An AR (Augmented Reality) Application for Food Inspection

BY

NICHOLAS NGIAM LI XUAN

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ABSTRACT

The innovative mobile software, titled "An AR (Augmented Reality) Application for Food Inspection," aims to change how consumers interact with food products. This innovative tool will combine Augmented Reality (AR) technology and Unity as its development platform to give users an engaging and educational experience. The application will do complex image processing simply by scanning raw materials using a smartphone's camera, making it possible to precisely identify and analyse contents, expiration dates, nutritional information, and allergies. Users will then receive the information in a seamless overlay, which will help them better comprehend the makeup and safety of the product. The user interface will be made to be simple to use and accessible to users from all backgrounds. Additionally, a database that is continually being updated will be integrated into the program, giving users immediate access to in-depth knowledge about food products. Furthermore, this database will accommodate different dietary preferences, such as veganism and gluten-free eating, enabling users to make deft, health-conscious decisions. The AR Food Inspection application will be a resource for instant food inspection as well as education, raising consumer understanding of the value of ingredient lists, nutritional information, and food safety factors. This project, in essence, marks a significant advancement in the application of Unity-powered AR technology to address urgent issues relating to food safety, transparency, and informed consumer decision-making in today's dynamic food market.

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LIST OF ABBREVIATIONS

AR	Augmented Reality
3D	Three-Dimensional
CBIR	Content-Based Image Retrieval
USDA	U.S. Department of Agriculture
RIS	Recognize-Identify-Search
LDB	Local Difference Binary
ORB	Oriented FAST and Rotated BRIEF
JNI	Java Native Interface
AI	Artificial Intelligent
API	Application Programming Interface
SDK	Software Development Kit
OpenCV	Open Source Computer Vision Library
UAT	User Acceptance Testing
MVP	Minimum Viable Product
TFLite	TensorFlow Lite

Chapter 1

Project Background

In this chapter, we present the background of AR application on Food Inspection and motivation of our research, our contributions to identify the food details and information with AR presentation solution, and the outline of the thesis.

1.1 Introduction

In the era of globalization, AR has now become a widespread technology that affects a lot of activities of our lives [1]. An example given to current mobile application, Google Maps has used the AR features that allows users to view streets through their smartphone's camera and see directions on their screen [2]. Based on [3, Figure 1.1a], it is a bar graph showing the number of mobile AR active user devices worldwide from 2019 to 2024. The number of active user devices in billions ranges from 0 to 2. The bars are blue in color and show a steady increase in the number of active user devices from **0.44 billion** in 2019 to **1.73 billion** in 2024.

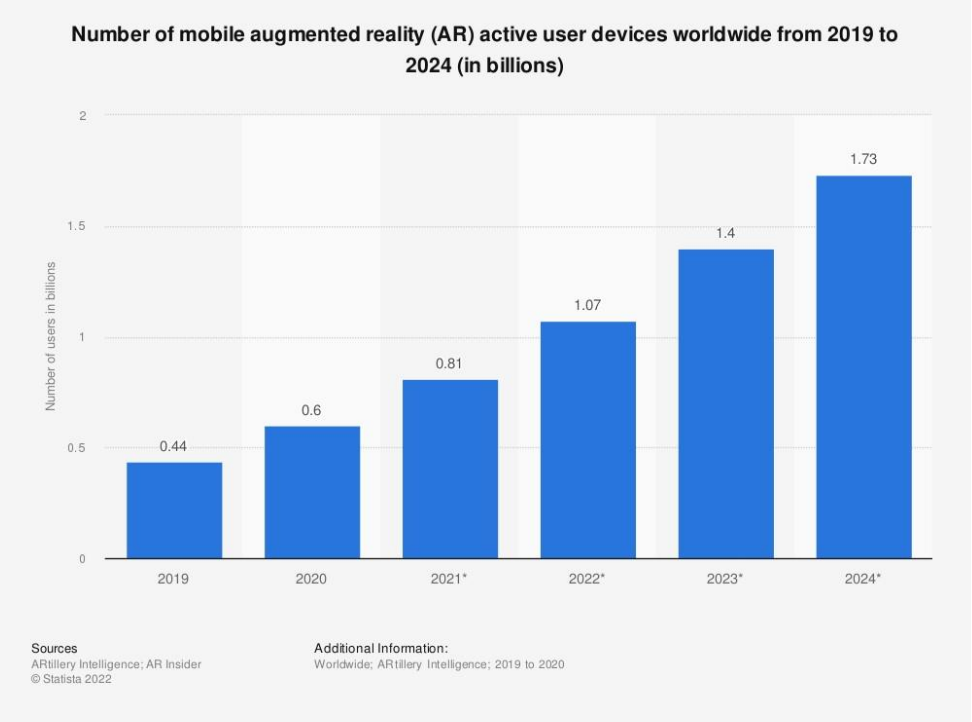


Figure 1.1.1: Number of mobile augmented reality (AR) active user devices worldwide from 2019 to 2024 (in billions).

Before we are getting into the topic, we need to first know that we actually are AR. AR as known as Augmented Reality, it is a technology that overlays digital information in the real world, creating an enhanced experience for the user. AR can be defined as a system that incorporates three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects. The overlaid sensory information can be constructive, such as adding digital information to a real-world environment, or destructive, such as masking part of the natural environment. AR can be delivered to the user through a device like a smartphone or glasses, and the overlaid information can be added to an environment or mask part of the natural environment. AR has been used in various industries, including healthcare, retail, education, and the military, and has a growing trend among companies involved in mobile computing and business applications in particular [4].

To implement the AR feature into the mobile application for food inspection, you would begin by leveraging Unity, which is a versatile development platform. In a theoretical sense, the process involves integrating the smartphone's camera and sensors to capture the real-world environment. It would then apply image processing algorithms to recognize and analyze raw materials, such as food product packaging or labels. Once identified, the relevant information, such as ingredient lists, nutritional facts, and allergen warnings, would be digitally overlaid onto the user's view in real-time. This information would appear as an AR overlay, enhancing the user's understanding of the raw materials composition and safety. The user could interact with this data, perhaps by tapping on specific elements for additional details. [Figure 1.1b] will be the basic process diagram of the overall application of this project.

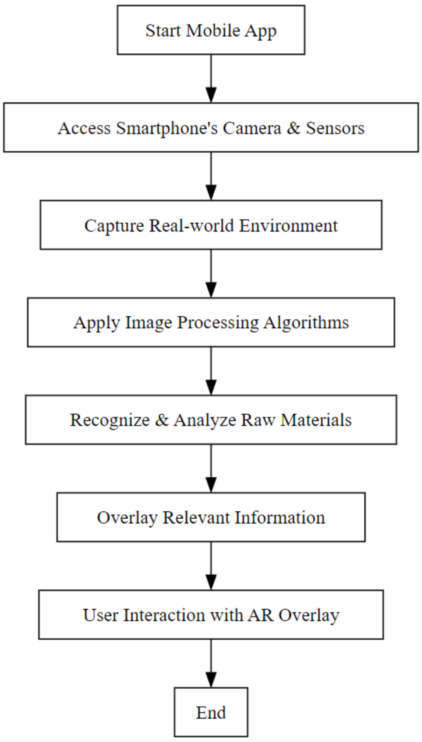


Figure 1.1.2: Basic Process Diagram of Application for Food Inspection

1.2 Problem Statement and Motivation

This project aims to tackle current issues by applying the effectiveness of AR technology. In the following sections, we dive into three different problem statements, each rooted in the overarching goal of changing the way we inspect, understand, and interact with food.

1.2.1 Lack of Transparency

Figure 1.2.1: Example of the lack of transparency packaging

The existing food inspection and labelling rules lack of transparency presents a serious challenge for customers trying to find thorough and accurate information about the raw materials in the food they purchase. Frequently, customers need to be given more information on food packaging or labels to comprehend the contents of the items they are buying fully. Frequently, ingredient lists are complex and contain technical or scientific terminology that is difficult for the general public to understand. Furthermore, the label information might not be updated in real-time and might not provide enough specificity to accommodate different dietary requirements. It is crucial that this problem be resolved, and a system that gives customers accurate and up-to-date information on the food they consume must be established immediately. By increasing transparency, this project aims to increase customer trust in the food industry.

1.2.2 Complexity of Food Product Labels

Figure 1.2.2: Example of Complex Information Term

Consumers have a difficult time identifying and understanding food product ingredient lists and allergy warnings due to their complexity as food product labels often contain ingredient lists that are lengthy and consist of technical or scientific terms. These lists can be challenging for consumers to interpret, especially when it comes to identifying allergens or specific ingredients of concern. The complexity arises from variations in terminology, abbreviations, and the use of unfamiliar terms that may not align with common language. It is essential to create and apply a user-friendly solution that simplifies the process of allergy and ingredient identification in raw materials to solve this issue. The implementation of this strategy will enable customers to make knowledgeable decisions about their dietary needs and raise their general understanding of food safety by overlaying the information with AR feature.

1.2.3 Foodborne illnesses are a global concern, occurring worldwide.

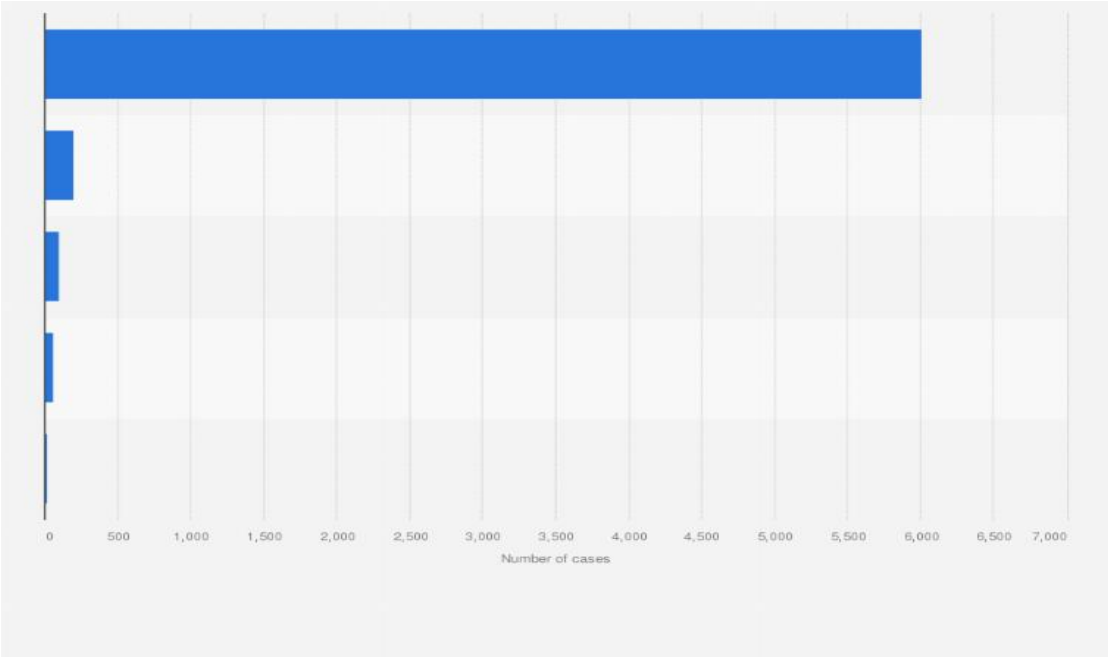


Figure 1.2.3: Number of food and water borne disease cases in Malaysia in 2021

Food-borne illnesses represent a significant worldwide health issue, affecting people all over the world. Malaysia's noteworthy report of cases in 2021 serves as an example of the seriousness of these illnesses and highlights the widespread impact of these health risks [5, Figure 1.2.3]. Malaysia reported over 6,000 incidents of food poisoning that year, which were linked to both foodborne and waterborne illnesses. Furthermore, with 64 recorded instances of cholera and 24 cases of hepatitis A recorded in the same period, particular cases of both diseases increased concerns. These figures highlight how important it is to adopt strong rules and take a comprehensive approach to food safety in order to reduce and avoid the consequences of foodborne illnesses throughout the world. By doing this, we can all contribute to creating a safer and better global food ecosystem.

1.3 Research Objectives

1.3.1 To Implement AR Feature into the Mobile Application for Food Inspection

The main objective of this project is to create a mobile application for food inspection that effectively integrates augmented reality (AR) technology. By using augmented reality (AR) to overlay real-time data on raw materials, this solution seeks to improve user understanding of a range of topics, including ingredient specifics, freshness indications, and possible hazards to food safety. The application seeks to improve how customers interact with food inspection by offering users an interactive and educational experience via the use of AR overlays. By aiming the device's camera at the objects of interest, users will be able to get the necessary details on raw materials concerning the AR feature. This goal is in line with the more general mission of updating food inspection procedures and providing consumers with an innovative, user-friendly tool to help them make wise choices about the goods they eat.

1.3.2 To Conduct a Comprehensive Analysis of AR-Enabled Raw Food Material Detection

The second goal is to carry out an in-depth review of the mobile application's AR-enabled raw material detecting procedure. This includes testing the system's capacity to recognize different raw food materials with accuracy using the camera on the device. In order to make sure that the detection algorithm can accurately identify a wide variety of food products, the research will concentrate on assessing the detection system's durability and reliability. The purpose of this objective is to clarify the usefulness and effectiveness of the AR-based detection system, fixing issues and improving the technology for best results.

1.3.3 To Evaluate the Accuracy and Effectiveness of Detection and AR Overlay Information

The third objective is to conduct an evaluation of the effectiveness and precision of the mobile application's augmented reality (AR) overlay data as well as the raw material detection procedure. This comprehensive assessment examines how well the system uses advanced algorithms to detect and identify raw materials. It includes an examination of the AR overlay data, evaluating the extent to which it enhances the user's experience by offering pertinent and significant information on the identified raw materials. To guarantee that the information provided is correct, educational, and improves the user's comprehension of the examined food products, the research will concentrate on the smooth integration of detection findings with the AR overlay.

A variety of factors will be taken into consideration in this evaluation, such as the degree of detection accuracy, the readability of the overlay data, and the overall user experience. The purpose is to offer insights into the areas of strength and possible development in the combined functioning of detection and AR overlay information by evaluating these components. This evaluation is necessary to improve the accuracy of the mobile application, optimize the user's interaction with the AR overlay, and optimize it. In the end, the objective advances the area of AR technology for useful and significant applications by assisting in the creation of a strong, dependable, and user-friendly smartphone application for food inspection.

1.4 Project Scope and Direction

The scope of the project is to develop an AR Application for food inspection to reduce the possibility of getting food poisoning. Nevertheless, there is only a few numbers of food related applications that implement AR feature into it. Thereby, an investigation and analysis need to be carried out to prove that using AR feature to provide detailed information on inspected raw food material thereby to reduce of consumer getting food poisoning. The followings are the focus of the project:
Conduct in-depth research and analysis of existing food inspection methods, safety standards, and technologies.

1. Define the user interface, AR interactions, and features to ensure a user-friendly and engaging experience.
2. Implement image processing algorithms and AR functionality that enable users to scan raw materials using their device's camera.
3. Overlay real-time details, including ingredient information, nutritional facts, allergen warnings, and safety guidelines, on the user's mobile screen using AR technology.
4. Incorporate interactive features that allow users to explore 3D models of ingredients, access detailed nutritional information, and receive instant alerts for potential allergens.
5. Conduct rigorous testing and validation of the AR-based food inspection application to ensure its accuracy and reliability in preventing food poisoning.
6. Develop recommendations for further enhancements, future research, and potential collaborations in the field of AR-based food safety solutions.

1.5 Project Contribution, Impact and Significance in general

Our project's innovative use of AR technology to transform how customers examine and interact with food goods is the basis of its success. Several crucial characteristics identify this technological advance:

Seamless Raw Material Identification

Traditional methods of food inspection often require external identifiers like QR codes or barcodes. However, the project takes a giant leap by directly identifying and capturing the raw materials of food products. This means that users can simply point their device's camera at the food, and the application will intelligently recognize and capture the raw material. This innovation eliminates the need for additional steps or markers, streamlining the inspection process and making it more intuitive for users. It represents a significant breakthrough in user-friendliness and accessibility.

Real-time Database Integration:

The concept makes use of a dynamic database that has comprehensive data on each kind of food raw ingredient. A key element of this system is the database, which guarantees that users have access to the most up-to-date and correct data on the raw materials they are evaluating. Users always obtain the most recent information thanks to the app and database's real-time synchronization, which also increases the accuracy and usefulness of the data provided. This connection gives users the peace of mind that their judgments are based on the most recent information, making food inspection safer overall.

Immersive User Experience:

The immersive and engaging user experience that augmented reality (AR) technology provides exceeds conventional, frequently static labelling. Users can visually examine 3D representations of the raw materials which means overlaying the information of the raw materials, giving them a concrete and in-depth grasp of the makeup of each item. Users can also interact with digital components, such as touching on raw material to get detailed nutritional information or getting immediate alerts regarding allergy warnings. Food inspection becomes an entertaining and instructive adventure thanks to this immersive experience, which not only educates but also engages users on a deeper level.

Real-time Updates and Safety Assurance

Real-time updates made possible by AR technology ensure that users are instantly alerted of any alterations, recalls, or safety alerts pertaining to certain raw materials or food items. As a result, users are able to make knowledgeable choices regarding the security of the food they are checking. By demonstrating a dedication to giving people the most accurate and up-to-date information possible, the immediate notification system increases confidence and safety.

Industry-Leading Innovation

The initiative advances the use of AR technology for food inspection, setting new standards for this industry. It demonstrates the potential for technologically driven solutions to change the context of food inspection. The initiative pushes the envelope of innovation, which not only helps customers but also motivates the whole food business to investigate and embrace comparable technical developments. In this leadership capacity, your project is positioned to serve as a catalyst for more extensive change and advancement in food safety procedures.

In summary, the contribution of Technology Advancement aspect of the project represents a groundbreaking shift in food inspection practices. It simplifies the user experience, integrates real-time data, offers an immersive journey, ensures safety through instant updates, and leads the industry toward embracing technology-driven solutions for enhanced food safety and consumer engagement.

1.6 Report Organization

Our report is well structured to cover all the aspects of our project on developing AR application for food inspection. Chapter 2 will review existing literature on AR overlaying features and 3 existing applications in the market. This will give a foundation for understanding the significance of our research within the context. Moving on to Chapter 3, we will provide information about our proposed method and approach. This chapter will include design specifications, an overview of our system, a discussion about challenges faced during implementation, and a timeline highlighting the project development. Chapter 4 will discuss the progress and outcomes achieved by implementing AR feature in food inspection mobile application. We will present results and analyse their implications and feasibility, bridging the gap between theory and practical application. Finally, in Chapter 5, we summarize the entire project journey from start to finish.

This way, we ensure that all critical components are thoroughly covered, and readers gain an understanding of our research work.

Chapter 2 Literature Review

In this chapter, we will discuss the related works of overlay information of inspected raw food material on mobile application. At the end of this chapter, we will provide a summary table comparing the strengths and limitations of each proposed solution.

2.1 Previous Works on Related Research

2.1.1 Food Visualization on Google Glass

Based on the previous works on related research, Food nutrition visualization on Google Glass is a modern wearable technology system that uses AR to completely change how people access and interact with nutritional information in the real world [6]. At its very core, this innovative technology makes use of Google Glass to find food items in the user's line of sight. Once a food item is identified, the technology easily links to a sizable online database that the U.S. Department of Agriculture (USDA) diligently maintains. This database has a thorough archive of nutritional information for a wide range of food items. The algorithm then collects the relevant nutritional information linked to the identified food item and displays this useful data right on the user's Google Glass display.

This section goes into the complicated structure of the AR-based food monitoring system, which is made up of three essential elements: food recognition, nutrition data retrieval, and picture tracking and display. This system's main goal is to empower users to make knowledgeable decisions about their food preferences while also keeping track of their buying habits. [Figure 2.1.1] shows the usual use case for this strategy.

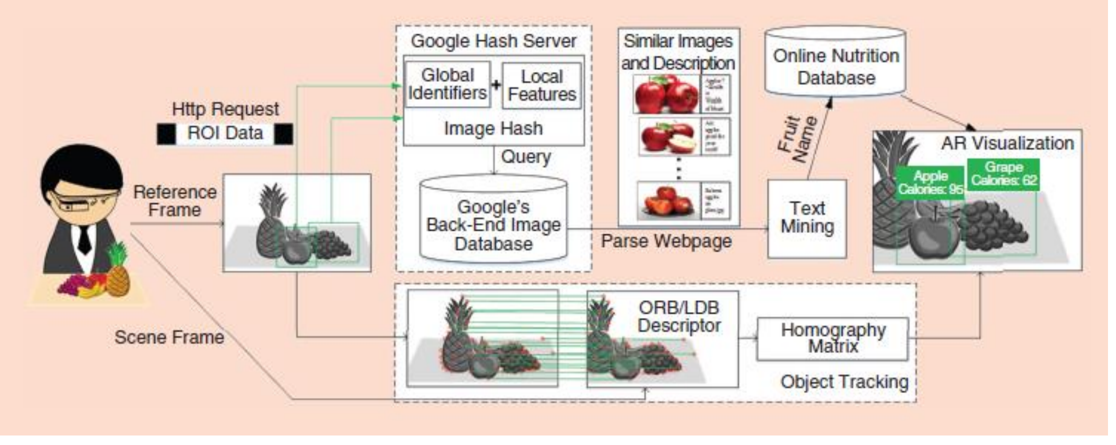


Figure 2.1.1: An Overview of the AR-based food monitoring system

For accurate food recognition, our system first uses content-based image retrieval (CBIR). Then, it uses the extensive online database run by the U.S. Department of Agriculture (USDA) to get the necessary nutritional information for the detected food item. CBIR execution might take a significant amount of time for each frame. Therefore, our system employs an effective technique instead of performing CBIR for each incoming frame: it records the particular food item and superimposes the pertinent nutritional information onto it. Based on the outcomes of image tracking for the most recent frame, the algorithm then determines the positions for overlaying nutritional data. In the end, each recognized food item displays nutritional information as a result of this.

By monitoring items in each frame, this system uses AR technology to overlay virtual information over real-world situations. The system can overlay nutritional information on tracked food products since it only performs the resource-intensive Recognize-Identify-Search (RIS) process once per object thanks to AR tracking. Local Difference Binary (LDB) and Oriented FAST and Rotated BRIEF (ORB) are two algorithms that are implemented by the system using OpenCV with Java Native Interface (JNI) and Native Development Kit. For stable and rotation-scale invariant food tracking, several techniques are compared. While LDB is offered as a unique tracking technique and integrated utilizing JNI to communicate with native code, ORB acts as the baseline. Real-time tracking is achieved through the system's use of homography matrix calculation, which is [Figure 2.1.2] and feature matching to update monitored food coordinates. Nutritional information is then displayed on the tracked food items like what it shows in [Figure 2.1.3], retrieved from the USDA database, providing users with immediate dietary insights and food identification.

$$\begin{pmatrix} x_2 \\ y_2 \\ z_2 \end{pmatrix} = \begin{pmatrix} H_{11} & H_{12} & H_{13} \\ H_{21} & H_{22} & H_{23} \\ H_{31} & H_{32} & H_{33} \end{pmatrix} \begin{pmatrix} x_1 \\ y_1 \\ z_1 \end{pmatrix} \Leftrightarrow X_s = HX_r,$$

Figure 2.1.2: Homography Matrix Calculation

Figure 2.1.3: The nutritional information on a tracked grocery item.

In conclusion, this article introduces an innovative application for retrieving and visualizing food nutrition information in real-world scenarios. It conducts a comprehensive comparison of computational algorithms, spanning from established baseline methods to cutting-edge solutions. The evaluation also considers the constraints of consumer electronics, specifically Google Glass, in implementing this application. The food-monitoring system functions by recognizing food items, accessing nutritional data from a remote database, and superimposing dietary facts onto the food's surface using AR. The article details the use of Recognize-Identify-Search (RIS) for image retrieval, the application of a blacklist and whitelist for food recognition, and the utilization of AR for overlaying nutritional information. Through four experiments, including speed testing, RIS recognition rates, AR stability assessment, and examining the trade-off between jitter and RIS, the study demonstrates that the proposed AR system effectively retrieves and overlays nutritional information on food images with stability and reasonable food identification accuracy. The advantages of this application are:

- Provides real-time access to nutritional information.
- Hands-free and private way of accessing dietary information.
- Has the potential to improve dietary behavior and promote healthy eating habits.

2.2 Previous Works on Existing Applications

2.2.1: Food Lens AR

An augmented reality software for food recognition called Food Lens AR provides information on the caloric value, carbohydrate, protein, and fat composition of the food user had consumed as well as specifics on its vitamin and mineral content [7]. The app is intended to offer a simple and enjoyable method to learn about food and keep track of your nutrition. It is appropriate for those who are interested in leading a healthy lifestyle, are competitive athletes, are worried about their weight, or have a chronic illness like diabetes or hypertension.

Food Lens AR's computer vision and most precise food AI deep learning technologies are used to identify numerous of food categories from various cuisines throughout the world. The software is compatible with iPhone devices and can be downloaded from the software Store. Every meal is automatically recorded in the food journal, so it's enjoyable to check back on what you consumed a week, a month, or a year ago. The app gives users access to real-time data on food products' nutritional worth, including their caloric content, carbohydrate, protein, and fat composition, as well as information on their vitamin and mineral content.

