BGBP – A MOBILE APPLICATION FOR DIABETIC SELF-MANAGEMENT

BY

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A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF COMPUTER SCIENCE (HONOURS)

Faculty of Information and Communication Technology

(Kampar Campus)

JAN 2023

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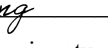

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SUBMISSION OF FINAL YEAR PROJECT /DISSERTATION/THESIS

It is hereby certified that ***Chew Ke Xin*** (ID No: ***19ACB03038***) has completed this final year project entitled "*BGBP – A Mobile Application For Diabetic Self-Management*" under the supervision of Dr Chai Meei Tyng (Supervisor) from the Department of Computer Science, Faculty of Information and Communication Technology .

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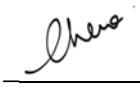
Signature : 

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ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciation to my supervisor, Dr Chai Meei Tyng who has given me encouragement and opportunity to engage in this project.

Finally, I must say thanks to my family and my friends for their support and motivation throughout the course.

ABSTRACT

This project is a mobile application project for diabetic self-management. The mobile application will be developed through Android Studio software with Java programming language. It will provide convenience to users to record their blood glucose and blood pressure level. Besides, it is beneficial for elderly patients who always tend to forget to take medicines such as injection of insulin and pill of hypertension as there will be a reminder on medication feature implemented into the project. In order to improve the awareness of diabetes patients on the food nutrition contents especially on the sugar intake amount, food recognition technology will be implemented into this project as well. After capturing the food or selecting image of food from users' devices, then it is able to detect and recognize the food and displaying the relevant nutrition facts such as sugar, carbohydrates, fat and so on, as well as the healthiness level of food so that users can control and plan for their diet.

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Chapter 1
Introduction

Based on [1], hypertension often arises along with diabetes. Both of these diseases share common risk factors such as unhealthy diet and obesity. It is also found that people with diabetes are having the higher rate of getting hypertension too. Both of the diseases might lead to severe effects on health such as kidney failure, stroke and etc. Hence, managing both blood glucose and blood pressure levels can help to reduce the risk of cardiovascular diseases. Having a proper diet plan that limiting sugar and unhealthy food is also considered essential for diabetic and hypertension patients.

Type 1 diabetes is usually diagnosed in children and teens and it is caused by autoimmune reaction while for type 2 diabetes is diagnosed in adults [2]. The only treatment for type 1 diabetes is to rely on insulin pumps and the treatment for type 2 diabetes is to consume oral hypoglycemic medications [3]. Patients with type 1 diabetes are required to monitor glycemic control daily and also control blood pressure and cholesterol [3].

Nowadays, the number of diabetic in Malaysia is increasing drastically. There are around 3.9 million of Malaysia citizens are having diabetes and the rate had increased from 13.4% (2015) to 18.3% (2019) according to a survey [4]. Therefore, the implementation of diabetic self-management mobile application is very beneficial in order to keep track on users' blood glucose and blood pressure level records as well as to help in controlling the diet.

1.1 Problem Statement and Motivation

The problem statements are mentioned as below:

- Poor self-monitoring of blood glucose level and blood pressure level [5]. Lack of attention on their own glucose level and blood pressure level may lead to a more serious effects on health and the current condition may become worse. Patients tend to be lazy or forgetful to record their blood glucose and blood pressure levels. Those records are very important as they act as future references for further consultation with doctors for new treatment and for monitoring own health condition every day to avoid any bad circumstances.
- Poor diet [5]. Lack of awareness or control on their sugar intake amount or other nutrition such as fat, calories, cholesterol and etc. from food. As mentioned before, a healthy and proper diet with limiting sugar and fat is vital for patients to prevent getting worsen on health condition, as well as to avoid another diseases or reduce the risks such as cardiovascular diseases, stroke and so on.
- Poor time management on taking medicine. Patients often forget to take medication especially for the elderly patients. Medication for diabetic and hypertension patients is very important and should not be skipped. It is because it may lead to a worsen condition and also may cause the current treatment that is set by doctor will not be effective anymore.

The aim of the project is to propose a new feature on food recognition technology on BGBP mobile application. This function can help diabetes patients to take note on the sugar intake amount and other nutrition facts label from certain food which will then alert them to plan for a proper diet. Besides, reminder on medication feature is also proposed in this project to help patients avoid any skipping medication.

1.2 Objectives

The project objectives are mentioned as below:

- **To provide a mobile platform for checking and monitoring blood glucose and blood pressure level.**
- **To implement the food recognition feature in diabetic self-management mobile application.**
    - Nutrition facts label such as protein, cholesterol, sugar, fats and so on from the meal pictures will be displayed for improving user's awareness.
- **To develop an improved diabetic self-management application with food recognition technology and reminder on medication feature.**

1.3 Project Scope and Direction

This diabetic self-management mobile application is developed using Android Studio Arctic Fox Version. The splash screen and application icon are designed with Canva software and import to Android Studio. Registration and login function in the app is implemented with Firebase Authentication as it saves user data in the cloud securely and provides built-in library to reset password. Besides, all blood glucose and blood pressure records saved will be stored into Firebase Realtime Database as it is suitable for large data storage and accessible when offline. For plotting the charts of blood glucose and blood pressure level, external libraries are required in Android Studio. MPAndroidChart library which is created by Philipp Jahoda can support few types of graphs such as bar graph, pie chart, scatter chart and so on. Another library implemented in this application is GraphView by Jonas Gehring which can support line graphs, point graphs and so on. Records will be retrieved from Firebase Realtime Database and stored into DataPoint or ArrayList to plot a line graph for blood glucose level overview and bar chart for systolic and diastolic blood pressure level.

For food recognition feature in this application, pre-trained CNN (Convolutional Neural Networks) MobileNet model will be used to recognize the food image from device and the output will then link to the food database for displaying relevant nutrition details and the category of food healthiness. All the food nutrition information is sourced from USDA Food

Data Central and Nutritionix database and the food healthiness level is determined by the percent Daily Value (%DV).

For the history records, RecyclerView will be used as the layout interface for displaying all blood glucose records. Any modification or deletion on the record will be updated instantly to Firebase Realtime Database. The internal Android function such as AlarmManager and BroadcastReceiver will be used to develop the reminder on medication feature. Medicine record will also be saved into Firebase Realtime Database and it is allowed to perform modification and deletion action. Besides, scatter chart and line chart from MPAndroidChart library are utilized for displaying the monthly statistics of blood glucose and blood pressure. In the report generator feature, iTextPdf library is applied to create new PDF documents with the help of Firebase Realtime Database to retrieve the data and write into cell to display a tabular format of report.

1.4 Contributions

The main contribution for this proposed mobile application is to develop a food recognition feature with nutrition facts displayed for users. User is allowed to capture photo or select a food image from device and the image will be processed through a pre-trained CNN model for recognition. Food database is needed for displaying the detected food nutrition facts label such as total fat, cholesterol, sugar, protein and so on. Moreover, the food detected will also be grouped as either healthy, moderate or unhealthy food for user's reference. Alternatively, user can search for the food nutrition information manually through the search button provided. This can improve the awareness of user on the food nutrients especially the sugar intake amount for helping to control or plan a proper diet, reducing the risk of getting cardiovascular diseases. Besides, to solve the issue of being forgetful to take medicine, a reminder of medication feature in this mobile application is able to help notifying user especially for the elderly patient.

1.5 Report Organization

This report is organized into 7 chapters: Chapter 1 Introduction, Chapter 2 Literature Review, Chapter 3 System Methodology/Approach, Chapter 4 System Design, Chapter 5 System Implementation, Chapter 6 System Evaluation and Discussion, Chapter 7 Conclusion and Recommendation. The first chapter is the introduction of this project which includes problem statement, motivation, project scope, project objectives, project contribution and report organization. The second chapter is the literature review where some related existing mobile applications are reviewed. The third chapter is regarding the use case diagram, hardware requirement and food recognition model details. The fourth chapter is discussing the overall system design of this project. The fifth chapter is regarding the details on how to implement the system. Furthermore, the sixth chapter reports the system testing results and project challenges with issues. The last chapter reports the conclusion, recommendations and future work on the mobile application project.

Chapter 2
Literature Review

2.1 Previous Works on Self-Monitoring Applications

Based on the research from Google PlayStore, there are some existing self-monitoring mobile applications for diabetic and hypertension patients, such as Diabetes Diary [6], Glucose Buddy Diabetes Tracker [7], Health2Sync [8], Diabetes:M [9], MySugar – Blood Sugar [10], Blood Pressure Monitor [11], Blood Pressure Diary [12], Undermyfork [13] and No Sugar In Me [14].

The major issue for most of the studied mobile applications such as [6], [7], [9], [10], [11] and [12] is having a lot of pop-up advertisement while in-using, which affects the user experience and users may get annoyed. Besides, another limitation for the existing applications is required to buy plan and upgrade to premium account in order to unlock more features in the applications. For instance, [6], [7], [8], [9] and [10]. Lack of access to apps features lead to user-unfriendly and inconvenience to users as it is limiting the users' actions. Upgrading account to VIP may not be affordable to all users, it costs between MYR 12 to MYR 64 for one to six months of subscription plan [8]. For instance, users are only allowed to generate reports for the first two times in [8], cannot search for food database in [9], cannot access to the articles about health and nutrition in [7] and etc. Hence, the proposed mobile application will be ad-free and all the features will not be limiting for users.

In terms of app features, for the mobile application [6], it includes statistics and charts that showing the blood sugar and blood pressure readings so that users can view the overview record easily. It also provides users to manually input for their sugar concentration and blood pressure data. Report can also be generated into PDF file for user references. However, it does not include reminders on medication and also filling-in the glucose data.

For [7], it brings convenient to patients that are using CGM device or Dexcom meter to measure the blood glucose level. It can connect to those devices to record the readings. Besides, it also provide manual input for tracking blood glucose, blood pressure, medicine, physical activity,

weight, hemoglobin A1c and carbohydrates. In the function of adding carbs, users are allowed to take photo of food, manually search food name as well as barcode scanning. Then, the content of certain food including calories, carbs, fat, protein and so on will be displayed. However, this mobile application requires users to upgrade account to premium in order to unlock more features in it like diabetes education articles. There is also no graphs, charts and statistics available for users to view.

For [8], it has a dashboard displaying the summary of daily record. It also includes charts and graphs for comparison between before and after meal. It provides users to manually input the blood glucose data, blood pressure, weight and medication. Most importantly, this mobile application has the feature of medication reminder. In the diary section, it enables users to view the past records in table or list form and can apply filter on the period as well as item. Nonetheless, it cannot allow users to generate reports anymore after two-time trial as it also requires users to upgrade to premium account.

In [9], it is similar as [6], [7], [8] which need to buy premium to access the additional functions in the application for instance, search for food database. It also requires users to manually input glucose, carbs and medication records. It has the reminder feature on filling-in the glucose data with some options given such as breakfast, lunch, dinner, night reminder to let users to opt. In [10], it enables users to input blood sugar, blood pressure, body temperature, body oxygen saturation, hemoglobin A1c and weight. It also allows users to generate PDF reports by filtering the date period. Yet, this mobile application has a lot of advertisements and requires users to pay RM17.99 for unlocking other premium features.

In this mobile application [11], it only can insert blood pressure record which is only designed for hypertension patients. It shows the latest record and the average value in the home page. This app also provides a lot of useful information about blood pressure to gain users' awareness. It also displays bar chart and allows users to export the records as CSV file and share it via email, WeChat or WhatsApp. While in [12], it is also another blood pressure monitoring application. It provides line graph and bar chart in the statistics section and it also provides the reference table, showing the type of hypertension and each suitable range of value for systolic and diastolic in mmHg. This enables users to be more aware and control own blood

pressure to avoid exceeding the level. Similar to [11], it also allows users to share data in CSV file via email.

For [13], it only allows users to keep track on their blood glucose level. It has another feature which is to add meals by either inserting photo or capturing photo. Then, it will detect the food and display some relevant food tags to let users to opt for the correct tags. However, it does not provide the nutrition details and sugar amount. The feature only acts as a meal reference together with blood glucose record, time and carbs. There is no advertisement and it is free from purchasing VIP to access functions in [13] and [14]. In [14], this application only keeps track on the sugar amount intake. It allows users to take photo of food, scan barcode and search manually with food name. It is then displayed the amount of sugar of the particular detected food. Nevertheless, it is not very effective and inaccurate for the taking photo feature as testing with different food are done for quite a few times. It is unable to display any result. Moreover, it also includes articles on education about sugar and health concern which is beneficial for users.

From the research and study based on the few existing apps mentioned above, almost all apps are lack of food recognition feature which can give users an idea on what is the sugar amount of the food and other relevant nutrition facts label. It is very important because a healthy and proper diet plan for diabetic and hypertension patients is essential to prevent from getting more serious illness such as stroke, cardiovascular disease. Therefore, this new feature is being proposed to be implemented in the BGBP mobile application, as well as improving those limitations that are found from the existing mobile applications as mentioned earlier.

Some journals related to food classification and food recognition using deep learning techniques had been studied. In this paper [15], food classification model using transfer learning technique has been proposed by G. et al. with utilizing Python programming language and TensorFlow package as well as with Food-101 data. Deep learning is highly recommended as a data analysis technique to deal with the recognition in food domain. The most effective way to construct a food recognition model for a mobile application is by using CNN as it is can detect the important features automatically [15]. Convolution layers are the most important part and the main layers to perform the filtering processes and the feature detector will observe the

picture for the existence of features to focus on basic features like edges and colors. Pooling layers will summarize the characteristics learnt from the convolution layer's feature map [15].

In [15], transfer learning is used. It is a technique to train a learned model for a new problem domain. This includes feature transfer, fine-tuning, using a pre-trained model and train data. A new classification layer will be trained by feature transfer as the input layer maps data from one layer to another layer. Besides, there are a lot of pre-trained models such as YOLO, EfficientNet-b0, MobileNet and etc. It can be used by updating it with features of the convolution layers and retraining the model.

In the paper [16], Jamil et al. had proposed to use a pre-trained model (MobileNet) on TensorFlow Lite deep learning environment to implement a food recognition function for the management of calorie intake. The transfer learning DCNN (Deep Convolutional Neural Network) is being implemented as it can reduce the need for a huge dataset for training. Jamil et al. also had reviewed MobileNet, GoogLeNet and AlexNet transfer learning models. AlexNet consists of five convolutional layers, three pooling layers and two fully-connected layers. GoogLeNet has two convolutional layers and one pooling layer and it is a more powerful architecture compared to others. MobileNet is a more efficient model that is produced specifically for mobile applications due to the flexibility of image size and the suitability in mobile devices [16]. It can achieve a good accuracy however, the problem occurred when there are two or more labels displayed the similar features, for instance, the similarity of sauce's color and shape of noodles between 'laksa' and 'curry noodles' in the test case from [16].

2.2 Screenshots of Existing Self-Monitoring Mobile Apps

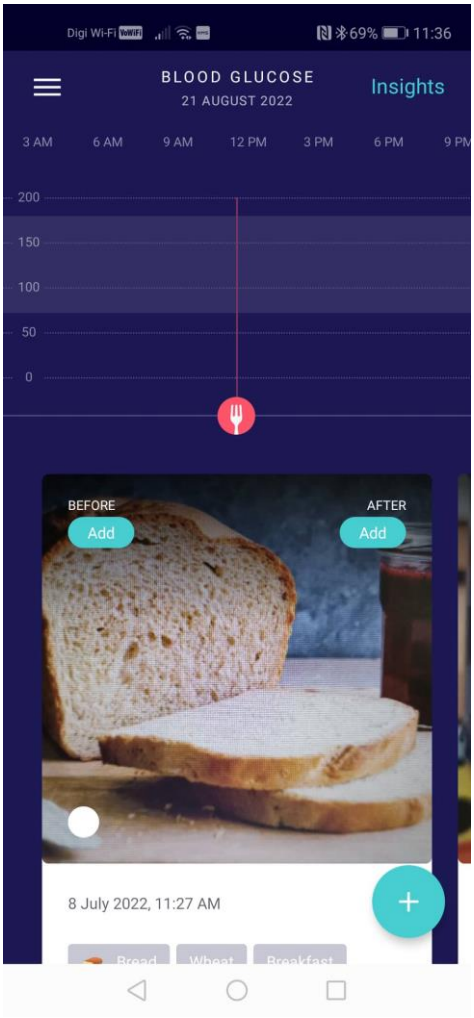


Fig. 2.1: Dashboard of Undermyfork app showing the blood glucose level and the meal from [13]

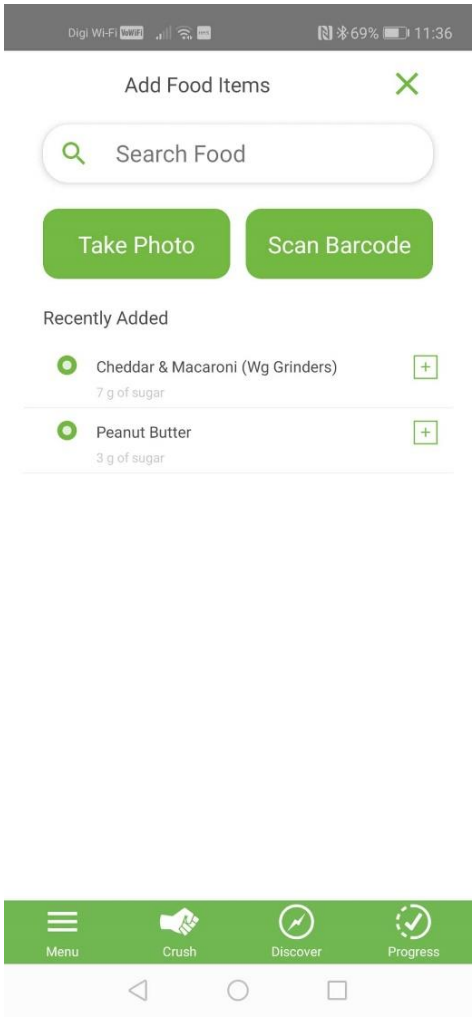


Fig. 2.2: Search food feature to view the amount of sugar from [14]

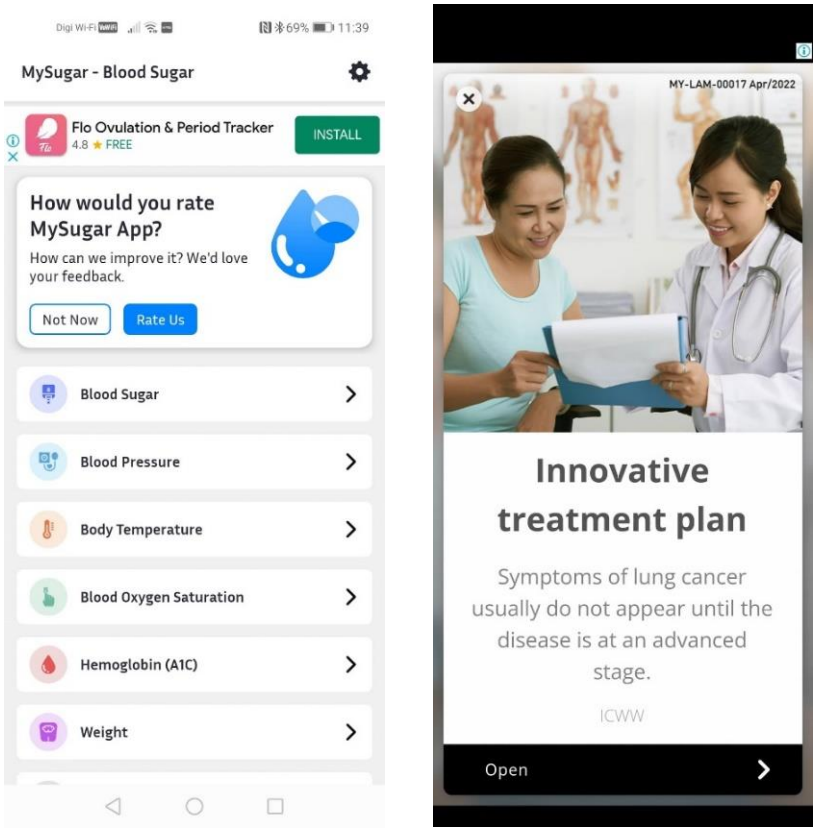


Fig. 2.3: MySugar – Blood Sugar app includes many categories such as body temperature, hemoglobin to be recorded but having a lot of pop-up ads [10]

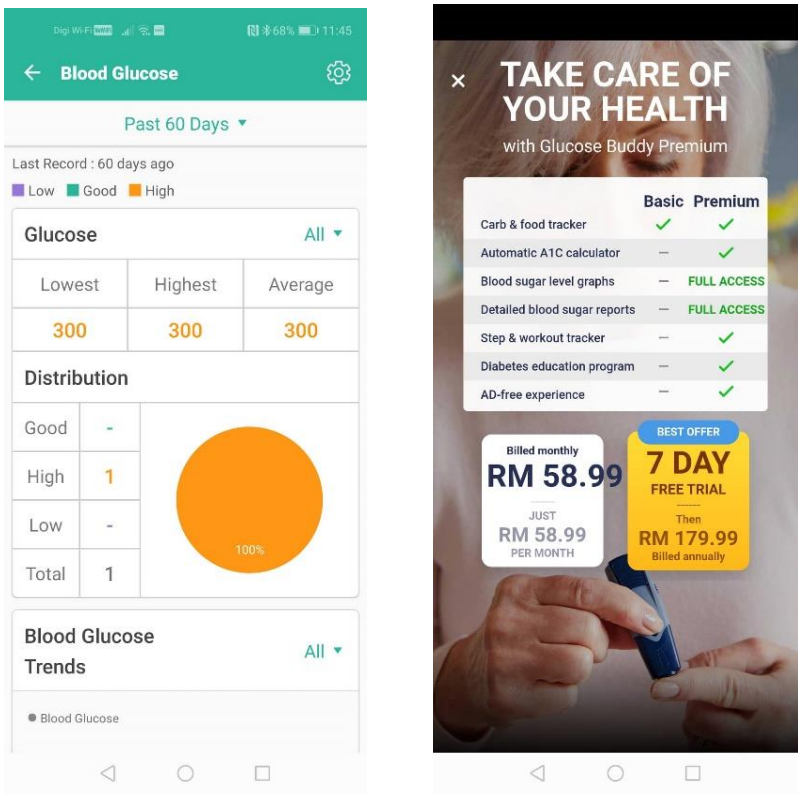


Fig. 2.4: Health2Sync app includes statistics showing the blood glucose level and this app also requires user to upgrade premium account to access more features [8]

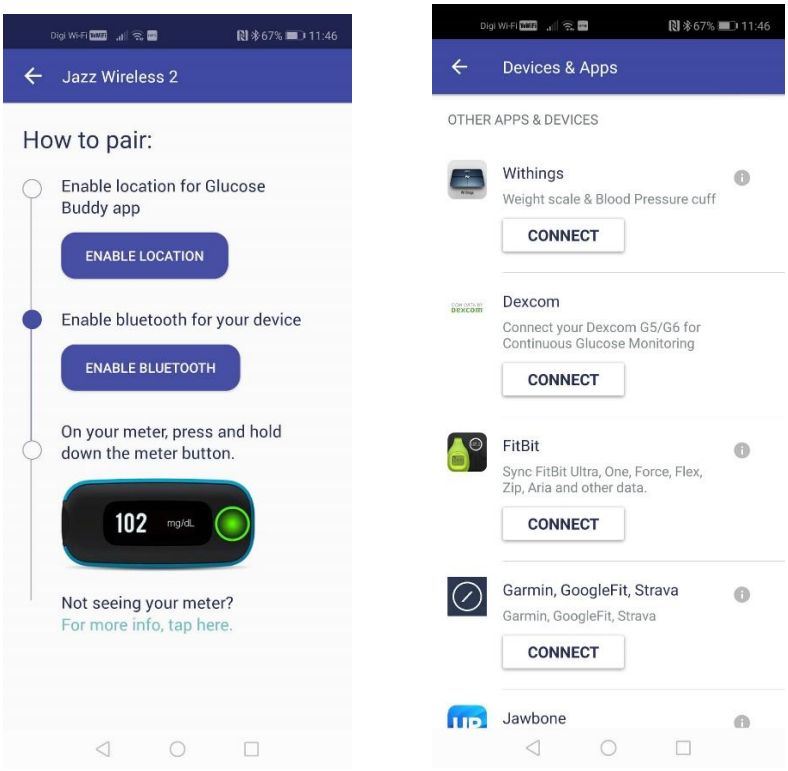


Fig. 2.5: Able to connect to CGM devices, Dexcom meter and etc. to read the measurement of data from [7]

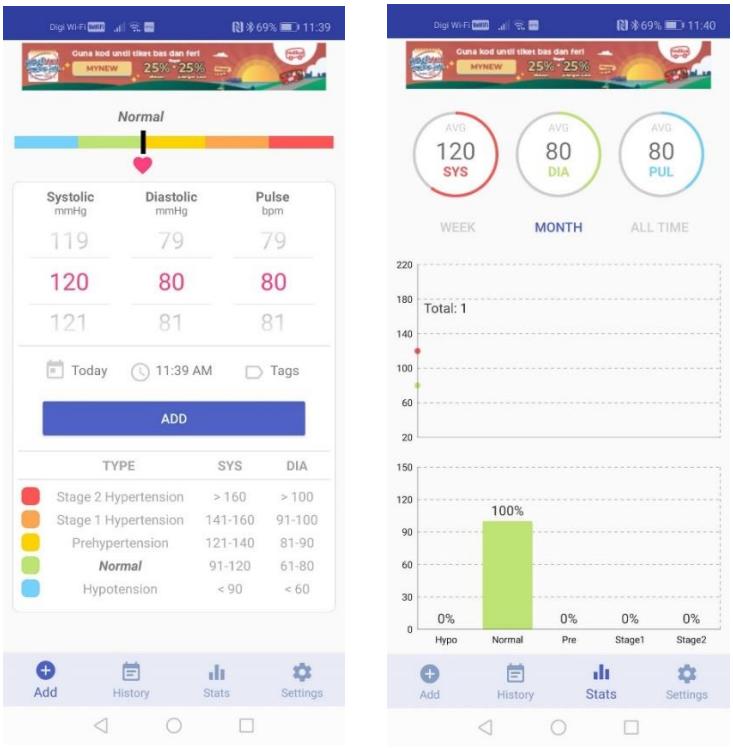


Fig. 2.6: Reference table showing the suitable range value of blood pressure and including statistics records from [12]

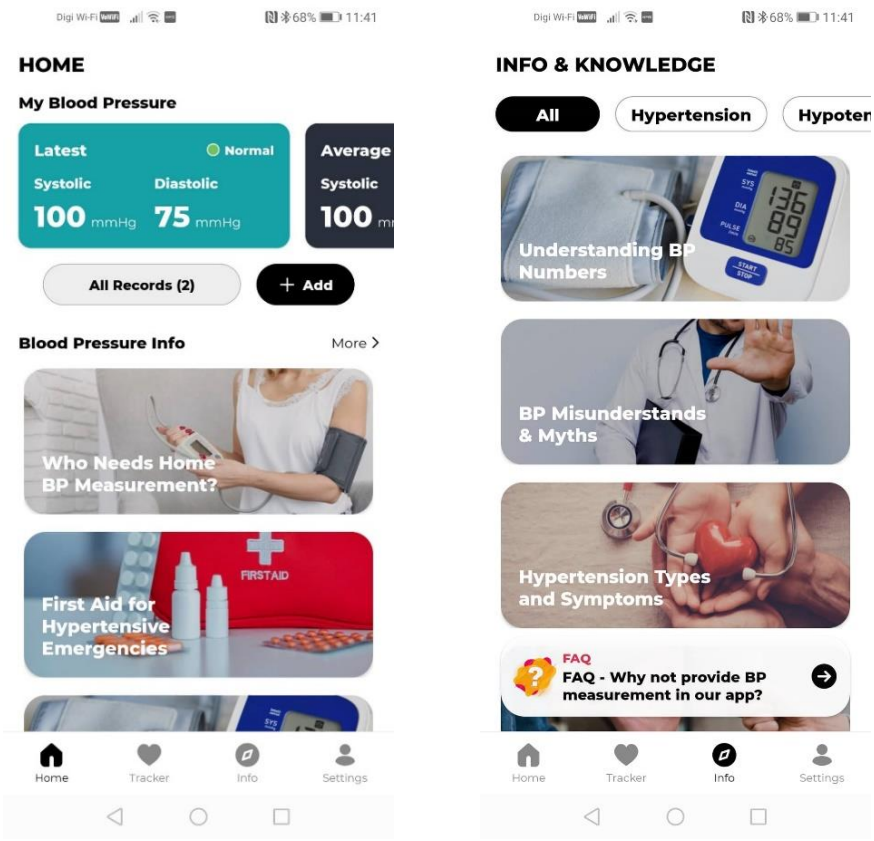


Fig. 2.7: Include information and knowledge articles about blood pressure from [11]

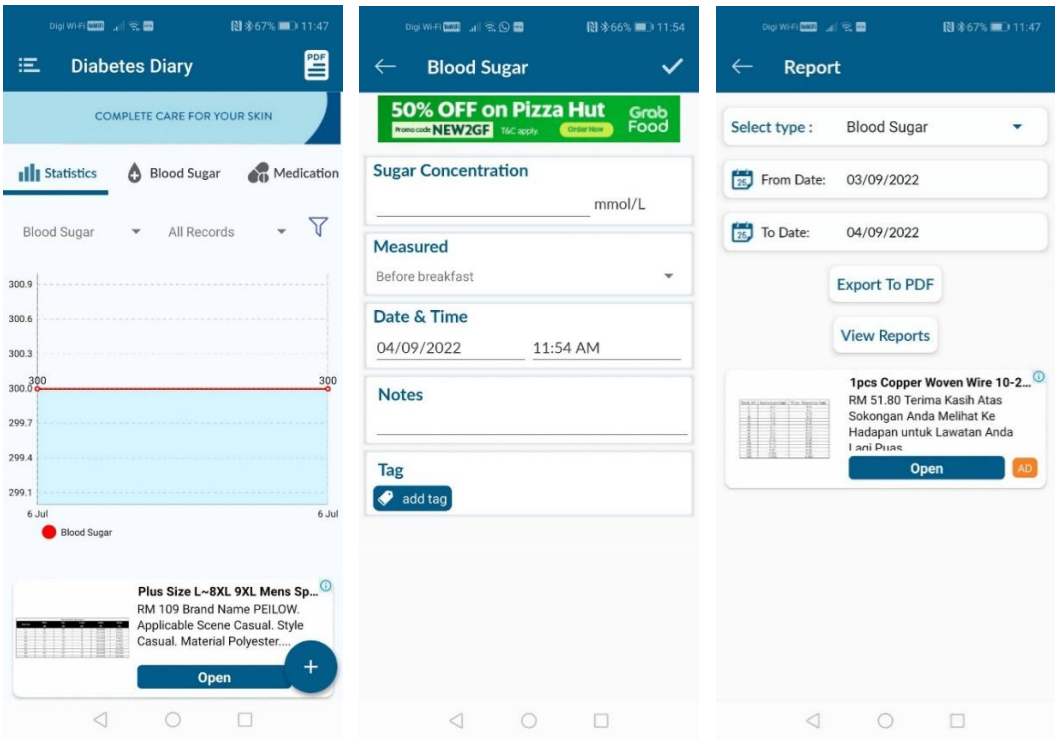


Fig. 2.8: Statistics reading, input record and export report to PDF features from [6]

2.3 Table of Comparison between Existing Mobile Apps and Proposed App

	Limitations
	Strengths

	Diabetes Diary	Glucose Buddy Diabetes Tracker	Health2Sync	Diabetes:M	MySugar – Blood Sugar	Blood Pressure Monitor	Blood Pressure Diary	Undermyfork	No Sugar In Me	Proposed self-monitoring mobile application
No pop-up ads	×	×	✓	×	×	×	×	✓	✓	✓
No need to upgrade premium account (to access more features)	×	×	×	×	×	✓	✓	✓	✓	✓
Able to record blood glucose data	✓	✓	✓	✓	✓	×	×	✓	✓	✓
Able to record blood pressure data	✓	✓	✓	✓	✓	✓	✓	×	×	✓
Reminders on filling-in record	×	×	×	✓	×	×	×	×	×	✓
Reminders on medication	×	×	✓	×	×	×	×	×	×	✓

Graphs/ charts/ statistics displayed	✓	×	✓	✓	✓	✓	✓	✓	✓	✓
Report generator (PDF or CSV file)	✓ (PDF)	×	×	✓ (HTML)	✓ (PDF)	✓ (CSV)	✓ (CSV)	×	×	✓
Can connect to CGM device or Dexcom meter	×	✓	×	×	×	×	×	×	×	×
Include articles about health concern	×	×	×	×	×	✓	×	×	✓	×
Reference table on suitable range value of blood pressure	×	×	×	×	×	×	✓	×	×	×
Search food name/ barcode scanning/ take photo of food	×	✓ (display food calories, protein & etc.)	×	×	×	×	×	✓ (but only display food name)	✓ (show amount of sugar)	✓ (Food recognition technology to detect food and display relevant

										nutrition details)
Accurate result of food detected	–	✓	–	–	–	–	–	✓	×	✓
Categorize food healthiness level (healthy/ moderate/ unhealthy)	×	×	×	×	×	×	×	×	×	✓

Table 2.1: Table of comparison of strengths and limitations of apps

Chapter 3

System Methodology/Approach

3.1 System Development Methodology

The software development methodology used for developing the mobile application is Agile methodology as this project is considered as a medium-scale project with one year of development timeline. Agile methodology is suitable for non-complex project and do not require a lot of upfront analysis compared to waterfall methodology. This method also reduces overheads in software process, reduce documentation and it is not necessary to have a very detailed specification to develop a project.

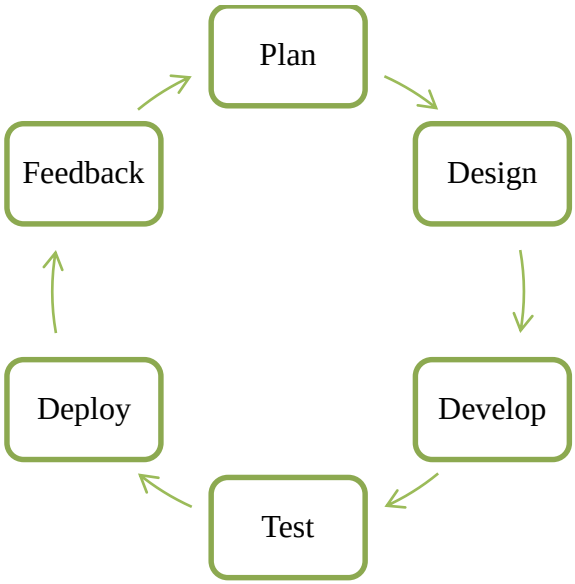


Figure 3.0: Agile software development life cycle

Phase 1: Plan

The background study of diabetes and the problem of diabetes patients encountered are studied and identified. The scope of the project and objectives are then determined. Timeline schedule and the work to be done for each sprint are also planned and estimated.

Phase 2: Design

Existing self-monitoring diabetes mobile applications and software are studied and started to mock-up the user interface (wireframe) for the project. Features are proposed and designed by creating architecture diagrams such as use-case diagram and block diagram. Besides, system requirements such as hardware and software to be used in the project development is also determined.

Phase 3: Develop

All the external libraries are loaded for developing the mobile application. Functionalities proposed in the project as well as the user interfaces are then coded in Android Studio. Each sprint is examined and developed, following the time schedule proposed.

Phase 4: Test

After developing the features, testing is needed to ensure the functionalities work well and correctly. Any bugs and issues found in the system testing are fixed. In the implementation of project, food recognition model is being tested with various number of food images, as well as the functions in the application are tested with test cases and test data.

Phase 5: Deploy

After system testing, the mobile application is ready to be deployed. Users are able to start using the application while developer is ready to provide support to ensure the application runs smoothly without any bugs.

Phase 6: Feedback

Feedback from users will be gathered and it will be used to evaluate the mobile application by helping developer to identify future improvement. Any refinement or update on the mobile application is to be done in this phase based on users' feedback and suggestions. In this project, the food database will be periodically updated.

3.2 System Requirement

3.2.1 Hardware

The hardware involved in this project is computer and it is used for coding the mobile application and a smartphone acts as an emulator for testing this application.

Table 3.1 Specifications of laptop

Description	Specifications
Model	Dell Vostro 3478
Processor	Intel Core i5-8250U
Operating System	Windows 10
Graphic	Intel(R) UHD Graphics 620
Memory	20GB RAM
Storage	463GB (C:) & 454GB (D:)

Table 3.2: Specifications of Mobile Phone

Description	Specifications
Model	Huawei Nova 5T
EMUI Version	9.1.0
Android Version	9 (Pie)
CPU	Huawei Kirin 980
GPU	Mali-G76 720 MHz
RAM	8.0 GB
Storage	128 GB

3.2.2 Programming Language

- Java programming language is used for developing this mobile application in Android Studio.

3.3 Use Case Diagram

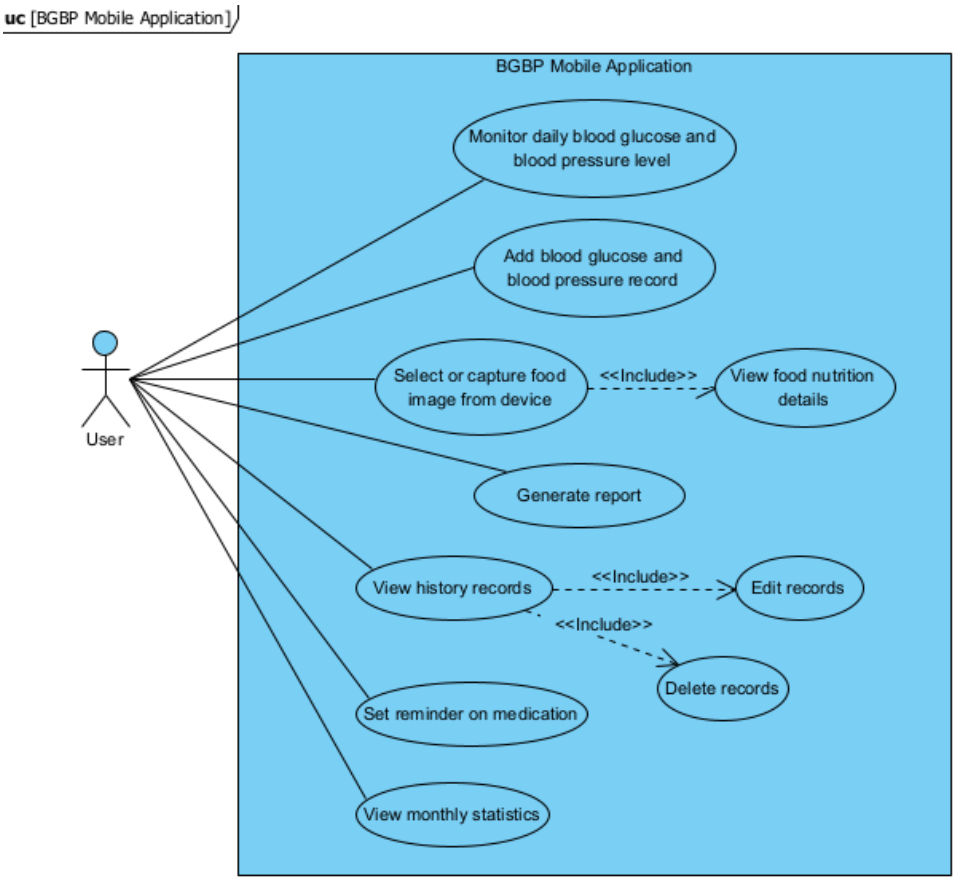


Figure 3.1: Use case diagram for BGBP mobile application by using Visual Paradigm Software

In general, BGBP mobile application enables user to monitor the daily blood glucose and blood pressure level in graph-view, allows user to add blood glucose and blood pressure records and view the food nutrition details and food healthiness by capturing or selecting photo. Besides, this mobile application also allows user to set reminder on medication, view monthly statistics of blood glucose and blood pressure, view for the past records as well as to generate and download PDF report into user's device.

3.4 Food Recognition Model Details

The food recognition model utilized in this project is obtained from TensorFlow Hub [17]. The model is trained and developed by Google AIY (Artificial Intelligence Yourself) team. Moreover, Convolutional Neural Network (CNN) technique is used to train the model with MobileNetV1 architecture which is specifically designed for embedded device like mobile phone. This architecture is lightweight and efficient for mobile devices that have limited computational resources. It provides lower memory usage and faster processing. CNN technique is commonly used in image classification as it is capable of learning and extracting features from dataset images. When differentiating food types, features such as color, texture and shape are used to identify between food from another.

Besides, the food recognition model has been trained on 2023 dataset of food images. The dataset consists of food that are from different regions and cuisines, such as Western, Japanese, Italian, Chinese cuisines and etc. However, it is mentioned that the dataset is skewed more towards North American food. Food such as pad thai, pizza, spaghetti, ramen, sushi, dim sum, desserts and so on are able to be detected with the pre-trained model. The model is open-source which benefits users, however there is a limitation of the model which is not fine-tunable. This indicates that the model is not allowed to be further trained with additional new dataset or modify its training process by users.

