.3 Frontend Technologies: HTML, CSS

Frontend technologies like HTML, and CSS are important in development. It helps to create an interactive and attractive interface. HTML defines features like headers, paragraphs, and graphics and organizes the content of web pages. Next, CSS enhances the design of the interface including colors, fonts, and layouts, guaranteeing a visually appealing and responsive experience. These technologies work together to create web apps that are entertaining and easy to use (Jain, 2024).

2.4.4 Streamlit

Streamlit is an open-source Python framework used for developing the frontend interface. Streamlit makes it easier to create interactive web apps and enables smooth interaction with deep learning models and Python scripts (Inc, n.d.).

2.4.5 PostgreSQL (PgAdmin)

PostgreSQL is a free and powerful database system used to store and manage data. It supports different types of data, like numbers, text, and even more complex data like JSON. People use PostgreSQL in websites, apps, and big systems because it is reliable, secure, and handles large amounts of data well (GeeksforGeeks, 2023).

2.4.6 Visual Studio Code

Visual Studio Code is a great option for both frontend and backend system development since it supports many programming languages, such as HTML, JavaScript, and Python. It helps to improve productivity and streamline the development process as it offers several essential features including intelligent code completion, debugging tools, and version control integration. Besides, its flexibility also enables developers to build unique plugins for tasks, enhancing functionality and customizing the editor to meet the requirements of the project. Therefore, Visual Studio Code is suitable to be used in developing the proposed system (*Why Visual Studio Code?*, 2021).

2.5 Summary

Chapter 2 provides a comprehensive literature review of 3 existing systems. It looks at the strength and weakness of three systems: Image Recognition, Fruit Identifier, and Glean Machine. Additionally, it highlights the features provided by the proposed system by comparing the aspects of the current systems, helps to improve usability, and provides a more flexible and user-friendly platform. The study also discusses the tools and technologies used to create the existing system, guaranteeing that it offers a reliable, flexible, and effective fruit classification solution.

CHAPTER 3: REQUIREMENT ANALYSIS AND DESIGN

3.1 Introduction

The chapter begins with an introduction to the Agile Scrum framework, a flexible method for managing and gradually improving the development process. Then, it goes on to the questionnaire process, describing how surveys were used to get user opinions on what they wanted the system to do. Lastly, the system design is discussed and divided into 2 sections which were logical design and physical design. For the logical design of the system, it focuses on the underlying processes and workflows. Flowcharts and data flow diagrams is used to show the steps and processes involved, from uploading a fruit image to displaying the classification results. Meanwhile, the physical design, specifically graphical user interface (GUI) design, discusses how the system will look and how the user will interact with it.

3.2 Methodology

Agile Scrum framework will be employed as it is a flexible approach designed to improve the software development efficiency and flexibility. It is suitable because it emphasizes cooperation and iterative progress, enabling structured task management while adapting changes as they occur.

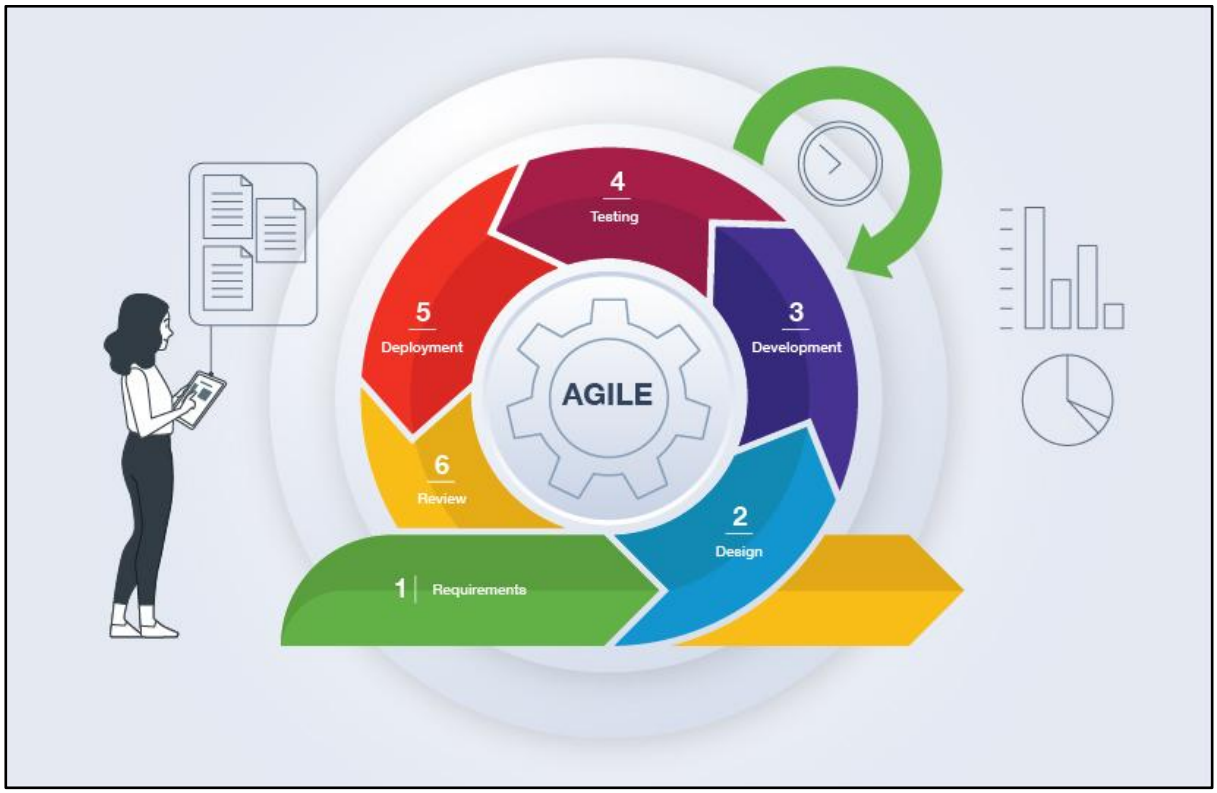

Figure 3.1: Agile Software Development Process from Chauhan (2024)

The process starts with planning, where the developer produces a list of user stories and describes the platform's fundamental characteristics. Second step is the design phase which involves creating a graphical user interface (GUI) design for visualization, enabling the early detection of any design flaws. Third step goes to the development phase. This phase is divided into short cycles known as sprints that usually run two to four weeks, allowing the developer the opportunity to concentrate on one or two user stories at a time. Then, it will proceed to the testing phase along with the deployment phase. Continuous testing will go on during deployment to ensure the functionality and quality of every finished product. Lastly, each sprint concludes with a review session that evaluates the outcome, collects feedback, and considers lessons gained to guide improvements for the next sprint.

3.3 Requirement Analysis

This chapter describes the methodology for collecting requirements via questionnaires and lists the essential functional needs for the system.

3.3.1 Questionnaires

In this section, a Google Form survey was conducted and distributed to the public to collect user requirements and explore the motivation for developing the proposed system. The survey was structured into 4 sections: **Section A: Demographic Information**, **Section B: Technology Awareness**, **Section C: User Background and Relevance to the Platform** and **Section D: Platform Functionality and Features**. A total of 30 respondents were collected from the public for analysis to gain a comprehensive understanding of user requirements that would guide the development of a system that effectively meets the needs of its target audience.

Section A: Demographic Information

This section aims to gather basic information about the respondents, inquiring about respondents' age, gender and occupation.

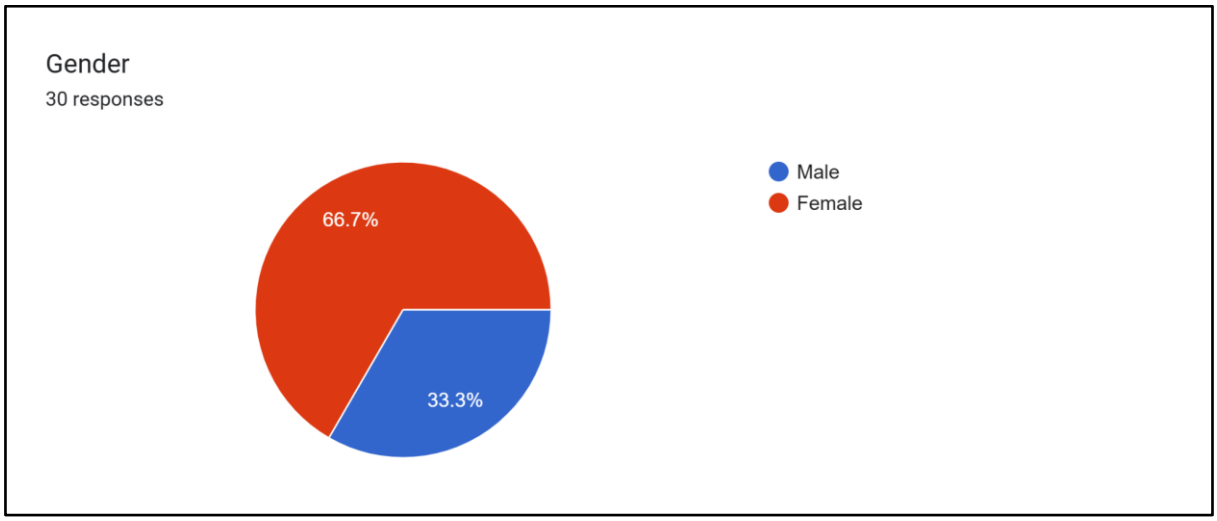

Figure 3.2: Gender of Respondents

Figure 3.2 shows that out of 30 respondents, a total of 10 (33.3%) are male respondents while the number of female respondents is 20 (66.7%).

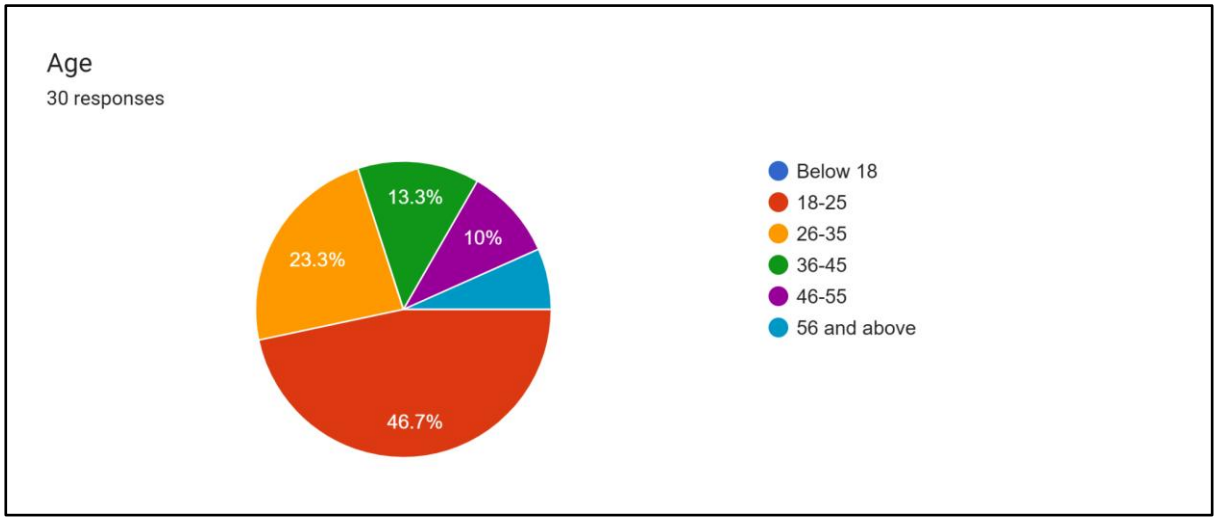

Figure 3.3: Age of Respondents

The age distribution of the 30 respondents is shown in Figure 3.3. Most respondents consist of 14 individuals (46.7%) aged between 18-25, followed by 7 respondents (23.3%) within the 26-35 age range. After that, 4 respondents (13.3%) are between the ages of 36 and

45, and 3 respondents (10%) are between the ages of 18 and 25. Age ranges above 56 have 2 respondents (6.7%) while age ranges below 18 have no respondents.

Section B: Technology Awareness

This section aims to know user experience with AI tools and web applications to evaluate level of familiarity with this type of platform.

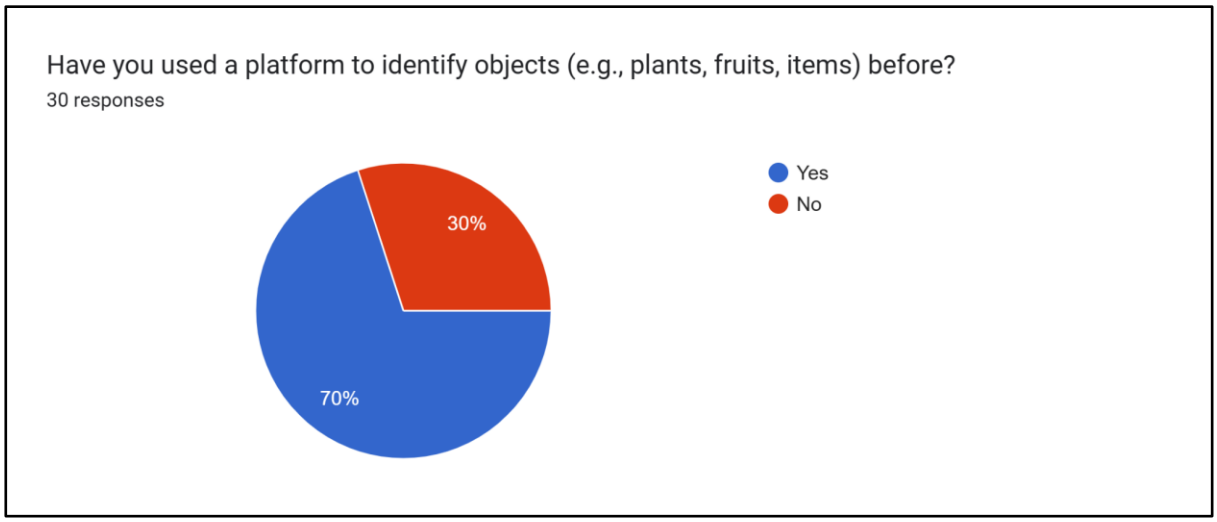

Figure 3.4: Usage of Identification Platform

Based on Figure 3.4, it found that 21 respondents (71%) have used a platform to identify objects while 9 respondents (30%) have not used it before. This shows a high level of user involvement with object-identification technologies in the past, which may reflect familiarity and interest in related AI-based products.

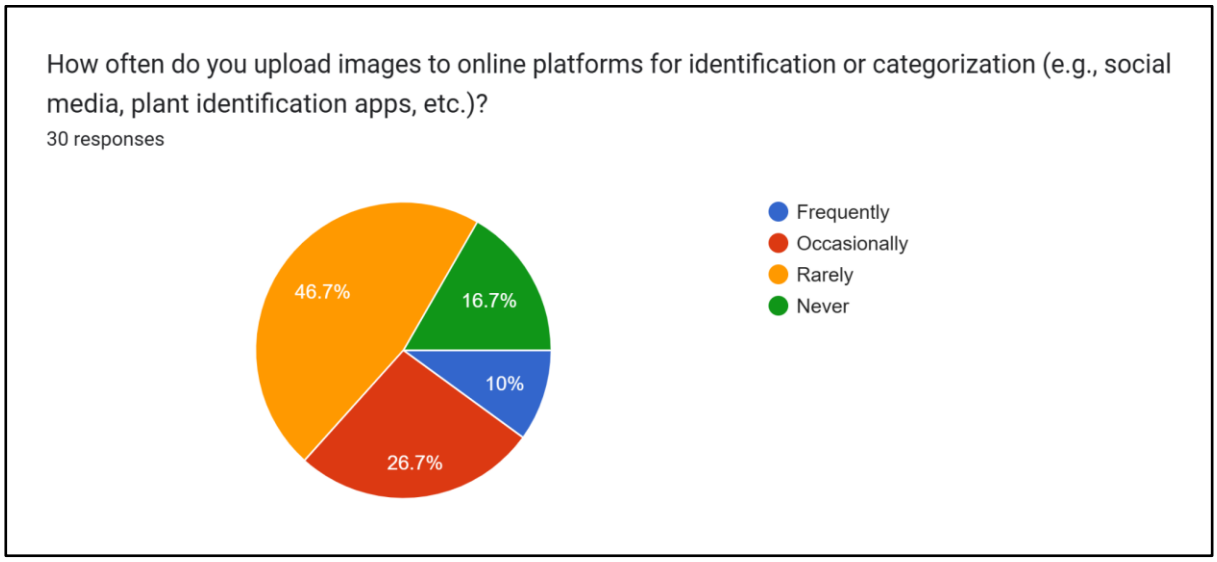

Figure 3.5: Frequency of Uploading Images for Identification

Figure 3.5 shows that 8 respondents (26.7%) undertake this activity occasionally, whereas 14 respondents (46.7%) do it rarely. Furthermore, only 3 respondents (10%) frequently involve this activity, and 5 respondents (16.7%) never upload any images for such purposes. These results show that most individuals do not use image-based identification services, even though only a small percentage of users are open to them. This emphasizes how important it is to highlight the advantages and usability of these applications to get more users to seek out them.

Section C: User Background and Relevance to the Platform

This section aims to identify the relevance of the platform to the users and their potential needs.

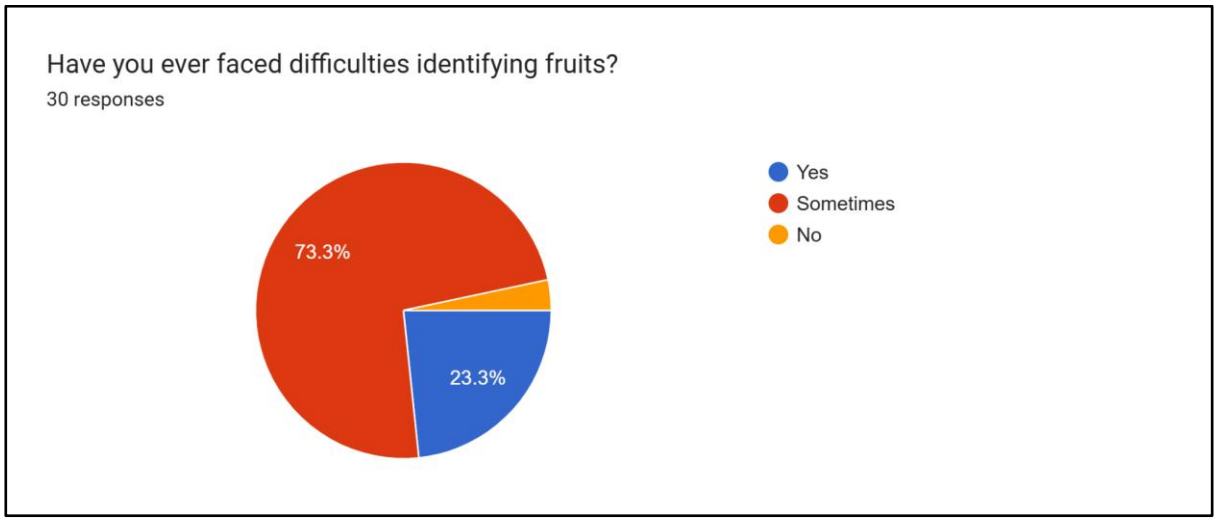

Figure 3.6: Familiarity with Identifying Fruits

A total of 22 respondents (73.3) occasionally have trouble identifying fruits, and 7 respondents (23.3%) do this daily based on Figure 3.6. Only 1 respondent (3.3%) do not face this issue. These results highlight the possible need for tools or software designed to make this process easier as most of the people have difficulty identifying fruits.

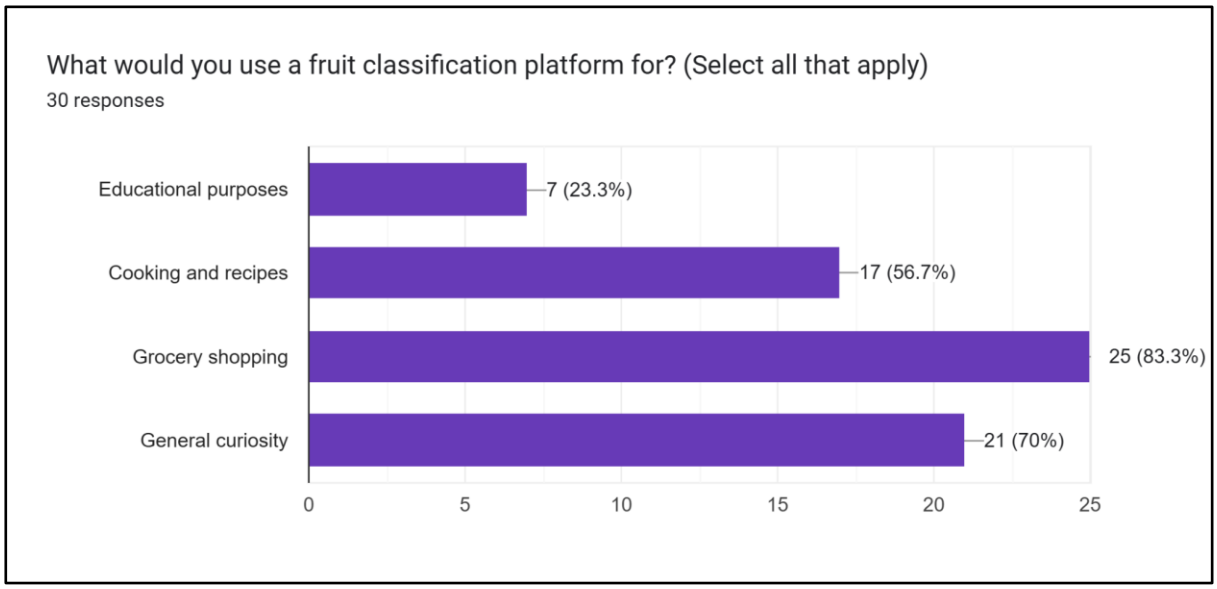

Figure 3.7: Uses for a Fruit Classification Platform:

Referring to Figure 3.7, grocery shopping contains a majority of 25 respondents (85.3%) as their primary need, followed by general curiosity with a total of 21 respondents (70%) choosing this option. Additionally, 17 respondents (56.7%) choose to use it for cooking and recipes, while 7 respondents (23.3%) think about using it for teaching. These findings indicate the platform's wide popularity, especially for real-world uses like shopping and cooking while also meeting demands for curiosity and education.

Section D: Platform Functionality and Features

This section helps in understanding the essential features of a fruit categorization platform.

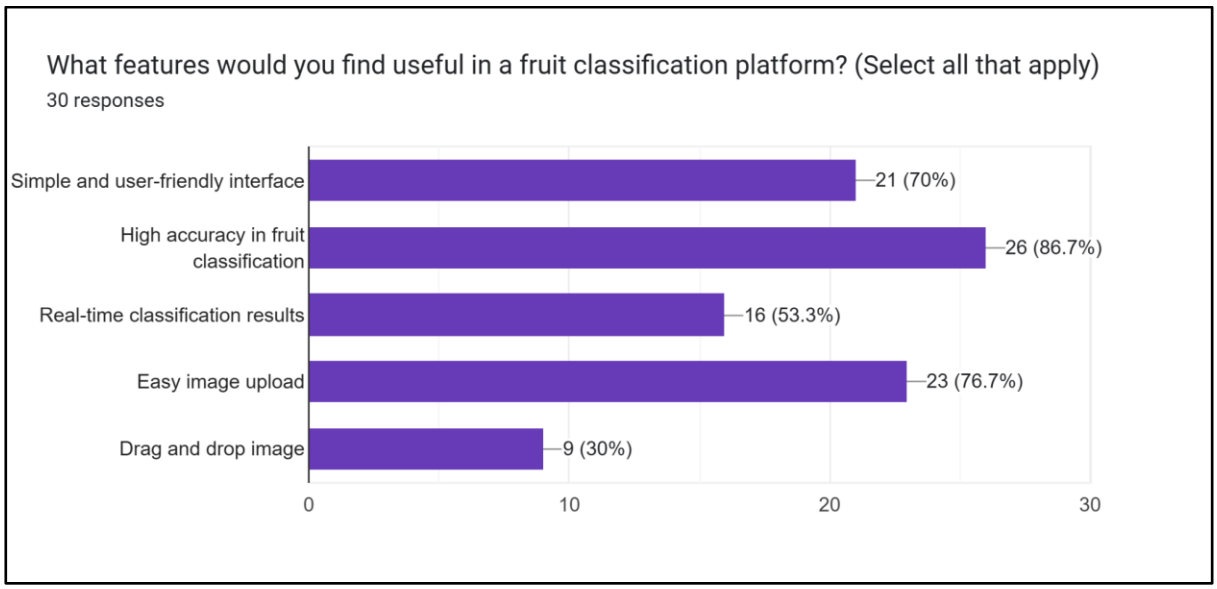

Figure 3.8: Useful Features for a Fruit Classification Platform

Figure 3.8 shows that most of the respondents select high accuracy in fruit classification as their main option, namely 26 respondents (86.7%). A simple and user-friendly interface option obtained 21 number of responders (70%), followed by 23 respondents (76.7%) choosing an easy image upload option was also highly rated. Additionally, 16 responders (53.3%)

preferred real-time classification results, while 9 responders (30%) preferred drag-and-drop image functionality. These results show the significance of precision and usability, indicating that satisfying user expectations requires smooth operation and straightforward design.

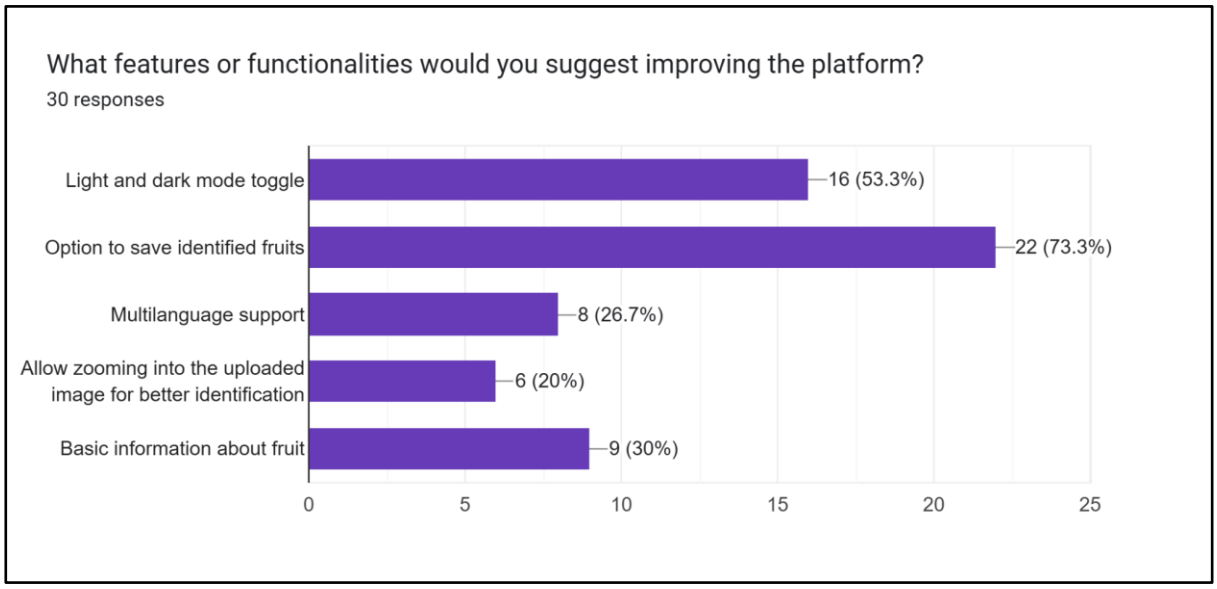

Figure 3.9: Suggested Features for Improving the Platform

According to Figure 3.9, improvements to the fruit classification platform include the ability to save detected fruits, which is chosen by 22 respondents (73.3%) and bright and dark mode toggle, which is preferred by 16 respondents (53.3%). Additional suggested improvements include providing basic fruit information (30%). support for multiple languages (26.7%) and the option to enlarge uploaded photos for easier identification (20%). These findings highlight how crucial it is to improve usability, accessibility, and personalization to better meet the varied demands of users.

3.3.2 Functional Requirements

The functional requirements of the proposed system outlined as follow:

- User able to upload an image of fruit to the platform.
- A prediction result will be generated regarding the type of fruit that is uploaded.
- Display the result to the user in a clear and organized way.

3.4 System Design

In this section, there are 2 main parts to system design which are logical design and physical design.

3.4.1 Logical Design

The logical design skips over technical details and concentrates on how the system will function. It consists of system architecture design, flowchart and data flow diagram which are context diagram and Level 0 diagram, entity relationship diagram and data dictionary.

3.4.1.1 System Architecture Design

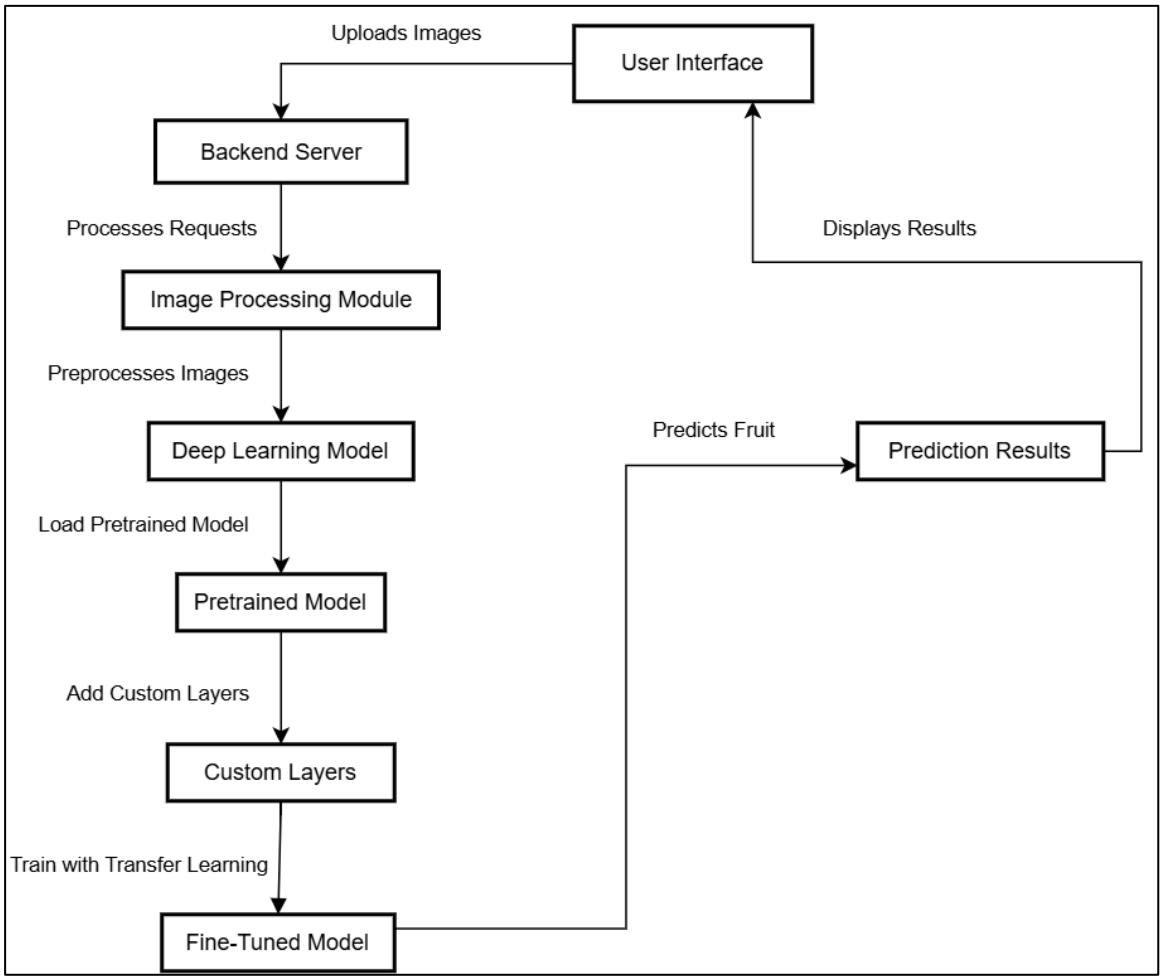

Figure 3.10: System Architecture Design for a Fruit Classificaion System

According to Figure, 3.10, the system architecture shows how a deep learning method is used to classify fruits. The first step is the **User Interface**, where people upload pictures of fruits to engage with the system. The **Backend Server** receives the uploaded photos, handles the requests, and serves as a link between the user and the system's several components.

The **Image Processing Module** handles uploaded pictures first, preprocessing them before feeding them into the **Deep Learning Model**. A **Pretrained Model** is the starting point for the deep learning process, and **Custom Layers** are added to improve it. The model is refined using transfer learning techniques to provide a **Fine-Tuned Mode**l that is especially suited for

fruit categorization. Based on the processed picture, this model provides a fruit species prediction and uses the interface to deliver the **Prediction Results** to the user.