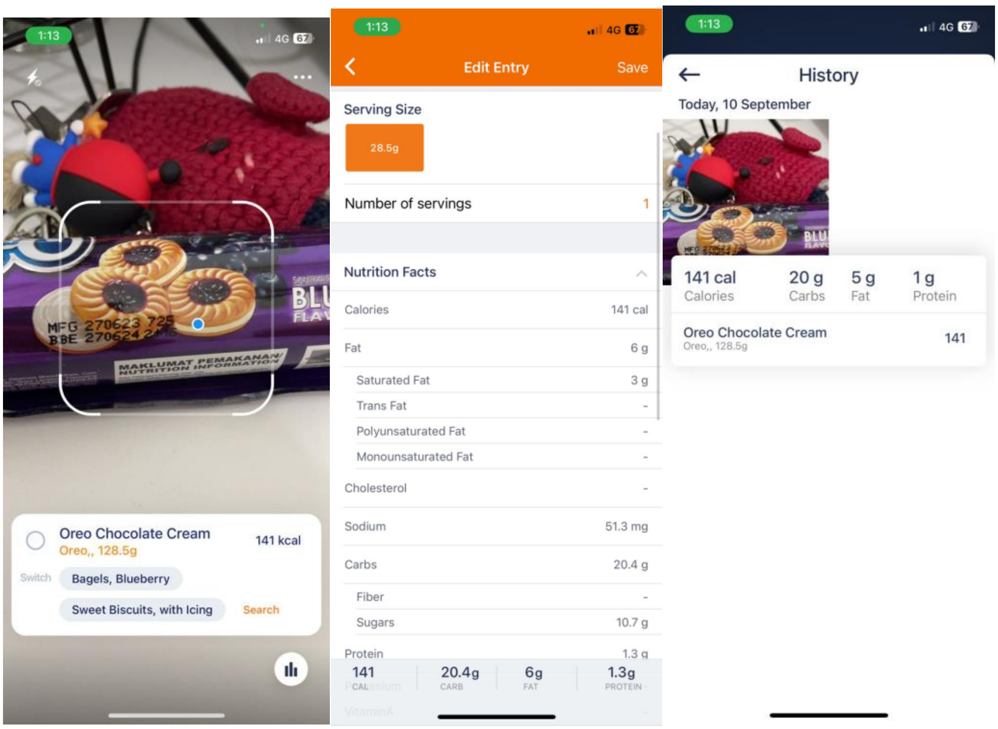


Figure 2.2.1: Food Lens AR overlay and store information

Following a seamless integration of augmented reality (AR) technology on [Figure 2.2.1], it detects the food in front of you and then overlays an enormous selection of nutritional information over the actual image of the food item. With the overlayed vital information about nutrition, including calorie value, carbohydrate content, protein composition, fat ratios, and a thorough analysis of vitamins and minerals. Food Lens AR helps to increase insight and control over user's food choices. All of the meals will be automatically stored in the app's food journal as an extra bonus, allowing user to look back on culinary adventures from days, weeks, or even months past. Food Lens AR.

As a conclusion, Food Lens AR is a modern application that employs augmented reality (AR) technology to give users real-time information on the nutritional worth of food products and assist them in tracking their dietary progress. The software does have some restrictions, though, like the fact that it only works with iPhones and that the lighting and food presentation may have an impact on how well it recognizes objects. The key benefits are as below:

- Delivers up-to-the-minute nutritional insights for food items.
- Enables long-term nutritional tracking for users.
- Harnesses advanced deep learning and computer vision to identify diverse food categories.
- Accommodates individuals committed to a healthy lifestyle, athletes focused on performance, those mindful of weight management, and individuals dealing with chronic conditions such as diabetes or hypertension.

2.2.2: Suggestic

Suggestic is an innovative platform for personalized nutrition assistance that evaluates dietary limitations, medical problems, lifestyle factors, and genetic information to develop tailored nutrition plans [8]. The platform offers alternatives for White Label, API, and SDK to shorten time to market and improve the user experience. The Suggestic App introduces a testing augmented reality feature designed to help consumers choose healthier restaurant meals [9, Figure 2.2.2]. Suggestic offers an advanced AR solution in an effort to make the difficult task of choosing healthy selections from alluring menus easier.

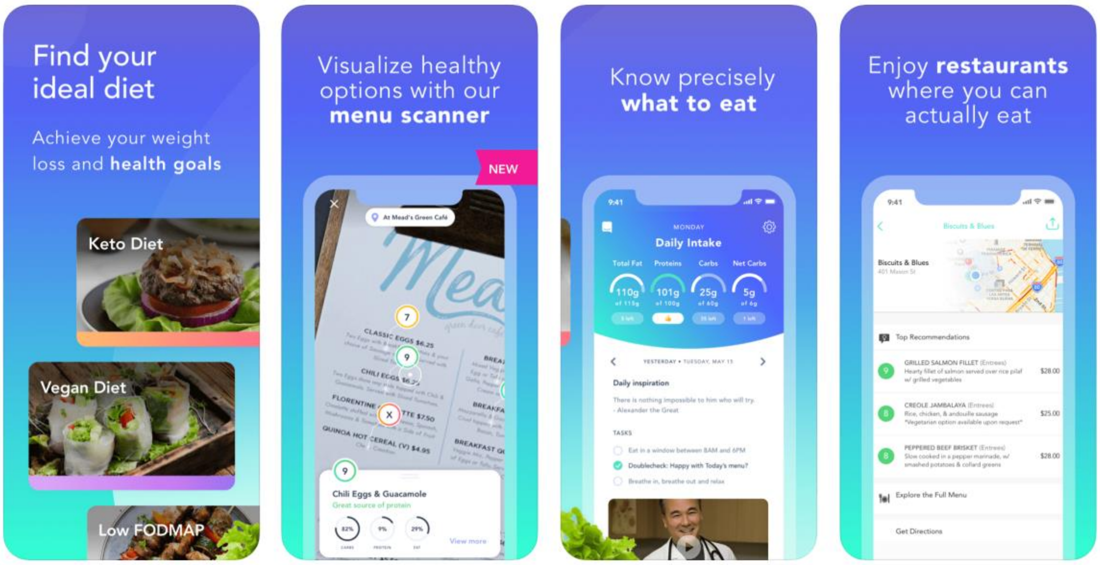


Figure 2.2.2: Suggestic's New AR Meal Planning Feature

Suggestic is a feature-rich software intended to assist users in attaining a variety of health goals, such as weight loss, higher energy, better digestion, and enhanced performance. The Suggestic Lens, an experimental addition to the groundbreaking AR function, directs visitors to the best meal options on restaurant menus. Users of this application get access to a graphic summary of menu items that are suited to various dietary needs, such as balanced, vegetarian, low-carb, and paleo alternatives. Users must run the Suggestic app on their smartphones and enable the AR feature in order to utilize the Suggestic Lens.

The Suggestic Lens makes use of two powerful Apple tools to maximize the potential of augmented reality: Core ML, which uses machine learning to identify items inside menu descriptions, and Apple's ARKit 3. Users may easily scan restaurant menus using their smartphones' cameras to access vital nutritional data, such as the amount of protein, fat, and carbohydrates, utilizing this mutual benefit. On a scale of 1 to 10, the app rates different meal options, with a higher score signifying a healthier choice [Figure 2.2.3]. Notably, the app offers ingredient breakdowns for clarity and may clearly indicate foods that should be avoided owing to calorie content or special dietary constraints.

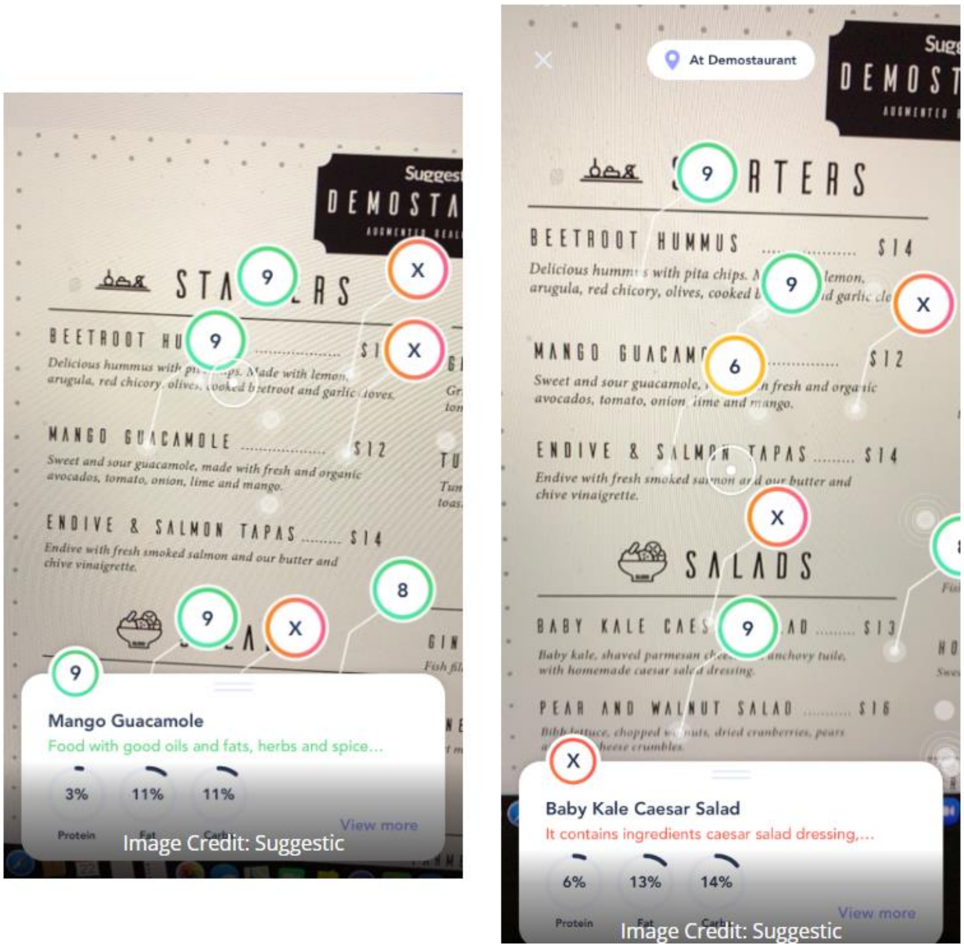


Figure 2.2.3: Scale of 1 to 10 overlay

Users are able to assess protein, fat, and carbohydrate content for each menu item, as well as receive personalized dietary recommendations according to their specific health goals, using the Suggestic Lens app's AR interface, which gives users a visual representation of menu options, making it simpler to identify the best options and avoid foods that do not fit with individual health objectives. Overall, Suggestic conclude in these key benefits, which are:

- Provides real-time information on the nutritional value of food products.
- Uses AR technology to overlay nutritional information onto the real-world image of the food item.
- Easy to use and provides a fun way to learn about food and track your nutrition.

2.2.3: KabaQ

The KabaQ mobile application is a big development in the world of food and discovering cuisine. By effortlessly integrating AR technology into the restaurant industry, KabaQ presents a paradigm change in a time when eating out has evolved into a complex experience. Through realistic 3D depictions of the meals and thorough ingredient information, this cutting-edge program provides users with an immersive and educational way to peruse restaurant menus before making their final selections. To fill the gap between digital image and the actual eating experience, KabaQ was created. Within the app, customers may view a digital menu and select the meals they're interested in. KabaQ goes beyond utilizing just written details or still photos by employing augmented reality to build 3D representations of every menu item. Through the camera on the user's smartphone or tablet, these 3D images overlay onto the actual restaurant table or the user's surroundings.

As what we can see on [10, Figure 2.2.4]. By scanning the actual surroundings with the device's camera and then superimposing 3D food representations onto the camera stream, KabaQ uses AR technology. The software employs augmented reality to place a lifelike 3D image of the meal the user chose on their table after choosing it from the digital menu. These 3D food models may be interacted with by users by tapping them or turning them to see them from various perspectives. A dynamic and aesthetically appealing manner to explore menu items is offered by this solution. The main information offered by KabaQ is detailed in the result/information and it includes that users may view accurate 3D images of menu items, enabling them to judge the appearance and size of servings. Next, KabaQ can provide users with ingredient details so they can better understand what goes into each meal. Furthermore, ratings for menu items which to assist users in making wise decisions, the app may offer ratings or suggestions for certain items.

Figure 2.2.4: Implementation of AR feature in KabaQ mobile application

Last but not least, by offering guests an immersive and engaging eating experience, KabaQ is transforming the restaurant business. By showing clients virtual 3D food on their table, in a restaurant, or at home, the app aids customers in choosing what to eat. Additionally, KabaQ assists eateries in boosting enjoyment and revenue [11].

In general, KabaQ is a modern application that makes use of AR technology to give users an immersive and engaging eating experience. The program does have some restrictions, though, including the fact that it only works with mobile devices and needs forefront scanning technology to produce incredibly high-quality 3D representations of foods. The key benefits are as below:

- Provides an immersive and interactive dining experience for customers.
- Helps customers decide what to eat by presenting virtual 3D food on their table, in a restaurant, or at home.
- Helps restaurants increase sales and fun.

2.3 Limitation of Previous Studies

2.3.1 Limitation of Previous Research

Limited Battery Life and Processing Power

Being a wearable device, Google Glass is limited by its battery life and computing power. The entire usefulness of the application is impacted by this constraint. The battery of the smartphone might be quickly depleted if the app is used continuously, especially for long periods of time. Furthermore, a lack of processing capacity might result in sluggish performance or even program crashes when dealing with complicated activities. Users must be aware of these restrictions to prevent use interruptions.

Limited Field of View

Although Google Glass offers users a heads-up display, its field of vision is constrained. When attempting to present nutritional information for bigger food items, such as a complete dinner or a large plate, this constraint becomes clear. In some situations, users could find it difficult to read comprehensive information due to the display area's limited size. Due to this restriction, the content that will be presented must be carefully chosen to fit inside the given area.

Recognition Accuracy Affected by Lighting Conditions and Food Presentation

External elements like lighting and food presentation can have an impact on how accurately food is recognized and later nutritional information is retrieved. The information that is presented to users may be inaccurate due to poor lighting or strange food presentations. For instance, if the lighting is bad, the app can have trouble accurately identifying certain ingredients or quantities. Due to this constraint, it is now more important than ever to use reliable recognition algorithms and take into account a range of real-world events.

Limited to Google Glass

The project's reliance on Google Glass, which is no longer manufactured, is a big drawback. This suggests that people who do not already own Google Glass devices may not be able to view the program. The reach and impact of the software are also limited because of the small user base of Google Glass. Alternative AR platforms or devices may need to be taken into account in future development attempts to increase accessibility.

In conclusion, the study paper's limitations highlight the difficulties in applying AR technology for visualizing food nutrition. These restrictions highlight how crucial it is to address problems with hardware limits, identification accuracy, social dynamics, and device accessibility when creating AR-based food monitoring systems. In order to address these issues and improve the overall usability and efficiency of such programs, further investigation and innovation are required.

2.3.2 Strengths and Limitation of Reviewed Application

Application	Strengths	Weaknesses
Food Lens AR	Provides real-time information on the nutritional value of food products. Easy and fun way to learn about food and track your nutrition. Can be used to inspect the nutritional value of raw materials.	Recognition accuracy may be affected by lighting conditions and food presentation. Does not show the information of the probability of getting food poisoning.
KabaQ	Provides an immersive and interactive dining experience for customers. Helps customers decide what to eat by presenting virtual 3D food on their table, in a restaurant, or at home. Can be used to inspect the visual quality of raw materials.	Requires advanced scanning technologies to create ultra-high quality 3D models of food items. KabaQ charges $99-$199 per month for their services. Limited to mobile devices. Does not show the information of the probability of getting food poisoning.
Suggestics	Provides advanced personalized nutrition support by analyzing dietary restrictions, health conditions, lifestyle, and genetic information to create customized nutrition programs. Can be used to inspect the nutritional value of raw materials. Has an AR meal planning feature. Offer real-time	Does not show the information of the probability of getting food poisoning.

Table 2.3.1: Strengths and weaknesses of reviewed applications

In conclusion, [Table 2.2.1] has despite the fact that these apps provide useful resources for tracking dietary intake and dining out, none of them address the crucial issue of probabilities of food poisoning. Future improvements that take into consideration this crucial component might further increase their usefulness and user safety.

2.4 Proposed Solutions

The limitations of current apps are addressed in my suggested solution, "An AR (Augmented Reality) Application for Food Inspection," which focuses on giving thorough, real-time information on raw materials to improve food safety. Utilizing modern augmented reality (AR) technology, this mobile application gives users an effective tool for analyzing and evaluating the quality and safety of raw food products.

The primary use of this software is to scan raw materials using the camera on a mobile device. The software recognizes and examines the raw material using advanced image processing algorithms, obtaining important information about its quality, provenance, and safety. The user is then presented with this information in an overlay format, which uses AR technology to seamlessly integrate with the user's vision of the actual world.

By enabling customers to make informed details about the raw food materials they want to use in their meals, this solution's main objective is to avoid food poisoning. Users may see possible risks and stay away from components that can be harmful to their health by taking use of real-time insights regarding the quality and safety of these products. Further boosting user knowledge and safety, the application might also offer data on the likelihood of food illness linked to particular raw food materials.

This AR application might transform how customers interact with raw materials, enhancing transparency in the food supply chain in addition to its advantages for food safety. Users may learn more about the management and procurement of raw materials, promoting confidence in the food business. The app's potential also includes educational uses, which might encourage users to choose better and more environmentally friendly eating decisions.

In conclusion, "An AR (Augmented Reality) Application for Food Inspection" offers a groundbreaking solution to mitigate the risks of food poisoning by providing users with real-time, data-driven insights into the raw materials they encounter. This innovative mobile application not only enhances food safety but also promotes transparency and informed decision-making in the realm of food consumption.

Chapter 3 SYSTEM METHODOLOGY/APPROACH

In Chapter 3, I will discuss the system specifications, system overview, implementation issues and challenges as well as the timeline of the project.

Proposed Method/Approach

The processes of the project were categorized into different phases in the development, which were project pre-development, data pre-processing, model training architecture building and data training, and prediction on test dataset.

3.1 System Design Diagram

3.1.1 System Architecture Diagram

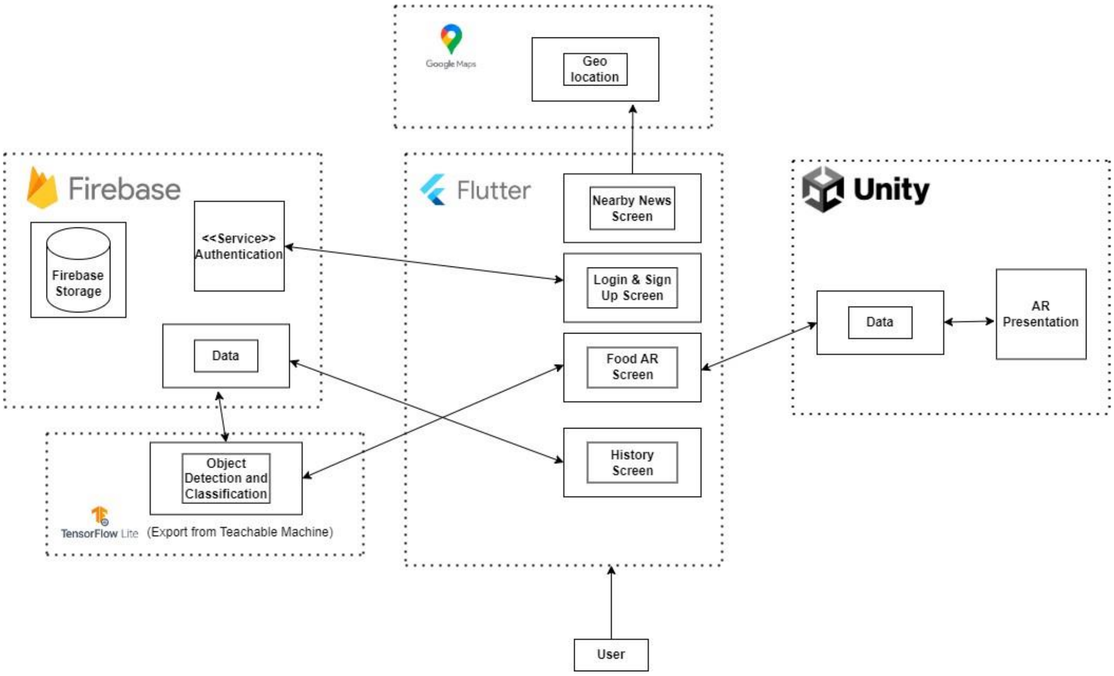


Figure 3.1.1 System Architecture Diagram

The architecture diagram illustrates the different components and technologies involved in building an application that provides various features such as user authentication, location-based news reporting, augmented reality (AR) experience for food object detection and classification, and a history screen to display the user's past predictions.

At the core of the application is Flutter, a cross-platform framework for building mobile applications. Flutter is responsible for rendering the user interface (UI) screens, including the Nearby News Screen, Login & Sign Up Screen, Food AR Screen, and History Screen.

Firebase, a comprehensive app development platform, is integrated into the application for several purposes. Firebase Storage is used to store data, including the predictions made in the Food AR Screen. Firebase also provides authentication services for user sign-in and sign-up functionality.

The Nearby News Screen utilizes the Google Maps API to obtain the user's geolocation, enabling the display of nearby news or reports based on the user's current location.

The Food AR Screen is powered by object detection and classification capabilities. Initially, the Teachable Machine platform was used to train a model for this purpose, and the resulting model was exported in the TFLite format. This TFLite model is then integrated into the application to perform object detection and classification on food items.

The Unity game engine is employed for rendering the AR experience in the Food AR Screen. Unity's Data component manages the data required for the AR presentation like prediction that predict by the TFLite, nutrition facts and possibilities to get food poisoning, It handled by the AR Presentation component, likely utilizing the AR Foundation framework.

The History Screen retrieves and displays the user's past predictions made in the Food AR Screen. These predictions are stored in Firebase Storage, and the History Screen fetches and presents this data to the user in a card view format.

Additionally, the diagram mentions a Profile Setting Screen, where users can input their personal information, such as name, allergies, and date of birth, upon their first login. There is also a User Profile Screen, which allows users to modify their settings, manage their allergies, and log out of the application.

Overall, the architecture diagram illustrates the integration of various technologies and services to create a comprehensive application with features like user authentication, location-based news reporting, augmented reality experience for food object detection and classification, and a history screen to track the user's past predictions.

3.1.2 Methodologies and General Work Procedures

In this section, I will discuss the methodology for the development of AR application for Food Inspection. The processes are set up as Figure 3.1.3.

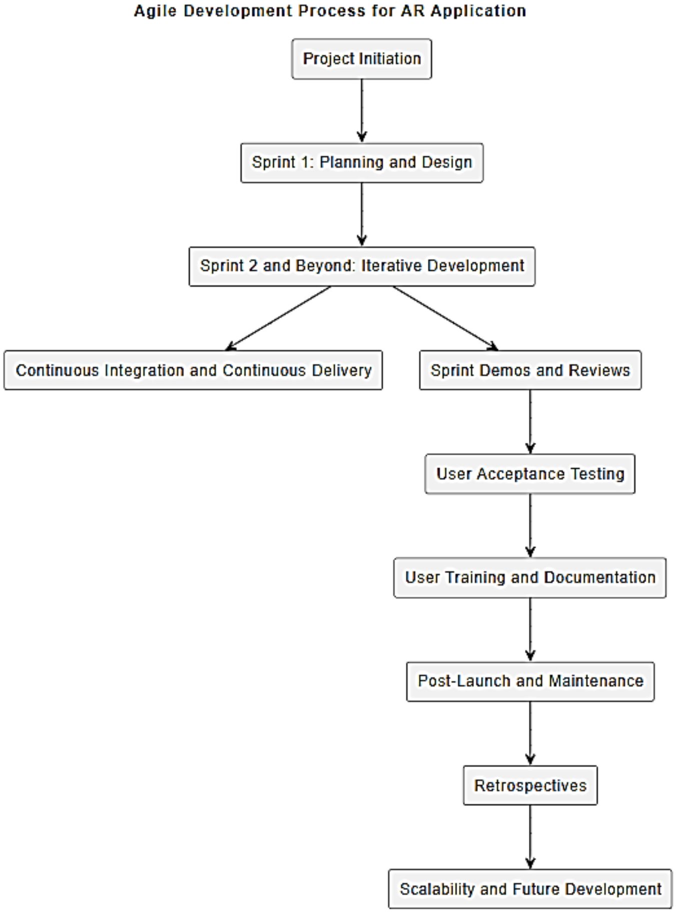


Figure 3.1.2: Agile Development Process for AR Application

Project Initiation

In the initial phase, project definition is crucial. This involves setting clear project objectives, outlining the scope, and defining goals. Identifying key stakeholders and establishing communication channels ensures smooth collaboration. Additionally, creating a product backlog is essential, listing the features and functionalities to be implemented, and prioritizing them based on user value and project goals.