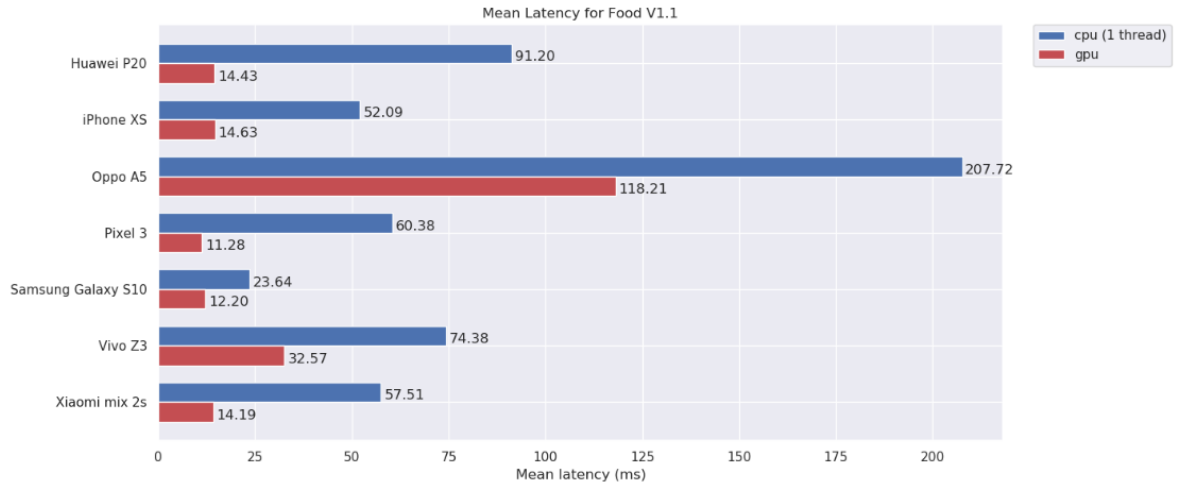


Figure 3.2: Mean latency benchmarks for the food recognition model

Figure 3.3: Metadata of model

Mean latency benchmarks are provided in the documentation [17]. It is used for evaluating the performance of model and it refers to the average amount of time to process an input for the model. The lower the latency, the faster the model can process with the input and generate output. Chart above (Figure 3.2) shows the latency benchmarks for several mobile devices. Metadata of the model is also provided in the documentation (Figure 3.3). The model takes image as input. The input must be a 3-channel RGB color images with size of 224x224. The model will output a list of probabilities of food classes.

3.5 Timeline

Timeline of FYP 1:

Activity / Week	1	2	3	4	5	6	7
Design GUI for each section, splash screen and app icon for mobile application							
Set up Firebase database and the needed entities, columns etc.							
Code for registration, login, logout and forget password features							
Code for 'Add Record' section for blood glucose, blood pressure, other categories input							
Code for 'Home' section for the dashboard (graph view)							
Code for 'History Records', modification and deletion records							
Code for reminder on medication feature							
Finalizing FYP 1 Report							

Table 3.3: Timeline diagram for FYP 1

Timeline of FYP 2:

Activity \ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Food recognition feature with food database (Nutrition facts label)														
Code for report generator feature														
Code for monthly statistics feature														
Finalizing all features in the mobile application														
Finalizing FYP 2 report														

Table 3.4: Timeline diagram for FYP 2

Chapter 4

System Design

4.1 System Design Diagram

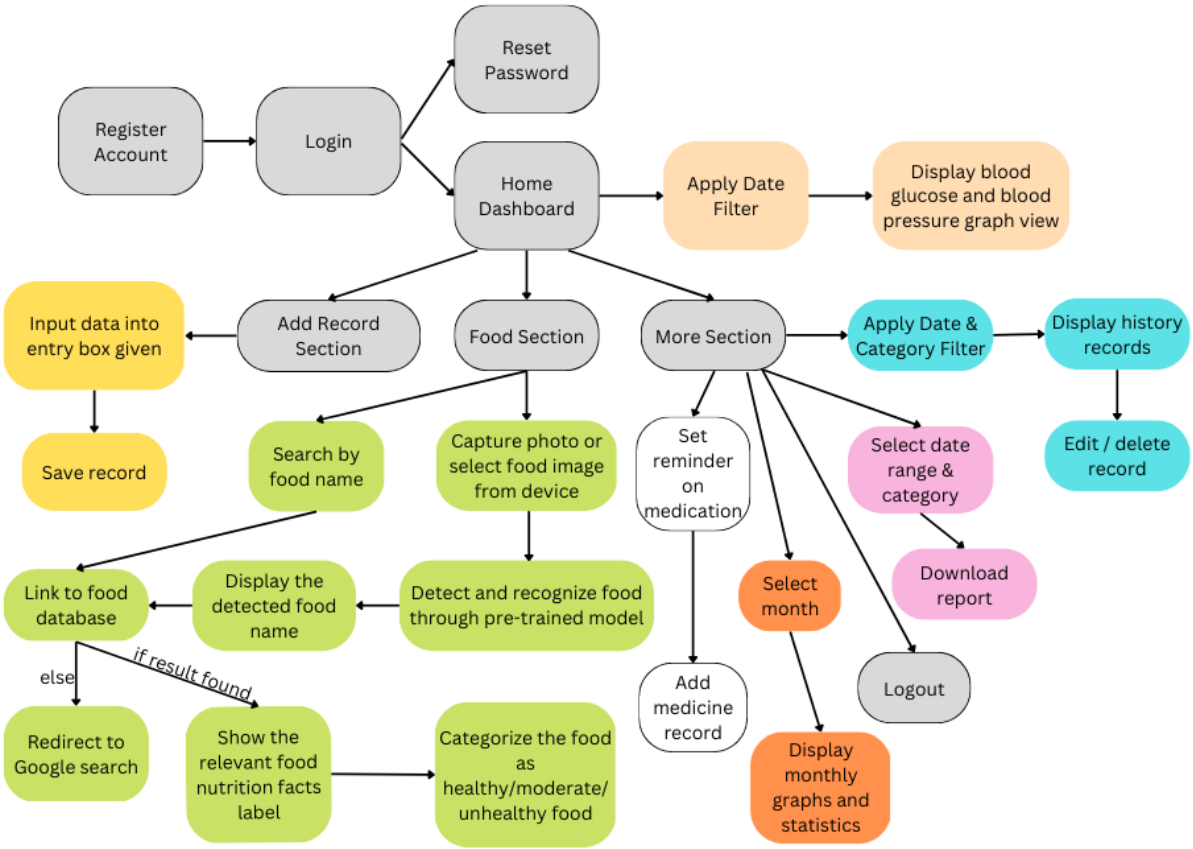


Figure 4.1: Block diagram for the overall features in BGBP mobile application by using Canva Software

User is required to register an account either using Google sign-in method or email-password method. After login, user is redirect to home dashboard which allows user to apply date filter to view daily blood glucose level with line graph and blood pressure level with bar charts. An alert message will be displayed to user if there is a blood glucose level record exceeding 10.5 for the particular day. Besides, user can choose to add blood glucose and blood pressure record by entering data into entry box provided and save the record.

The mobile application enables user to either search manually with food name or capture food photo or select the image from device to view the relevant nutrition information such as total fat, total sugars and etc. Using food recognition technology, the food image will be processed through a pre-trained model and the output (food name) will be displayed in the interface. This will further link to food database to show the relevant details and categorize the food detected healthiness, either healthy, moderate or unhealthy for user reference. If the output (food name) is not available in the food database, user can click into the output and it will automatically redirect user to Google search to display the food nutrition details. This approach is similar to the search function, such that if user manually input the food name and it is not found from the food database, Google page that showing the nutrition details will automatically display to user.

In the more options section, it consists of several features such as reminder on medication, monthly statistics, report generator, history records and logout. User is allowed to set reminder on medication by entering some information into the spaces provided. Moreover, monthly statistics of blood glucose and blood pressure (lowest, highest, average data) and monthly graphs are displayed after user selects the month from date picker. The mobile application also allows user to generate and download PDF report into device by selecting date range and category (all/ before breakfast/ after lunch etc.). User can choose to view the past records by applying date and category filter and also perform modification or deletion on the record. Lastly, logout function is also available in the mobile application.

4.2 Food Recognition Model Design & Usage in the Project

Figure 4.2: General flow of the pre-trained model

The food recognition model obtained from [17] takes image file as input and outputs a list of probability of food category. The food with the highest probability among others will be act as the food detected. The model is implemented into the project by importing it into Android Studio main project folder. After loaded into Android Studio, there is a sample code structure provided (Figure 4.3) in the model file (.tflite), which allows the developers to modify the code based on own usage.

```
Kotlin  Java

try {
    FoodModel model = FoodModel.newInstance(context);

    // Creates inputs for reference.
    TensorImage image = TensorImage.fromBitmap(bitmap);

    // Runs model inference and gets result.
    FoodModel.Outputs outputs = model.process(image);
    List<Category> probability = outputs.getProbabilityAsCategoryList();

    // Releases model resources if no longer used.
    model.close();
} catch (IOException e) {
    // TODO Handle the exception
}
```

Figure 4.3: Code structure for using the model

In the project, the food feature is developed by allowing user to either take food photo or upload food image from device. The image obtained will be act as the input for the food recognition model and go through the detection process. The model will output a list of probability which is not useful in the project feature development. Food name is the only attribute that is important in the project. Hence, a modification in the code structure is required. Some

additional functions such as converting captured or uploaded image into bitmap format as the input for the model and retrieving the food name from the maximum probability list as the output of the project feature (Figure 4.4) are required to be coded.

```
// Runs model inference and gets result.
FoodModel.Outputs outputs = model.process(image);
List<Category> probability = outputs.getProbabilityAsCategoryList();

int index = 0;
float max = probability.get(0).getScore();
for (int i =0; i < probability.size(); i++){
    if (max < probability.get(i).getScore()){
        max = probability.get(i).getScore();
        index = i;
    }
}
Category output = probability.get(index);
//tvResult.setText(output.getLabel());

//underline the output
SpannableString content = new SpannableString(output.getLabel());
content.setSpan(new UnderlineSpan(), start: 0, content.length(), flags: 0);
tvResult.setText(content);
```

Figure 4.4: One of the additional code is implemented in the food feature

In general, once the food image is obtained from user's device, its format will be changed and it is passed into the food recognition model as an input. The model will process the input to get an output which is a list of probability of food category. By using looping function, the index of the maximum probability score from the list is obtained and it is then utilized to get the food label name with output.getLabel( ). Therefore, the food name is determined and displayed in the textbox provided in the interface. Displaying relevant food nutrition facts and food healthiness level are further to be implemented in this feature as shown in Figure 4.5 as the new flow of this feature with the help of food recognition model. After getting the detected food name, it will pass to the project's food database which mainly sourced from [18], [19] to search its nutrition information and it will be displayed in the interface. Besides, food healthiness level will also be determined based on certain data from nutrition information.

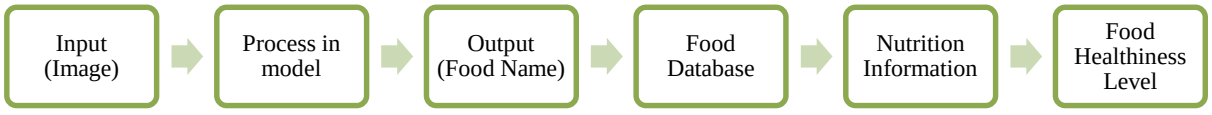


Figure 4.5: Flow of the food feature in the project with the food recognition model usage

4.3 System Architecture Diagram

Wireframe for BGBP mobile application is created by using MockFlow Software:

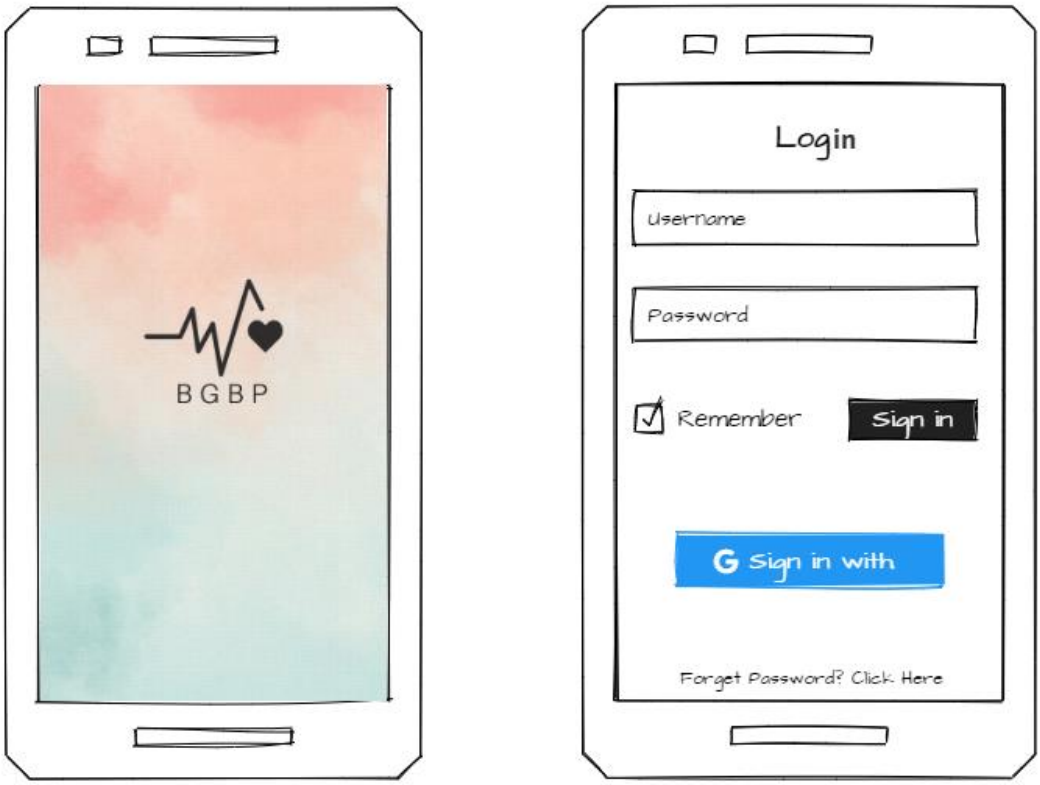


Figure 4.6: Splash screen for mobile application and the registration/login interface

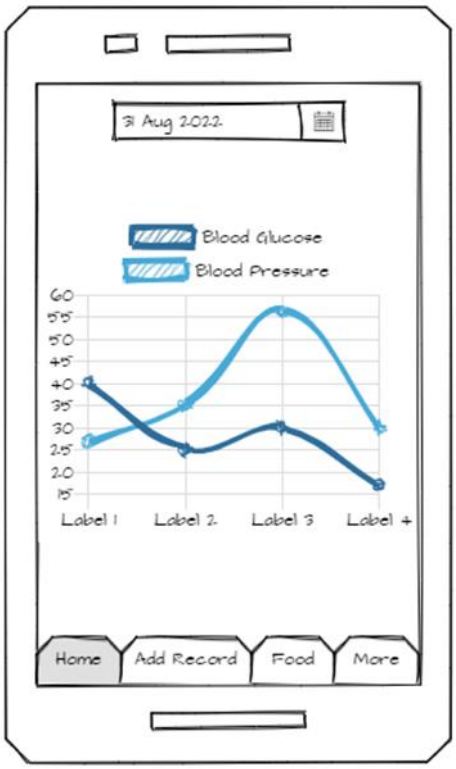


Figure 4.7: Home page where user can filter date to view the daily statistic record of blood glucose and blood pressure level

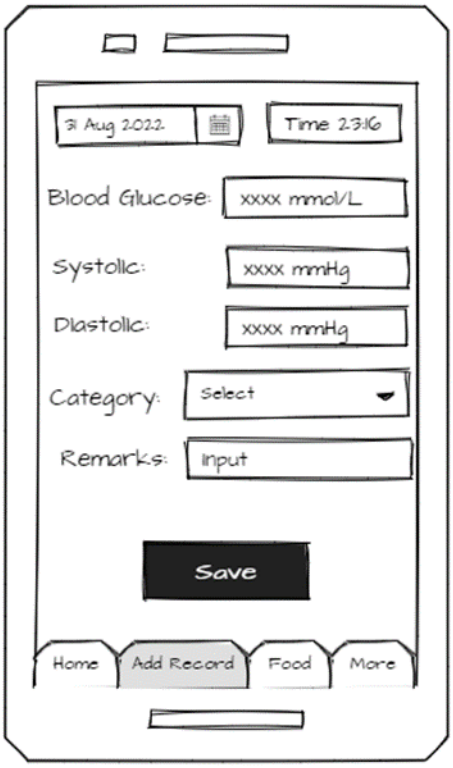


Figure 4.8: Add record page where user need to input the data for blood glucose and pressure and select category such as before breakfast, after lunch and etc. from spinner

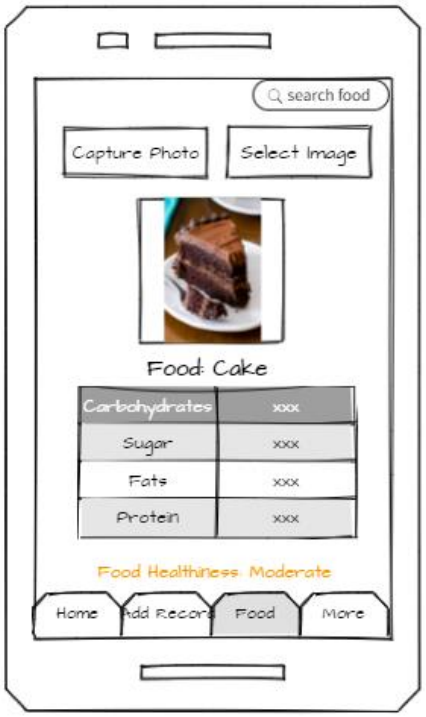


Figure 4.9: Food recognition feature where user can capture photo or select image to view the nutrition facts of food detected and the food healthiness categorization or by searching the food name manually

Figure 5.0: More options interface including features such as report generator, history records, reminder on medication, monthly statistics and logout

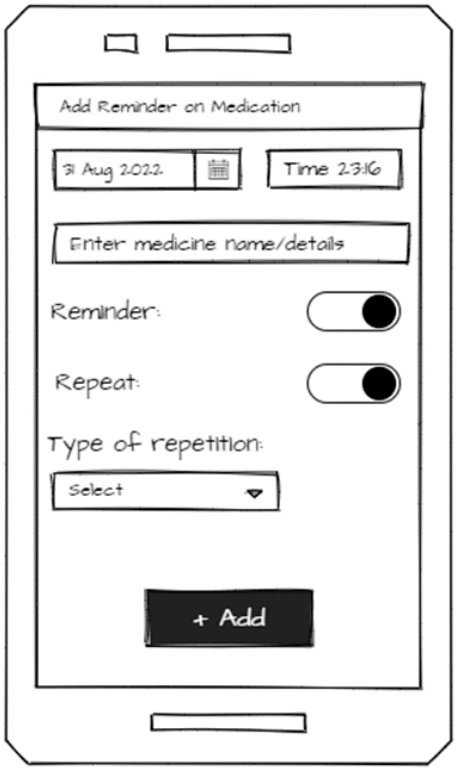


Figure 5.0a: Add reminder on medication interface

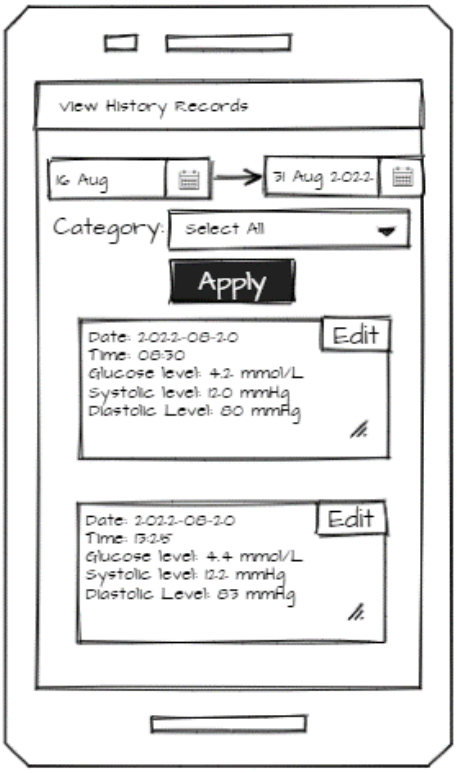


Fig 5.0b: View history records interface where user is able to apply date and category filter and perform modification or deletion on the specific record selected

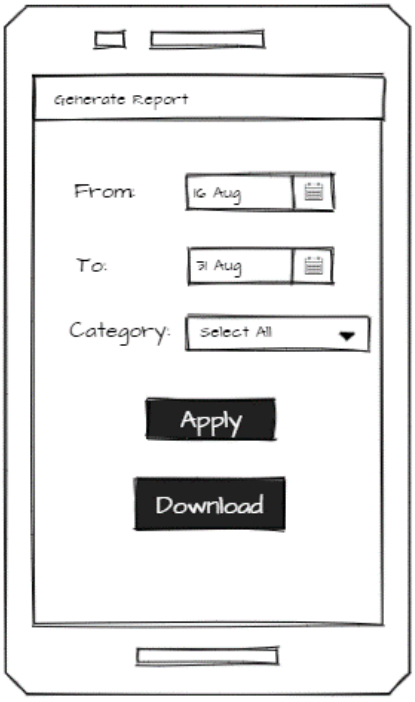


Figure 5.0c: Report generator interface where user is able to pick the date range, apply category filter and download the report to device

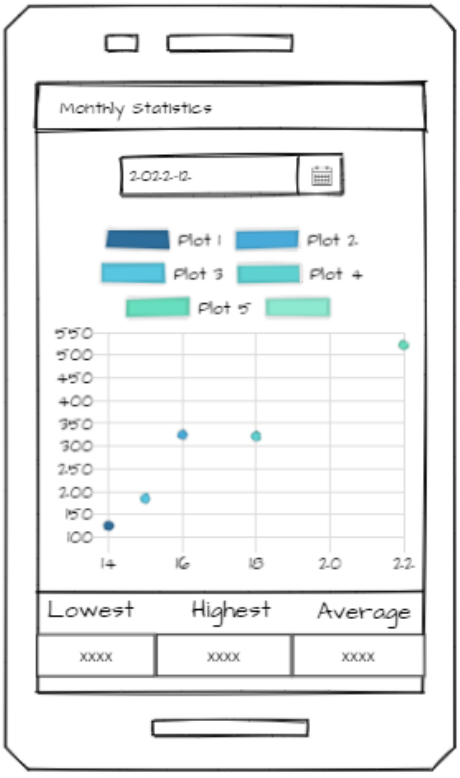


Figure 5.0d: Monthly statistics interface where user is able to select the month to view scatter chart for monthly data and the lowest, highest and average of blood glucose level

Chapter 5

System Implementation

5.1 Software Setup

- Android Studio
    - Version: Arctic Fox (2020.3.1)
    - Released Date: July 28, 2021
    - Utilize this platform to build BGBP mobile application

- Firebase:
    - Authentication (for login, logout, registration user account function)
    - Realtime Database (for storing daily blood glucose records, medication records as well as for the food nutrition information – food database)
    - Cloud Messaging (push notification for reminding user to add daily records)

- MPAndroidChart
    - Version: 3.1.0
    - Released Date: March 21, 2019
    - Released by: Philipp Jahoda
    - Use to plot bar chart for blood pressure record
    - Use to plot scatter chart and line graph for monthly statistics feature

- GraphView
    - Version: 3.1
    - Released Date: August 7, 2013
    - Released by: Jonas Gehring
    - Use to plot line chart for blood glucose record

- TensorFlow Hub
    - Obtain pre-trained food classification model (Architecture: MobileNet V1) from [17]

- USDA (U.S. Department of Agriculture) Food Data Central [18]
    - Obtain food nutrition information to write into BGBP food database

- Nutritionix database [19]
    - Obtain food nutrition information to write into BGBP food database

- iTextPdf
    - Version: 5.5.13.1
    - Released Date: February 25, 2022
    - Use to create PDF documents for report generator feature

5.2 Settings and Configuration

In Android Studio module build.gradle file, enable mlModelBinding to true in order to allow TensorFlow Lite Model to be used in the project file.

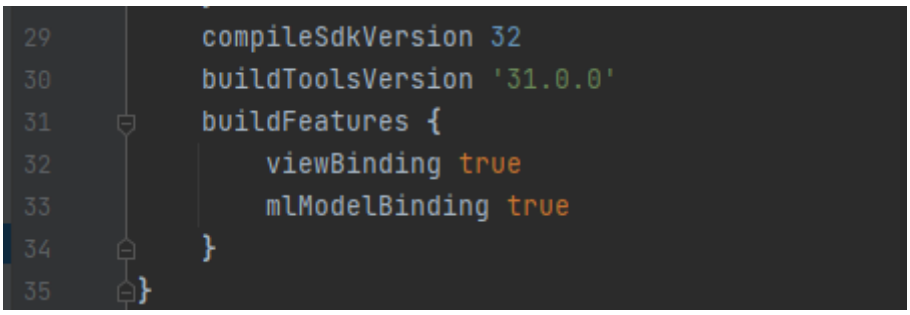


Figure 5.1: Setup 1

Add new TensorFlow Lite Model into resource folder (res).

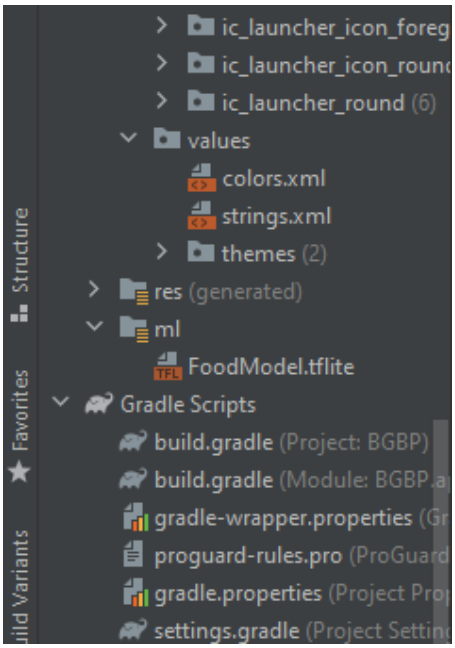


Figure 5.2: Setup 2

In Android Studio project build.gradle file, add "**maven {url 'https://jitpack.io'}**" into repositories to allow external libraries to be used, and also add "**classpath 'com.google.gms:google-services:4.3.14'**" into dependencies to allow Firebase services to be used in this project.

```
// Top-level build file where you can add configuration options common to all su
buildscript {
    repositories {
        google()
        mavenCentral()
        maven { url 'https://jitpack.io' }
    }
    dependencies {
        classpath "com.android.tools.build:gradle:7.0.0"
        classpath 'com.google.gms:google-services:4.3.14'

        // NOTE: Do not place your application dependencies here; they belong
        // in the individual module build.gradle files
    }
}

task clean(type: Delete) {
    delete rootProject.buildDir
}
```

Figure 5.3: Setup 3

In settings.gradle file, add "**maven {url 'https://jitpack.io'}**" into repositories.

Figure 5.4: Setup 4

Under the dependencies of module build.gradle file, add the relevant implementation of external libraries such as google firebase authentication, google firebase database, google firebase messaging, tensorflow lite support, graphview, MPAndroidChart and itextpdf.

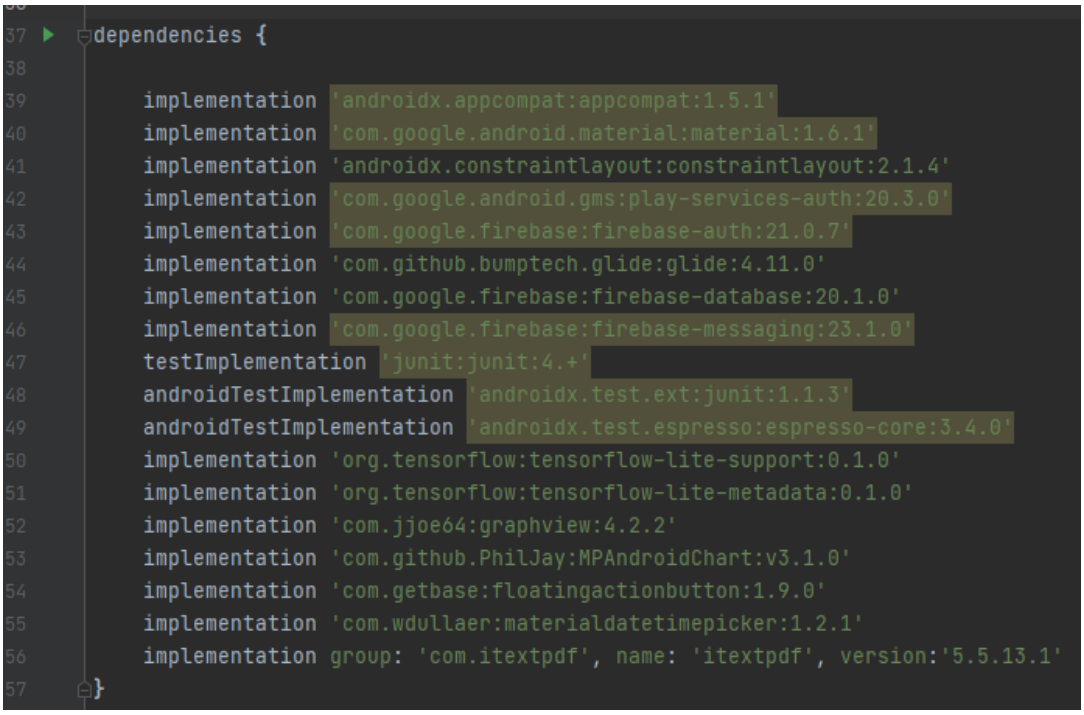


Figure 5.5: Setup 5

In the AndroidManifest.xml, grant uses permission for internet, receive boot, schedule exact alarm, set alarm, wake lock and permission to write into external storage for some features such as Firebase, set reminder on medication and generate report into device.

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="my.edu.utar.bgbp">

    <uses-permission android:name="android.permission.INTERNET" />
    <uses-permission android:name="android.permission.RECEIVE_BOOT_COMPLETED" />
    <uses-permission android:name="android.permission.SCHEDULE_EXACT_ALARM" />
    <uses-permission android:name="android.permission.SET_ALARM" />
    <uses-permission android:name="android.permission.WAKE_LOCK" />
    <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE" />

