National College of Ireland

Bachelors (Honours) in Computing

Software Development

2020/2021

Sandupa Nilanjana Jayasiri Ampe Mohottige

X16151852

x16151852@student.ncirl.ie

EZ Food

Technical Report

Contents

Executive Summary

This report will analyse the implementation of EZ Food project. From the base functionality allowing a user to register and login into their account, to scanning objects and finding recipes. Further features of the system will also be highlighted that add ease of use functionality to the system. The results expected should be a full outline of proper functionality of the system and areas where in the future the system may be able to be streamlined for more straightforward use.

The recommended structure for the project is to breakdown each functionality of the project to the critical components that it will provide a user while explaining the core technology that will be behind the functionality. The expected results of the report will not represent the final outcomes, but the key goal is to keep as much of the actual outcomes of the project in the final work produced. It is expected that changes due to new ideas and updates to old ones are expected as the project lifecycle continues.

1.0 Introduction

1.1. Background

The project was undertaken to get more people to cook from home with items of food they either have in their household or are willing to go and get from the local supermarket. It is essential, especially now with the pandemic keeping a lot of people stuck at home and needing quick and easy meals to prepare in the free time they have through online work and classes.

1.2. Aims

The project aims to produce a system that allows any interested individual to give a try at cooking a quick and easy meal. It will help people both physically and mentally as well as financially. It will also contribute to less food wastage as it aims to use as much food items available, to reduce the number of foods thrown continuously out due to expiration dates.

1.3. Technology

The technology for this project will revolve around TensorFlow and TensorFlow Lite (Image classification | TensorFlow Lite, 2020) . These are machine learning algorithms that can determine objects and images through the lens of a camera, allowing them to know what is in front of them. The platform to support this will be either Android or a web-based platform. A Java-based Android platform will be used if resorting to mobile-first focus otherwise HTML, CSS, JavaScript, and Python will be used for a web-based platform. Either Google Firebase or AWS hosted MySQL server will be used to host data such as user accounts. An API will be used to retrieve the recipes.

1.4. Structure

The structure of the document consists of an overview of the requirements for the project. It is further broken down to all functional requirements with the use of use case diagrams as well as descriptions to follow the process of each use case. Each use case has additional sections to support each action the system will make. The function of the use case models is to break down the system's steps to understand better what each action represents to an actor, in this case, the user. Further emphasis on the system functionality and how it correlates with user experience is also analysed to understand better the viability of a user enjoying their use. Better the experience, the more likely the user is to use and recommend it to others.