Sprint 1 - Planning and Design

Sprint planning marks the start of the development process. During this phase, a subset of high-priority user stories from the product backlog is selected for the first sprint. Simultaneously, the design phase begins, focusing on the architecture and user interface of the AR application.

Prototyping, through the development of wireframes or prototypes, helps visualize the AR app's functionality.

Sprint 2 and Beyond - Iterative Development

After sprint planning, the development phase kicks off, starting with coding the core functionality of the AR app, such as real-time raw material scanning using the device's camera. Testing and quality assurance activities run in parallel, identifying and addressing issues early in the development process. Regular review meetings with the development team ensure alignment with project goals. User feedback collected on early prototypes or MVPs helps validate assumptions and refine the app's design.

Continuous Integration (CI) and Continuous Delivery (CD)

Implementing CI/CD pipelines automates build, test, and deployment processes, ensuring quick and reliable deployment of changes to users.

Sprint Demos and Reviews

At the end of each sprint, stakeholders participate in demo and review sessions, where completed features are showcased. Feedback collected during these sessions informs further refinements and the prioritization of new user stories.

User Acceptance Testing (UAT)

Stakeholders and end-users actively engage in UAT to ensure the AR application meets their expectations and requirements.

User Training and Documentation

Developing user documentation and training materials ensures that users can effectively operate the AR application.

Post-Launch and Maintenance

Once the AR app is launched to users, continuous monitoring of its performance and user feedback is crucial. Addressing bugs, issues, and necessary improvements through subsequent sprints is essential. Planning for regular updates and feature enhancements based on user needs and technological advancements is part of this phase.

Retrospectives

After each sprint, retrospectives are conducted to evaluate the development process, identify areas for improvement, and make necessary adjustments. For the evaluation part, we will evaluate the stability of AR and therefore develop metrics to support the quantitative assessment of the system's stability.

Scalability and Future Development

As the AR app gains popularity and usage, consideration of scalability requirements and future development efforts to expand its capabilities becomes vital.

By adhering to this Agile Development Methodology, we can systematically and iteratively develop the AR application for food inspection, ensuring a user-driven and efficient approach to the project

3.1.3 Use Case Diagram and Description

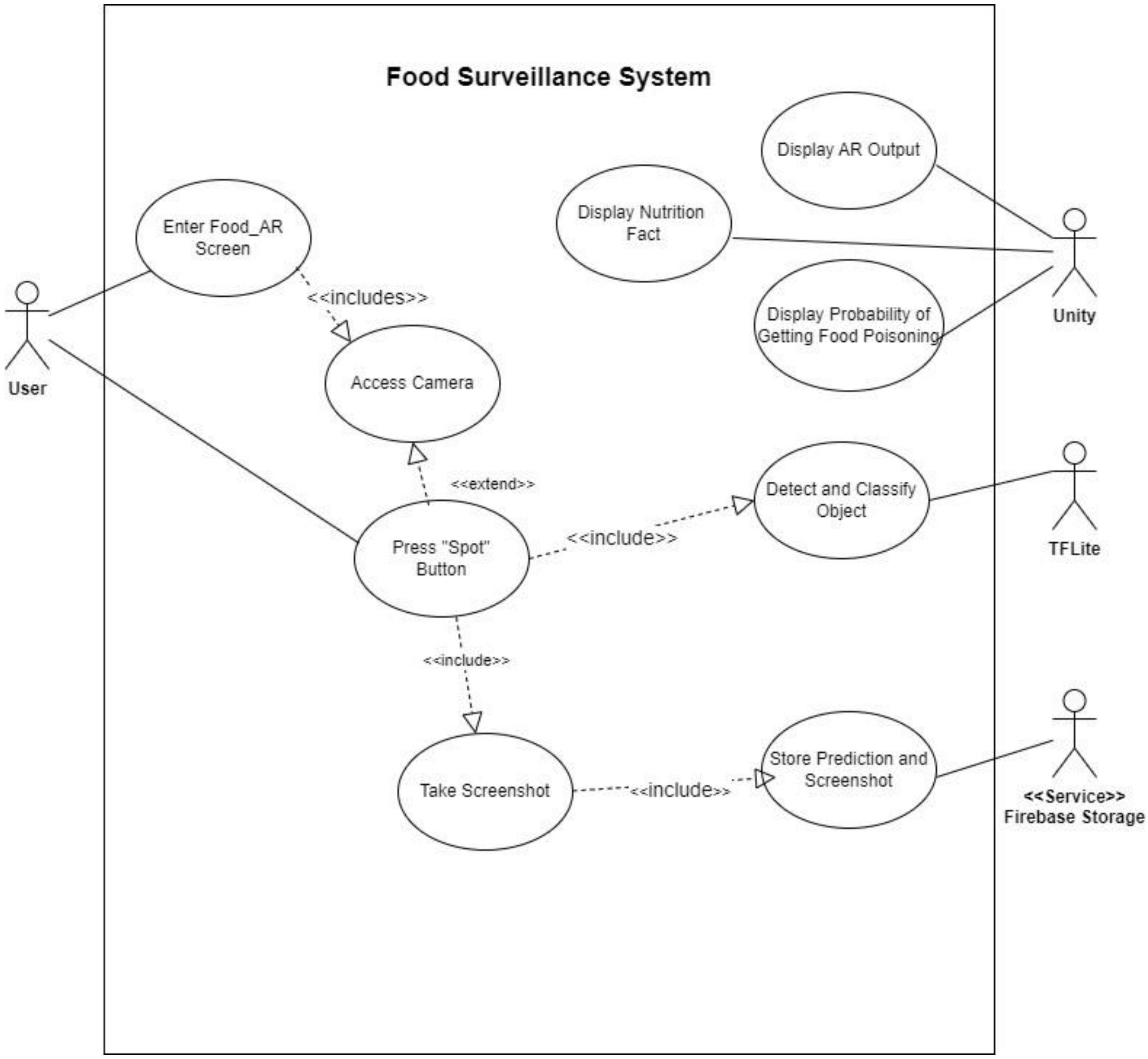


Figure 3.1.3: Use Case Diagram

In this use-case diagram, the User interacts with the Food Surveillance Screen by entering to Food AR Screen and it will access the camera. User can press the "Spot" Button and it will countdown 3 seconds, and when it counts to 1, system will take a screenshot. The Detection and Classification of object use case then utilizes the TFLite Object Detection Model to perform object detection and classification.

The results of the object detection and classification are then used to display the AR output, nutrition facts, and food poisoning probability on the Food AR Screen. The AR Presentation from the Unity package is used to render the AR output.

Additionally, the prediction result is stored in the Firebase Storage, and a screenshot of the output is also taken and stored in Firebase Storage.

Note that the use cases within the Food AR Screen rectangle represent the various functionalities available within that screen, and the dependencies between them are shown using include and uses relationships.

3.2 System Overview

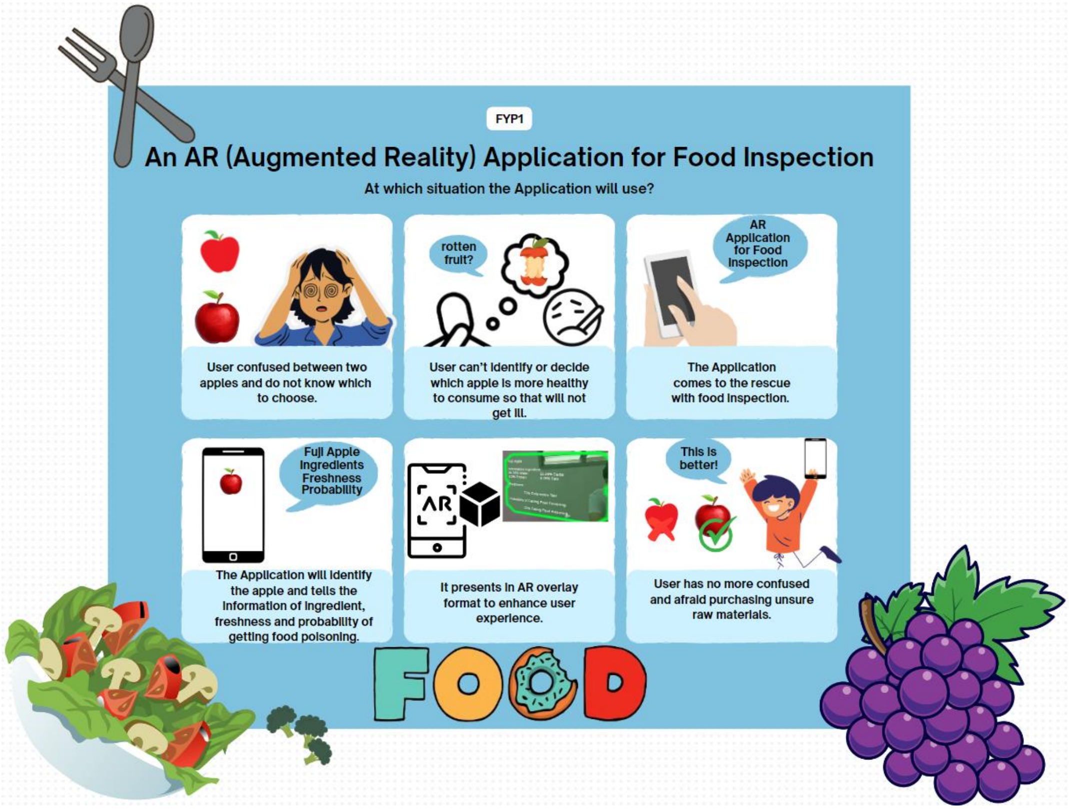


Figure 3.2: Storyboard of Proposed AR Application

Figure 3.2 had shown the Storyboard of Proposed AR Application:

Board 1: User Confusion Scenario

Scenario:

The user is standing in a grocery store, facing a choice between two different apples. They are uncertain about which one to choose due to similar appearances.

Initiation:

The user encounters a situation where they are uncertain about choosing between two apples. This initiates the engagement with the AR food inspection application.

Board 2: User Can't Identify Healthy Apple

Scenario:

The user, unable to visually identify the healthier apple, is concerned about making a choice that minimizes the risk of food poisoning or ensures better freshness.

Analysis:

It analyses the user's challenge in distinguishing the healthiest apple from the available options. It recognizes the need for detailed inspection to provide relevant information.

Board 3: Application Comes to the Rescue

Scenario:

The user decides to use the AR food inspection application for assistance. They launch the application on their mobile device.

System Engagement:

The AR application smoothly combines several different features, such as database management, AR rendering, and imagine processing. The system can respond to the user's request efficiently through the connection.

Board 4: Apple Identification and Information Retrieval

Scenario:

The AR application uses the device's camera to identify the apple in focus. It provides real-time information on the ingredients, freshness, and the probability of getting food poisoning for each apple.

Identification Process:

Using advanced image recognition algorithms, the AR application accurately identifies the apples in question. This process ensures precision in the subsequent data retrieval.

Data Retrieval:

The system accesses a comprehensive database containing information about ingredients, freshness, and the probability of food poisoning associated with each apple. This retrieval is a critical step in providing valuable insights to the user.

Board 5: AR Overlay Format for Enhanced Experience

Scenario:

The application presents the information in an augmented reality (AR) overlay format. Details about the apples appear seamlessly overlaid on the user's view, enhancing the user experience.

System Feature:

Leveraging the AR Foundation, the system dynamically overlays the identified information onto the user's real-world view. This immersive AR experience enhances the user's perception of the apple details, providing a seamless integration of digital information with the physical environment.

Board 6: User Confident in Purchasing Decision

Scenario:

Empowered with detailed information, the user is no longer confused or afraid of purchasing raw materials. They confidently make an informed decision, selecting the apple that aligns with their preferences and safety considerations.

System Impact:

The AR food inspection application ensures that users make informed decisions, fostering a sense of security in their food choices. The system's impact extends beyond addressing immediate concerns, contributing to an overall improvement in user confidence and well-being.

3.3 Novelties of Project

3.3.1 Implement AR Overlay in Food Inspection

According to my knowledge, this project stands out as the first of its kind in the domain of food inspection by introducing an augmented reality (AR) overlay format. Unlike traditional methods, this innovative approach allows users to view real-time information about raw materials seamlessly overlaid onto the physical objects. This pioneering feature enhances user engagement and understanding, making food inspection a more interactive and visually compelling experience.

3.3.2 Freshness Test for Enhanced Safety Analysis

A key novelty of the application lies in its implementation of a freshness test as a determinant for food safety. By analyzing the freshness of raw materials through the device's camera, the application goes beyond conventional inspection methods. This innovative feature provides users with insights into the quality of food products, allowing them to make informed decisions based on the probability of food poisoning. The integration of a freshness test sets a new standard for safety analysis in food inspection applications.

3.3.3 User-Friendly Experience

The project prioritizes user experience by introducing features that cater to the needs and concerns of consumers. The AR overlay not only makes the inspection process more interesting but also simplifies the understanding of complex information. By leveraging AR to visualize details about raw materials, the application fosters a user-centric approach, making food safety assessments more accessible and engaging for a wide audience.

3.3.4 Dynamic and Real-time Information

Unlike static food inspection techniques, this project excels at providing dynamic, real-time data. With the use of computer vision and machine learning, the AR application can identify raw materials quickly, giving users the most recent information on ingredients and freshness. By ensuring that users receive the most up-to-date and relevant information, this real-time analysis helps to improve the accuracy and efficiency of the food inspection process.

3.3.5 Emphasis on Consumer Empowerment

By combining AR technology with freshness testing, the application empowers consumers to make educated choices about the food they consume. This emphasis on consumer empowerment aligns with evolving trends in food safety and transparency. The project not only addresses safety concerns but also places control in the hands of consumers, fostering a sense of responsibility and confidence in their food purchasing decisions.

3.4 Timeline

Project Start Date:	30-Oct-23			
Project Title:	Indoor Positioning System (FYP1)			

#	Activity	Start	End	Days	Status
1	*FYP1*	30-Oct-23	14-Dec-23	45	Completed
2	Chapter 1: Project Background & Project Scope and Objectives	30-Oct-23	11-Nov-23	12	Completed
3	Discuss with supervisor to see if got any changes	30-Oct-23	11-Nov-23	12	Completed
4	Chapter 2: Literature Review	05-Nov-23	14-Nov-23	9	Completed
5	More research on relevant papers	05-Nov-23	14-Nov-23	9	Completed
6	Chapter 3: Proposed Methodology	14-Nov-23	26-Nov-23	12	Completed
7	Novelty elements	14-Nov-23	19-Nov-23	5	Completed
8	System Overview	16-Nov-23	21-Nov-23	5	Completed
9	Implementation Issues and Challenges	18-Nov-23	23-Nov-23	5	Completed
10	Timeline	21-Nov-23	26-Nov-23	5	Completed
11	Chapter 4: Preliminary Works	26-Nov-23	05-Dec-23	9	Completed
12	Setting Up and Coding	26-Nov-23	05-Dec-23	9	Completed
13	Testing	02-Dec-23	05-Dec-23	3	Completed
14	Chapter 5: Conclusion	02-Dec-23	08-Dec-23	6	Completed
15	Poster	02-Dec-23	08-Dec-23	6	Completed
16	FYP1 Weekly Report	30-Oct-23	08-Dec-23	39	Completed
17	Final Checking	02-Dec-23	08-Dec-23	6	Completed
18	Presentation	08-Dec-23	14-Dec-23	6	In progress

Week Starting Day — 2023: Nov: 30-Oct, 2-Nov, 5-Nov, 8-Nov, 11-Nov, 14-Nov, 17-Nov, 20-Nov, 23-Nov, 26-Nov, 29-Nov; Dec: 2-Dec, 5-Dec, 8-Dec, 11-Dec, 14-Dec

Figure 3.5.1: Timeline of FYP1

Project Start Date:	29-Jan-24			
Project Title:	Indoor Positioning System (FYP2)			

#	Activity	Start	End	Days	Status
1	*FYP2*	29-Jan-24	6-May-24	98	Not started
2	Chapter 1: Introduction	29-Jan-24	29-Jan-24	0	Not started
3	Discuss with supervisor to see if got any changes	29-Jan-24	29-Jan-24	0	Not started
4	Chapter 2: Literature Review	29-Jan-24	03-Feb-24	5	Not started
5	More research on relevant papers	29-Jan-24	03-Feb-24	5	Not started
6	Chapter 3: System Methodology/Approach	03-Feb-24	20-Feb-24	17	Not started
7	System Design Diagram/Equation	03-Feb-24	20-Feb-24	17	Not started
8	Chapter 4: System Design	20-Feb-24	12-Mar-24	21	Not started
9	System Block Diagram	20-Feb-24	27-Feb-24	7	Not started
10	System Components Specifications	27-Feb-24	12-Mar-24	14	Not started
11	Chapter 5: System Implementation	03-Feb-24	19-Mar-24	45	Not started
12	Setting Up and Coding	03-Feb-24	19-Mar-24	45	Not started
13	Chapter 6: System Evaluation And Discussion	19-Mar-24	09-Apr-24	21	Not started
14	System Testing and Performance Metrics	19-Mar-24	02-Apr-24	14	Not started
15	Result Evaluation	02-Apr-24	09-Apr-24	7	Not started
16	Chapter 7: Conclusion and Recommendation	09-Apr-24	25-Apr-24	16	Not started
17	Final Checking	22-Apr-24	25-Apr-24	3	Not started
18	Presentation	25-Apr-24	06-May-24	11	Not started

Week Starting Day — 2024: Jan: 29-Jan; Feb: 3-Feb, 10-Feb, 15-Feb, 20-Feb; Mar: 27-Feb, 5-Mar, 12-Mar, 19-Mar; Apr: 26-Mar, 2-Apr, 9-Apr, 17-Apr, 25-Apr; May: 6-May

Figure 3.5.2: Timeline of FYP2

Chapter 4 SYSTEM DESIGN

4.1 Package Diagram

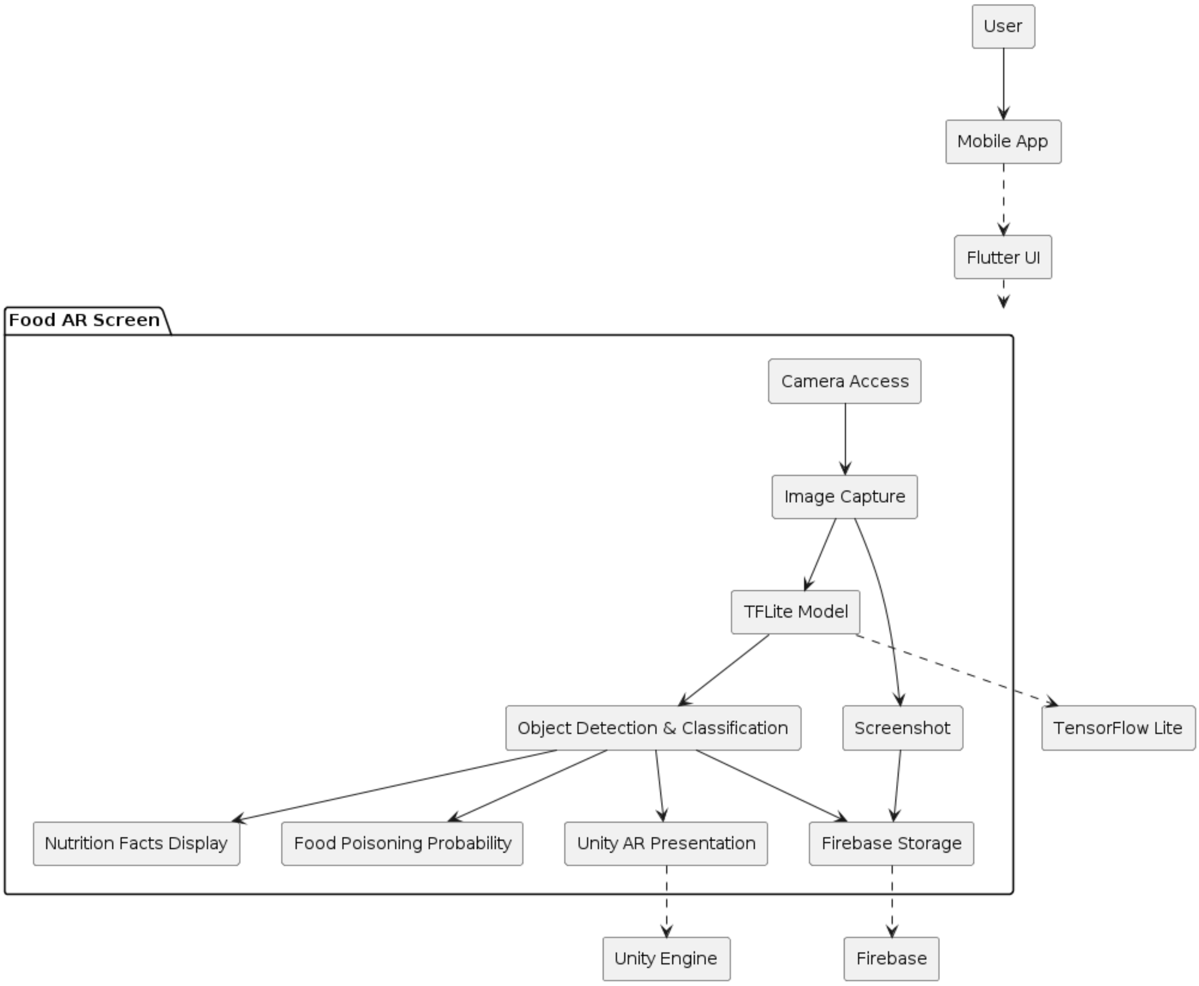


Figure 4.1: Package Diagram

The diagram illustrates the system architecture for the Food AR function of a mobile application. Here's an explanation of the different components and their interactions:

The User interacts with the Mobile App, which is built using the Flutter UI framework. The Flutter UI renders the Food AR Screen, which is the main interface for the augmented reality food recognition functionality.

Within the Food AR Screen, the Camera Access component allows the application to access the device's camera. The Image Capture component then captures an image from the camera.

The captured image is processed by the TFLite Model, which is a machine learning model exported from TensorFlow Lite. This model performs Object Detection & Classification on the captured image, identifying and classifying the food items present in the image.

The results of the Object Detection & Classification process are utilized by several components:

1. Nutrition Facts Display: This component displays the nutritional information of the detected food items.
2. Food Poisoning Probability: This component calculates and displays the probability of food poisoning based on the detected food items.
3. Unity AR Presentation: This component uses the Unity Engine to render an augmented reality view of the detected food items, overlaying them on the real-world scene.
4. Firebase Storage: The prediction results and a screenshot of the output are stored in Firebase Storage for future reference or history tracking.

The Unity AR Presentation component utilizes the Unity Engine to render the augmented reality view, while the Firebase Storage component interacts with the Firebase platform to store and retrieve data.

The TFLite Model component relies on the TensorFlow Lite library, which is a lightweight version of TensorFlow optimized for mobile and embedded devices.

Overall, the diagram represents the flow of data and interactions between the different components involved in the Food AR function, from capturing the image to processing it with machine learning models, displaying the results in an augmented reality view, and storing the data for future reference.

4.2 System Component Specifications

Development Platform: Unity 3D

Unity 3D serves as the foundational development platform for your project. It's a powerful and widely used game engine and development environment that's well-suited for creating AR applications. Unity provides a user-friendly interface, a robust scripting environment, and cross-platform compatibility. It allows you to seamlessly integrate various components like AR functionality, image processing, and database management, making it an ideal choice for building your AR food inspection app.

Augmented Reality: AR Development Kit (Unity's AR Foundation) and Vuforia

The AR Development Kit, specifically Unity's AR Foundation, is crucial for implementing AR features into your application. AR Foundation enables cross-platform development, meaning your app can run on both Android and iOS devices. It simplifies the integration of AR technologies like ARCore (for Android) and ARKit (for iOS). These toolkits provide the necessary capabilities for recognizing and interacting with the physical environment through your device's camera, allowing you to overlay real-time details of raw materials seamlessly.

Mobile Application Development: Flutter

Flutter is an open-source framework developed by Google for building natively compiled applications for mobile, web, and desktop from a single codebase. It offers a rich set of pre-designed widgets and a fast development cycle, making it an excellent choice for creating the user interface and functionality of your mobile app. Flutter supports both iOS and Android platforms, enabling you to target a wide range of mobile devices.

Image Processing and Recognition: Teachable Machine

Teachable Machine, developed by Google's TensorFlow team, is a user-friendly web-based tool that democratizes machine learning by enabling users without extensive coding or machine learning expertise to train models. Using transfer learning, Teachable Machine allows users to upload images or use their webcam to capture images, label them with categories, and train the model to recognize patterns. The tool supports three types of models: image, sound, and pose detection. After training, users can export their model in TensorFlow Lite (TFLite) format, optimized for mobile and edge devices, enabling the integration of machine learning models into mobile apps, websites, and other projects for tasks like image classification and object detection.

Database Management: Firebase Database

Firebase Realtime Database is a cloud-based database service that can enhance your app's functionality by enabling real-time data synchronization across multiple devices. In the context of your AR food inspection app, Firebase can be used to store and manage information about raw materials, nutritional data, and user preferences. This ensures that users receive up-to-date and consistent details when inspecting food items. Firebase's real-time capabilities can contribute to the overall user experience and data accuracy in your application.