    <application
        android:allowBackup="true"
        android:icon="@mipmap/ic_launcher_icon"
        android:label="BGBP"
```

Figure 5.6: Setup 6

5.3 System Operation

5.3.1 User Interface (UI) of BGBP mobile application

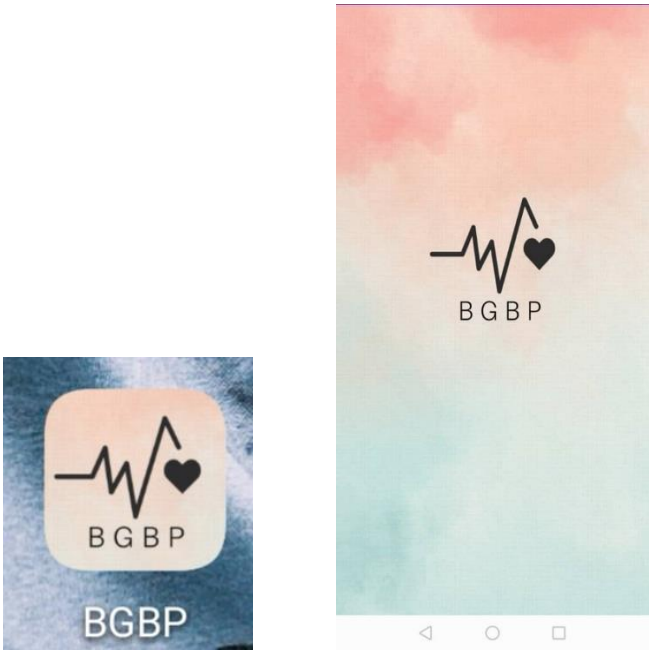


Figure 5.7: App icon and splash screen designed using Canva software for the mobile application

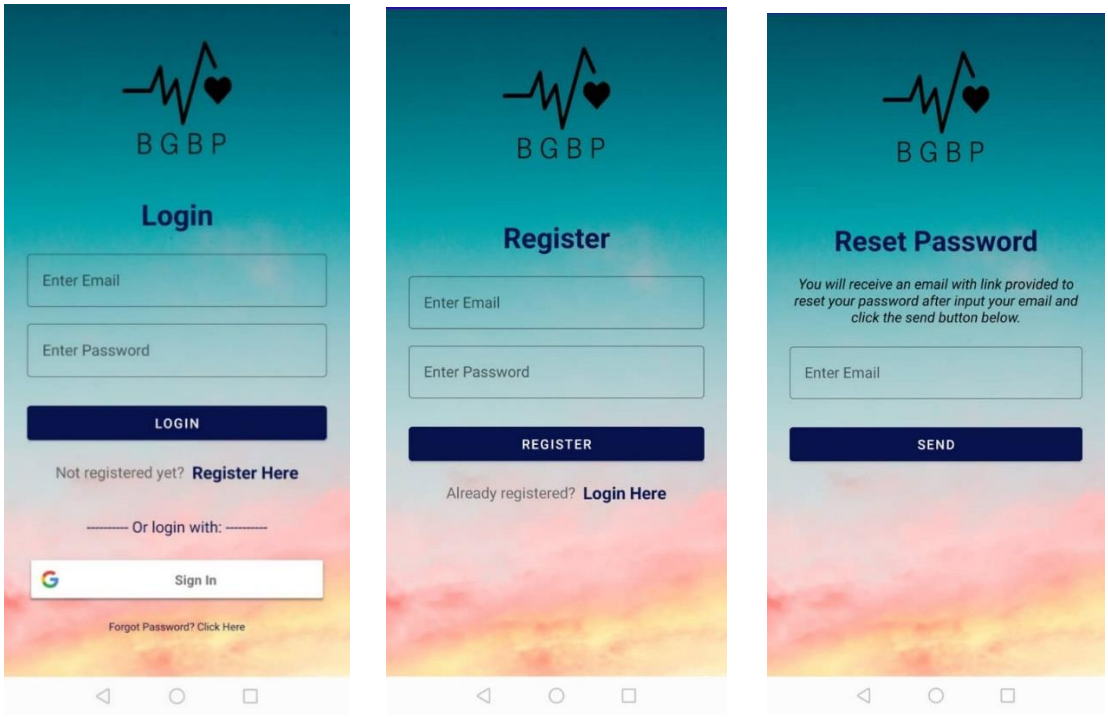


Figure 5.8: Login (either using email-password or Google sign-in method), register account and reset password interface

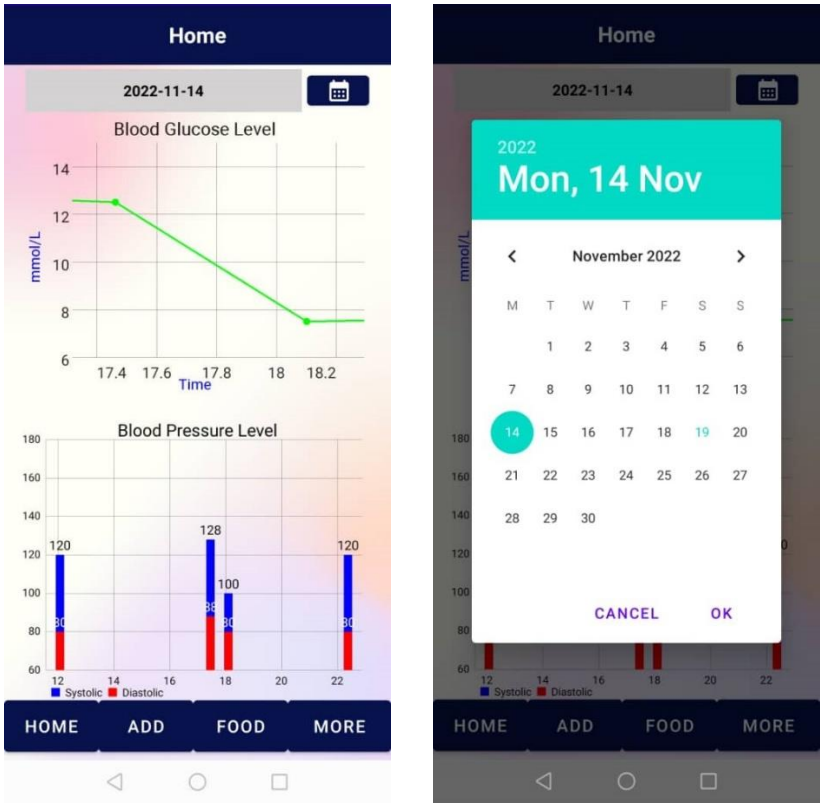


Figure 5.9: Home dashboard interface (with daily blood glucose and blood pressure level graph view) and able to apply date filter from DatePickerDialog function

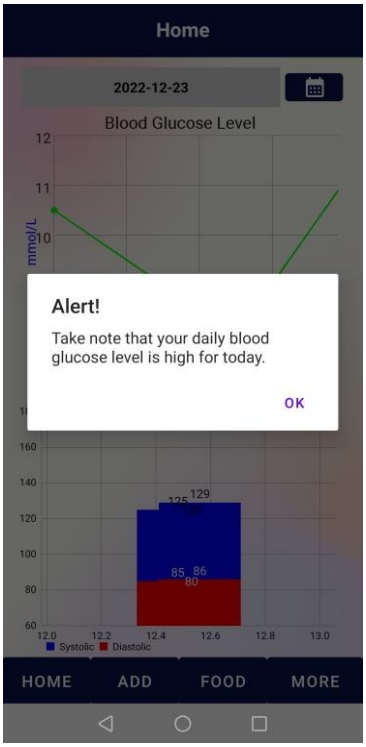


Figure 6.0: Alert message will be displayed to user if the day had exceeded the blood glucose value with 10.5 in home dashboard

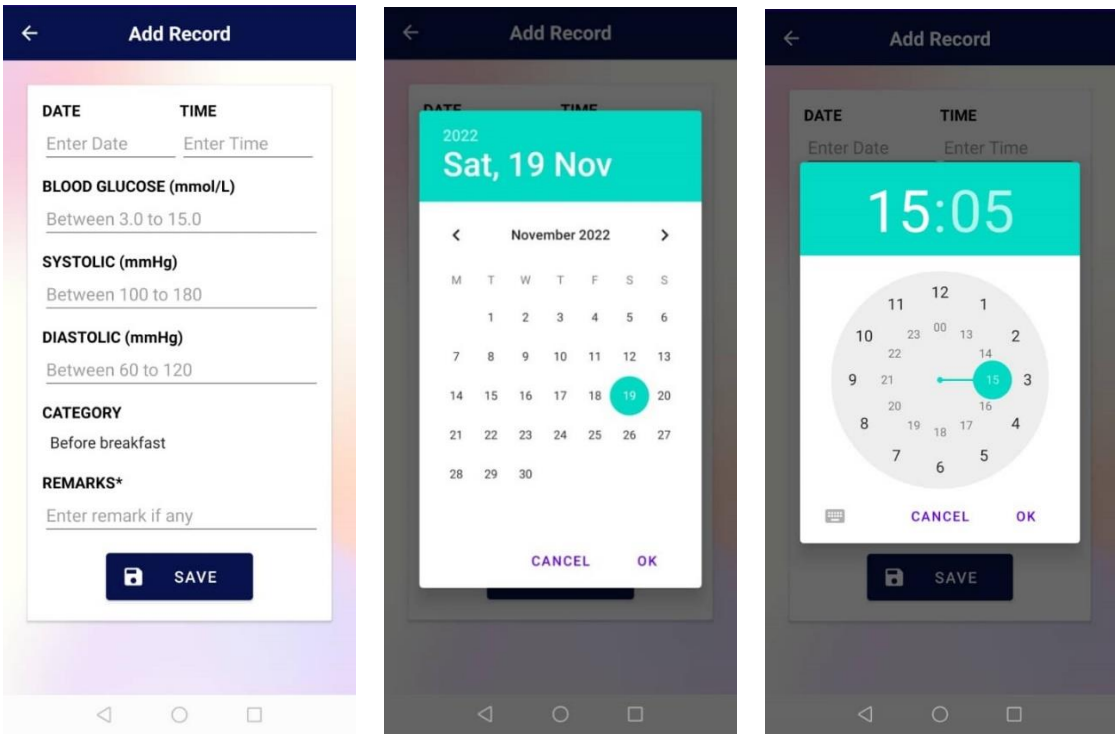


Figure 6.1: Add record interface (with textbox, Spinner for category, DatePickerDialog, TimePickerDialog for selecting date and time)

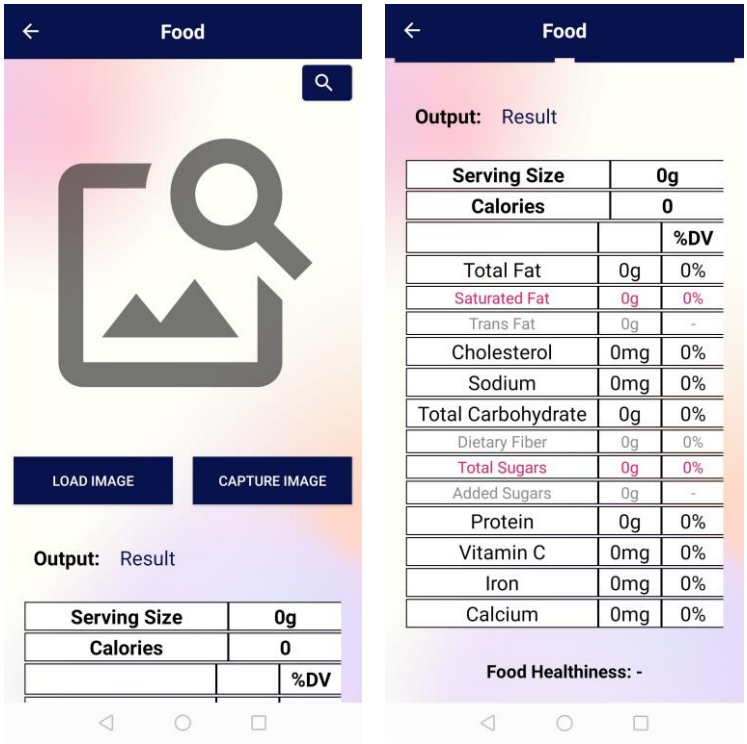


Figure 6.2: Food interface (with search function, load image or capture image to detect the output (food name) and nutrition table with healthiness level)

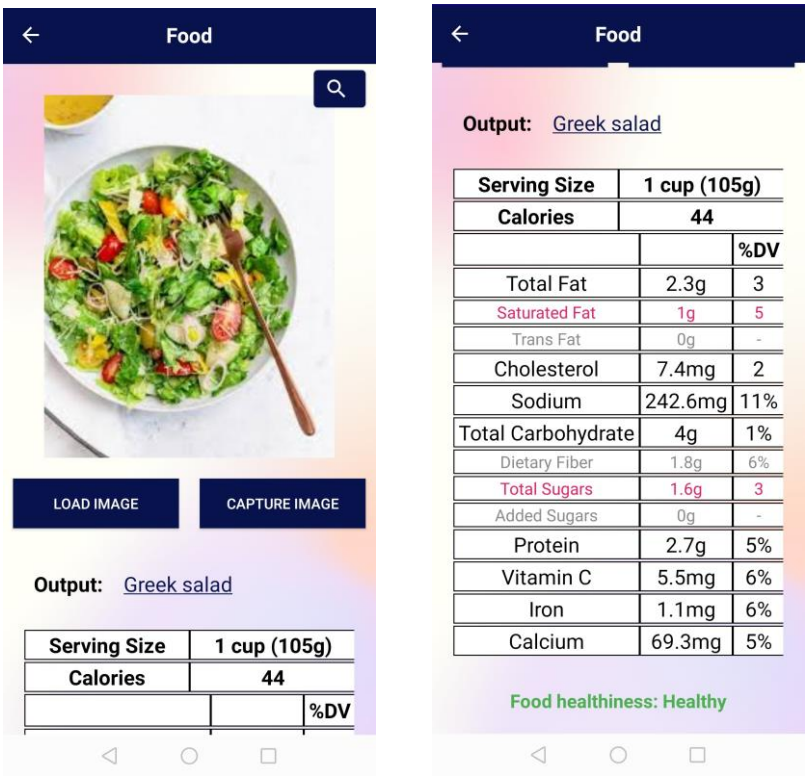


Figure 6.3: Example for using load image function and the food detected is greek salad with its nutrition details displayed in the table and food healthiness value (healthy) is shown

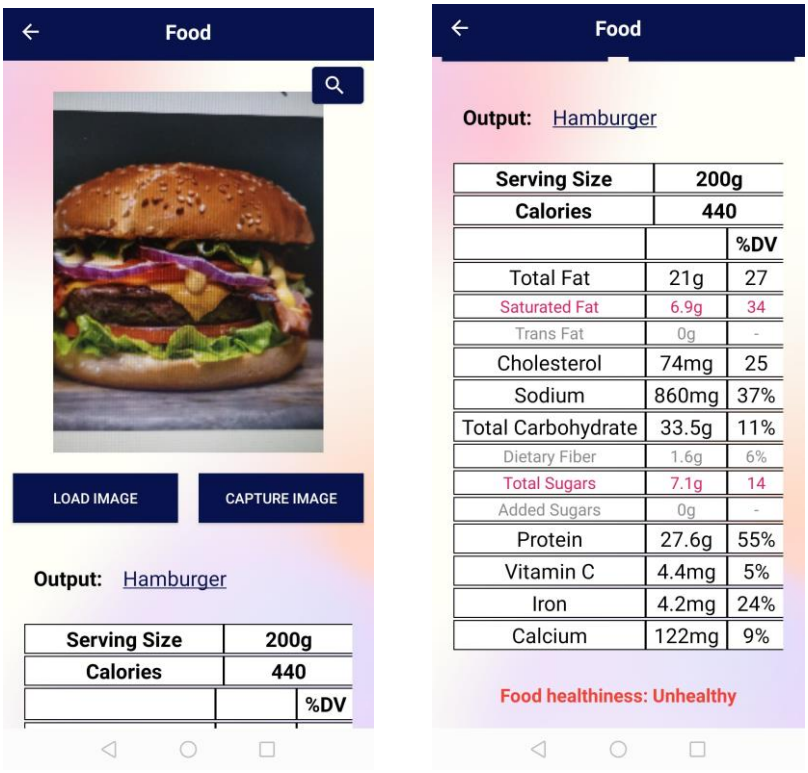


Figure 6.4: Example using capture image function and the food detected is hamburger with its nutrition details displayed in the table and food healthiness value (unhealthy) is shown

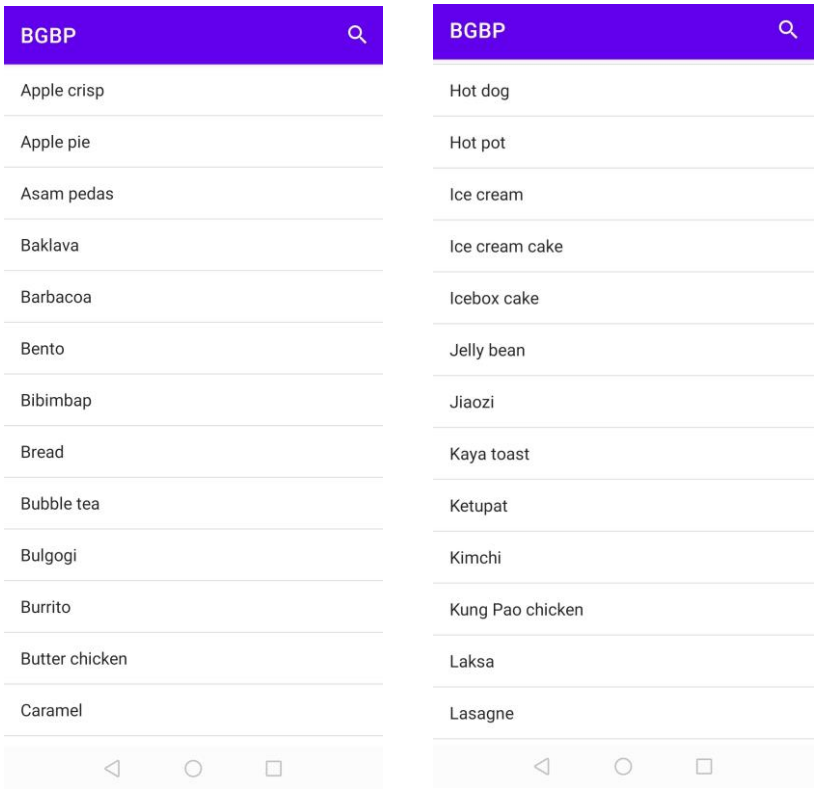


Figure 6.5: Access to list of food available in food database from search button and user can click to view the specific food nutrition information or enter the food name to search through

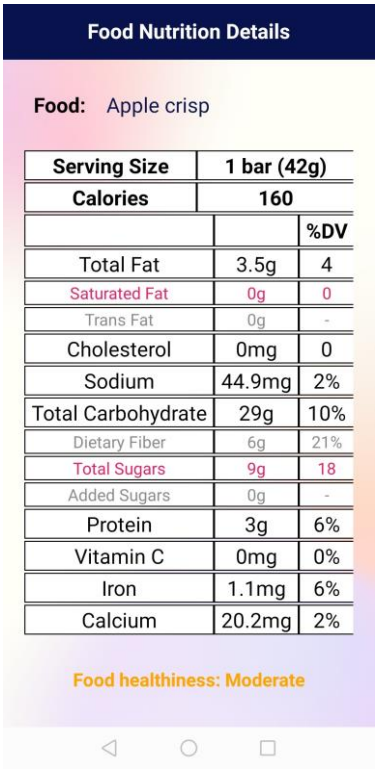


Figure 6.6: The interface after clicking the food (Apple crisp) from the list

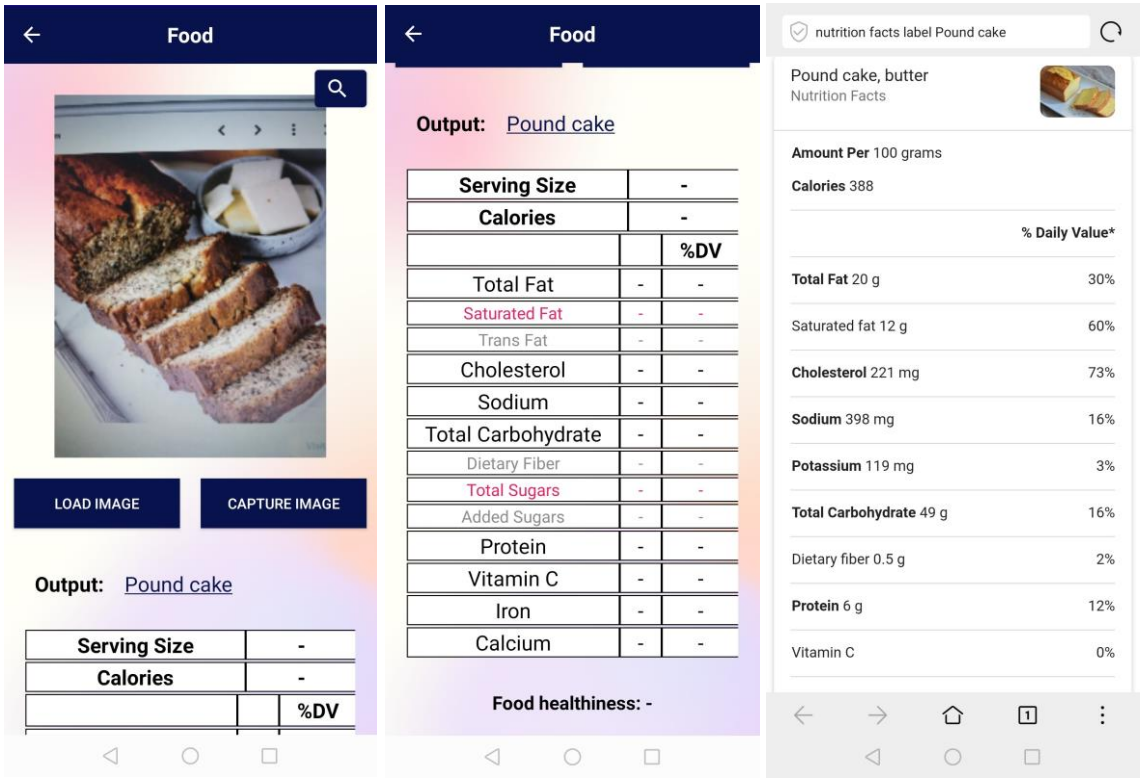


Figure 6.7: If the food detected (output) is not available in the food database, user can click the underlined food name ("Pound cake") and it will redirect user to Google quick search for displaying the relevant food nutrition details

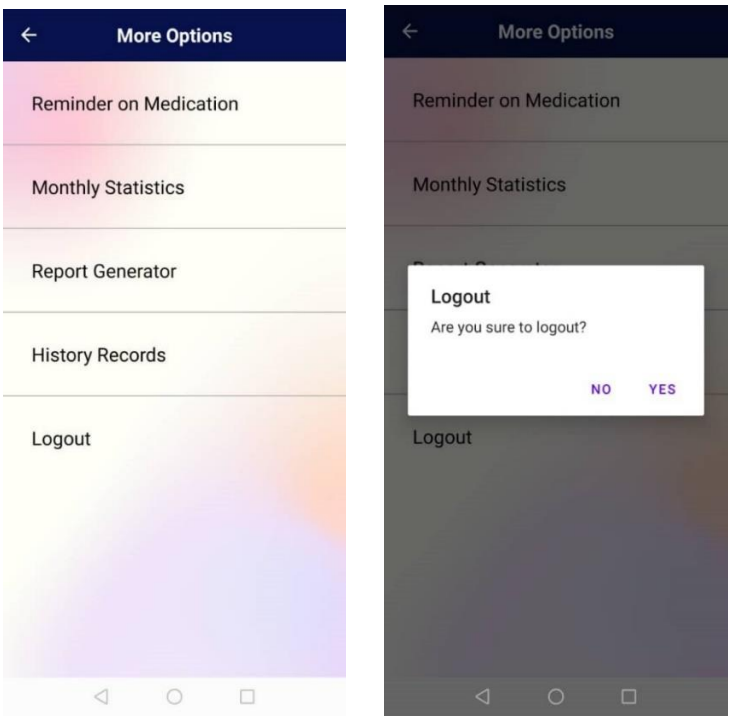


Figure 6.8: More options interface (including other functions), AlertDialog for logout function

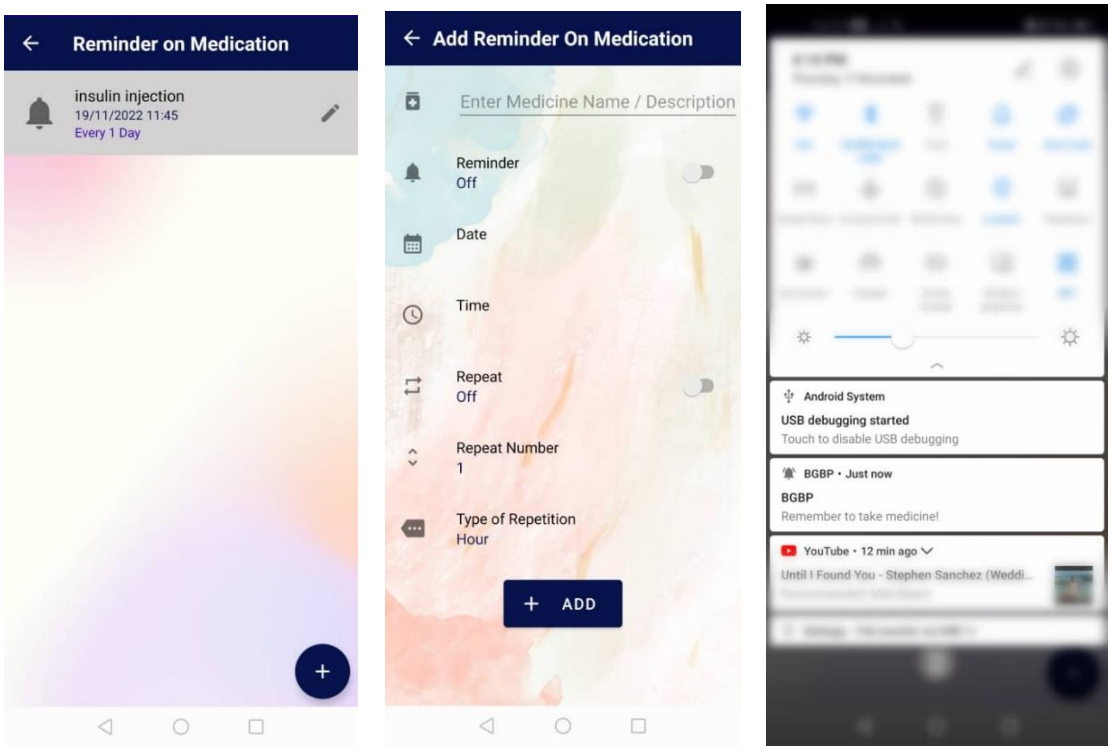


Figure 6.9: RecyclerView for medication record (Left); Add reminder on medication interface with textbox, toggle switch to turn on or off the reminder or repetition (Middle); Push notification received as reminder (Right)

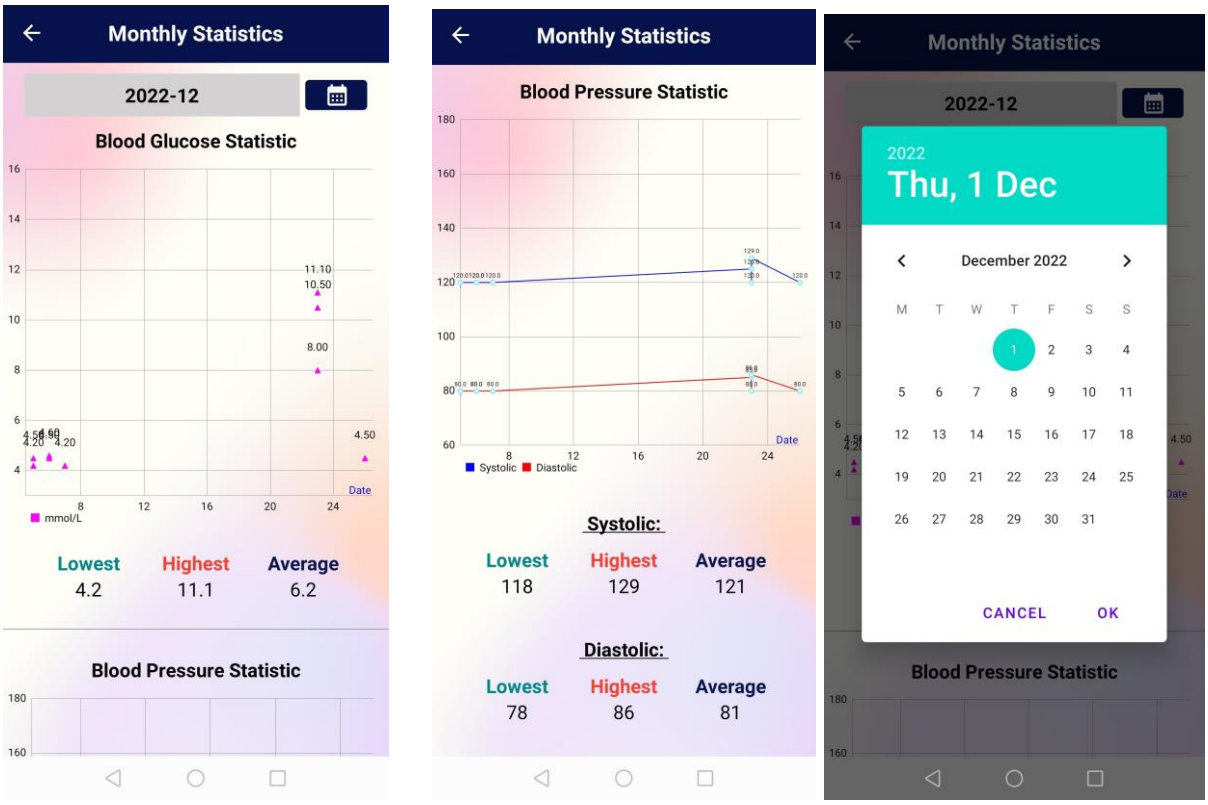


Figure 7.0: Monthly statistics interface (allow user to select the month from DatePickerDialog) and display blood glucose statistic in scatter chart, blood pressure statistic in line chart with the lowest, highest and average data shown for the month

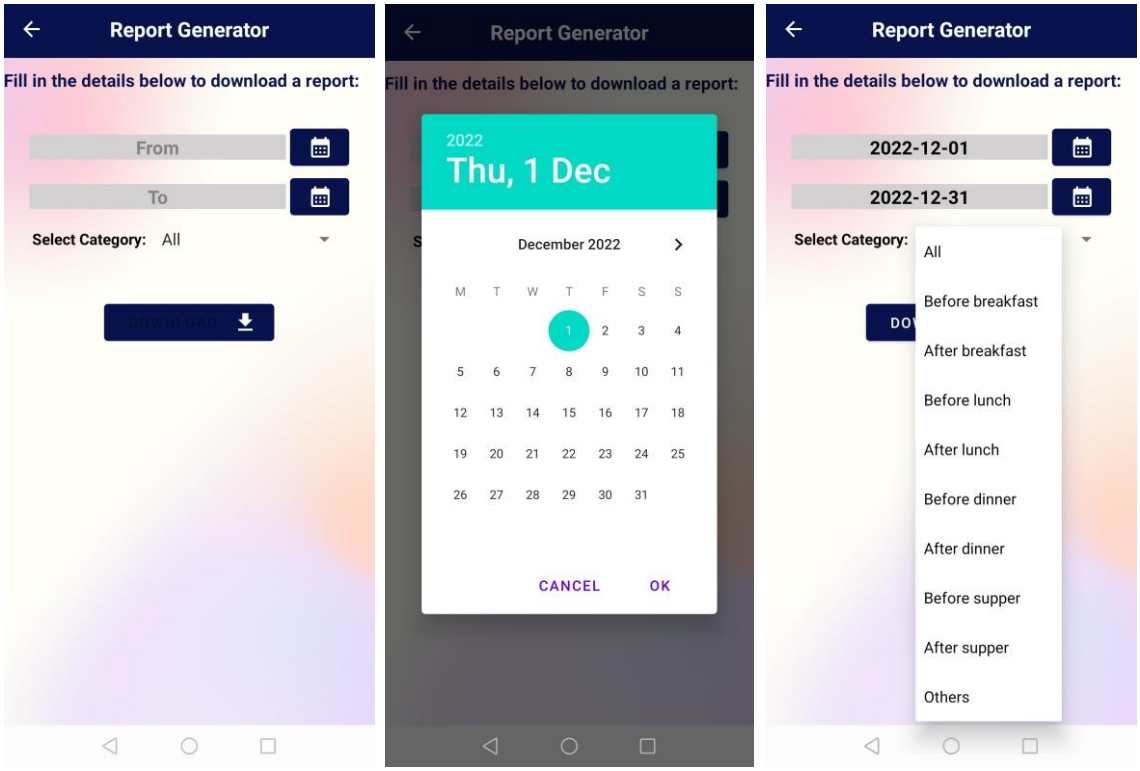


Figure 7.1: Report generator interface (allow user to pick from-date, to-date as well as apply category filter either select all or specific timeline given to download the statistics PDF report into the device)

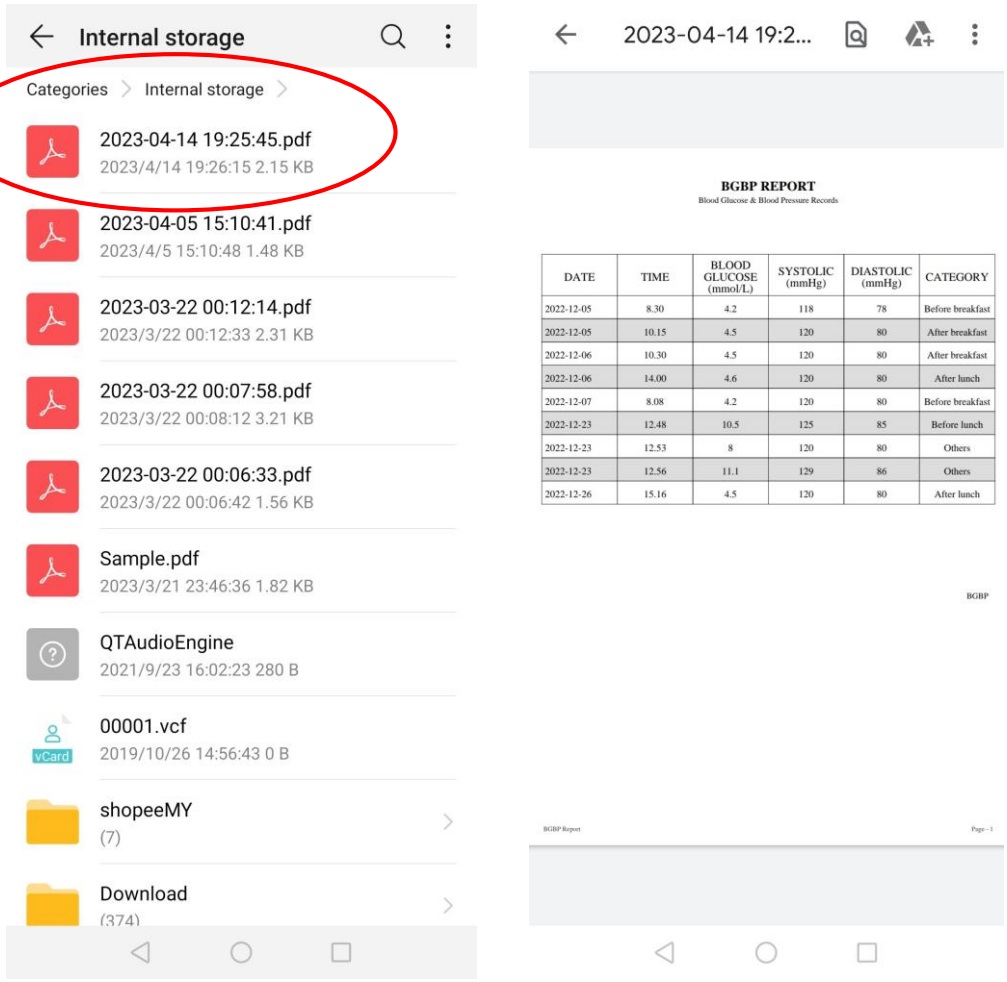


Figure 7.2: In the internal storage of the device, the generated PDF report can be found and the report is in a tabular format showing date, time, blood glucose data, blood pressure data and also category

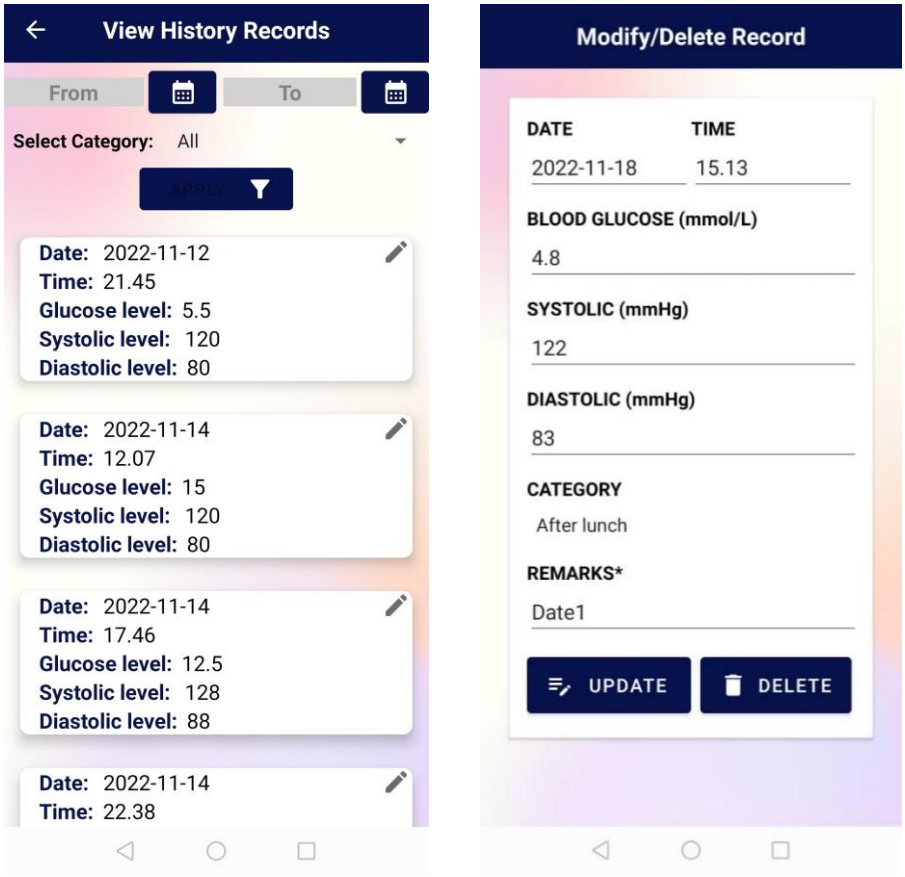


Figure 7.3: History records interface with RecyclerView layout of all records and able to modify or delete the specific record

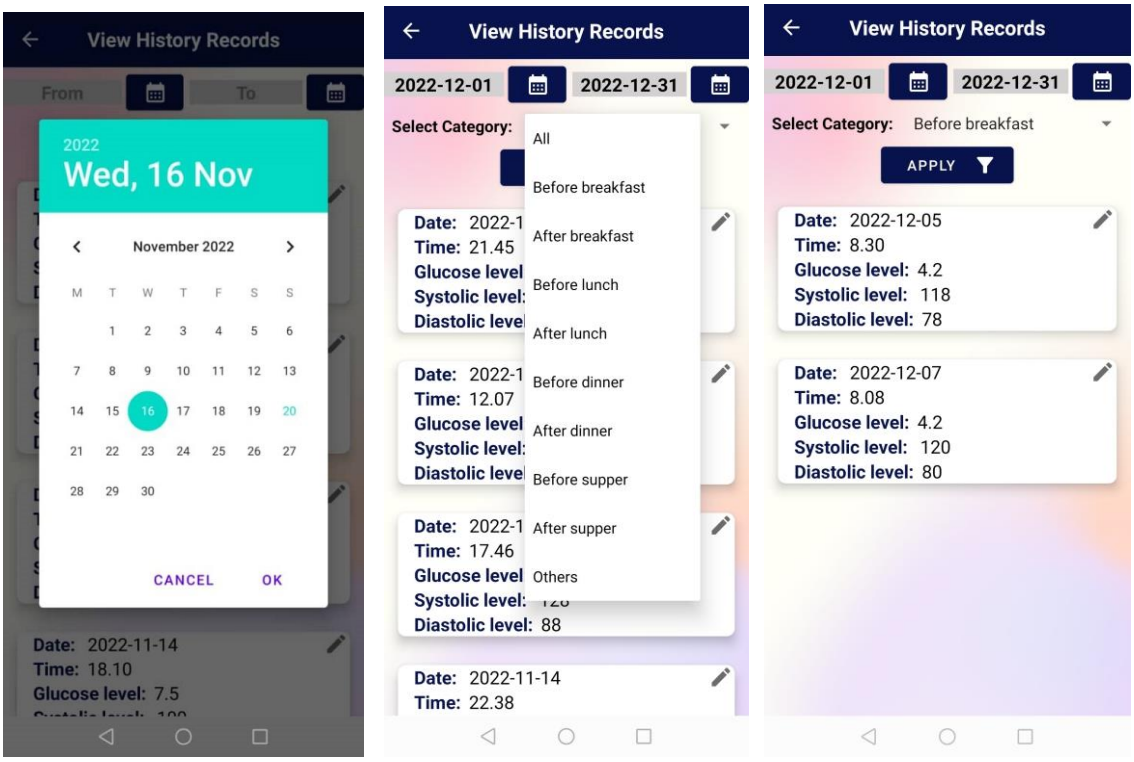


Figure 7.4: History records is also able to apply filter for date range with DatePickerDialog and category filter (for e.g. only showing 'before breakfast' records from 01/12/2022 to 31/12/2022 after applied filters)

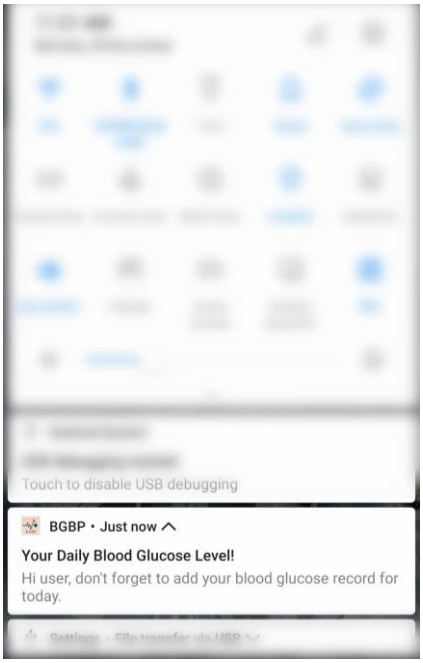


Figure 7.5: Firebase Cloud Messaging push notification (remind user to fill-in daily blood glucose record)

5.3.2 Comment and highlight the feasibility of proposed method

The user account registration and login function is implemented with Firebase Authentication where user can choose to use either email with password method or Google sign-in method. Firebase Authentication also provides reset password function. User will receive an email with a link provided to reset the account password after provide email address in the application.

After login, the home dashboard will be displaying the daily blood glucose level in line-chart and also blood pressure level in bar-chart which includes both systolic and diastolic records. This can allow user to view a summary of daily blood glucose and blood pressure level. By default, the date input will be the current date. User is able to pick the wanted date by clicking the calendar button and DatePickerDialog will be displayed so that it is convenient for user to select instead of manually typing the date. GraphView external library and MPAndroidChart library are being used to plot the graphs. Records will be first retrieved from Firebase Realtime Database with the selected date query and only insert into DataPoint and ArrayList for plotting the charts. The charts are able to zoom in and out and also scrollable for a better and clearer view. Besides, Android AlertDialog is being implemented in home dashboard to act as an alert message to aware user if the day has exceeded the blood glucose level with a value of 10.5. This can be done by looping through the blood glucose data from Firebase database with the specific date query to find the exceeding value.

In the ‘add record’ section, user is required to fill in all textboxes given except remarks. DatePickerDialog and TimePickerDialog features are being used for entering date and time entries. User need to manually fill in blood glucose, systolic and diastolic readings. There is a fixed range of values set for these three inputs, for instance, user can only input numerical value from 3.0 until 15.0 for blood glucose entry (mmol/L), a numerical value from 100 to 180 for systolic entry (mmHg) and 60 to 120 for diastolic entry (mmHg). Spinner feature is also implemented for category entry such as before breakfast, after lunch, before dinner and so on, so that user can directly choose from the options given. When user clicks the ‘Save’ button, the record will be stored into the Firebase Realtime Database and a toast message will be displayed at the bottom of interface if it is successfully saved into the database. The record will act as reference for user to self-monitor own blood glucose and blood pressure level.

Furthermore, food recognition technology is being implemented in the 'Food' section. A pre-trained CNN MobileNet food classification model [17] is imported to Android Studio from TensorFlow Hub and is utilized to detect the food image from user's device. User is allowed to either capture food image or load the image from device. The output (food name) generated will then form a query to pass into Firebase database (food database) through looping to check for the availability of food nutrition information. All the food nutrition data source is from USDA (U.S. Department of Agriculture) Food Data Central [18] and Nutritionix database [19]. The food nutrition information is extracted and written into Firebase database as the food database in BGBP mobile application. The food database consists of 155 food with its nutrition information, including Western food such as spaghetti, pizza and etc., Asian food such as char kway teow, rendang, nasi lemak and etc., as well as desserts such as pancake, cakes and etc.

If the food is available in the food database, the nutrition details including serving size, calories, total fat, saturated fat, trans fat, cholesterol, sodium, total carbohydrate, dietary fiber, total sugars, added sugars, protein, Vitamin C, iron and calcium will be retrieved and write into the table rows and cells provided. Hence, user can view the food nutrition facts label in a tabular form for improving the awareness. The highlighted nutrition information such as the total sugars and saturated fat indicate as the important aspects for diabetes patients to take note.

Besides, the food detected will also be categorized into its healthiness value, either healthy, moderate or unhealthy. Based on [20], the percent Daily Value (%DV) can be used to determine the food healthiness as it shows how much a nutrient in a serving of food contributes to a total daily diet. In this feature, the %DV of total sugars, cholesterol, saturated fat and total fats are retrieved from database and used to evaluate for the healthiness level. If 10%DV or less, it indicates as a healthy level, 20%DV or more indicates as unhealthy level and in between 10%DV to 20%DV indicates as moderate level. First, the %DV of total sugars is considered, if it is 10% or lower, the %DV of saturated fat is checked with the same condition. If both are below 10%DV, then the food is considered healthy. If the %DV of total sugars or saturated fat falls between 10% and 20%, then the food is considered in moderate level of healthiness. For the values that are about 20%, the food is considered unhealthy. However, if there is no data available for %DV of saturated fat, %DV of cholesterol is then used to check for the same conditions. If there is no data for cholesterol either, the %DV of total fats is used along with the %DV of total sugars to determine the food healthiness level.

If the food is not available in the food database, user is allowed to click the underlined output generated (food name). Then, it will redirect user to Google quick search and show the relevant food detected nutrition facts label to user. Moreover, there is an alternative method to view the food nutrition details in the application. A search button is implemented to allow accessing directly to the food database. Once user clicks the button, a new interface with list of food is displayed to allow user to search for the wanted food to view its details. User can also manually type the food name in the space provided. A query with the food name is again generated to find through within the food database in order to retrieve the nutrition information and to be displayed in the tabular format and determined the food healthiness. If the food is not available in the list, user can click search icon to link to Google quick search again. The list of food in search feature is implemented using MenuItem, ListView and also SearchView. In general, a combination of food recognition technology and manual input have been implemented in this project to handle the case where the model cannot detect certain dishes. In addition, the approach of redirecting user to Google quick search in order to show the food nutrition details is also implemented to handle the case where the food information is not available in the existing food database. This feature can help user to control and plan a healthy diet by providing the important nutrition information of food and healthiness level for user reference.

In the 'more options' section, there are few features such as reminder on notifications, monthly statistics, report generator, history records and logout. Reminder on medication function can help to notify user to take medicine especially for elderly patients that are forgetful. A FloatingActionButton is being implemented in the interface for user to add new medicine reminder. User is required to enter medicine name or description in the textbox provided, select date and time from DatePickerDialog and TimePickerDialog features, enter repeat number if any and choose whether to turn on or off for the reminder and repetition. This medicine record will also be saved into Firebase Realtime Database for further action. A successful toast message will be then displayed to notify user. A RecyclerView layout of medicine records will be displayed for user reference and it is able to update for any changes or remove from database. This push notification reminder is implemented using AlarmManager and BroadcastReceiver Android built-in function.

For the monthly statistics feature, which enables user to view back monthly data of both blood glucose and blood pressure levels as well as the lowest, highest and average value for the specific month. In this feature, user can choose the specific month from DatePickerDialog, and the data will be retrieved from Firebase database to store into ArrayList for finding the lowest and highest value as well as calculate for the average value for both blood glucose and blood pressure records. The data retrieved from the database will also be stored into DataPoint in order to plot scatter chart for displaying the whole month of blood glucose data and to plot line chart for blood pressure data (systolic and diastolic) by using MPAndroidChart external library. Hence, user is allowed to view the overall blood glucose level per day through the scatter chart and blood pressure level in a multi-line graph in the application, as well as the information of the lowest, highest and average readings for the specific month.

In the report generator feature, user can select start date and end date with DatePickerDialog as well as category, either select all or select the specific timeline such as before lunch, after lunch etc. to download the PDF report into device. This function is implemented with an external library, iTextPdf. Before that, permission to access external storage need to be granted so that the PDF documents are able to download into user's device. After selecting date and category, a query is created to pass through Firebase database to retrieve the wanted records and store them into an ArrayList. Then, the parameter is passed to a function which helps to create a new PDF file, where a new file path is first created and the document margin is set to create page header, table, cell, padding, alignment and color. In this feature, the data that will be displayed to user in the PDF report table are date, time, blood glucose, blood pressure (systolic and diastolic) and category. This feature enables user to take note and monitor on the blood glucose level for a specific range of dates and the report acts as future reference for medical consultation.

User is also allowed to view back all blood glucose records in 'history records' section. All records are retrieved from Firebase Realtime Database and a general view of the records are displayed by using RecyclerView layout. User can select the edit button to view the more detailed record and perform any modification or deletion. There is also a date range filter function to bring convenience for user to view a specific range of records. User need to click the calendar button and choose the date from DatePickerDialog for 'from' date and 'to' date in order to apply changes. If there is no record found between the date ranges, a toast message