3.4.1.2 Flowchart

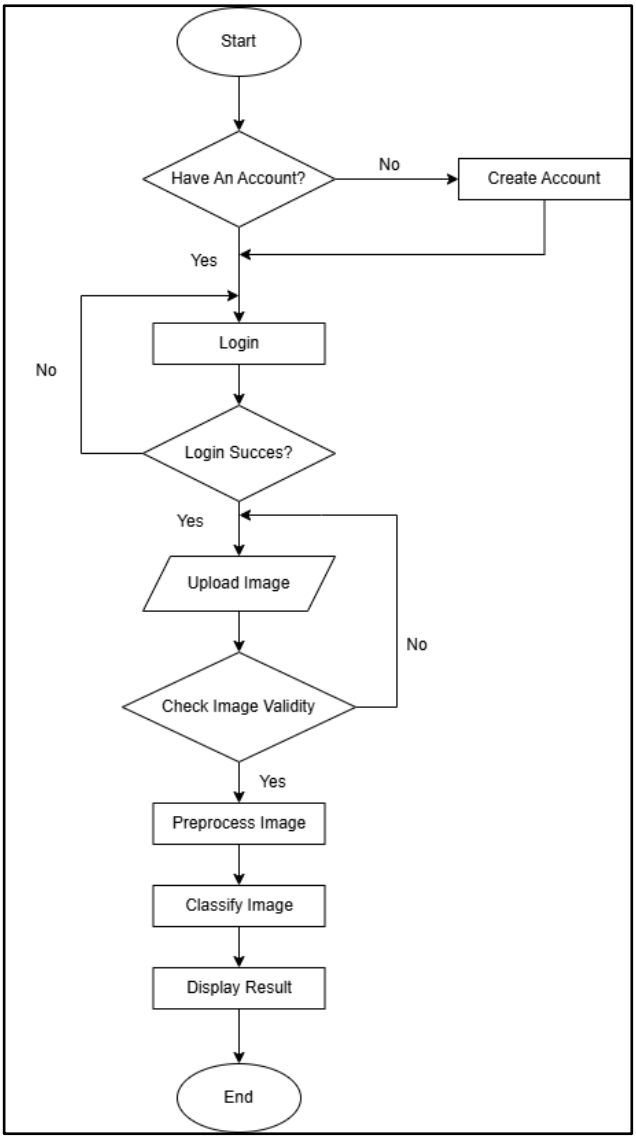

Figure 3.11: Flowchart of a Fruit Classification System

Figure 3.11 shows the process of workflow of the proposed system. It initially starts with a decision point that follows “Have An Account”. If the user answers “Yes”, it proceeds to the login step, while if the user answers “No”, the user is required to create an account. Then,

the system will then verify whether the login attempt was successful. If the user successfully logs in, they can upload a picture; if they don't, they have to try again. Once the image is uploaded, it goes through the “Check Image Validity” decision point, where the system verifies that the submitted picture is valid. After successful validation, the system performs image preprocessing steps before classifying it to determine the type of fruit. Next the pre-processed image will then be sent into a deep learning model, which uses features it has learnt from a training dataset to classify the fruit. A fruit type prediction will be generated by the model. Finally, the classification results are displayed to the user with the information of the fruit, and the process ends at the “End” point.

3.4.1.3 Data Flow Diagrams (DFDs)

Data Flow Diagrams (DFDs) act as a visual representation, illustrating how the data flow within the system. A relationship between different components can be clarified with the help in identifying the inputs, processes and outputs. By visualizing the information flow, DFDs foster clear understanding and communication between system users and designers, guaranteeing the requirements are appropriately captured and delivered.

3.4.1.3.1 Context Diagram

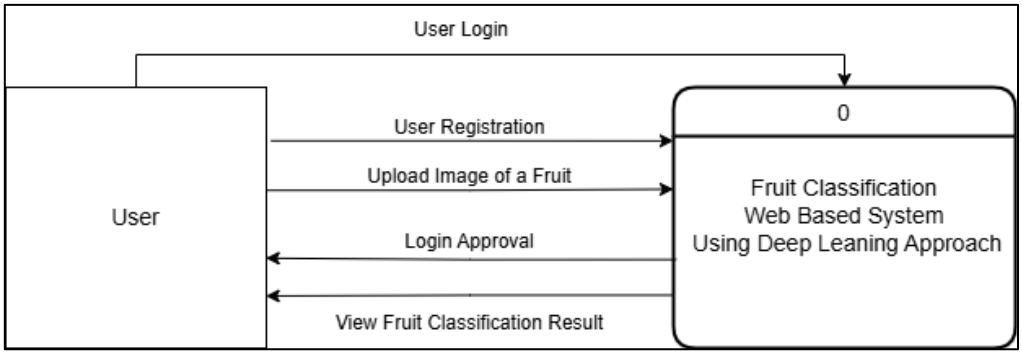

Figure 3.12: Context Diagram

Context diagrams give a high-level overview of the system and show how it interacts with external entities. The primary system being discussed is represented by the "Fruit Classification Web Based System Using Deep Learning Approach," which is shown in Figure 3.12. The procedure begins when the user registers, which entails entering personal data to establish an account. This step is essential to creating a safe and customized experience. After registering, the user can log in, upon which the system verifies the credentials through a login approval procedure. The user can post a picture of a fruit after successfully logging in. This step is essential to the operation of the system since it enables the deep learning model to identify the fruit and evaluate the image.

3.4.1.3.2 Data Flow Diagram (Level 1)

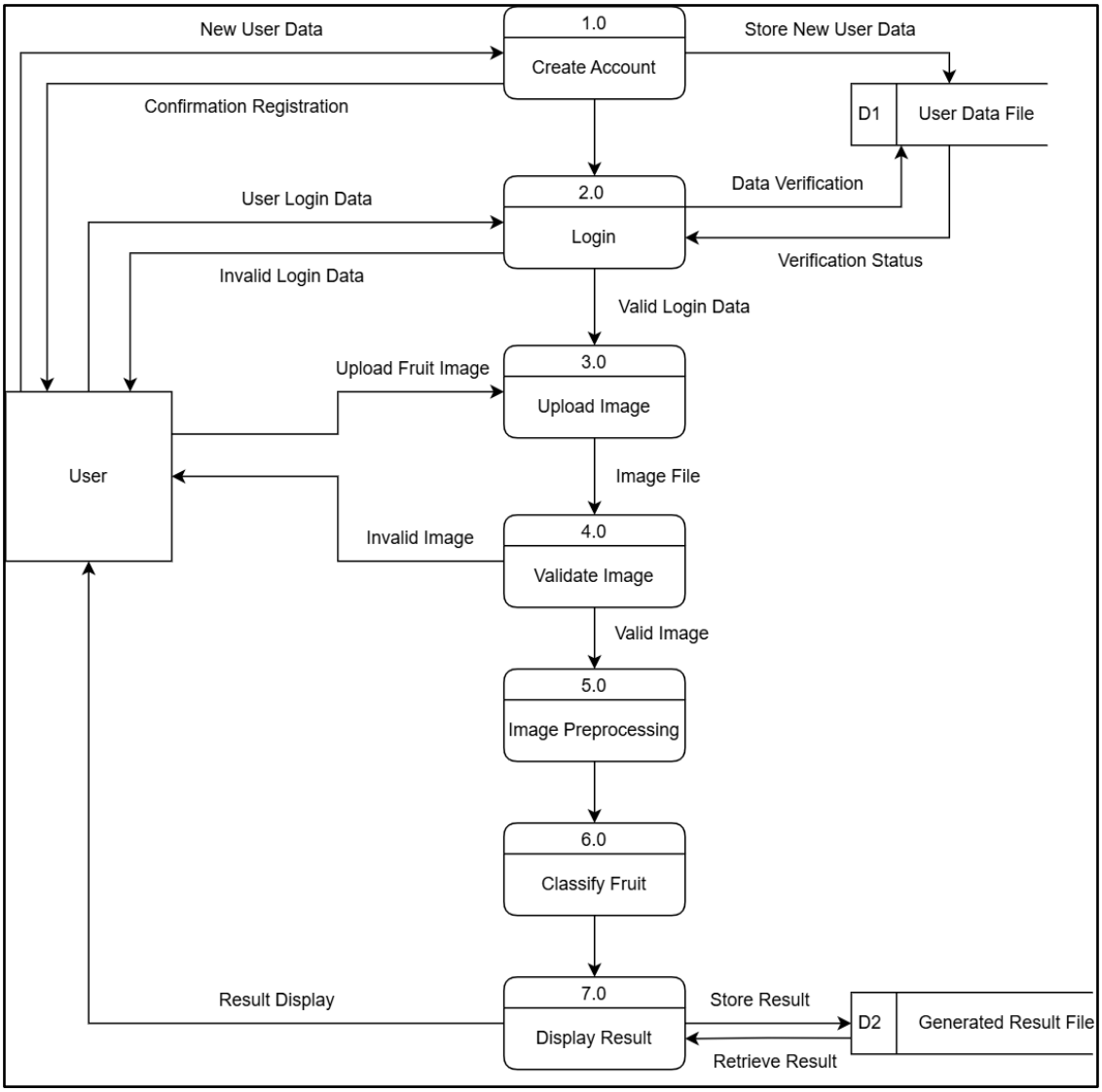

Figure 3.13: Level 1 Data Flow Diagram

Figure 3.13 shows the process is being expanded at Level 1. Based on Figure 3.13, the DFD Level 1 for the system shows the following key processes:

Process 1.0: Create Account

Users will need to register by providing their details including email and password for future log in. All collected data will be stored in a user data file.

Process 2.0: Login

After creating an account, the user needs to provide email and password to log in for system verification. If the login status is invalid, the user needs to re-enter the login credentials. If the login status is valid, it proceeds to the upload image process.

Process 3.0: Upload Image

Users can upload an image of fruit in this process.

Process 4.0: Validate Image

The system helps to determine if an image meets the requirements for classification. If the image is invalid, the user needs to re-upload a valid image for subsequent image preprocessing.

Process 5.0: Image Preprocessing

If the image is valid, the system will proceed to preprocess the image in preparation for the deep learning model.

Process 6.0: Classify Fruit

Once the preprocess is complete, the system uses deep learning techniques to identify the type of fruit based on the processed picture.

Process 7.0: Display Result

This process produces the classification results, with the name of the identified fruit along with its detail.

3.4.1.3.3 Data Flow Diagram (Level 2)

1. Process 1.0: Create Account

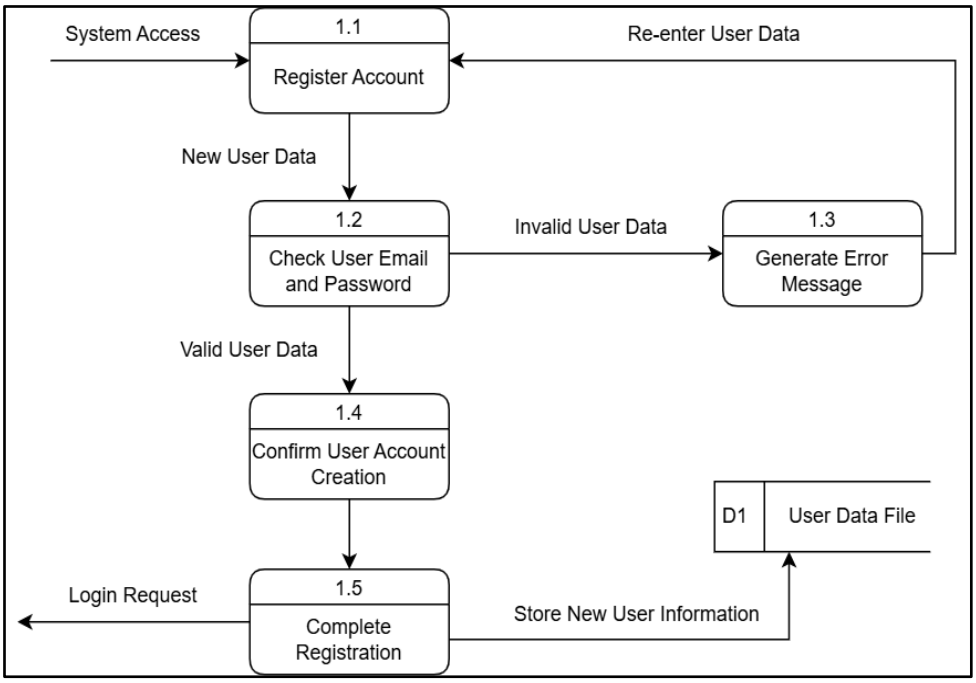

Figure 3.14: Level 2 Data Flow Diagram for Process 1.0

Process 1.0 outlines the steps for users to create an account. When a user first visits the website, they will need to create an account, providing their personal information including an email and password. The system will then verify that the password and email address entered are correct. If the data is incorrect, the system will display an error message to the user, asking them to re-enter the information. If the details are valid, the user will receive a confirmation that the account has been created, and the data will be stored in the user data file database. The system then directs the user to the login page.

2. Process 2.0: Login

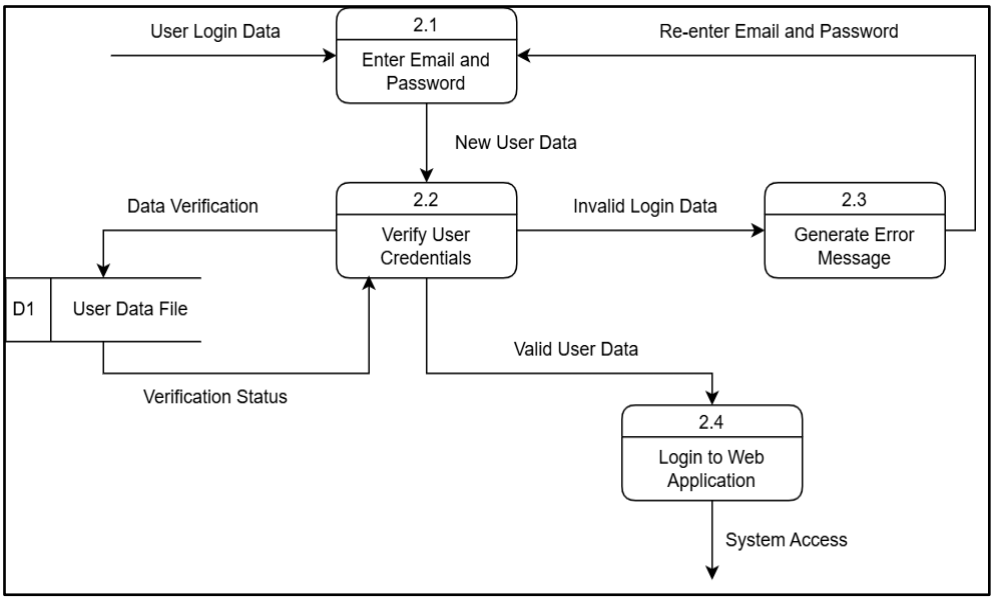

Figure 3.15: Level 2 Data Flow Diagram for Process 2.0

Process 2.0 shows the flow of user login data. Before access to the website, the user needs to enter their email and password. The system then checks the validity of the provided email and password against the user data file database. If the login data is invalid, an error message is generated, prompting the user to re-enter email and password. If the login data is valid, the system allows the user to access the web application.

3. Process 3.0: Upload Image

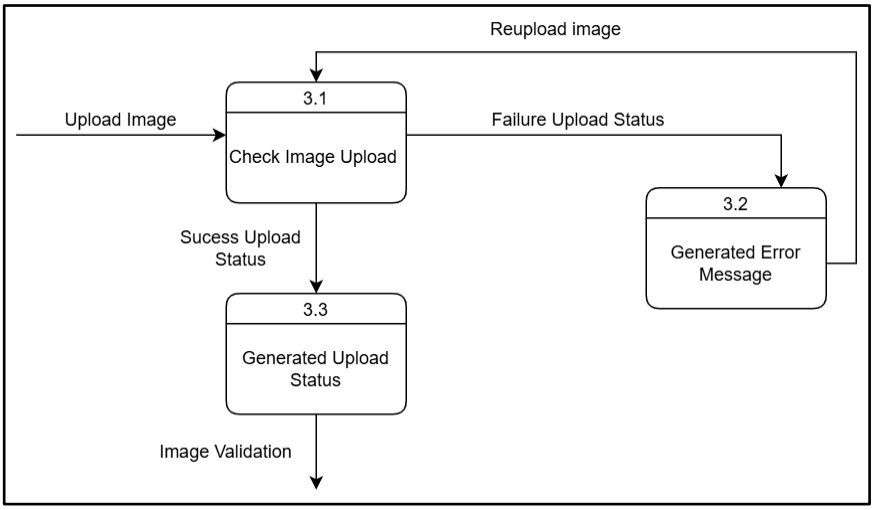

Figure 3.16: Level 2 Data Flow Diagram for Process 3.0

Process 3.0 describes the system's picture upload process. When a user uploads a picture, the system will first verify whether the picture has been uploaded successfully. If the upload fails, the system will generate an error message and require the user to upload the picture again. If the upload is successful, the system will generate an upload success status, and the successfully uploaded picture will enter the next process.

4. Process 4.0: Validate Image

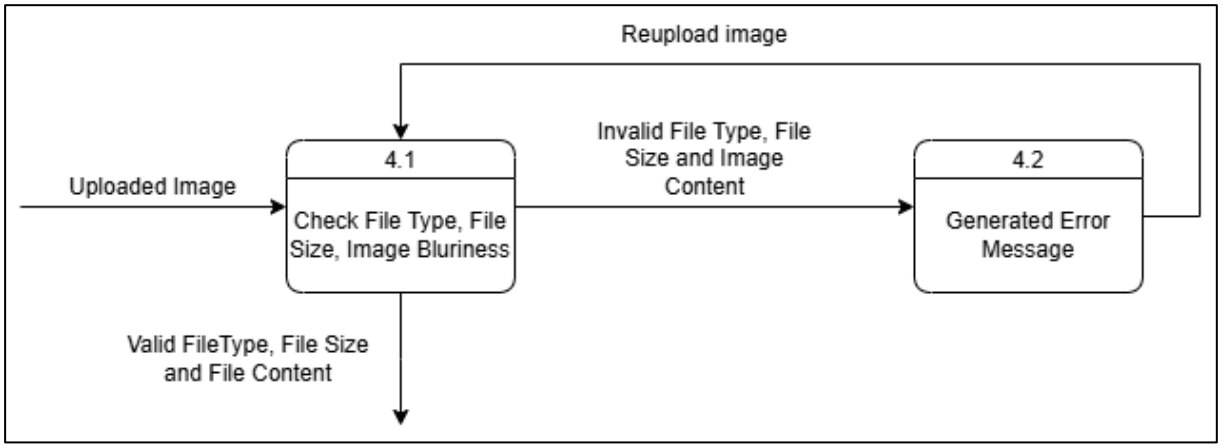

Figure 3.17: Level 2 Data Flow Diagram for Process 4.0

Process 4.0 outlines the steps involved in validating the uploaded image. When the image is successfully uploaded, the system will check if the file format, file size and the image blurriness is valid. If there is an invalid file type, file size and image content, the system will generate an error message asking the user to re-upload the image. When the image passes all the validation, the system will move on to the next flow.

5. Process 5.0: Preprocess Image

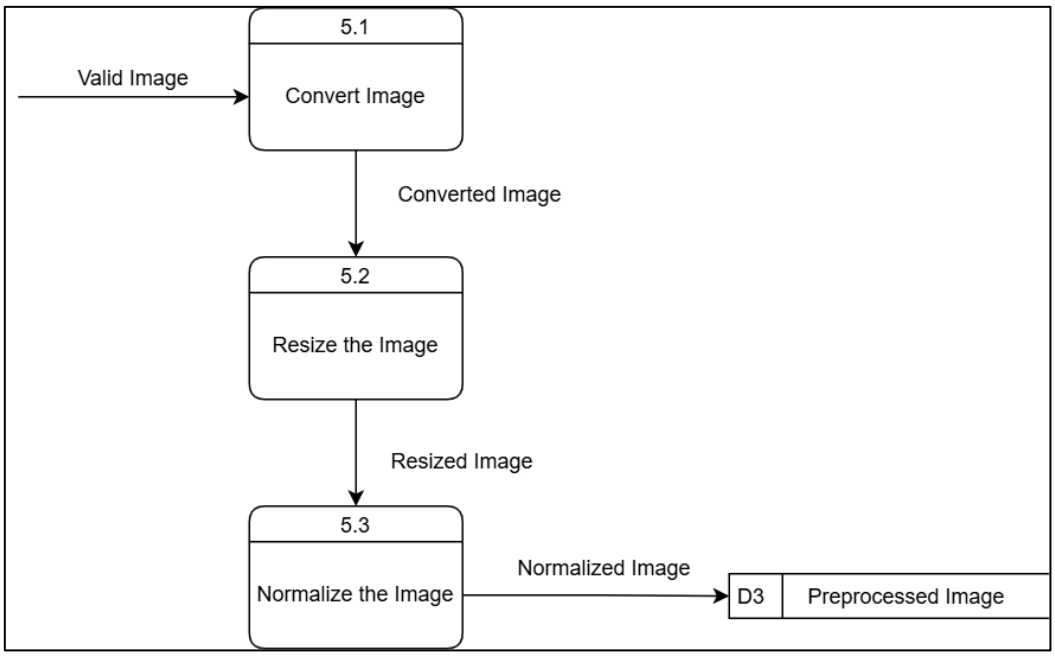

Figure 3.18: Level 2 Data Flow Diagram for Process 5.0

Process 5.0 outlines the flow of the preprocessing image. The system will convert uploaded images to required format by the model (e.g., RGB), ensuring image upload is consistent format. Next, the system resizes the image to the dimensions required by the model (e.g., 300*300 pixels), and then improving model performance by converting the pixel values to a standard range (e.g., [0,1] or [-1,1]). The preprocessing images are stored in a preprocesses image database and are ready for testing the model.

6. Process 6.0: Classify Fruit

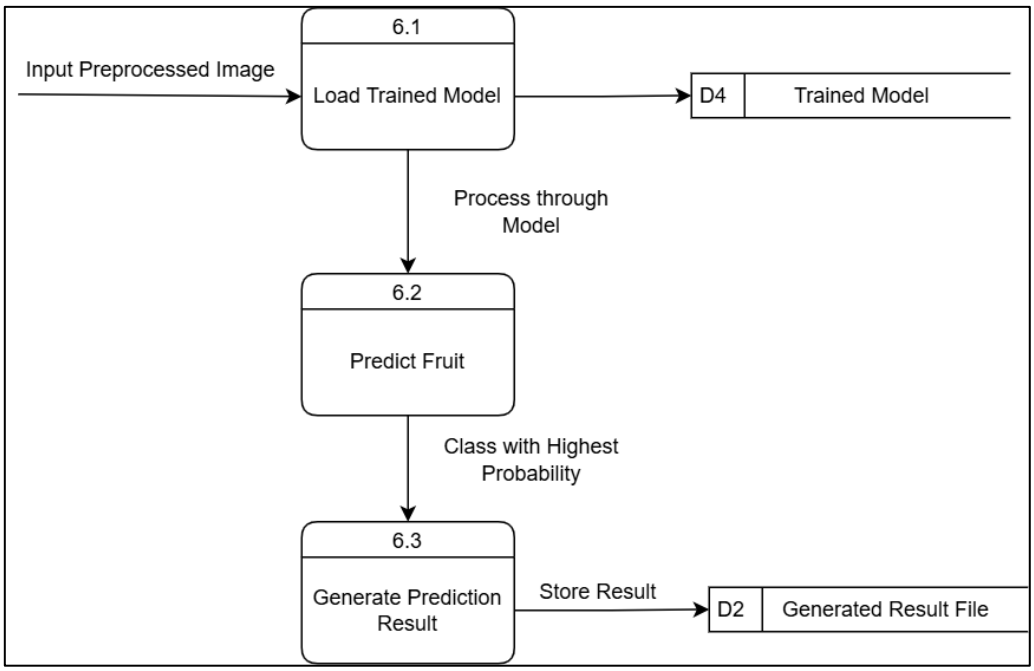

Figure 3.19: Level 2 Data Flow Diagram for Process 6.0

Process 6.0 describes how a submitted image is categorized by the system. It begins by loading a pre-trained model that can recognize various fruit varieties and is kept in the trained model database. This model is then applied to the pre-processed picture to provide predictions. By examining the greatest probability, the model predicts which fruit is most likely to be present in the image Ultimately, the classification's outcome is stored in a generated result file database.

7. Process 7.0: Display Result

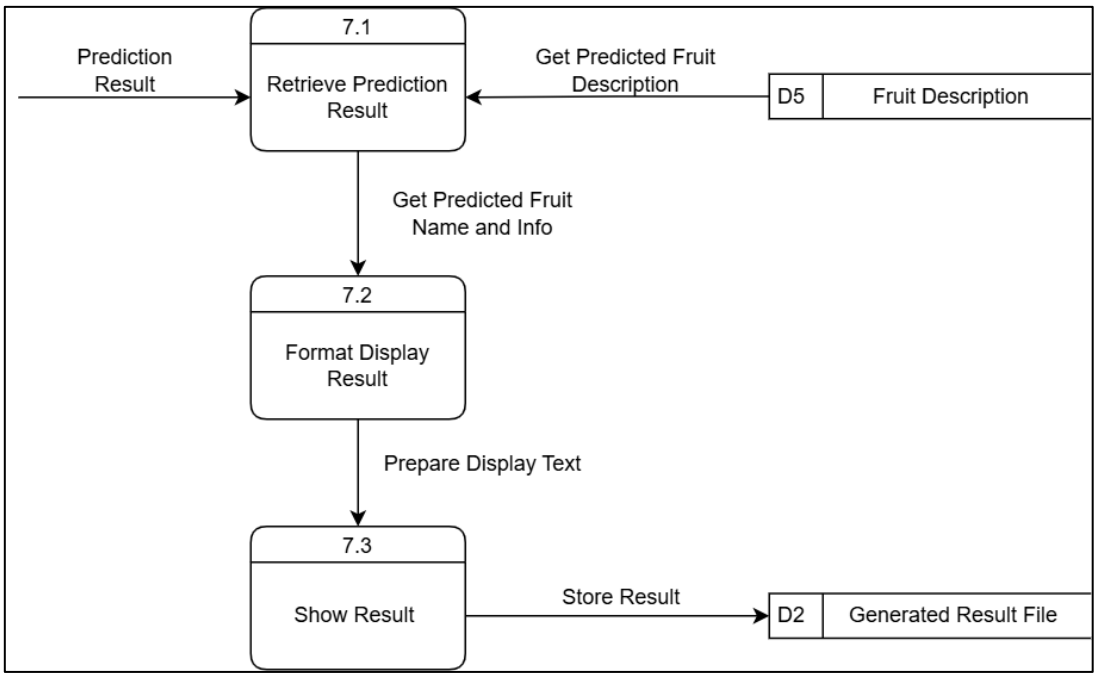

Figure 3.20: Level 2 Data Flow Diagram for Process 7.0

Process 7.0 outlines the steps involved in retrieving and displaying the prediction result for the uploaded image. It starts by retrieving the expected fruit description from the fruit description database, which contains information about various fruits. The system then formats the information to make it easily understandable. The user is then presented with the outcome, and all this data is stored in the generated result file database for future reference.

3.4.1.4 Entity Relationship Diagram (ERD)

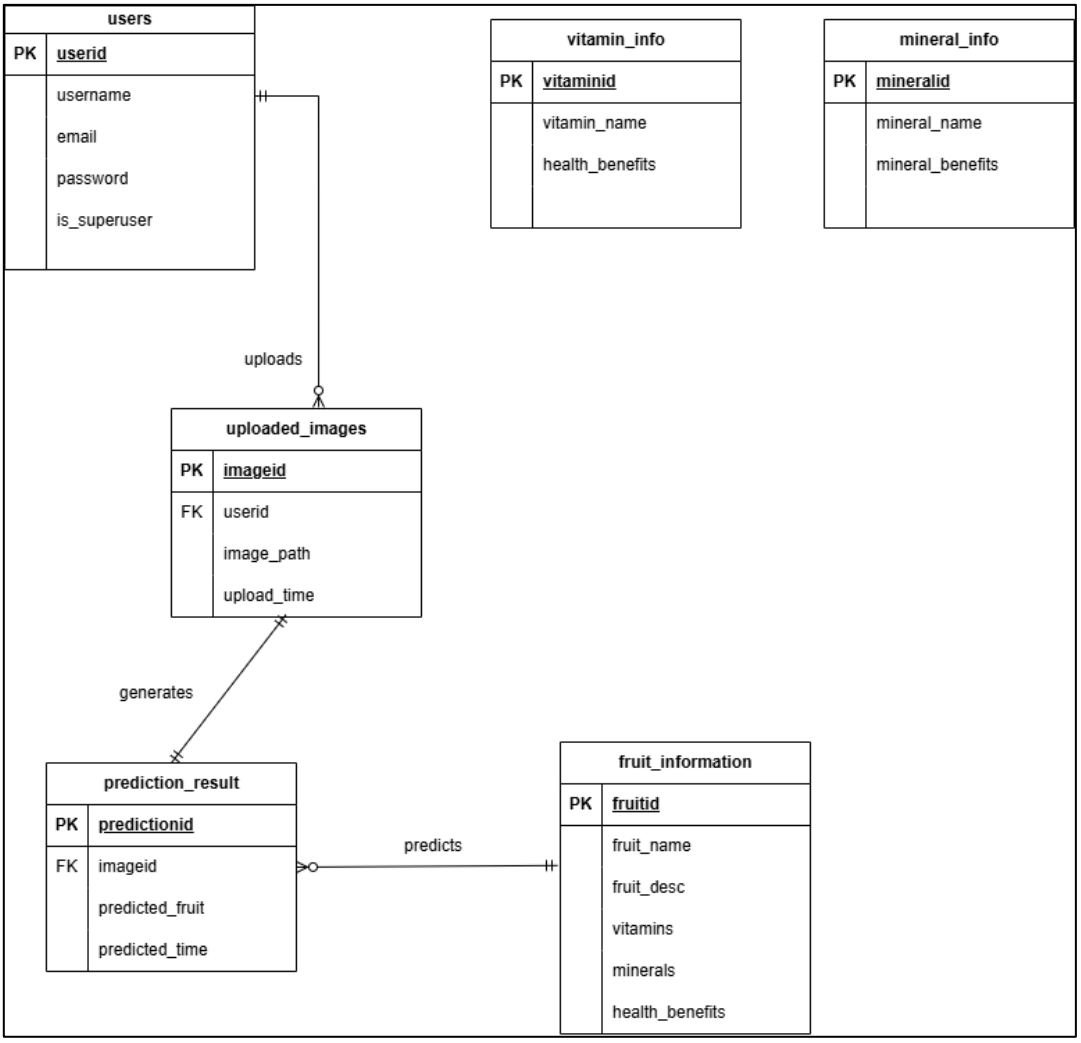

Figure 3.21: Entity Relationship Diagram

Figure 3.21 shows the entity relationship diagram (ERD) for the proposed system database structure, following with the entities: **user**, **uploaded_images**, **prediction_result**, and **fruit_information** with its attributes. Here the breakdown of each component:

1. **users**
    - Keep track of the user with its unique ID (userid) along with their username, email, password and role (is_superuser).

- A user can upload multiple images, creating a one-to-many link between the uploaded_images table and the users table.

2. **uploaded_images**
    - Each of the uploaded images have their own unique ID (imageid), image_path, upload_time and userid.
    - Only able to receive one image at a time and generate one prediction result.
3. **prediction_result**
    - Every prediction result includes a link to the uploaded image (imageid), a link to the predicted fruit (fruit_name), and a unique ID (predictionid).
    - Each uploaded image can only make one prediction.
4. **fruit_information**
    - The fruit_information table stores details about different fruit including a uniqueID (fruited), fruit_name, fruit_desc, vitamins, minerals and health_benefits.
    - Allows the system to store comprehensive information on fruits, providing more details about the fruit that are predicted.
5. **vitamin_info**
    - The vitamin_info table stores details about different type of vitamin including vitaminid (uniqueID), vitamin_name and health_benefits.
    - Allows the system to store comprehensive information about vitamin, providing more detailed information about vitamins for better understanding.
6. **mineral_info**
    - The mineral_info table stores details about different type of vitamin including mineralid (uniqueID), mineral_name and mineral_benefits.

- Allow the system to store comprehensive information about vitamin, providing more detailed information about vitamins for better understanding.

3.4.1.5 Data Dictionary

A data dictionary is a structured set of entire details about the data that is used in a database. It acts as a guide for understanding the relationships, features, and structure of the data components. Below is an overview of each entity along with its data dictionary.

Table 3.1: Data Dictionary for Users Table

Field Name	**Data Type**	**Description**
userid	INT(PK)	Unique identifier for each user
username	VARCHAR(50)	User's username
email	VARCHAR(100)	User's email address
password	VARCHAR(255)	User's password
is_superuser	BOOLEAN	Used to show whether the user is an administrator (True for admin, False for regular user)

Table 3.2: Data Dictionary for Uploaded Images Table

Field Name	**Data Type**	**Description**
imageid	INT (PK)	Unique identifier for each image
userid	INT(FK)	Foreign key for each session record
image_path	TEXT	File path where the image was uploaded

upload_time	DATETIME	Image upload time and date

Table 3.3: Data Dictionary for Prediction Result Table

Field Name	**Data Type**	**Description**
predictionid	INT (PK)	Unique identifier for each prediction result
imageid	INT(FK)	Foreign key for each image
predicted_fruit	TEXT	The name of the predicted fruit
predicted_time	DATETIME	Image predict time and time

Table 3.4: Data Dictionary for Fruit Information Table

Field Name	**Data Type**	**Description**
fruited	INT (PK)	Unique identifier for each prediction result
fruit_name	TEXT	Name of the fruit
fruit_desc	TEXT	A brief description of the fruit
vitamins	TEXT	List of vitamins present in the fruit
minerals	TEXT	List of minerals present in the fruit
health_benefits	TEXT	Health benefits bring by the fruit

Table 3.5: Data Dictionary for Vitamin Information Table

Field Name	**Data Type**	**Description**

vitaminid	INT (PK)	Unique identifier for each vitamin
vitamin_name	VARCHAR(100)	Name of the vitamin
health_benefits	TEXT	Show the health benefits of the corresponding vitamins.

Table 3.6: Data Dictionary for Mineral Information Table

Field Name	**Data Type**	**Description**
mineralid	INT (PK)	Unique identifier for each mineral
mineral_name	VARCHAR(100)	Name of the mineral
mineral_benefits	TEXT	Show the health benefits of the corresponding mineral.

3.4.2 Physical Design

The physical design plans how to apply the concepts from the logical design. This stage included graphical user interface design.