2.0 System

2.1. Requirements

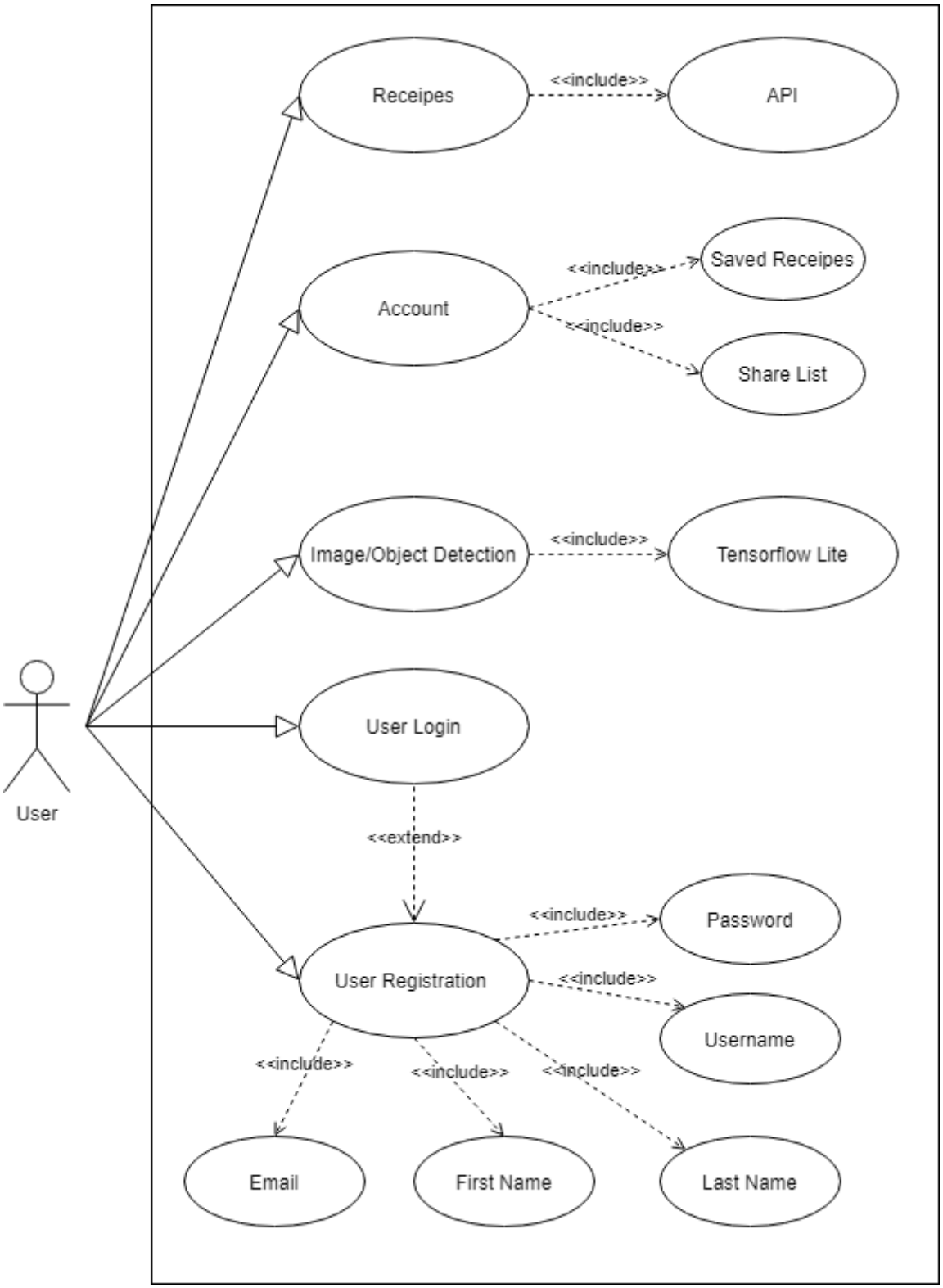
The following requirements outline the actions a user can take with moderate knowledge of mobile applications. Since the project will be engaging a wide ratio of age groups, it is adequate to start with more straightforward options and features before moving towards more complex functionality. An example of complex functionality that might be applicable here would be to allow users to mix and match recipes. Still, since the aim is to get people to cook at home in the first place, this would be more than what is necessary for the system to provide.

2.1.1. Functional Requirements

The following showcases with a ranking the importance each functional requirement for the project.

1. Image/Object Detection
    a. Highest priority
        i. Project core functionality revolves around this section functioning properly for the entire system to work.
        ii. A user requires the image or object to be adequately predicted to start searching for recipes.
2. Registration, Login System and Account
    a. Medium priority
        i. It is needed to access the system, but it will not be as necessary as getting both the Image/Object detection and API functioning during the testing phase.
        ii. However, the user does require this to be functional for them to access the system and manage their account further down the line.
3. API
    a. High priority
        i. The API will be called many times, so it is essential that the chosen API can function with moderate amounts of stress.
        ii. The data must also be consistent with producing accurate results to users.

2.1.1.1. Use Case Diagram



2.1.1.2. Requirement 1: User Registration

Use Case for User Registration.

2.1.1.3. Description & Priority

The user creates an account if not having one already to access the system. It is a medium priority but still important as the user cannot access the services without having a registered account with valid credentials.

2.1.1.4. Use Case

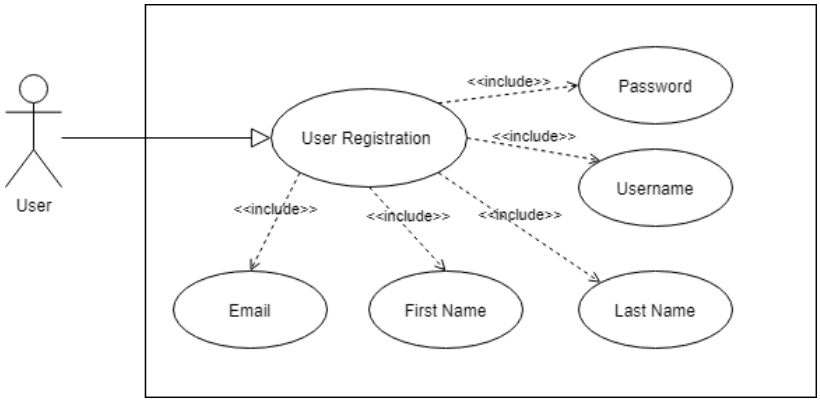
Scope

The scope of this use case is to analyse how a user registers an account.