will be displayed to notify user. Likewise, a category filter is also included in this feature to allow user for viewing more specific records. User can select to view all categories or specific category such as before breakfast, after breakfast, before lunch and etc. from the Spinner feature.

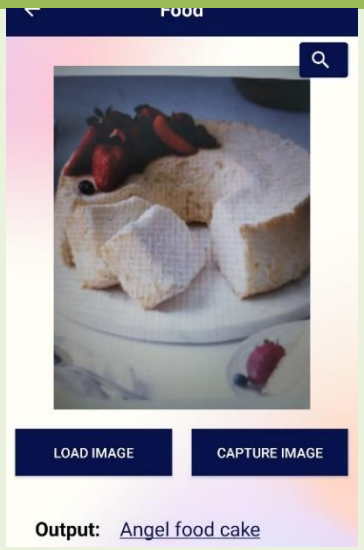
Firebase Cloud Messaging is also implemented in this mobile application. A recurring scheduled push notification is sent to all app users at specific time daily, 3pm (GMT+08:00 Malaysia Time) to act as a reminder for user to add daily blood glucose records. For the logout function, an AlertDialog box will be pop out asking for user confirmation. If user has successfully logout, it will redirect user to the login interface again.

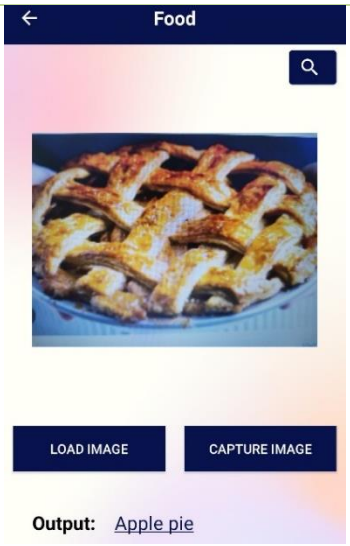
Chapter 6

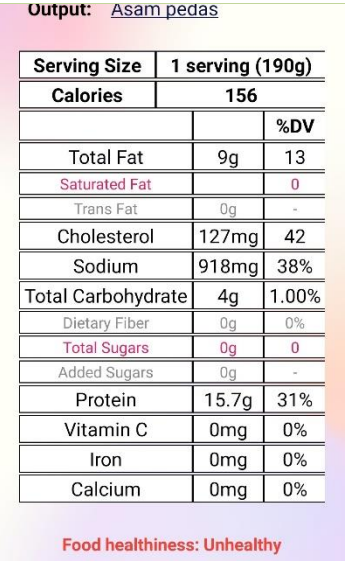
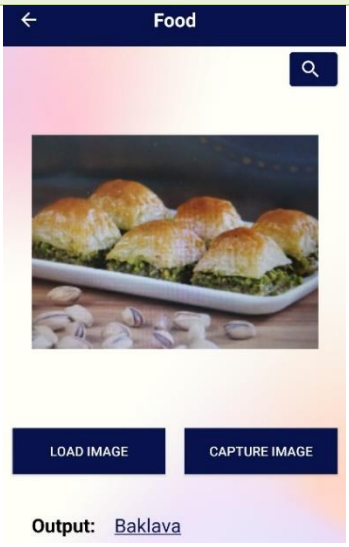
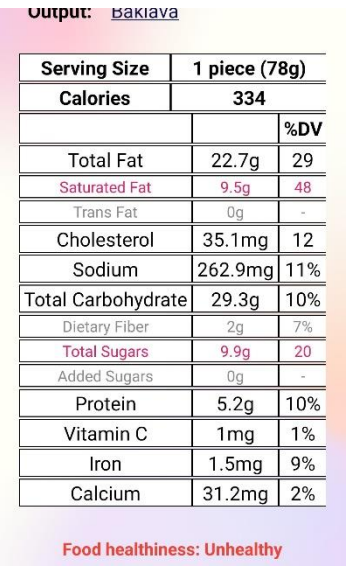
System Evaluation and Discussion

6.1 Food Recognition Model Testing

Food detection testing (100 types of food) for the recognition model:

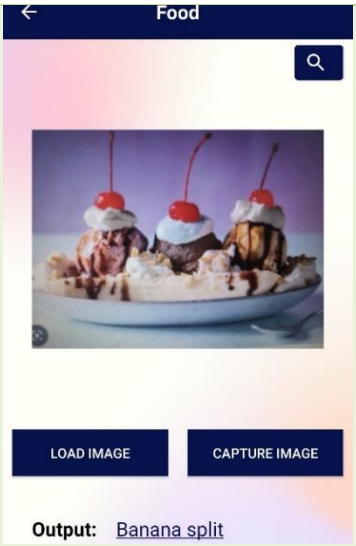
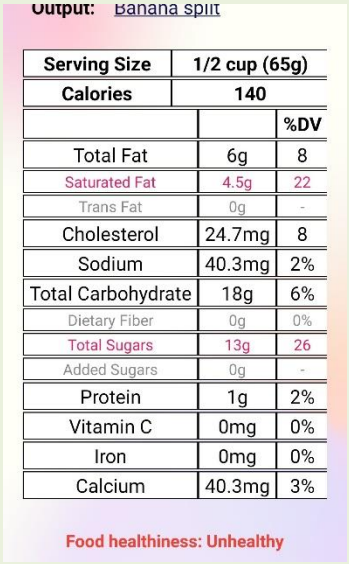
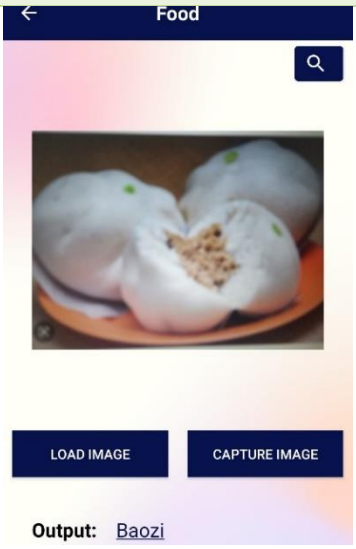
No.	Food	Testing Outcome	Output Correctness
1	Angel food cake	 Output: Angel food cake Serving Size 0.125 cake (49g) Calories 120 %DV Total Fat 0g 0 Saturated Fat 0g 0 Trans Fat 0g - Cholesterol 0mg 0 Sodium 125mg 5% Total Carbohydrate 27g 9% Dietary Fiber 0g 0% Total Sugars 21g 42 Added Sugars 0g - Protein 3g 6% Vitamin C 0mg 0% Iron 0.7mg 4% Calcium 0mg 0% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in sugars) are displayed.

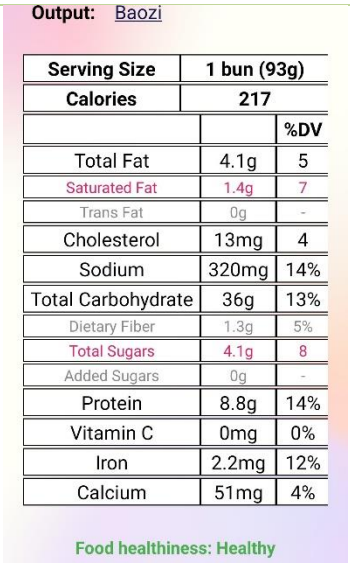
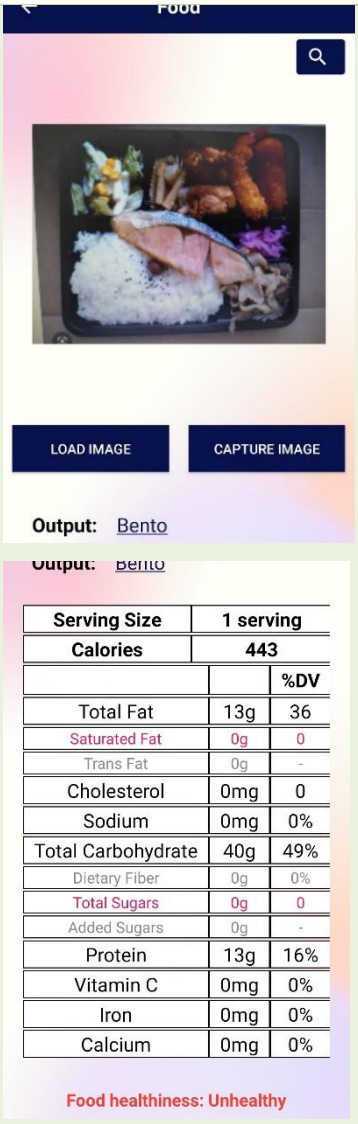
2	Apple pie	 **Output:** Apple pie **Serving Size** 1/8 pie (131g) **Calories** 380 %DV Total Fat 15.1g 19 Saturated Fat 3g 15 Trans Fat 0g - Cholesterol 0mg 0 Sodium 262mg 11% Total Carbohydrate 58.3g 19% Dietary Fiber 2.1g 7% Total Sugars 28.8g 58 Added Sugars 0g - Protein 2.8g 6% Vitamin C 7.5mg 8% Iron 1.2mg 7% Calcium 18.3mg 1% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in sugars) are displayed.
3	Asam pedas		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in cholesterol) are displayed.

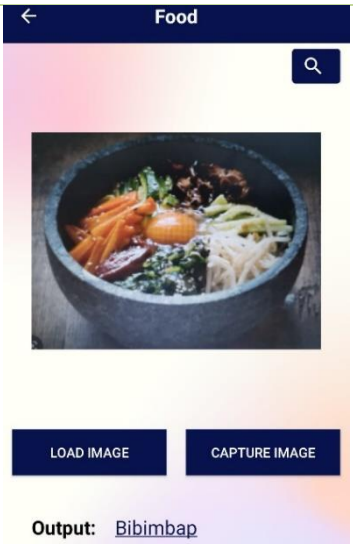
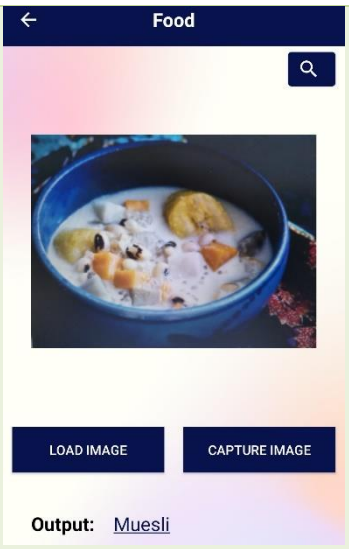
		Output: Asam pedas  Food healthiness: Unhealthy	
4	Baklava	 Output: Baklava  Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in sugars and saturated fat) are displayed.

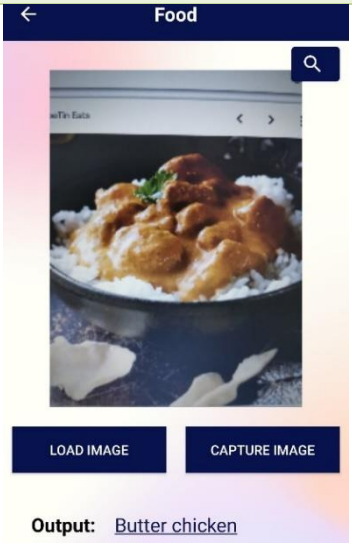
Serving Size	1 serving (190g)	
Calories	156	
		%DV
Total Fat	9g	13
Saturated Fat		0
Trans Fat	0g	-
Cholesterol	127mg	42
Sodium	918mg	38%
Total Carbohydrate	4g	1.00%
Dietary Fiber	0g	0%
Total Sugars	0g	0
Added Sugars	0g	-
Protein	15.7g	31%
Vitamin C	0mg	0%
Iron	0mg	0%
Calcium	0mg	0%

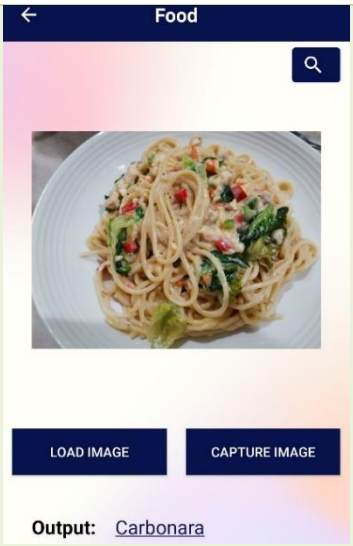
Serving Size	1 piece (78g)	
Calories	334	
		%DV
Total Fat	22.7g	29
Saturated Fat	9.5g	48
Trans Fat	0g	-
Cholesterol	35.1mg	12
Sodium	262.9mg	11%
Total Carbohydrate	29.3g	10%
Dietary Fiber	2g	7%
Total Sugars	9.9g	20
Added Sugars	0g	-
Protein	5.2g	10%
Vitamin C	1mg	1%
Iron	1.5mg	9%
Calcium	31.2mg	2%

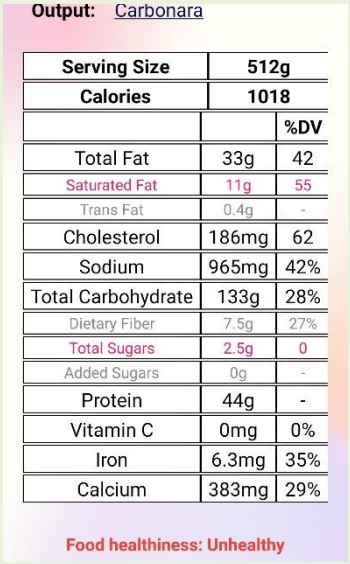
5	Banana split	 	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in sugars and saturated fat) are displayed.
6	Baozi		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

			
7	Bento		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in total fat) are displayed.

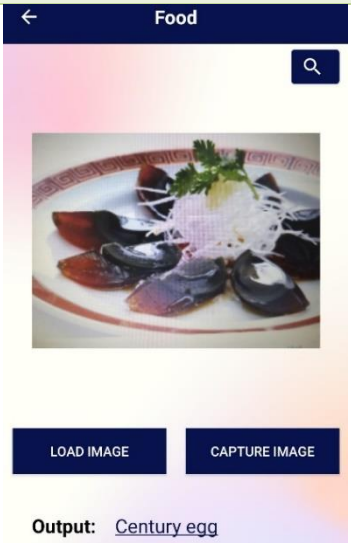
8	Bibimbap	 Output: Bibimbap **Serving Size** 1 bowl (864g) **Calories** 972 %DV Total Fat 22g 28 Saturated Fat 5.7g 29 Trans Fat 0.3g - Cholesterol 239mg 80 Sodium 1655mg 72% Total Carbohydrate 155g 56% Dietary Fiber 6.4g 23% Total Sugars 11g 0 Added Sugars 0g - Protein 36g - Vitamin C 0mg 0% Iron 8.3mg 46% Calcium 233mg 18% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in saturated fat) are displayed.
9	Bubur Cha Cha		▪ Cannot detect the food correctly (recognized as muesli) ▪ No data available (Nutrition details and food healthiness level)

		Output: Muesli Serving Size - / Calories - / %DV Total Fat - - Saturated Fat - - Trans Fat - - Cholesterol - - Sodium - - Total Carbohydrate - - Dietary Fiber - - Total Sugars - - Added Sugars - - Protein - - Vitamin C - - Iron - - Calcium - - Food healthiness: -	
10	Butter chicken	 Output: Butter chicken Output: Butter chicken Serving Size 4 pieces (75g) / Calories 220 / %DV Total Fat 13g 17 Saturated Fat 7g 35 Trans Fat 0g - Cholesterol 35.3mg 12 Sodium 210mg 9% Total Carbohydrate 18g 6% Dietary Fiber 4g 14% Total Sugars 1g 2 Added Sugars 0g - Protein 5g 10% Vitamin C 2.4mg 3% Iron 2.7mg 15% Calcium 80.3mg 6% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in saturated fat) are displayed.

<table>
<tr>
<td>11</td>
<td>Carbonara</td>
<td> 

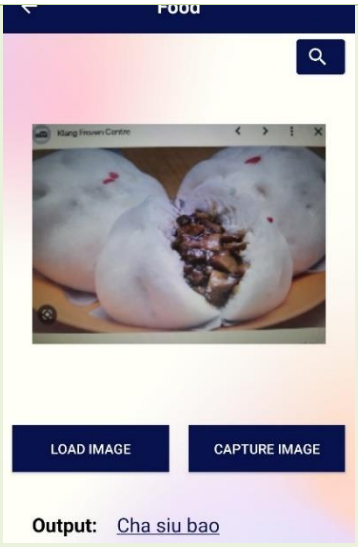

</td>
<td>

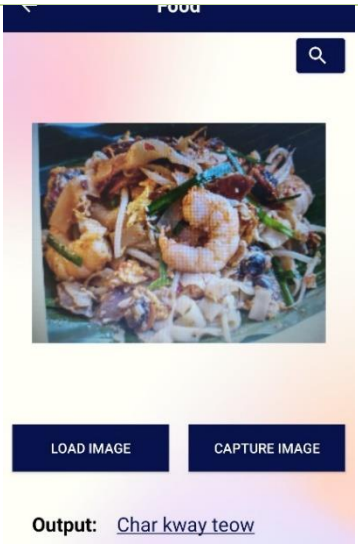
Able to detect the food correctly.
Nutrition details and food healthiness level (unhealthy → high %DV in saturated fat) are displayed.

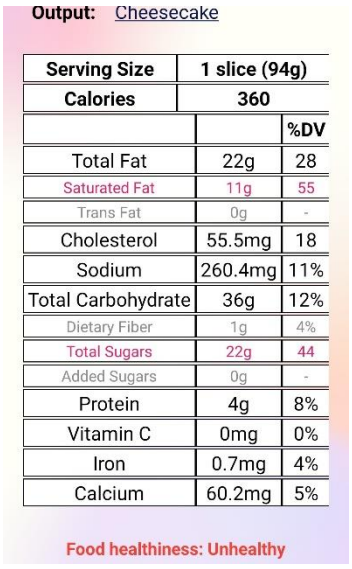
</td>
</tr>
<tr>
<td>12</td>
<td>Century egg</td>
<td> 
</td>
<td>

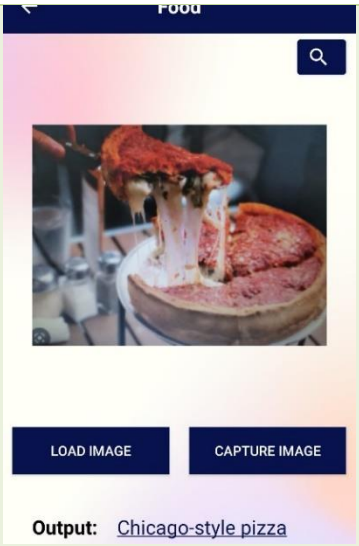
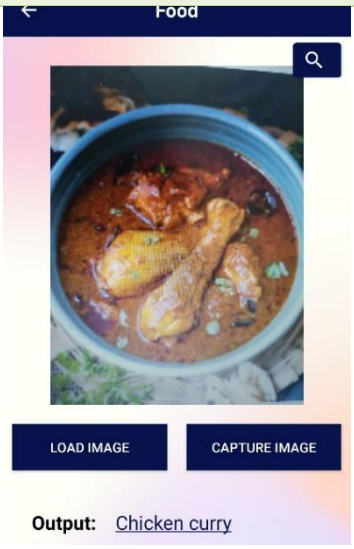
Able to detect the food correctly.
Nutrition details and food healthiness level (moderate) are displayed.

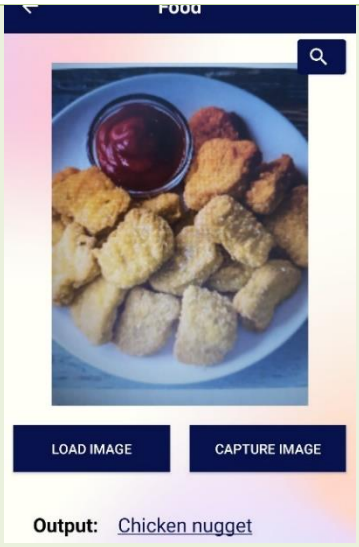
</td>
</tr>
</table>

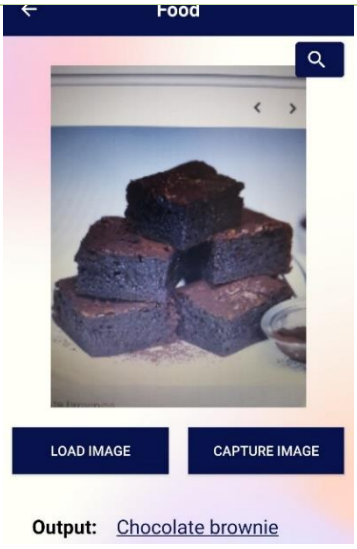
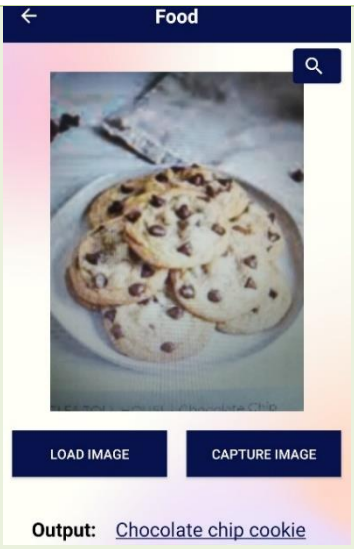
		Output: Century egg Serving Size 71g Calories 130 %DV Total Fat 9.6g 12 Saturated Fat 2.6g 13 Trans Fat 0g - Cholesterol 619mg 206 Sodium 529mg 23% Total Carbohydrate 1g 0% Dietary Fiber 0g 0% Total Sugars 0.7g 0 Added Sugars 0g - Protein 9g - Vitamin C 0mg 0% Iron 2.7mg 15% Calcium 45mg 3% Food healthiness: Moderate	
13	Cha siu bao	 Output: Cha siu bao Serving Size 1 bun Calories 250 %DV Total Fat 7g 11 Saturated Fat 2.5g 13 Trans Fat 0g - Cholesterol 20mg 7 Sodium 250mg 10% Total Carbohydrate 37g 12% Dietary Fiber 1g 4% Total Sugars 8g 18 Added Sugars 0g - Protein 9g 14% Vitamin C 0mg 0% Iron 1.8mg 10% Calcium 51mg 4% Food healthiness: Moderate	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.

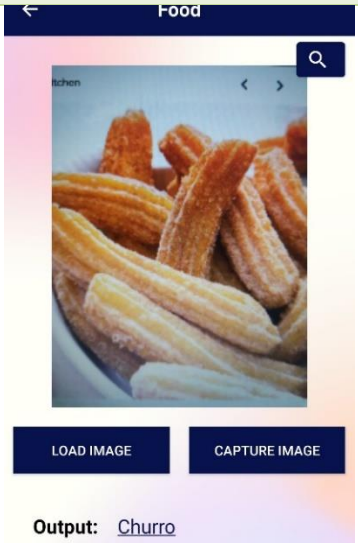
14	Char kway teow	 Output: Char kway teow **Serving Size** | **1 serving (298g)** **Calories** | **365** | | **%DV** Total Fat | 15g | 19 Saturated Fat | 1.9g | 10 Trans Fat | 0.1g | - Cholesterol | 221mg | 74 Sodium | 1122mg | 49% Total Carbohydrate | 36g | 13% Dietary Fiber | 2.7g | 10% Total Sugars | 2.3g | 0 Added Sugars | 0g | - Protein | 22g | - Vitamin C | 0mg | 0% Iron | 1.9mg | 11% Calcium | 106mg | 8% **Food healthiness: Healthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.
15	Char siu		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

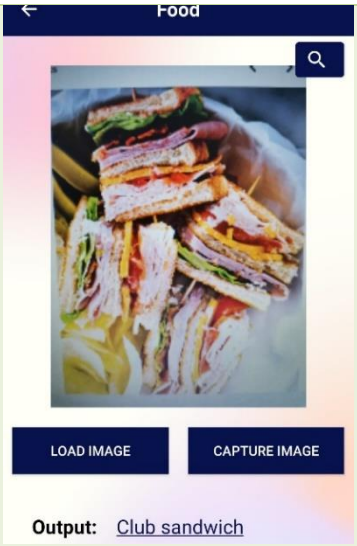
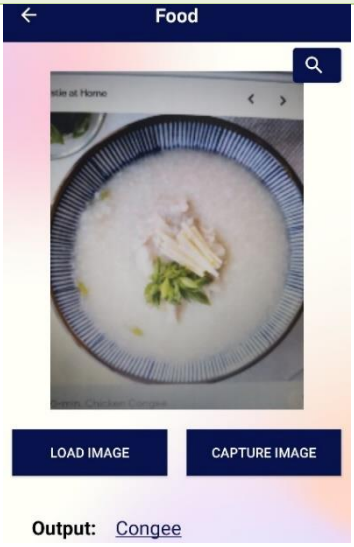
		Output: Chai siu  Food healthiness: Healthy	
16	Cheesecake	 Output: Cheesecake Output: Cheesecake  Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in both sugars and saturated fat) are displayed.

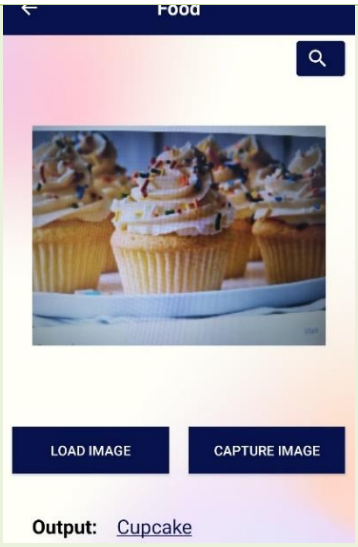
17	Chicago-style pizza	 **Food:** Chicago-style pizza **Serving Size** | **0.25 pizza (126g)** **Calories** | **330** %DV Total Fat 12g 15 Saturated Fat 5g 25 Trans Fat 0g - Cholesterol 20.2mg 7 Sodium 419.6mg 18% Total Carbohydrate 41g 14% Dietary Fiber 2g 7% Total Sugars 2g 4 Added Sugars 0g - Protein 14g 28% Vitamin C 2.4mg 3% Iron 2.7mg 15% Calcium 249.5mg 19% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
18	Chicken curry		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

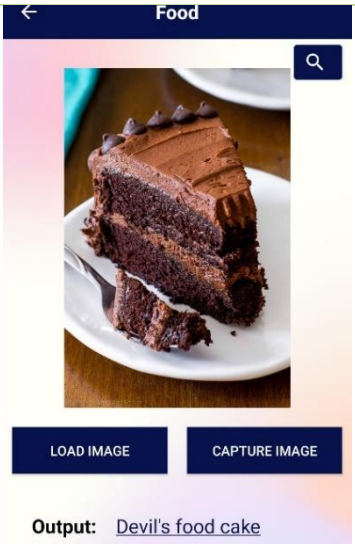
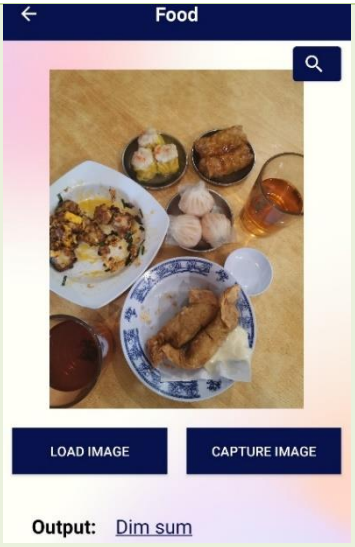
		Food: Chicken curry Serving Size 1 cup (235g) Calories 243 %DV Total Fat 11g 14 Saturated Fat 1.5g 8 Trans Fat 0.2g - Cholesterol 74mg 25 Sodium 73mg 3% Total Carbohydrate 7.5g 3% Dietary Fiber 1.5g 5% Total Sugars 2g 0 Added Sugars 0g - Protein 28g - Vitamin C 0mg 0% Iron 2mg 11% Calcium 39mg 3% Food healthiness: Healthy	
19	Chicken nugget	 Food: Chicken nugget Serving Size 1 piece (16g) Calories 49 %DV Total Fat 3.3g 4 Saturated Fat 0.6g 3 Trans Fat 0g - Cholesterol 8.8mg 3 Sodium 95mg 4% Total Carbohydrate 2.4g 1% Dietary Fiber 0.1g 1% Total Sugars 0g 0 Added Sugars 0g - Protein 2.5g - Vitamin C 0mg 0% Iron 0.1mg 1% Calcium 1.8mg 0% Food healthiness: Healthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

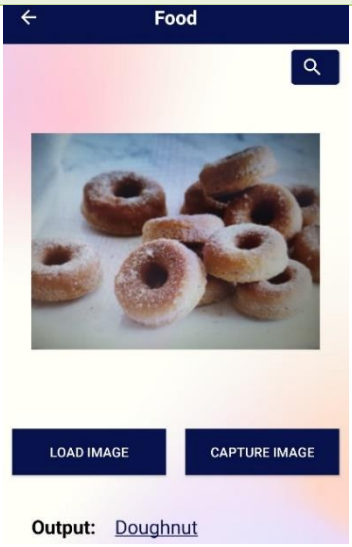
20	Chocolate brownie	 Food: Chocolate brownie **Serving Size** 57g **Calories** 235 %DV Total Fat 12g 15 Saturated Fat 7g 35 Trans Fat 0g - Cholesterol 54.7mg 18 Sodium 65mg 3% Total Carbohydrate 31g 10% Dietary Fiber 1.5g 5% Total Sugars 24g 48 Added Sugars 0g - Protein 3g 6% Vitamin C 0mg 0% Iron 0.4mg 2% Calcium 0mg 0% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy → high %DV in both sugars and saturated fat) are displayed.
21	Chocolate chip cookie		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

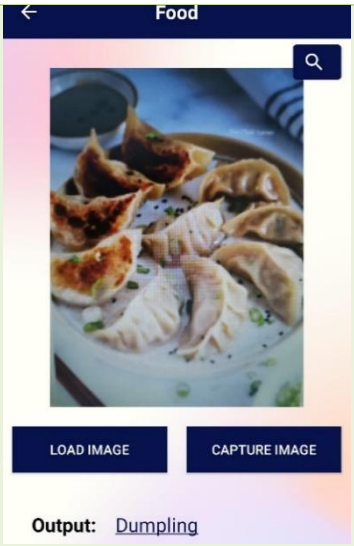
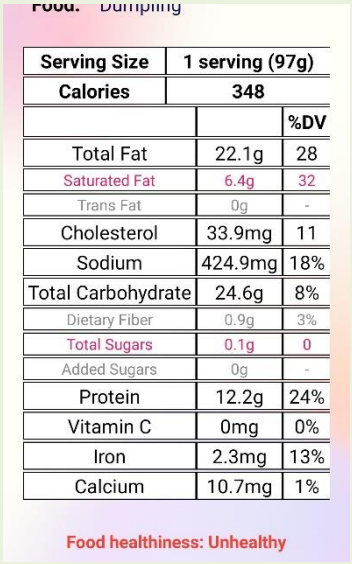
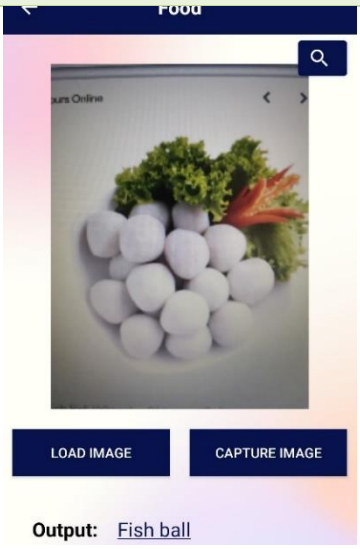
		Food: Chocolate chip cookie Serving Size 30g Calories 148 %DV Total Fat 7.4g 9 Saturated Fat 2.4g 12 Trans Fat 0.2g - Cholesterol 0mg 0 Sodium 93mg 4% Total Carbohydrate 20g 7% Dietary Fiber 0.6g 2% Total Sugars 9.9g 20 Added Sugars 0g - Protein 1.5g - Vitamin C 0mg 0% Iron 1.7mg 9% Calcium 6.3mg 0% Food healthiness: Unhealthy	
22	Churro	 Food: Churro Serving Size 1 churro (26g) Calories 125 %DV Total Fat 8g 10 Saturated Fat 2.2g 11 Trans Fat 0g - Cholesterol 1.8mg 1 Sodium 41.6mg 2% Total Carbohydrate 12.9g 4% Dietary Fiber 0.2g 1% Total Sugars 7.1g 14 Added Sugars 0g - Protein 0.8g 2% Vitamin C 0mg 0% Iron 0.4mg 2% Calcium 1.8mg 0% Food healthiness: Moderate	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.

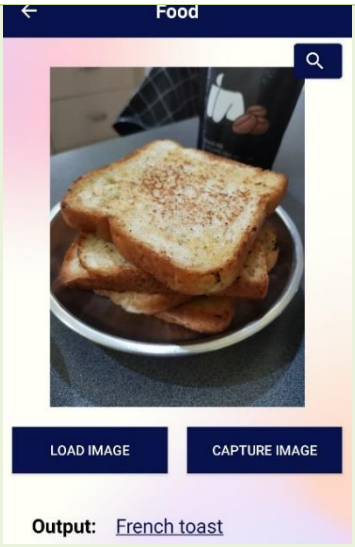
23	Club sandwich	 Food: Club sandwich Serving Size 292g Calories 710 %DV Total Fat 36g 46 Saturated Fat 17g 85 Trans Fat 0g - Cholesterol 111mg 37 Sodium 1900.9mg 83% Total Carbohydrate 59g 20% Dietary Fiber 4.1g 15% Total Sugars 5g 10 Added Sugars 0g - Protein 41g 82% Vitamin C 9.1mg 10% Iron 3.6mg 20% Calcium 499.3mg 38% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
24	Congee		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

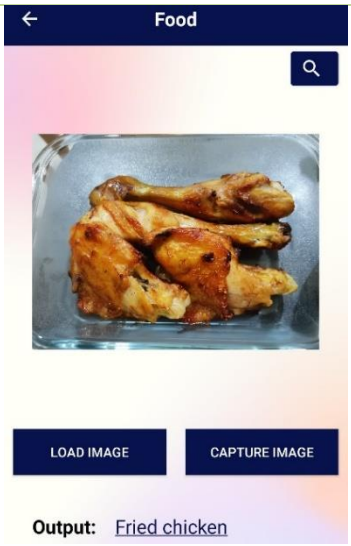
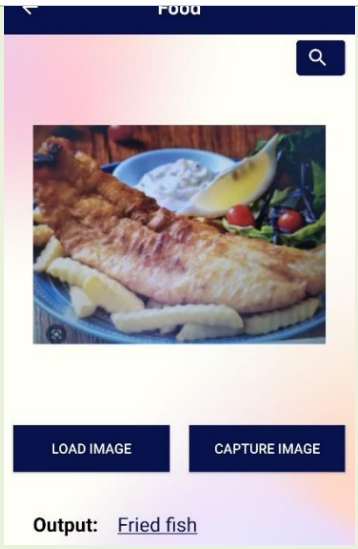
		Food: Congee Serving Size: 1 bowl (249g) Calories: 132 %DV Total Fat 2.3g 3 Saturated Fat 0.7g 4 Trans Fat 0g - Cholesterol 34.9mg 12 Sodium 610.1mg 27% Total Carbohydrate 15.2g 5% Dietary Fiber 0.2g 1% Total Sugars 0g 0 Added Sugars 0g - Protein 12g 24% Vitamin C 0mg 0% Iron 1.1mg 6% Calcium 14.9mg 1% Food healthiness: Healthy	
25	Cupcake	 Food: Cupcake Serving Size: 1 cupcake (75g) Calories: 292 %DV Total Fat 15g 19 Saturated Fat 4.4g 22 Trans Fat 1g - Cholesterol 17mg 6 Sodium 261mg 11% Total Carbohydrate 40g 15% Dietary Fiber 1.7g 6% Total Sugars 30g 0 Added Sugars 0g - Protein 2.6g - Vitamin C 0mg 0% Iron 2.3mg 13% Calcium 23mg 2% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

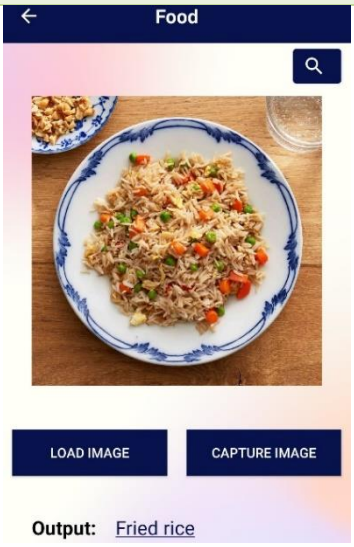
26	Devil's food cake	 Output: Devil's food cake Serving Size 1 slice (95g) Calories 352 %DV Total Fat 14.3g 18 Saturated Fat 5.2g 26 Trans Fat 0g - Cholesterol 55.1mg 18 Sodium 299.3mg 13% Total Carbohydrate 50.7g 17% Dietary Fiber 1.5g 5% Total Sugars 40g 0 Added Sugars 0g - Protein 5g 10% Vitamin C 0.2mg 0% Iron 1.5mg 8% Calcium 57mg 4% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
27	Dim sum		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

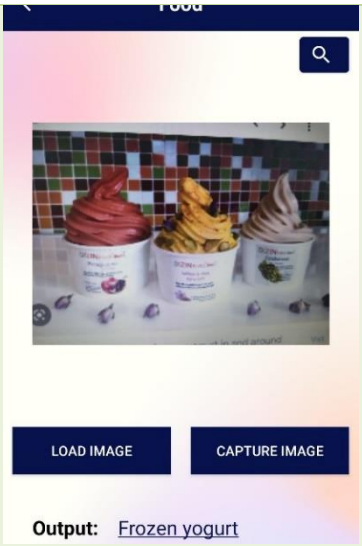
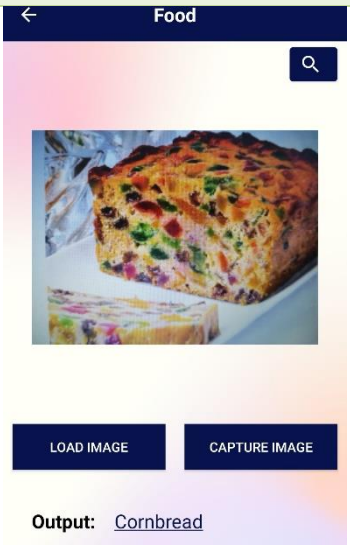
		Output: Dim sum Serving Size: 1 piece (65g) Calories: 134 %DV Total Fat 3.7g 5 Saturated Fat 0.9g 4 Trans Fat 0g - Cholesterol 10mg 3 Sodium 225mg 10% Total Carbohydrate 19g 7% Dietary Fiber 0.9g 3% Total Sugars 1.9g 3 Added Sugars 0g - Protein 5.2g - Vitamin C 0mg 0% Iron 1.2mg 7% Calcium 27mg 2% Food healthiness: Healthy	
28	Doughnut	 Food: Doughnut Serving Size: 60g Calories: 253 %DV Total Fat 14g 18 Saturated Fat 5.7g 29 Trans Fat 0.3g - Cholesterol 18mg 6 Sodium 190mg 8% Total Carbohydrate 29g 11% Dietary Fiber 1.3g 5% Total Sugars 14g 0 Added Sugars 0g - Protein 3.7g - Vitamin C 0mg 0% Iron 1.4mg 8% Calcium 61mg 5% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

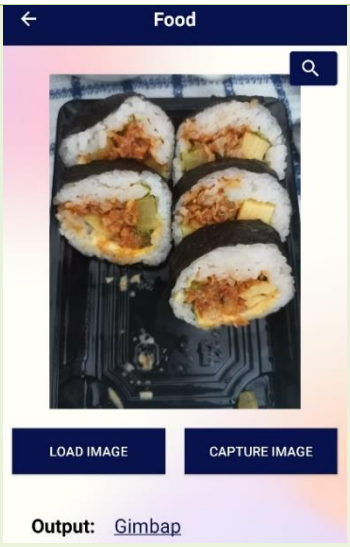
29	Dumpling	 	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
30	Fish ball		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

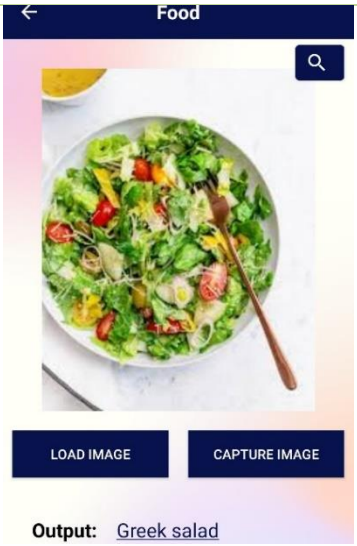
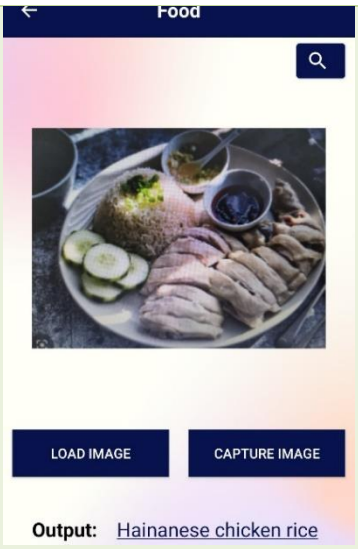
		Food: Fish ball Serving Size: 1 ball (28g) Calories: 62 | | | %DV | | Total Fat | 3.9g | 5 | | Saturated Fat | 0.9g | 4 | | Trans Fat | 0g | - | | Cholesterol | 15mg | 5 | | Sodium | 172mg | 7% | | Total Carbohydrate | 1.1g | 0% | | Dietary Fiber | 0g | 0% | | Total Sugars | 0.6g | 0 | | Added Sugars | 0g | - | | Protein | 5.3g | 7% | | Vitamin C | 0mg | 0% | | Iron | 0.3mg | 2% | | Calcium | 3.7mg | 0% | Food healthiness: Healthy	
31	French toast	 Output: French toast | Serving Size | 1 slice (65g) | | Calories | 176 | | | | %DV | | Total Fat | 7.1g | 9 | | Saturated Fat | 2.1g | 11 | | Trans Fat | 0g | - | | Cholesterol | 104mg | 35 | | Sodium | 214.5mg | 9% | | Total Carbohydrate | 21g | 7% | | Dietary Fiber | 0.9g | 3% | | Total Sugars | 6.7g | 13 | | Added Sugars | 0g | - | | Protein | 6.6g | 13% | | Vitamin C | 0mg | 0% | | Iron | 1.7mg | 9% | | Calcium | 72.8mg | 6% | Food healthiness: Moderate	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.

32	Fried chicken	 **Output:** Fried chicken **Serving Size** 1 piece (140g) **Calories** 377 %DV Total Fat 21g 27 Saturated Fat 5.7g 29 Trans Fat 0g - Cholesterol 126mg 42 Sodium 118mg 5% Total Carbohydrate 4.4g 2% Dietary Fiber 0.1g 1% Total Sugars 0g 0 Added Sugars 0g - Protein 40g - Vitamin C 0mg 0% Iron 1.9mg 11% Calcium 24mg 2% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
33	Fried fish		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.

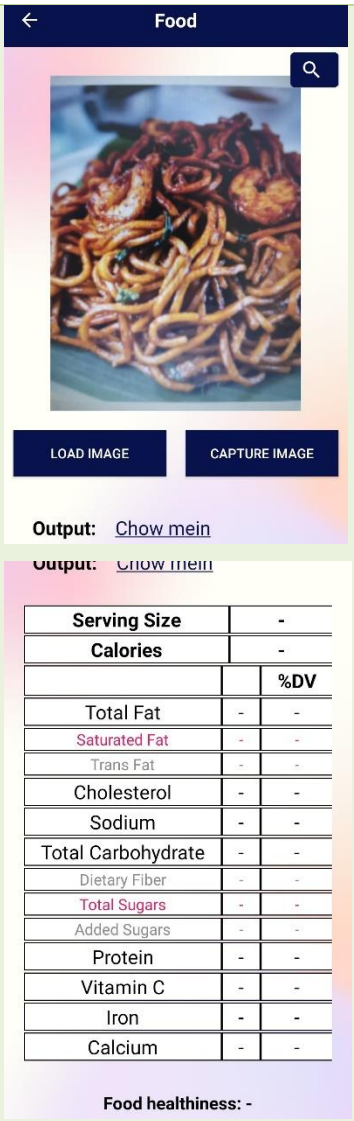
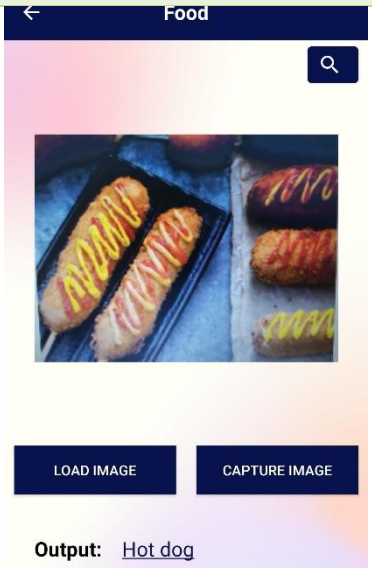
		Food: Fried fish Serving Size: 1 fillet (87g) Calories: 199 %DV Total Fat 12g 15 Saturated Fat 2.9g 14 Trans Fat 0g - Cholesterol 62mg 21 Sodium 244mg 11% Total Carbohydrate 7g 3% Dietary Fiber 0.6g 2% Total Sugars 0g 0 Added Sugars 0g - Protein 16g - Vitamin C 0mg 0% Iron 1.2mg 7% Calcium 38mg 3% Food healthiness: Moderate	
34	Fried rice	 Output: Fried rice Serving Size: 1 bowl (227g) Calories: 411 %DV Total Fat 12g 15 Saturated Fat 2.5g 12 Trans Fat 0g - Cholesterol 40.9mg 14 Sodium 1150.9mg 50% Total Carbohydrate 64g 21% Dietary Fiber 2g 7% Total Sugars 2g 4 Added Sugars 0g - Protein 13g 26% Vitamin C 9.1mg 10% Iron 2.7mg 15% Calcium 79.5mg 6% Food healthiness: Moderate	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.