3.4.2.1 Graphical User Interface (GUI) Design

Graphical User Interface (GUI) design creates the visual layout that enables users to interact with the elements of the proposed system.

3.4.2.1.1 Guest

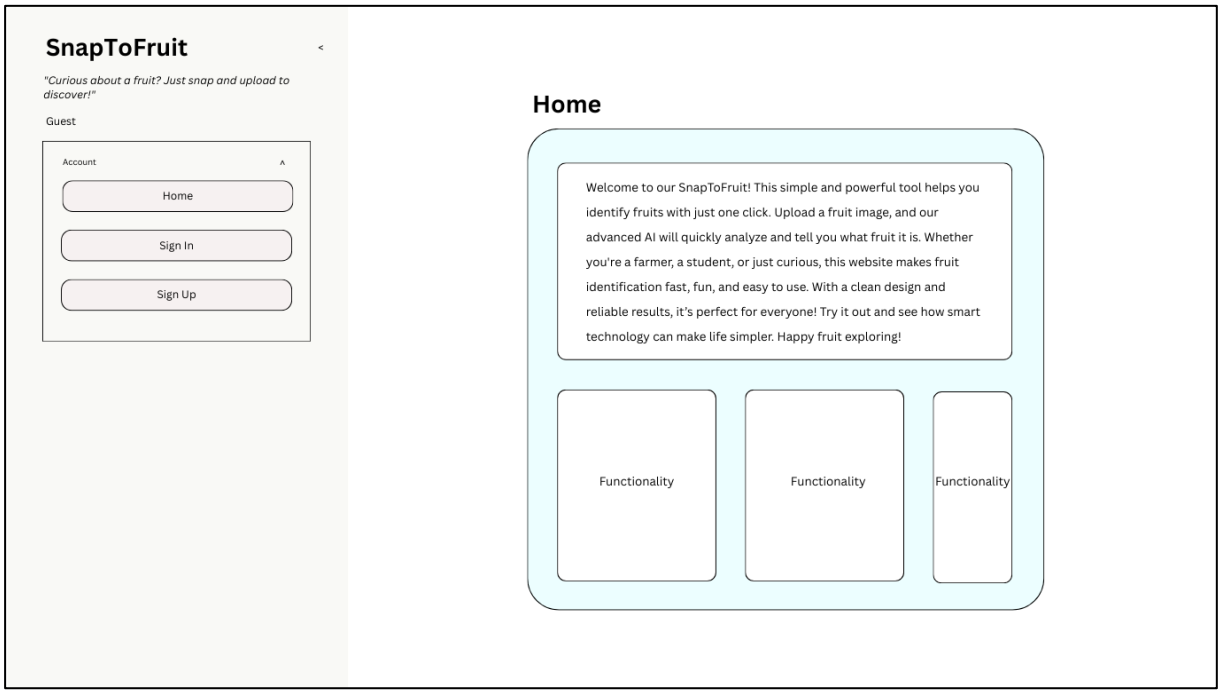

Figure 3.22: Home Page

Figure 3.22 shows the home page of the web-based fruit classification platform. The sidebar displays the platform name which is called as "SnapToFruit" along with a welcoming tagline: "Curious about a fruit? Just snap and upload to discover". Below of the side bar contains "Home", "Sign In" and "Sign Up" button. The goal, features, and workings of the system are described on this page.

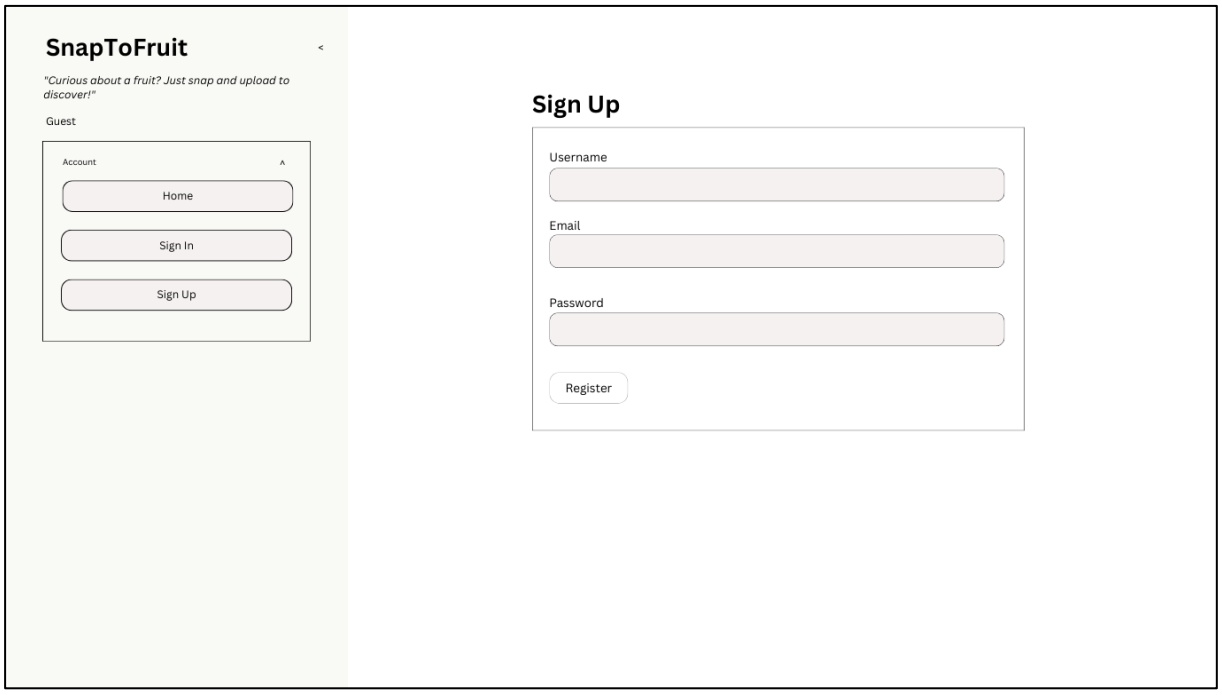

Figure 3.23: Guest - Sign Up Page

Figure 3.23 shows the interface of the sign-up page for the proposed system. There is a registration area for the user to enter their information including username, email and password, and a “Register” button for the user to submit their information to the system.

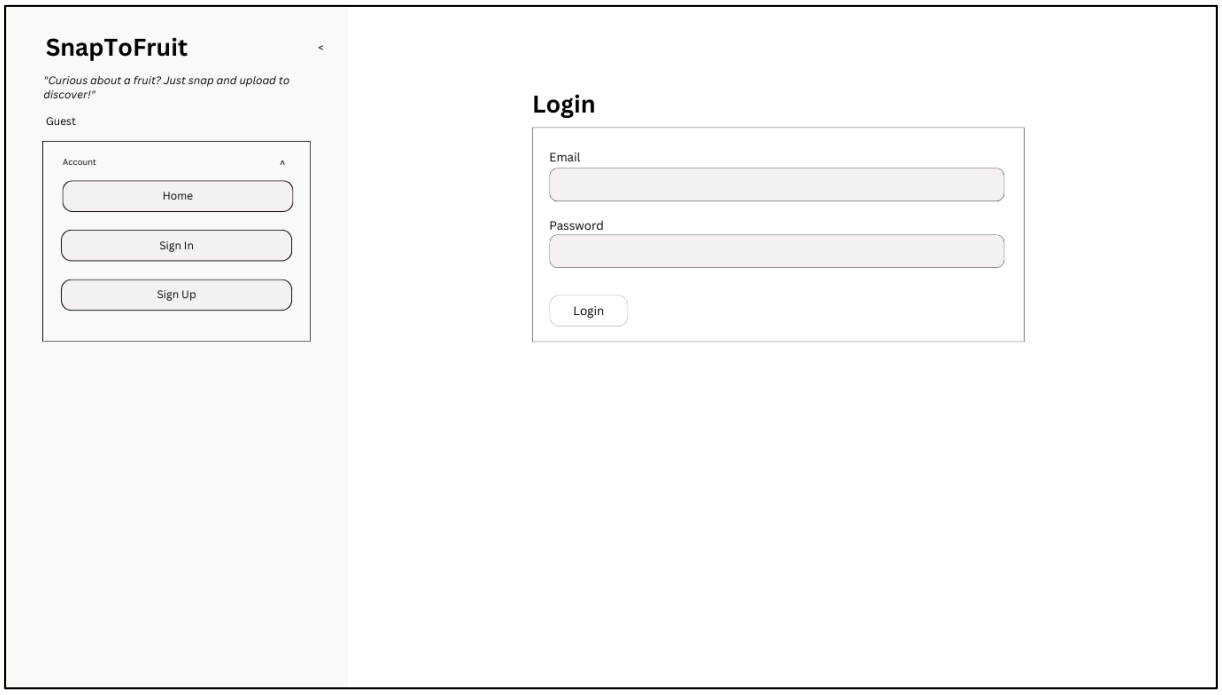

Figure 3.24: Guest - Sign In Page

Figure 3.24 shows the interface of the login page for the proposed system. There is a login area for the user to enter their information including email and password, and a “Login” button for the user to log into the website.

3.4.2.1.2 User

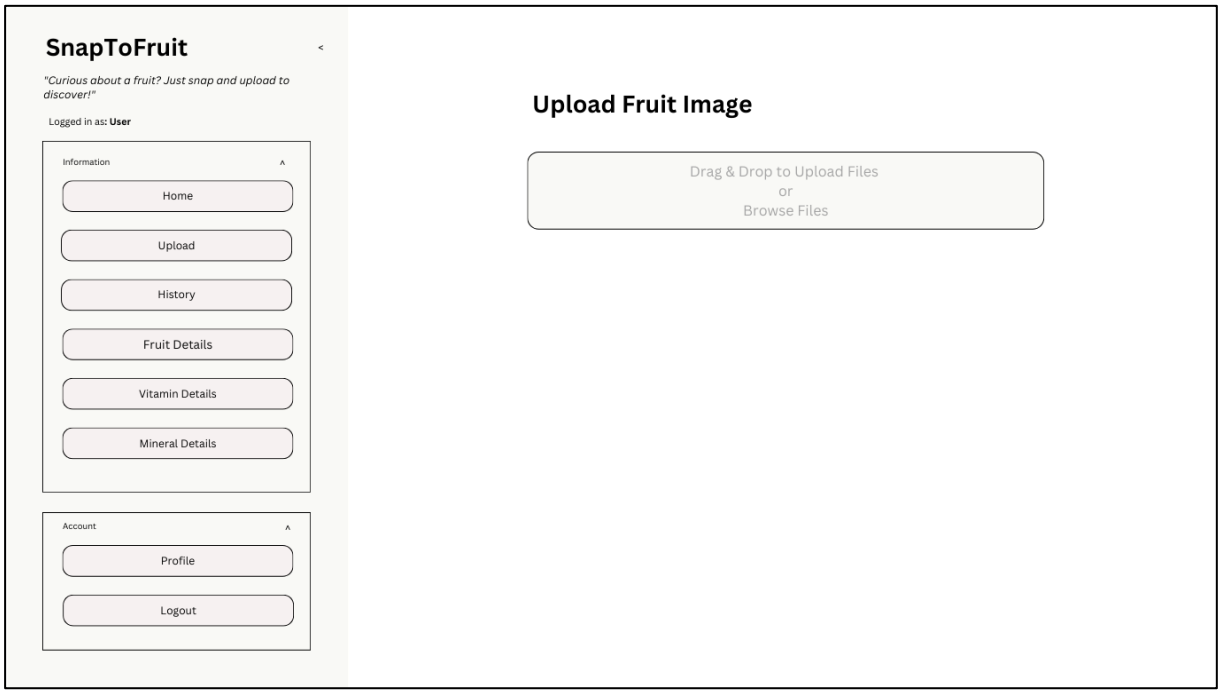

Figure 3.25: User - Upload Fruit Image Page

Figure 3.25 shows the interface for user to upload an image. Users can drag and drop pictures or upload file pictures to this interface for image prediction.

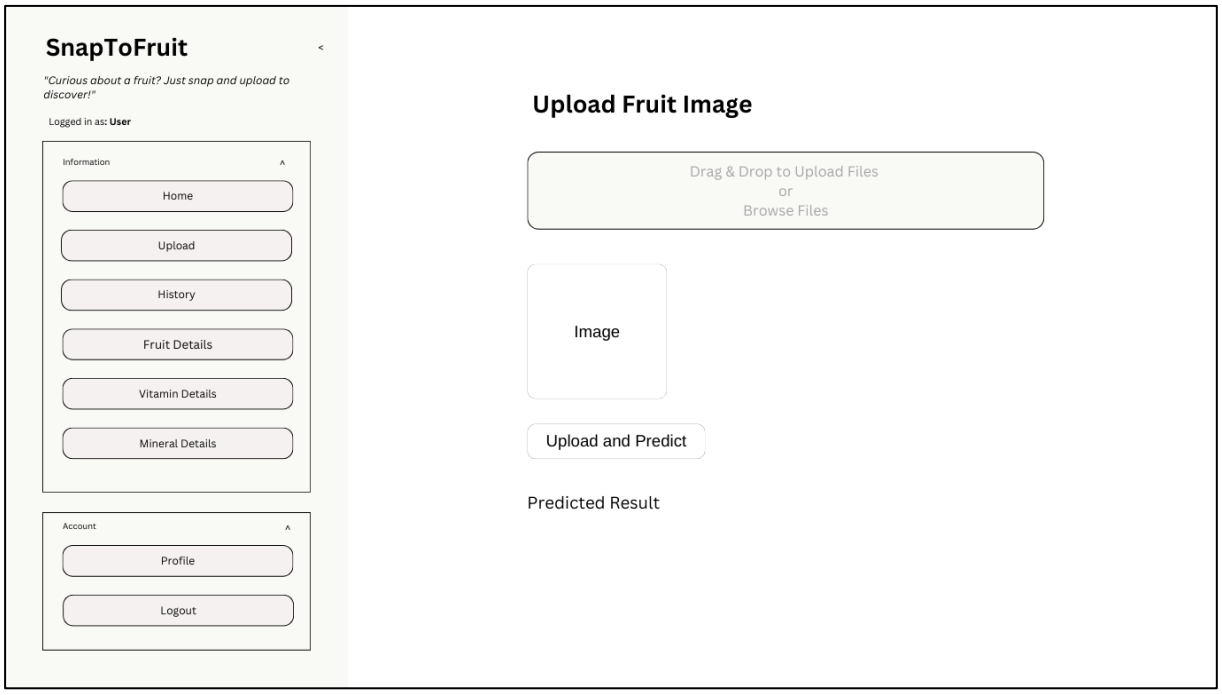

Figure 3.26: User - Upload and Predict Result Page

Figure 3.26 shows the interface for user to upload an image and get a prediction result. Users can drag and drop pictures or upload file pictures to this interface for image prediction. After user uploading successfully, an image will be displayed and a “Upload and Predict” button is shown. User needs to click the button to predict the result. Then the system will showing the identified fruit's name and relevant details in clear and readable text.

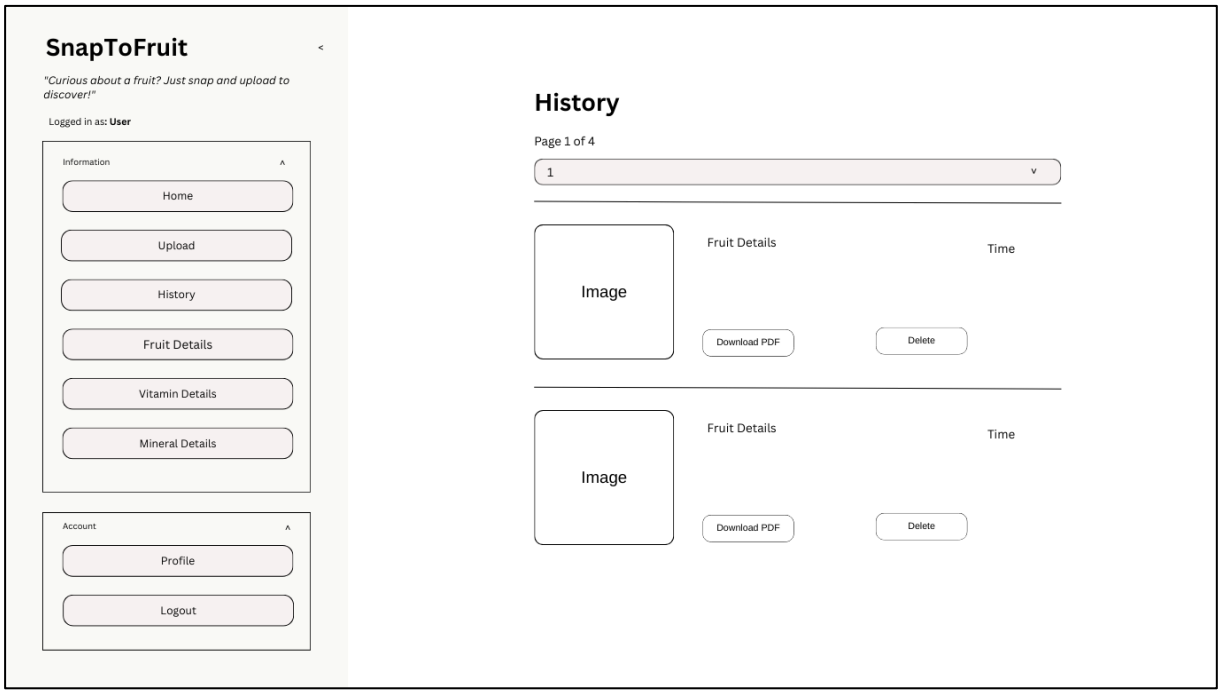

Figure 3.27: User - History Page

Figure 3.27 shows the interface for users to view historical records, including fruit name and its information. Besides, there is a "Download PDF" button for each specific entry, which allows users to download the record, and a "Delete" button, which allows users to delete the records.

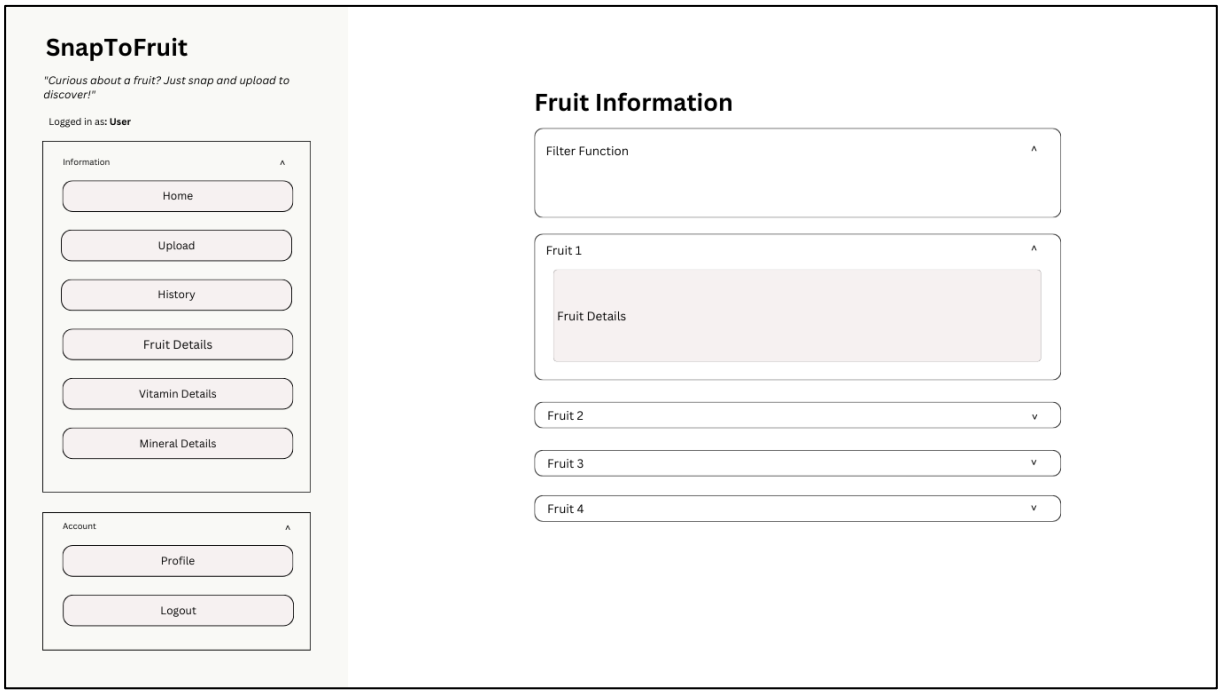

Figure 3.28: User - Fruit Information Page

Figure 3.28 shows a fruit information page where users can browse a complete list of fruits. The page also provides a search function to facilitate navigation and finding specific fruits.

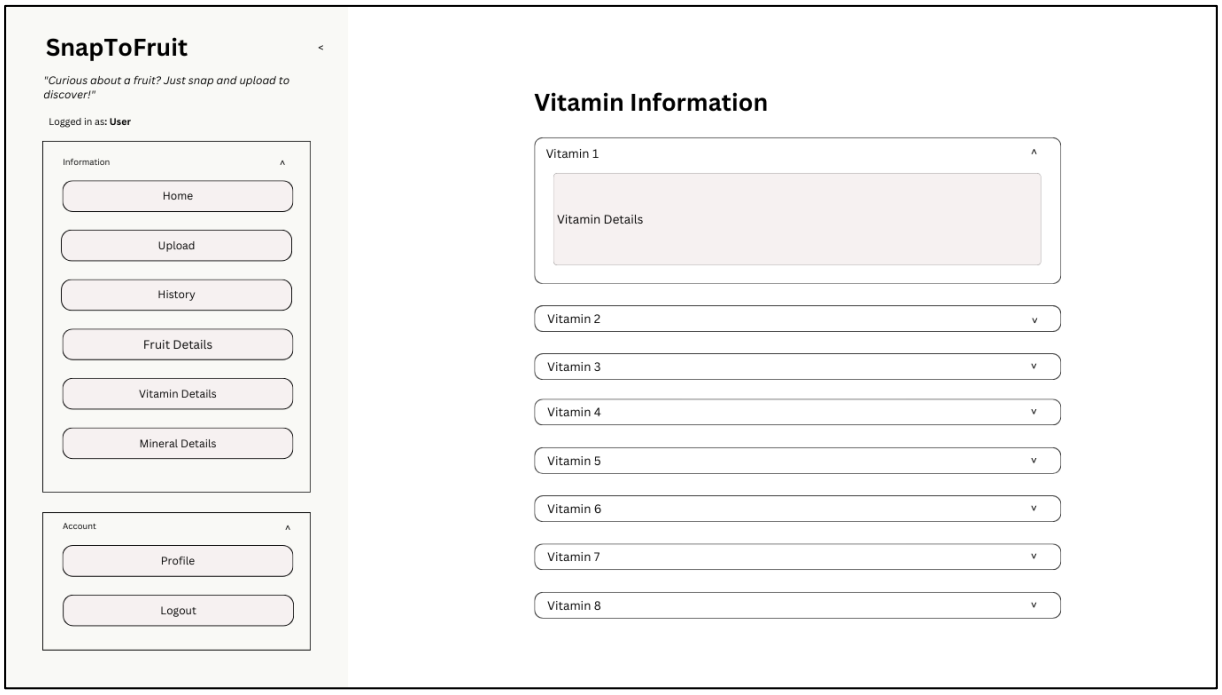

Figure 3.29: User - Vitamin Information Page

Figure 3.29 shows a vitamin information page where users can browse a complete list of vitamins.

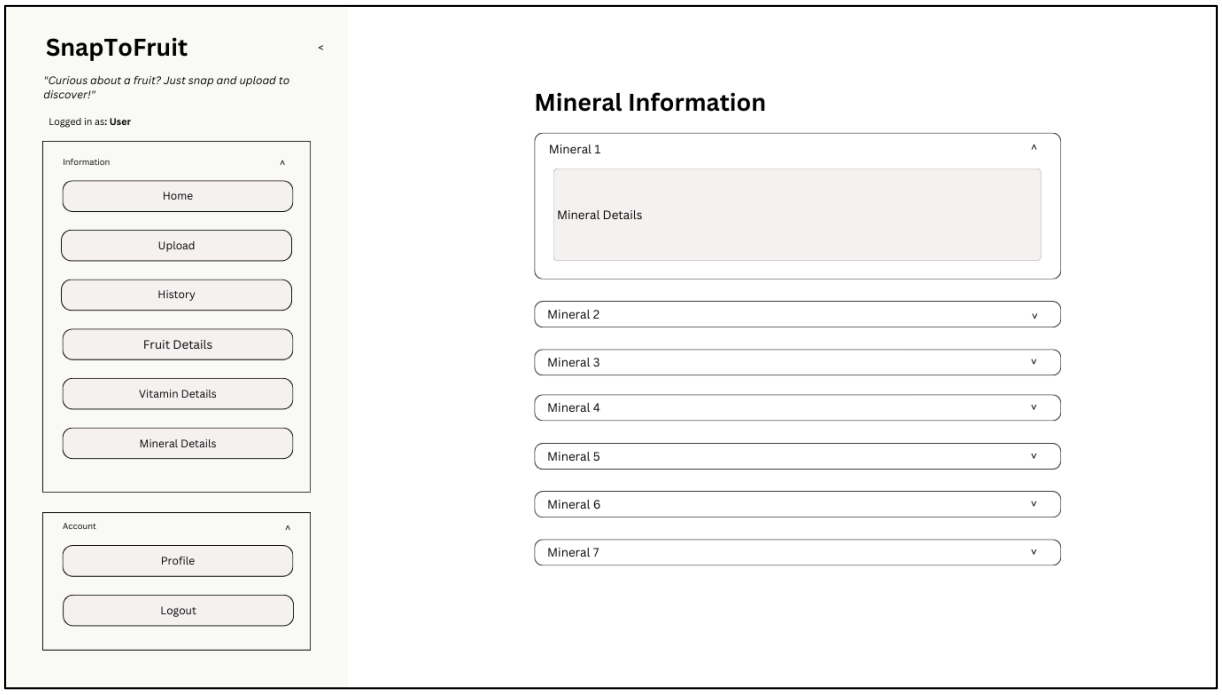

Figure 3.30: User - Mineral Information Page

Figure 3.30 shows a mineral information page that allows the user to browse the complete list of minerals.

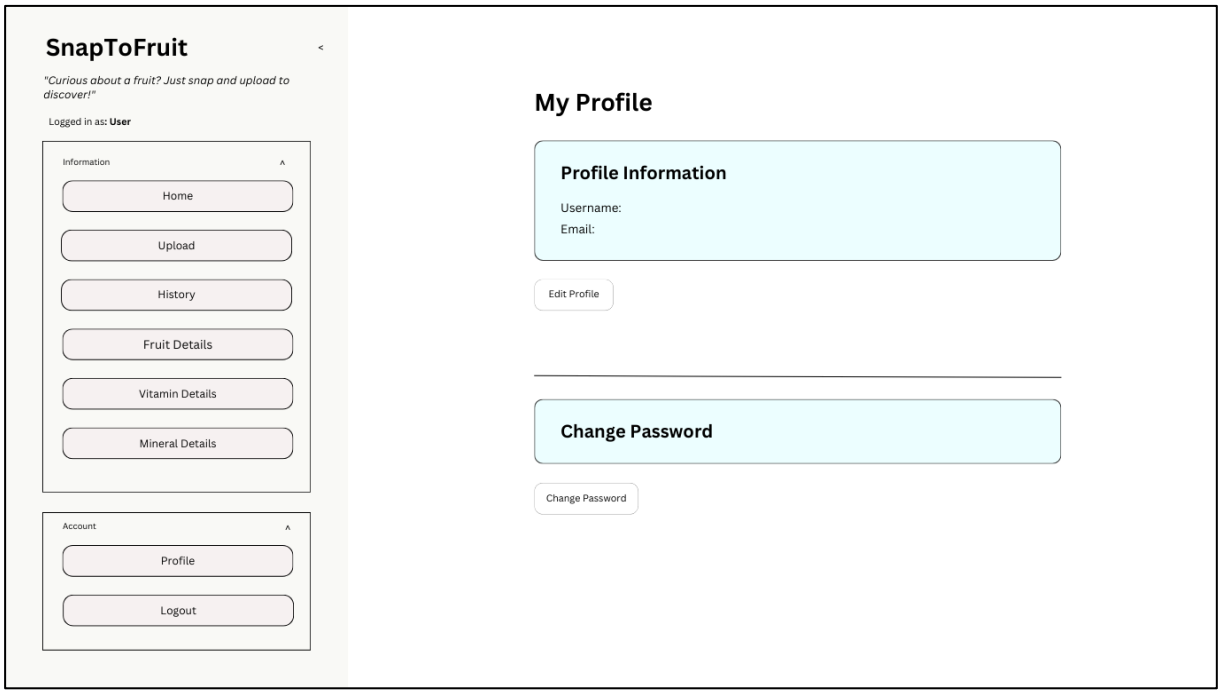

Figure 3.31: User – My Profile Page

Figure 3.31 shows the interface for user to view the profile information, including username and email. User has an option to edit the profile information. Additionally, there is also provide a section for user to change the password.

3.4.2.1.3 Admin

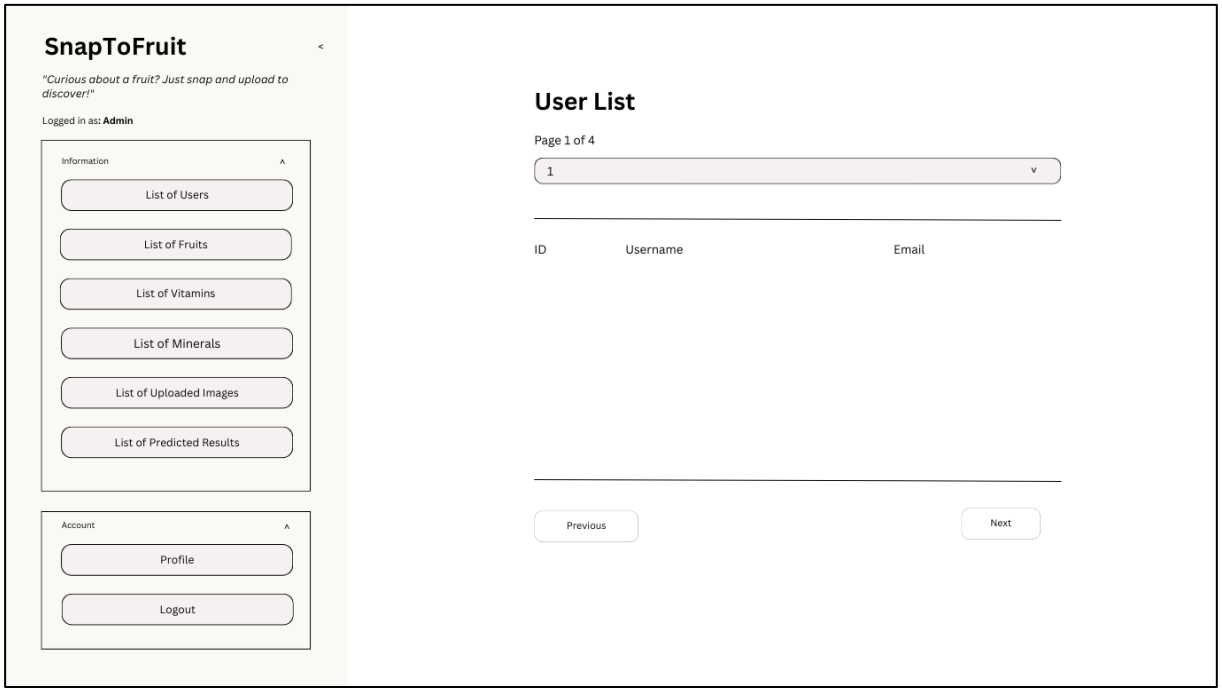

Figure 3.32: Admin - User List Page

Figure 3.32 shows a “User List” section for admin to manage users, including username and email. A pagination control is provided in this section for easy navigation between pages.

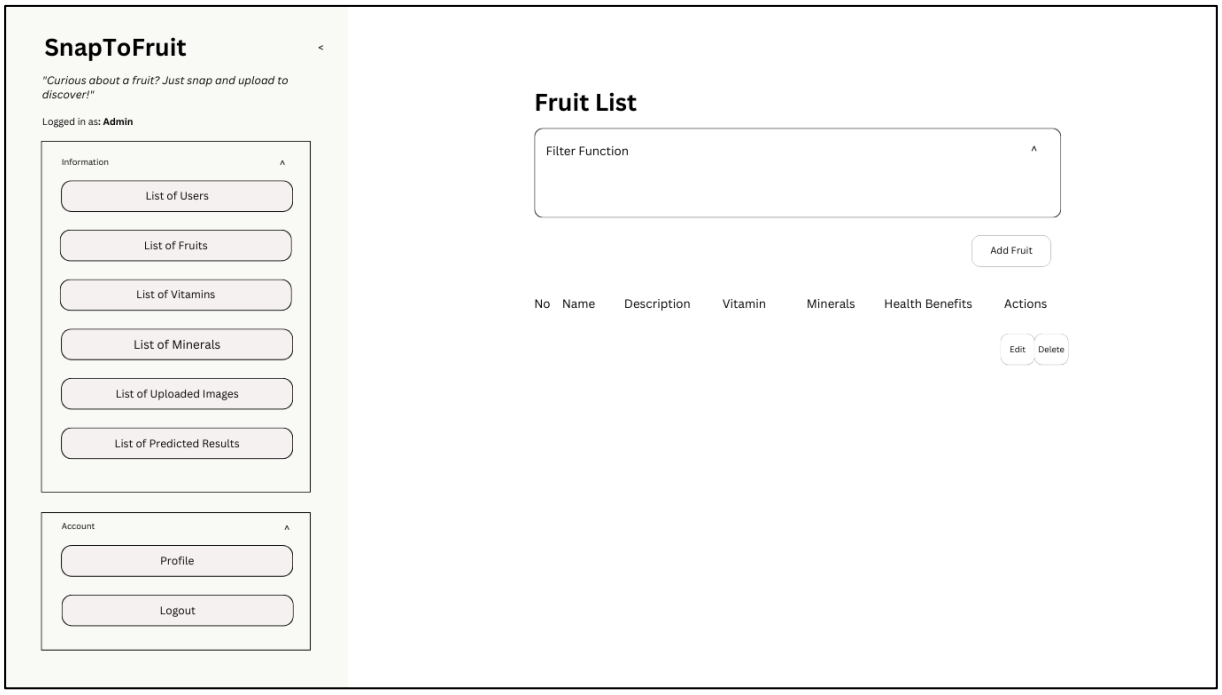

Figure 3.33: Admin - Fruit List

Figure 3.33 shows the interface for admin to manage a fruit list. This interface provides a search function, allowing admin to quickly navigate to the desired fruit. In addition, the administrator can also add, edit, and delete actions on this interface to facilitate the management of the fruit list.