Description

This use case describes how a user will register a new account, including the data they need to provide for the system.

Use Case Diagram



Flow Description

Precondition

The system should be initialised, and the user should not have an account before registering.

Activation

This use case starts when the user initiates the registration process to make a new account (Clicking the Registration Button).

Main flow

1. The system asks the user if they want to register.
2. The user selects the registration option.
3. The system will display the registration page.
4. The user enters their valid information into all fields.
5. The user is sent to the log in page once registration is successful.

Alternate flow

1. The system checks the credentials provided by the user.
2. The system deems the credentials are not authentic.
3. The error message is shown to the user.
4. User is required to re-enter the credentials again.

Termination

The system presents the login page after the registration process is complete.

Post condition

The system does nothing further unless a new account must be registered where this use case will run again.

2.1.1.5. Requirement 2: User Login

Use Case for User Registration.

2.1.1.6. Description & Priority

The user needs to login to the account that they just created. It also has a medium priority as the system cannot be accessed without successfully logging into a verified account.

2.1.1.7. Use Case

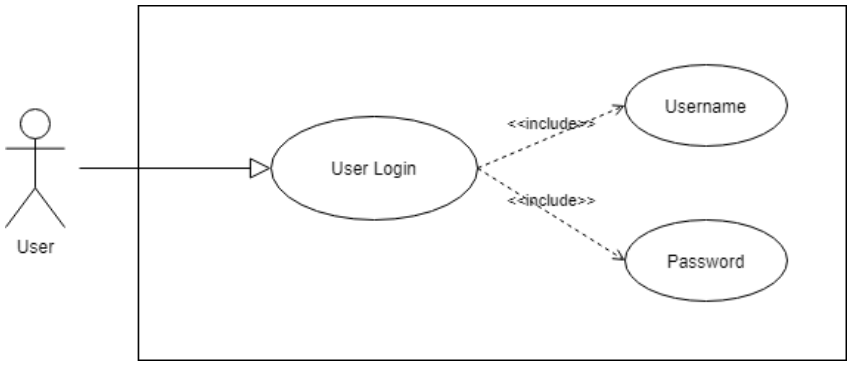
Scope

The scope of this use case is to analyse the steps required to login to the system.

Description

This use case describes the requirements to successfully log in to the system to access the features and account information for a user.

Use Case Diagram



Flow Description

Precondition

A user must have already created an account to use the login in the section of the system.

Activation

This use case starts when the user chooses to log in to the system by selecting the login option in the start screen.

Main flow

1. The system asks the user if they want to log in.
2. The user selects the log in option.
3. The system will display the login page.
4. The user enters their valid information into all fields.
5. The system logs the user into the main dashboard.

Alternate flow

1. The system checks the credentials provided by the user.
2. The system deems the credentials are not authentic.
3. The error message is shown to the user.
4. User is required to re-enter the credentials again.

Termination

The system presents the main dashboard of the application once a successful login attempt occurs.

Post condition

The user must log in only once; the system will remember the user. If the user signs out of the account, then this use case will run again.

2.1.1.8. Requirement 3: Image/Object Detection

Use case for Image/Object Detection.

2.1.1.9. Description & Priority

The central systems functionality is to use image/object recognition technology to recognise food through the camera of a device to present the user with recipes they can make with them. As such, this is a high priority feature to be implemented as the entire project revolves around it.

2.1.1.10. Use Case

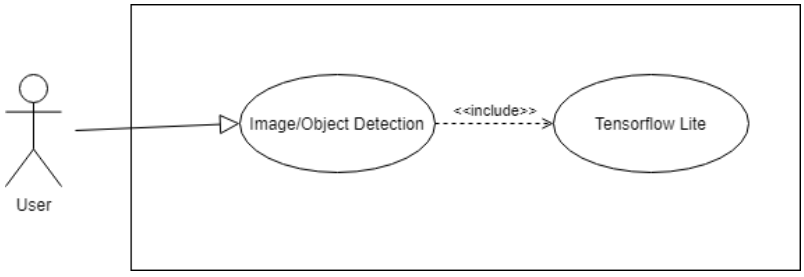
Scope

The scope of this use case is to analyse the image/object detection system.