35	Frozen yogurt	 Food: Frozen yogurt **Serving Size** 100g **Calories** 112 %DV Total Fat 0g 0 Saturated Fat 0g 0 Trans Fat 0g - Cholesterol 0mg 0 Sodium 62mg 3% Total Carbohydrate 25.8g 9% Dietary Fiber 1.1g 4% Total Sugars 20.2g 40 Added Sugars 0g - Protein 3.4g 7% Vitamin C 0mg 0% Iron 0.4mg 2% Calcium 90mg 7% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
36	Fruit cake		▪ Cannot detect the food correctly (recognized as Cornbread) ▪ No data available (Nutrition details and food healthiness level)

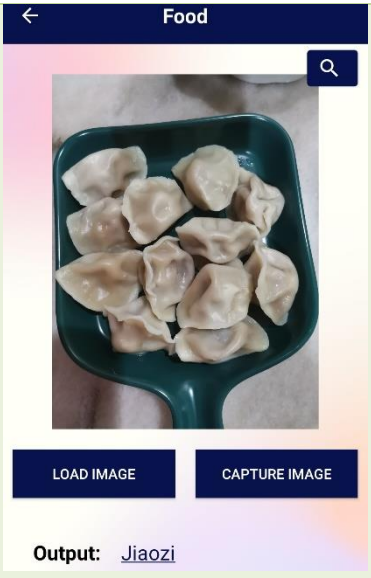
		Output: Cornbread Serving Size - Calories - %DV Total Fat - - Saturated Fat - - Trans Fat - - Cholesterol - - Sodium - - Total Carbohydrate - - Dietary Fiber - - Total Sugars - - Added Sugars - - Protein - - Vitamin C - - Iron - - Calcium - - Food healthiness: -	
37	Gimbap	 Output: Gimbap Output: Gimbap Serving Size 1 roll (293g) Calories 434 %DV Total Fat 18g 23 Saturated Fat 4.2g 21 Trans Fat 0.1g - Cholesterol 132mg 44 Sodium 1059mg 46% Total Carbohydrate 51g 19% Dietary Fiber 1.7g 6% Total Sugars 12g 0 Added Sugars 0g - Protein 17g 14% Vitamin C 0mg 0% Iron 3.4mg 19% Calcium 99mg 8% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

38	Greek salad	 **Output:** Greek salad **Serving Size** 1 cup (105g) **Calories** 44 %DV Total Fat 2.3g 3 Saturated Fat 1g 5 Trans Fat 0g - Cholesterol 7.4mg 2 Sodium 242.6mg 11% Total Carbohydrate 4g 1% Dietary Fiber 1.8g 6% Total Sugars 1.6g 3 Added Sugars 0g - Protein 2.7g 5% Vitamin C 5.5mg 6% Iron 1.1mg 6% Calcium 69.3mg 5% **Food healthiness: Healthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.
39	Hainanese chicken rice		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

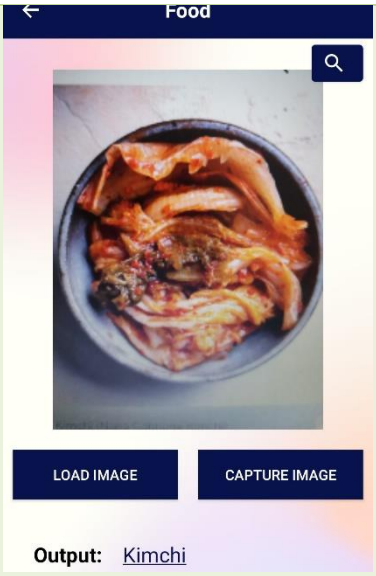
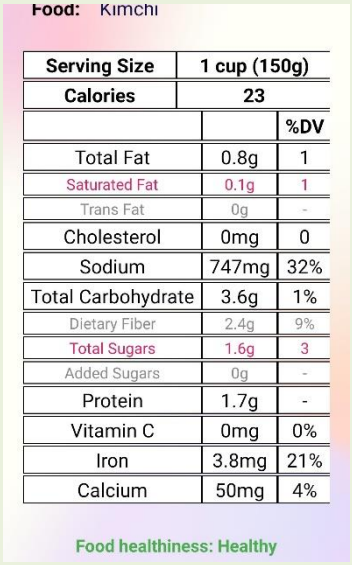
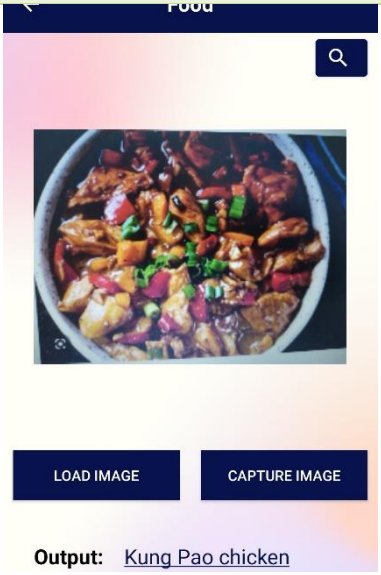
		Food: Hainanese chicken rice Serving Size: 1 plate Calories: 618 | | | %DV | | Total Fat | 23g | 34 | | Saturated Fat | - | 0 | | Trans Fat | 0g | - | | Cholesterol | - | 0 | | Sodium | - | - | | Total Carbohydrate | 76g | 50% | | Dietary Fiber | - | - | | Total Sugars | 0g | 0 | | Added Sugars | 0g | - | | Protein | 25.7g | 17% | | Vitamin C | 0mg | 0% | | Iron | 0mg | 0% | | Calcium | 0mg | 0% | Food healthiness: Unhealthy	
40	Hamburger	Food  LOAD IMAGE CAPTURE IMAGE Output: Hamburger Food: Hamburger Serving Size: 200g Calories: 440 | | | %DV | | Total Fat | 21g | 27 | | Saturated Fat | 6.9g | 34 | | Trans Fat | 0g | - | | Cholesterol | 74mg | 25 | | Sodium | 860mg | 37% | | Total Carbohydrate | 33.5g | 11% | | Dietary Fiber | 1.6g | 6% | | Total Sugars | 7.1g | 14 | | Added Sugars | 0g | - | | Protein | 27.6g | 55% | | Vitamin C | 4.4mg | 5% | | Iron | 4.2mg | 24% | | Calcium | 122mg | 9% | Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

41	Hokkien mee		▪ Cannot detect the food correctly (recognized as Chow mein) ▪ No data available (Nutrition details and food healthiness level)
42	Hot dog		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

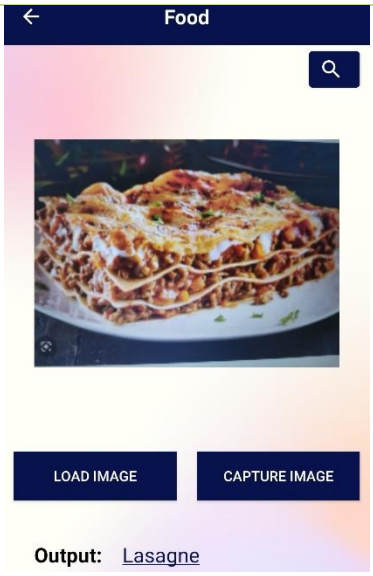
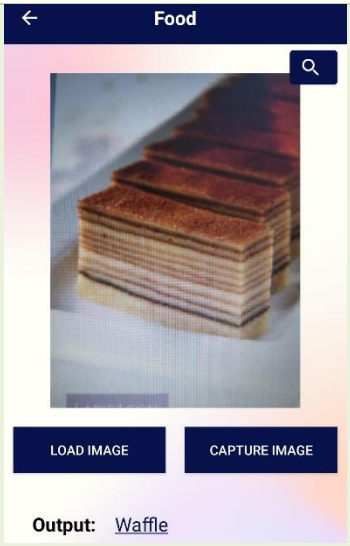
		Food: Hot dog **Serving Size** 1 serving (48g) **Calories** 155 %DV Total Fat 14g 18 Saturated Fat 5.6g 28 Trans Fat 0g - Cholesterol 28mg 9 Sodium 409mg 18% Total Carbohydrate 1.3g 0% Dietary Fiber 0g 0% Total Sugars 0.6g 0 Added Sugars 0g - Protein 5.6g - Vitamin C 0mg 0% Iron 0.6mg 3% Calcium 5.3mg 0% **Food healthiness: Unhealthy**	
43	Hot pot	Food  LOAD IMAGE CAPTURE IMAGE **Output:** Hot pot **Food:** Hot pot **Serving Size** 1 serving (494g) **Calories** 622 %DV Total Fat 33g 42 Saturated Fat 9.1g 45 Trans Fat 0g - Cholesterol 114mg 38 Sodium 2180mg 95% Total Carbohydrate 35g 13% Dietary Fiber 3.1g 11% Total Sugars 14g 24 Added Sugars 0g - Protein 46g - Vitamin C 0mg 0% Iron 5.9mg 33% Calcium 250mg 19% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

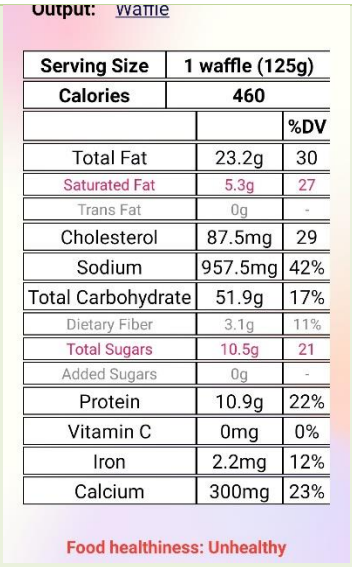
44	Icebox cake		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
45	Jiaozi		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

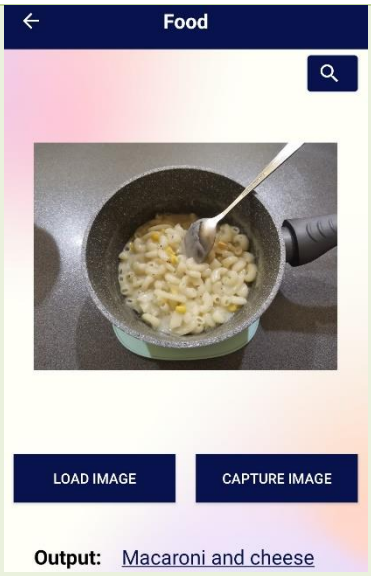
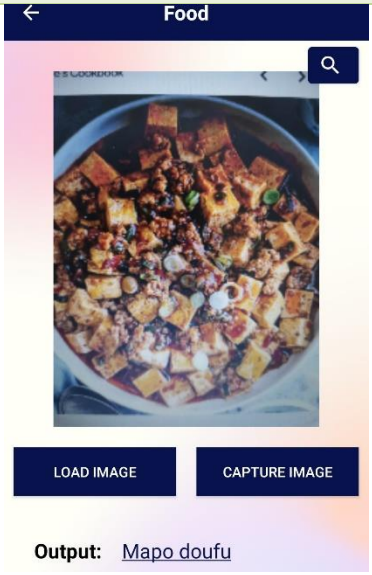
		Output: Jiaozi **Serving Size** 1 piece (37g) **Calories** 67 %DV Total Fat 2.3g 3 Saturated Fat 0.8g 4 Trans Fat 0g - Cholesterol 9.5mg 3 Sodium 146mg 6% Total Carbohydrate 7.7g 3% Dietary Fiber 0.6g 2% Total Sugars 0.5g 1 Added Sugars 0g - Protein 3.6g - Vitamin C 0mg 0% Iron 0.6mg 3% Calcium 14mg 1% **Food healthiness: Healthy**	
46	Ketupat	Food LOAD IMAGE CAPTURE IMAGE **Output:** Ketupat **Food:** Ketupat **Serving Size** 1 dumpling **Calories** 88 %DV Total Fat 0g 0 Saturated Fat 0g 0 Trans Fat 0g - Cholesterol 0mg 0 Sodium 4mg - Total Carbohydrate 20g 91% Dietary Fiber 0g 0% Total Sugars 0g 0 Added Sugars 0g - Protein 2g 9% Vitamin C 0mg 0% Iron 0mg 0% Calcium 0mg 0% **Food healthiness: Healthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

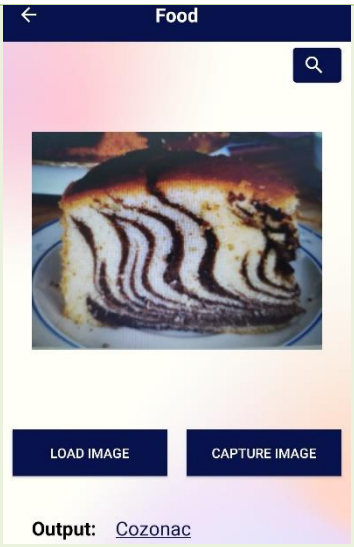
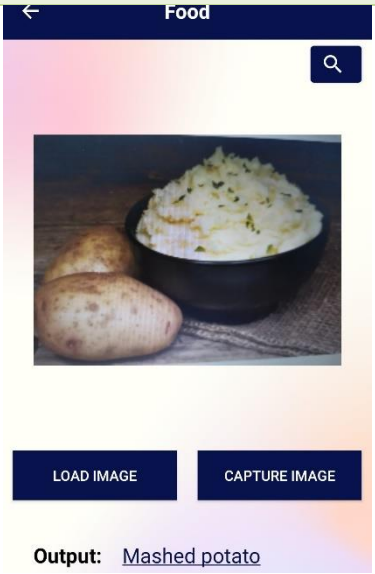
47	Kimchi	 	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.
48	Kung Pao chicken		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

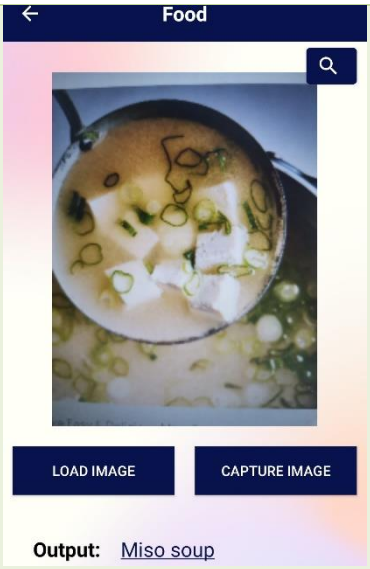
		Food: Kung Pao chicken **Serving Size** | **1 serving (604g)** **Calories** | **779** | | **%DV** Total Fat | 42g | 54 Saturated Fat | 8.2g | 41 Trans Fat | 0.2g | - Cholesterol | 157mg | 52 Sodium | 2428 | 106% Total Carbohydrate | 41g | 15% Dietary Fiber | 9.1g | 33% Total Sugars | 18g | 0 Added Sugars | 0g | - Protein | 59g | - Vitamin C | 0mg | 0% Iron | 4.6mg | 26% Calcium | 121mg | 9% **Food healthiness: Unhealthy**	
49	Laksa	Food  LOAD IMAGE CAPTURE IMAGE **Output:** Udon **Output:** Udon **Serving Size** | **60g** **Calories** | **250** | | **%DV** Total Fat | 7g | 9 Saturated Fat | 3.5g | 17 Trans Fat | 0g | - Cholesterol | 0mg | 0 Sodium | 880.2mg | 38% Total Carbohydrate | 42g | 14% Dietary Fiber | 2g | 7% Total Sugars | 2g | 4 Added Sugars | 0g | - Protein | 4g | 8% Vitamin C | 0mg | 0% Iron | 1.4mg | 8% Calcium | 0mg | 0% **Food healthiness: Moderate**	▪ Cannot detect the food correctly (recognized as Udon) ▪ Hence, nutrition details and healthiness level of Udon are displayed.

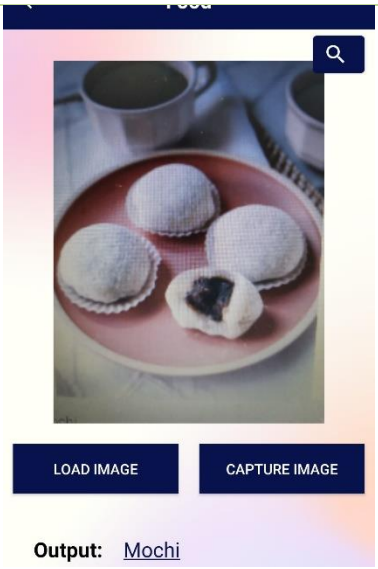
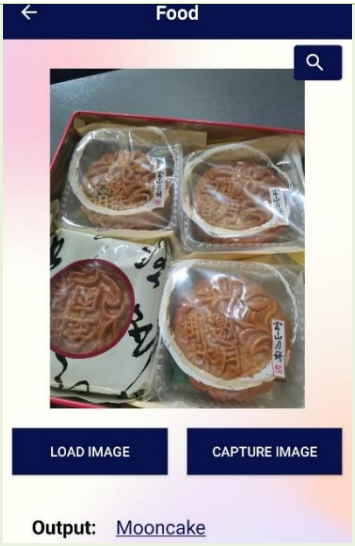
50	Lasagne	 Food: Lasagne **Serving Size** | **1 serving (385g)** **Calories** | **602** | | %DV Total Fat | 32g | 41 Saturated Fat | 15g | 75 Trans Fat | 0.3g | - Cholesterol | 166mg | 55 Sodium | 1576mg | 69% Total Carbohydrate | 35g | 13% Dietary Fiber | 3.9g | 14% Total Sugars | 11g | 0 Added Sugars | 0g | - Protein | 44g | - Vitamin C | 0mg | 0% Iron | 4.6mg | 26% Calcium | 527mg | 41% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
51	Layer cake		▪ Cannot detect the food correctly (recognized as Waffle) ▪ Hence, the nutrition details and healthiness level of Waffle are displayed.

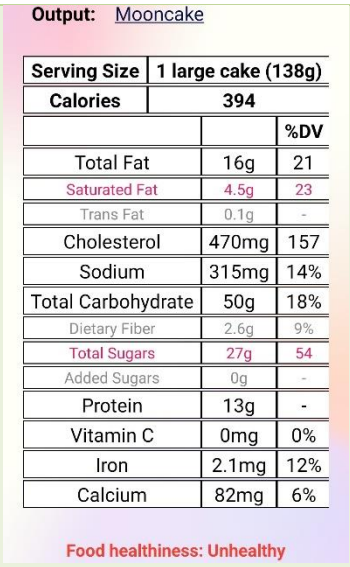
			
52	Macaron		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

53	Macaroni and cheese	 Output: Macaroni and cheese Serving Size | 1 serving (198g) Calories | 376 %DV Total Fat 16g 21 Saturated Fat 3.6g 18 Trans Fat 2.5g - Cholesterol 5.9mg 2 Sodium 669mg 29% Total Carbohydrate 47g 17% Dietary Fiber 2.4g 9% Total Sugars 8.5g 0 Added Sugars 0g - Protein 9.7g - Vitamin C 0mg 0% Iron 2mg 11% Calcium 125mg 10% Food healthiness: Moderate	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.
54	Mapo doufu		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

		Food: Mapo doufu **Serving Size** | **1 serving (471g)** **Calories** | **482** | | **%DV** Total Fat | 35g | 45 Saturated Fat | 5.6g | 28 Trans Fat | 0.4g | - Cholesterol | 39mg | 13 Sodium | 1797mg | 78% Total Carbohydrate | 14g | 5% Dietary Fiber | 3.9g | 14% Total Sugars | 4.8g | 10 Added Sugars | 0g | - Protein | 34g | - Vitamin C | 0mg | 0% Iron | 5.5mg | 31% Calcium | 612mg | 47% **Food healthiness: Unhealthy**	
55	Marble cake		▪ Cannot detect the food correctly (recognized as Cozonac) ▪ No data available for nutrition details and healthiness level.
56	Mashed potato		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

		Food: Mashed potato **Serving Size** 200g **Calories** 179 %DV Total Fat 7.4g 38 Saturated Fat 4.7g 23 Trans Fat 0g - Cholesterol 0mg 0 Sodium 0mg 0% Total Carbohydrate 24g 54% Dietary Fiber 0g 0% Total Sugars 0g 0 Added Sugars 0g - Protein 3.4g 8% Vitamin C 0mg 0% Iron 0mg 0% Calcium 0mg 0% **Food healthiness: Unhealthy**	
57	Miso soup	 **Output:** Miso soup **Food:** Miso soup **Serving Size** 1 cup (241g) **Calories** 59 %DV Total Fat 3g 4 Saturated Fat 0.5g 3 Trans Fat 0g - Cholesterol 0.1mg 0 Sodium 1071mg 47% Total Carbohydrate 3.5g 1% Dietary Fiber 1.1g 4% Total Sugars 1.2g 0 Added Sugars 0g - Protein 5.8g - Vitamin C 0mg 0% Iron 1.2mg 7% Calcium 139mg 11% **Food healthiness: Healthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

58	Mochi	 **Food:** Mochi **Serving Size** 1 piece (46g) **Calories** 126 %DV Total Fat 2.6g 3 Saturated Fat 2.1g 11 Trans Fat 0g - Cholesterol 2mg 1 Sodium 9.2mg 0% Total Carbohydrate 25g 9% Dietary Fiber 0.2g 1% Total Sugars 17g 0 Added Sugars 0g - Protein 1.3g - Vitamin C 0mg 0% Iron 0.4mg 2% Calcium 20mg 2% **Food healthiness: Moderate**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.
59	Mooncake		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

			
60	Nasi kandar		▪ Cannot detect the food correctly (recognized as Pilaf) ▪ No data available for nutrition details and healthiness level.

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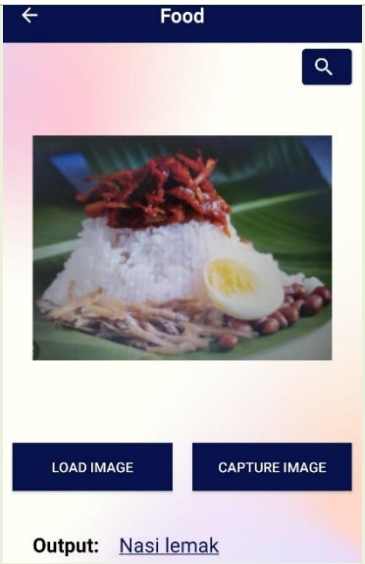
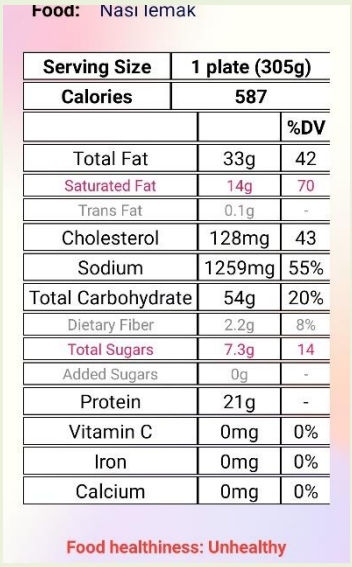
<td> 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Able to detect the food correctly.
Nutrition details and food healthiness level (unhealthy) are displayed.

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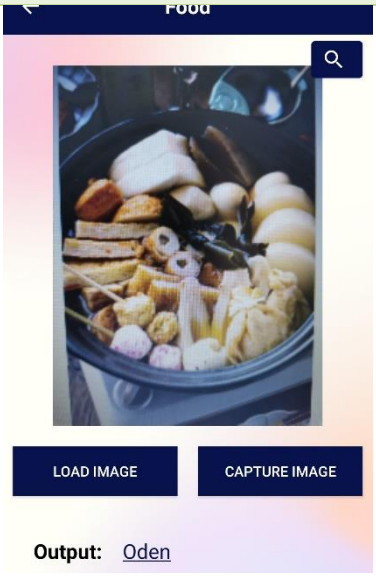
<td>Oden</td>
<td> 
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Able to detect the food correctly.
Nutrition details and food healthiness level (healthy) are displayed.

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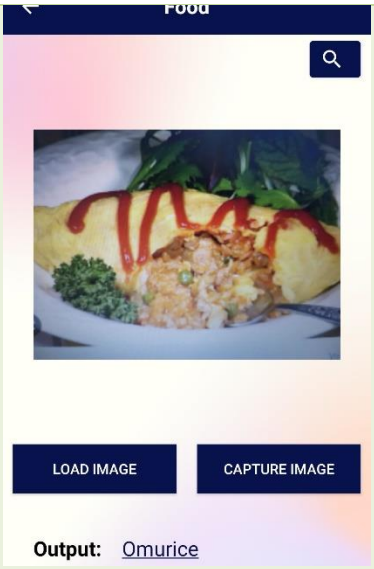
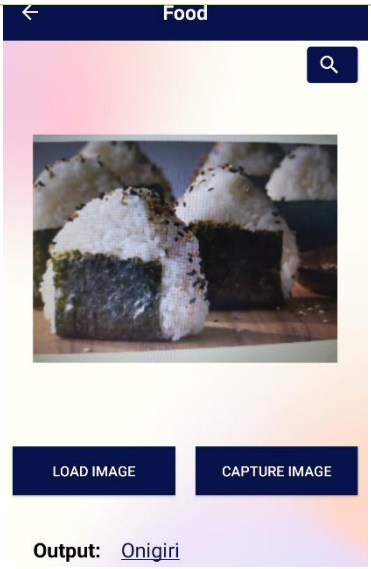
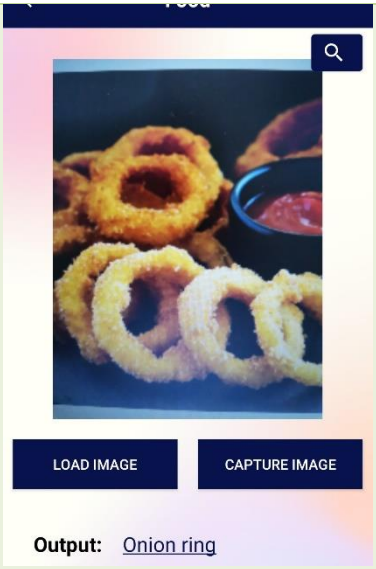
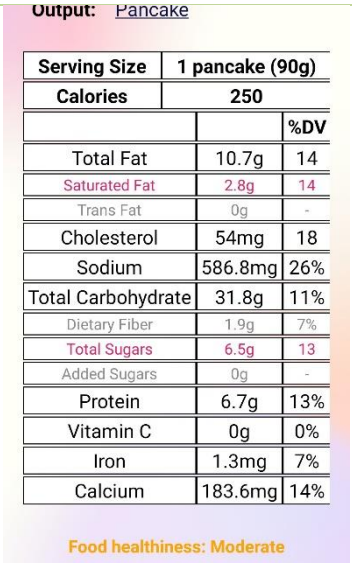
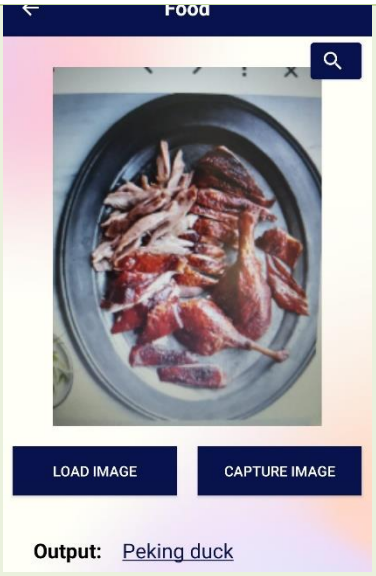
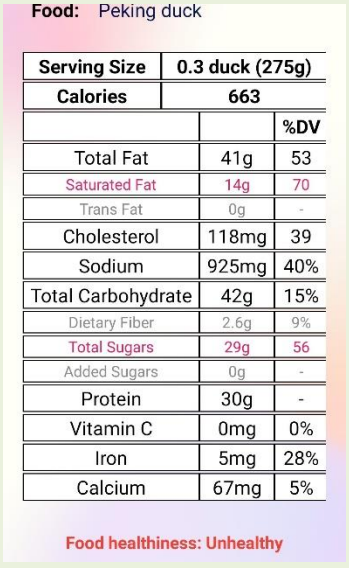
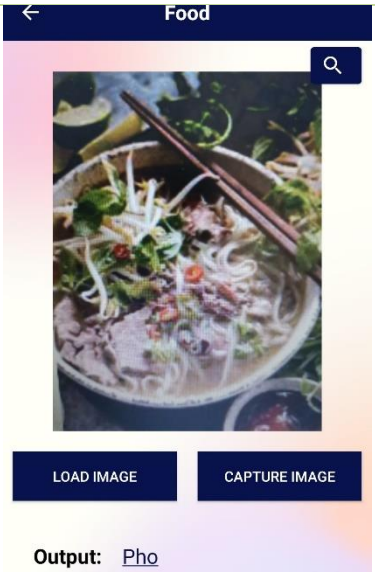
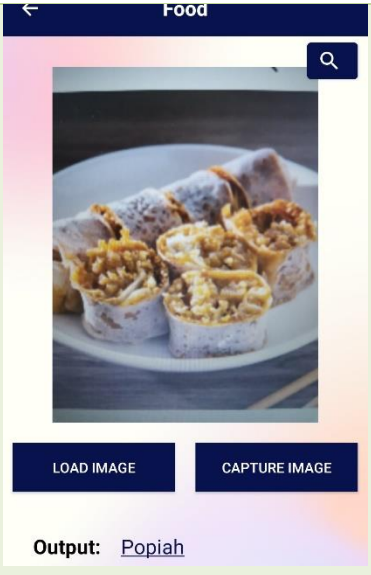
		Food: Oden **Serving Size** 1 serving **Calories** 176 %DV Total Fat 8.5g 40 Saturated Fat 2.2g 10 Trans Fat 0g - Cholesterol 212mg 70 Sodium 262.5mg 12% Total Carbohydrate 16.1g 34% Dietary Fiber 2.3g 9% Total Sugars 1.7g 3 Added Sugars 0g - Protein 12.7g 26% Vitamin C - 23.10% Iron - 11% Calcium - 22% **Food healthiness: Healthy**	
63	Omurice	 **Food:** Omurice **Serving Size** 195g **Calories** 338 %DV Total Fat 19g 24 Saturated Fat 5.7g 29 Trans Fat 0.2g - Cholesterol 156mg 52 Sodium 311mg 14% Total Carbohydrate 25g 9% Dietary Fiber 1.5g 5% Total Sugars 2.5g 6 Added Sugars 0g - Protein 17g - Vitamin C 0mg 0% Iron 1.3mg 7% Calcium 133mg 10% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

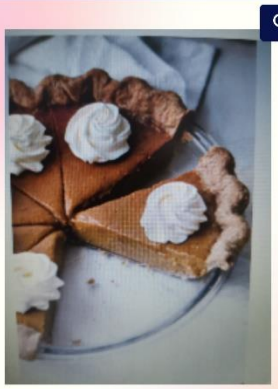
64	Onigiri	 **Food:** Onigiri **Serving Size** 1 piece (142g) **Calories** 232 %DV Total Fat 7.8g 10 Saturated Fat 1.4g 7 Trans Fat 0g - Cholesterol 20mg 7 Sodium 76mg 3% Total Carbohydrate 30g 11% Dietary Fiber 0.1g 0% Total Sugars 0.3g 0 Added Sugars 0g - Protein 8.9g 14% Vitamin C 0mg 0% Iron 0.4mg 2% Calcium 8.1mg 1% **Food healthiness: Healthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.
65	Onion ring		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

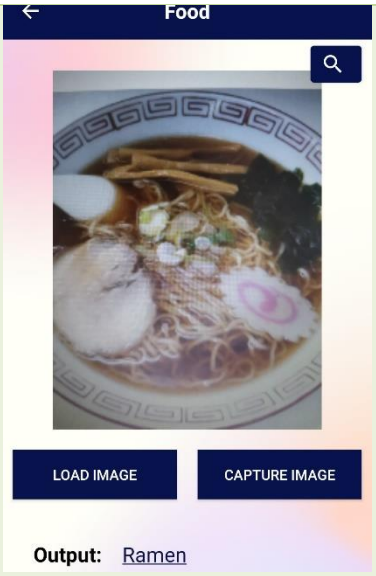
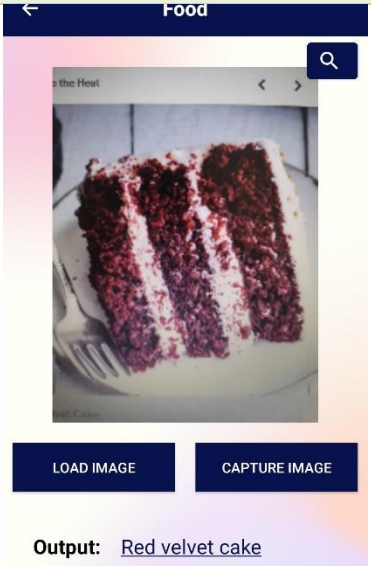
		Food: Onion ring Serving Size: 1 order (282g) Calories: 1004 %DV Total Fat 54g 69 Saturated Fat 9.6g 48 Trans Fat 0.5g - Cholesterol 0mg 0 Sodium 1951mg 85% Total Carbohydrate 115g 42% Dietary Fiber 7.3g 26% Total Sugars 13g 0 Added Sugars 0g - Protein 14g - Vitamin C 0mg 0% Iron 2mg 11% Calcium 59mg 5% Food healthiness: Unhealthy	
66	Pad thai	Food LOAD IMAGE CAPTURE IMAGE Output: Pad thai Food: Pad thai Serving Size: 494g Calories: 838 %DV Total Fat 45g 58 Saturated Fat 11g 55 Trans Fat 0.8g - Cholesterol 402mg 134 Sodium 1301mg 57% Total Carbohydrate 46g 17% Dietary Fiber 4.4g 16% Total Sugars 18g 0 Added Sugars 0g - Protein 64g - Vitamin C 0mg 0% Iron 4.2mg 23% Calcium 107mg 8% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

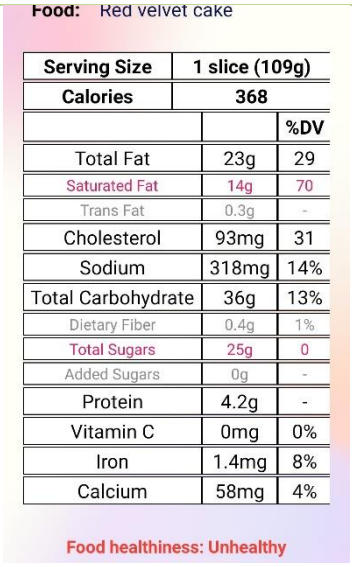
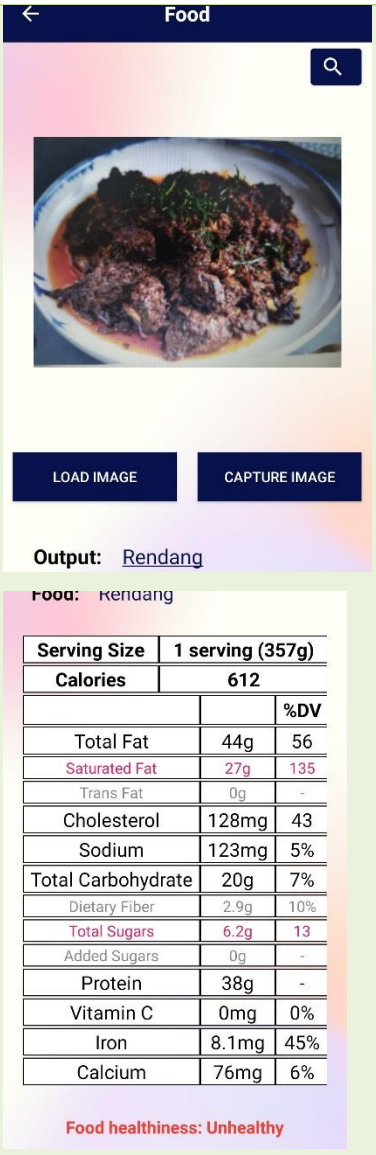
67	Pan mee		▪ Cannot detect the food correctly (recognized as Tekwan) ▪ No data available for nutrition details and healthiness level.
68	Pancake		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.

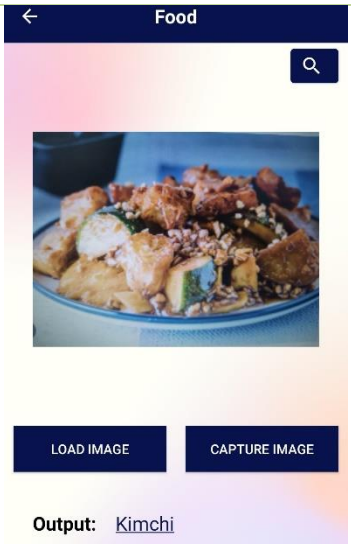
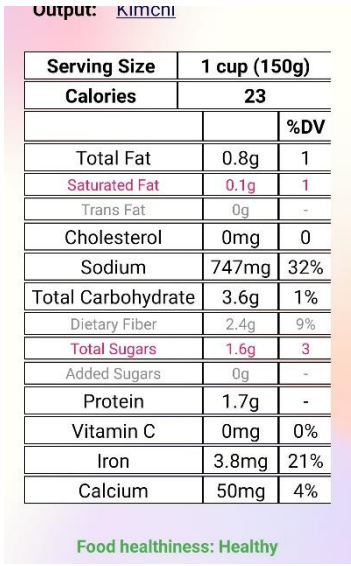
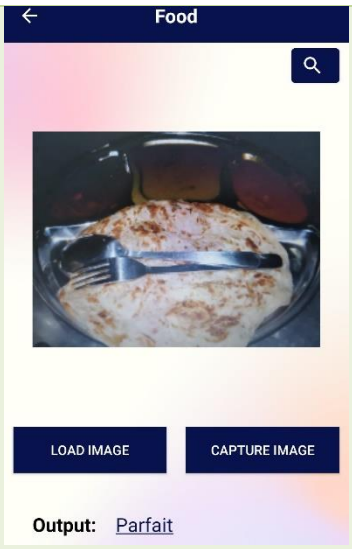
			
69	Peking duck	 	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

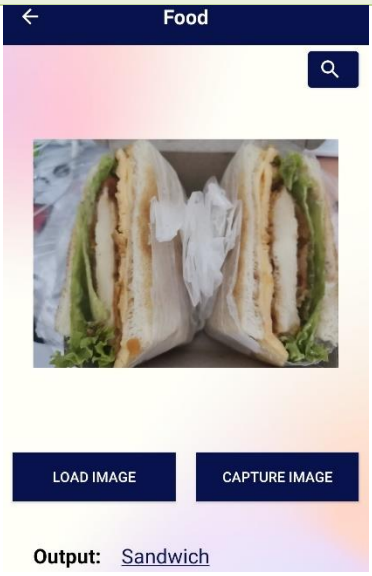
70	Pho	 **Food:** Pho **Serving Size** 1 bowl (710g) **Calories** 638 %DV Total Fat 14g 18 Saturated Fat 3.1g 16 Trans Fat 0.2g - Cholesterol 86mg 29 Sodium 3268mg 142% Total Carbohydrate 78g 28% Dietary Fiber 5.8g 21% Total Sugars 14g 24 Added Sugars 0g - Protein 47g - Vitamin C 0mg 0% Iron 6.7mg 37% Calcium 113mg 9% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
71	Popiah		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.

		Food: Popiah **Serving Size** | **1 roll (157g)** **Calories** | **175** | | **%DV** Total Fat | 6.4g | 8 Saturated Fat | 1.2g | 6 Trans Fat | 0.1g | - Cholesterol | 10mg | 3 Sodium | 309mg | 13% Total Carbohydrate | 24g | 9% Dietary Fiber | 3.5g | 13% Total Sugars | 6.3g | 13 Added Sugars | 0g | - Protein | 6.7g | - Vitamin C | 0mg | 0% Iron | 1mg | 6% Calcium | 44mg | 3% **Food healthiness: Moderate**	
72	Pumpkin pie	Food  LOAD IMAGE CAPTURE IMAGE **Output:** Pumpkin pie **Food:** Pumpkin pie **Serving Size** | **1 slice (113g)** **Calories** | **260** | | **%DV** Total Fat | 11g | 14 Saturated Fat | 6g | 30 Trans Fat | 0g | - Cholesterol | 45.2mg | 15 Sodium | 140.1mg | 6% Total Carbohydrate | 37g | 12% Dietary Fiber | 2g | 7% Total Sugars | 24g | 48 Added Sugars | 0g | - Protein | 5g | 10% Vitamin C | 2.4mg | 3% Iron | 1.8mg | 10% Calcium | 59.9mg | 5% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

73	Ramen	 **Food:** Ramen **Serving Size** 47g **Calories** 220 %DV Total Fat 10g 13 Saturated Fat 5g 25 Trans Fat 0g - Cholesterol 0mg 0 Sodium 1000.2mg 43% Total Carbohydrate 28g 9% Dietary Fiber 2g 7% Total Sugars 4g 8 Added Sugars 0g - Protein 5g 10% Vitamin C 0mg 0% Iron 2.7mg 15% Calcium 39.9mg 3% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
74	Red velvet cake		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

			
75	Rendang		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