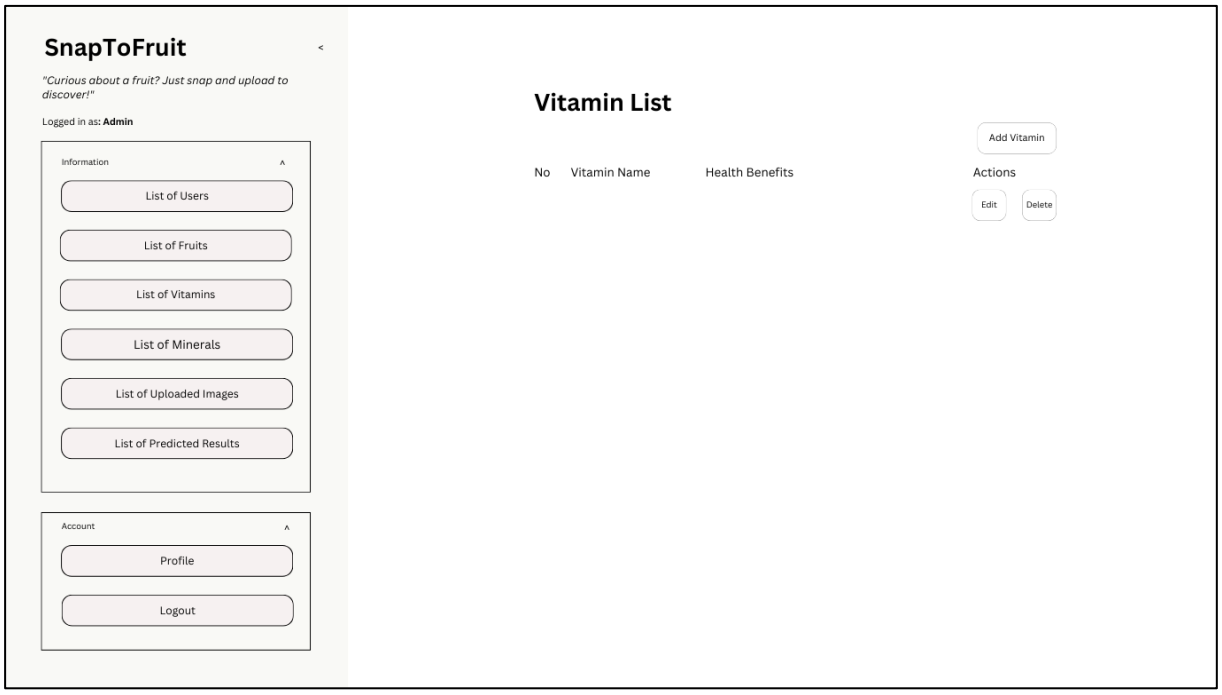

Figure 3.34: Admin – Vitamins List Page

Figure 3.34 shows the interface for admin to manage a vitamin list, including name and health benefits. Admin users can add, edit and delete entries on this interface.

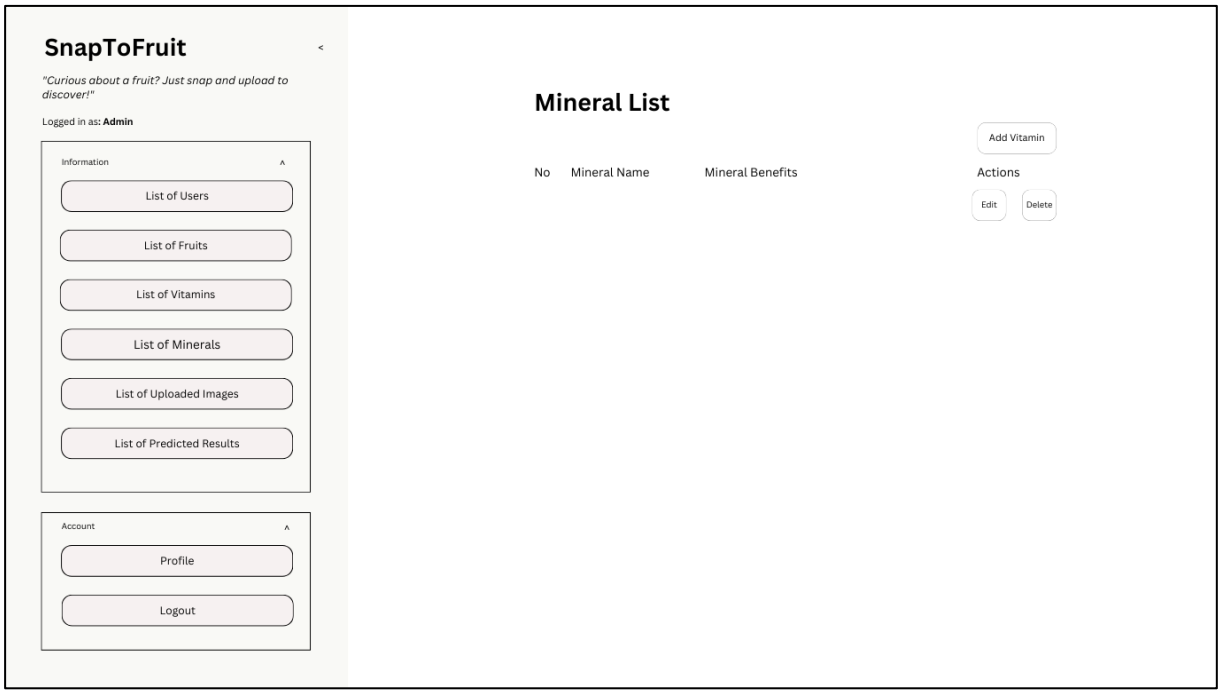

Figure 3.35: Admin - Mineral List Page

Figure 3.35 shows the interface for admin to manage a mineral list, including name and mineral benefits. Admin users can add, edit and delete entries on this interface.

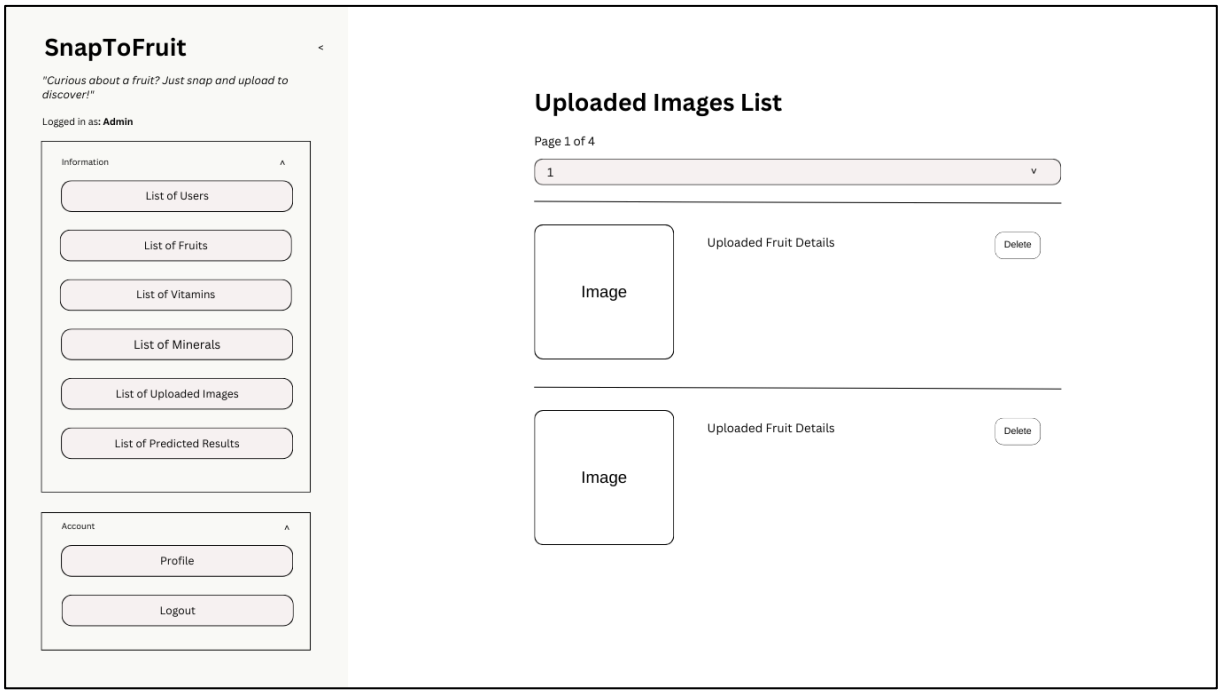

Figure 3.36: Admin - Uploaded Images List

Figure 3.36 shows the interface for admin to view the uploaded images list. It displays the details of all uploaded images and provides an option for admin to delete the images. This section also provides paging controls to facilitate navigation between pages.

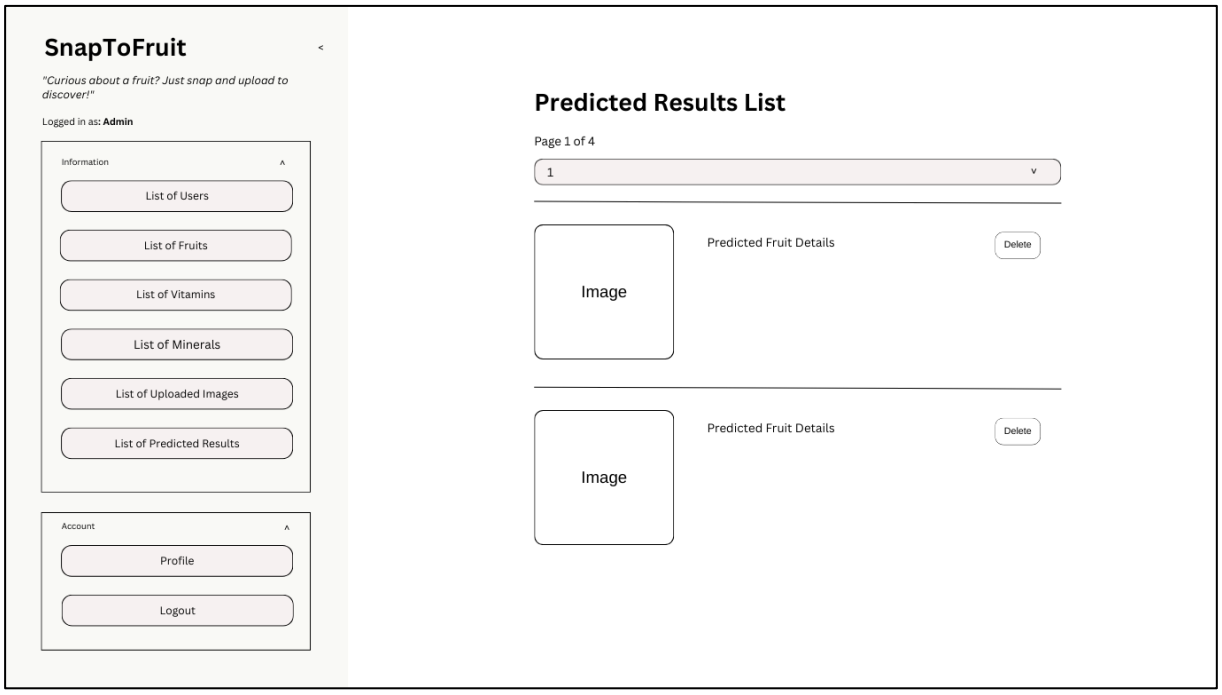

Figure 3.37: Admin - Predicted Results List Page

Figure 3.37 displays the interface for admin to view the predicted results list. It shows the details of all predicted results and provides an option for admin to delete the entry. This section also provides paging controls to facilitate navigation between pages.

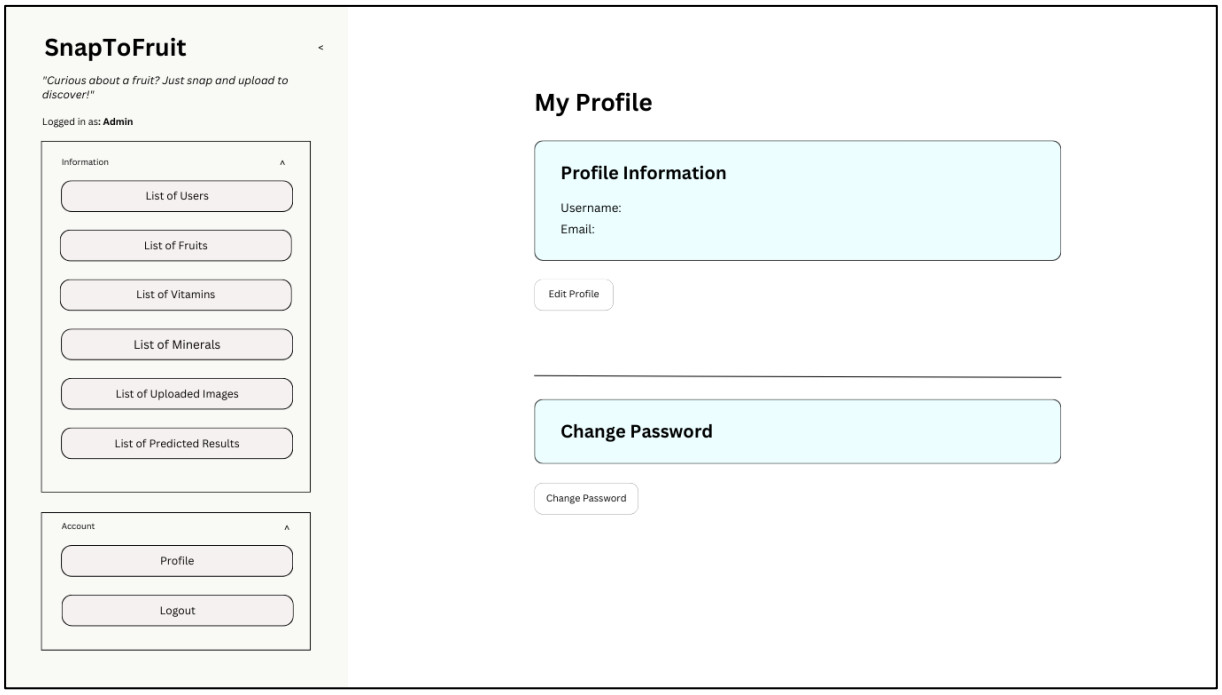

Figure 3.38: Admin – My Profile Page

Figure 3.38 shows the interface for admin to view the profile information, including username and email. Admin has an option to edit the profile information. Additionally, there is also provide a section for user to change the password.

3.5 Summary

This chapter explained with a description of the development process for the fruit classification platform, which made use of the Agile Scrum methodology to ensure continuous improvement. A total of 30 respondents were given a questionnaire to identify key needs of users. Additionally, a system architectural design includes logical design and physical design were made to show the features of the suggested system.

CHAPTER 4: IMPLEMENTATION

4.1 Introduction

This chapter describes the SnapToFruit web application's general design and implementation process. The setup of the database, user interface, and model training environment is explained, as well as the technologies, environments, and development tools used in the system. During the implementation phase, frontend design, backend programming, and machine learning models are all combined using the appropriate frameworks and libraries.

4.2 Hardware Specifications

A personal computer with the following specs was used for the system's development and testing:

- **Processor**: Intel(R) Celeron(R) N4500 @ 1.10GHz 1.11 GHz
- **RAM**: 12GB
- **Storage**: 237GB
- **Operating System**: Windows 11 Home 64-bit

4.3 Environment Setup

4.3.1 Programming Language and Libraries

Python 3.10 is used in the system's development because of its broad support for database operations, web development, and machine learning. The following are important Python packages need to be installed in the virtual environment, as shown in Table 4.1.

Package Name	Installation Purpose
streamlit	A Python framework that used to build an interactive web application.
tensorflow	Used to load and run the deep learning model
opencv-python	Enables more image processing features (read, open)
psycopg2	Used to connect and execute queries on the PostgreSQL database
numpy	Used to manage array processing and numerical processes, particularly for picture data.
fpdf	Used to generate a PDF file
pillow	Used for preprocess image (resize format)
streamlit-extras	Provides Streamlit apps additional UI elements and personalized design options.

Table 4.1: Python packages

4.3.2 Training Model on Kaggle Notebook

The deep learning model was trained using Kaggle, a cloud-based platform that offers public datasets and powerful GPUs. In this case, the **EfficientNetB2 model** was trained and fine-tuned on the **Fruits-100 dataset** with the help of an **GPU Tesla T4**, which offered enough processing capability. To incorporate it into the web application, the trained model's output will be stored in **.h5 format**.

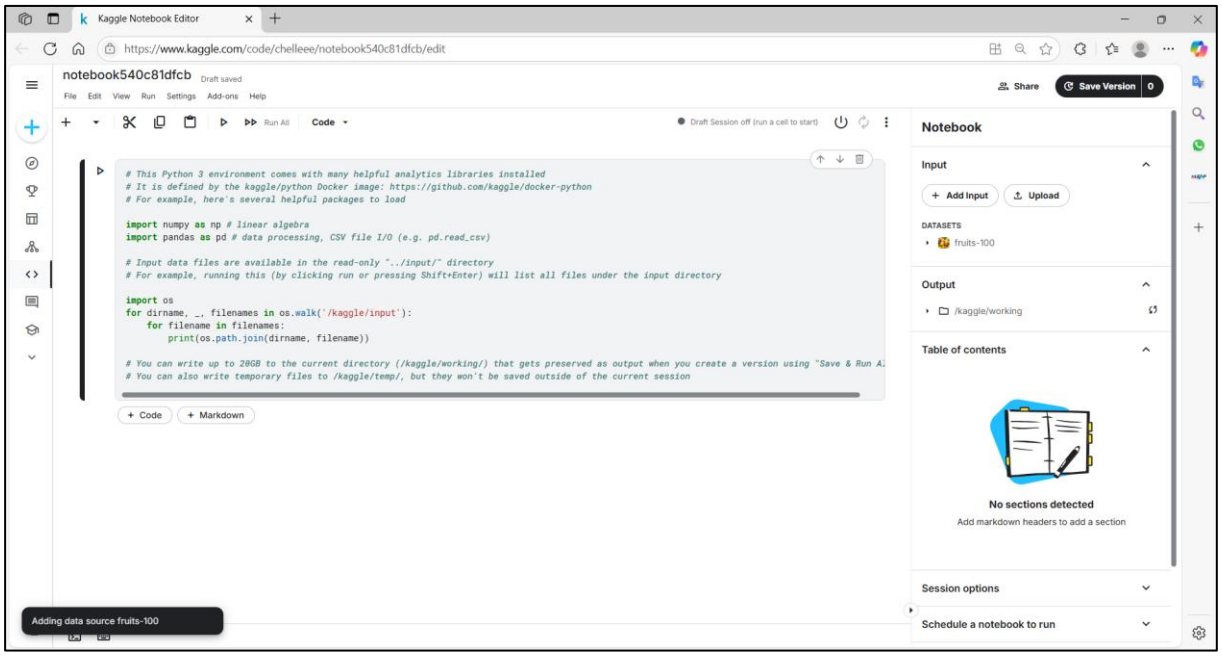

Figure 4.1: Kaggle Notebook

4.3.3 Visual Studio Code

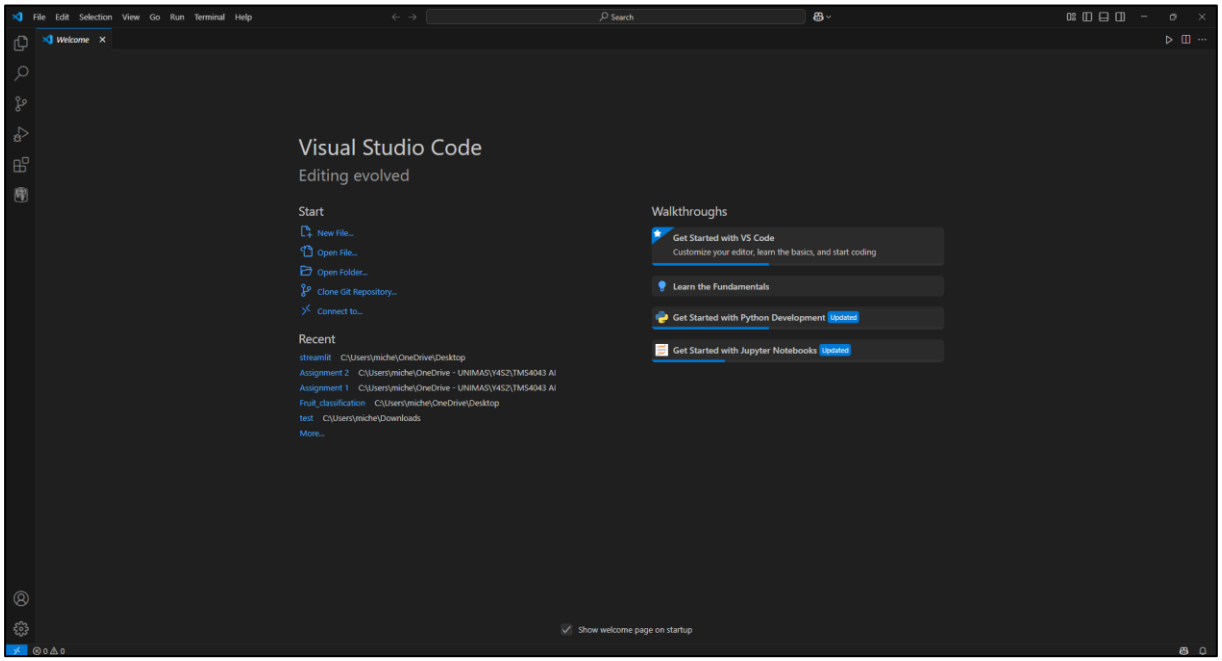

Figure 4.2: Visual Studio Code

Figure 4.2 shows a flexible and lightweight source-code editor that supports Python and works well with version control systems It was used for developing the fruit classification

platform due to its debugging features, extensive extension library, and ease of use. To control project dependencies and guarantee a consistent development configuration, a Python virtual environment (venv) was developed as the necessary libraries may be installed in this isolated environment without interfering with the Python installation on the entire machine. The program was originally deployed and tested locally with the use of the Streamlit framework, which provides a simple command-line interface for app startup.

4.3.4 Database Management using PostgreSQL (pgAdmin)

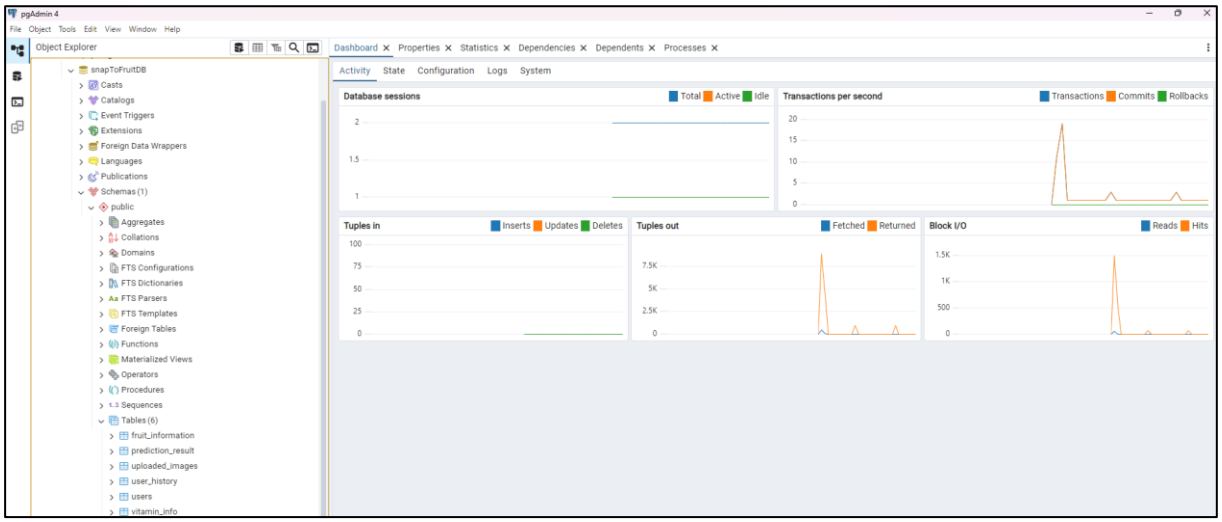

Figure 4.3: pgAdmin 4

Figure 4.3 shows the overview interface of pgAdmin 4. It is an open-source PostgreSQL management tool that improves database development when used with Visual Studio Code. With the PostgreSQL plugin, users may connect to databases in Visual Studio Code after creating and managing them in PgAdmin.

4.4 User Interface Design

4.4.1 Guest

4.4.1.1 Login

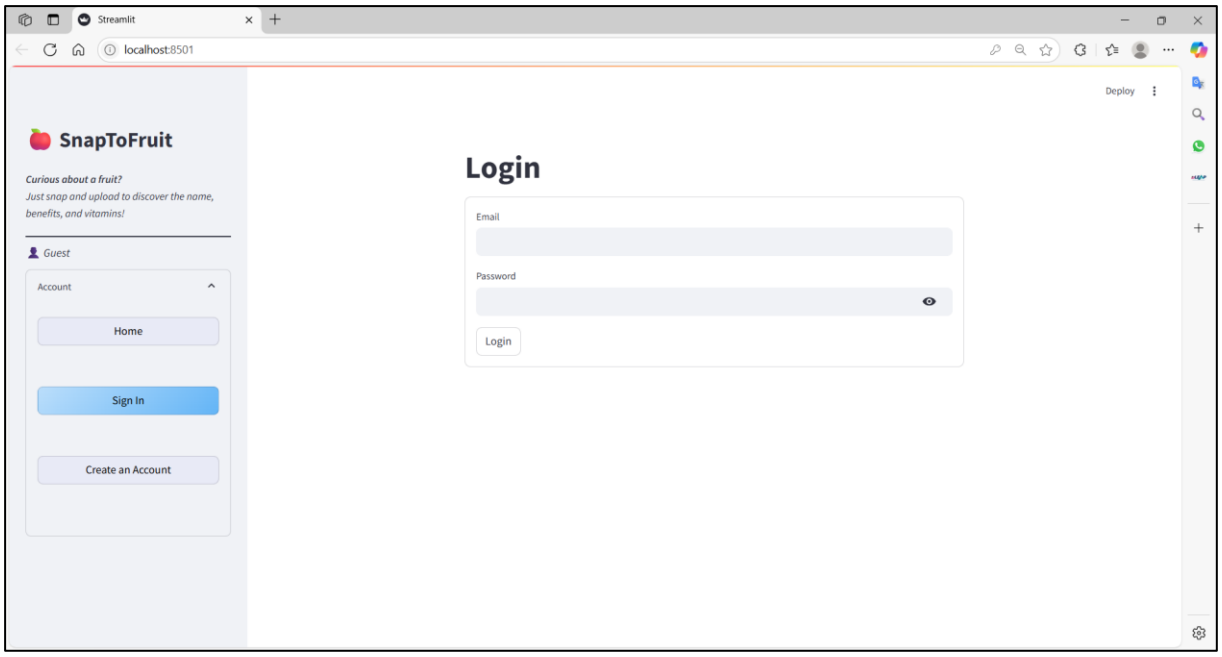

Figure 4.4: Login Page

Figure 4.4 shows the guest login page. User required to fill in the email and password before proceeding to the next step.

4.4.1.2 Sign Up

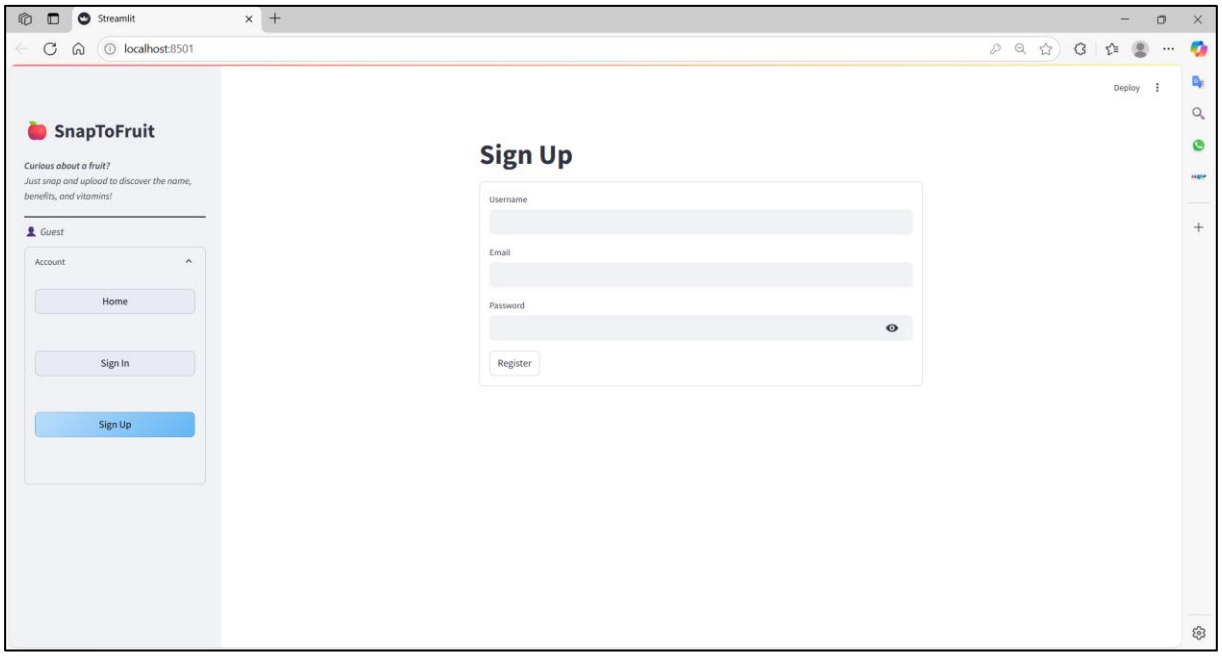

Figure 4.5:Sign Up Page

Figure 4.5 shows the guest registration page. Users without an account need to create an account before moving to the “Sign In” page.

4.4.1.3 Home

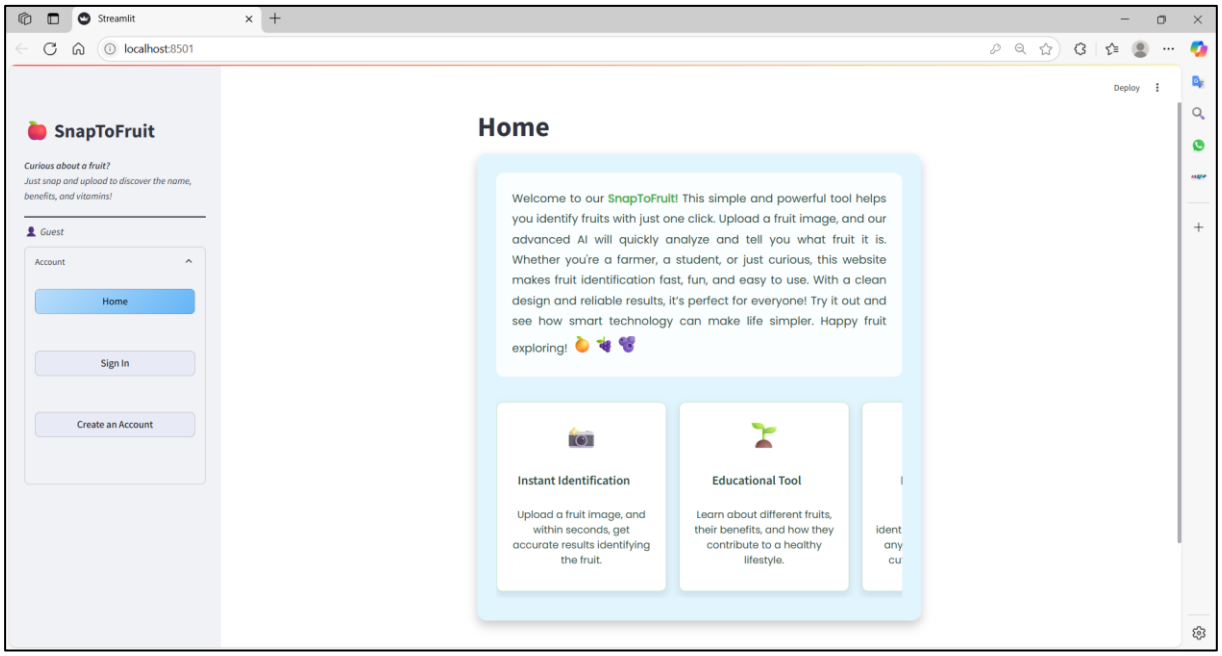

Figure 4.6: Home Page

Figure 4.6 showcases the SnapToFruit home page, highlighting features like instant identification, educational tools and fast and reliable for fruit recognition.