By leveraging these software components, you'll have a solid foundation for developing an AR application that provides real-time details of raw materials, helping users prevent food poisoning. Unity 3D, AR Development Kit (AR Foundation), Vuforia, OpenCV, and Firebase Realtime Database collectively empower you to create a feature-rich, cross-platform mobile app that enhances food inspection and safety for users.

Chapter 5 SYSTEM IMPLEMENTATION (FOR DEVELOPMENT-BASED PROJECT)

5.1 Hardware Setup

The hardware involved in this project is a laptop and android mobile device. A computer issued for development or implementing the AR technology into the mobile application. A mobile device is used for testing and deploying this AR application.

Table 5.1.1 Specifications of Laptop

Description	Specifications
Model	Acer Aspire A315-55G
Processor	Intel(R) Core(TM) i5-10210U CPU @ 1.60GHz 2.11 GHz
Operating System	Windows 11
Graphic	NVIDIA GeForce MX230
Memory	12 GB RAM
Storage	512 GB SSD

Table 5.1.2 Specifications of Mobile Device

Description	Specifications
Model	Huawei EVR-L29
Processor	Huawei Kirin 980
Kernel Version	4.14.116 os@localhost#1
Memory	6.0 GB RAM
Storage	128 GB

5.2 Software Setup

Before starting to develop the AR Application, there are four software needed to be installed and downloaded in my laptop:

1. Unity Hub 3.6.0
2. Microsoft Visual Studio Enterprise 2019
3. Visual Studio Code 1.84.2

After installing the software, there are 3 libraries needed to be installed and downloaded in my laptop:

1. Unity Editor 2022.3.2f1
2. Visual Studio Tools for Unity
3. C# Script and Visual Basic
4. Teachable Machine on Website
5. Flutter v3.78.0
6. Dart v3.78.0

5.3 Setting and Configuration

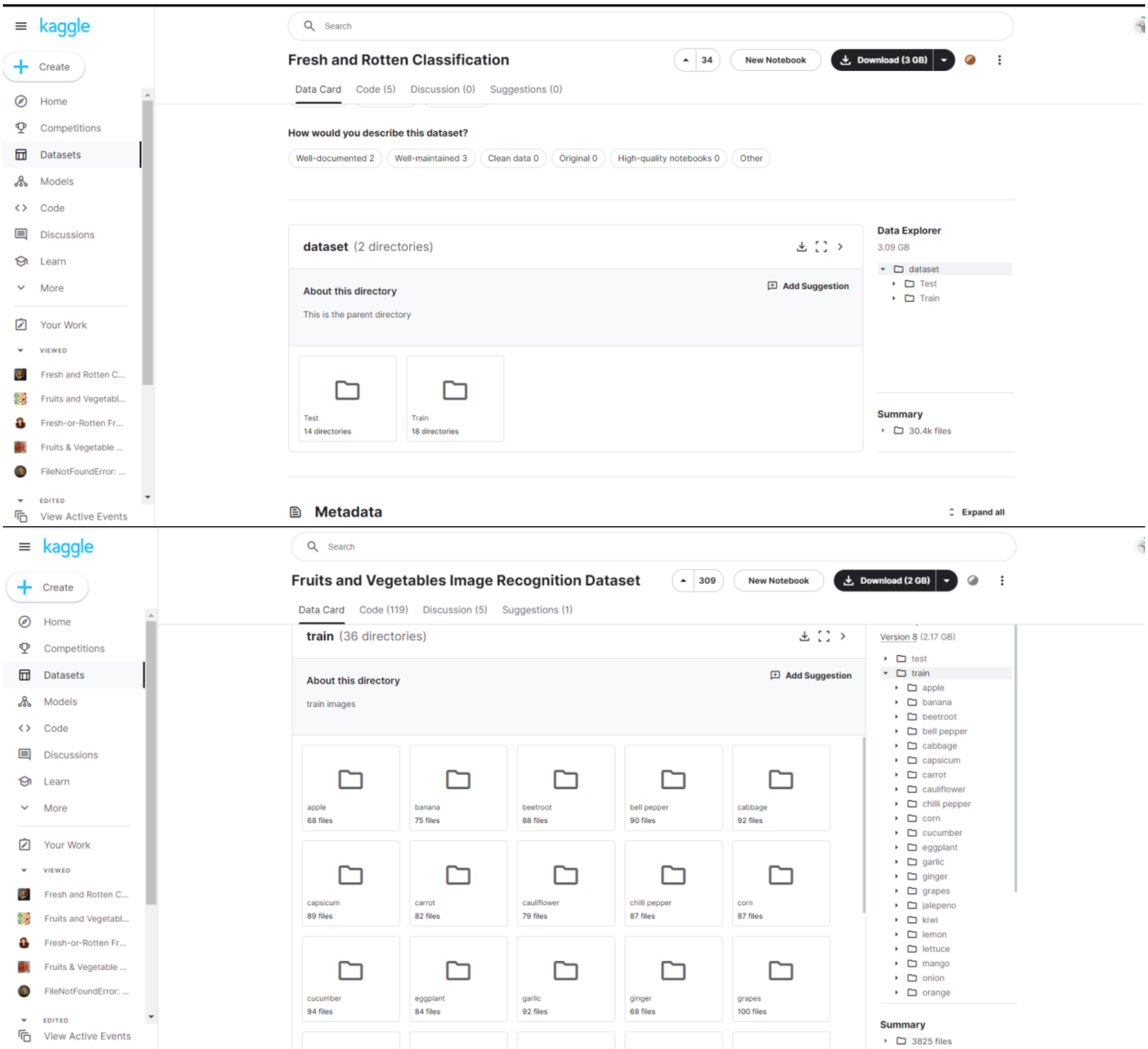


Figure 5.3.1: Dataset download from Kaggle.com

In the initial stages of the project, meticulous attention was paid to dataset selection and preprocessing to lay a solid foundation for subsequent object detection and classification tasks. Datasets were sourced from Kaggle, specifically from repositories such as "Fresh and Stale Classification" and "Fruit and Vegetable Image Recognition." From these datasets, a thoughtful curation process was undertaken to select 10 classes of fruits and vegetables that would represent a diverse range of common food items encountered in real-world scenarios. These classes included Fresh Apples, Rotten Apples, Fresh Banana, Rotten Banana, Fresh Carrot, Rotten Carrot, Fresh Tomato, Rotten Tomato, Fresh Oranges, and Rotten Oranges.

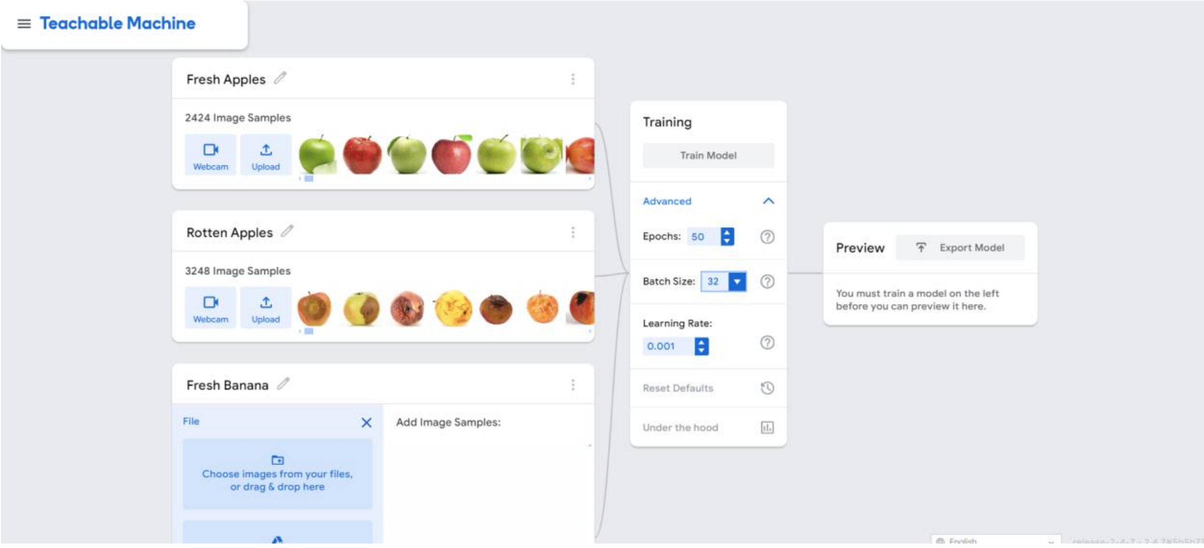


Figure 5.3.2: Train model from Teachable Machine

Following dataset selection, a comprehensive preprocessing phase was executed. This involved organizing and standardizing the images from the dataset to ensure uniformity and consistency. The preprocessed images were then fed into the Teachable Machine platform for model training. The training parameters were meticulously configured, with 50 epochs, a batch size of 32, and a learning rate of 0.001 chosen to optimize the model's performance. After successful training, the model was exported to TensorFlow Lite using the floating-point model conversion type, a crucial step to ensure compatibility with the Flutter framework.

Transitioning to the Flutter part of the project, the focus shifted to setting up and configuring Firebase for user authentication, database management, and storage. Firebase authentication was seamlessly integrated into the login and signup pages, providing a robust mechanism to manage user access and authentication. Additionally, Firebase database was configured to store user information, while Firebase storage was utilized to store and retrieve historical data such as prediction history.

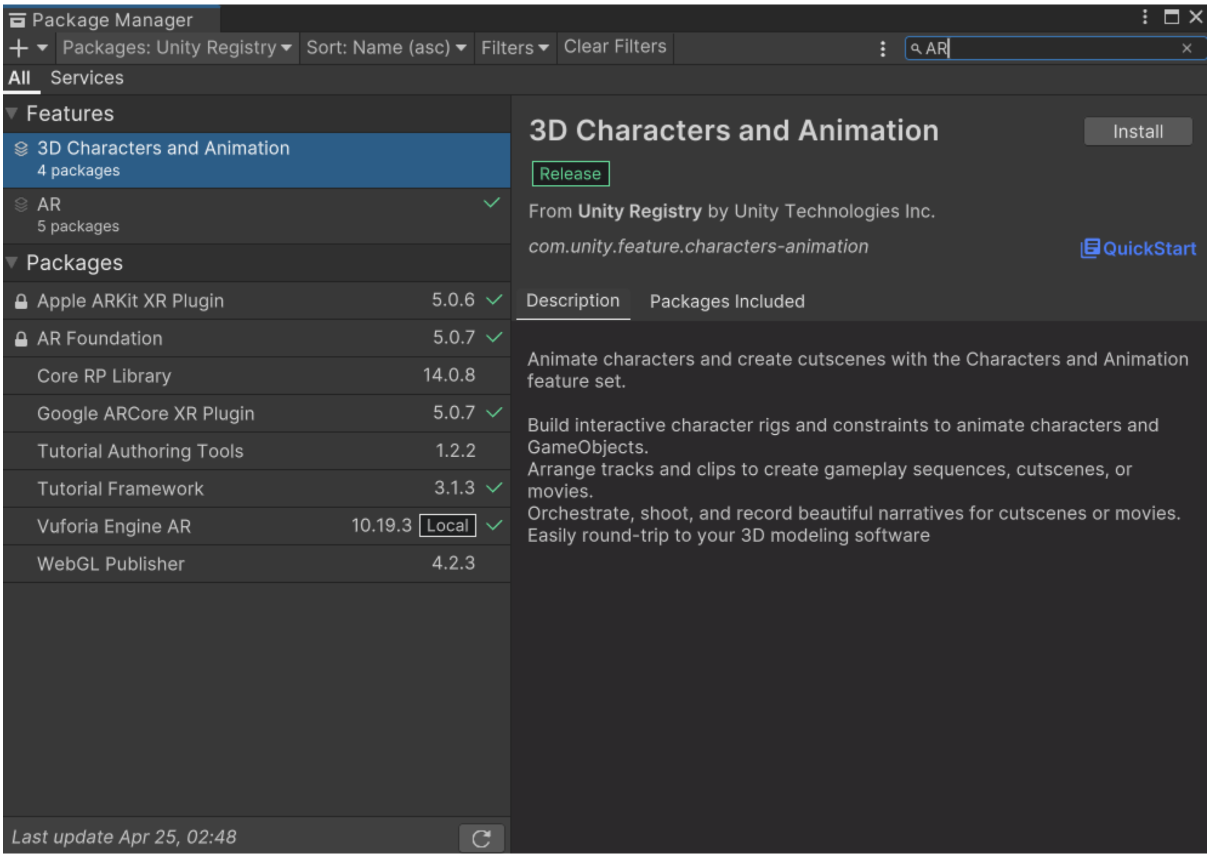


Figure 5.3.3: Installation and Version Update of AR packages

In the Unity segment of the project, meticulous attention was paid to ensuring version compatibility and updates. The AR Foundation, ARKit XR Plugin, and XR Core Utilities were updated to their latest versions (5.0.7, 5.0.6, and 2.2.1, respectively). This proactive approach was crucial to ensure compatibility with the latest features and improvements in the Unity platform. Furthermore, Microsoft Visual Studio was configured to support Unity development, with all necessary packages and extensions installed to facilitate a smooth workflow between the two platforms.

Throughout the project lifecycle, a vigilant approach was adopted towards version compatibility and updates. This proactive stance helped maintain the stability and reliability of the project, ensuring a seamless integration of AR features and enhancing the overall user experience.

5.4 System Operation

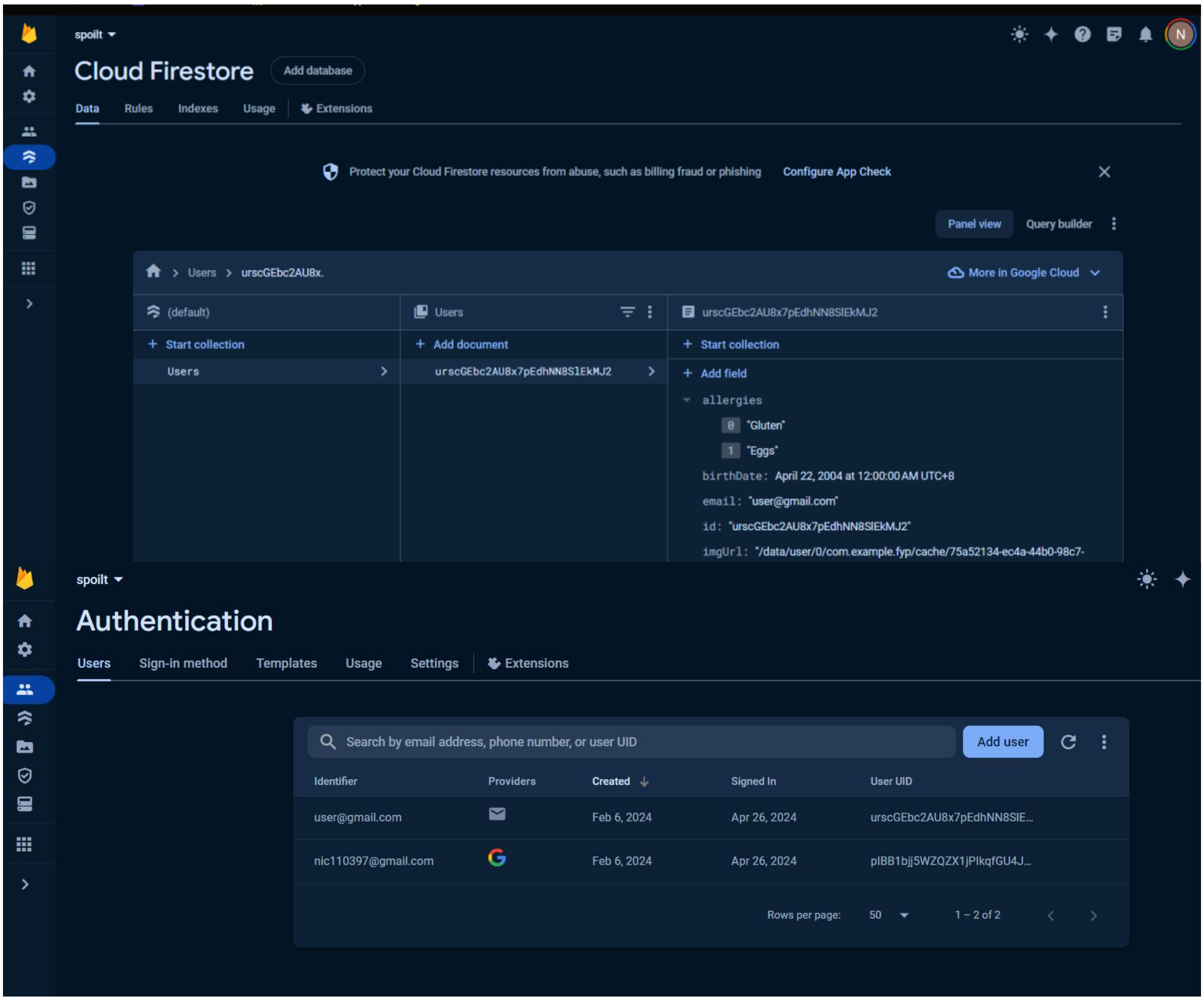


Figure 5.4.1: Figure of Firebase Authentication & Firebase Database.

The application's system operation is designed to offer users a seamless and engaging experience. Users interact with the mobile app through a user-friendly interface, accessing features like logging in, signing up, viewing nearby news, and managing user profiles. Upon logging in, users can update their profiles with details such as name, birthdate, and allergies, which are stored in the Firebase Firestore database for future reference and personalization. Firebase Authentication is used to manage logins, Google SignIn, and Apple SignIn, ensuring secure access to the app's features. This allows users to create accounts using their email and password, log in securely, and use Google or Apple accounts for authentication, enhancing the app's usability and security.

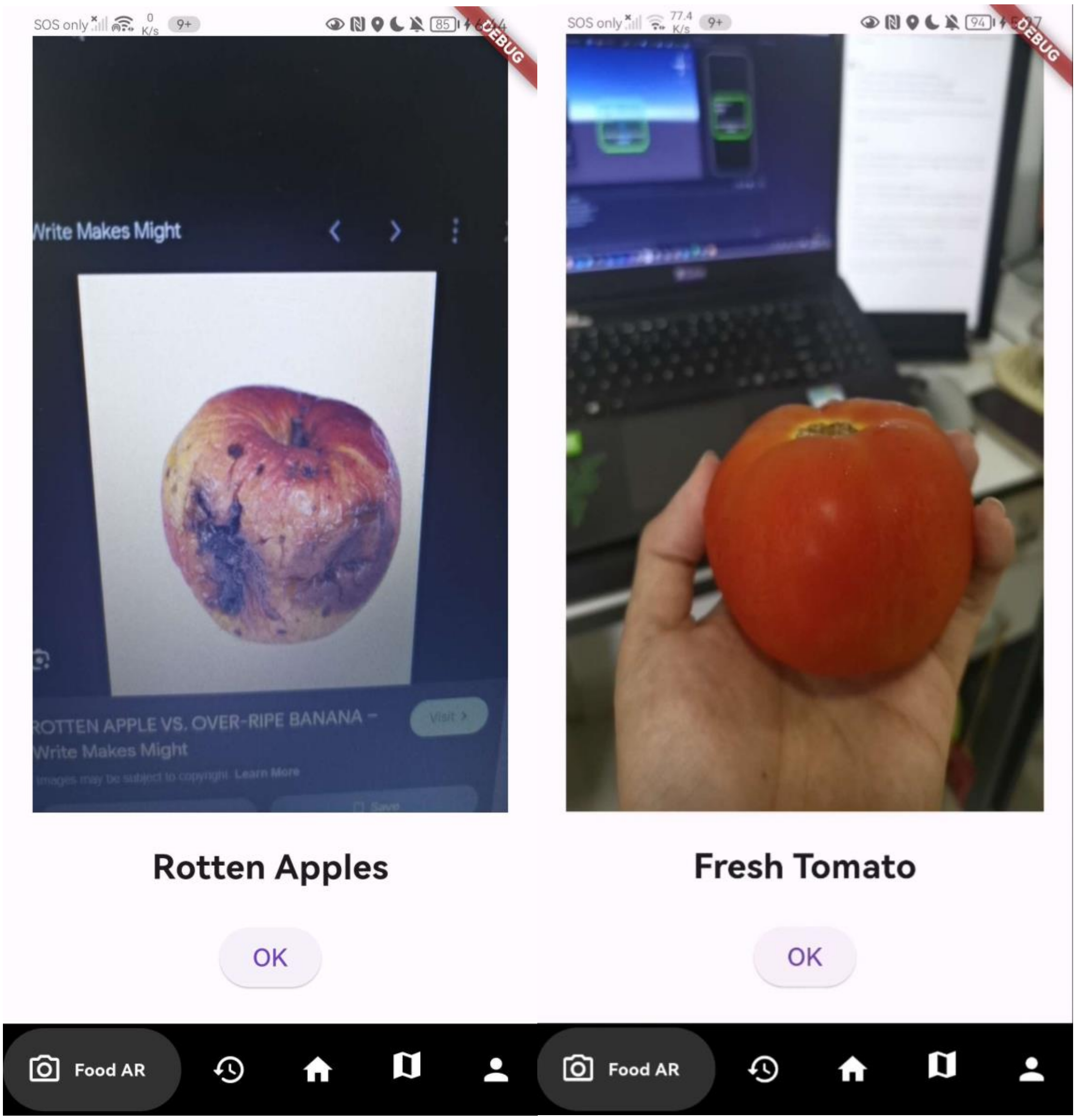


Figure 5.4.2: Predicted Output for TensorFlow Lite

The key feature of the application is the Food AR screen, where users can scan food items using their device's camera. TensorFlow Lite, a lightweight and efficient machine learning library, is utilized for object detection and classification, enhancing the accuracy of food recognition. When a user enters the Food AR screen, the camera is activated, and the user can point it towards the desired food item. Upon pressing the "OK" button, the system initiates a 3-second countdown to ensure a stable image capture. After the countdown, a screenshot is taken, and the captured image is sent to the TensorFlow Lite model for processing. The model analyzes the image and provides predictions on the food items present, including their classifications and confidence scores.

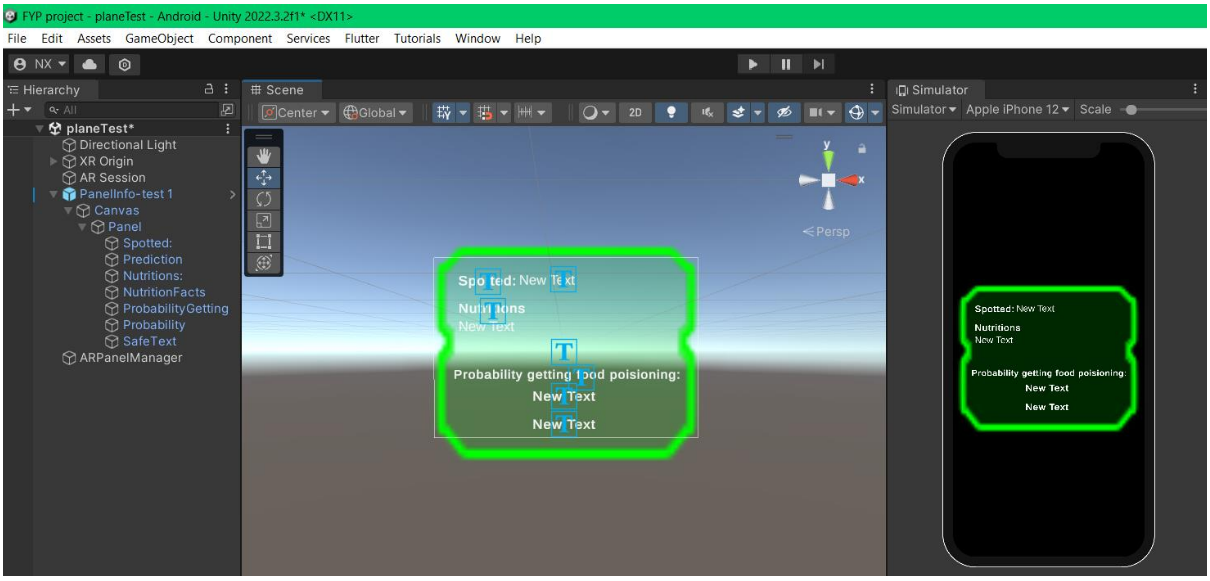


Figure 5.4.3: AR Panel design and configuration in Unity

The prediction data is then sent to Unity, a powerful game engine that handles the augmented reality (AR) presentation. Unity receives the prediction data and generates an interactive AR panel that is displayed on top of the camera view. This AR panel contains the predicted output, displaying the identified food items along with their respective names and confidence scores. Additionally, the panel includes relevant nutrition facts for the recognized food items, providing users with valuable information about their dietary intake. Furthermore, the application calculates the probability of food poisoning based on the identified food items and displays this information in the AR panel, alerting users to potential food safety risks. The AR panel remains fixed in the camera view, allowing users to move their device around and explore the augmented reality experience. This interactive and informative presentation enhances the user's understanding of the scanned food items and raises awareness about nutrition and food safety.