76	Rojak	 	▪ Cannot detect the food correctly (recognized as Kimchi) ▪ Hence, the nutrition details and healthiness level of Kimchi are displayed.
77	Roti canai		▪ Cannot detect the food correctly (recognized as Parfait) ▪ No data available for nutrition details and healthiness level.

		Output: Parfait Serving Size - Calories - %DV Total Fat - - Saturated Fat - - Trans Fat - - Cholesterol - - Sodium - - Total Carbohydrate - - Dietary Fiber - - Total Sugars - - Added Sugars - - Protein - - Vitamin C - - Iron - - Calcium - - Food healthiness: -	
78	Sandwich	 Output: Sandwich Serving Size 112g Calories 250 %DV Total Fat 7g 9 Saturated Fat 1.4g 7 Trans Fat 0g - Cholesterol 48.2mg 16 Sodium 521.9mg 23% Total Carbohydrate 26.4g 9% Dietary Fiber 1.5g 5% Total Sugars 3.1g 6 Added Sugars 0g - Protein 19.9g 40% Vitamin C 0mg 0% Iron 2.2mg 12% Calcium 84mg 6% Food healthiness: Healthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

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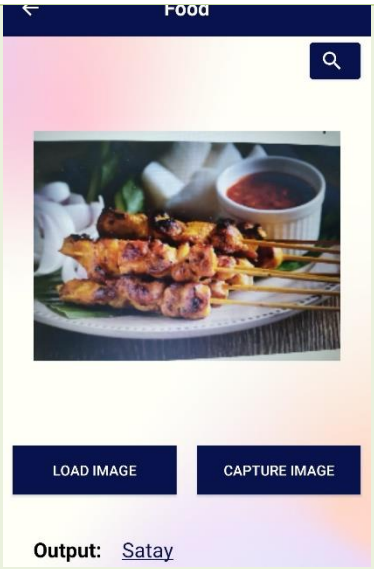
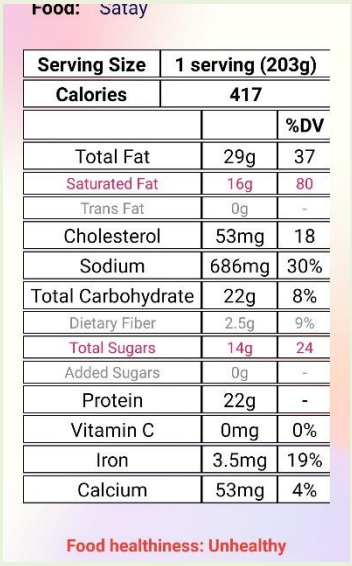
<td> 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Able to detect the food correctly.
Nutrition details and food healthiness level (unhealthy) are displayed.

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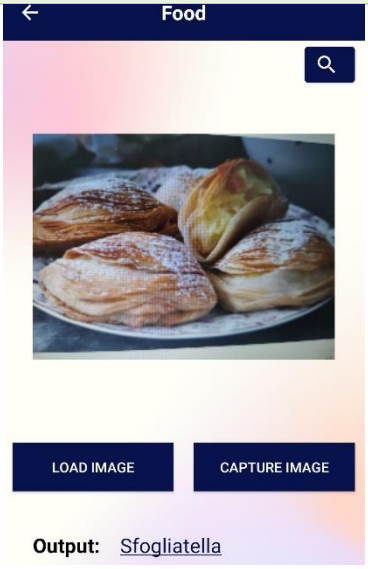
<tr>
<td>80</td>
<td>Sfogliatella</td>
<td> 
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Able to detect the food correctly.
Nutrition details and food healthiness level (unhealthy) are displayed.

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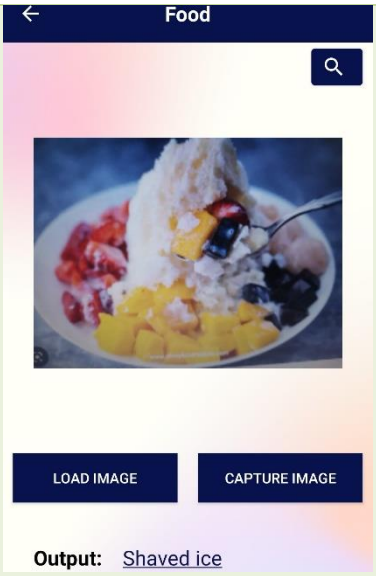
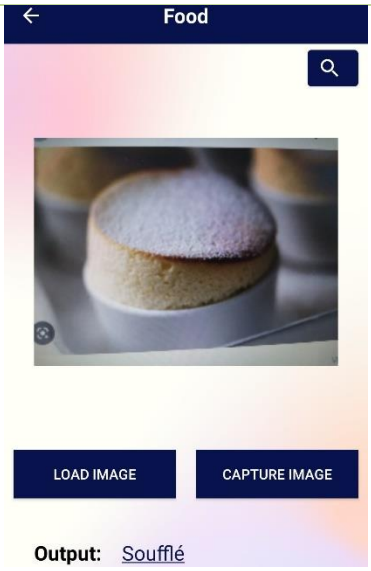
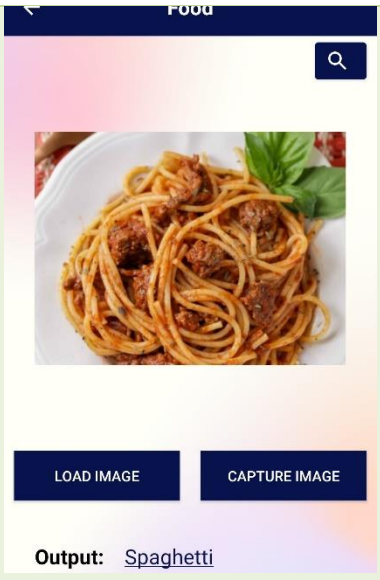
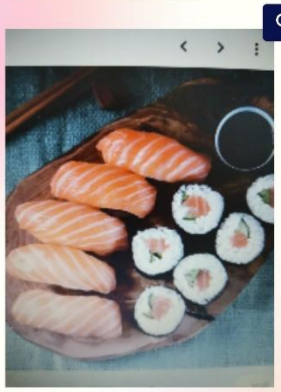
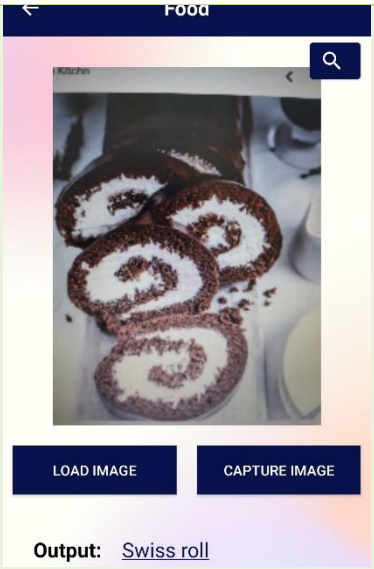
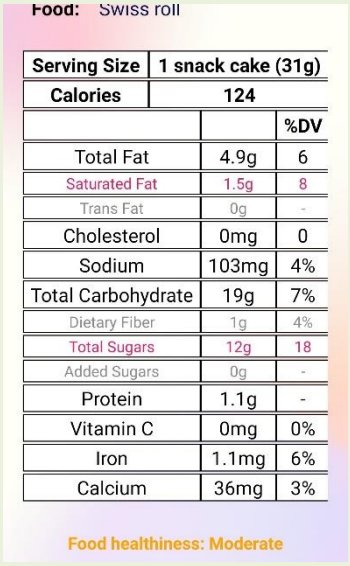
</table>

		Food: Sfogliatella Serving Size 67g Calories 272 %DV Total Fat 14.1g 18 Saturated Fat 7.8g 39 Trans Fat 0g - Cholesterol 44.9mg 15 Sodium 257.3mg 11% Total Carbohydrate 30.7g 10% Dietary Fiber 1.7g 6% Total Sugars 7.5g 15 Added Sugars 0g - Protein 5.5g 11% Vitamin C 0.1mg 0% Iron 1.4mg 8% Calcium 24.8mg 2% Food healthiness: Unhealthy	
81	Shaved ice	 Food: Shaved ice Serving Size 8 oz Calories 50 %DV Total Fat 0g 0 Saturated Fat 0g 0 Trans Fat 0g - Cholesterol 0mg 0 Sodium 0mg 0% Total Carbohydrate 14g 5% Dietary Fiber 0g 0% Total Sugars 14g 24 Added Sugars 0g - Protein 0g 0 Vitamin C 0mg 0% Iron 0mg 0% Calcium 0mg 0% Food healthiness: Unhealthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

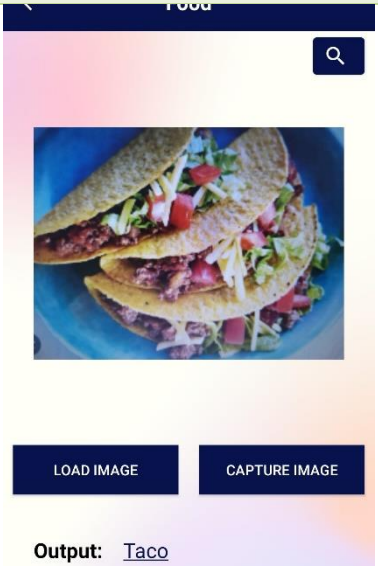
82	Soufflé	 Output: Soufflé Serving Size - Calories - %DV Total Fat - - Saturated Fat - - Trans Fat - - Cholesterol - - Sodium - - Total Carbohydrate - - Dietary Fiber - - Total Sugars - - Added Sugars - - Protein - - Vitamin C - - Iron - - Calcium - - Food healthiness: -	▪ Able to detect the food correctly. ▪ However, there is no data available for its nutrition details and healthiness level.
83	Spaghetti		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

		Output: Spaghetti Serving Size 660g Calories 667 %DV Total Fat 22g 28 Saturated Fat 6.5g 33 Trans Fat 0.5g - Cholesterol 62mg 21 Sodium 637mg 28% Total Carbohydrate 84g 31% Dietary Fiber 11g 39% Total Sugars 14g 24 Added Sugars 0g - Protein 35g - Vitamin C 0mg 0% Iron 6.7mg 37% Calcium 204mg 18% Food healthiness: Unhealthy	
84	Sushi	Food  LOAD IMAGE CAPTURE IMAGE Output: Sushi Food: Sushi Serving Size 1 piece (30g) Calories 28 %DV Total Fat 0.2g 0 Saturated Fat 0g 0 Trans Fat 0g - Cholesterol 1.2mg 0 Sodium 128.7mg 6% Total Carbohydrate 5.5g 2% Dietary Fiber 0.3g 1% Total Sugars 0.6g 1 Added Sugars 0g - Protein 0.9g 2% Vitamin C 0.3mg 0% Iron 0.1mg 0% Calcium 1.8mg 0% Food healthiness: Healthy	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

<table>
<tr>
<td>85</td>
<td>Swiss roll</td>
<td> 


</td>
<td>

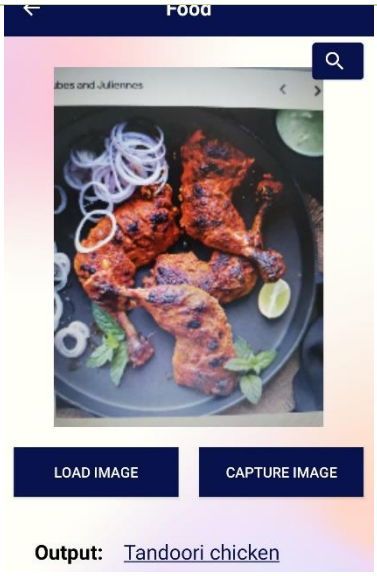
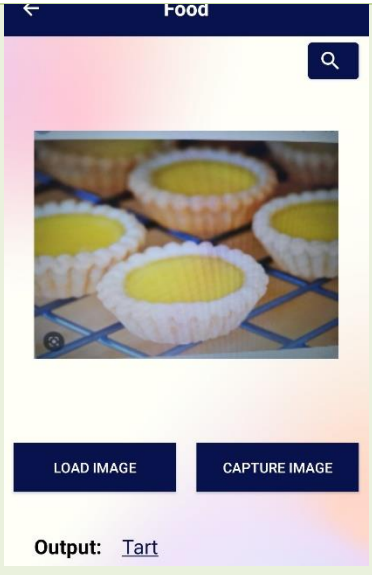
Able to detect the food correctly.
Nutrition details and food healthiness level (moderate) are displayed.

</td>
</tr>
<tr>
<td>86</td>
<td>Taco</td>
<td> 
</td>
<td>

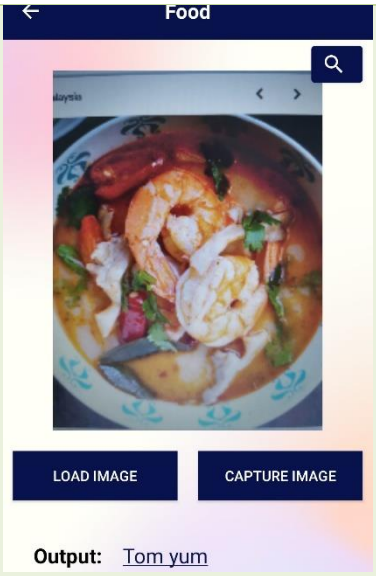
Able to detect the food correctly.
Nutrition details and food healthiness level (healthy) are displayed.

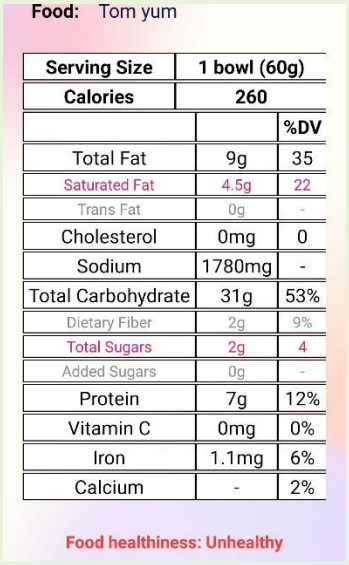
</td>
</tr>
</table>

		Food: Taco **Serving Size** 1 serving (80g) **Calories** 280 %DV Total Fat 17.2g 22 Saturated Fat 1.7g 9 Trans Fat 0g - Cholesterol 2.4mg 1 Sodium 250.4mg 11% Total Carbohydrate 27.9g 9% Dietary Fiber 2.6g 9% Total Sugars 1.7g 3 Added Sugars 0g - Protein 3.5g 7% Vitamin C 0mg 0% Iron 0.6mg 3% Calcium 50.4mg 4% **Food healthiness: Healthy**	
87	Takoyaki	Food  LOAD IMAGE CAPTURE IMAGE **Output:** Takoyaki **Food:** Takoyaki **Serving Size** 1 piece (39g) **Calories** 58 %DV Total Fat 2.5g 3 Saturated Fat 0.3g 2 Trans Fat 0g - Cholesterol 19mg 6 Sodium 161mg 7% Total Carbohydrate 5.8g 2% Dietary Fiber 0.2g 1% Total Sugars 0.1g 0 Added Sugars 0g - Protein 3g - Vitamin C 0mg 0% Iron 0.9mg 5% Calcium 31mg 2% **Food healthiness: Healthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

88	Tandoori chicken	 **Food:** Tandoori chicken **Serving Size** 1 piece (200g) **Calories** 263 %DV Total Fat 12g 15 Saturated Fat 4.2g 21 Trans Fat 0g - Cholesterol 135mg 45 Sodium 132mg 6% Total Carbohydrate 6.1g 2% Dietary Fiber 0.7g 3% Total Sugars 3.7g 8 Added Sugars 0g - Protein 31g - Vitamin C 0mg 0% Iron 1.5mg 8% Calcium 105mg 8% **Food healthiness: Unhealthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.
89	Tart		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

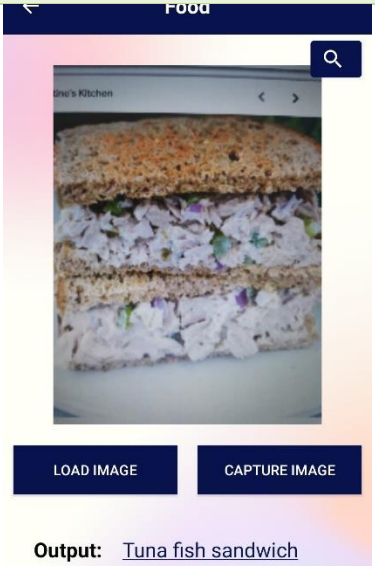
		Food: Tart **Serving Size** 1 slice (147g) **Calories** 412 %DV Total Fat 18g 23 Saturated Fat 11g 55 Trans Fat 0.7g - Cholesterol 46mg 15 Sodium 139mg 6% Total Carbohydrate 62g 23% Dietary Fiber 2.1g 8% Total Sugars 38g 70 Added Sugars 0g - Protein 3.3g - Vitamin C 0mg 0% Iron 1.5mg 8% Calcium 25mg 2% **Food healthiness: Unhealthy**	
90	Tiramisu	Food  LOAD IMAGE CAPTURE IMAGE **Output:** S'more **Output:** S'more **Serving Size** - **Calories** - %DV Total Fat - - Saturated Fat - - Trans Fat - - Cholesterol - - Sodium - - Total Carbohydrate - - Dietary Fiber - - Total Sugars - - Added Sugars - - Protein - - Vitamin C - - Iron - - Calcium - - **Food healthiness: -**	▪ Cannot detect the food correctly (recognized as S'more) ▪ No data available for nutrition details and healthiness level.

<table>
<tr>
<td>91</td>
<td>Tom yum</td>
<td>




</td>
<td>

Able to detect the food correctly.
Nutrition details and food healthiness level (unhealthy) are displayed.

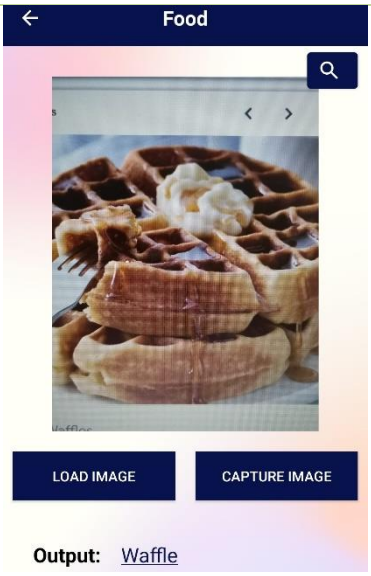
</td>
</tr>
<tr>
<td>92</td>
<td>Tuna fish sandwich</td>
<td>


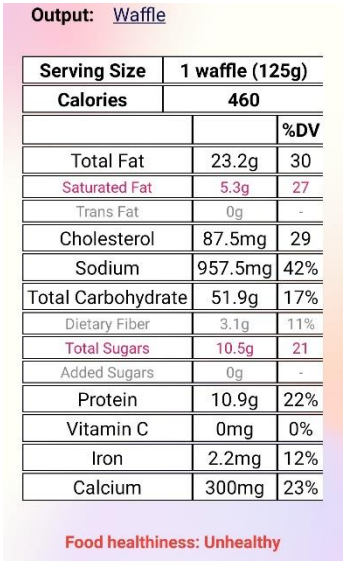
</td>
<td>

Able to detect the food correctly.
Nutrition details and food healthiness level (moderate) are displayed.

</td>
</tr>
</table>

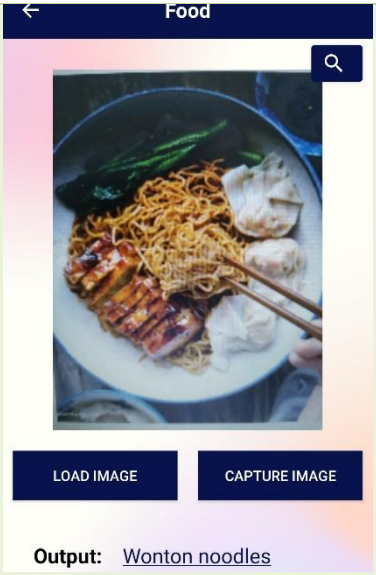
		Food: Tuna fish sandwich **Serving Size** 210g **Calories** 438 %DV Total Fat 16g 21 Saturated Fat 2.8g 14 Trans Fat 0g - Cholesterol 20mg 7 Sodium 896mg 39% Total Carbohydrate 42g 15% Dietary Fiber 1.5g 5% Total Sugars 3.2g 6 Added Sugars 0g - Protein 30g - Vitamin C 0mg 0% Iron 3.6mg 20% Calcium 108mg 8% Food healthiness: Moderate	
93	Udon	Food  LOAD IMAGE CAPTURE IMAGE **Output:** Udon **Output:** Udon **Serving Size** 60g **Calories** 250 %DV Total Fat 7g 9 Saturated Fat 3.5g 17 Trans Fat 0g - Cholesterol 0mg 0 Sodium 880.2mg 38% Total Carbohydrate 42g 14% Dietary Fiber 2g 7% Total Sugars 2g 4 Added Sugars 0g - Protein 4g 8% Vitamin C 0mg 0% Iron 1.4mg 8% Calcium 0mg 0% Food healthiness: Moderate	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (moderate) are displayed.

<table>
<tr>
<td>94</td>
<td>Waffle</td>
<td>




</td>
<td>

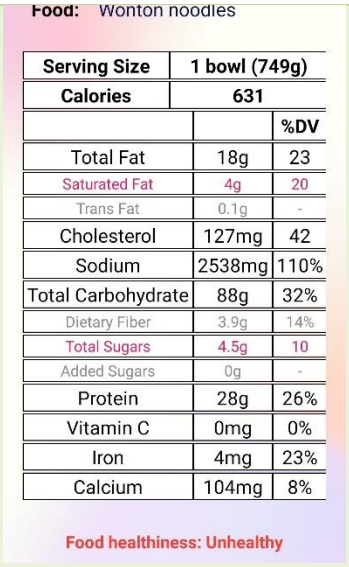
Able to detect the food correctly.
Nutrition details and food healthiness level (unhealthy) are displayed.

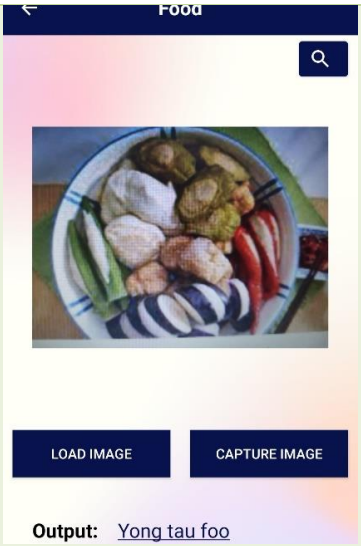
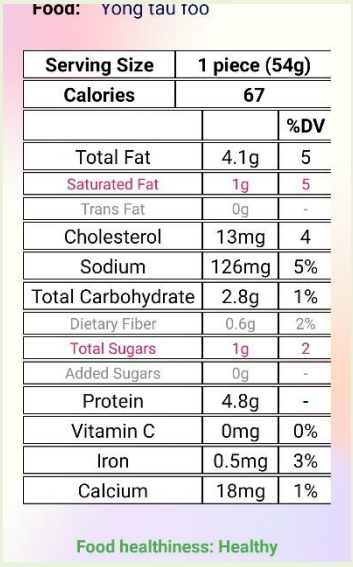
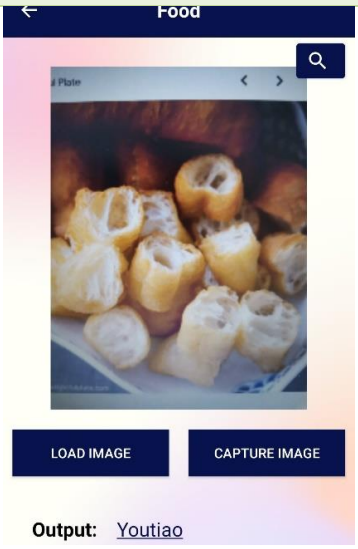
</td>
</tr>
<tr>
<td>95</td>
<td>Wonton noodles</td>
<td>


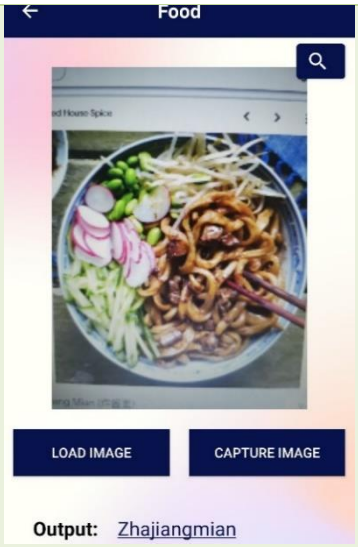
</td>
<td>

Able to detect the food correctly.
Nutrition details and food healthiness level (unhealthy) are displayed.

</td>
</tr>
</table>

			
96	Yakiniku		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

97	Yong tau foo	 	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.
98	Youtiao		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

		Food: Youtiao **Serving Size** 1 stick (56g) **Calories** 161 %DV Total Fat 6.4g 8 Saturated Fat 0.7g 3 Trans Fat 0g - Cholesterol 1.7mg 1 Sodium 396mg 17% Total Carbohydrate 22g 8% Dietary Fiber 0.7g 3% Total Sugars 0.1g 0 Added Sugars 0g - Protein 3.5g - Vitamin C 0mg 0% Iron 1.4mg 8% Calcium 102mg 8% **Food healthiness: Healthy**	
99	Zhajiangmian	 **Food:** Zhajiangmian **Serving Size** 250g **Calories** 263 %DV Total Fat 9g 12 Saturated Fat 1.1g 6 Trans Fat 0g - Cholesterol 12mg 4 Sodium 98mg 4% Total Carbohydrate 35g 13% Dietary Fiber 3.9g 14% Total Sugars 5.8g 10 Added Sugars 0g - Protein 11g 22% Vitamin C 0mg 0% Iron 1.7mg 9% Calcium 35mg 3% **Food healthiness: Healthy**	▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (healthy) are displayed.

100	Zongzi		▪ Able to detect the food correctly. ▪ Nutrition details and food healthiness level (unhealthy) are displayed.

Table 6.1: Table of food testing

The food recognition model [17] is tested using 100 food images from different categories including desserts, Western and Asian dishes. The model is able to recognize food from both uploaded and captured food images. A variety of food are tested such as desserts (pancake, waffle, macaron, mooncake, cheesecake, chocolate brownie etc.), Western food (pizza, sandwich, hamburger, spaghetti, lasagna, fried chicken etc.), Asian food including Malaysian cuisines (char kway teow, dimsum, nasi lemak, asam pedas, satay etc.), Japanese cuisines (omurice, onigiri, sushi, udon, takoyaki etc.) and Korean cuisines (bibimbap, kimchi, gimbap etc.).

Out of the 100 food images, 89 food images are correctly detected while 11 are incorrectly recognized as other food names. The model is found to be capable of detecting both Western and Asian food. However, it is not effective in recognizing certain Malaysian cuisines such as bubur cha cha (*No. 9 in Table 6.1*), nasi kandar (*No. 60 in Table 6.1*), rojak (*No. 77 in Table 6.1*) and roti canai (*No. 77 in Table 6.1*). In addition, the food recognition model struggled to identify some cakes such as fruit cake (*No. 36 in Table 6.1*), layer cake (*No. 51 in Table 6.1*), marble cake (*No. 55 in Table 6.1*) and tiramisu (*No. 90 in Table 6.1*). Noodle-type dishes are also not well differentiated by the model, such as hokkien mee (*No. 41 in Table 6.1*), pan mee (*No. 67 in Table 6.1*) and laksa (*No.49 in Table 6.1*) which is identified as udon.

In order to determine the accuracy of the model, it is required to calculate precision, recall and F1-score. Precision is needed to evaluate the accuracy of the model's positive predictions. Recall is used as a measure of the model's ability to detect instances. F1-score indicates the performance of the model. So, below is the formula for calculating precision, recall and F1-score:

- Precision = TP / (TP+FP)
- Recall = TP / (TP+FN)
- F1-score = 2*(Precision*Recall) / (Precision + Recall)

TP is true positive which indicates food that are correctly detected as their food name, FP is false positive which indicates food that are incorrectly detected as other food name and FN is false negative which indicates food image is detected as a non-food instance.
Based on the testing result above,

- TP (true positive) = 89
- FP (false positive) = 11
- FN (false negative) = 0

Using the formula above,

Precision = 89 / (89 + 11) = 0.89 (89%)
Recall = 89 / (89 + 0) = 1.0

F1-score = 2 * (0.89*1.0) / (0.89 + 1.0)
= 1.78 / 1.89
= 0.9418 (94.18%)

Hence, the model shows a high accuracy of detection and better performance based on the testing data as the values of evaluation metrics are high.

6.2 System Testing

Below is the list of developed functions in the mobile application that are tested:

No.	Functions	No. of test cases	Ability to function
1	Register account, Login, Reset password	7	✓
2	Home dashboard	3	✓
3	Add record	5	✓
4	Food detection & nutrition details with healthiness level displayed	4	✓
5	Reminder on notification	4	✓
6	Monthly statistics	2	✓
7	Report generator	2	✓
8	History records	4	✓
9	FCM push notification	1	✓
10	Logout	2	✓

Table 6.2: List of developed functions that are tested

Function 1: Register account, Login, Reset password

- **Test Case 1:** To test login with an unregistered account, and it should be unsuccessful to login into the mobile application.
- **Test Plan 1:** Enter email (kexin01@1utar.my), password (123456) and click “Login”.
- **Test Result 1:** It shows login error and no user record is found, which is correct as expected output.

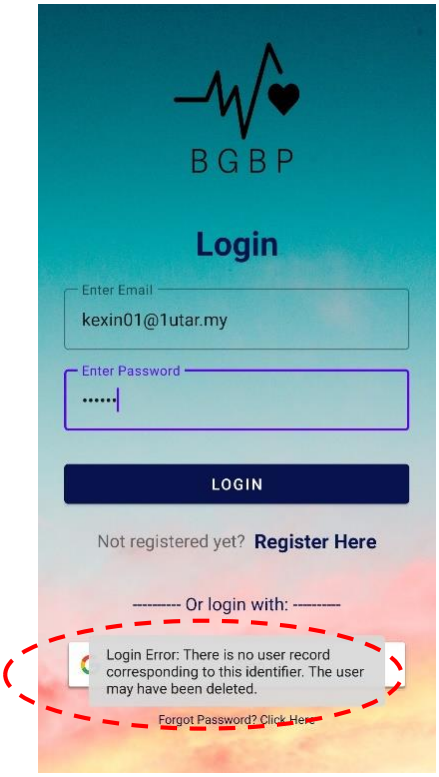


Figure 8.0a: Test case 1 for function 1

- **Test Case 2:** To test register account with a bad format of email, and it should be unsuccessful to register.
- **Test Plan 2:** Enter email (kexin01), password (123456) and click “Register”.
- **Test Result 2:** It shows registration error, which is correct as expected output.

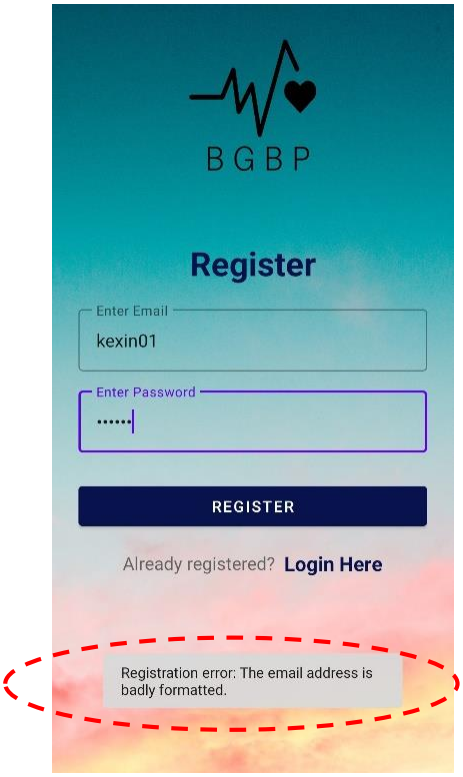


Figure 8.0b: Test case 2 for function 1

- **Test Case 3:** To test register account with correct email format, and it should be successful to register and redirect user to the home dashboard.
- **Test Plan 3:** Enter email (kexin01@1utar.my), password (123456) and click "Register".
- **Test Result 3:** Successfully registered an account and redirect to home dashboard, which is correct as expected output.

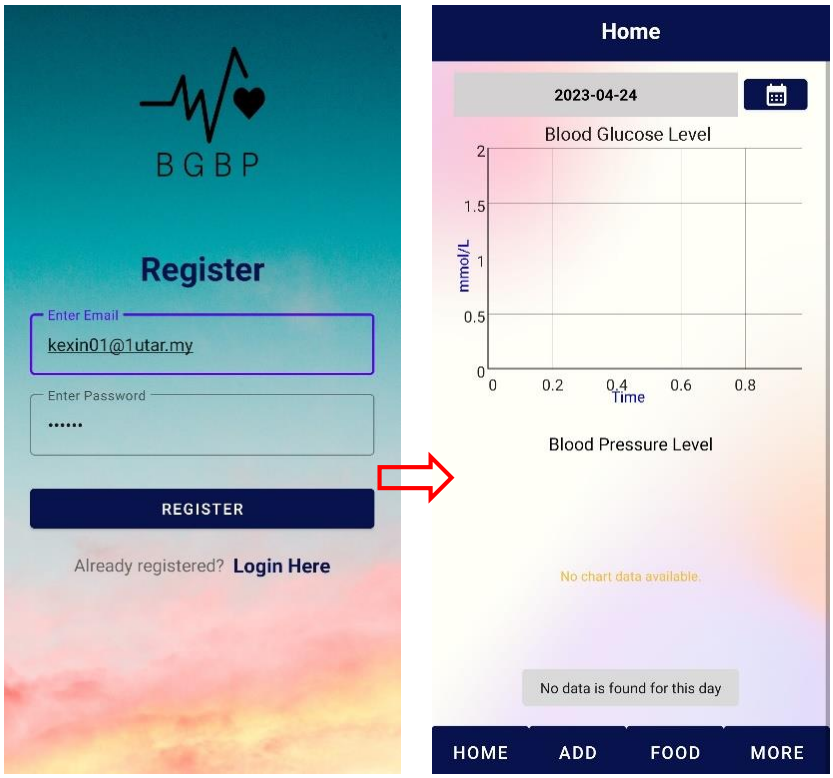


Figure 8.0c: Test case 3 for function 1

- **Test Case 4:** To test login with incorrect password, and it should be unsuccessful to login.
- **Test Plan 4:** Enter email (kexin01@1utar.my), password (567890) and click “Login”.
- **Test Result 4:** It shows login error and invalid password, which is correct as expected output.

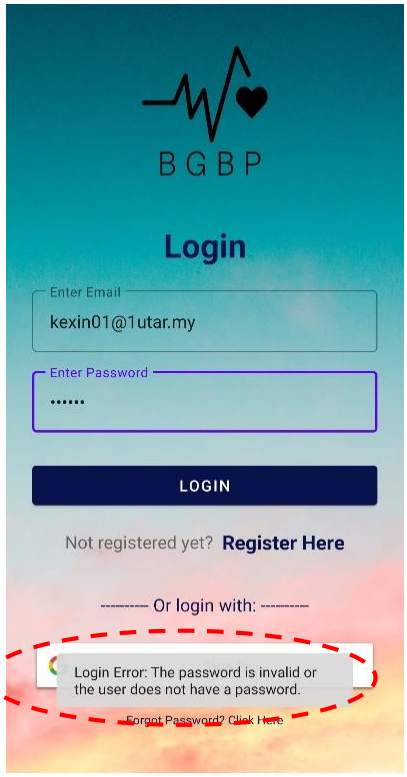


Figure 8.0d: Test case 4 for function 1

- **Test Case 5:** To test login with correct email and password, and it should be successful to login and go to home dashboard.
- **Test Plan 5:** Enter email (kexin01@1utar.my), password (123456) and click “Login”.
- **Test Result 5:** Successfully login and redirect to home dashboard, which is correct as expected output.

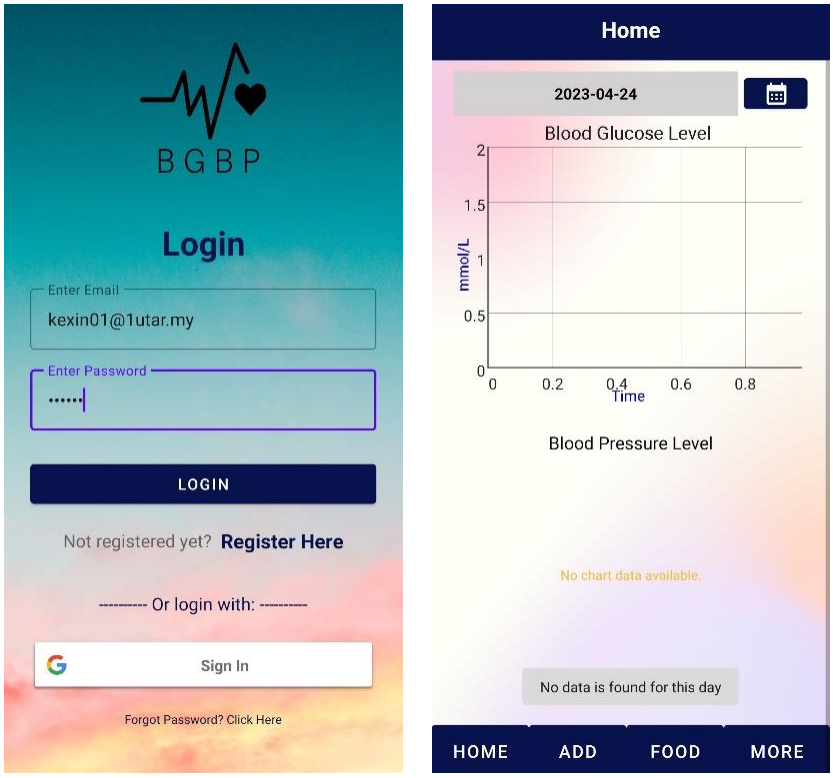


Figure 8.0e: Test case 5 for function 1

- **Test Case 6:** To test login with Google sign-in method, and it should be successful to login and go to home dashboard.
- **Test Plan 6:** Click “Google Sign In”.
- **Test Result 6:** Successfully login and redirect to home dashboard, which is correct as expected output.