Description

This use case describes the process of which the image/object detection is utilised to recognise food presented by the user to the system through the camera of a device.

Use Case Diagram



Flow Description

Precondition

The user must be logged into an account to access the system.

Activation

This use case starts when the user selects the option to open the camera to start the image/object detection.

Main flow

1. The user selects the option to view the camera.
2. The system starts the image/object detection system.
3. The system recognises the food presented to it.
4. The user confirms if the item is correct.
5. The system adds it to a list.

Alternate flow

5. The system makes an incorrect prediction of the item.
6. The user selects the item is incorrect.
7. The use case continues from main flow 2 again.

Termination

The system presents the next step to allow the user to search for recipes with the list of items it has recognised.

Post condition

The system goes into a wait state until the user has confirmed the list is correct and then proceeds with the next step to find the recipes.

2.1.1.11. Requirement 4: Account

Use case for the Account section.

2.1.1.12. Description & Priority

The account section holds all the account details, including the information from the registration section, saved recipes and share list to allow users to share recipes with other users. It is a medium priority as the systems primary function is not affected by this section's exclusion.

2.1.1.13. Use Case

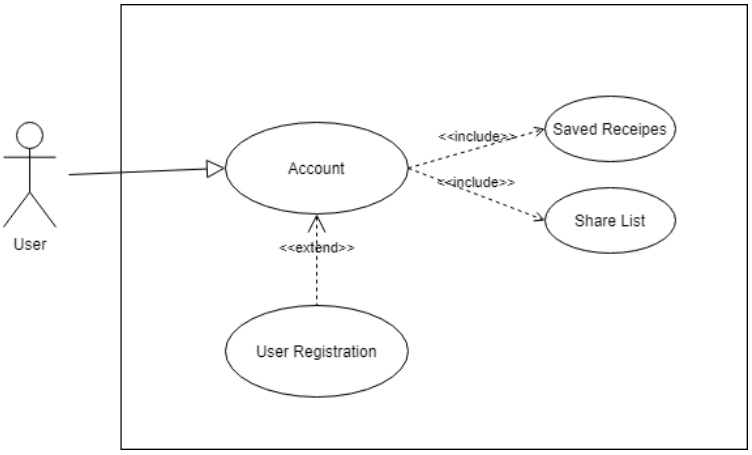
Scope

The scope of this use case is to analyse the accounts section.

Description

This use case describes the process the account section holds in the system, including displaying previous recipes and friends list to the user.

Use Case Diagram



Flow Description

Precondition

The system is beginning when the user is logged in and in the main dashboard.

Activation

This use case starts when the user selects the accounts section in the dashboard.

Main flow

1. The system shows options on the dashboard.
2. The user selects the accounts options.
3. The system shows all information within the account options.
4. The user can modify the limited amount of data in the account section.

Termination

The system presents information specific to a user. A user can leave the accounts page to go back to the main dashboard.

Post condition

The system goes into a wait state till another action is executed by the user.

2.1.1.14. Requirement 5: Recipes

Use case for the recipes section.

2.1.1.15. Description & Priority

The recipes sections communicate with an API to access the recipes available for the items listed by the image/object recognition section. This is a high priority feature as it involves the main idea of the system to display quick and easy recipes for users to make at home.

2.1.1.16. Use Case

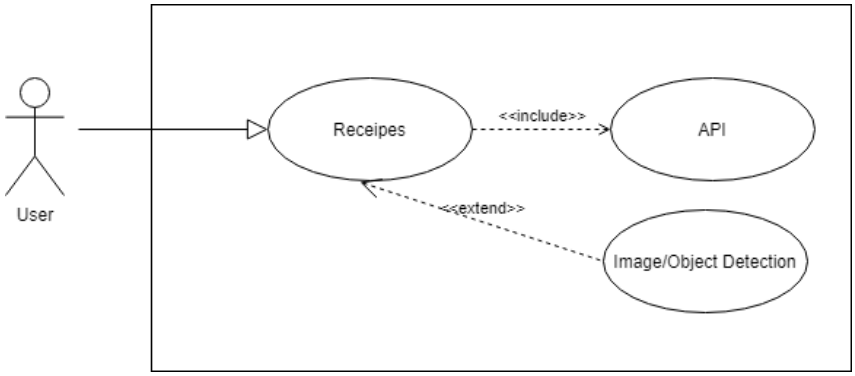
Scope

The scope of this use case is to analyse the recipes section.