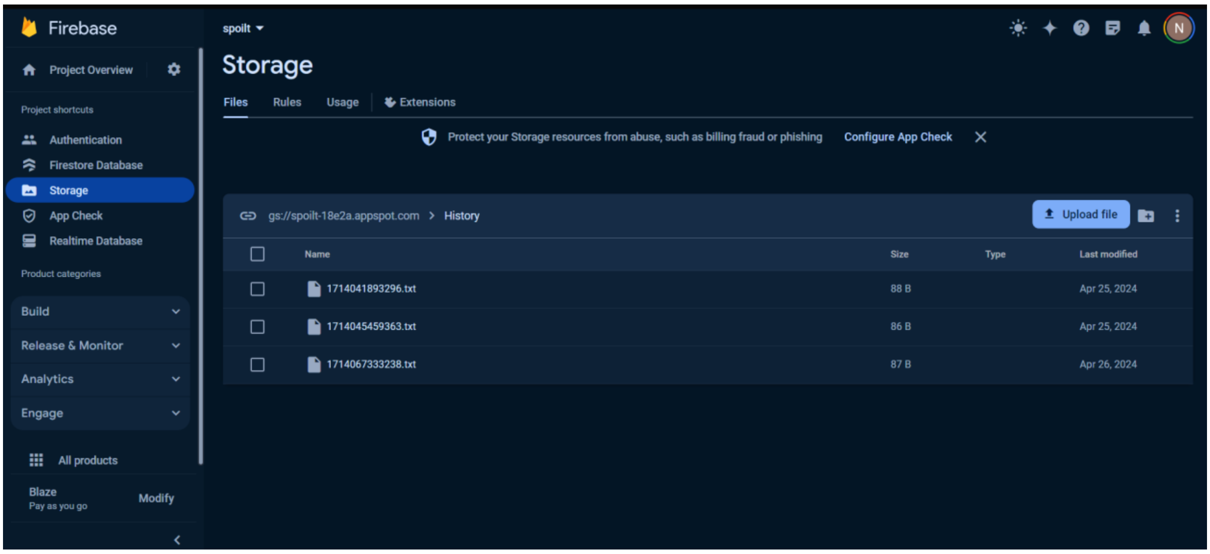


Figure 5.4.4: Store and Fetch Data into Firebase Storage

The application also includes a History screen, where users can access and review their past predictions. The prediction history is stored in Firebase Storage, a secure and scalable cloud storage service provided by Firebase. The History screen retrieves the stored prediction data and displays it to users in a card view format, providing a chronological overview of the food items scanned over time. Users can easily navigate through their prediction history, review the details of each scanned item, and gain insights into their dietary habits and patterns.

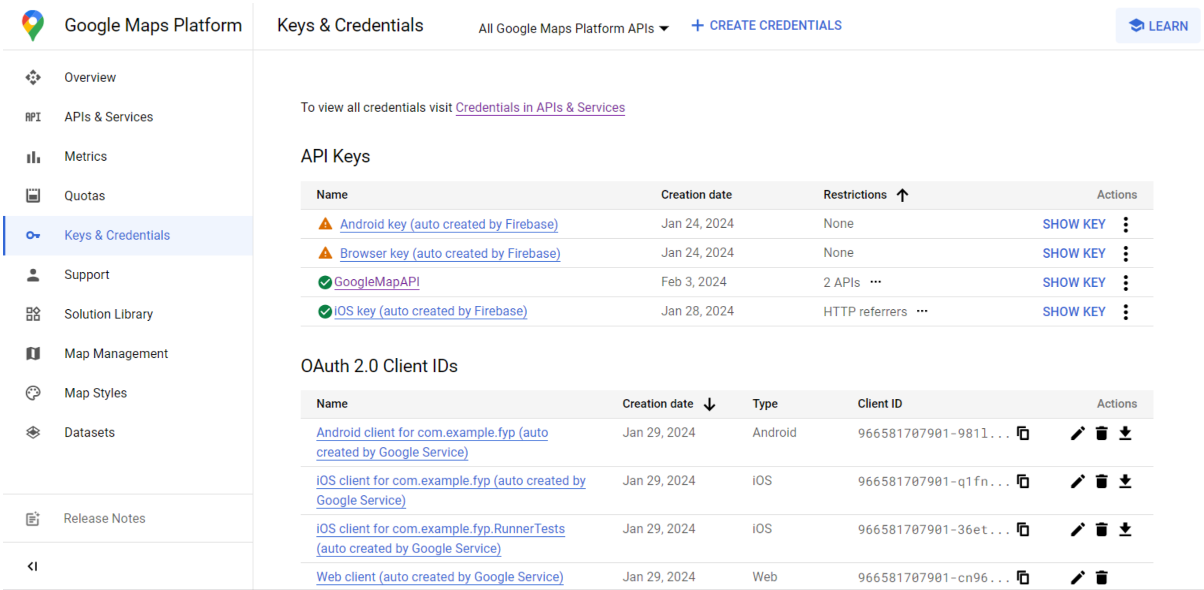


Figure 5.4.5: Integrate Google Maps API into Application

Furthermore, the application features a Nearby News section, which leverages the user's location obtained from the Google Maps API. This section allows users to view and report on food safety issues in their area, fostering a community-driven approach to food safety awareness. Users can access relevant news and reports, as well as contribute their own observations or concerns related to food safety in their local vicinity.

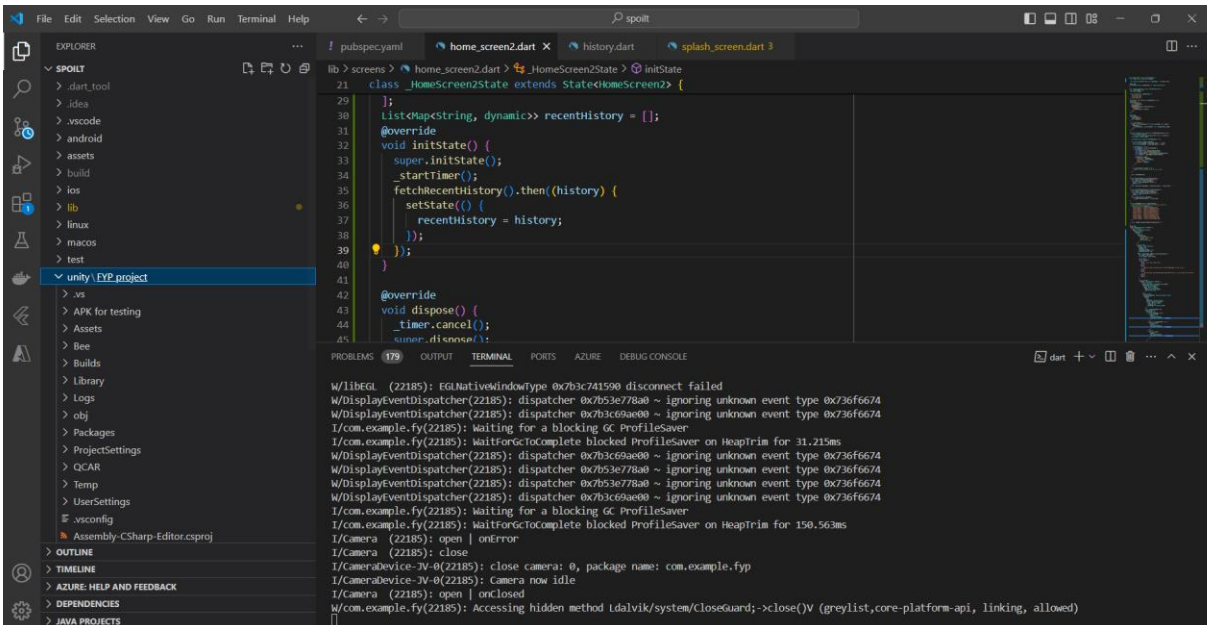


Figure 5.4.6: Integration of Unity to Flutter

Communication between Flutter, the cross-platform UI framework used for building the application, and Unity is facilitated through platform channels. These channels enable seamless integration of the AR presentation into the Flutter UI and facilitate the transfer of prediction data from Flutter to Unity. By leveraging platform channels, the application ensures smooth communication and data exchange between the two frameworks, resulting in a cohesive and integrated user experience.

Overall, the system operation of the application ensures a user-friendly experience with valuable insights into food items scanned by users. By combining advanced technologies such as TensorFlow Lite, Unity, and Firebase, the application provides users with accurate food recognition, interactive AR presentations, nutrition information, food safety assessments, and a comprehensive history of their past scans. Additionally, the Nearby News feature promotes community engagement and awareness regarding food safety issues in the user's local area.

5.5 Implementation Issues and Challenges

5.5.1 Self-learning Unity 3D and C# Scripting

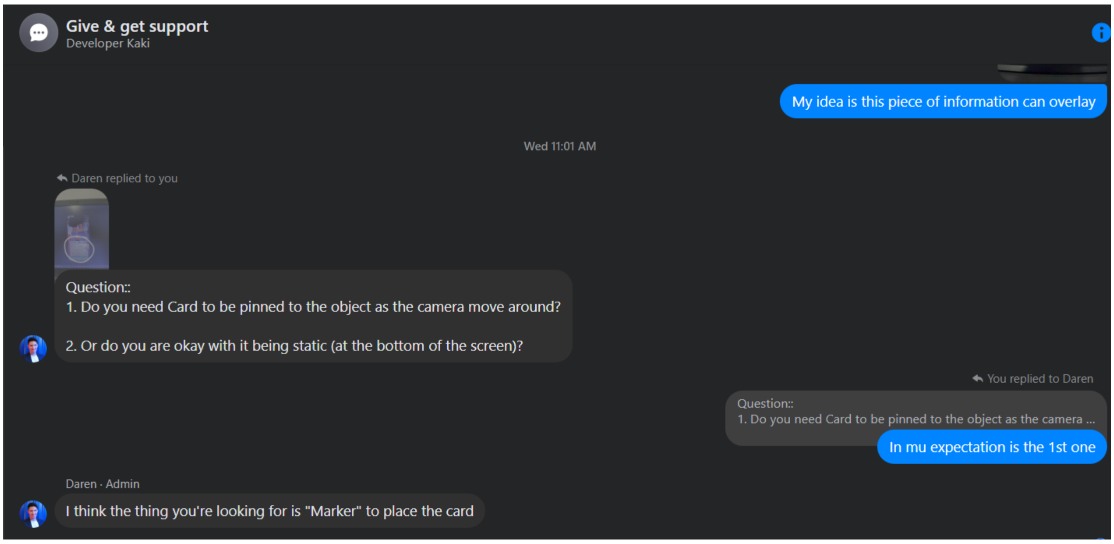


Figure 5.5.1: Asking for Guidance in Online Groups

It was somewhat difficult for me to start my programming career using Unity 3D and C# scripting because I had no prior knowledge of these technologies. I turned to internet resources to get around this challenge, using websites like GitHub repositories for useful examples and YouTube for detailed guidance. I was able to gradually understand the foundations of both C# scripting and Unity 3D thanks to the self-paced learning technique. Active involvement in online groups in Facebook and forums also proved helpful in obtaining advice and support, which promoted a cooperative learning environment.

5.5.2 Object Detection and Classification

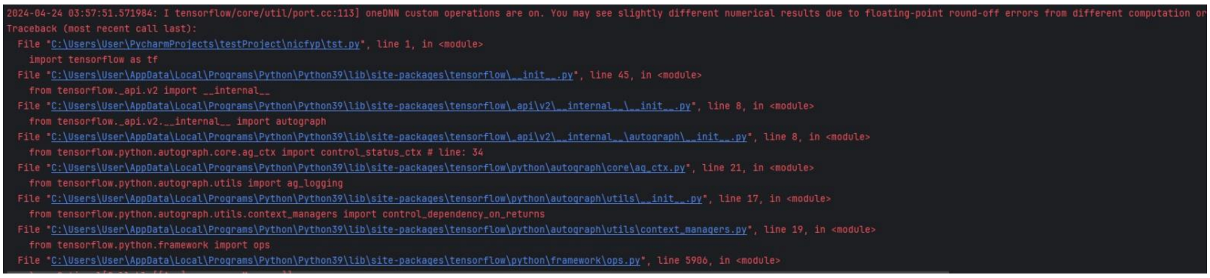


Figure5.5.2 Issues happens to Tensorflow

During the initial phase of the project, I aimed to utilize TensorFlow, a widely acclaimed tool for object detection and classification. However, I encountered significant challenges during the setup process. Despite following numerous guidelines and online tutorials, I repeatedly faced errors indicating that essential modules were not found. This impasse prompted me to explore alternative solutions. One such solution was the adoption of Teachable Machine, a user-friendly web-based tool developed by Google. With Teachable Machine, I was able to train the model using dataset images, a process that proved surprisingly effective. Upon successful training, I exported the model to TensorFlow Lite (TFLite) format, making it compatible with integration into the Flutter application. This alternative approach not only addressed the initial hurdles but also demonstrated the adaptability and versatility required in navigating complex technical challenges.

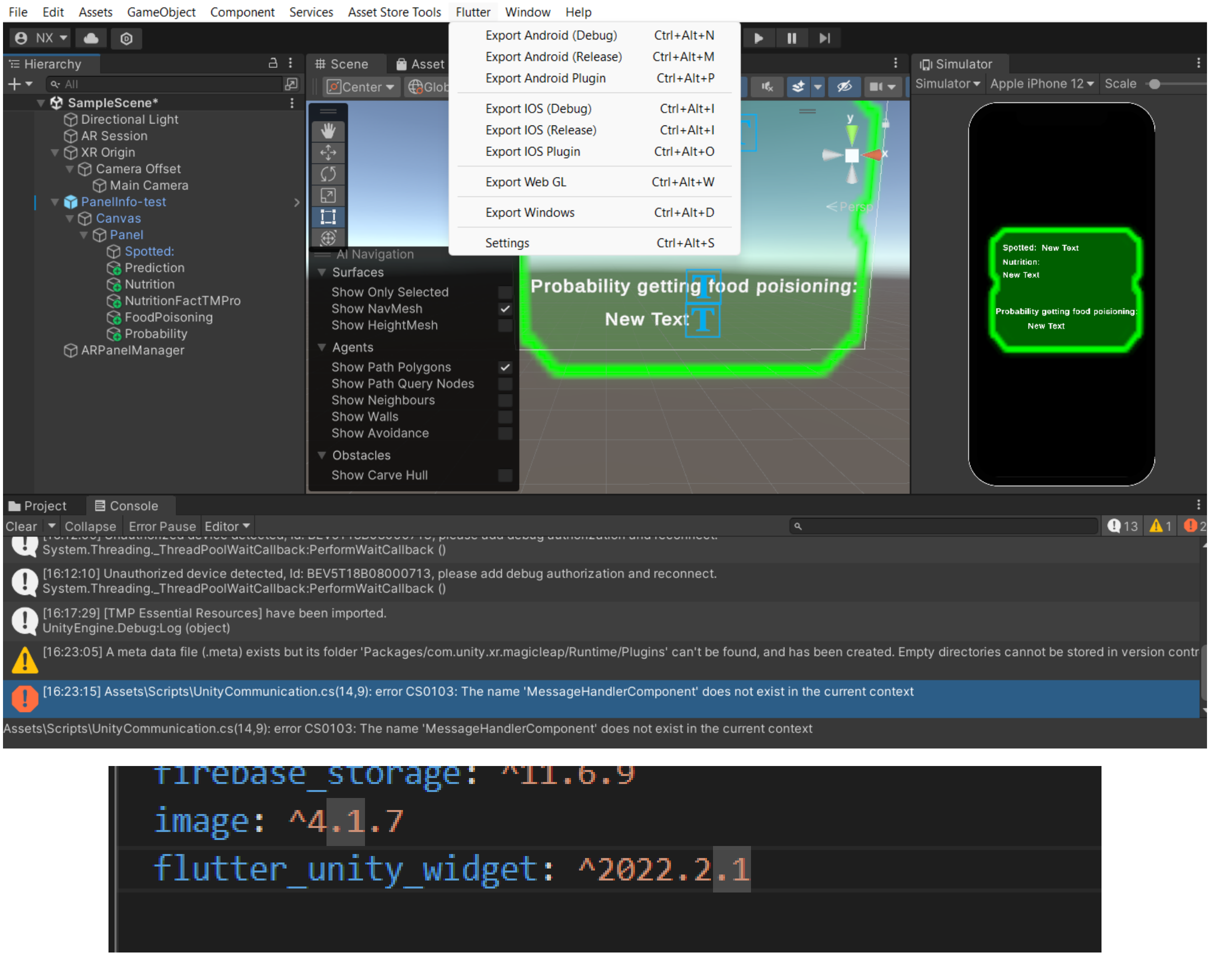


Figure 5.5.3: Issues of Integration Unity to Flutter

5.5.3 Communication Between Flutter and Unity

Integrating Unity's augmented reality (AR) functionality into the Flutter application was a challenging yet rewarding endeavor. One of the key challenges was establishing seamless communication between Flutter and Unity, as they are built on different frameworks and use different programming languages. This required the implementation of robust communication channels to ensure data exchange between the two platforms.

To achieve this, I utilized platform channels in Flutter, which allowed me to communicate with native code on iOS and Android platforms. These platform channels served as a bridge between Flutter and Unity, enabling the passing of data such as prediction results from Flutter to Unity. This was crucial for displaying the prediction data in the AR panel, ensuring that users could see the relevant information overlaid on the real-world objects captured by the camera.

One specific scenario where this communication was essential was when a user pressed the "OK" button to initiate the object detection and classification process. Flutter would send this trigger to Unity through the platform channels, prompting Unity to start the AR presentation and display the prediction results. Additionally, bidirectional communication was enabled, allowing Unity to send any necessary data back to Flutter if required.

By leveraging platform channels and other communication methods, I successfully enabled bidirectional communication between Flutter and Unity, ensuring the seamless integration of AR features into the Flutter application. This enhanced the overall user experience, providing users with an immersive and interactive AR experience within the Flutter app.

5.6 Concluding Remark

In conclusion, the implementation of the project involved a meticulous process of dataset selection, model training, software setup, and system configuration. Despite encountering challenges such as setting up TensorFlow for object detection, learning Unity 3D and C# scripting, and establishing communication between Flutter and Unity, innovative solutions and proactive measures were employed to overcome these obstacles. The application's system operation was designed to provide users with a seamless and engaging experience, offering features such as food recognition, AR presentation, prediction history, and food safety news. Overall, the project demonstrated the successful integration of advanced technologies to create a valuable and user-centric application that enhances food recognition and promotes food safety awareness.

Chapter 6 SYSTEM EVALUATION AND DISCUSSION

6.1 System Testing and Performance Metrics

System testing and performance metrics were conducted to evaluate the accuracy and performance of the FoodAR application. Accuracy per class was measured to assess the model's ability to correctly classify each of the 10 selected food classes. A confusion matrix was generated to visualize the model's performance in classifying each food item and identify any patterns of misclassification. Accuracy per epoch and loss per epoch were monitored throughout the training process to evaluate the model's learning progress over time. These metrics provided valuable insights into the effectiveness of the object detection and classification model, helping to identify areas for improvement and optimize the application's performance.

6.1.1 Accuracy per Class

Accuracy per class

CLASS	ACCURACY	# SAMPLES
Fresh Apples	1.00	254
Rotten Apples	1.00	413
Fresh Banana	1.00	236
Rotten Banana	1.00	380
Fresh Oranges	1.00	220
Rotten Oranges	1.00	240
Fresh Tomato	0.99	279
Rotten Tomato	0.99	274
Fresh Carrot	0.89	93
Rotten Carrot	0.99	87

Figure 6.1.1 Accuracy per Class

This image shows the accuracy and the number of samples for different classes in a classification task. The classes include fresh and rotten fruits/vegetables like apples, bananas, oranges, tomatoes, and carrots. The accuracy for most classes is 1.00 (100%), except for Fresh Tomato (0.99) and Fresh Carrot (0.89). The number of samples varies across classes, with Rotten Apples having the highest (413) and Fresh Carrot the lowest (93) number of samples.

6.1.2 Confusion Matrix

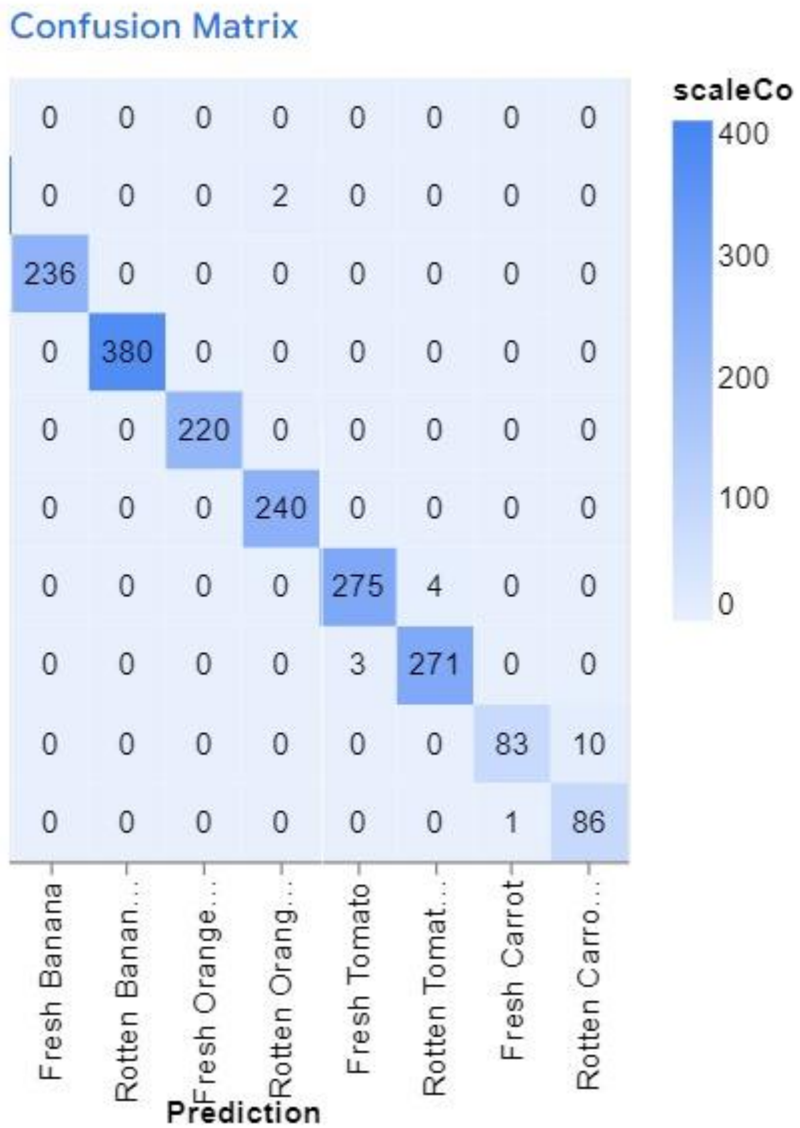


Figure 6.1.2 Confusion Matrix

The confusion matrix provides a visual representation of the model's predictions against the true labels. The diagonal elements (top-left to bottom-right) represent the correctly classified instances for each class. The off-diagonal elements indicate misclassifications. In this case, the model has performed reasonably well, with most instances correctly classified, except for a few misclassifications between Fresh Tomato and Rotten Tomato, and between Fresh Carrot and Rotten Carrot.

6.1.3 Accuracy per Epoch

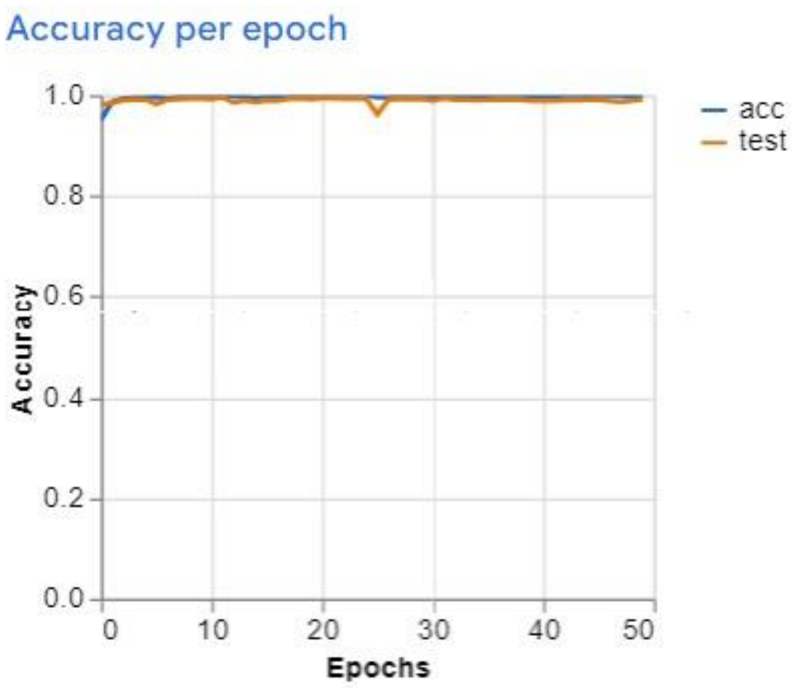


Figure 6.1.3 Accuracy per Epoch

This graph shows the training accuracy (acc) and validation/test accuracy (test) of the model over multiple epochs (iterations) during the training process. The x-axis represents the epoch number, and the y-axis represents the accuracy. Both training and validation accuracy curves start low and gradually improve as the model learns from the data. Towards the end, the training accuracy reaches nearly 1.0 (100%), while the validation accuracy plateaus slightly lower.