4.4.1.4 Dark Mode Settings Panel

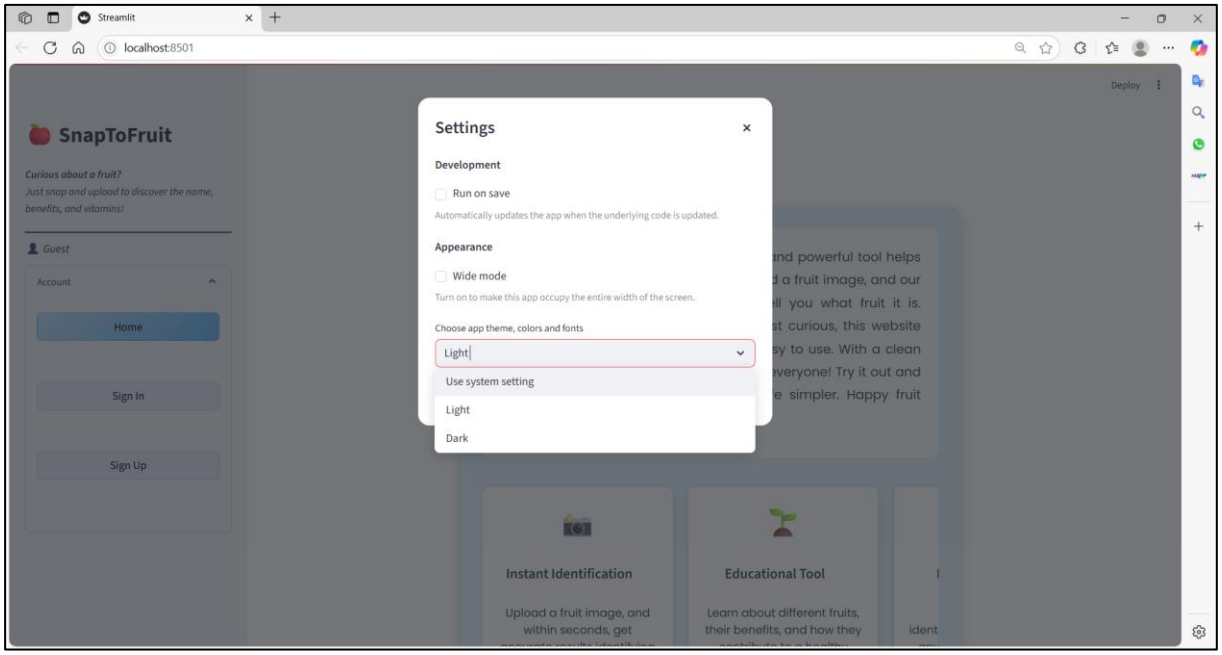

Figure 4.7: Dark Mode Settings Panel

Figure 4.7 allow user to customize the system appearance by selecting theme such as Use System Setting, Light or Dark mode.

4.4.2 Admin

4.4.2.1 Profile

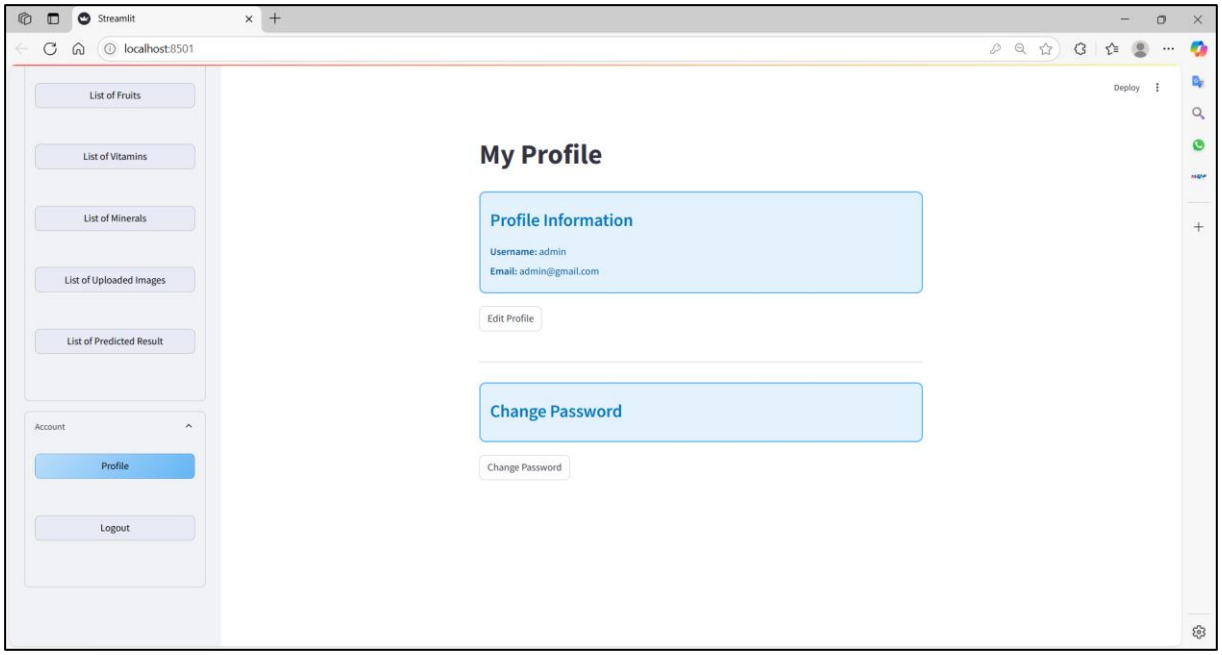

Figure 4.8: Profile Page

Figure 4.8 shows the admin's profile page. From this interface, admin can view their profile information, such as their username and email address. Admin can also edit their profile or change their password through this interface.

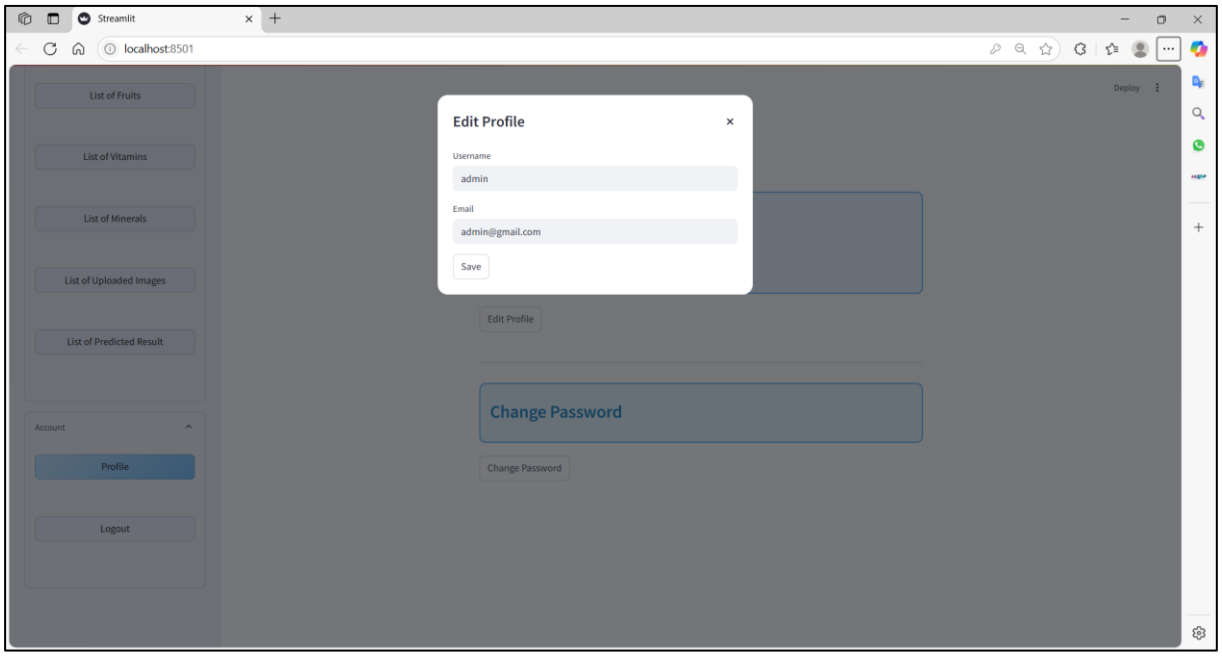

Figure 4.9: Profile Page - Edit Profile

Figure 4.9 shows the page for admin edit the profile. The page displays fields for updating the username and email of the logged-in user, and a “Save” button allows admin to submit their updates.

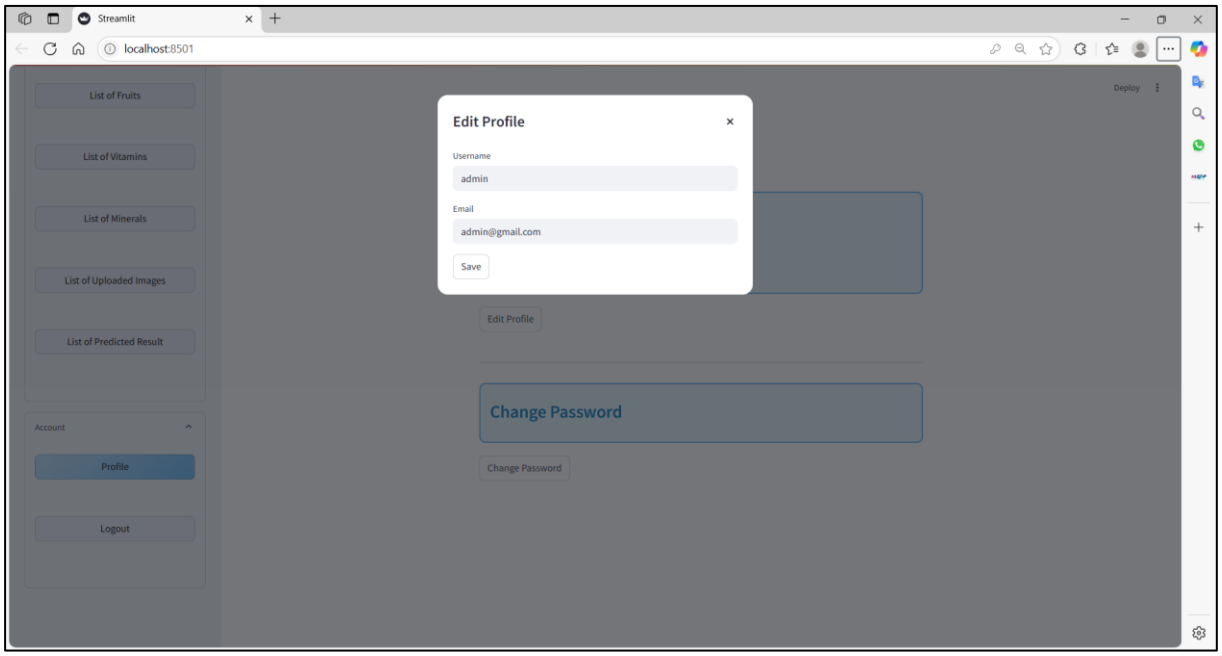

Figure 4.10: Profile Page - Change Password

Figure 4.10 shows the administrator's password change page, which contains fields for entering the old password and the new password for the logged-in user. A "Save" button also provided to allows admin to submit their updates easily.

4.4.2.2 List of Users

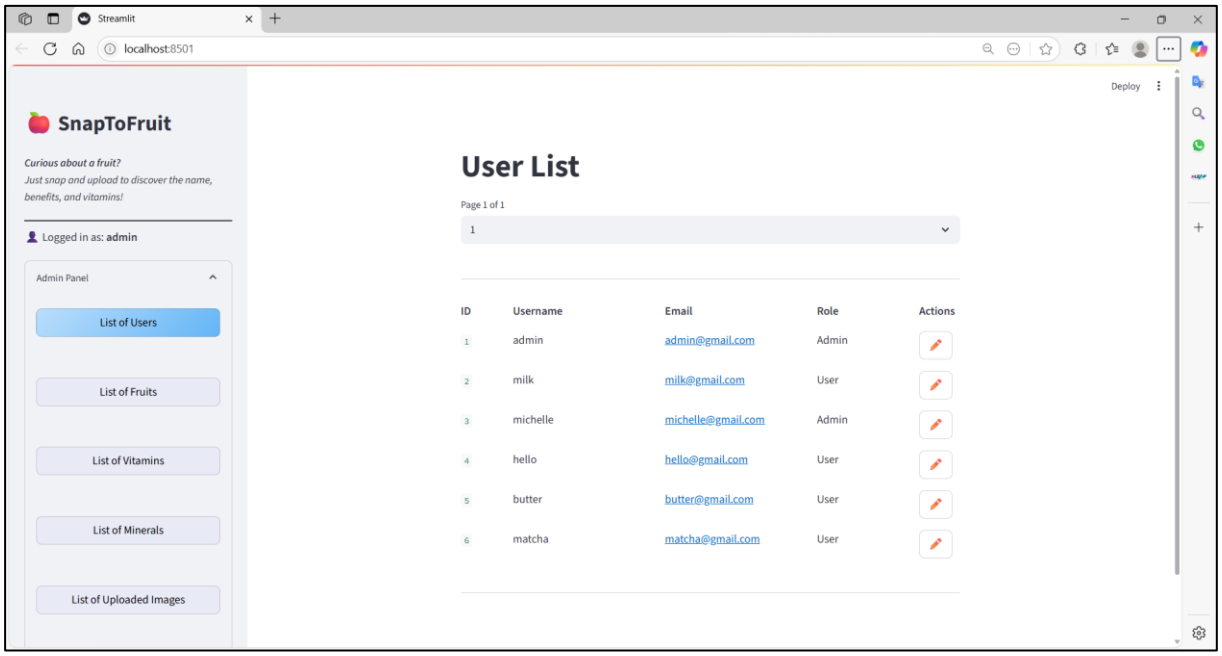

Figure 4.11: List of Users

Figure 4.11 shows the list of users that an administrator can view, including username and email. There is an edit option which allows administrators able to edit user password if user forgotten their own password.

4.4.2.3 List of Fruits

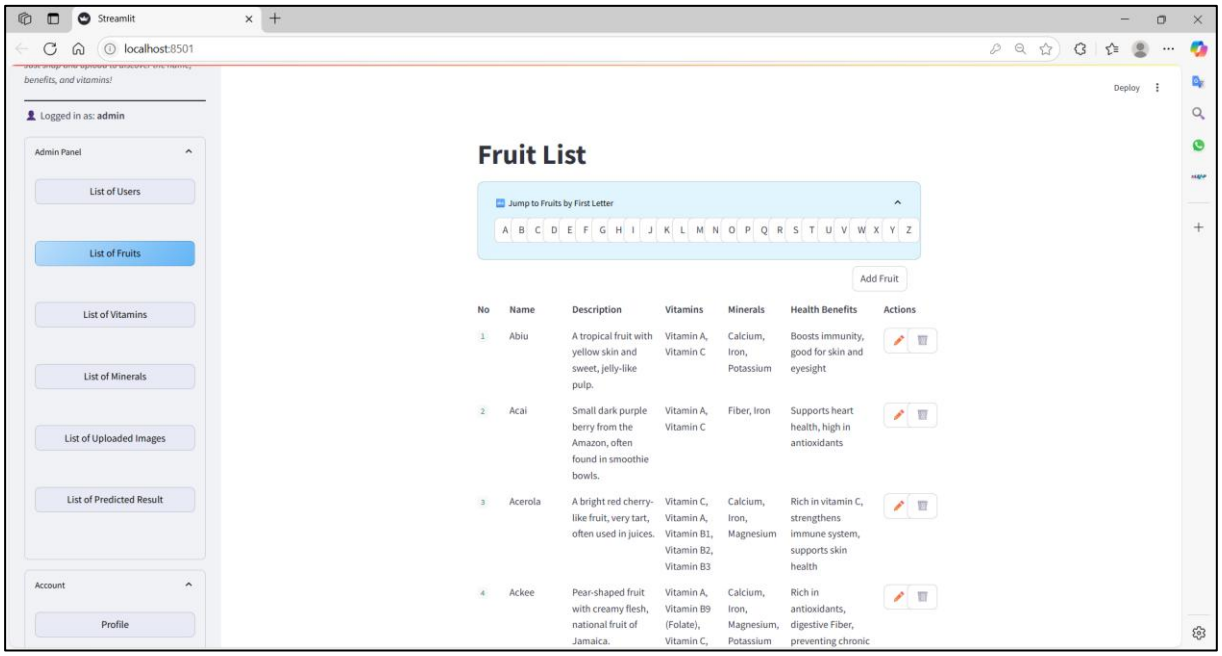

Figure 4.12: List of Fruits

Figure 4.12 shows the list of fruits that an administrator to view. It also includes a search function to filter the fruits by first letter, along with an option to add, edit or delete fruit.

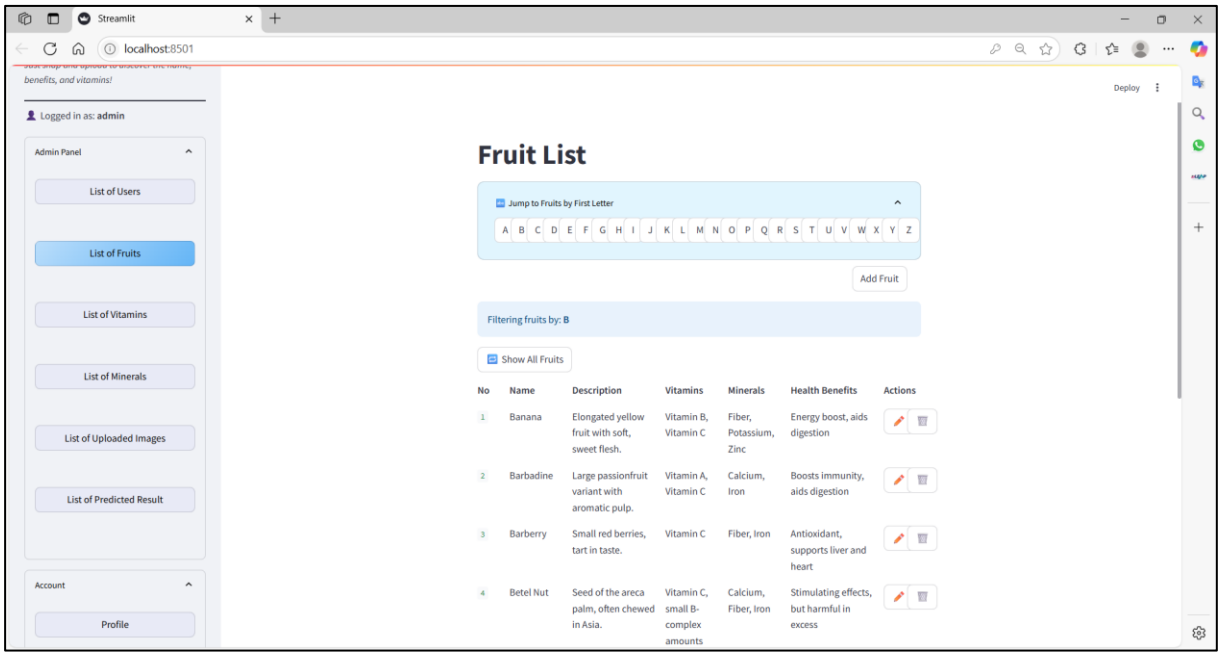

Figure 4.13: List of Fruits - Filter Fruits by First Letter

Figure 4.13 shows the search functionality that allows administrators to quickly locate fruits by filtering the first letter of the fruits. There is a “Show All Fruits” button to let admin view all the fruit list.

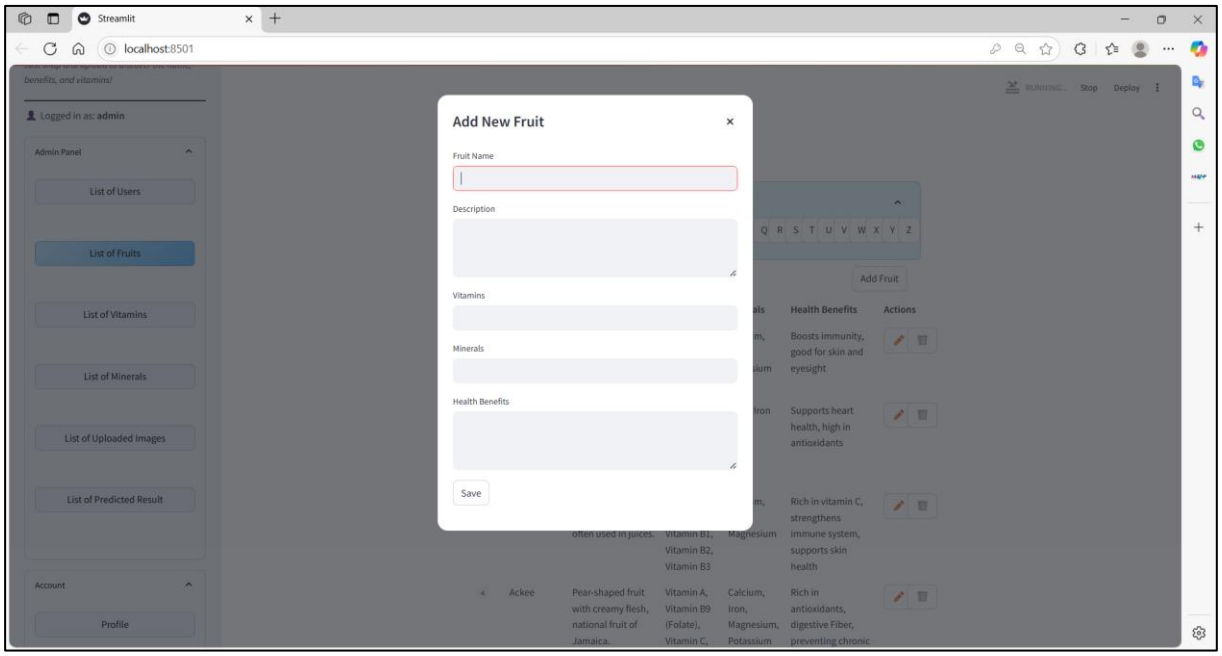

Figure 4.14: List of Fruits – Add New Fruit

Figure 4.14 shows the interface for admin to add new fruits. All the fields are required including fruit name, description, vitamins, minerals and health benefits. Then, click the “Save” button to ensure it created successfully.

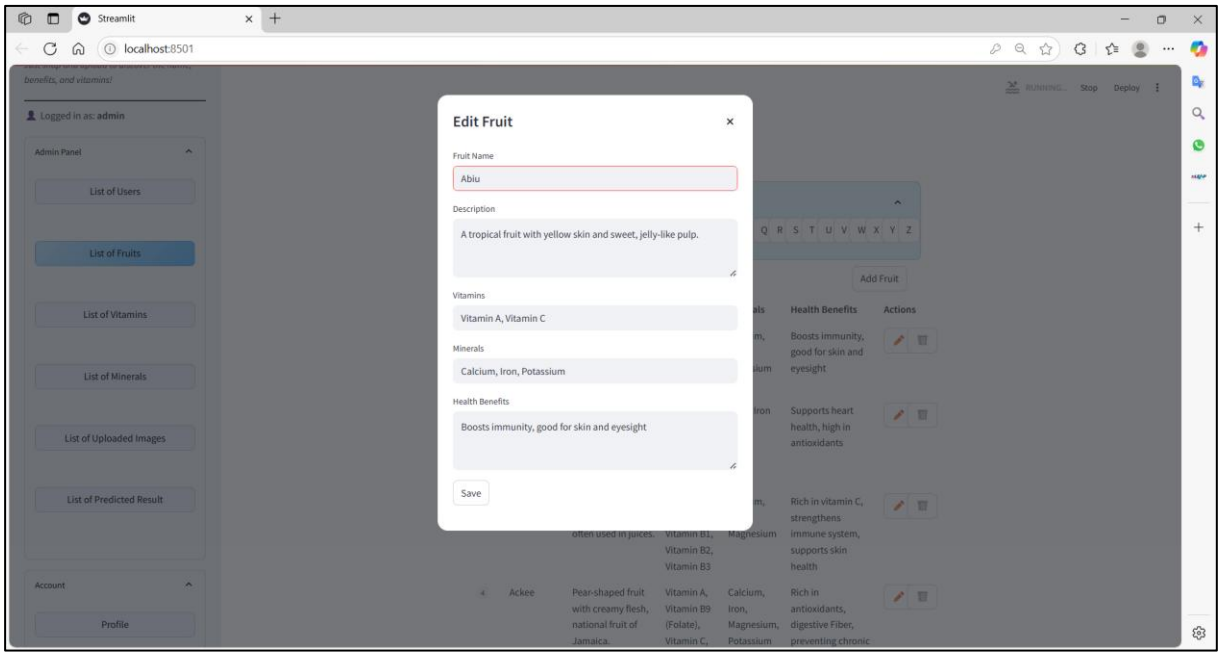

Figure 4.15: List of Fruits - Edit Fruit

Figure 4.15 show fruit editing panel for admin to manage fruit information within a web application. Admin can update the fruit name, description, vitamins, minerals and health benefits.

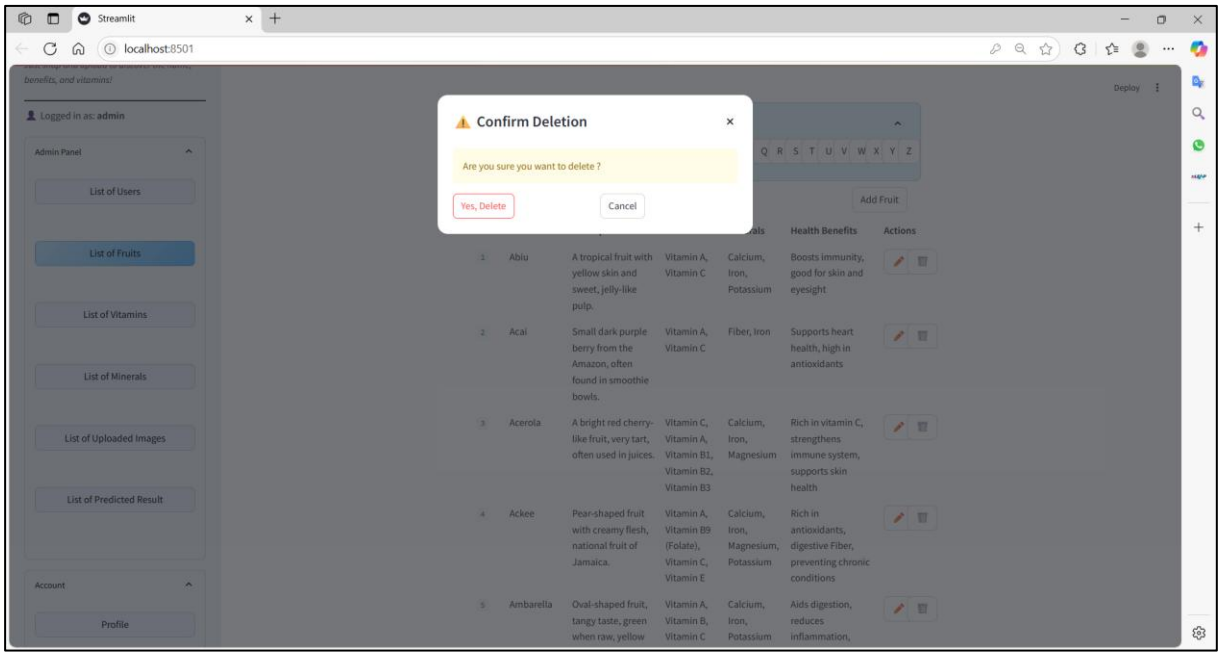

Figure 4.16: List of Fruits – Confirmation Message to Delete Fruit

Figure 4.16 displays the alert panel confirming the deletion of a fruit. After successful confirmation, the fruit detail will be deleted from the list.

4.4.2.4 List of Vitamins

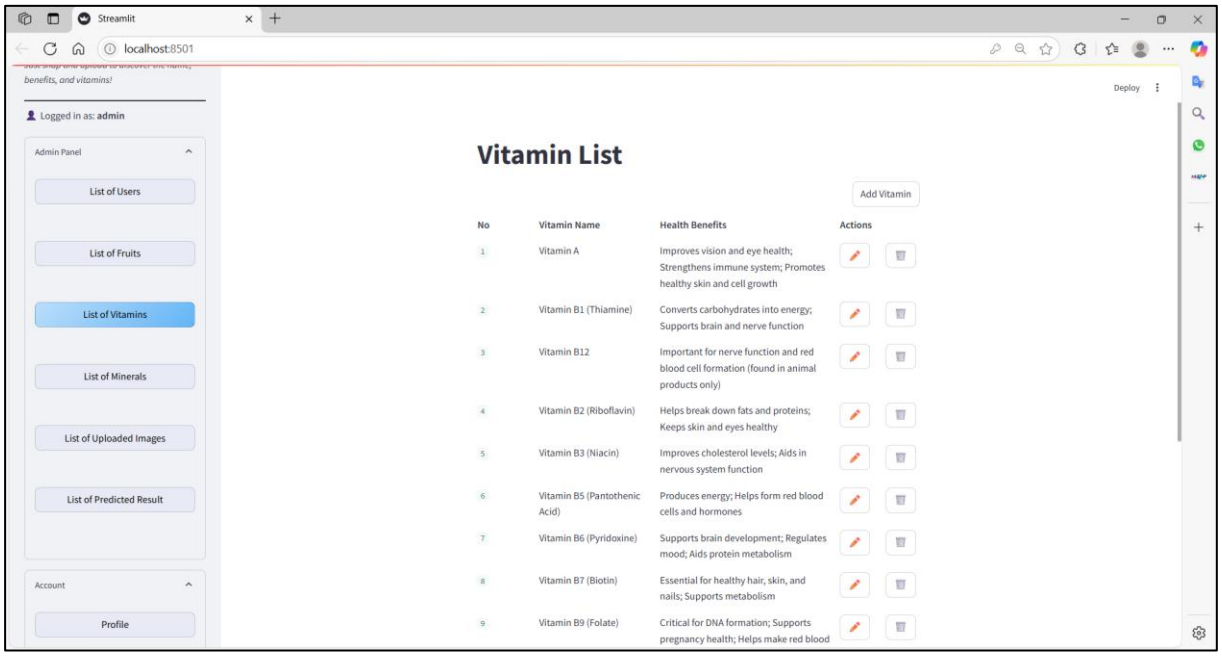

Figure 4.17: List of Vitamins

Figure 4.17 shows the list of vitamins that an administrator can view. Admin can add, edit or delete vitamin detail through this interface.

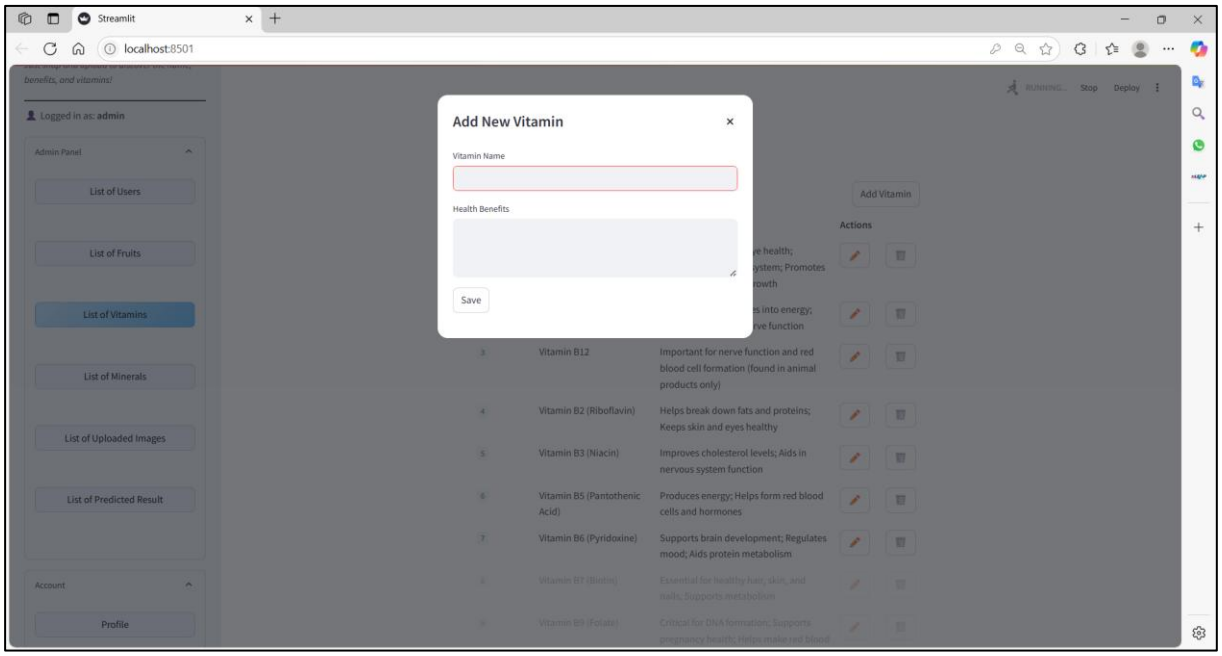

Figure 4.18: List of Vitamins – Add New Vitamin

Figure 4.18 shows the interface for admin to add new vitamin. All the fields are required including vitamin name and health benefits. Then, click the “Save” button to ensure it created successfully.