Description

This use case describes the how the recipes section calls the API with the data provided by the image/object recognition section to output a viable recipe for the user.

Use Case Diagram



Flow Description

Precondition

The user must be logged in to access this feature as it ties in with another feature that requires a user to be logged in.

Activation

This use case starts when a user completes the image/object recognition section. Once that is finished the recipes API can be called to find the recipe according to the ingredients mentioned.

Main flow

1. The system saves the list of ingredients captured by the image/object recognition section.
2. The user selects to view all recipes found.
3. The system displays all available recipes for the given ingredients.
4. The user can choose to access whichever recipe they want.

Termination

The system presents the next the user with all recipes it has found.

Post condition

The system goes into a wait state till another action is executed by the user.

2.1.2. Data Requirements

Requirement 1: Standard account information (Username (String), Password (String), First Name (String), Last Name (String), Email (String)).

Requirement 2: Registered account information (Username (String), Password (String)).

Requirement 3: TensorFlow compatible files ([.tflite] (TensorFlow file format containing raw image/object data), [.txt] (TensorFlow label file containing labels for images/objects)).

Requirement 4: All account information and more (Username (String), Password [Editable] (String), First Name (String), Last Name (String), Email (String), Saved Recipes (Reference to API), Saved User List (String) [Reference to the user table in the database]).

Requirement 5: *JSON based API*.

2.1.3. User Requirements

Requirement 1: The user can create an account through the registration portal.

Requirement 2: The user can log into the newly created account.

Requirement 3: The user can use the camera to list available ingredients they have.

Requirement 4: The user can save the recipes they have found for later use.

The user can share the recipes with other users.

The user can update their account in a limited format (i.e., Password).

Requirement 5: The user can view all recipes that match the ingredients available.

2.1.4. Environmental Requirements

This system's concept is to cut down on food wastage to reduce the amount of food ending up in landfills around the world. More utility that can be given for everyday ingredients, the better. Thus, requirement five will be vital as it is tasked with showing as many easy to make meals as possible to the user without boring them from the concept of cooking at home.

2.1.5. Usability Requirements

Requirement 1: The user can enter valid information to register an account and be guided successfully to the login page to log into their account.

Requirement 2: The user should easily log into the account by entering valid credentials without issue.

Requirement 3: The user should be able to point their device camera at an ingredient, and the system should try to predict as best as it can what precisely the item is. The better the prediction, the better the user will be satisfied.

Requirement 4: The user can modify their account information and manage their saved recipes and their friend's list. This should be done simply without hindrance to the user.

Requirement 5: The recipe provided to the user should be ones that are simple and quick to make. Filter out any complicated meals that might draw the user away from the idea of cooking at home.

2.2. Design & Architecture

The system design revolves around TensorFlow's (Image classification | TensorFlow Lite, 2020) use of machine-learning algorithm to detect images or objects in a given space using a device's camera. TensorFlow is a powerful library that allows the integration of machine learning into any system and is an ever-evolving technology used by many industries. The concept of implementing the algorithm into the current project is to allow it to visually distinguish an ingredient, identify what it is and output a result as close to what it is.

This information is then fed into a function that calls an API that holds a vast number of recipes in its database to come up with a good recipe for a user to make. The process will also consider the time it takes to make the meal to evaluate the complexity of the meal preparation. All of this will be supported either on a mobile-based platform such as Android or to make the system more widely accessible, a web-based platform with the only requirement being a web browser.