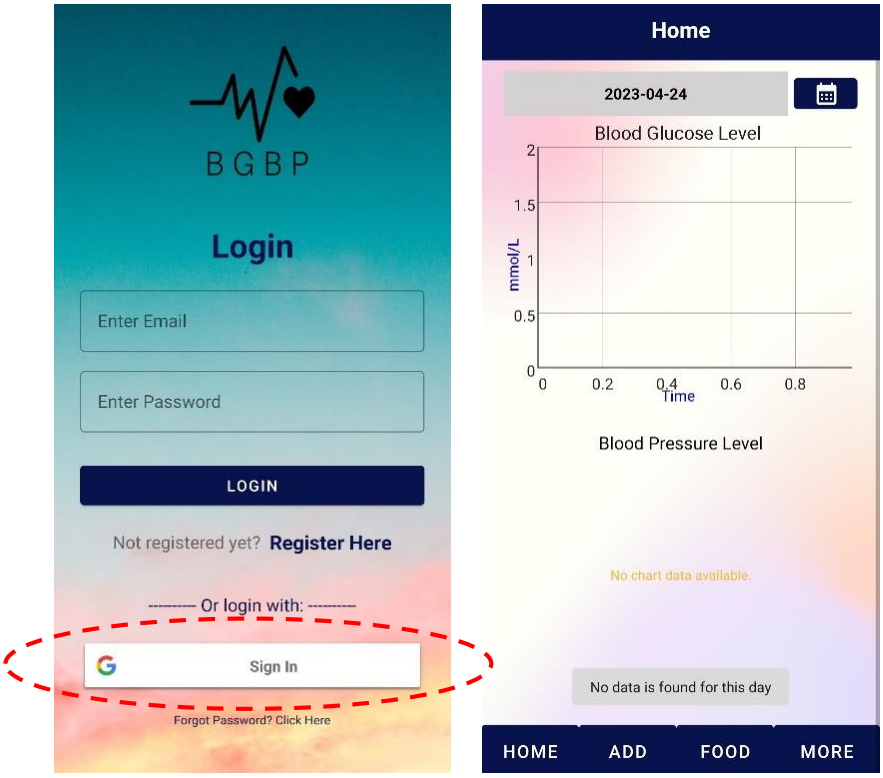


Figure 8.0f: Test case 6 for function 1

- **Test Case 7:** To test reset password, and user should be receiving email and able to change the account password.
- **Test Plan 7:** Provide email (kexin01@1utar.my) in the Reset Password interface and click “Send”.
- **Test Result 7:** Email is received and able to reset the password, which is correct as expected output.

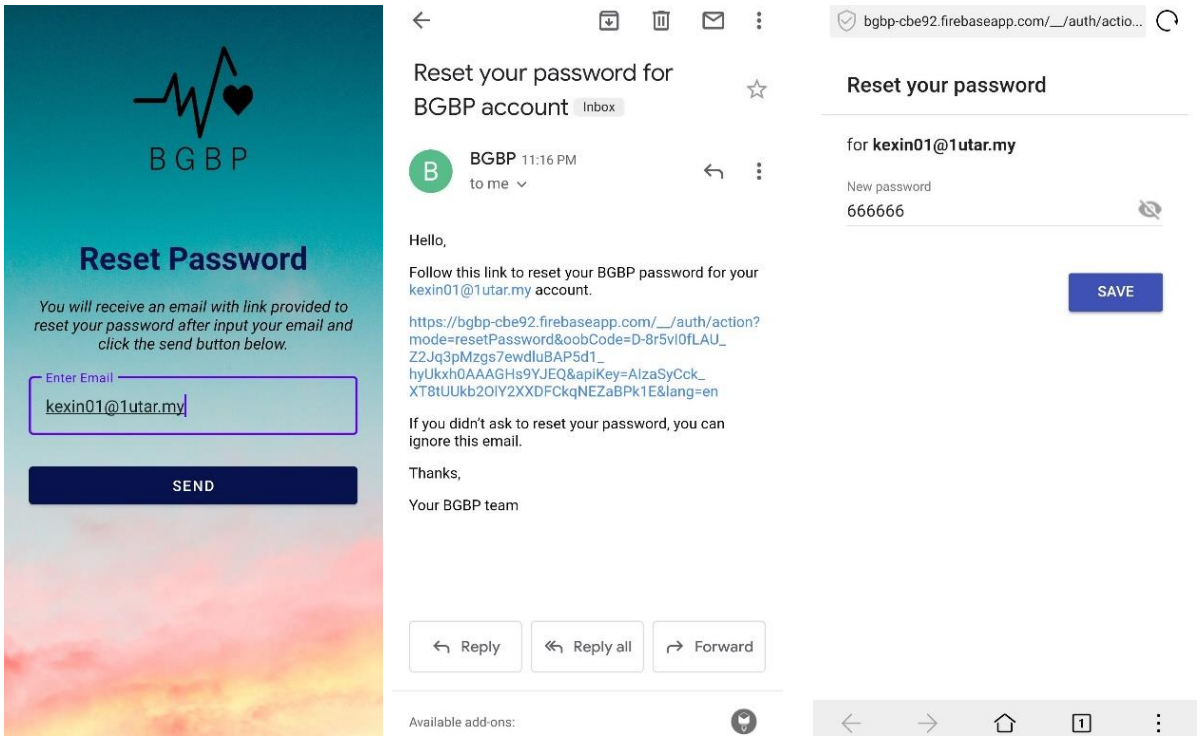


Figure 8.0g: Test case 7 for function 1

Function 2: Home dashboard

- **Test Case 1:** To test if selecting the date which contains records, the dashboard will be showing a line chart for blood glucose level and bar charts for blood pressure levels.
- **Test Plan 1:** Choose date (2022-12-05) from date picker.
- **Test Result 1:** Line graph and bar charts are displayed in the home dashboard. The function is working well.

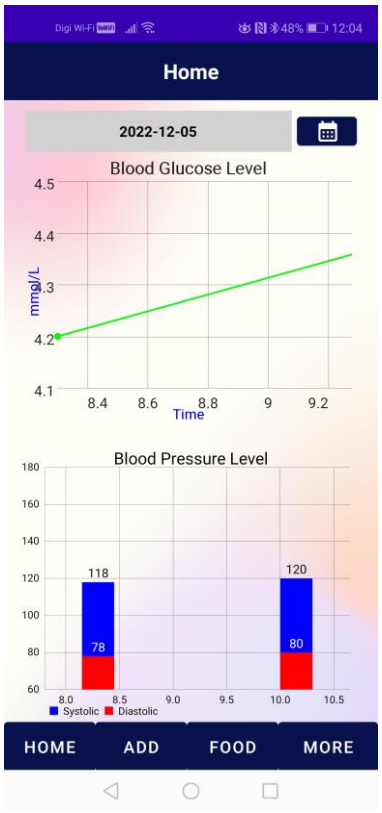


Figure 8.1a: Test case 1 for function 2

- **Test Case 2:** To test if selecting the date which does not contain any records, the dashboard will not be showing line chart for blood glucose level and bar charts for blood pressure levels.
- **Test Plan 2:** Choose date (2023-04-24) from date picker.
- **Test Result 2:** A toast message "No data is found for this day" is displayed and no charts are displayed in the home dashboard. The function is working well.

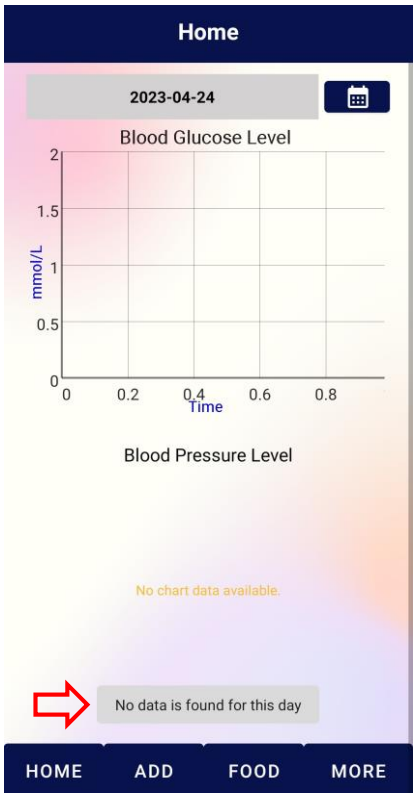


Figure 8.1b: Test case 2 for function 2

- **Test Case 3:** To test if selecting the date which contains blood glucose data that has exceeded the limit (10.5), the dashboard will be showing an alert message dialog box.
- **Test Plan 3:** Choose date (2022-12-23) from date picker.
- **Test Result 3:** An alert message is displayed. The function is working well.

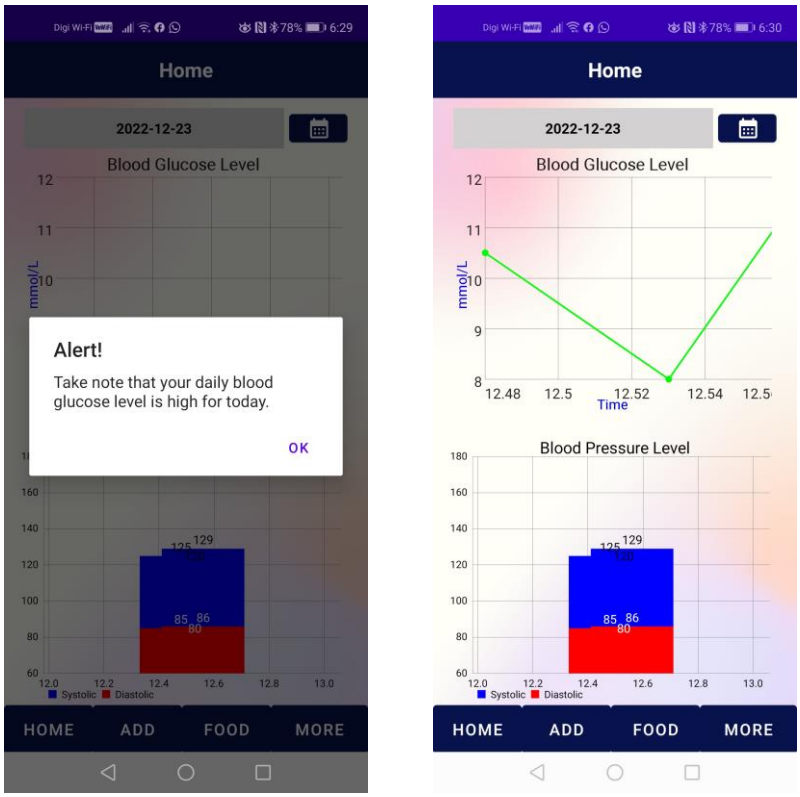


Figure 8.1c: Test case 3 for function 2

Function 3: Add record

- **Test Case 1:** To test if leaving all textboxes blank, the record will not be saved into database.
- **Test Plan 1:** Leave all textboxes empty and click “Save”.
- **Test Result 1:** A toast message “Please fill in data” is displayed and the function did not save any records into database. The function is working well.

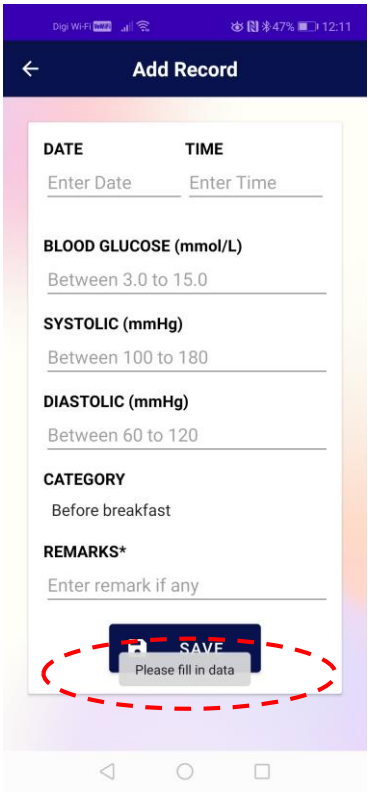


Figure 8.2a: Test case 1 for function 3

- **Test Case 2:** To test if entering incorrect range for blood glucose data, the record will not be saved into database.
- **Test Plan 2:** Enter (2) for blood glucose data, enter other data and click “Save”.
- **Test Result 2:** An error message that mentioning “Cannot less than 3.0 or exceed 15.0” is displayed and the function did not save the record into database. The function is working well.

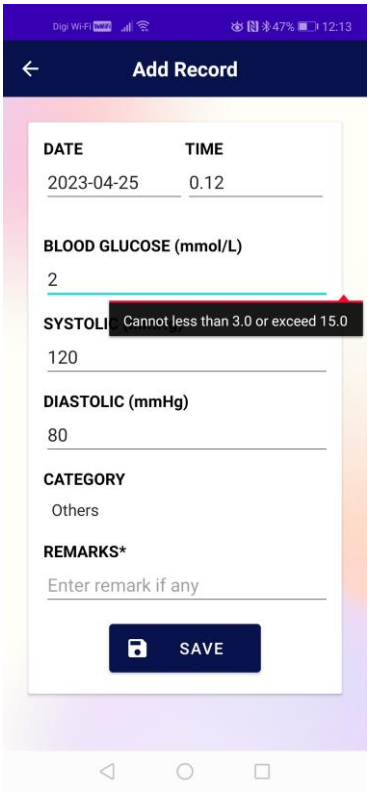


Figure 8.2b: Test case 2 for function 3

- **Test Case 3:** To test if entering incorrect range for systolic data, the record will not be saved into database.
- **Test Plan 3:** Enter (50) for systolic data, enter other data and click “Save”.
- **Test Result 3:** An error message that mentioning “Cannot less than 100 or exceed 180” is displayed and the function did not save the record into database. The function is working well.

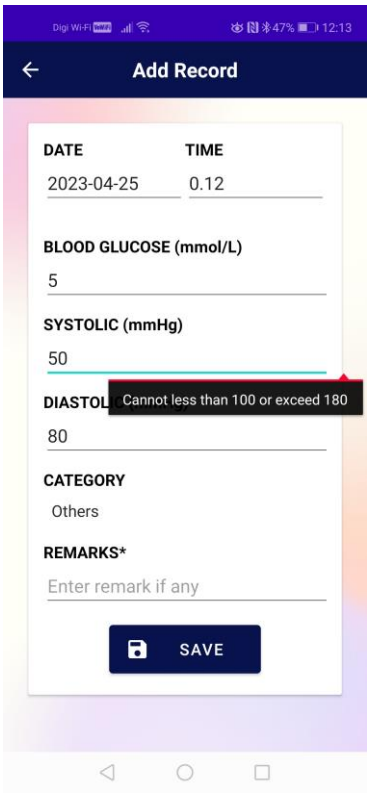


Figure 8.2c: Test case 3 for function 3

- **Test Case 4:** To test if entering incorrect range for diastolic data, the record will not be saved into database.
- **Test Plan 4:** Enter (150) for diastolic data, enter other data and click “Save”.
- **Test Result 4:** An error message that mentioning “Cannot less than 60 or exceed 120” is displayed and the function did not save the record into database. The function is working well.

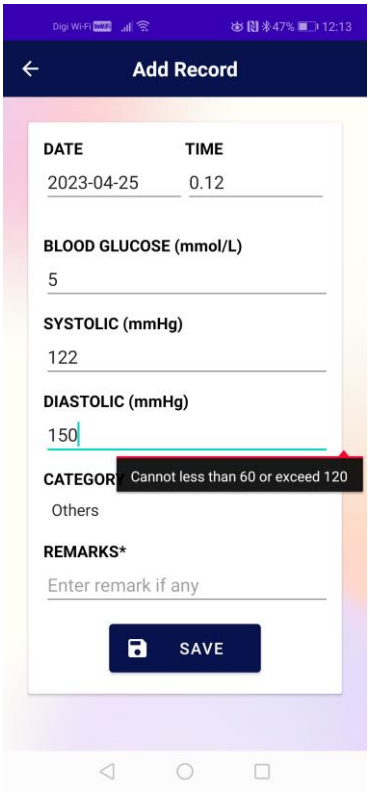


Figure 8.2d: Test case 4 for function 3

- **Test Case 5:** To test if entering all data in the textboxes except remarks, the record will be stored into database.
- **Test Plan 5:** Select date, time from date time picker, enter relevant data (5, 122, 85) for blood glucose and blood pressure readings, select category (Others) from spinner and click “Save”.
- **Test Result 5:** The function has successfully saved the record into database. The function is working well.

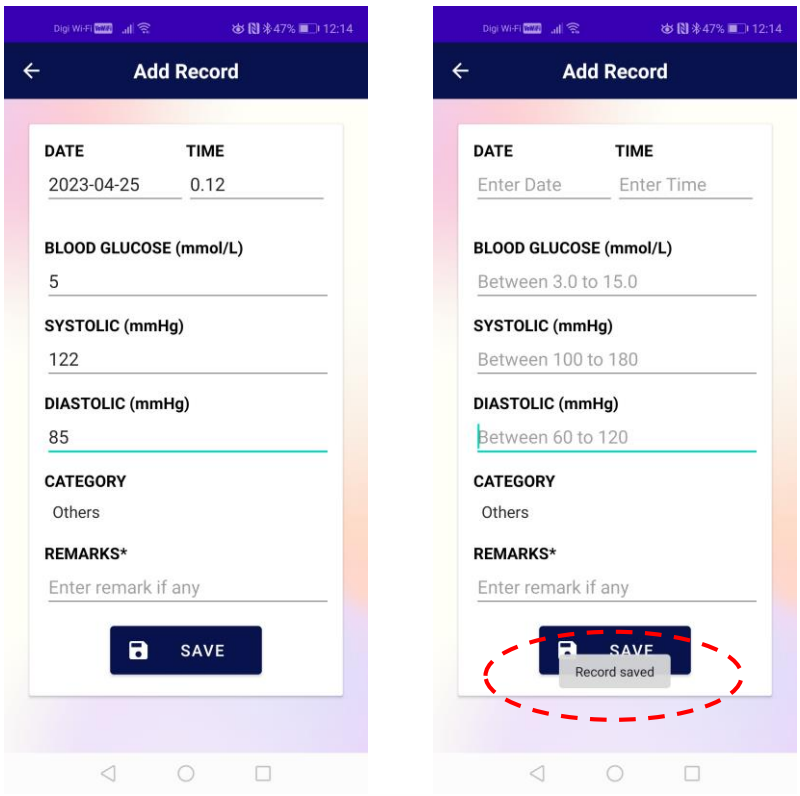


Figure 8.2e: Test case 5 for function 3

Function 4: Food detection & nutrition details with healthiness level displayed

- **Test Case 1:** To test the food image uploaded from device can be detected and the relevant food nutrition details with healthiness level are displayed.
- **Test Plan 1:** Click “Load Image” and choose food image from device.
- **Test Result 1:** The food name is output and showing its nutrition details and healthiness level. The function is working well.

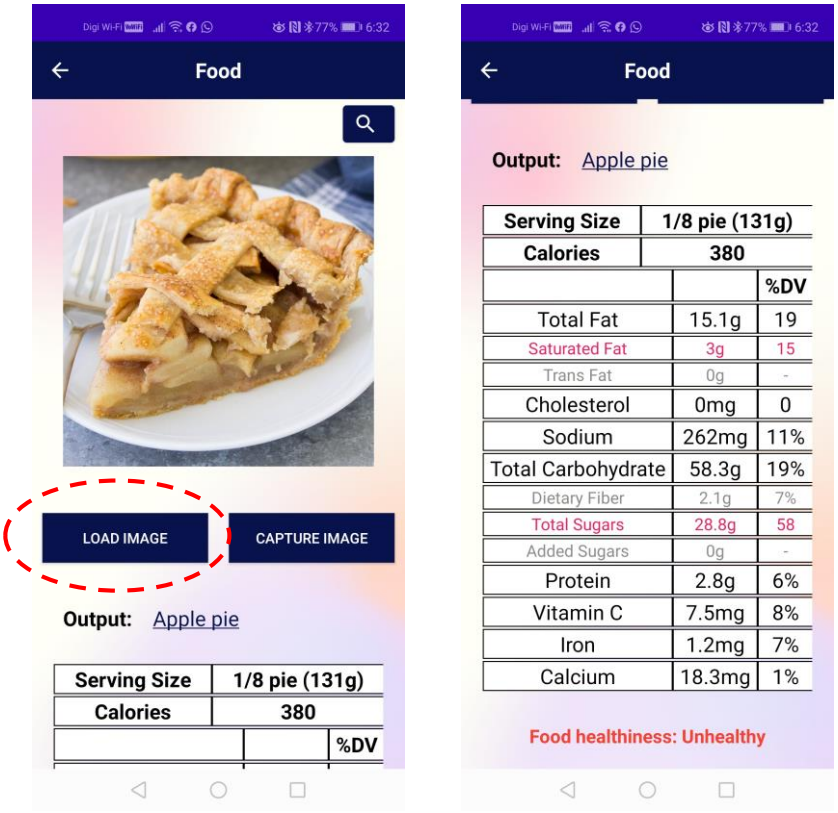


Figure 8.3a: Test case 1 for function 4

- **Test Case 2:** To test the food image captured from device can be detected and the relevant food nutrition details with healthiness level are displayed.
- **Test Plan 2:** Click “Capture Image” and take food photo.
- **Test Result 2:** The food name is output and showing its nutrition details and healthiness level. The function is working well.

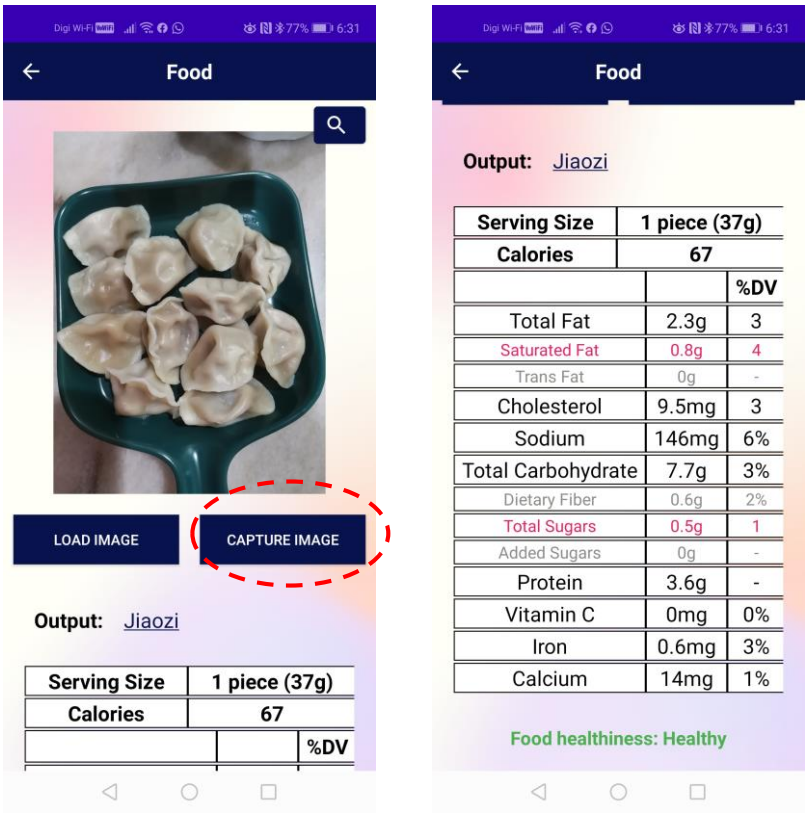


Figure 8.3b: Test case 2 for function 4

- **Test Case 3:** To test the generated output can be linked to Google search by clicking the food name to view its nutrition information.
- **Test Plan 3:** Click “Capture Image”, take a food photo and click on the food name.
- **Test Result 3:** The food name is output but there is no available food database. Google search is linked to show its nutrition details after clicking the food name.

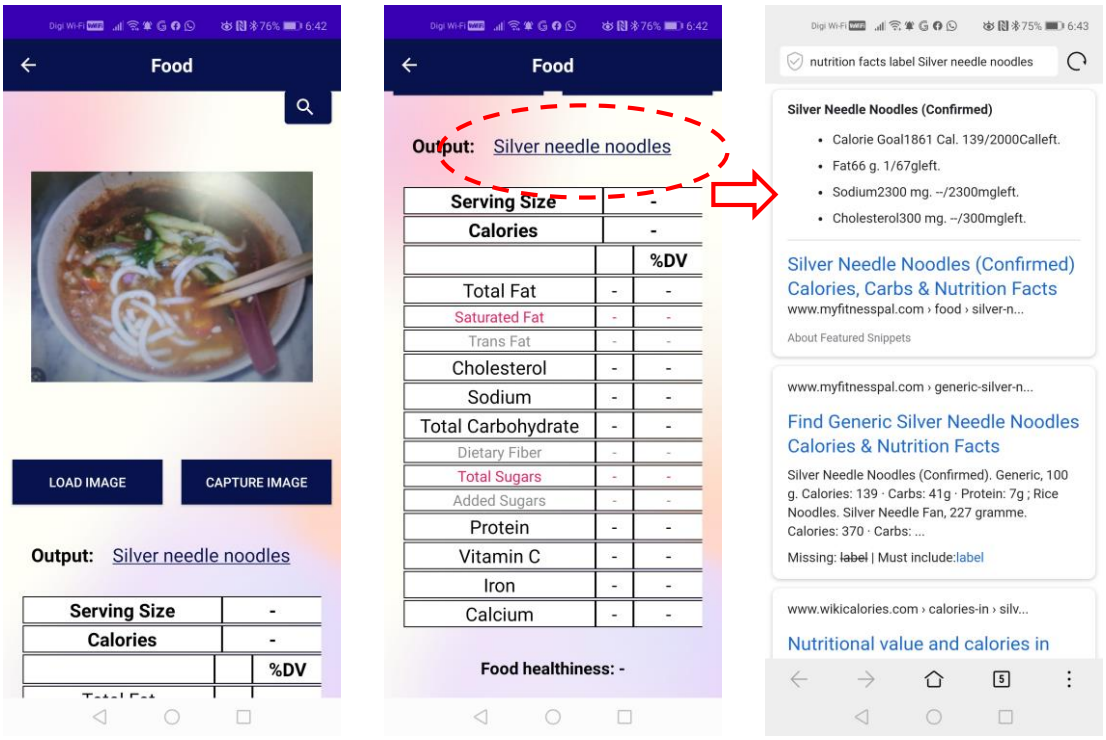


Figure 8.3c: Test case 3 for function 4

- **Test Case 4:** To test the search feature for viewing food nutrition information and healthiness level.
- **Test Plan 4:** Enter food name, find from the list and click the food name.
- **Test Result 4:** The relevant food nutrition details and healthiness level are shown. The function is working well.

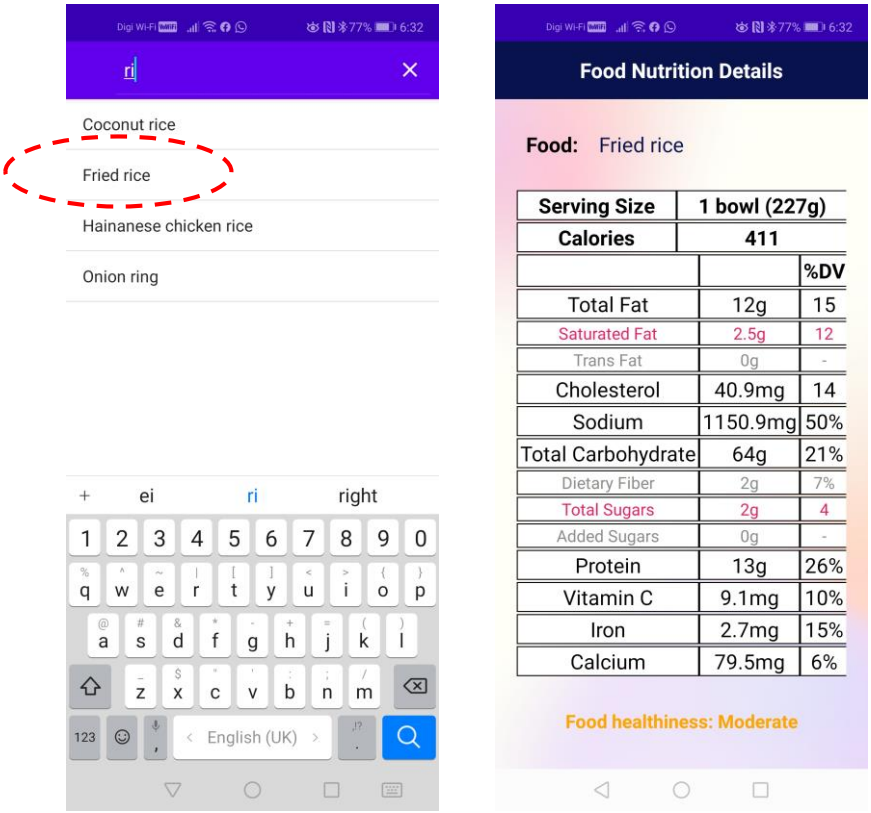


Figure 8.3d: Test case 4 for function 4

Function 5: Reminder on medication

- **Test Case 1:** To test if leaving all textboxes blank, the medication record will not be saved into database and the reminder will not be generated.
- **Test Plan 1:** Leave all textboxes empty and click “Add”.
- **Test Result 1:** A toast message “Please fill in data” is displayed and the function did not save any records into database and did not generate the reminder as well. The function is working well.

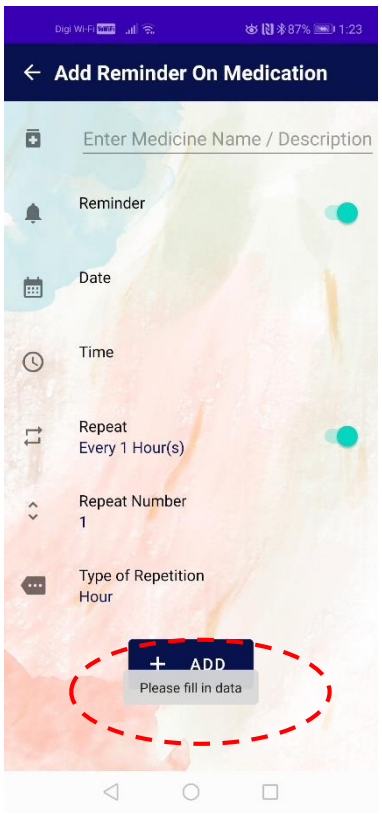


Figure 8.4a: Test case 1 for function 5

- **Test Case 2:** To test if entering details into all textboxes provided, the medication record will be saved into database and the reminder will be received by user.
- **Test Plan 2:** Fill in details (test1, turn on reminder, date, time, allow repetition for every 2 minutes) and click “Add”.
- **Test Result 2:** The function has successfully saved the record into database and generated the reminder. Reminder message can be received every 2 minutes. The function is working well.

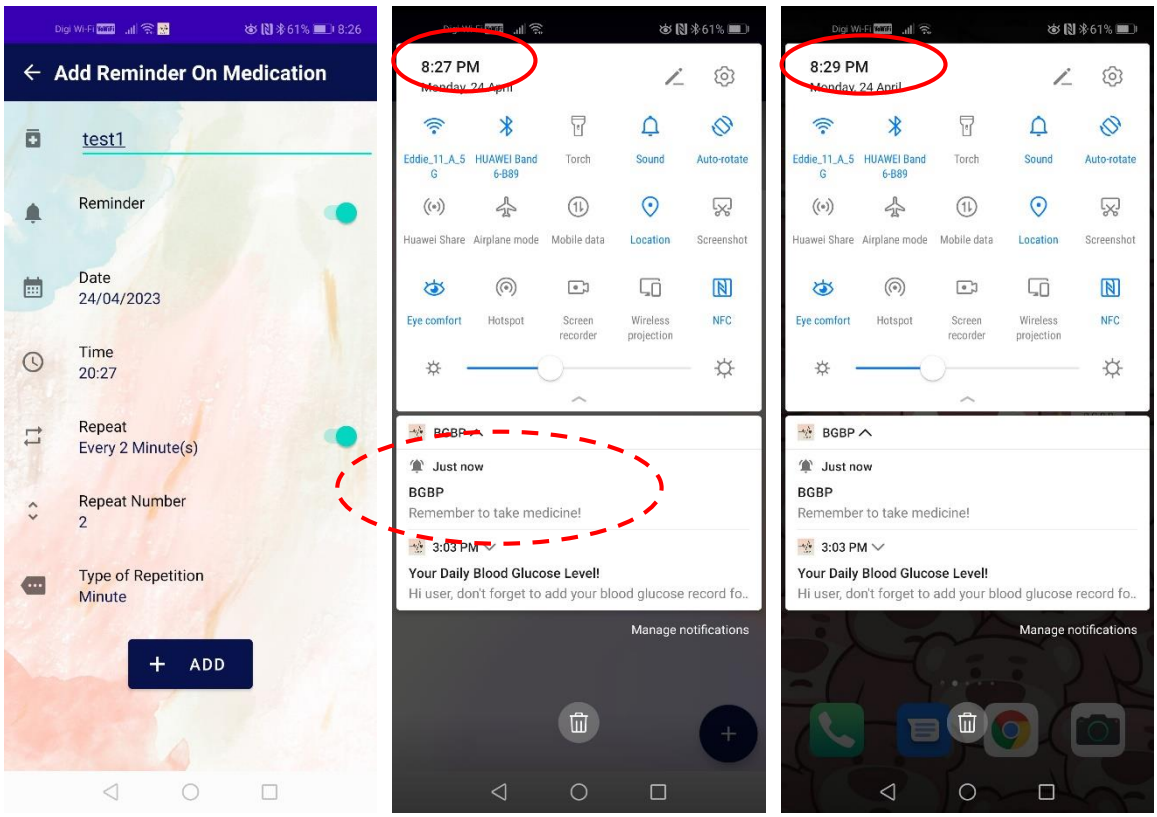


Figure 8.4b: Test case 2 for function 5

- **Test Case 3:** To test if the modification of record can be performed in the feature.
- **Test Plan 3:** Change from “mec1” to “mec2”, click “Save” and confirm to modify by clicking “Yes”.
- **Test Result 3:** It is successfully edited. The function is working well.

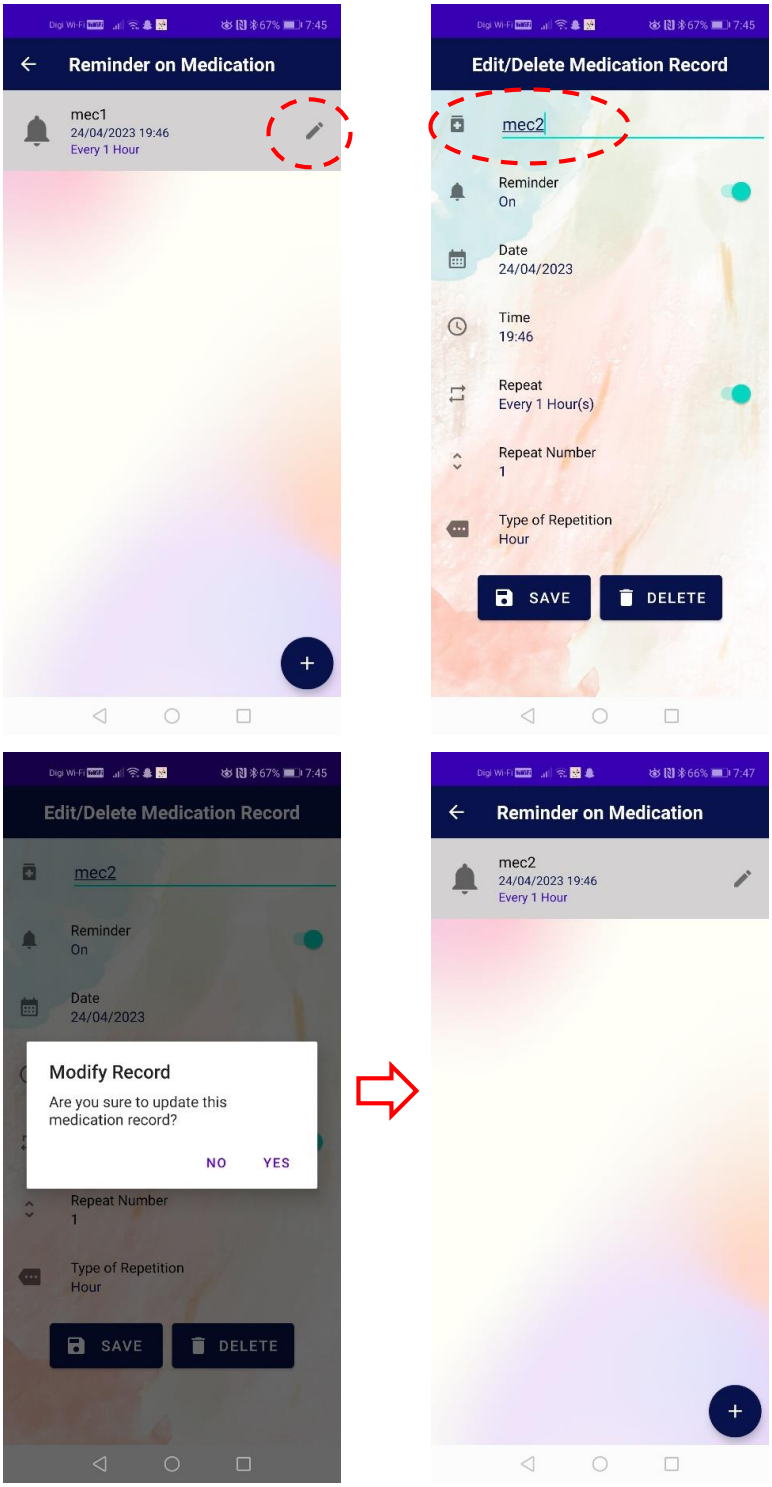


Figure 8.4c: Test case 3 for function 5

- **Test Case 4:** To test if the deletion of record can be performed in the feature.
- **Test Plan 4:** Confirm to delete by clicking “Yes”.
- **Test Result 4:** It is successfully deleted. The function is working well.

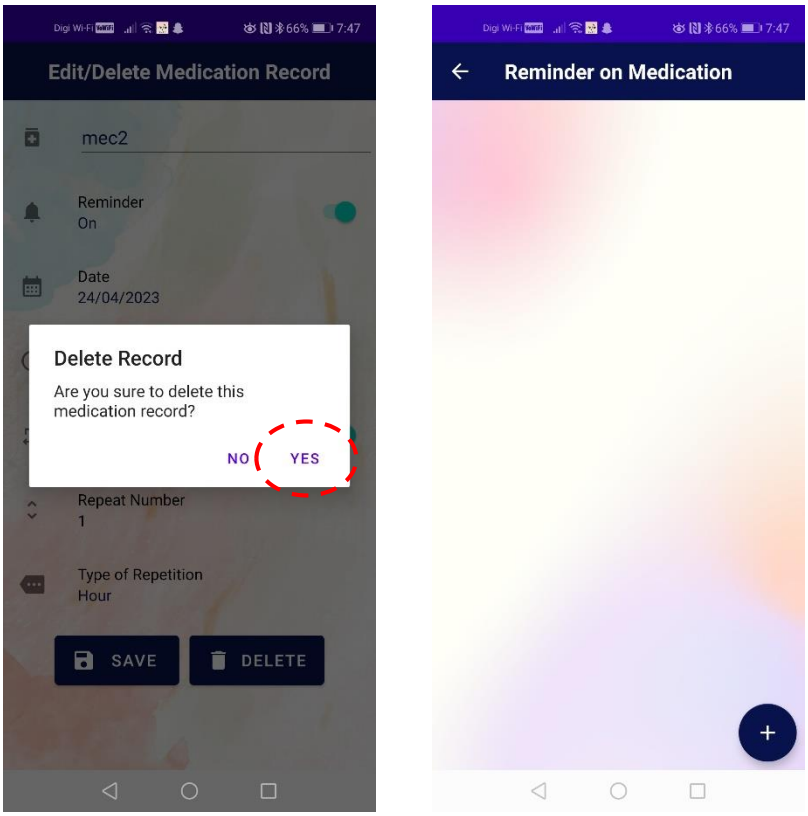


Figure 8.4d: Test case 4 for function 5

Function 6: Monthly statistics

- **Test Case 1:** To test if the selected month which do not contain any records will not display any graphs and statistics for both blood glucose and blood pressure levels.
- **Test Plan 1:** Select month from date picker (February → 2023-02).
- **Test Result 1:** A toast message "No data is found for this month" is displayed and no charts are shown in the interface, as well as the values of zero are displayed for the lowest, highest and average readings. The function is working well.

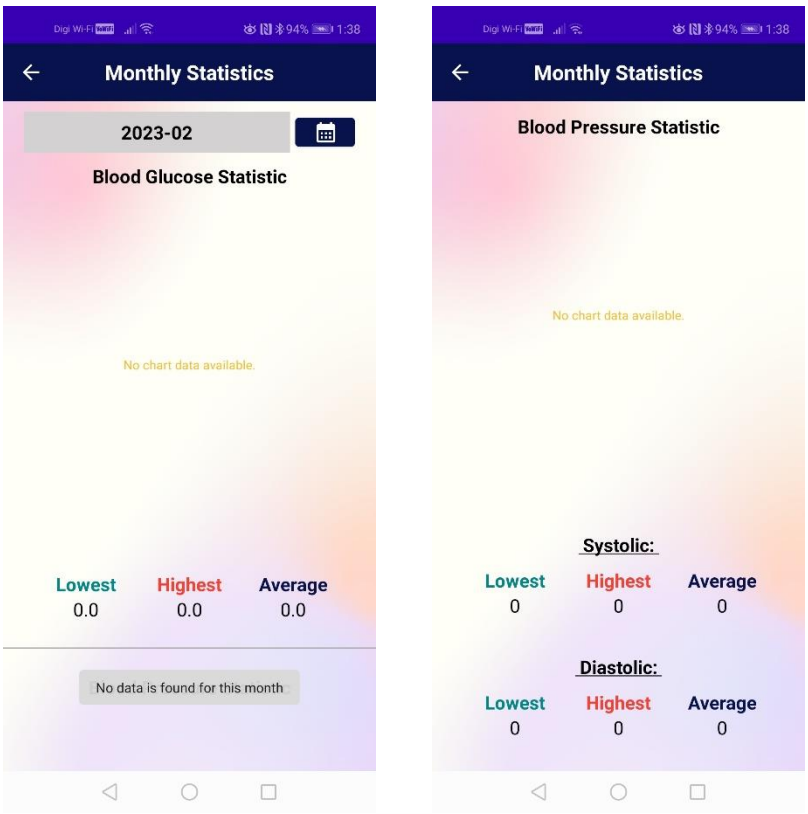


Figure 8.5a: Test case 1 for function 6

- **Test Case 2:** To test if the selected month which contain records will display a scatter chart with statistics for blood glucose level and also a multi-line chart with statistics for blood pressure level.
- **Test Plan 2:** Select month from date picker (December → 2022-12).
- **Test Result 2:** Scatter chart, multi-line chart and statistics for both blood glucose and blood pressure levels of the month are shown in the interface. The function is working well.

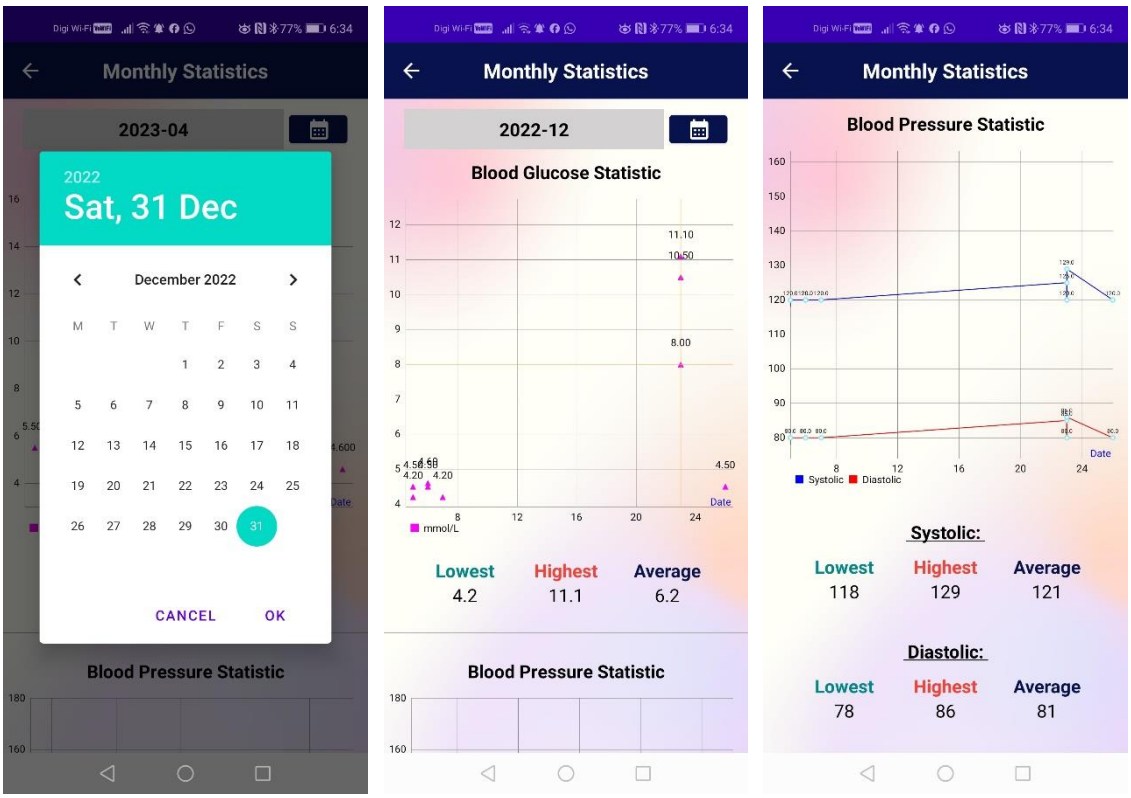


Figure 8.5b: Test case 2 for function 6

Function 7: Report generator

- **Test Case 1:** To test if the selected date range and category which do not contain any records will not generate PDF report into the device.
- **Test Plan 1:** Select date range from date picker (from 2023-03-01 to 2023-03-31), select category (Before breakfast) and click “Download”.
- **Test Result 1:** A toast message “No data available” is displayed and no PDF report is generated. The function is working well.

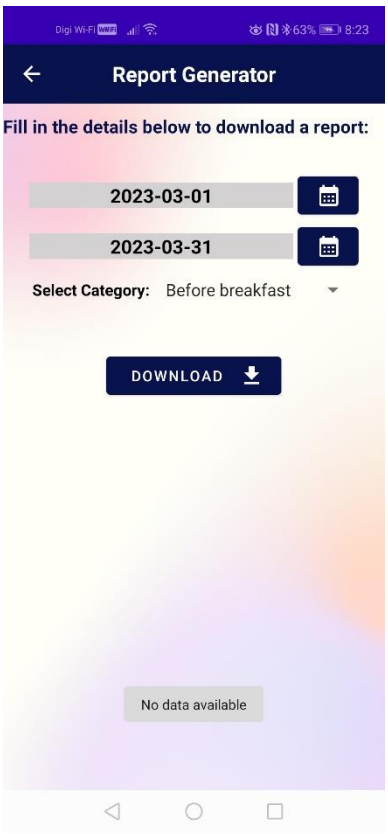


Figure 8.6a: Test case 1 for function 7

- **Test Case 2:** To test if the selected date range and category which contain records will generate PDF report into the device.
- **Test Plan 2:** Select date range from date picker (from 2022-12-01 to 2022-12-31), select category (All) and click “Download”.
- **Test Result 2:** A PDF report is generated into the device’s internal storage with the correct data. The function is working well.

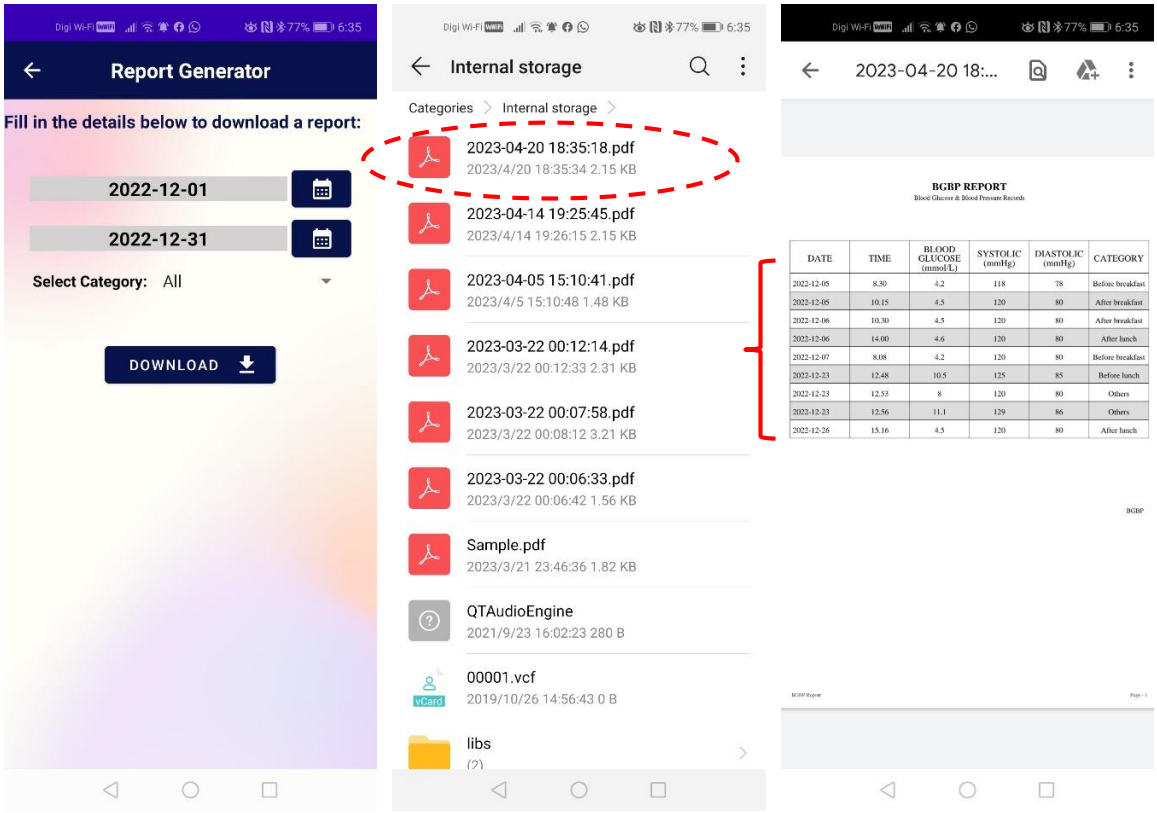


Figure 8.6b: Test case 2 for function 7

Function 8: History records

- **Test Case 1:** To test if after applied date range and category filter, the feature is able to display the relevant records.
- **Test Plan 1:** Select date from date picker (from 2023-04-01 to 2023-04-20), select category (All) and click 'Apply'.
- **Test Result 1:** Able to display the correct records based on the filters applied. The function is working well.

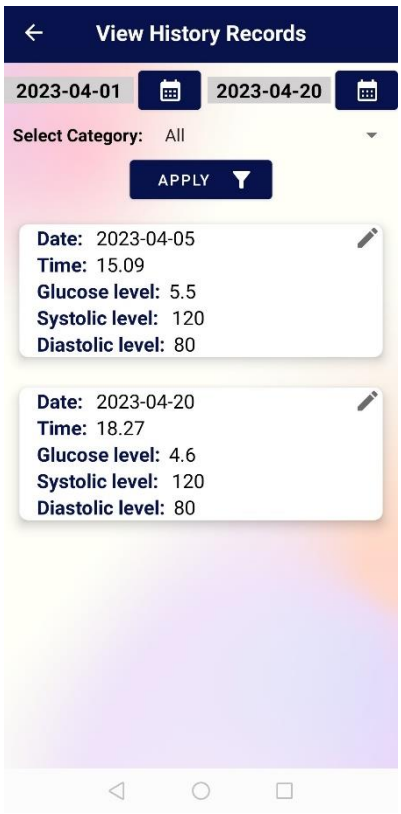


Figure 8.7a: Test case 1 for function 8

- **Test Case 2:** To test if after applied date range and category filter which do not contain any records, the feature will not display any records in the interface.
- **Test Plan 2:** Select date from date picker (from 2023-03-01 to 2023-03-16), select category (After lunch) and click ‘Apply’.
- **Test Result 2:** The feature did not display the records and only show a toast message “No data exists”. The function is working well.

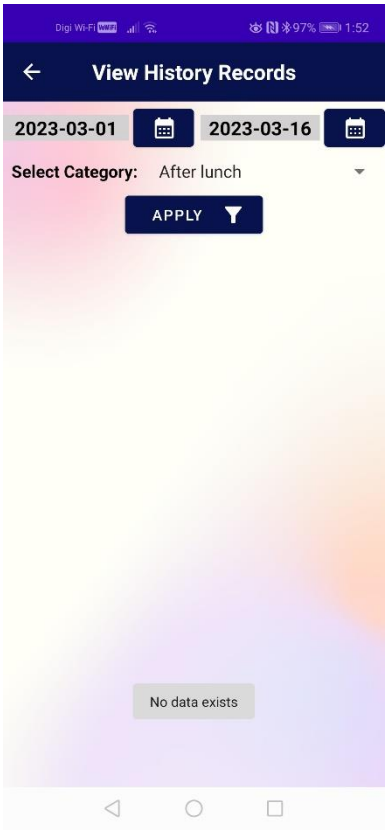


Figure 8.7b: Test case 2 for function 8

- **Test Case 3:** To test if the modification of record can be done in the feature.
- **Test Plan 3:** Select the specific record, change value (from 80 to 84), click “Update” and click “Yes” to confirm.
- **Test Result 3:** The record has been successfully edited, the feature is working well.

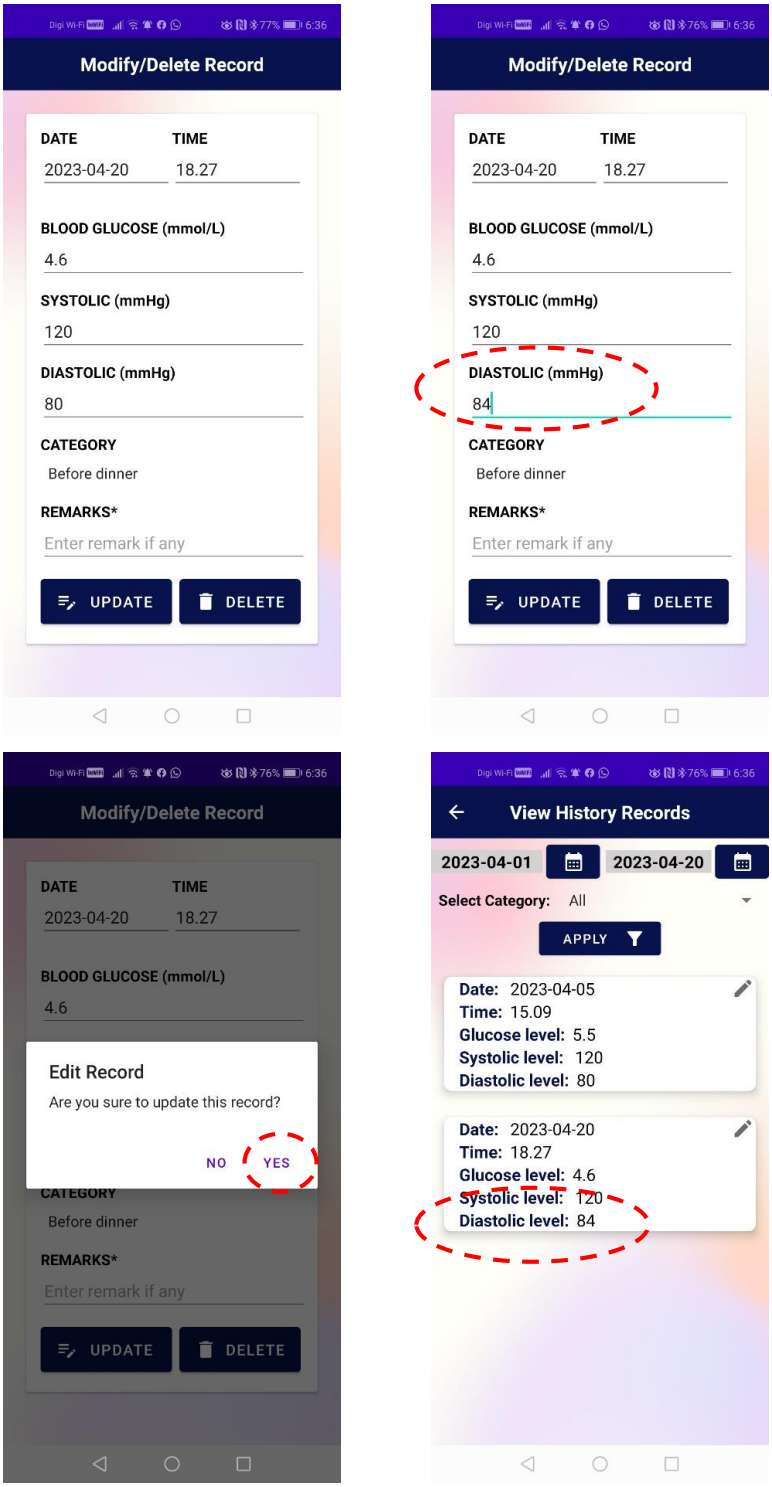


Figure 8.7c: Test case 3 for function 8

- **Test Case 4:** To test if the deletion of record can be done in the feature.
- **Test Plan 4:** Select the specific record, click “Delete” and select “Yes”.
- **Test Result 4:** The record has been successfully removed, the feature is working well.

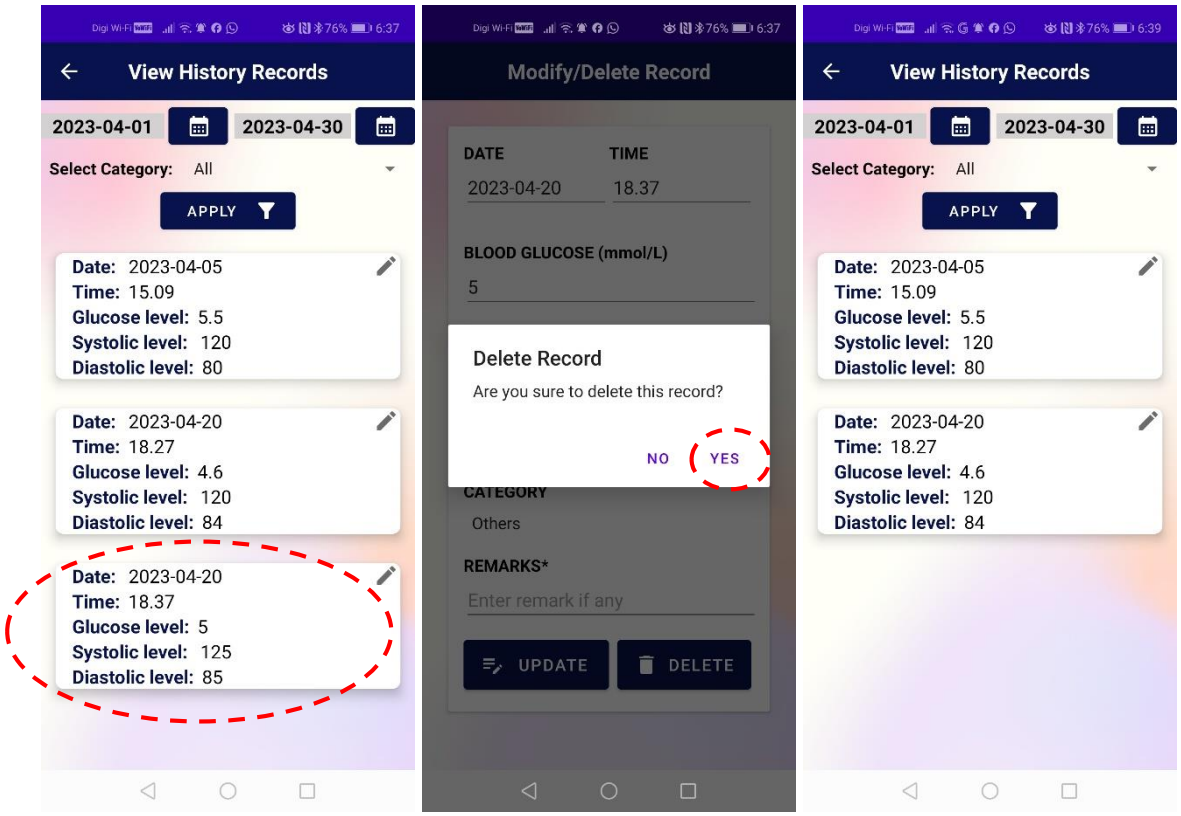


Figure 8.7d: Test case 4 for function 8

Function 9: Firebase Cloud Messaging (FCM) push notification

- **Test Case 1:** To test if a scheduled push notification will be sent to user.
- **Test Plan 1:** Observe notification in the device at 3pm (GMT+08:00).
- **Test Result 1:** Able to receive the reminder FCM push notification.

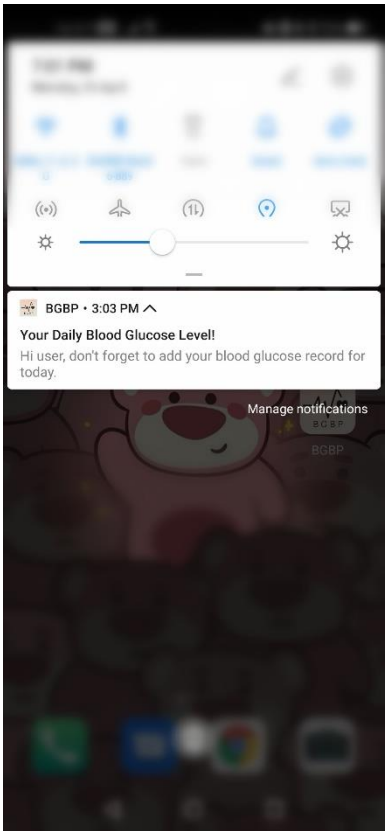


Figure 8.8: Test result 1 for function 9

Function 10: Logout

- **Test Case 1:** To test if the user remains in the system when choose not to log out.
- **Test Plan 1:** Click 'Logout' and select 'No'.
- **Test Result 1:** Able to remain in the system after selecting 'No' in confirmation dialog box as shown in figure below. The function is working well.

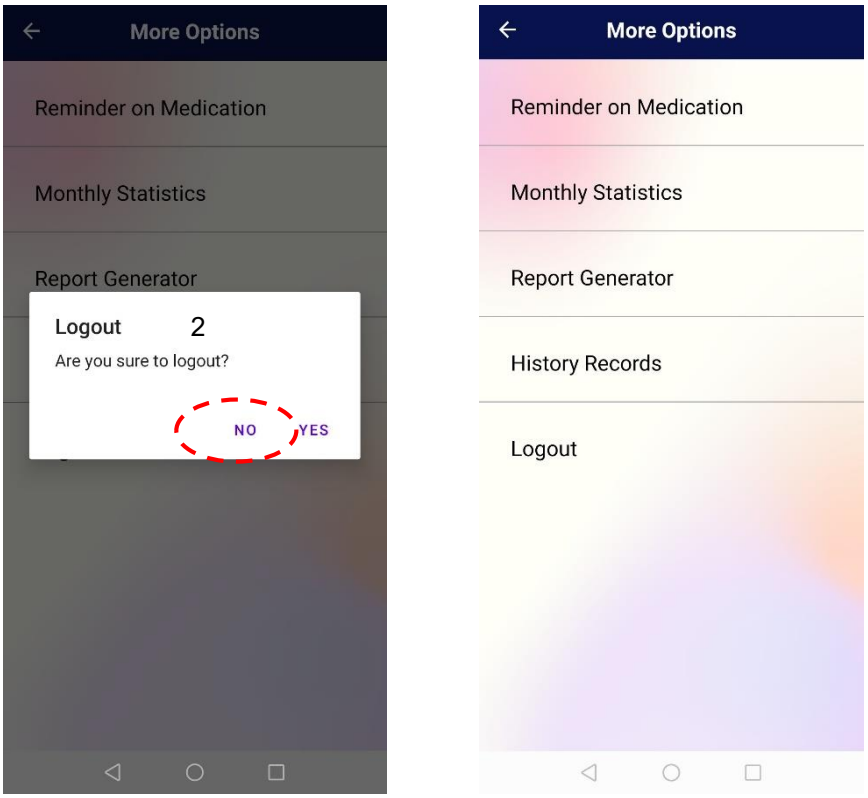


Figure 8.9a: Test result 1 for function 10

- **Test Case 2:** To test if the account can be successfully signed out and redirect user to login interface.
- **Test Plan 2:** Click ‘Logout’ and select ‘Yes’.
- **Test Result 2:** Able to logout after selecting ‘Yes’ in confirmation dialog box and redirect back to login interface as shown in figure below. The function is working well.

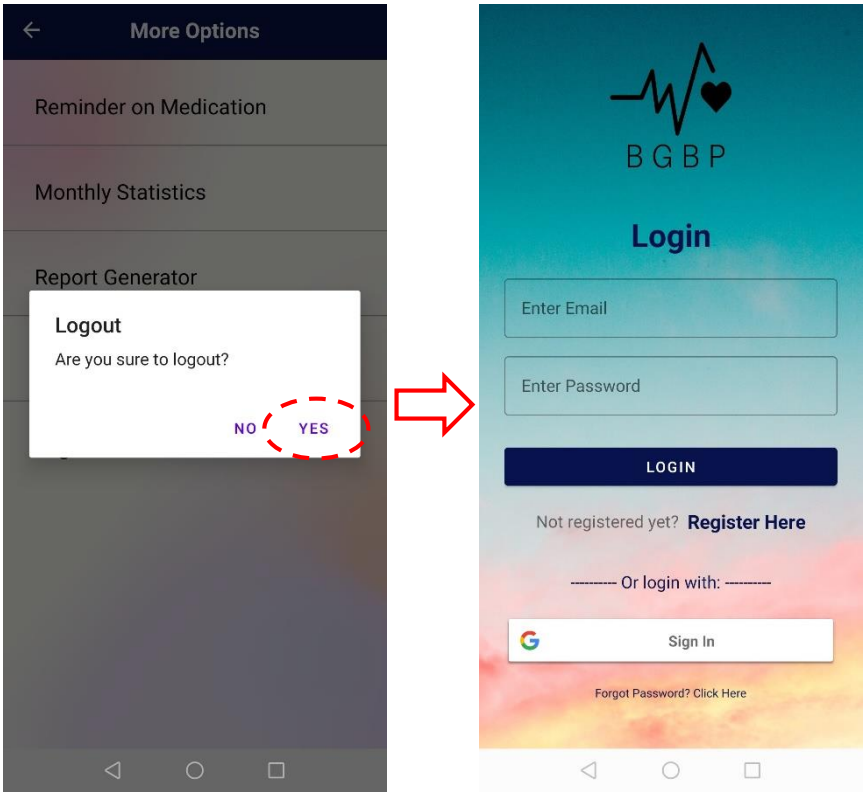


Figure 8.9b: Test result 2 for function 10

Based on the system testing conducted, all the functionalities developed for the mobile application are working properly. Hence, the objectives of the project have been successfully achieved. The mobile platform has been developed to check and monitor blood glucose and blood pressure levels and the food recognition technology has been implemented to display food nutrition details and food healthiness level. The application is also enhanced with several additional features such as reminder on medication, report generator and etc.

6.3 Challenges and Issues

This project is utilized Firebase Realtime Database to store multiple set of data such as medication records, blood glucose records and food nutrition information. The main limitation of this project is related to the storage space provided by Firebase database as it only offers up to 1GB of data storage for the no-cost plan. Therefore, there is a limited amount of storage available for the food database which contains various type of food nutrition details as well as for other records that need to be saved into the Firebase database. This may cause problems in the future when the amount of data in the Firebase database have exceeded the available storage space. The mobile application may not be able to store additional data such as updating new nutrition details of new food and error may occur when user is trying to save records into the database.

Furthermore, another limitation of the project is the availability of Asian food databases. As the food nutrition data sources in this project are mainly from USDA Food Data Central and Nutritionix, these databases are having limited information on Asian food nutrition. Both sources are mostly focused on Western food nutrition information. Hence, the nutrition details for Asian food like Malaysian cuisine such as ‘lemang’ and ‘roti jala’, are unavailable from the databases. This lead to an incomplete of nutrition information for a variety of Asian food in this project.