6.1.4 Loss per Epoch

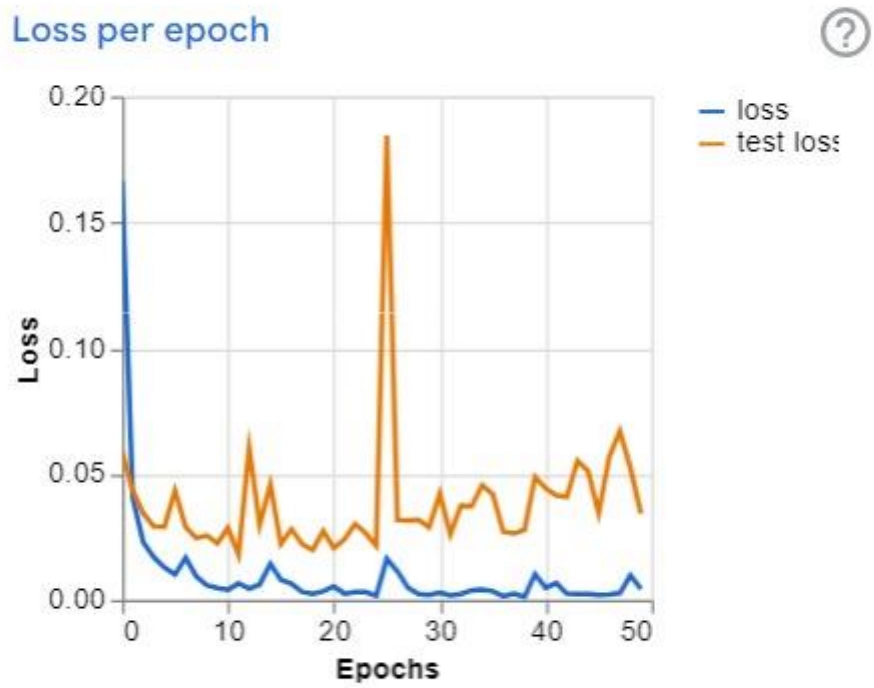


Figure 6.1.4 Loss per Epoch

This graph depicts the training loss (loss) and validation/test loss (test loss) of the model over multiple epochs during training. The x-axis represents the epoch number, and the y-axis represents the loss value. Initially, both training and validation losses are high but decrease as the model learns from the data. The training loss decreases more rapidly than the validation loss, and towards the end, the validation loss stabilizes at a higher value compared to the training loss, again indicating some overfitting.

Overall, these images provide insights into the performance of a classification model trained on a dataset of fresh and rotten fruits/vegetables. The model appears to perform well, with high accuracy for most classes, but some misclassifications and overfitting are evident.

6.2 Testing Setup and Result

6.2.1 Security Testing

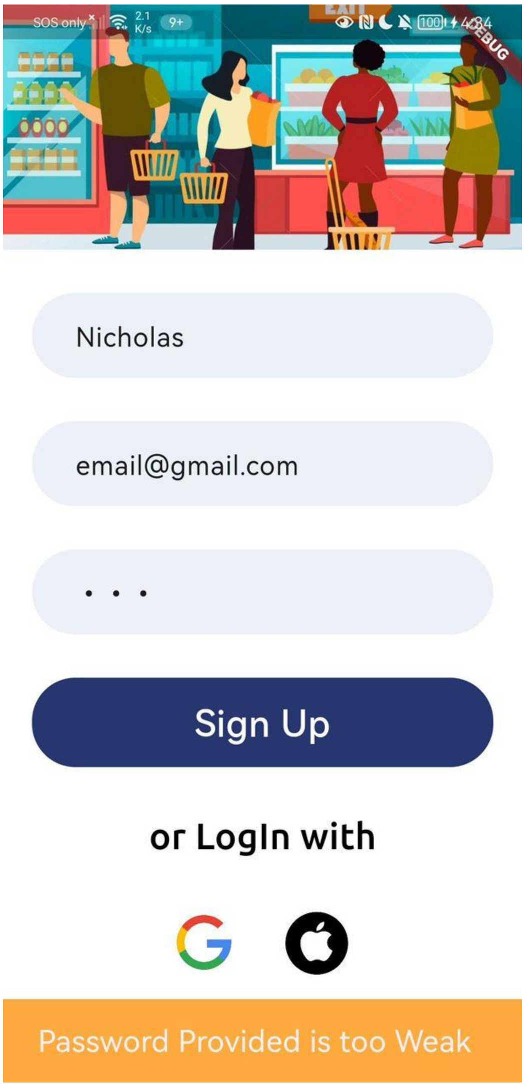


Figure 6.2.1 Security Testing

To enhance the security of the FoodAR application, specific measures have been implemented to mitigate potential vulnerabilities and security risks, particularly concerning user data and communication between Flutter and Unity. One crucial aspect of security testing involves checking the strength of passwords provided by users during the registration process. When a new user attempts to register with a weak password, the system detects this and prompts the user to choose a stronger password. This proactive approach helps prevent unauthorized access to user accounts and ensures that passwords meet minimum security standards.

Additionally, the application checks for duplicate email addresses during the registration process to prevent multiple accounts from being created using the same email. If an email address is found to be already in use, the system notifies the user, preventing the creation of duplicate accounts and helping maintain the integrity of user data.

These security measures are essential for protecting user data and ensuring the overall security of the FoodAR application. By implementing these checks and notifications, the application provides users with a secure environment for managing their accounts and interacting with the AR features seamlessly.

6.2.2 Component Testing

Figure 6.2.2.1: Splash Screen

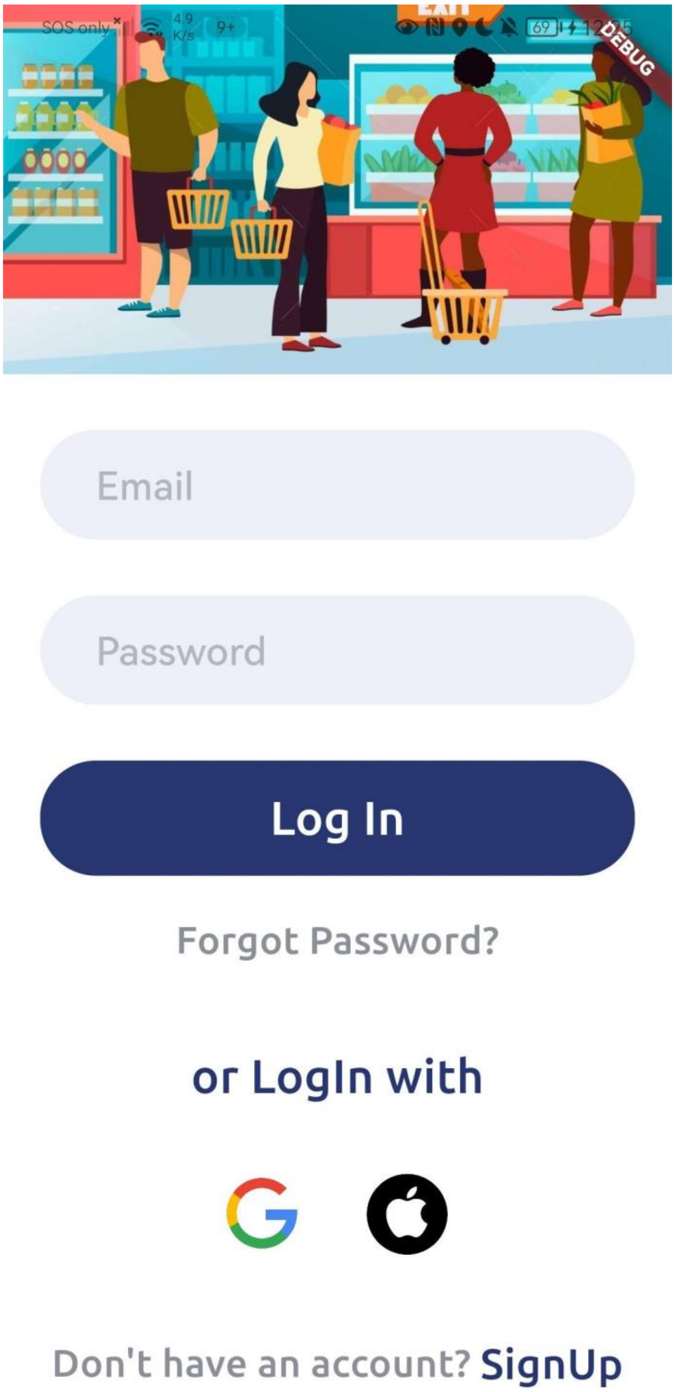


Figure 6.2.2.2: Login Screen

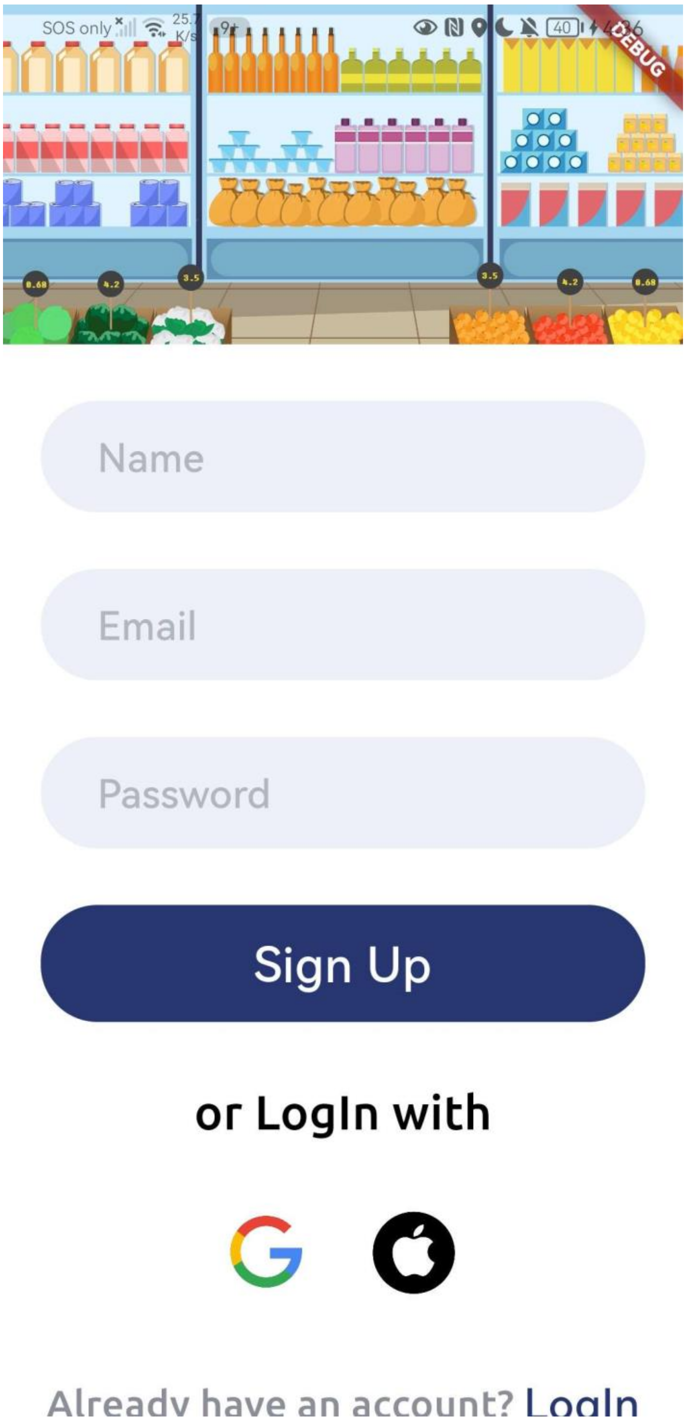


Figure 6.2.2.3: Sign up Screen

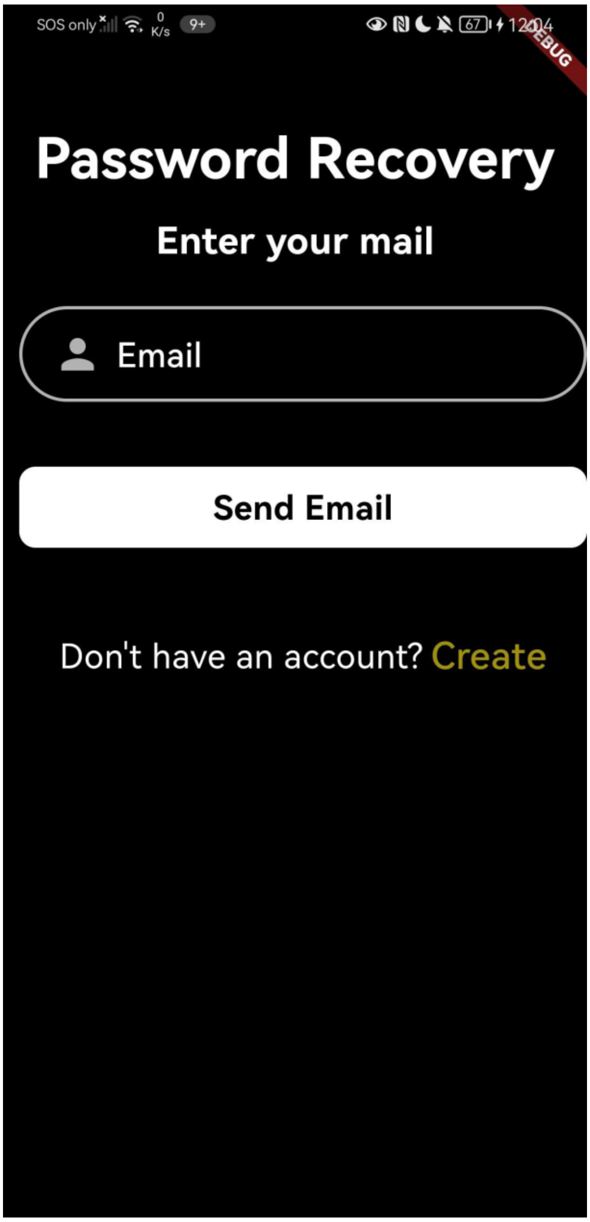


Figure 6.2.2.4: Forgot Password Screen

The application undergoes thorough component testing to ensure that every component functions correctly. The SplashScreen, appearing for 5 seconds, transitions smoothly to the LogIn screen, indicating that the initial setup is successful. Users can seamlessly log in using their email and password, Google SignIn, or Apple SignIn, verifying that authentication processes are functioning as intended. For users who have forgotten their password, the Forgot Password screen allows them to reset their password via email, demonstrating the system's ability to handle password recovery requests effectively.

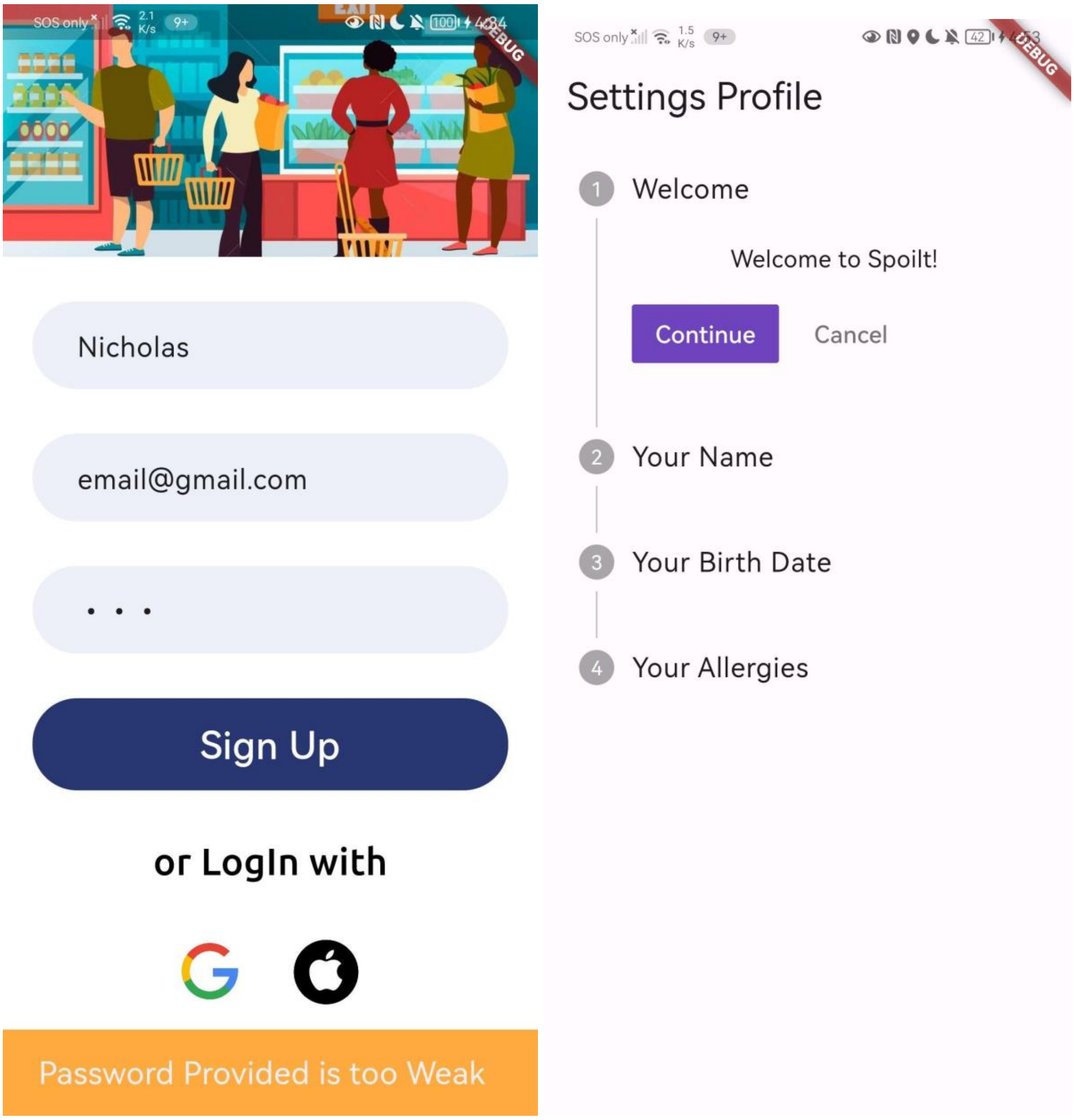


Figure 6.2.2.5: Sign Up screen with Snackbar prompt and Setting Profile Screen

The Sign Up process includes regex checks for password strength and email availability, ensuring that user registration is secure and reliable. Upon successful registration, users are directed back to the LogIn screen, confirming that the registration flow is complete and accurate. First-time users are guided to the Setting Profile screen to input their personal information, including name, date of birth, and allergies. This step ensures that user data is captured accurately for personalized experiences. After completing their profile, users are seamlessly redirected to the Home screen, indicating that user profile management is functioning as expected.

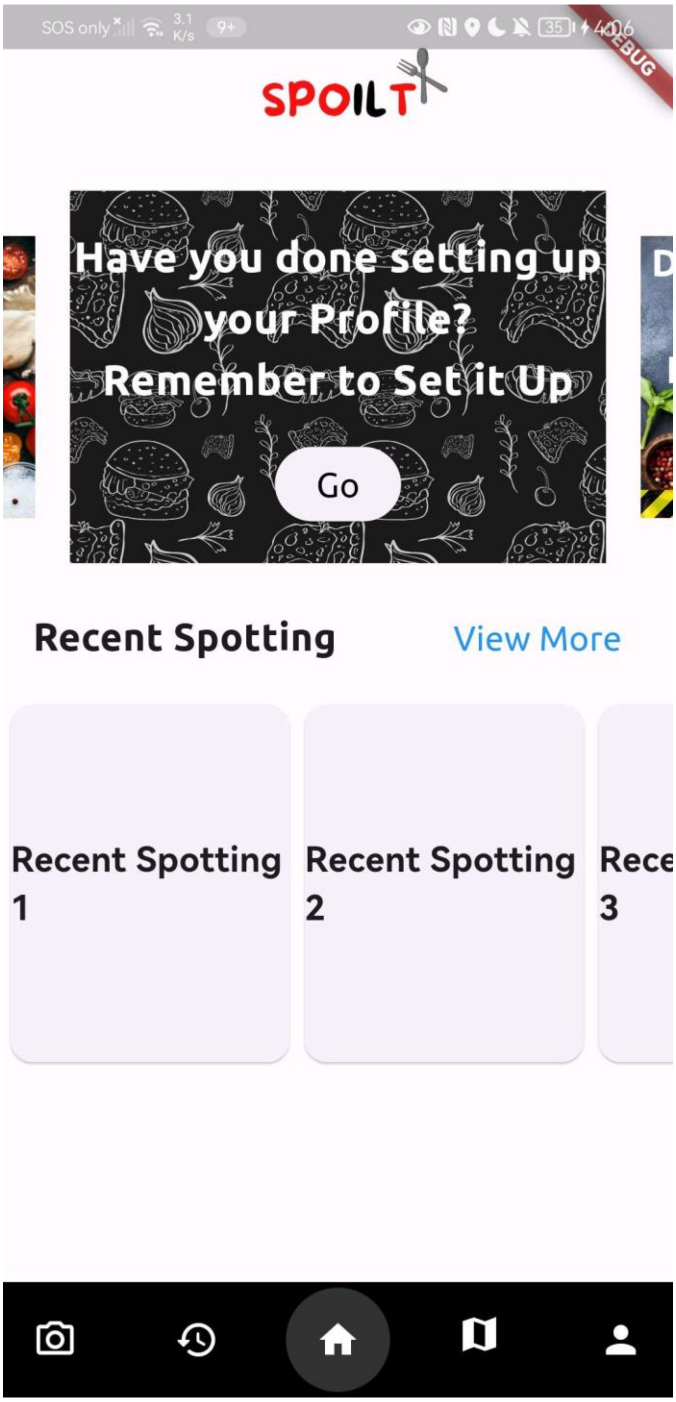


Figure 6.2.2.6: Home Screen

The Home screen's carousel slider and card interactions provide a visually engaging experience, indicating that the UI components are responsive and interactive. The Recent Spotting section displays the most recent history data, demonstrating that data retrieval and display components are functioning correctly.