2.3. Implementation

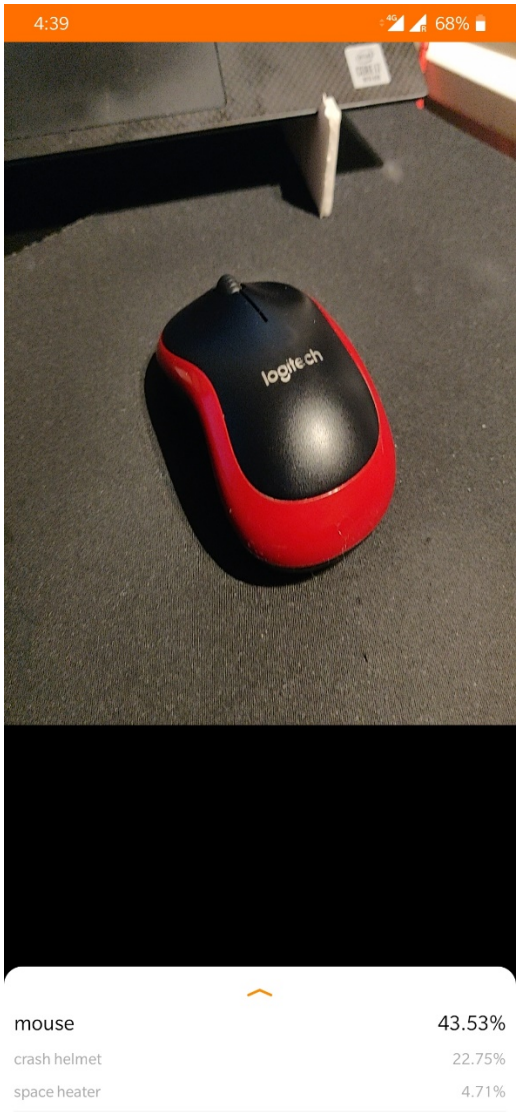
The project's current progress only focuses on the use of the template provided by TensorFlow for image classification and simple modification to meet the current needs of the project. The provided template code is more than expected, and as the project life cycle continues, the code will be re-implemented for the strict use of the project's needs.

A new life cycle has begun in the form of a significant shift from a mobile-based platform to a more open web-based one. Even Google (*Why you might want to play Google Stadia in Microsoft Edge*, 2021) and Microsoft (Warren, 2021) are doing it as they see the benefits of moving to a more powerful web. But the main reason is the better tools available for machine learning in other places.

The switch results from the complicated documentation on implementing machine learning libraries such as TensorFlow and Keras on mobile. However, on the Web, any device can use it. Since most everything is server-side, any device with a browser and an internet connection can access the system. This dramatically increases the reach the project had when locked to a single operator.

However, the new implementation with Python allows for a greater sense of freedom to tinker around with the technology and learn what can and cannot be done with it. Python is known for having a package for many things, so it was wise to move there. Using Python and Flask also dives deeper into running code on the server that is a substantial upgrade.