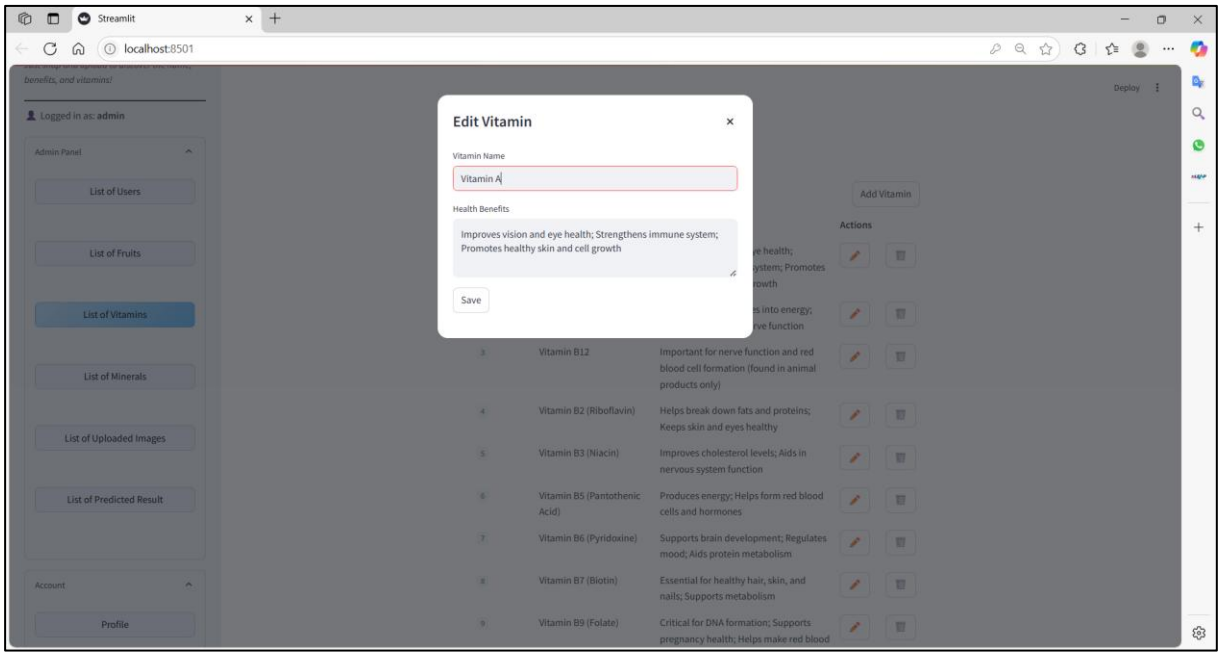

Figure 4.19: List of Vitamins – Edit Vitamin

Figure 4.19 shows vitamin editing panel for admin to manage vitamin details within a web application. Admin can update the vitamin name and its health benefits.

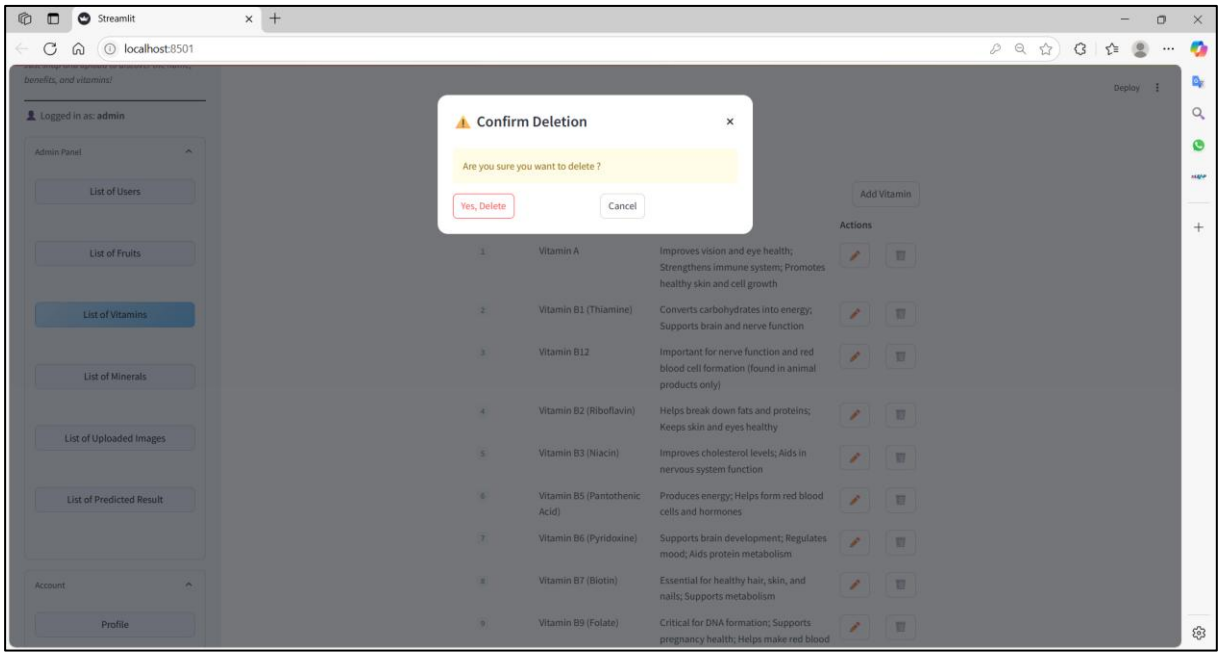

Figure 4.20: List of Vitamins – Confirmation Message to Delete Vitamin

Figure 4.2 displays the alert panel confirming the deletion of a vitamin. After successful confirmation, the vitamin details will be deleted from the list.

4.4.2.5 List of Minerals

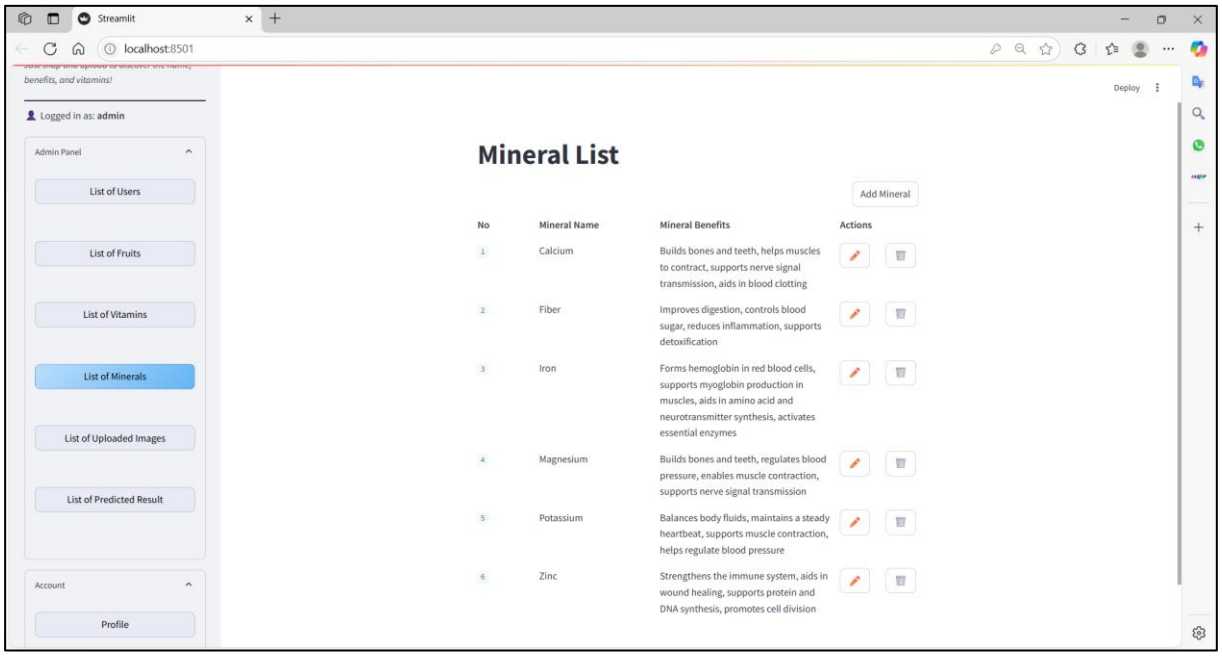

Figure 4.21: List of Minerals

Figure 4.21 shows the list of minerals that an administrator can view. Admin can add, edit or delete mineral detail through this interface.

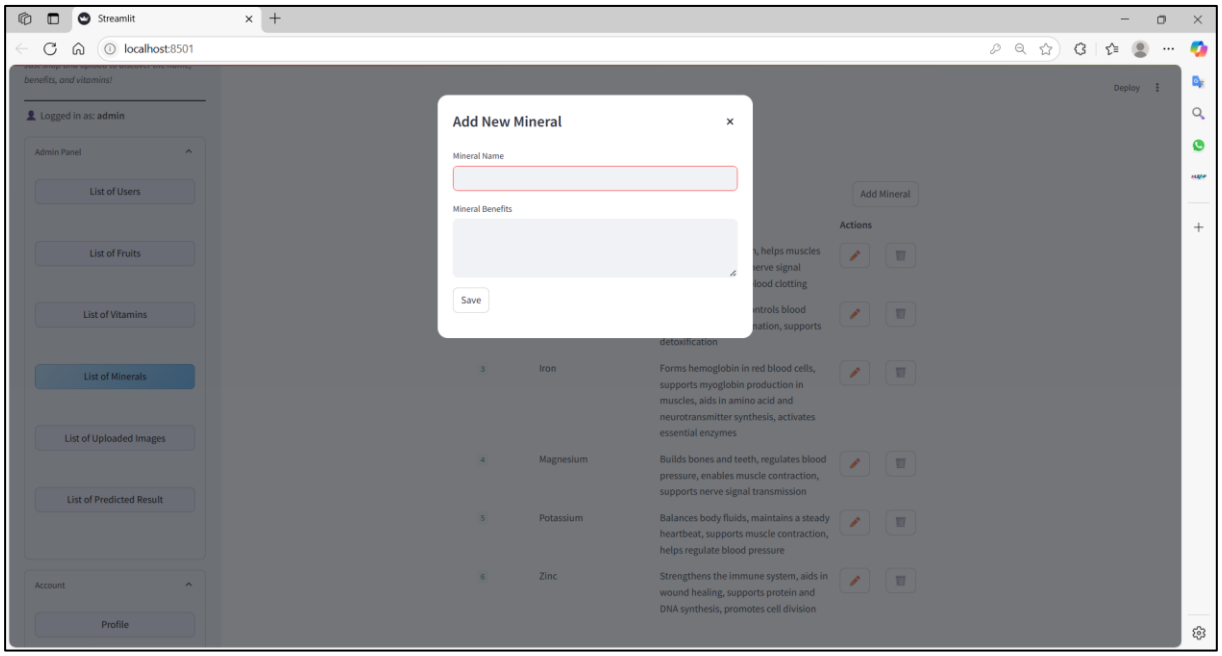

Figure 4.22: List of Minerals – Add New Mineral

Figure 4.22 shows the interface for admin to add new mineral. All the fields are required including mineral name and mineral benefits. Then, click the “Save” button to ensure it created successfully.

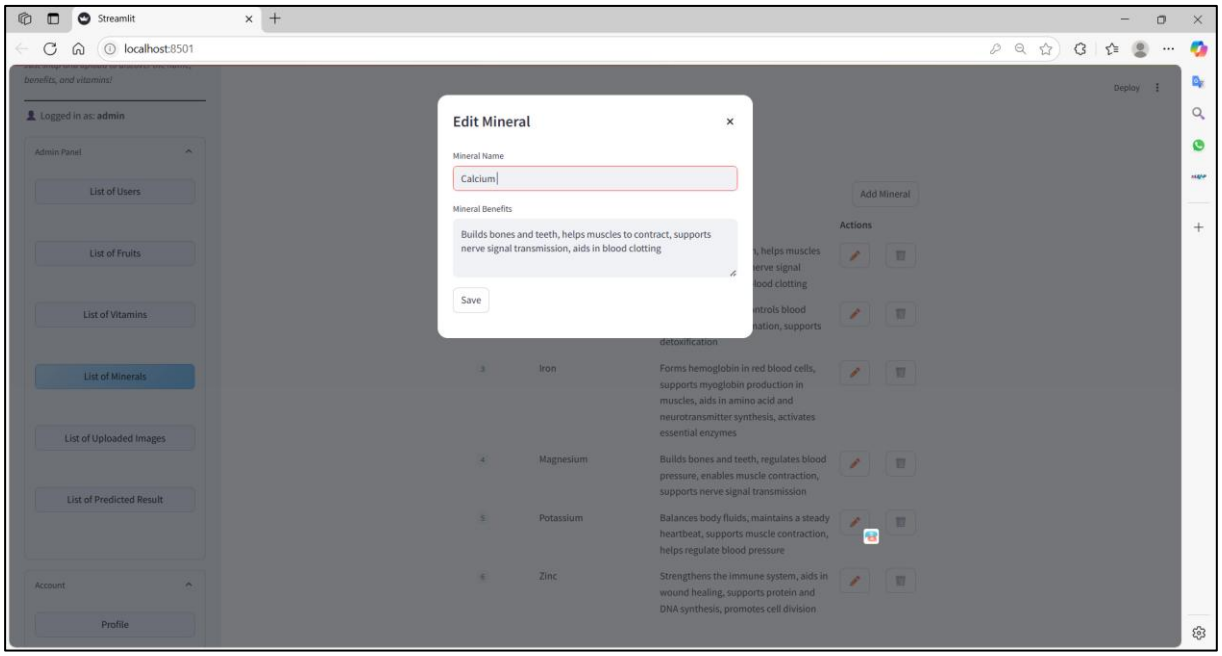

Figure 4.23: List of Minerals - Edit Mineral

Figure 4.23 shows mineral editing panel for admin to manage mineral details within a web application. Admin can update the mineral name and mineral benefits through this panel.

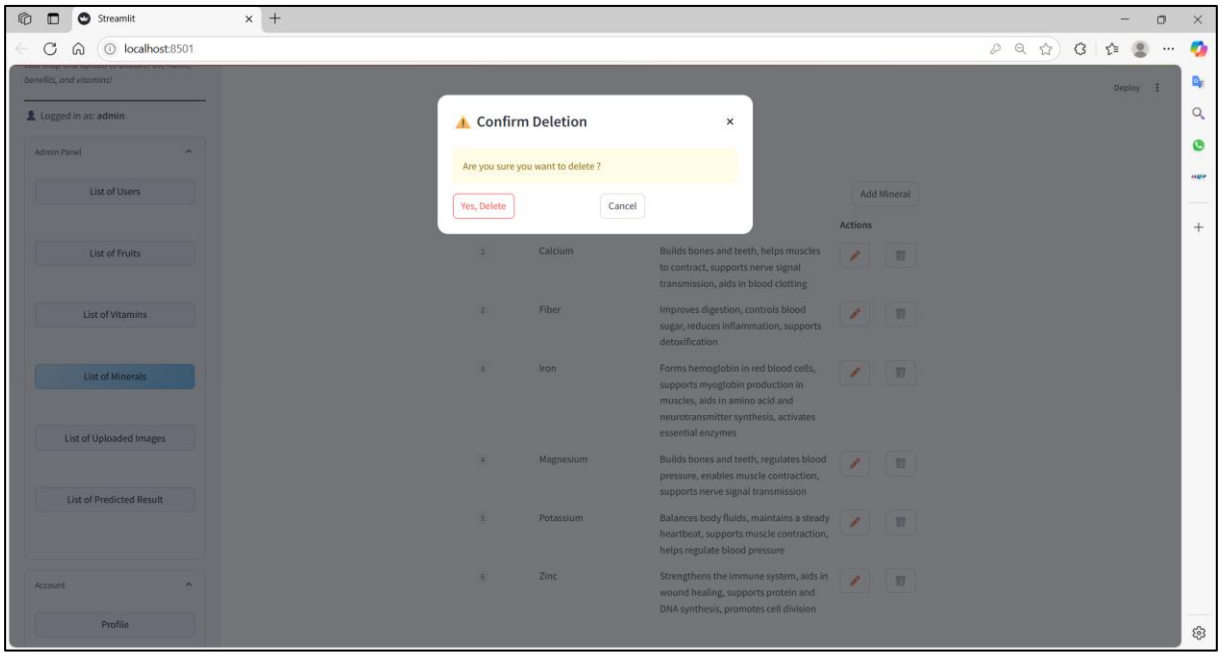

Figure 4.24: List of Minerals - Confirmation Message to Delete Fruit

Figure 4.24 displays the alert panel confirming the deletion of a mineral. After successful confirmation, the mineral details will be deleted from the list.

4.4.2.6 List of Users Uploaded Images

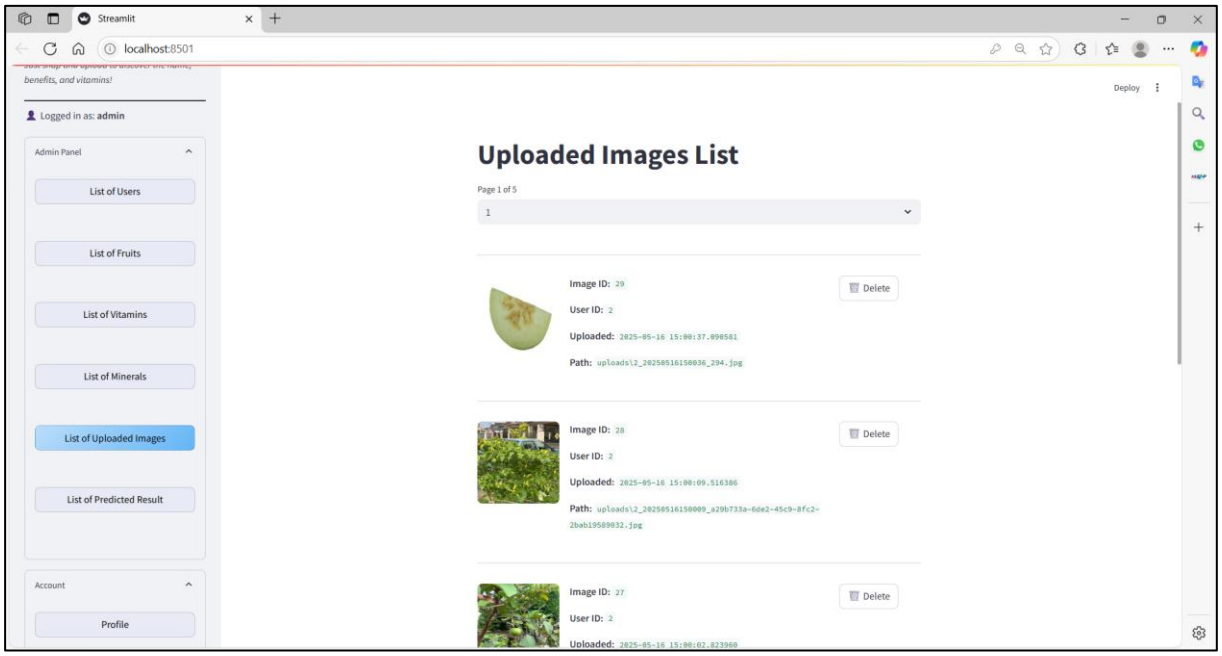

Figure 4.25: List of Users Uploaded Images

Figure 4.25 displays the list of users uploaded images that an administrator can view in a table format.

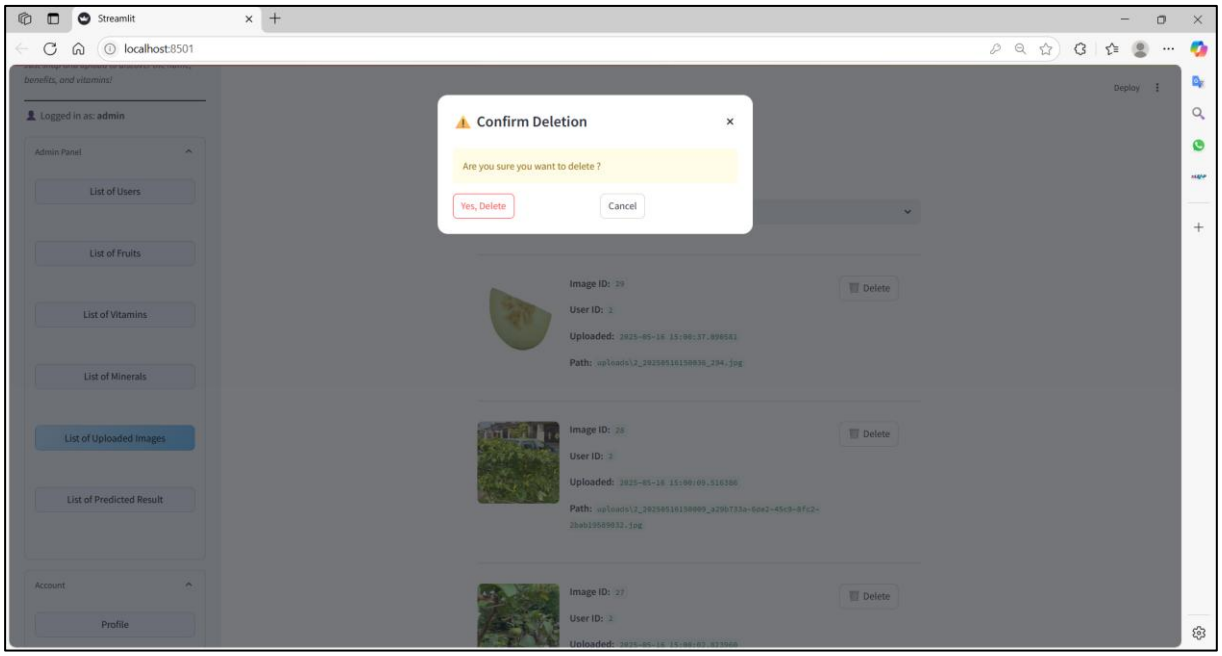

Figure 4.26: List of Updated Image – Confirmation Message to Delete Uploaded Image

Figure 4.26 displays the alert panel confirming the deletion of an uploaded image. After successful confirmation, the uploaded image with its detail will be deleted from the list.

4.4.2.7 List of Predicted Results

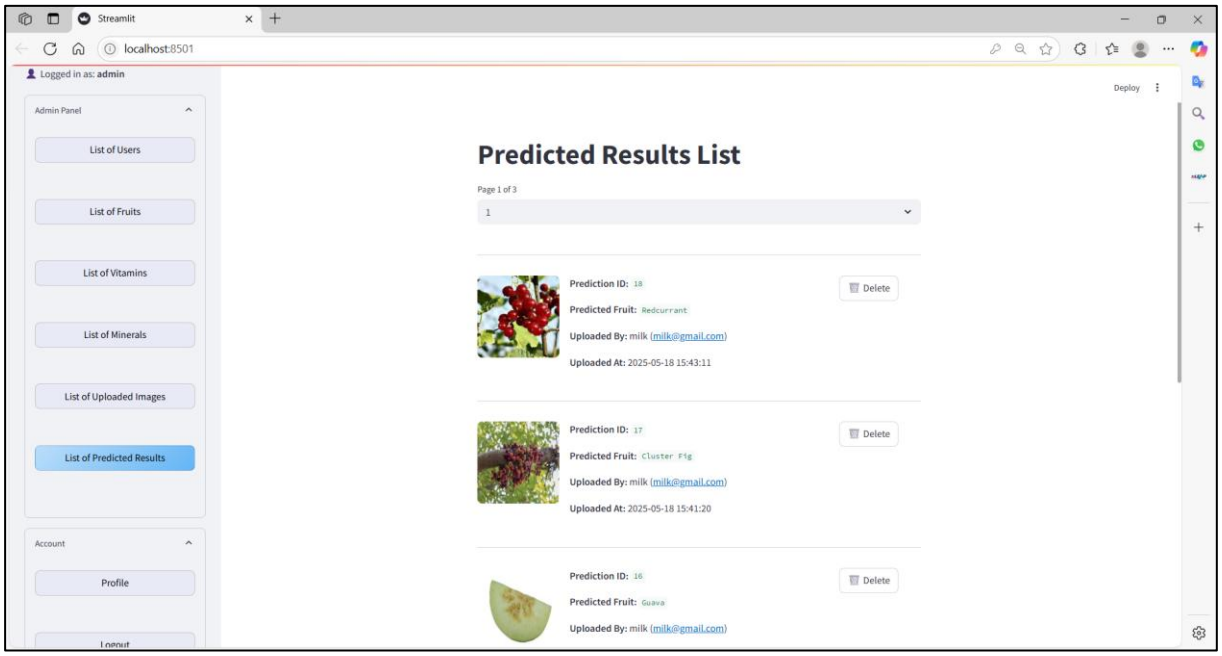

Figure 4.27: List of Predicted Results

Figure 4.27 displays the list of predicted results that an administrator can view in a table format.

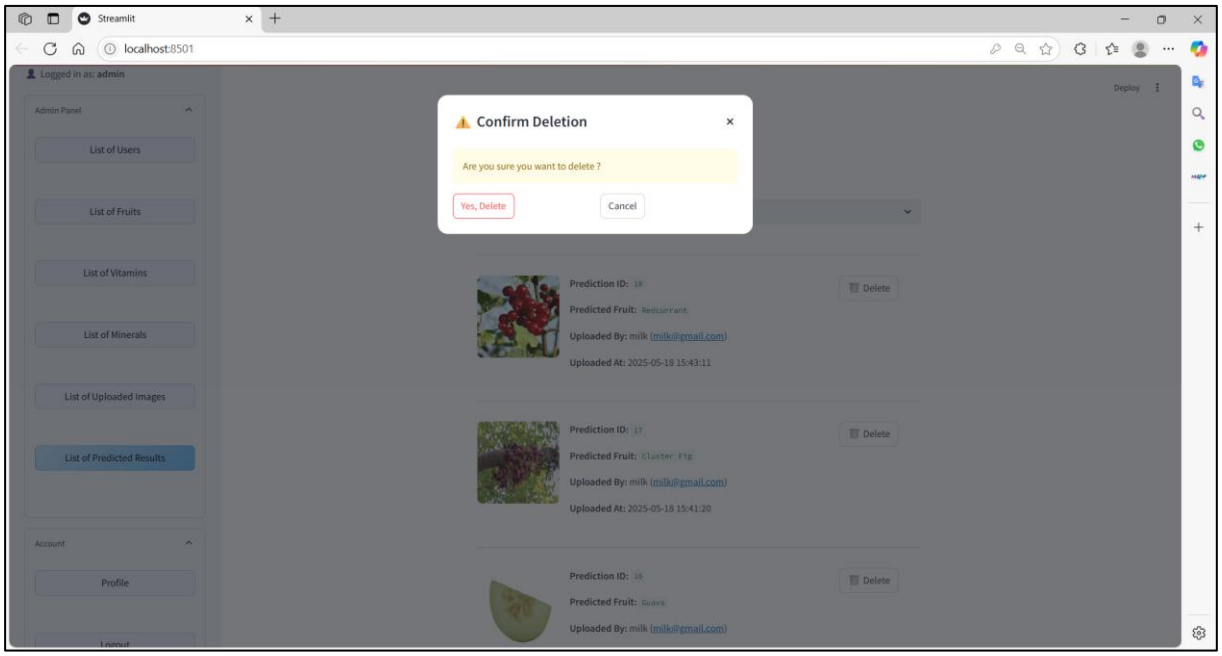

Figure 4.28: List of Predicted Results - Confirmation Message to Delete Predicted Result

Figure 4.28 displays the alert panel confirming the deletion of a predicted result. After successful confirmation, the predicted result will be deleted from the list.

4.4.3 Users

4.4.3.1 Profile

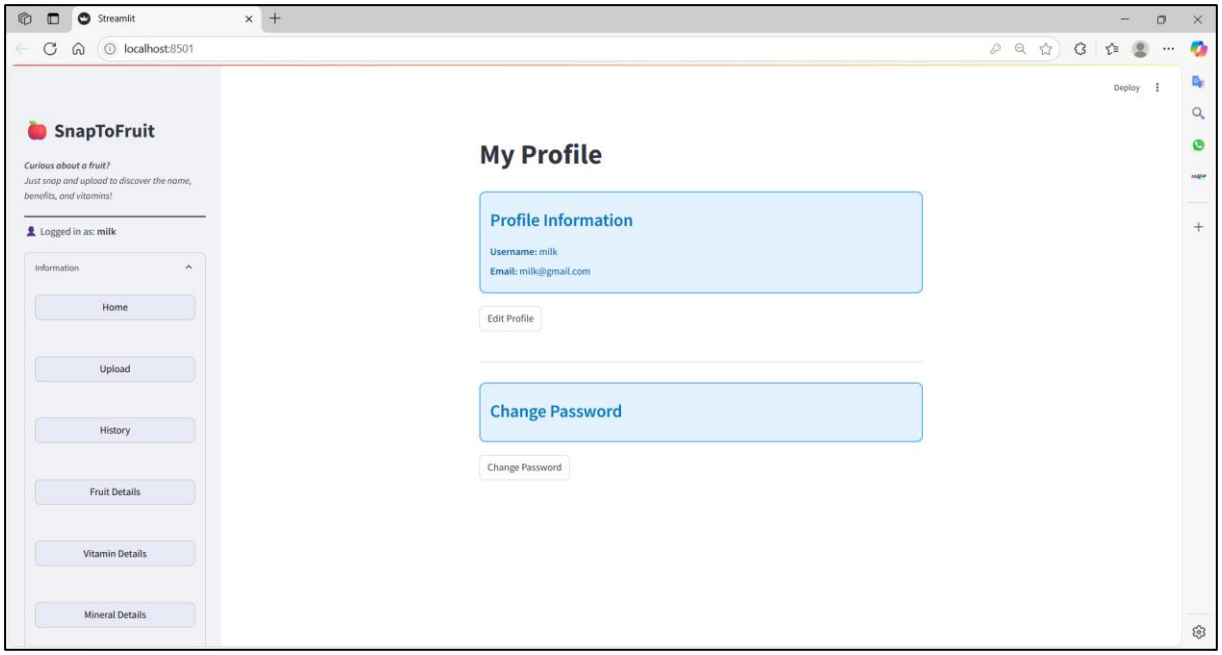

Figure 4.29: Profile Page

Figure 4.23 shows the user's profile page. From this interface, user can view their profile information, such as their username and email address. User can also edit their profile or change their password through this interface.

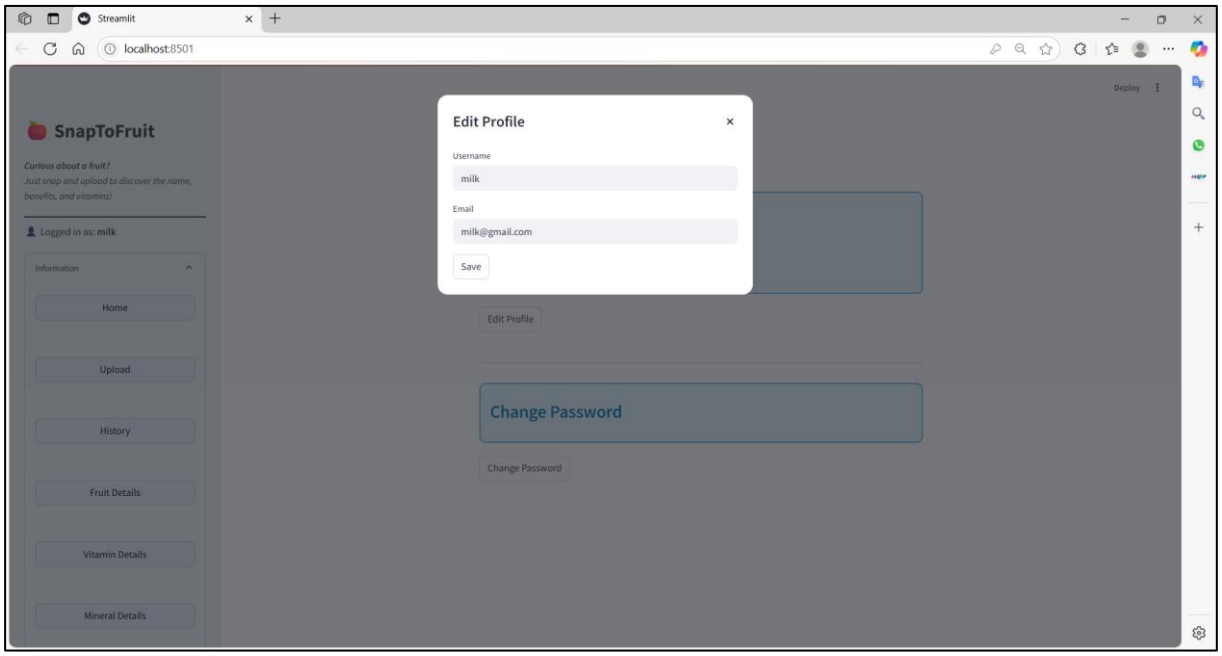

Figure 4.30: Profile Page - Edit Profile

Figure 4.30 shows the page for user edit the profile. The page displays fields for updating the username and email of the logged-in user, and a “Save” button allows users to submit their updates.

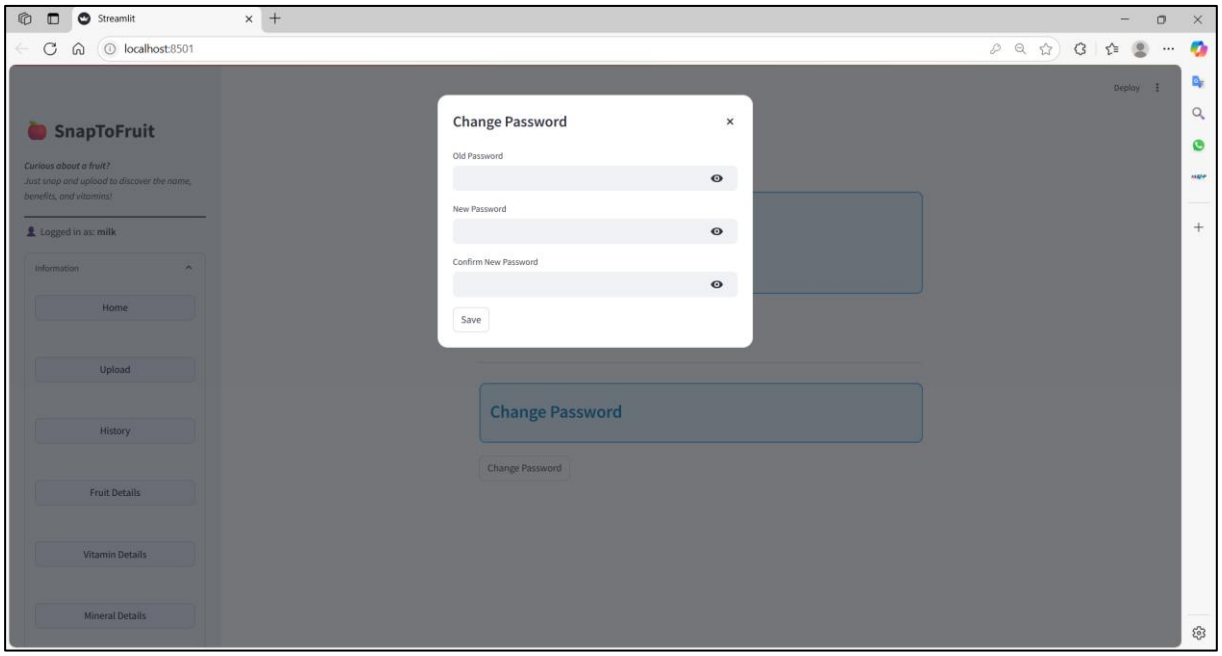

Figure 4.31: Profile Page - Change Password

Figure 4.31 shows the user's password change page, which contains fields for entering the old password and the new password for the logged-in user. A "Save" button also provided to allows users to submit their updates easily.