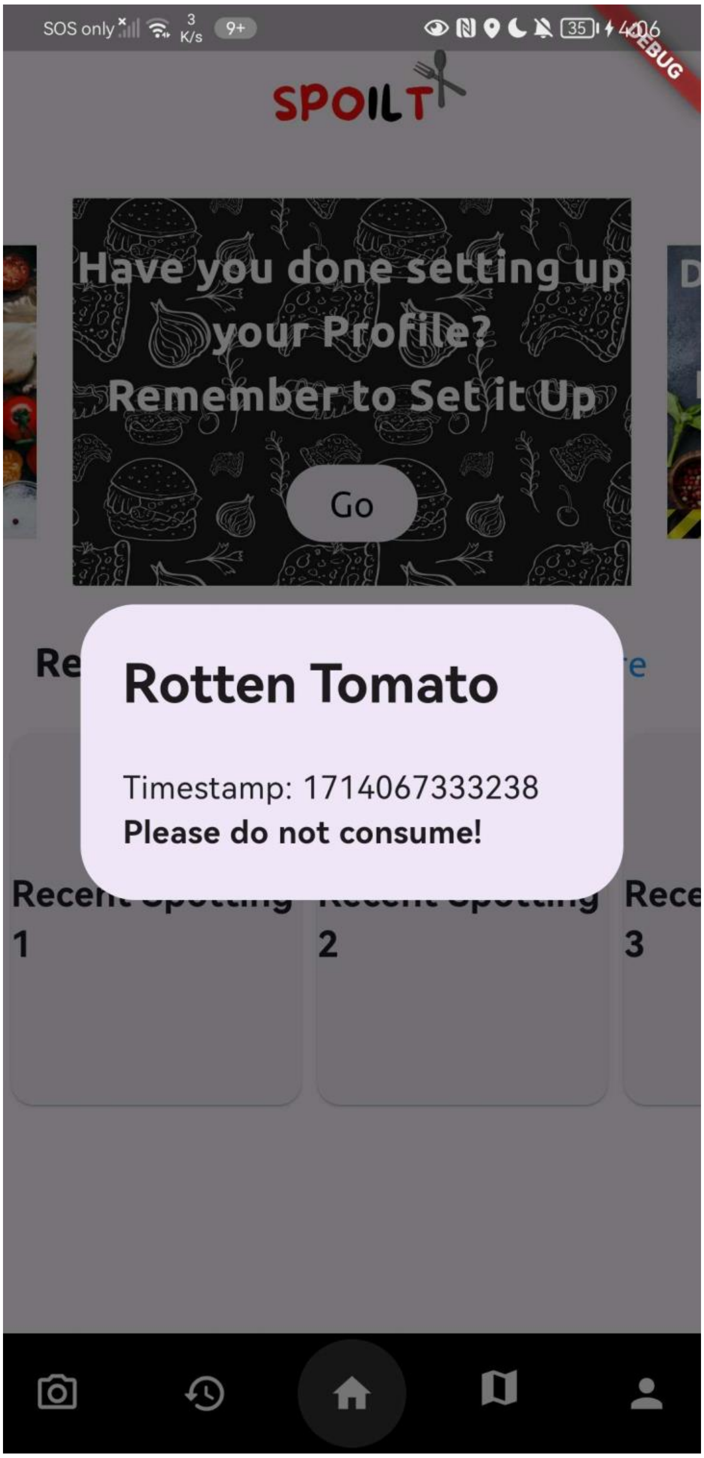


Figure 6.2.2.7: Home Screen Cards

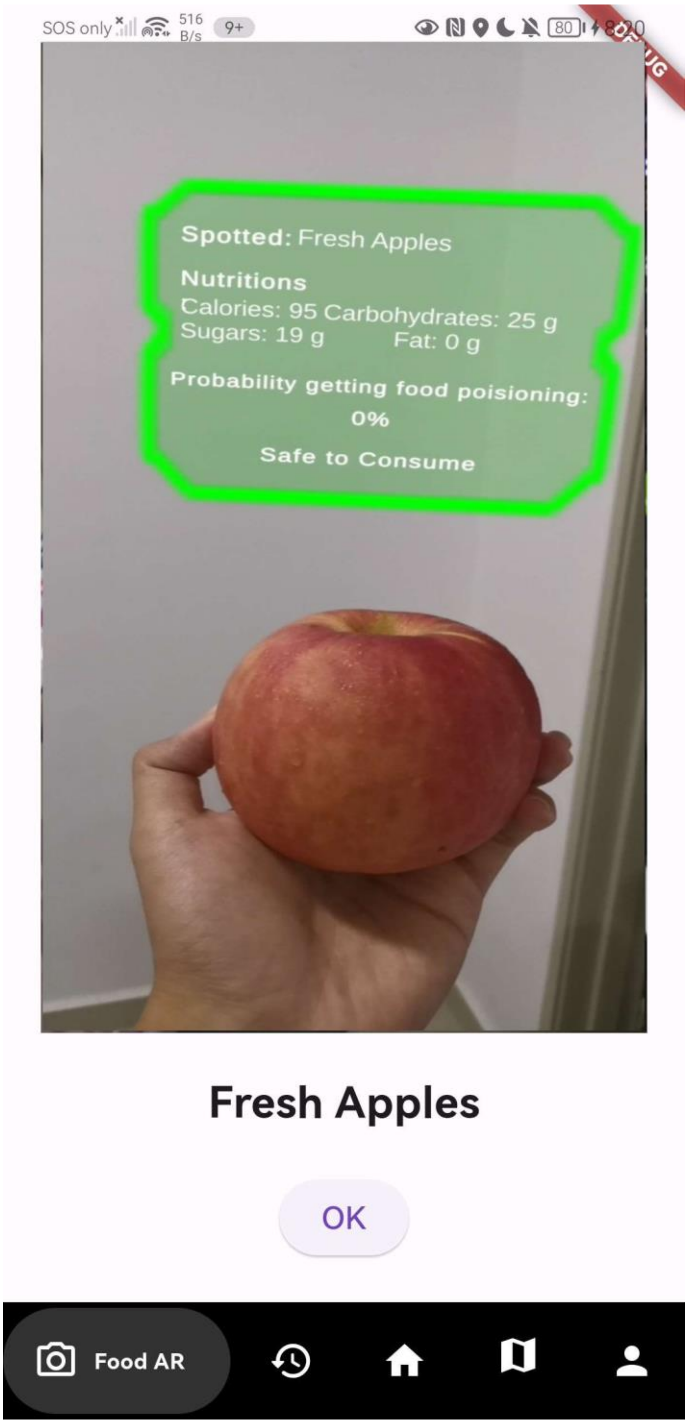


Figure 6.2.2.8: Food AR Screen with Prediction

In the Food AR Screen, users can spot fruits or vegetables, with the AR presentation confirming that the AR functionality is operational.

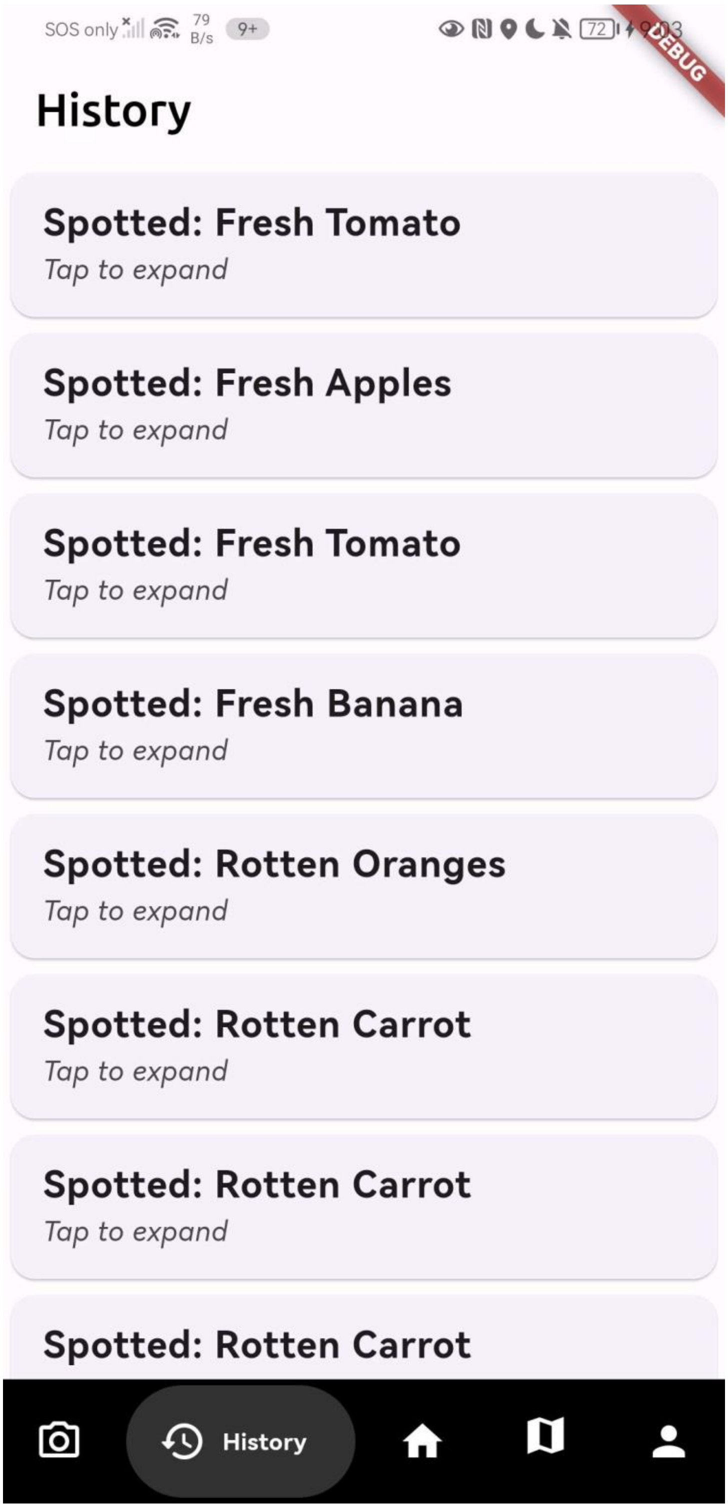


Figure 6.2.2.9: History Screen

The History screen displays past spotted items and their nutrition facts, verifying that data retrieval and display components work accurately.

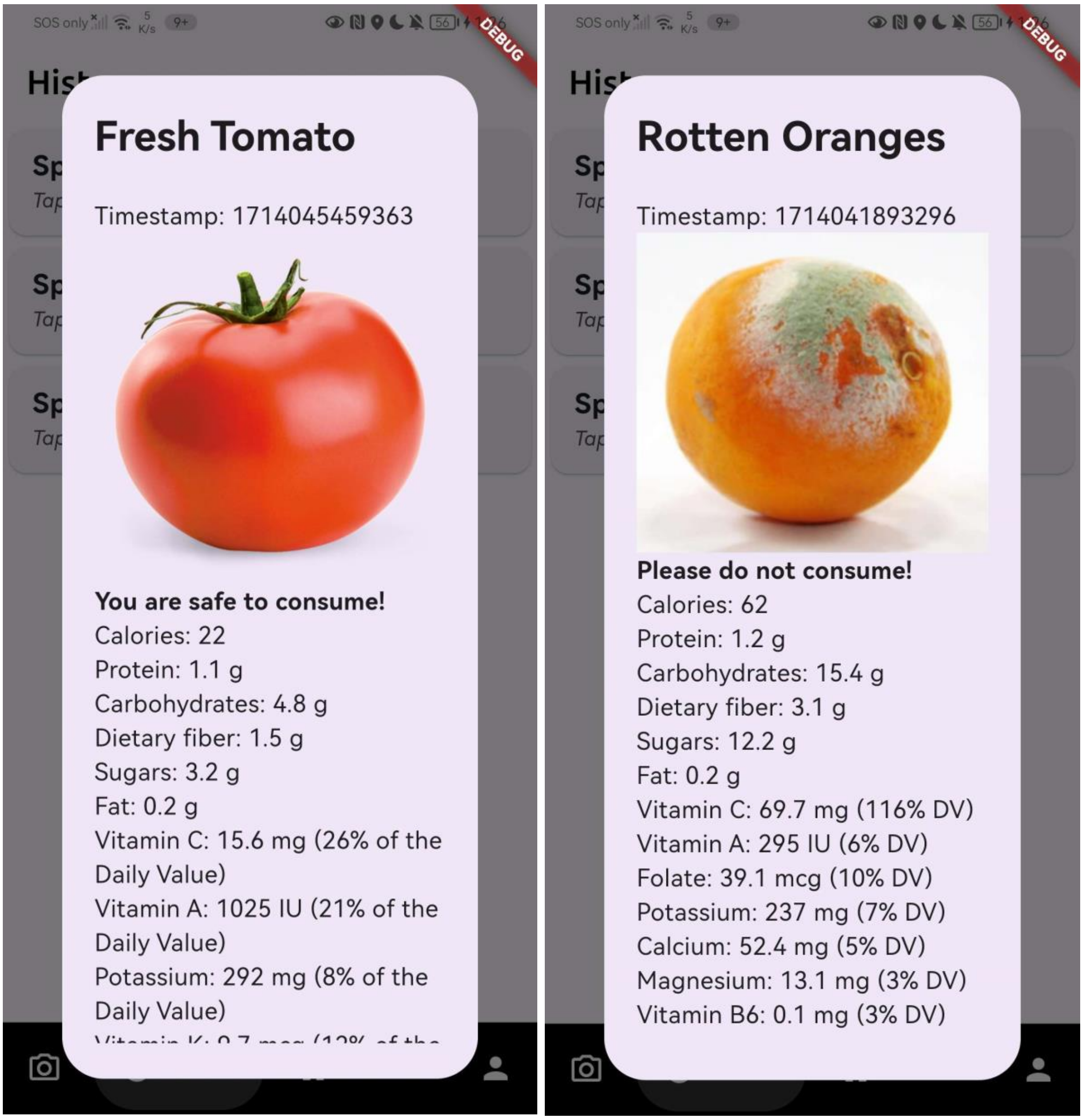


Figure 6.2.2.10: History Screen Cards Detail

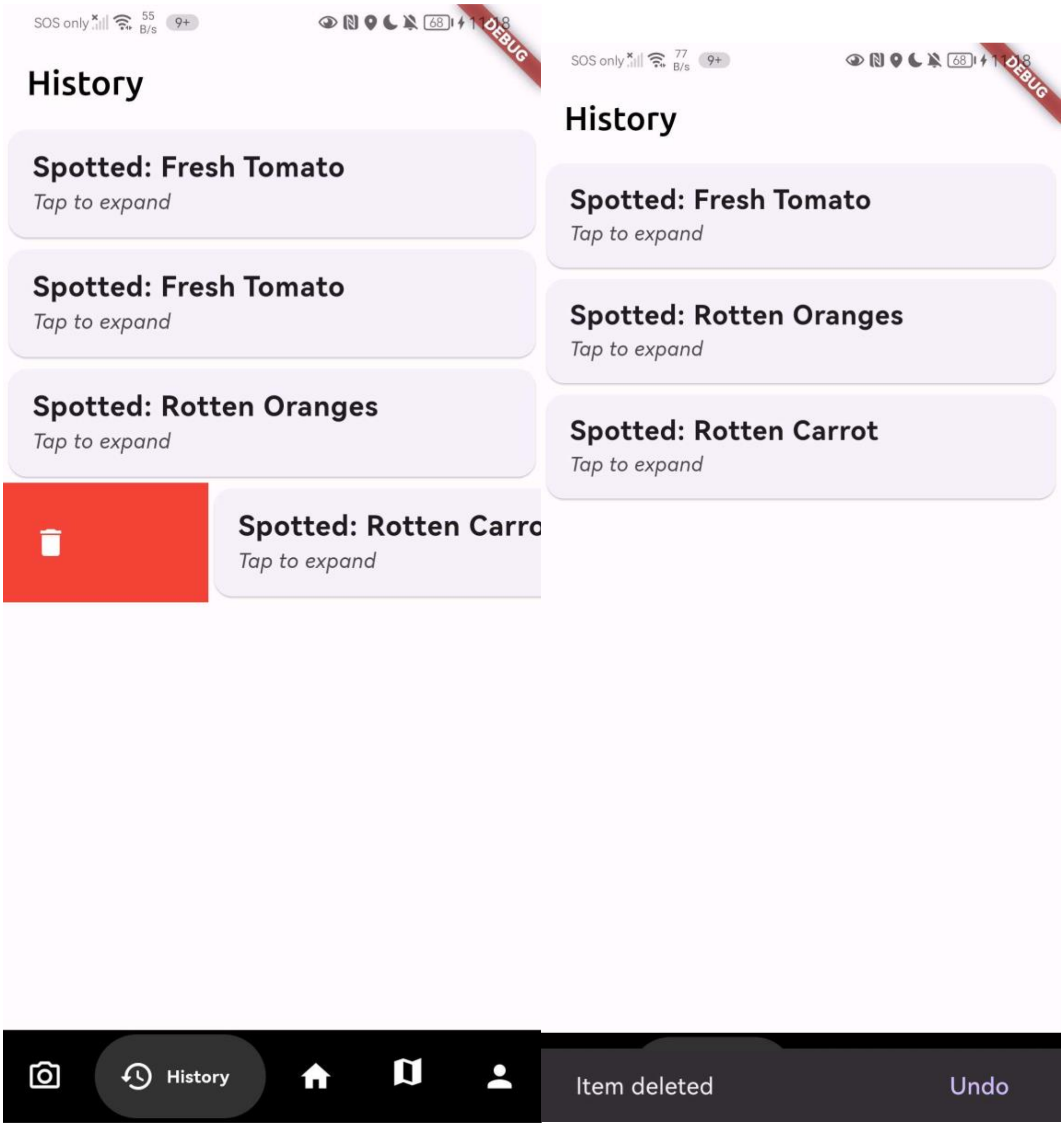


Figure 6.2.2.11: History Screen Delete Card functionality

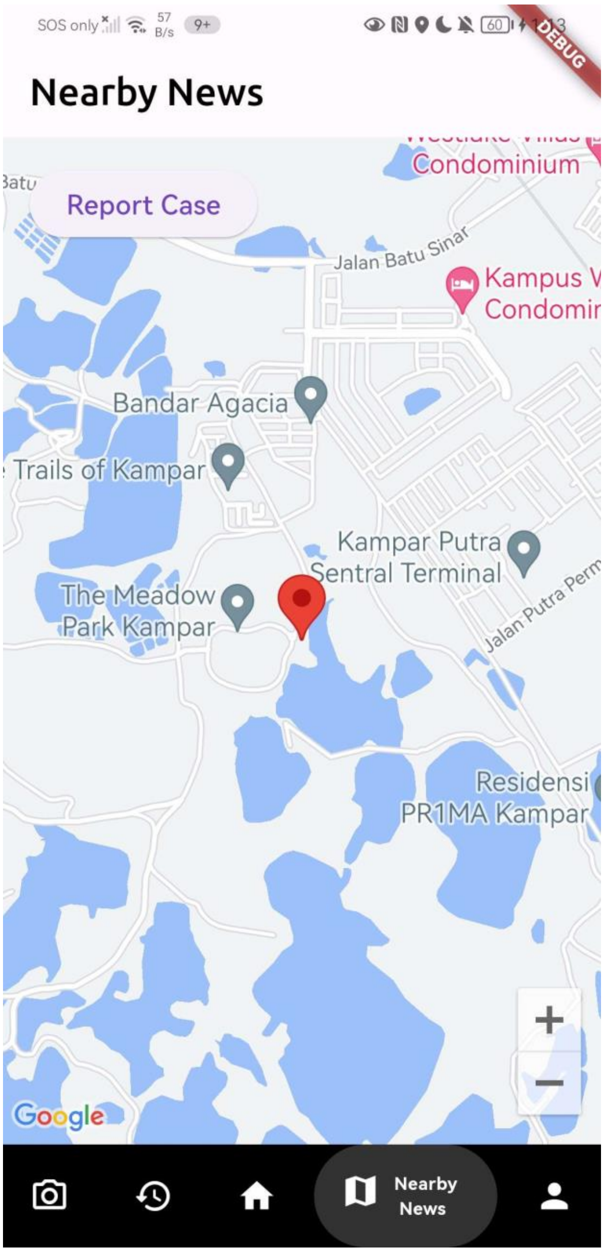


Figure 6.2.2.12: Nearby News Screen

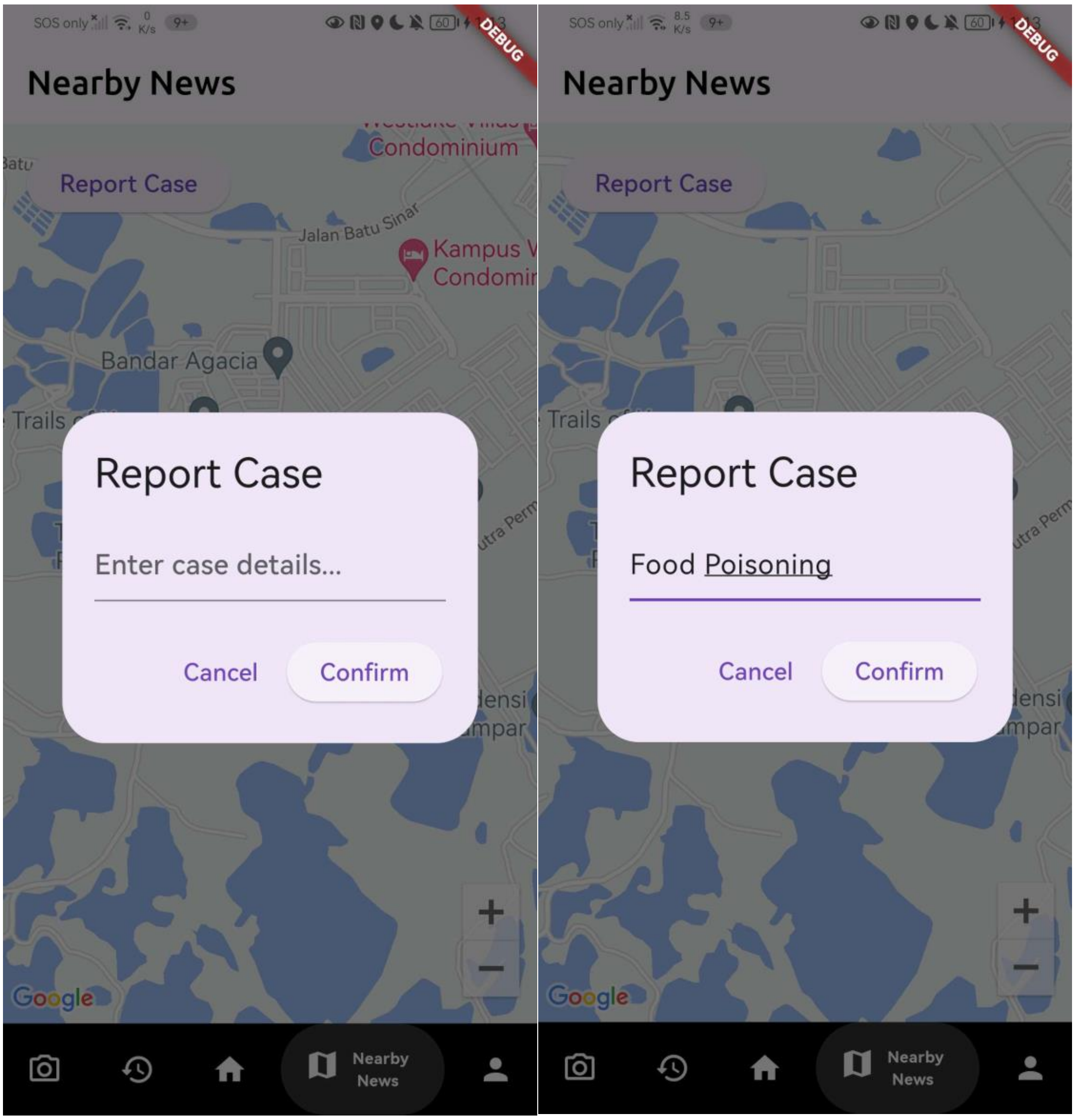


Figure 6.2.2.13: Nearby News Screen Report Case

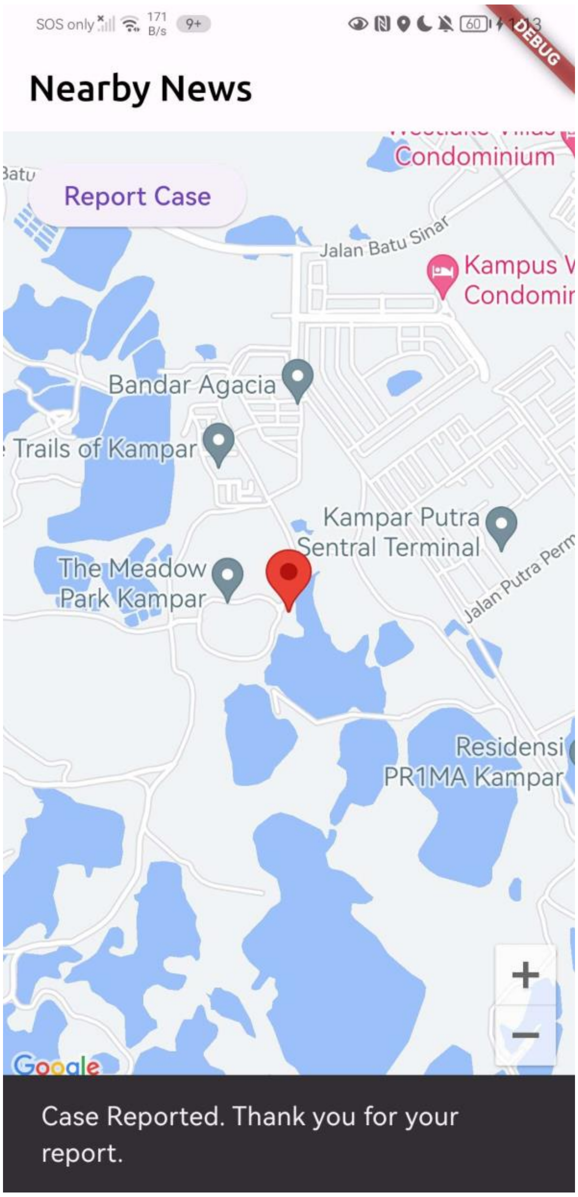
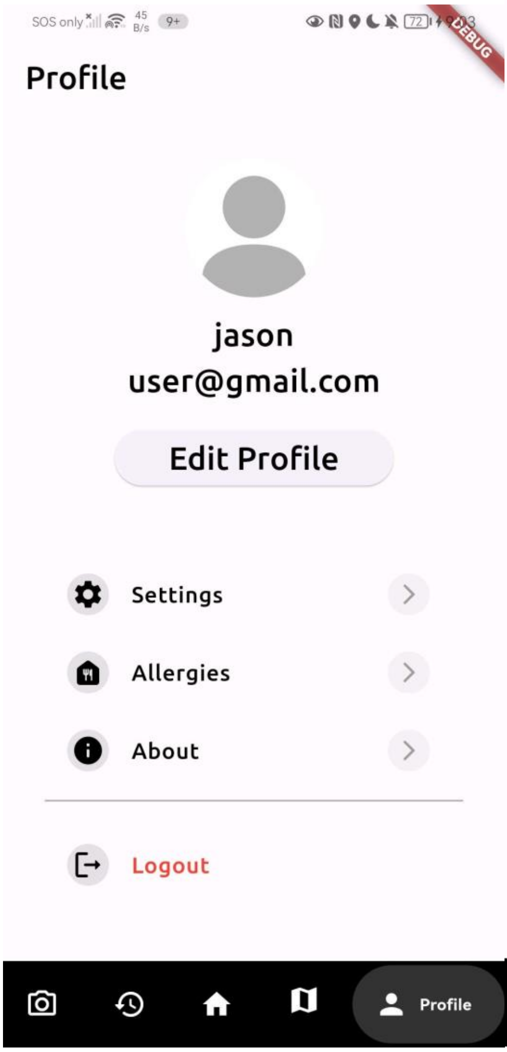