Besides, the food recognition model used in the project has several limitations. It is not efficient in detecting different types of noodles such as ‘hokkien mee’, ‘mee goreng’, ‘pan mee’ and etc., as well as desserts such as cakes and bread. The model has difficulty in differentiating between various types of cakes, such as marble cake, fruit cake, layer cake and tiramisu. Its accuracy is limited when detecting multiple dishes in a single food image. It is also incapable of detecting beverage or drinks (desserts) such as bubble tea, ‘bubur cha cha’, green bean soup and so on and it cannot identify fruits as well. Moreover, the model struggles to identify some types of Asian food, such as Malaysian dishes like ‘roti canai’, ‘roti paratha’, ‘nasi biryani’, ‘nasi kandar’, ‘laksa’ and ’rojak’. However, the model is still able to detect Asian food well such as ‘char kway teow’, ‘chicken curry’, ‘nasi lemak’, ‘dumpling’ and so on although the model is mainly capable of detecting Western dishes.

Chapter 7
Conclusion and Recommendation

7.1 Conclusion

BGBP is a self-management mobile application mainly designed for diabetic. This is to allow diabetes patients to monitor and keep track on their blood glucose level and improve their awareness on the nutrition intake from food. This application consists of several functions such as adding blood glucose and blood pressure record, monitor both levels in graph-view, food recognition feature with nutrition facts label displayed, reminder on medication, generate report, view monthly statistics and history records.

User is able to view the line-chart and bar-chart for daily blood glucose and blood pressure level, as well as enable zooming and scrolling on the graphs. Firebase software is mainly utilized to develop this application for storing and retrieving all the records. Besides, user is allowed to input data in the add-form provided as well as checking the past records in list-view. Any modification and deletion of records will be updated instantly in Firebase Realtime Database. Moreover, this mobile application has included some Android built-in functions such as DatePickerDialog, TimePickerDialog, AlarmManager, BroadcastReceiver and so on for the reminder on medication feature. Push notification will be sent to remind user to take medicine.

In addition, user is able to view the overall blood glucose level per day through the scatter chart and blood pressure level in a multi-line graph in the application. The information of the lowest, highest and average readings for the specific month are also provided. User is allowed to download PDF report into device that acts as future reference for medical consultation. Most importantly, by using food recognition technology, the mobile application displays the relevant nutrition information such as total sugars, saturated fat, protein and etc. with the food healthiness level provided along. This increases user's awareness of nutrition intake and also helps in encouraging healthier food consumption.

7.2 Recommendations and Future Work

To deal with the limitation of storage space in the project that is mentioned earlier, Firebase Cloud Firestore can be utilized for storing food database only, which consisting various types of food nutrition information such as calories, total fat, saturated fat, total sugars, each %DV and etc. Cloud Firestore is another service provided by Firebase and it is highly scalable compared to Realtime Database. As the food database is considered as large amounts of structured data, hence this service can be useful for handling the food database and it also provides flexible data model and automatic scaling function. The limit of storage space provided by Cloud Firestore for the no-cost plan is 1GiB, which is slightly larger than Realtime Database. It offers a "pay-as-you-go" pricing model which is only pay for the additional resources that are used after exceeding the free capacity.

Besides, to deal with the Asian food nutrition information, this project can be considered to collaborate with Food Science experts and dietitians to work on it. It is because they have rich knowledge on food nutrition and expertise in it. Hence, this can help to obtain more comprehensive nutrition details and ensure completeness of information in the food database. Also, users of the application can also help in contributing the information by giving feedback on the missing food details. Another approach to increase the food nutrition details into the food database is to implement web scraping technique. This can be done during the process when the user is redirected to Google quick search, showing the relevant food nutrition information if there is no food details available in the existing food database. The information from Google search results can be obtained by using web scraping technique and extract it to write into the existing food database to increase its coverage.

In order to have a more advanced food recognition model, developing a custom model can be considered. For instance, focus on training the model with a dataset of Asian food images. Not only that, fruits and drinks dataset can also be included as well. So that the custom food recognition model can be highly specialized for the project's usage. Lastly, there is a potential future enhancement for this project which is to integrate with CGM (continuous glucose monitoring) devices into the mobile application. This can bring convenience to users as it is able to capture the blood glucose level measurements automatically to the mobile application

and users do not need to manually input the data anymore. However, this function will require extra effort in developing and partnership with the device manufacturers.

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APPENDIX

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3T3	**Study week no.: 1 & 2**
Student Name & ID: Chew Ke Xin (19ACB03038)	
Supervisor: Dr Chai Meei Tyng	
Project Title: BGBP – A Mobile Application For Diabetic Self-Management	

1. WORK DONE

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

1) History Record feature: add new filter option (allow user to select category options)
2) Add new feature on home dashboard (suggested by moderator during FYP1 presentation)
   -alert message to user if the daily blood glucose has exceeding value of 10.5 reading

2. WORK TO BE DONE

Implement 'Monthly Statistics' feature.

3. PROBLEMS ENCOUNTERED

–

4. SELF EVALUATION OF THE PROGRESS

Need to rush for other functions implementation.

tyng
_____
Supervisor's signature

Chew
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Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3T3	**Study week no.: 3**
Student Name & ID: Chew Ke Xin (19ACB03038)	
Supervisor: Dr Chai Meei Tyng	
Project Title: BGBP – A Mobile Application For Diabetic Self-Management	

1. WORK DONE

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

1) Monthy Statistics feature:

-set DatePickerDialog and try to retrieve data from database

-try insert into DataPoint to plot charts for both blood glucose and blood pressure readings

-tried few types of graphs and decided to use scatter chart for showing overall blood glucose data per day and use multi-line graph for blood pressure data

-code for finding the lowest, highest and calculation of average readings

2. WORK TO BE DONE

Develop food recognition with nutrition details function

3. PROBLEMS ENCOUNTERED

–

4. SELF EVALUATION OF THE PROGRESS

Project implementation is on track.

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Supervisor's signature

Chew

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3T3	**Study week no.: 4 & 5**
Student Name & ID: Chew Ke Xin (19ACB03038)	
Supervisor: Dr Chai Meei Tyng	
Project Title: BGBP – A Mobile Application For Diabetic Self-Management	

1. WORK DONE

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

1) Setup food database in Firebase database
   -plan for data structure with a total of 27 attributes needed
2) Design UI for nutrition table with showing those attributes and their %DV
3) Import the food recognition model into Android Studio and design the interface (allow capture photo and load image from device)
4) Try to test the model with various type of food to get output (food name)

2. WORK TO BE DONE

Extract food nutrition details from data sources and write into own database

3. PROBLEMS ENCOUNTERED

Found that the model is not very effective in detecting all types of Asian food (some Malaysian cuisine), differentiating variety of cakes.

4. SELF EVALUATION OF THE PROGRESS

A bit slow in progressing 'Food' feature.

tyng

Supervisor's signature

Chew

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3T3	**Study week no.: 6, 7, 8 & 9**
Student Name & ID: Chew Ke Xin (19ACB03038)	
Supervisor: Dr Chai Meei Tyng	
Project Title: BGBP – A Mobile Application For Diabetic Self-Management	

1. WORK DONE

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

1) extract food database from USDA and Nutritionix database and write into own database
   -browse through internet to get the common food list and Asian food list
2) thinking alternative methods to get access into database if the model cannot detect the food
   -did a combination of food recognition technology and also manual input in this feature
   -redesign and added new interface (list-view and search function)
   -did another method: redirect user to Google quick search (to deal with unavailable food results in database)
3) did research on how to determine the food healthiness level
   -research on %DV and study on that
4) find more food nutrition details to add into own database

2. WORK TO BE DONE

Implement 'Report Generator' function

3. PROBLEMS ENCOUNTERED

–

4. SELF EVALUATION OF THE PROGRESS

Project implementation is on track.

tyng
Supervisor's signature

Chew
Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3T3	**Study week no.: 10**
Student Name & ID: Chew Ke Xin (19ACB03038)	
Supervisor: Dr Chai Meei Tyng	
Project Title: BGBP – A Mobile Application For Diabetic Self-Management	

1. WORK DONE

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

1) Report Generator feature:
- -implement with itextpdf library
- -design the interface (date range and category filter)
- -code for pdf margin, style, alignment etc.
- -encounter issue in writing into PDF cells
- -the file can be downloaded into device, but it shows empty table although it has successfully retrieve data from database

2. WORK TO BE DONE

Find out the issue that it cannot be written into pdf cells.

3. PROBLEMS ENCOUNTERED

The pdf report generated in the device shows empty table.

4. SELF EVALUATION OF THE PROGRESS

On track but need to debug the issue as soon as possible.

tyng

Supervisor's signature

Chew

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3T3	**Study week no.: 11**
Student Name & ID: Chew Ke Xin (19ACB03038)	
Supervisor: Dr Chai Meei Tyng	
Project Title: BGBP – A Mobile Application For Diabetic Self-Management	

1. WORK DONE

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

1) Report Generator feature:
-found out bug/error in writing data into ArrayList
-it always pass empty arraylist into function that is used to created pdf table
-solve the issue and re-code the structure to obtain data from database to pass it as a parameter into function
-add try-catch block into the code

2. WORK TO BE DONE

Finalize all features in the mobile application and start to write FYP report.

3. PROBLEMS ENCOUNTERED

–

4. SELF EVALUATION OF THE PROGRESS

Project implementation is on track.

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POSTER

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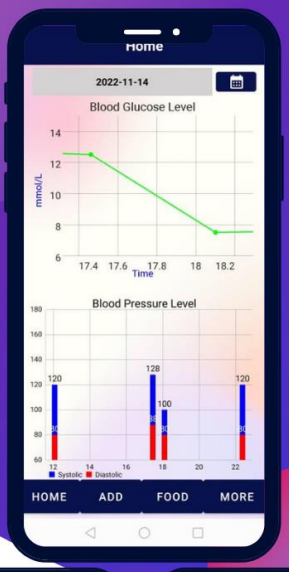
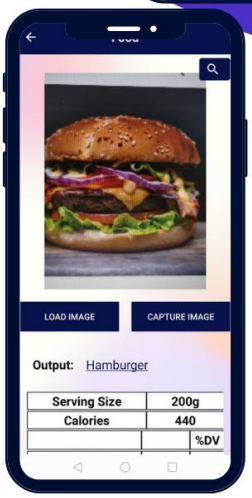
Faculty of Information and Communication Technology

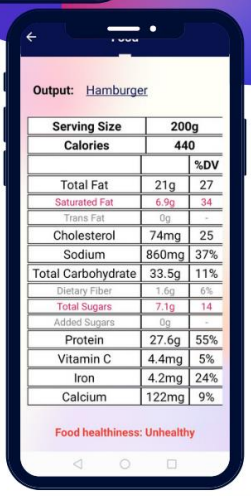


BGBP

A mobile application for diabetic self-management

Nowadays, the number of diabetic in Malaysia is increasing drastically. This might lead to severe effects on health such as cardiovascular diseases, kidney failure, stroke and etc. Hence, the implementation of diabetic self-management mobile app is very beneficial in order to keep track on the blood glucose and blood pressure levels as well as to help in controlling the diet.

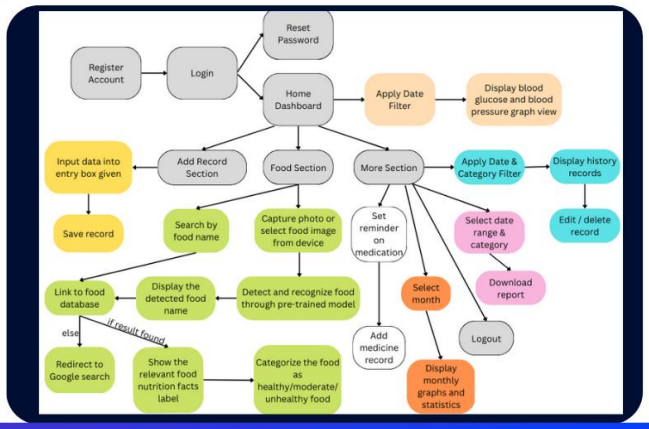




OBJECTIVES

- To provide a mobile platform for checking and monitoring blood glucose and blood pressure level.
- To implement the food recognition feature in diabetic self-management mobile application. (Nutrition facts label such as protein, cholesterol, sugar and etc. from the meal pictures will be displayed for improving user's awareness.)
- To develop an improved diabetic self-management application with food recognition technology and reminder on medication feature.

SYSTEM DESIGN DIAGRAM



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SUPERVISOR: DR CHAI MEEI TYNG

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Based on [1], hypertension often arises along with diabetes. Both of these diseases share common risk factors such as unhealthy diet and obesity. It is also found that people with diabetes are having the higher rate of getting hypertension too. Both of the diseases might lead to severe effects on health such as kidney failure, stroke and etc. Hence, managing both blood glucose and blood pressure levels can help to reduce the risk of cardiovascular diseases. Having a proper diet plan that limiting sugar and unhealthy food is also considered essential for diabetic and hypertension patients. Type 1 diabetes is usually diagnosed in children and teens and it is caused by autoimmune reaction while for type 2 diabetes is diagnosed in adults [2]. The only treatment for type 1 diabetes is to rely on insulin pumps and the treatment for type 2 diabetes is to consume oral hypoglycemic medications [3]. Patients with type 1 diabetes are required to monitor glycemic control daily and also control blood pressure and cholesterol [3]. Nowadays, the number of diabetic in Malaysia is increasing drastically. There are around 3.9 million of Malaysia citizens are having diabetes and the rate had increased from 13.4% (2015) to 18.3% (2019) according to a survey [4]. Therefore, the implementation of diabetic self- management mobile application is very beneficial in order to keep track on users' blood

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ID Number(s)	19ACB03038
Programme / Course	Bachelor Of Computer Science (Honours)
Title of Final Year Project	BGBP – A Mobile Application For Diabetic Self-Management

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Name: Chai Meei Tyng

Date: 25 April 2023

Signature of Co-Supervisor

Name: _____

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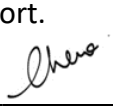

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