4.4.3.2 Upload

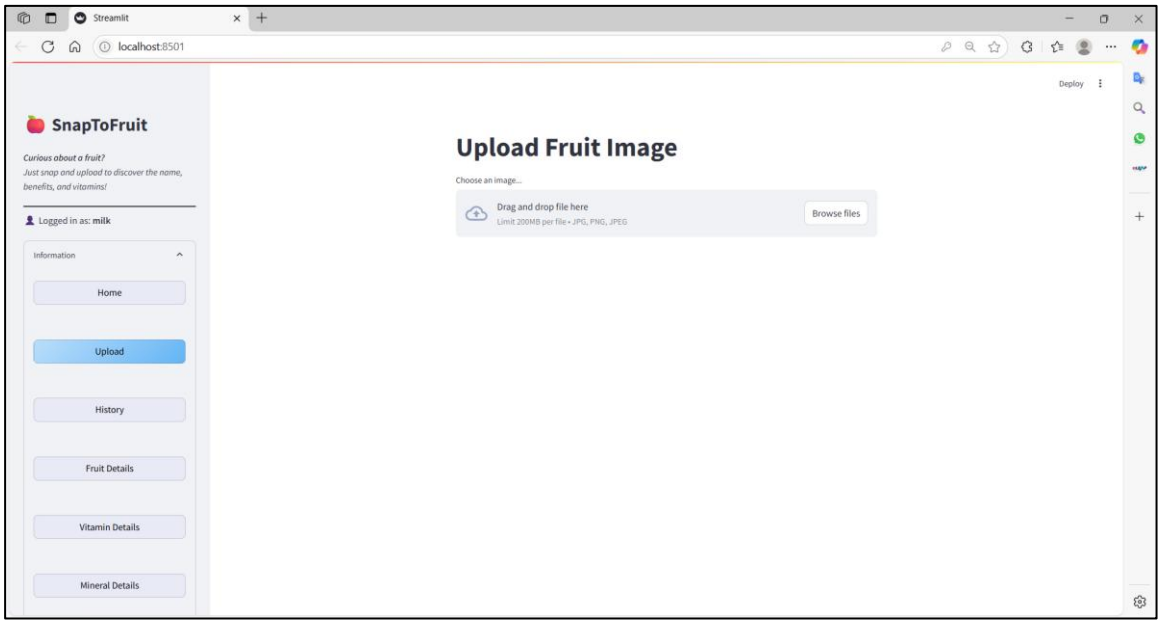

Figure 4.32: Upload Fruit Image Interface without Uploaded Image

Figure 4.32 provide an interface for users to upload pictures. Users can drag and drop pictures or upload file pictures to this interface for image prediction.

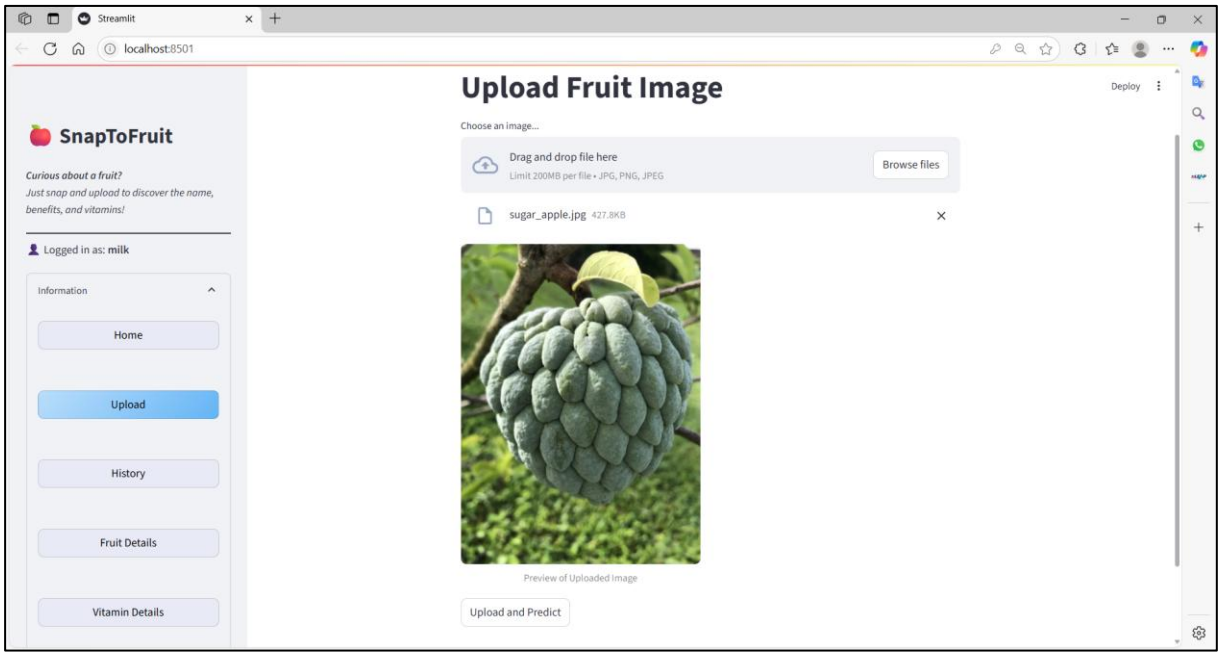

Figure 4.33: Upload Fruit Image Interface with Uploaded Image

Figure 4.33 shows the user interface for uploading a fruit image. A preview of the submitted image and upload and predict options will be shown after user uploading a fruit image.

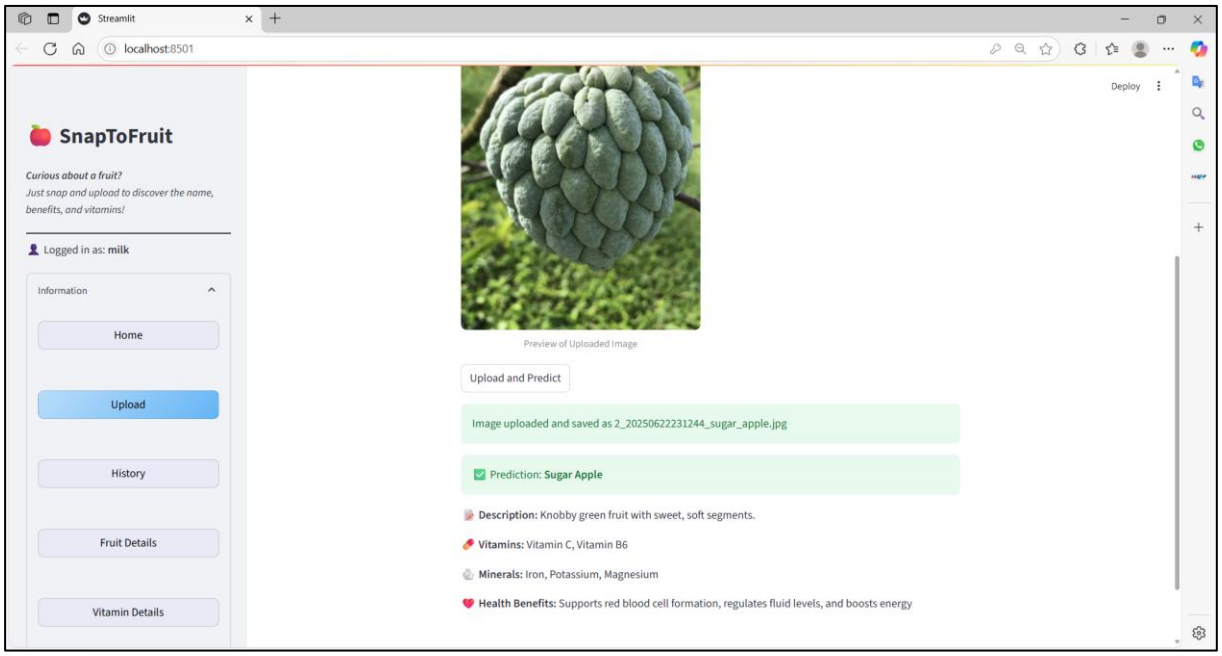

Figure 4.34: Display Prediction Result

Figure 4.34 shows the interface of the prediction fruit along with its information after user click the “Upload and Predict” button

4.4.3.3 History

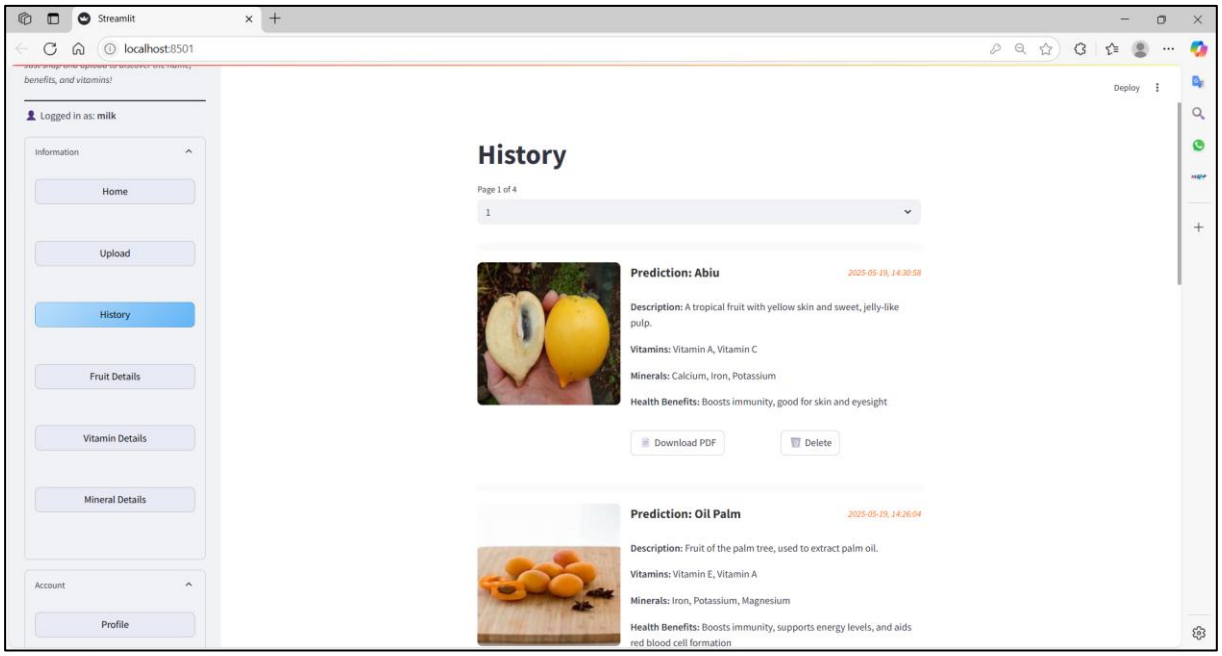

Figure 4.35: History Page

Figure 4.35 display a history page for user to preview their previous fruit predictions Each entry features a fruit's name, a brief description and its nutritional benefit, including vitamins and minerals**.** Other than that, user given an option to download the detail or delete specific entries.

4.4.3.4 Fruit Details

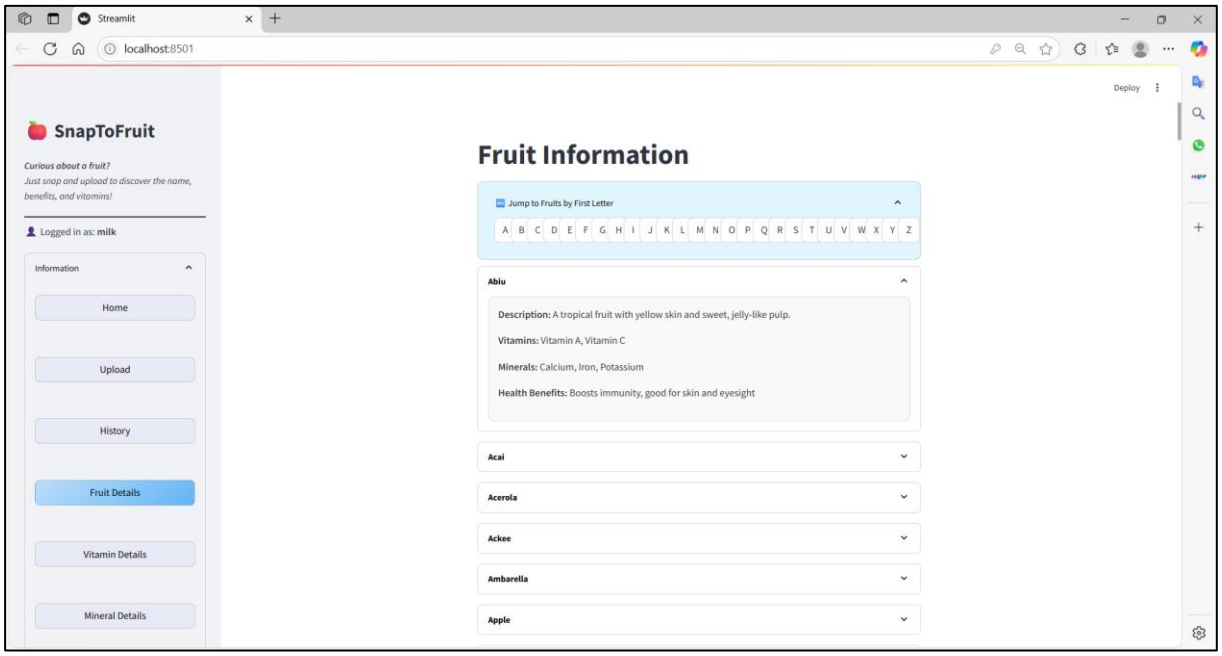

Figure 4.36: Fruit Details Page

*Figure 4.*36 shows the fruit information page, allowing users to browse a comprehensive list of fruits. The page also provides a search function to facilitate navigation and finding specific fruits.

4.4.3.5 Vitamin Details

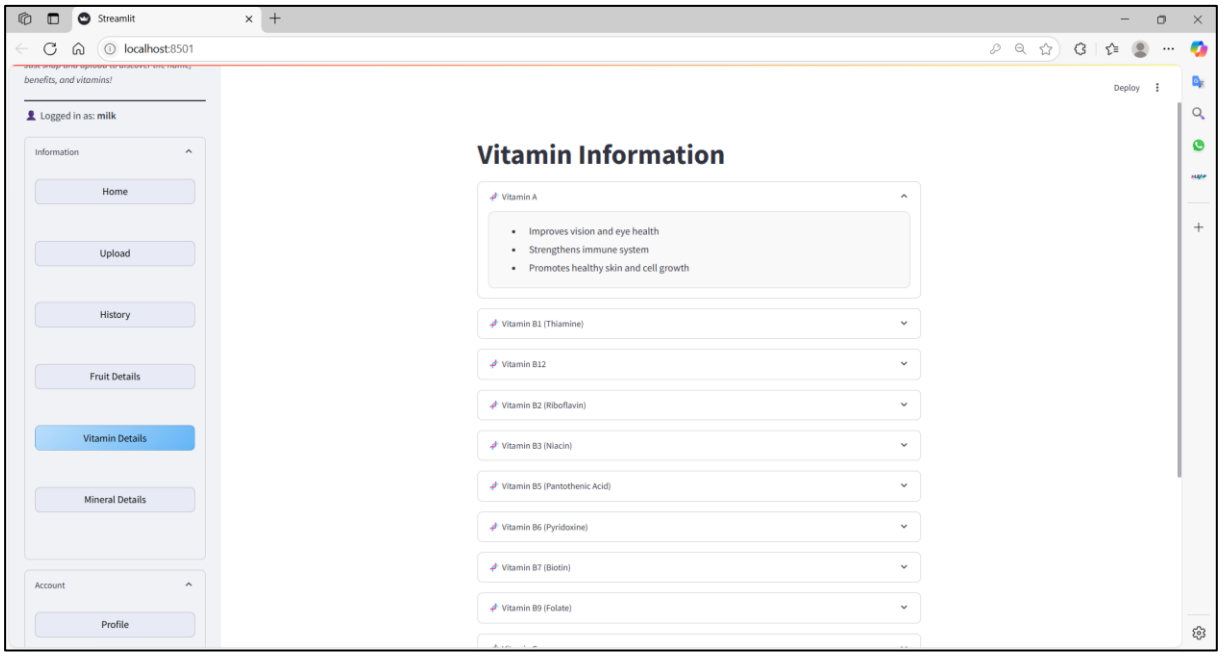

Figure 4.37: Vitamin Details Page

Figure 4.37 shows the vitamin information page that provide users with a detailed overview of essential vitamin and their health benefits.

4.4.3.6 Minerals Details

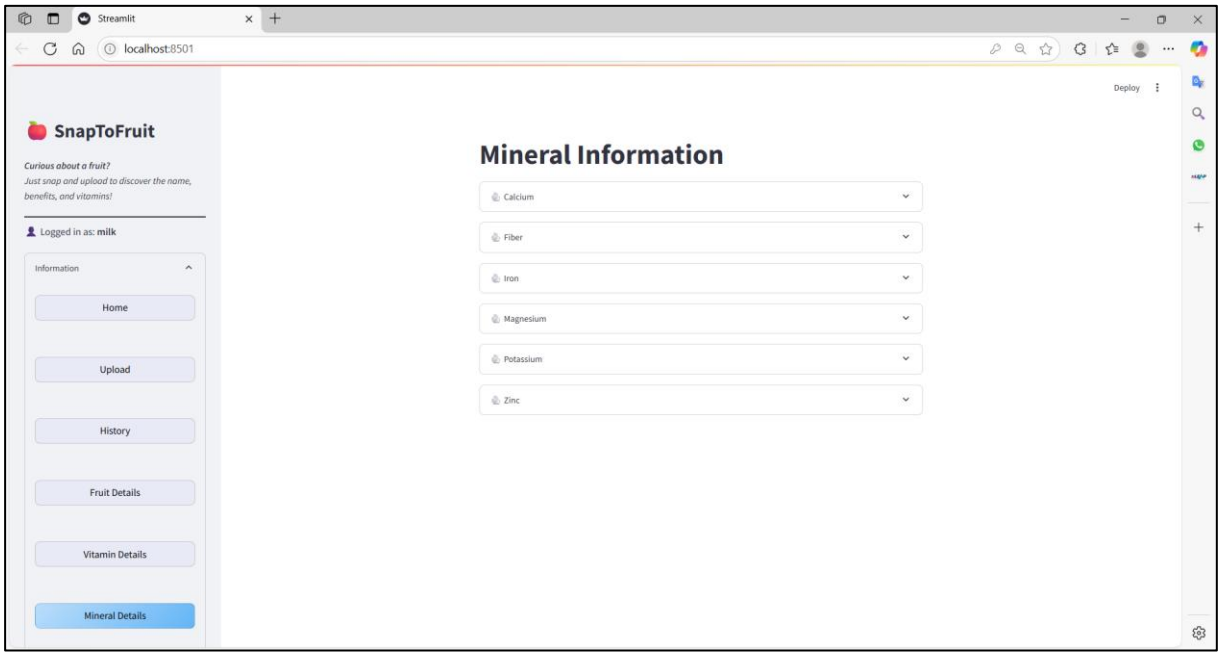

Figure 4.38: Mineral Details Page

Figure 4.38 shows the mineral information page that provide users with a detailed overview of essential minerals and its benefits.

4.5 Summary

This chapter provided a detailed overview of the fruit classification web application implementation process, including the development environment, model training, database setup, and user interface design. The successful deployment of a working and interactive system was made possible by the integration of many technologies, including Streamlit, Kaggle, TensorFlow, pgAdmin 4, and Visual Studio Code. Every element was carefully set up to guarantee seamless functioning and an easy-to-use interface.

CHAPTER 5: TESTING

5.1 Introduction

This chapter covers the functional testing and usability testing performed to ensure that the proposed system can function accurately and provide a smooth user experience. Functional testing was conducted out to ensure that every feature works as expected and meet the requirements, while usability testing evaluated the overall interface design and user-friendliness of the system.

5.2 Functional Testing

Functional testing was conducted to ensure that the system function properly under various conditions. The test objective, input data, expected result, actual result, and status are all included in each test case.

Table 5.1: Test Case 1 – User Sign Up

Test Case ID: TC01 **Triggered by: User**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test successful sign up	Enter valid username, email and password	Username: milk Email: milk@gmail.com	Show success message and redirect to login page	Show success message and redirect to login page	Pass

		and click “Sign up” button	Password: milk1234			
2	To test missing fields.	Click “Sign Up” with empty fields.	Username: (empty) Email: (empty) Password: (empty)	Show error: “All fields are required.’	Show error: “All fields are required.’	Pass
3	To test invalid email format	Enter invalid email and valid username with password.	Username: milk Email: milk@.com Password: milk1234	Show error: “Invalid email.”	Show error: “Invalid email.”	Pass
4	To test invalid password format	Enter invalid password and valid username with email.	Username: milk Email: milk@gmail.com Password: milk	Show error: “Password must contain at least 8 characters long and contain at least one alphabet character.”	Show error: “Password must contain at least 8 characters long and contain at least one alphabet character.”	Pass
5	To test already registered username or email	Use a username or email that is already registered	Username: milk000 Email: milk@gmail.com Password: milk	Show error: “Registration failed. Username or email may already exist.”	Show error: “Registration failed. Username or email may already exist.”	Pass

5.2.1 Test Case for the Proposed Web Application Administrator Module

Table 5.2: Test Case 2 – Admin Login

Test Case ID: TC02 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**

1	To test admin successful login	Enter valid email and password and then click "Login" button	Email: admin@gmail.com Password: admin1234	Show success message and redirect to "List of Users" page	Show success message and redirect to "List of Users" page	Pass
2	To test missing fields.	Click "Login" with empty fields.	Email: (empty) Password: (empty)	Show error: "All fields are required.'	Show error: "All fields are required.'	Pass
3	To test invalid email or password	Enter invalid email or password and click "Login"	Email: admin@gmail.com Password: admin123445	Show error: "Invalid email or password."	Show error: "Invalid email or password."	Pass
4	To test forgot password button	Click "Forgot Password" button	-	Show a dialog message: "If you've forgotten your password, please contact the official office at 📞 082-123456 for assistance.	Show a dialog message: "If you've forgotten your password, please contact the official office at 📞 082-123456 for assistance.	Pass

Table 5.3: Test Case 3 - Admin Manage Profile

Test Case ID: TC03 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test admin successful editing username and email	Admin updates username and/or email and clicks "Save"	Username: hi_admin Email: hi_admin@gmail.com	Show success message and update profile info	Show success message and update profile info	Pass

2	To test missing fields for edit profile information	Admin leave username or email empty and clicks "Save"	Username: (empty) Email: (empty)	Show error: "All fields are required."	Show error: "All fields are required."	Pass
3	To test invalid email format	Admin enters invalid email	Username: admin Email: admin@gm.com	Show error: "Invalid email."	Show error: "Invalid email."	Pass
4	To test admin successful changing password	Admin enters old password, new password and confirm password	Old password: admin1234 New Password: admin 12345 Confirm Password: admin12345	Show success message and update password info	Show success message and update password info	Pass
5	To test incorrect current password	Admin enters wrong current password when changing password	Old password: admin12345 New Password: admin000 Confirm Password: admin000	Show error: "Old password is incorrect."	Show error: "Old password is incorrect."	Pass
6	To test mismatch new password	Admin enters new password that do not match	Old password: admin12345 New Password: admin000 Confirm Password: admin0000	Show error: "Password do not match."	Show error: "Password do not match."	Pass
7	To test invalid new password format	Admin enters invalid new password format	Old password: admin12345 New Password: admin Confirm Password: admin	Show error: "New password must contain at least 8 characters long and contain at least one alphabet character."	Show error: "New password must contain at least 8 characters long and contain at least one alphabet character."	Pass

8	To test missing field for changing password	Admin leaves old password, new password or confirm password empty and clicks "Save"	Old password: (empty) New Password: (empty) Confirm Password: (empty)	Show error: "All fields are required."	Show error: "All fields are required."	Pass

Table 5.4: Test Case 4 – Admin Manage List of User

Test Case ID: TC04 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To check if the admin can view the user list	Admin clicks on the "List of Uses' in menu	-	Display a table of registered users with their details	Display a table of registered users with their details	Pass
2	To test pagination "Next" button functionality	Admin clicks on the "Next" button	Button: Next	Display next page of user list	Next page shown	Pass
3	To test pagination "Previous" button functionality	Admin clicks on the "Previous" button	Button: Previous	Display the previous page of user list	Previous page shown	Pass
4	To test selecting a specific page	Admin clicks the selected page from pagination control	Page number: 3	Display users list from Page 3	Page 3 shown	Pass
5	To test admin successful editing user's password	Admin updates password and clicks "Save"	Username: milk Email: milk@gmail.com	Show success message and update user info	Show success message and update user info	Pass

			New Password: milk12345			
6	To test invalid new password format	Admin updates user password using invalid new password format	Username: milk Email: milk@gmail.com New Password: milk12	Show error: "New password must contain at least 8 characters long and contain at least one alphabet character."	Show error: "New password must contain at least 8 characters long and contain at least one alphabet character."	Pass
7	To test missing field for changing new password	Admin leaves new password field blank and clicks "Save"	Username: milk Email: milk@gmail.com New Password: (empty)	Show error: "No changes were made."	Show error: "No changes were made."	Pass

Table 5.5: Test Case 5 - Admin Manage Fruits List

Test Case ID: TC05 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test viewing the fruit list	Admin click on the "List of Fruits" in menu	-	Display a list of fruits with their details	Display a list of fruits with their details	Pass
2	To test adding a new fruit	Admin clicks "Add Fruit", fill in the form and clicks "Save" button	Fruit Name: Avocado Description: Creamy-textured fruit rich in healthy fats Vitamins: Vitamin B9, Vitamin E, Vitamin K, Vitamin C	Admin can add new fruit with its respective details successfully. A success message is displayed, and the new fruit appears in the list	Admin can add new fruit with its respective details successfully. A success message is displayed, and the new fruit appears in the list	Pass

			Minerals: Calcium, Fiber, Magnesium Health Benefits: Heart health, supports metabolism, reduce inflammation			
3	To test editing an existing fruit	Admin clicks ‘ ” on an existing fruit, changes it details and saves it.	Fruit Name: Avocado Description: Creamy-textured fruit rich in healthy fats Vitamins: Vitamin B9, Vitamin E, Vitamin K Minerals: Calcium, Fiber, Magnesium Health Benefits: Heart health, supports metabolism, reduce inflammation	Display a success message and update the fruit in the list	Display a success message and update the fruit in the list	Pass
4	To test deleting an existing fruit	Admin clicks “ ” on an existing fruit and confirms it	-	Display a confirmation message and remove the fruit from the list.	Display a confirmation message and remove the fruit from the list.	Pass
5	To test filtering by first letter	Admin selects “A” from filter search bar	Filter: A	Show only fruits that start with alphabet A	Show only fruits that start with alphabet A	Pass
6	To test filtering with no matching result	Admin select “Z” from filter search bar	Filter: Z	Show message: “No fruits found”	Show message: “No fruits found”	Pass
7	To test all fruits are shown after removing filtering	Admin click “Show All Fruit” button to clear the filter	-	Display all fruits list	Display all fruits list	Pass

Table 5.6: Test Case 6 - Admin Manage Vitamins List

Test Case ID: TC06 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test viewing the vitamin list	Admin click on the "List of Vitamins" in menu	-	Display vitamins list with their details	Display vitamins list with their details	Pass
2	To test adding a new vitamin	Admin clicks "Add Vitamin", fill in the form and clicks "Save" button	Vitamin Name: Vitamin K Health Benefits: Helps blood clot normally; Supports bone strength	Admin can add new vitamin with its respective details successfully. A success message is displayed, and the new vitamin appears in the list	Admin can add new vitamin with its respective details successfully. A success message is displayed, and the new vitamin appears in the list	Pass
3	To test editing an existing vitamin	Admin clicks "✏️" on an existing vitamin, changes it details and saves it.	Vitamin Name: Vitamin K Health Benefits: Helps blood clot normally;	Display a success message and update the vitamin in the list	Display a success message and update the vitamin in the list	Pass
4	To test deleting an existing vitamin	Admin clicks "🗑️" on an existing vitamin and confirms it	-	Display a confirmation message and remove the vitamin from the list.	Display a confirmation message and remove the vitamin from the list.	Pass

Table 5.7: Test Case 7 - Admin Manage Minerals List

Test Case ID: TC07 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test viewing the minerals list	Admin click on the "List of Minerals" in menu	-	Display minerals list with their details	Display minerals list with their details	Pass
2	To test adding a new mineral	Admin clicks "Add Mineral", fill in the form and clicks "Save" button	Mineral Name: Fibre Mineral Benefits: Improves digestion, controls blood sugar, reduces inflammation, supports detoxification	Admin can add new mineral with its respective details successfully. A success message is displayed, and the new mineral appears in the list	Admin can add new mineral with its respective details successfully. A success message is displayed, and the new mineral appears in the list	Pass
3	To test editing an existing mineral	Admin clicks "✏️" on an existing mineral, changes it details and saves it.	Mineral Name: Fibre Mineral Benefits: Improves digestion, controls blood sugar, reduces inflammation	Display a success message and update the mineral in the list	Display a success message and update the mineral in the list	Pass
4	To test deleting an existing mineral	Admin clicks "🗑️" on an existing mineral and confirms it	-	Display a confirmation message and remove the mineral from the list.	Display a confirmation message and remove the mineral from the list.	Pass

Table 5.8: Test Case 8 - Admin Manage Uploaded Images List

Test Case ID: TC08 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test viewing the uploaded images list	Admin click on the "List of Uploaded Images" in menu	-	Display all uploaded images list	Display all uploaded images list	Pass
2	To test deleting an uploaded image	Admin clicks " Delete" on an uploaded image and confirms it	-	Display a confirmation message and remove the uploaded image from the list.	Display a confirmation message and remove the uploaded image from the list.	Pass
3	To test pagination "Next" button functionality	Admin clicks on the "Next" button	Button: Next	Display next page of uploaded images list	Next page shown	Pass
4	To test pagination "Previous" button functionality	Admin clicks on the "Previous" button	Button: Previous	Display the previous page of uploaded images list	Previous page shown	Pass
5	To test selecting a specific page	Admin clicks the selected page from pagination control	Page number: 3	Display uploaded images list from Page 3	Page 3 shown	Pass

Table 5.9: Test Case 9 - Admin Manage Predicted Result List

Test Case ID: TC09 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**

1	To test viewing the predicted results list	Admin click on the "List of Predicted Results" in menu	-	Display all predicted results list	Display all predicted results list	Pass
2	To test deleting a predicted result	Admin clicks " Delete" on a predicted result and confirms it	-	Display a confirmation message and remove the predicted result from the list.	Display a confirmation message and remove the predicted result from the list.	Pass
3	To test pagination "Next" button functionality	Admin clicks on the "Next" button	Button: Next	Display next page of predicted results list	Next page shown	Pass
4	To test pagination "Previous" button functionality	Admin clicks on the "Previous" button	Button: Previous	Display the previous page of predicted results list	Previous page shown	Pass
5	To test selecting a specific page	Admin clicks the selected page from pagination control	Page number: 3	Display predicted results list from Page 3	Page 3 shown	Pass

Table 5.10: Test Case 11: Admin Logout

Test Case ID: TC10 **Triggered by: Admin**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test admin successful logout	Admin clicks "Logout" button from navigation	Button: Logout	Admin is logged out and redirect to the "Sign In" page	Admin is logged out and redirect to the "Sign In" page	Pass

5.2.2 Test Case for the Proposed Web Application User Module

Table 5.11: Test Case 11 - User Login

Test Case ID: TC11 **Triggered by: User**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test user successful login	User enters valid email and password and then click "Login" button	Email: milk@gmail.com Password: milk1234	Show success message and redirect to "Upload" page	Show success message and redirect to "Upload" page	Pass
2	To test missing fields.	User clicks "Login" with empty fields.	Email: (empty) Password: (empty)	Show error: "All fields are required.'	Show error: "All fields are required.'	Pass
3	To test invalid email or password	User enters invalid email or password and click "Login"	Email: milk@gmail.com Password: milk555	Show error: "Invalid email or password."	Show error: "Invalid email or password."	Pass

Table 5.12: Test Case 12 - User Upload Fruit Image

Test Case ID: TC12 **Triggered by: User**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test supported images format	User uploads image in supported format (JPG, JPEF, PNG, WEBP)	Image file: apple.png	Image is successfully uploaded	Image is successfully uploaded	Pass

2	To test unsupported image format	User uploads image format in unsupported files (.gif, .webp)	Image file: avocado.gif	Show error: “image/gif are not allowed.”	Show error: “image/gif are not allowed.”	Pass
3	To test drag and drop functionality	Users drag and drop image into the upload area	Image file: apple.png	Image is successfully uploaded	Image is successfully uploaded	Pass
4	To test uploading image from file	User clicks “Browse files” to upload an image	Image file: apple.png	Image is successfully uploaded.	Image is successfully uploaded.	Pass
5	To test file size restriction	User uploads image larger than 200MB	Image file: acai.png (256MB)	An error message is shown	An error message is shown	Pass
6	To test viewing the uploaded image preview	User uploads an image into the uploaded area	Image file: apple.png	Preview of uploaded image is shown	Preview of uploaded image is shown	Pass
7	To test remove image after uploaded	User clicks “X” on uploaded image	-	Image removed successfully	Image removed successfully	Pass
8	To test viewing the predicted fruit details	User clicks “Upload and Predict” after uploaded an image	Image file: apple.png	Predicted fruit name with its detail is displayed	Predicted fruit name with its detail is displayed	Pass
9	To test blurriness detection	User uploads a blurry image	Upload a blurry image	Show error: “The uploaded image is blurry. Please upload a clearer image.”	Show error: “The uploaded image is blurry. Please upload a clearer image.”	Pass

Table 5.13: Test Case 13 - User Manage History

Test Case ID: TC13

Triggered by: User						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test viewing the prediction history	User clicks on the "History" in menu	-	Display all previous prediction results	Display all previous prediction results	Pass
2	To test PDF download	User clicks " Download PDF" on a specific history	Button: Download PDF	A PDF file with a fruit prediction detail is downloaded	A PDF file with a fruit prediction detail is downloaded	
3	To test deleting an existing history record	User clicks " Delete" on a specific history entry	Button: Delete	Display a confirmation message and remove the selected history entry from the list.	Display a confirmation message and remove the selected history entry from the list.	
4	To test pagination "Next" button functionality	User clicks on the "Next" button	Button: Next	Display next page of predicted history list	Next page shown	Pass
5	To test pagination "Previous" button functionality	User clicks on the "Previous" button	Button: Previous	Display the previous page of predicted history list	Previous page shown	Pass
6	To test selecting a specific page	User clicks the selected page from pagination control	Page number: 3	Display predicted history list from Page 3	Page 3 shown	Pass

Table 5.14: Test Case 14 - User View Fruit Details

Test Case ID: TC14 Triggered by: User						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**

1	To test viewing the fruit information	User clicks on the "Fruit Details" in menu	-	Display a list of fruits with their information	Display a list of fruits with their information	Pass
2	To test filtering by first letter	User selects "A" from filter search bar	Filter: A	Show only fruits that start with alphabet A	Show only fruits that start with alphabet A	Pass
3	To test filtering with no matching result	User selects "Z" from filter search bar	Filter: Z	Show message: "No fruits found."	Show message: "No fruits found."	Pass
4	To test all fruits are shown after removing filtering	User clicks "Show All Fruit" button to clear the filter	-	Display all fruits list	Display all fruits list	Pass

Table 5.15: Test Case 15 - User View Vitamin Information

Test Case ID: TC15 **Triggered by: User**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test viewing the vitamin information	User clicks on the "Vitamin Details" in menu	-	Display a list of vitamins with their information	Display a list of vitamins with their information	Pass

Table 5.16: Test Case 16 - User View Mineral Details

Test Case ID: TC16 **Triggered by: User**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**

1	To test viewing the mineral information	User clicks on the “Mineral Details” in menu	-	Display a list of minerals with their information	Display a list of minerals with their information	Pass

Table 5.17: Test Case 17 - User View Home

Test Case ID: TC17 **Triggered by: User**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test viewing the home page	User clicks on the “Home” in menu	-	Display the home page with clear explanation about the system purpose	Display the home page with clear explanation about the system purpose	Pass

Table 5.18: Test Case 18: User Logout

Test Case ID: TC18 **Triggered by: User**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test user successful logout	User clicks “Logout” button from navigation	Button: Logout	User is logged out and redirect to the “Sign In” page	User is logged out and redirect to the “Sign In” page	Pass

Table 5.19: Test Case 19: Dark Mode Setting Panel

Test Case ID: TC19 **Triggered by: User**						
Test ID	**Test Objective**	**Test Case**	**Input Data**	**Expected Result**	**Actual Result**	**Status (Pass/Fail)**
1	To test whether the user can switch dark mode options	User selects “Dark” theme dropdown in the setting spanel	Choose app theme, colors and fonts: Dark from the setting dropdown	All components have a darker UI when the application theme switches to Dark Mode.	All components have a darker UI when the application theme switches to Dark Mode.	Pass

5.3 Usability Testing

In this section, a usability testing questionnaire was conducted with a small group to evaluate the usability and user experience of the developed web-based fruit classification system which called as SnapToFruit. The aim of this test was to gather user feedback regarding the overall system functionality. The survey was structured into 2 sections: **Section A: Demographic Information**, and **Section B: User Experience**.