Figure 6.2.2.14: Nearby News Screen Case Reported



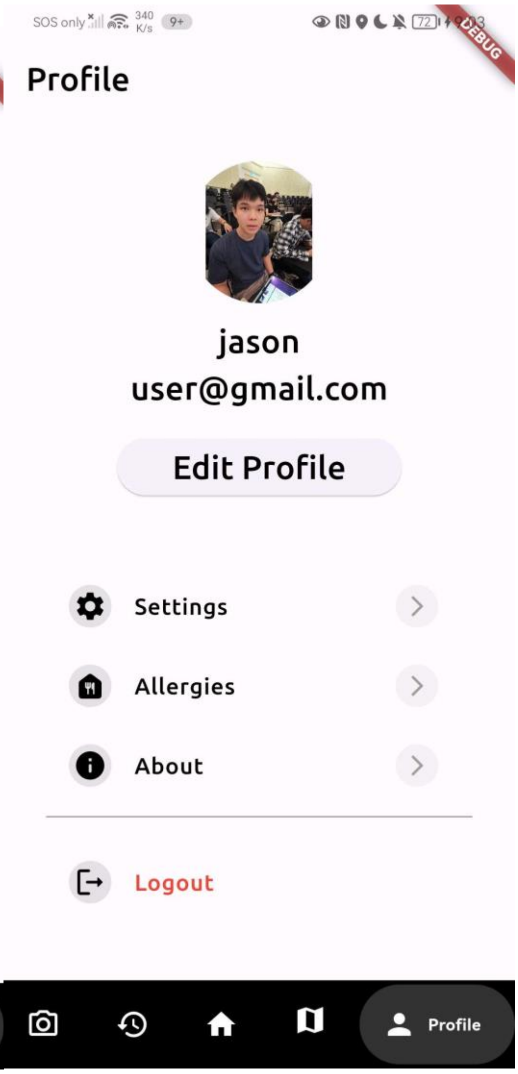


Figure 6.2.2.15: Profile Screen Before and After Upload Profile Image

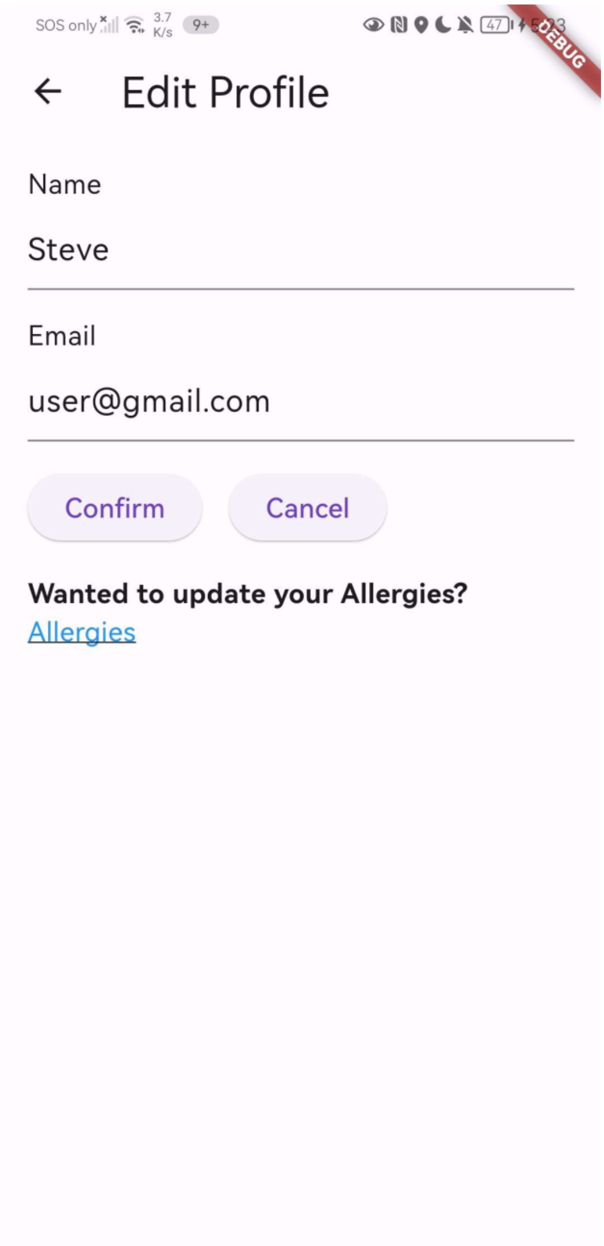


Figure 6.2.2.16: Edit Profile Screen

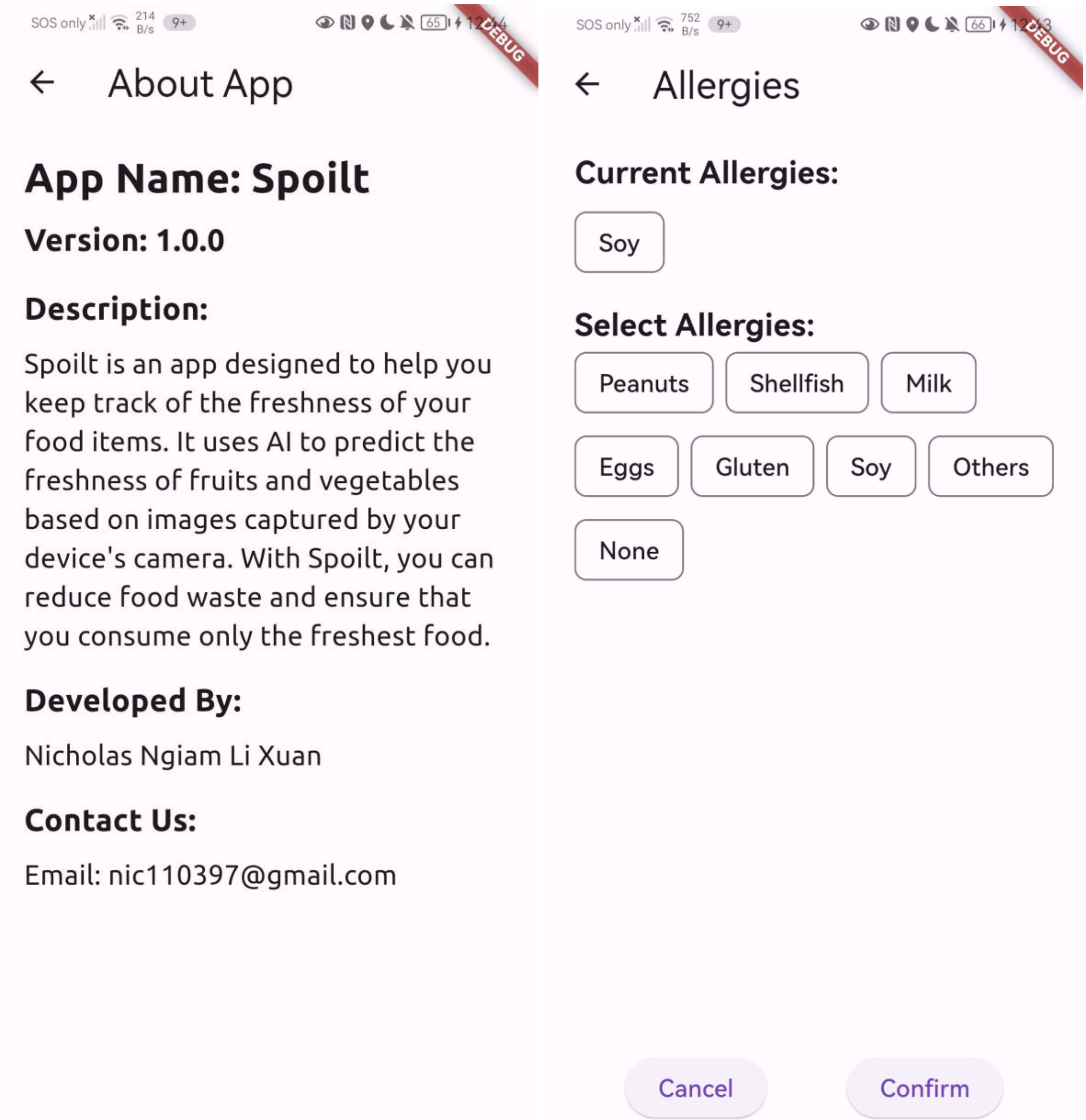


Figure 6.2.2.16: About Screen & Allergies Screen

The Nearby News section allows users to report food-related issues, with the system prompting a confirmation snackbar upon successful reporting, confirming that reporting functionalities are operational. The Profile screen displays user information and allows for profile photo updates, indicating that profile management features are functioning correctly. The Edit Profile and Allergies sections allow users to manage their profile and allergies, with notifications prompting appropriately when allergens are spotted in the Food AR screen, confirming that notification features are working as intended.

Overall, component testing ensures that each aspect of the application functions seamlessly, providing users with a reliable and engaging experience.

6.3 Project Challenges

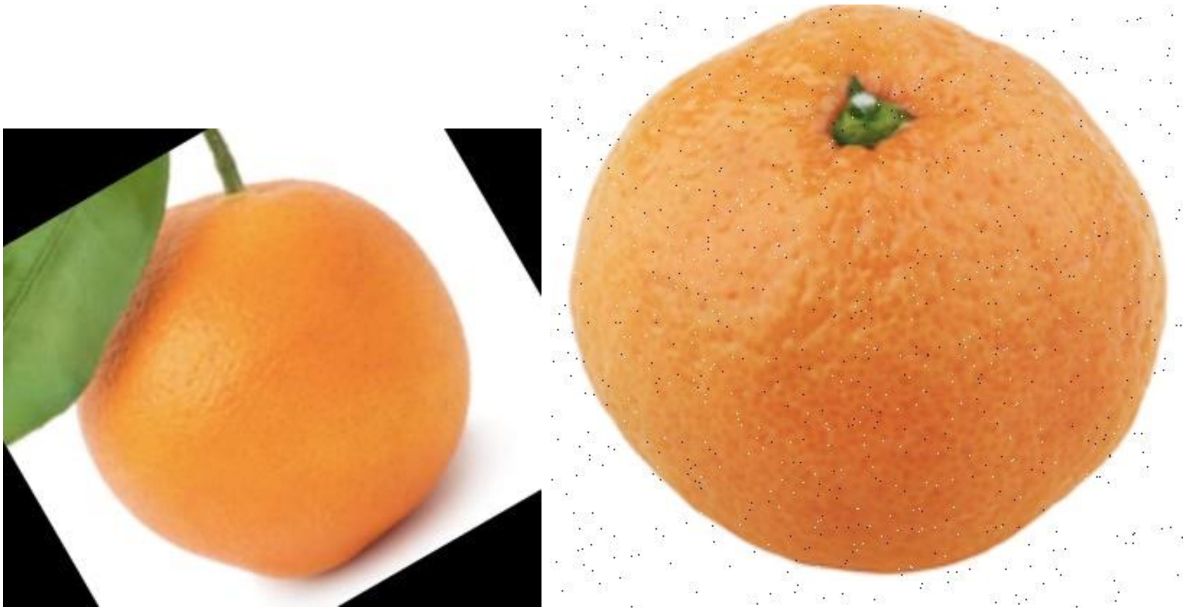


Figure 6.3 Example of transformation of image

One of the primary challenges encountered in the project was the insufficiency of images in the dataset for certain classes, particularly for items like carrots. The images in these classes underwent several transformations, such as random cropping, rotation, salt and pepper noise, and vertical and horizontal swaps. These transformations affected the quality of the features extracted from the images, leading to a decrease in the accuracy of classifying carrots, whether they were fresh or rotten. This underscored the critical importance of having a diverse and well-curated dataset to improve the accuracy and robustness of the classification model.

Another significant challenge was the limited number of classes available for classification. While the selected dataset provided a good starting point, it became apparent that additional datasets would be necessary to include more classes of fruits and vegetables. Expanding the range of classes would not only enhance the accuracy and performance of the classification model but also make the application more comprehensive and useful for users.

Furthermore, the application's current restriction to the English language posed a challenge in terms of accessibility and user engagement. To address this limitation, implementing multi-language support could significantly improve the user experience and broaden the application's appeal to a more diverse audience. By enabling users from different linguistic backgrounds to use the application in their preferred language, it would enhance usability and make the application more inclusive and user-friendly.

6.4 Objectives Evaluation

The project's objectives were evaluated based on the successful implementation of key features and functionalities, as well as the challenges encountered and lessons learned throughout the development process. Firstly, the primary objective of implementing object detection and classification using TensorFlow Lite was achieved, marking a significant milestone in the project's development. The selected dataset provided a solid foundation for training the model, but challenges arose when certain classes, such as carrots, lacked sufficient images for effective training. This resulted in lower accuracy for carrot classification, highlighting the importance of dataset quality and diversity in machine learning models. Despite these challenges, the model performed admirably in classifying fresh and rotten fruits and vegetables, meeting the primary goal of the project.

Secondly, the successful integration of augmented reality (AR) presentation with Flutter was a major achievement. Unity was utilized to create an AR panel that effectively displayed prediction outputs, nutrition facts, and food poisoning probabilities. Communication between Flutter and Unity was established using platform channels, enabling seamless data exchange and enhancing the user experience with AR features within the Flutter application. This integration not only met the project's objectives but also showcased the versatility and compatibility of Flutter and Unity in creating immersive and interactive experiences for users.

Thirdly, the implementation of Firebase for user management and data storage was another key success. Firebase authentication ensured secure user authentication, while Firebase database and storage were used for storing user information and prediction history, respectively. This integration facilitated efficient data management and seamless integration with the application's features, enhancing the overall user experience and meeting the project's usability goals.

Furthermore, the development of a user-friendly interface was a critical objective that was successfully met. The application features a simple and intuitive user interface, allowing users to navigate between screens easily and access various features without complications. The integration of AR presentation into the interface was seamless, enhancing the overall user experience and meeting the project's usability goals.

However, the objective of ensuring security and privacy, while partially achieved, requires further attention. Measures were taken to secure user data and communication between Flutter and Unity, but additional testing and evaluation are necessary to identify and mitigate any vulnerabilities or security risks.

In conclusion, the project has successfully achieved its objectives, providing users with a comprehensive and user-friendly application for detecting food freshness using object detection and classification, augmented reality presentation, and Firebase integration. Further enhancements and improvements can be made based on user feedback and additional testing to ensure the application's security and privacy. The challenges faced and lessons learned throughout the development process have contributed to a deeper understanding of the technologies involved and will inform future projects in similar domains.

6.5 Concluding Remark

Based on the conducted system testing and performance metrics evaluation, the FoodAR application has demonstrated promising accuracy and performance in its key functionalities. The accuracy per class analysis revealed high accuracies for most food classes, indicating the model's effectiveness in classifying fresh and rotten fruits and vegetables. The confusion matrix provided further insights into the model's performance, highlighting some misclassifications that could be addressed in future iterations. The accuracy per epoch and loss per epoch graphs depicted the model's learning progress over time, showing a steady improvement in accuracy and a decrease in loss.

These performance metrics indicate that the object detection and classification model, as well as the overall application, have been successfully implemented and are functioning as intended. The results of the system testing, and performance evaluation validate the effectiveness of the machine learning and augmented reality technologies used in the application. Further refinement and optimization could enhance the application's performance and user experience, but overall, the project has achieved its objectives and demonstrated the feasibility of using these technologies for food freshness detection.

Chapter 7 CONCLUSION AND RECOMMENDATION

7.1 Conclusion

Having successfully implemented the AR feature into our mobile application for food inspection, our team embarked on a comprehensive analysis of AR-enabled raw material detection. The primary goal was to evaluate the accuracy and effectiveness of detection and AR overlay information, focusing on enhancing user experience and providing valuable insights into food items.

The integration of AR technology into our application proved to be a significant milestone, allowing users to inspect food items using their mobile devices. This feature not only enhances the user experience but also provides a visually engaging and interactive inspection process, setting our application apart in the market.

Our thorough analysis of AR-enabled raw material detection yielded promising results. The AR technology accurately detected various types of raw materials, including fruits and vegetables, and provided users with real-time information and insights. This accuracy and efficiency are crucial in ensuring that users can make informed decisions about their food items.

Furthermore, our evaluation of the accuracy and effectiveness of detection and AR overlay information showed positive outcomes. The AR overlay information, such as freshness predictions and nutrition facts, proved to be accurate and valuable for users, enabling them to make informed decisions about the food they consume.

In conclusion, the FoodAR project has successfully developed an innovative application that combines machine learning, augmented reality, and Firebase integration to detect and classify the freshness of fruits and vegetables. Despite encountering challenges such as dataset limitations and language support, the project has demonstrated its potential to enhance food inspection processes significantly.

Moving forward, the FoodAR project can be further enhanced by expanding the dataset to include more classes of fruits and vegetables, implementing multi-language support for a broader user base, and conducting additional security testing. Overall, the FoodAR project represents a successful integration of cutting-edge technologies to address a practical and relevant problem, offering users a convenient and effective way to assess the freshness of their food items.

7.2 Recommendation

For future work, the FoodAR project could benefit from several enhancements and expansions. Firstly, expanding the dataset to include more classes of fruits and vegetables would improve the model's accuracy and versatility. By incorporating a wider variety of food items, the application could provide more comprehensive and accurate predictions, enhancing its usefulness to users.

Secondly, implementing multi-language support would make the application more accessible to a global audience. By offering the option to use the application in different languages, users from diverse linguistic backgrounds would be able to utilize its features more effectively, improving user engagement and satisfaction.

Additionally, further optimization of the object detection and classification model could enhance its performance and efficiency. Fine-tuning the model's hyperparameters and exploring advanced machine learning techniques could lead to improved accuracy and faster processing times, enhancing the overall user experience.

Furthermore, enhancing the security features of the application to ensure the privacy and security of user data would be a valuable addition. Conducting thorough security testing and implementing best practices for data encryption and storage could help mitigate potential vulnerabilities and risks, enhancing user trust and confidence in the application.

Moreover, further investigation into AR usability for the application could lead to the development of more interactive features for users. By exploring new ways to utilize AR technology, such as interactive tutorials or gamified elements, the application could enhance user engagement and provide a more immersive experience.

Overall, the FoodAR project has laid a solid foundation for future development and expansion. By incorporating these recommendations and continuing to innovate, the project has the potential to become a valuable tool for consumers seeking to make informed decisions about the freshness of their food items.

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3T3	**Study week no.: 2**
Student Name & ID: Nicholas Ngiam Li Xuan 20ACB02248	
Supervisor: Dr. Saw Seow Hui	
Project Title: An AR (Augmented Reality) Application for Food Inspection	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Implemented AR functionality into the mobile application for food inspection. Conducted initial analysis of AR-enabled raw material detection.

2. WORK TO BE DONE

Continue refining AR detection algorithms for improved accuracy. Begin testing AR overlay information for effectiveness.

3. PROBLEMS ENCOUNTERED

Some issues with AR calibration and object recognition in different lighting conditions.

4. SELF EVALUATION OF THE PROGRESS

Progress is on track, but there is room for improvement in the accuracy of AR detection.

Supervisor's signature

Student's signature

Trimester, Year: Y3T3	Study week no.: 4
Student Name & ID: Nicholas Ngiam Li Xuan 20ACB02248	
Supervisor: Dr. Saw Seow Hui	
Project Title: An AR (Augmented Reality) Application for Food Inspection	

1. WORK DONE
[Please write the details of the work done in the last fortnight.]

Continued refinement of AR detection algorithms and testing of AR overlay information. Explored additional features to enhance user experience.

2. WORK TO BE DONE

Further optimize AR detection algorithms for higher accuracy. Begin testing for feedback on AR usability.

3. PROBLEMS ENCOUNTERED

Limited dataset for training AR models, affecting accuracy.

4. SELF EVALUATION OF THE PROGRESS
Progress is steady, but more work is needed to improve.

Supervisor's signature

Student's signature

Trimester, Year: Y3T3	Study week no.: 6
Student Name & ID: Nicholas Ngiam Li Xuan 20ACB02248	
Supervisor: Dr. Saw Seow Hui	
Project Title: An AR (Augmented Reality) Application for Food Inspection	

1. WORK DONE
[Please write the details of the work done in the last fortnight.]

Try on Teachable machine for object detection.

2. WORK TO BE DONE

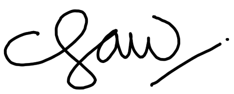
Redo the Object Detection by integrating Teachable Machine's model.

3. PROBLEMS ENCOUNTERED

Some challenges with integrating Object detection into AR features.

4. SELF EVALUATION OF THE PROGRESS

Progress is negative in integrating AR accuracy and usability.



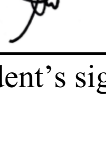
Supervisor's signature

Student's signature

Trimester, Year: Y3T3	Study week no.: 8
Student Name & ID: Nicholas Ngiam Li Xuan 20ACB02248	
Supervisor: Dr. Saw Seow Hui	
Project Title: An AR (Augmented Reality) Application for Food Inspection	

1. WORK DONE [Please write the details of the work done in the last fortnight.] Refined AR features. Conducted comprehensive AR testing for accuracy and effectiveness.
2. WORK TO BE DONE Analyze results of AR testing and make final adjustments to AR features. Prepare for final presentation and documentation.
3. PROBLEMS ENCOUNTERED Minor issues with AR calibration in certain scenarios.
4. SELF EVALUATION OF THE PROGRESS Progress is excellent, with AR features performing well in testing.

Supervisor's signature



Student's signature

Trimester, Year: Y3T3	**Study week no.: 10**
Student Name & ID: Nicholas Ngiam Li Xuan 20ACB02248	
Supervisor: Dr. Saw Seow Hui	
Project Title: An AR (Augmented Reality) Application for Food Inspection	

1. WORK DONE
[Please write the details of the work done in the last fortnight.]

Analyzed results of AR testing and made final adjustments to AR features. Prepared final presentation and documentation.

2. WORK TO BE DONE

Finalize documentation and prepare for project completion.

3. PROBLEMS ENCOUNTERED

None.

4. SELF EVALUATION OF THE PROGRESS

Progress is satisfactory, with all project goals achieved.

Supervisor's signature

Student's signature

Trimester, Year: Y3T3	Study week no.: 12
Student Name & ID: Nicholas Ngiam Li Xuan 20ACB02248	
Supervisor: Dr. Saw Seow Hui	
Project Title: An AR (Augmented Reality) Application for Food Inspection	

1. WORK DONE
[Please write the details of the work done in the last fortnight.]

Finalized documentation and completed project presentation. Reviewed overall project progress and outcomes.

2. WORK TO BE DONE

None

3. PROBLEMS ENCOUNTERED

None

4. SELF EVALUATION OF THE PROGRESS

Project completed successfully, with all objectives achieved.

Supervisor's signature

Student's signature

Trimester, Year: Y3T3	Study week no.: 14
Student Name & ID: Nicholas Ngiam Li Xuan 20ACB02248	
Supervisor: Dr. Saw Seow Hui	
Project Title: An AR (Augmented Reality) Application for Food Inspection	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Submitted final project documentation and presented project outcomes. Received positive feedback from peers and mentors.

2. WORK TO BE DONE

Do some adjustment for best presentation towards supervisor.

3. PROBLEMS ENCOUNTERED

None.

4. SELF EVALUATION OF THE PROGRESS

Project concluded successfully, meeting all objectives and receiving positive feedback.

Supervisor's signature

Student's signature

POSTER


UTAR
UNIVERSITI TUNKU ABDUL RAHMAN
FACULTY OF INFORMATION TECHNOLOGY AND COMMUNCIATION (FICT)
Augmented Reality (AR) Application for food inspection
This project aims to aims to change how consumers interact with food products.
Author: Nicholas Ngiam Li Xuan
Supervisor: Dr Saw Seow Hui
Problem Statements
• Lack of Transparency
• Complexity as Food Product Labels
• Foodborne illnesses are a global concern
Objectives
• To Implement AR Feature into the Mobile Application for Food Inspection
• To Conduct a Comprehensive Analysis of AR-Enabled Raw Food Detection
• To Evaluate the Accuracy and Effectiveness of Detection and AR Overlay Information
Tools
Unity
Unity Mobile AR Development
Teachable Machine
Flutter
Firebase
Contribution
• Seamless Raw Food Identification
• Immersive User Experience
• Real-time Database Integration
Future Work
• Link Unity Project with Flutter for Cross-Platform Mobile Application Developmer
• Application Deployment
• User Testing

PLAGIARISM CHECK RESULT

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Nicholas Ngiam Li Xuan
ID Number(s)	2002248
Programme / Course	Bachelor of Computer Science (Honours)
Title of Final Year Project	**An AR (Augmented Reality) Application for Food Inspection**

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)**
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____
Signature of Supervisor

Name: Dr. Saw Seow Hui

Date: 26/4/2024

____
Signature of Co-Supervisor

Name: ______________________

Date: ______________________

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

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Student Name	Nicholas Ngiam Li Xuan
Supervisor Name	Dr. Saw Seow Hui

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√	Appendices (if applicable)
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I, the author, have checked and confirmed all the items listed in the table are included in my report.

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