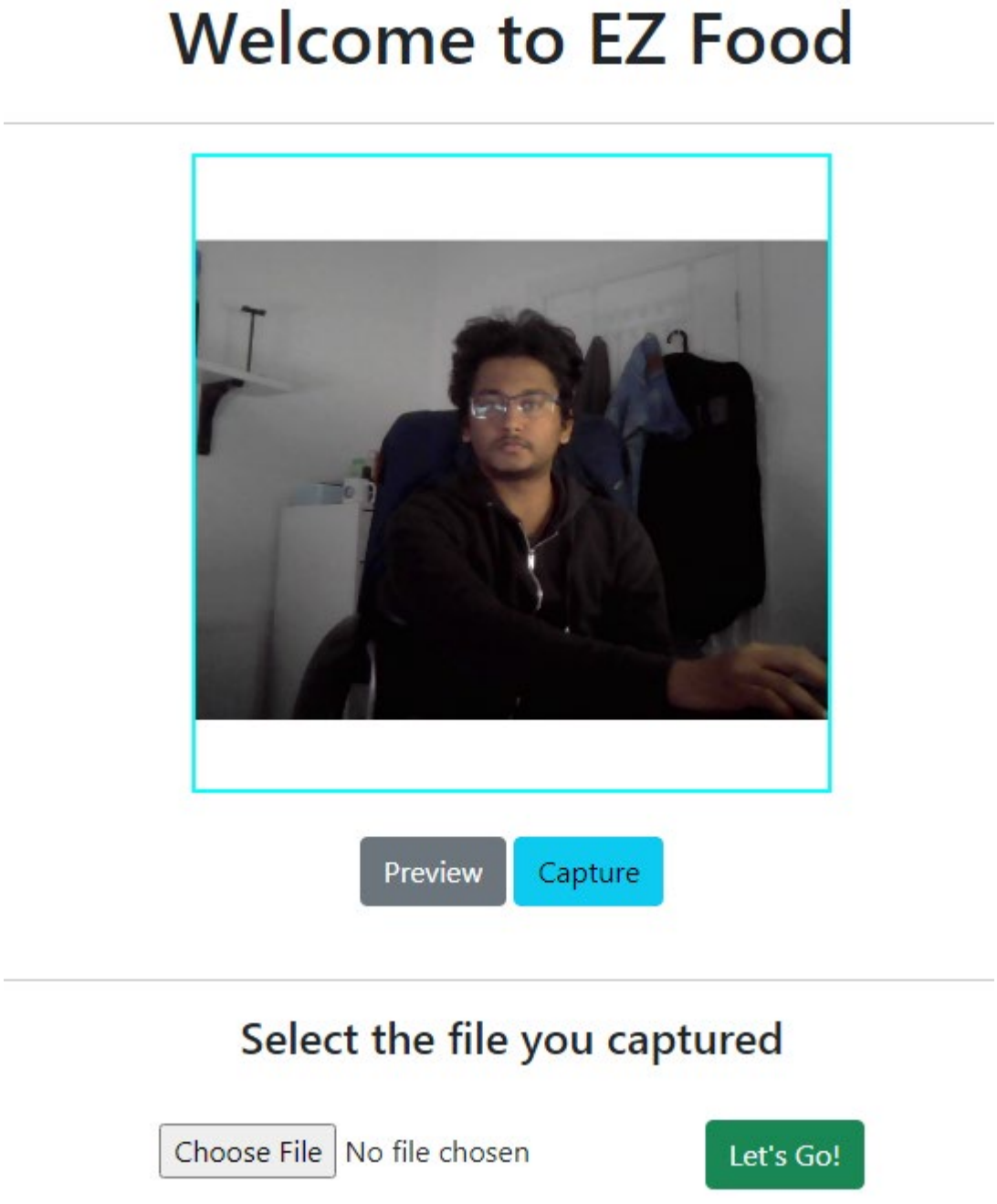
2.4. Graphical User Interface (GUI)



The above screenshot represents the TensorFlow Lite implementation on Android predicting the item in the view finder of the camera is a 43.53% match to a mouse.

New GUI

As a result of shifting focus away from a mobile-based system, the new application has a web-based GUI. The homepage is where everything starts. They see themselves through their device's camera, take a snapshot and upload that snapshot. They can then proceed to search for the recipes based on the ingredient they showed on the camera.



The recipes window will showcase all the recipes available to the user based on the ingredient they showed to the camera. This is then displayed on a separate page, as shown below.

Bubble & Squeak

2.5. Testing

Unit Testing

The final web-based software was not used to conduct testing. Instead, a separate testing environment was needed to test the creation of the data model thoroughly. The data to create the model was gathered from Kaggle (*Fruits 360*, no date). The importance of the data model is to ensure the prediction algorithms in TensorFlow and Keras (*Keras: the Python deep learning API*, no date) can match the object to their respected values.

The first testing script involves creating the data model in the format of *.h5*. the script is called *model.py*.

Element	**Function**	**Testing**	**Result**
batch_size	Controls the chunks of data being processed at any given time.	Modified the values from values of 8, 16, 32, 64 and 128 to see which made the most impact.	Greater sizes did not yield many changes to the overall quality of the data being processed but higher values increased time to process and used much more resources from the PC.
num_classes	Defines how many testing data is available for the system to go through.	The system counts either individual files or just folders. While the total image quantity was over 1000, they were separated into 131 folders hence 131 is the value kept.	Changing the value earlier on showed the importance of the value as reducing it means less items were recognised. The exact amount of data you have must be represented in this value.
epochs	Represents how many runs the model creator must go through. This includes checks for accuracy between the data and what it has consumed.	Running check below 50 have shown a horrible level of accuracy between the image data and what the model has constructed. Hence 50 was set as the process to create one data module took time.	With the fixed set of 50 epochs the model was able to operate effectively but still shows signs of inaccuracy. This is due to mostly to image sizes being limited to 100x100 as higher values were too taxing for my PC.