5.3.1 Demographic Information

A total of 15 respondents have participated in SnapToFruit usability testing. Figure 5.1 and 5.2 shows the demographic information of the respondents.

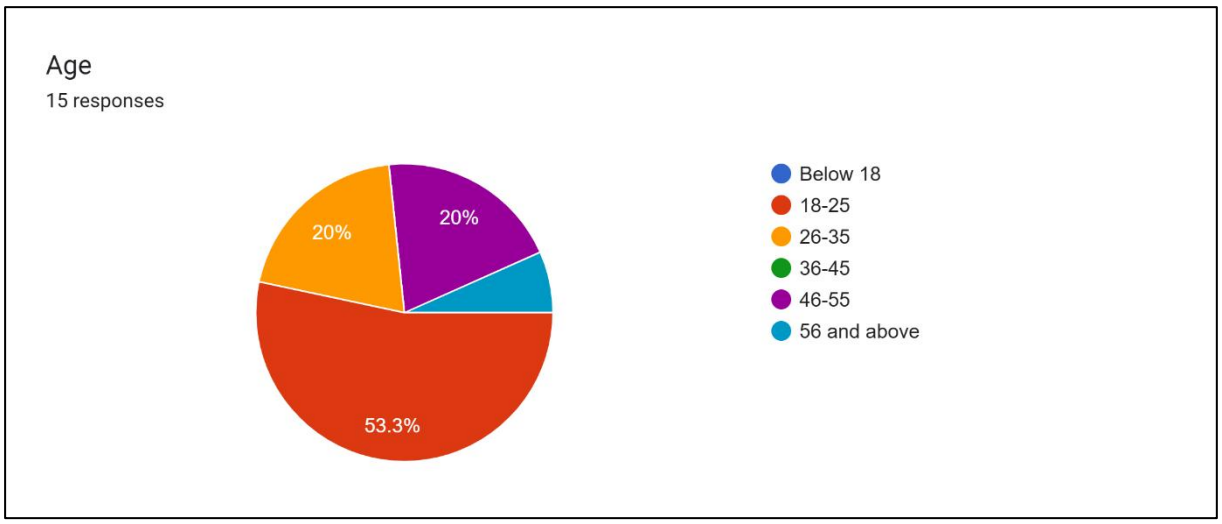

Figure 5.1: Age of Respondents

Figure 5.1 shows the age distribution of respondents, with 8 respondents (53.3%) aged 18-25, followed by 3 respondents (20%) in both the 26-35 and 46-55 age groups. There was only 1 respondent (6.7%) aged 56 and above. There are no respondents below 18 years old and in the 36-45 age range.

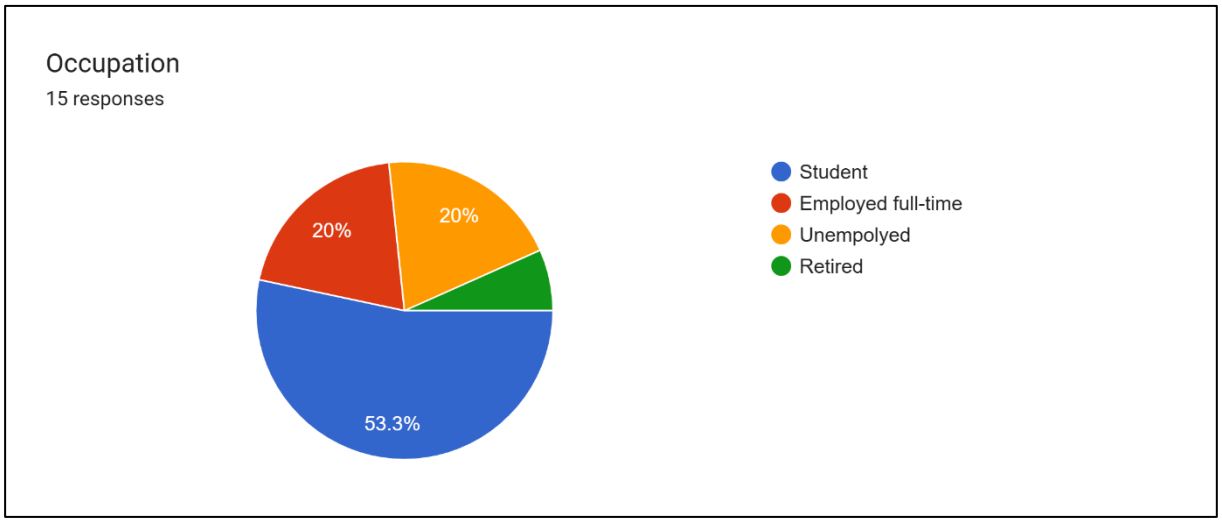

Figure 5.2: Occupation of Respondents

Figure 5.2 shows the occupation distribution of the respondents, with 8 respondents (53.3%) identifying as students, followed by 3 respondents (20%) each in the employed full-time and unemployed categories. Additionally, there is 1 respondent (6.7%) identifying as retired.

5.3.2 User Experience

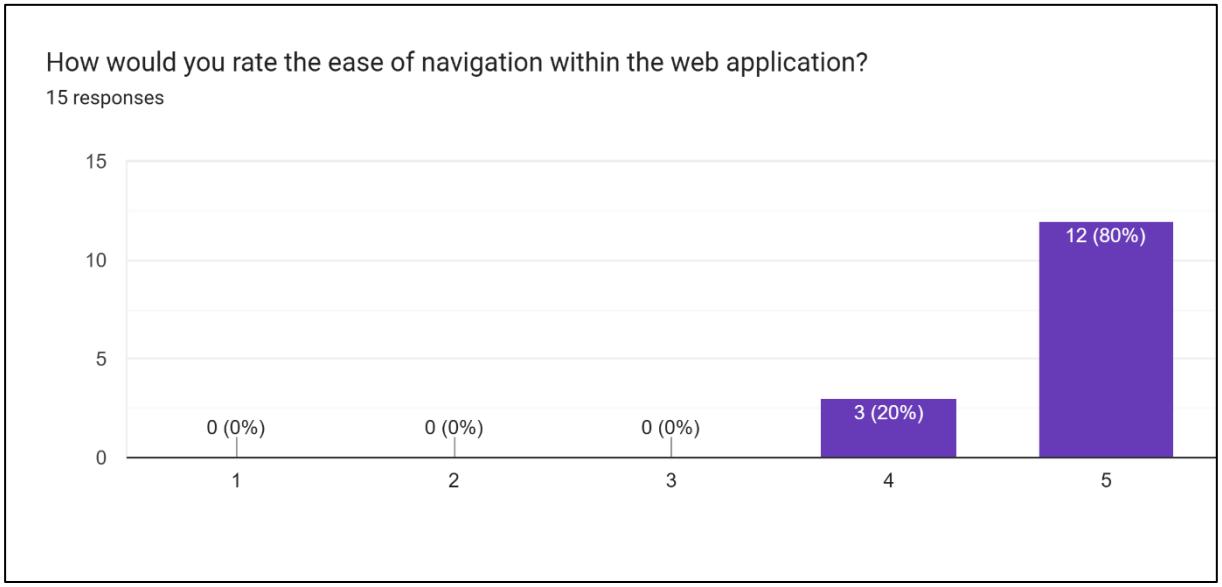

Figure 5.3: User Ratings on Navigation Ease

Users rate the web application's usability on a scale of 1 (very difficult) to 5 (very easy), as shown in Figure 5.3. There were 3 respondent (20%) gave the navigation a rating of 4, while 12 respondents (80%) gave it a 5, meaning it is very straightforward to use. None of those surveyed gave it a score of 1, 2, or 3.

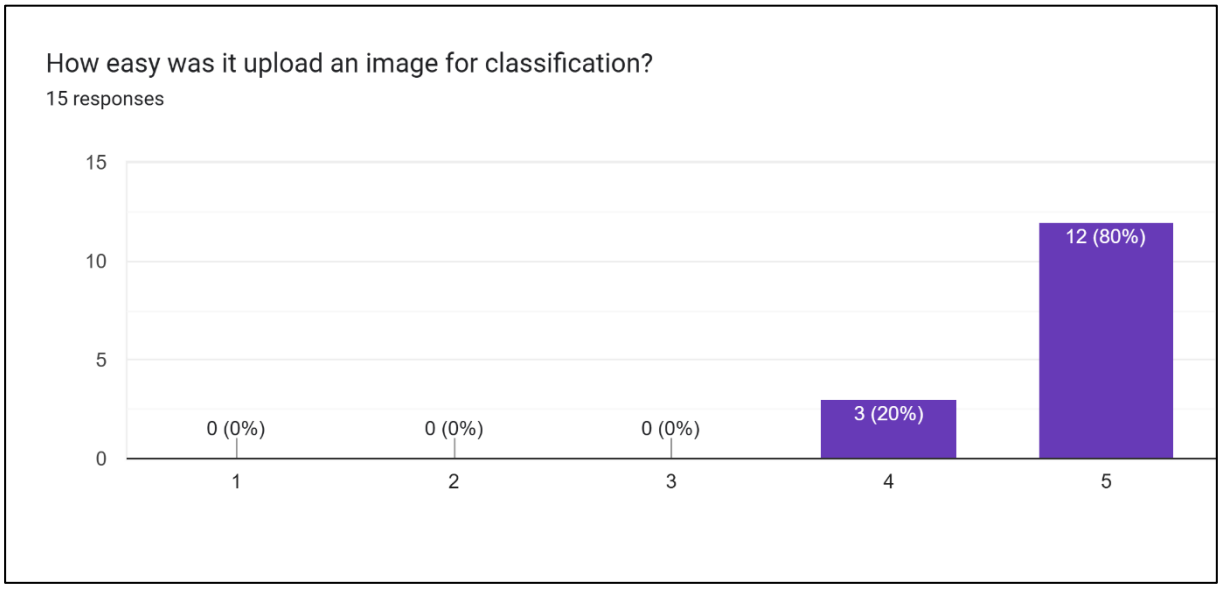

Figure 5.4: User Ratings for Image Upload Ease

In Figure 5.4, users rated the ease of uploading images for classification on a scale of 1 (very difficult) to 5 (very easy). A total of 12 respondents (80%) gave the uploading process a 5 (very easy) rating, while the remaining 3 respondents (20%) gave it a 4. There were no respondents who gave the procedure a rating below than 4, suggesting that uploading photos for categorization was a generally satisfying experience for users.

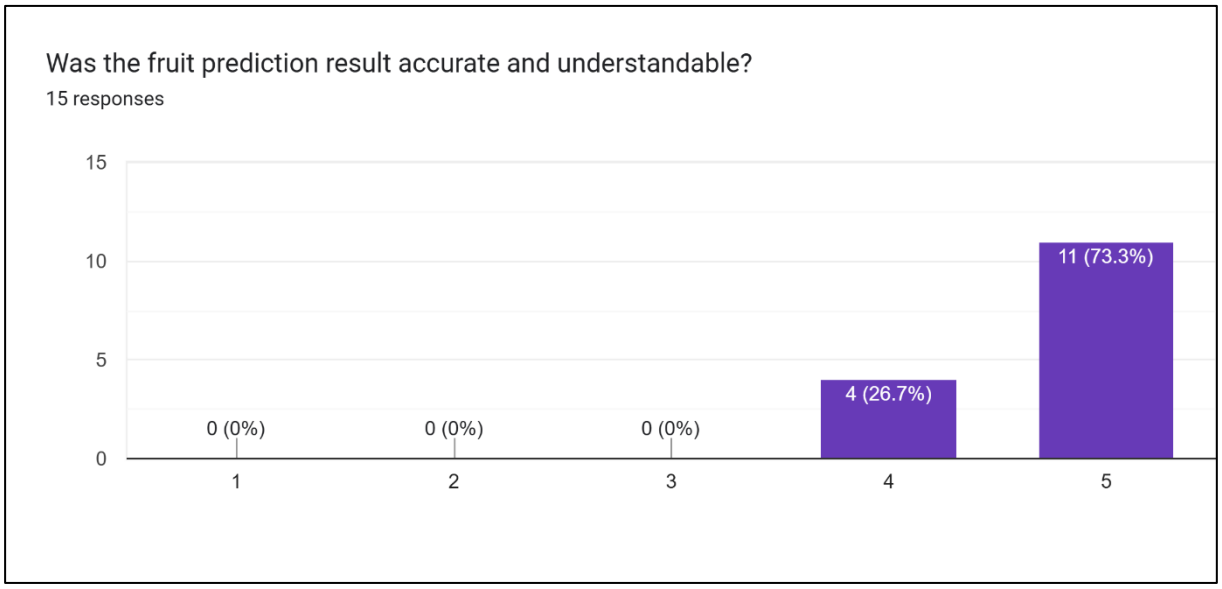

Figure 5.5: User Ratings for Fruit Prediction Accuracy and Clarity

Figure 5.5 shows the user rating of the accuracy of fruit prediction on a scale from 1 (strongly disagree) to 5 (strongly agree). Most users (11 responders, 73.3%) rate at 5, showing that they strongly agreed that the prediction findings were clear and accurate. Additionally, the system received a rating of 4 from 4 respondents (26.67%), and no user gave a rate lower than 4. This shows that users are very satisfied with the accuracy and simplicity of the prediction results.

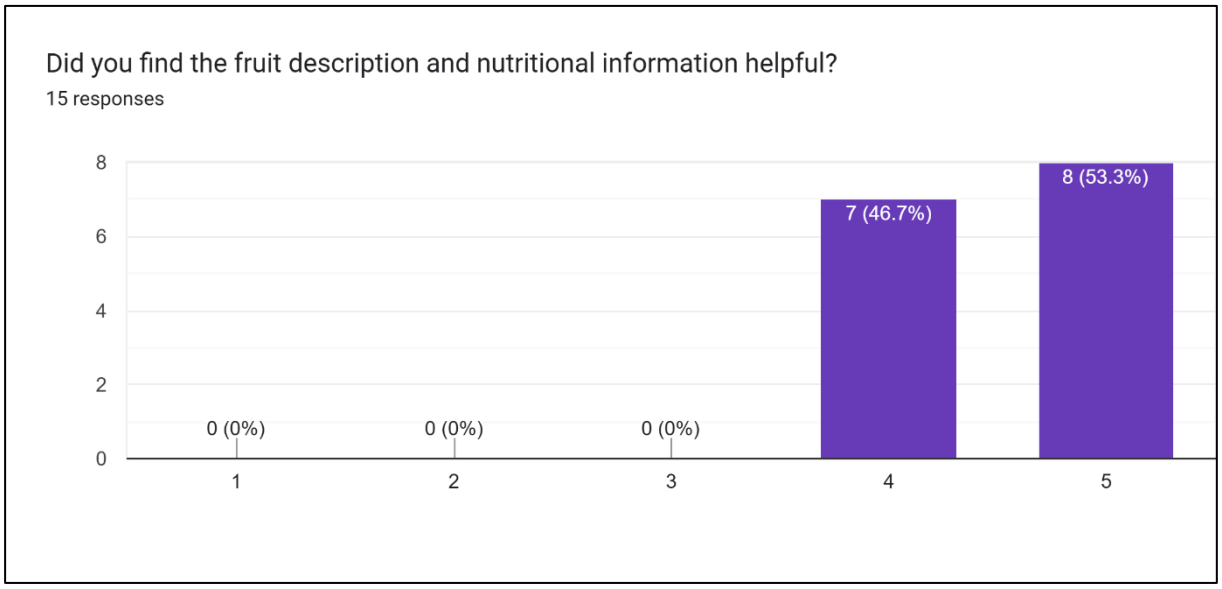

Figure 5.6: Users Ratings on Fruit Description and Nutritional Information Helpfulness

Figure 5.6 using a scale from 1 (not helpful) to 5 (very helpful) to rate the fruit description and nutritional information helpfulness. There are 8 respondents (53.3%) rated it a 5, indicating high helpfulness, and 7 respondents (46.7%) rated it a 4. None of the users rated below 4, indicating that the overall reaction was very positive and all participants found the information provided is somewhat helpful.

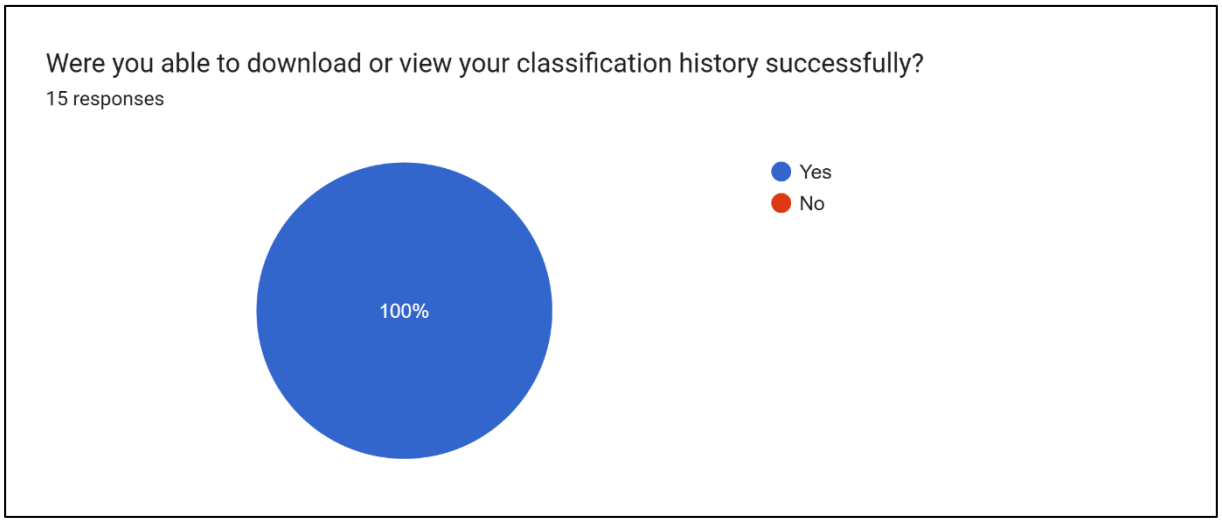

Figure 5.7: User Success in Downloading or Viewing Classification History

Figure 5.7 shows that all respondents successfully downloaded or viewed historical results, and no respondent was unable to download or view historical results.

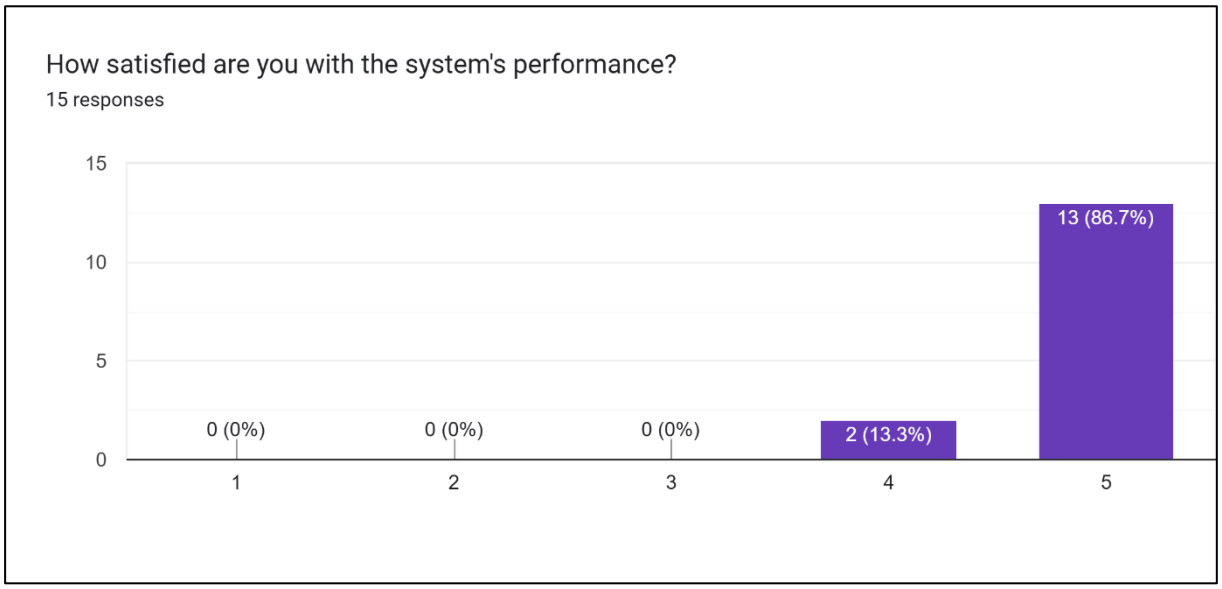

Figure 5.8: User Satisfaction with System Performance

Figure 5.8 shows most participants (86.7%, or 13 people) gave their satisfaction a rating of 5, with the remaining 13.3% (2 people) only giving it a 4. This indicates that the users are

happy with the system's performance, as no one gave a rate less than 4.

5.4 Summary

In this chapter, the testing for the proposed system is discussed in depth. Functional testing ensure that every feature worked as expected. Usability testing shows that users can navigate the system successfully. The findings show that the system satisfies the specified functional and usability criteria, offering administrators and users a trustworthy and convenient experience.

CHAPTER 6: CONCLUSION AND FUTURE WORK

6.1 Introduction

This chapter outlines the project's achievements, highlights the limitations encountered, and proposes directions for future improvements and research. The project aimed to develop a web-based fruit classification platform that utilizes deep learning techniques to identify fruit species based on uploaded images, providing users with relevant fruit information including description, vitamin content, and health benefits.

6.2 Project Achievement

The objectives stated in Chapter 1 of this project has been successfully achieved, with the following specific results:

- A SnapToFruit web-based system integrated with a trained deep learning model (EfficientNetB2) was successfully developed, allowing users to upload fruit images and classify various fruit species.
- SnapToFruit supports users' knowledge and awareness by providing fruit information such as fruit name, description, vitamin and mineral content, and related health benefits.
- Evaluated usability through user acceptance testing and received positive feedback from the community.

6.3 Project Limitation

The project has several of limitations despite its success. First, the system has limited dataset variety. A predetermined set of fruits from the Fruits-100 dataset were used to train the model, causing the system lacks the ability to identify outside the training classes.

Next, accuracy of the classification will be affected by image quality dependence. Factor such as poor lighting, low resolution or image closure can negatively affect the prediction result.

Another limitation is absence of ripeness or quality detection. The model was only train to classify fruit species, making it impossible for the system to determine the fruit ripeness or identifying rot.

Lastly, multiple object detection is not supported by the current system. The system can only detect one fruit per picture. If many fruits appear in the picture, the computer system cannot identify or categorize them all. This limitation reduces the system's effectiveness in more complicated situations where several fruits tend to appear in a single image, including market inventory, kitchen scanning, or huge fruit sorting.

6.4 Future Work

All limitations of the current proposed system should be fixed to increase the usefulness of the system in future applications. This involves adding more fruit classes by enlarging the training dataset to cover a greater range of fruits and real-world picture variations, which enhancing the model's ability to generalize and be used in a variety of situations. Advanced methods including background removal can also be incorporated into the image preparation pipeline to improve classification accuracy and model flexibility.

Additionally, implementation of ripeness and quality detection using a multi-task learning strategy is another possible approach to improve the usability of the proposed system, enabling the system to evaluate the fruit's overall quality or ripeness stage.

Another future improvement is the implementation of multiple object detection. The system might be improved by employing object detection frameworks like YOLO (You Only Look Once) which help to detect and categorize several fruits inside a single image, instead of to only one fruit per image. This will greatly improve the system's usefulness in situations where several products are usually shown in a single picture,

Lastly, creating a framework for continuous learning with a user feedback system that allows users to provide feedback on incorrectly identified photos, allowing the model to iteratively improve based on actual user input and help increase performance over the long run.

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APPENDIX

Appendix A: Survey on User Preference for a Web-Based Fruit Classification System Using Deep Learning

Final Year Project: Survey on User Preference for a Web-Based Fruit Classification System Using Deep Learning

Thank you for taking the time to participate in this survey. My name is Michelle Chang Jia Wen, and I am a final-year student pursuing a degree in Computational Science at the Faculty of Computer Science and Information Technology (FCSIT), Universiti Malaysia Sarawak (UNIMAS). I am conducting this survey as part of my project titled **"Web-Based Fruit Classification System Using Deep Learning."**

The purpose of this project is to develop a web application that can accurately classify fruits using advanced deep learning techniques. Your feedback is crucial in helping me understand user preferences, expectations, and needs, which will guide the design and functionality of the system.

This survey will take approximately **3 - 5 minutes** to complete. Your responses will be kept confidential and used solely for academic purposes.

Thank you for your support!

Sincerely,

Michelle Chang Jia Wen

Computational Science, FCSIT, UNIMAS

80043@siswa.unimas.my

Section A: Demographic Information

This section helps us understand who is answering the survey and identify the audience for this platform.

Gender *

- Male
- Female

Age *

- Below 18
- 18-25
- 26-35
- 36-45
- 46-55
- 56 and above

Occupation *

- Student
- Employed full-time
- Employed part-time
- Self-employed
- Unemployed
- Retired

Section B: Technology Awareness

This section is about your experience with web applications and AI tools to see how familiar you might be with this kind of platform.

Have you used a platform to identify objects (e.g., plants, fruits, items) before? *

- Yes
- No

How familiar are you with web applications that provide AI-based services (e.g., image classification, recognition)? *

- Very familiar
- Somewhat familiar
- Not familiar at all

How often do you upload images to online platforms for identification or categorization (e.g., social media, plant identification apps, etc.)? *

- Frequently
- Occasionally
- Rarely
- Never

Section C: User Background and Relevance to the Platform

This section identifies the relevance of the platform to the users and their potential needs

Have you ever faced difficulties identifying fruits? *

- ○ Yes
- ○ Sometimes
- ○ No

What would you use a fruit classification platform for? (Select all that apply) *

- ☐ Educational purposes
- ☐ Cooking and recipes
- ☐ Grocery shopping
- ☐ General curiosity
- ☐ Other...

How important is a tool that helps you identify fruits accurately? *

- Very important
- Somewhat important
- Not important

How often do you look up the names of fruits online?

- Frequently
- Occasionally
- Rarely
- Never

Section D: Platform Functionality and Features

This section helps us understand what features you think are necessary for a good fruit classification platform.

What features would you find useful in a fruit classification platform? (Select all that apply) *

- [ ] Simple and user-friendly interface
- [ ] High accuracy in fruit classification
- [ ] Real-time classification results
- [ ] Easy image upload
- [ ] Drag and drop image

What kind of interface do you find most appealing for a web application? *

- ( ) Minimalist and clean
- ( ) Colorful and engaging

Should the platform allow you to upload images in different formats?

- ( ) Yes, multiple formats (e.g., JPEG, PNG)
- ( ) No, one format is fine

How would you like the results to be displayed?

- ◯ Text-only results (e.g., "Apple")
- ◯ Text and image together
- ◯ Image-only results

If a fruit cannot be identified, what should the platform do? *

- ◯ Say "Fruit not recognized"
- ◯ Display an error message with tips

How important is the speed of the platform in delivering results? *

- ◯ Very important
- ◯ Somewhat important
- ◯ Not important

How accurate should the classification be for you to trust the system? *

- ◯ 90% or above
- ◯ 80–89%
- ◯ 70–79%

What features or functionalities would you suggest improving the platform? *

- [ ] Light and dark mode toggle
- [ ] Option to save identified fruits
- [ ] Multilanguage support
- [ ] Allow zooming into the uploaded image for better identification
- [ ] Basic information about fruit

Appendix B: Survey on Usability Testing Questionnaire for SnapToFruit

Section 1 of 3

Final Year Project: Usability Testing Questionnaire for SnapToFruit

Thank you for taking the time to participate in this survey. My name is Michelle Chang Jia Wen, and I am a final-year student pursuing a degree in Computational Science at the Faculty of Computer Science and Information Technology (FCSIT), Universiti Malaysia Sarawak (UNIMAS). This questionnaire aims to evaluate the usability of the SnapToFuit platform. Your responses will help improve the system's design and functionality.

This survey will take approximately **3 - 5 minutes** to complete. Your responses will be kept confidential and used solely for academic purposes.

Sincerely,

Michelle Chang Jia Wen

Computational Science, FCSIT, UNIMAS

80043@siswa.unimas.my

Section 2 of 3

Section A: Demographic Information

This section helps us understand who is answering the survey and identify the audience for this platform.

Age

- Below 18
- 18-25
- 26-35
- 36-45
- 46-55
- 56 and above

Occupation

- Student
- Employed full-time
- Unempolyed
- Retired

Section 3 of 3

Section B: User Experience

This section evaluates the ease of use, clarity of instructions, and overall experience while performing key tasks within the application.

How would you rate the ease of navigation within the web application?

	1	2	3	4	5	
Very difficult	○	○	○	○	○	Very easy

How easy was it upload an image for classification?

	1	2	3	4	5	
Very difficult	○	○	○	○	○	Very easy

Was the fruit prediction result accurate and understandable?

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Did you find the fruit description and nutritional information helpful?

	1	2	3	4	5	
Not helpful	○	○	○	○	○	Very helpful

Were you able to download or view your classification history successfully?

○ Yes

○ No

How satisfied are you with the system's performance?

	1	2	3	4	5	
Very dissatisfied	○	○	○	○	○	Very satisfied