path_to_train & path to test	This is used by Keras to validate if they can match the trained material to the similar testing material.	Initially using just 1 set of the data showed not much difference. This script was run multiple times but not tested under extreme conditions.	When tested more realistically with images captured from a camera, it couldn't figure out the data. Thus, both sets of data were used. Both sets of data are the same, but the model needs it as a verification step.
ImageDataGenerator	This is used to modify the properties of the images before they used to make the model.	The images previously used were too large and cause the system to take longer than expected to finish. Thus, the system is set to accept 100x100 images.	The changes did have an adverse effect elsewhere, but it was necessary.
Sequential	Model is plain stacked with 1 input and 1 output.	This is how the Keras modelling system runs. Efficient but at some degradation to quality.	
Conv2D & MaxPooling2D	This is a Keras module working which is a part of TensorFlow. They break the images down into layer to create a map.	My initial understanding of the function of each element was unknown but they are critical components to Keras to break images down for their data.	The values were kept identical to ones given on the documentation of Keras website.
compile	Here the data is configured to be trained.	Both the Adam optimiser and accuracy metrics show efficient behaviour over the past months of testing output quality.	While there are other settings available, these were the ones observed to be sufficient.
fit	This is where the data is trained for	Initial tests showed the validation test	Only 1 value had to be changed being

	the number of epochs that have been allocated.	had to be increased to ensure optimal results.	the validation steps from 1 to 3. Took longer but improved accuracy per run.
save	The final generated model is then saved as a .h5 file.	Decoding the file proved tough so its important to know what the order of your data is. This Is because the data is stored in orders starting from 0.	The data is categorised but isn't labelled. So, to find what is what labels must be added separately. They do not apply to the model file, instead they have to be hard coded or present in a text file and retrieved when needed.

The next file named *main.py* is where the prediction algorithm took place. Here the labels for items were issued and 2 functions handled the image retrieval and prediction.

Element	Function	Testing	Result
self.label	Assigns the labels to the categorical values in the loaded model.	This step proved important as the results were always blank. The data model doesn't store any label data. For testing and final version, the labels had to be written down according to the folders in the test data.	131 records had to be accounted for the correct value to be placed. Mistaking a position would yield incorrect results only because the label was wrong and not the actual prediction.
read_images	This function handled grouping the images while making sure they retain the size that has been fixed to 100x100.	Without this function an image of different size could mess up the prediction algorithm.	After the function is complete it holds the images as one big batch ready for the next function to process it.
predict	This is where the given image is predicted to be what it and isn't.	The image is weighed against the model and a result it given. In the test case it is using matplotlib to display the data but in the final system it only outputs the label of the prediction. Accuracy so far is still hit or miss. The model has not been able to exceed 12.5mb which is still an issue.	While the results are decent, the fact the system requires low resolution images is still setting it back and predicting with over 90% accuracy.

The prediction material (images) is placed in a test_images folder and every time the script is run, it is fetched and run through the system to make a reading. Below is a table containing the accuracy observed since June.

Test Case	**Accuracy (less than 1 is better)**	**Reason**
Test Case 1 (04.06.21)	0.143	/
Test Case 2 (07.06.21)	0.021	/
Test Case 3 (10.06.21)	0.12	/
Test Case 4 (20.06.21)	14.0	Issues with computer.
Test Case 5 (23.06.21)	12.30	Issues with computer.
Test Case 6 (06.07.21)	0.22	Updated Keras version.
Test Case 7 (14.07.21)	0.35	/
Test Case 8 (20.07.21)	0.33	/

2.6. Evaluation

The main aim and outcome of the project are to provide a resource for people to use during the lockdown periods to make a meal at home. It also helps to cut down on food wastage. Providing a platform to interact and share recipes amongst each other is the whole idea of the app—a semi-social media for food lovers. The concept and thoughts that went to the project were focused on those principles. While not all aims have been met, the idea and the technological scope may inspire someone else to dream a bigger picture.

An idea itself isn't anything without the resources, and in this case, it is there. However, theirs is a while to go before such ideas can come to fruition without a team building them. The scope is more considerable than expected. Time is necessary, but how you use the time helps and if something isn't helping you keep that time, it becomes a waste. This is a point that someone who's creating a user dependant system must consider. Will you waste a user's time?

The goal was to keep the system minimalistic so that not the focus will be on the recipes and not trying to figure the system out. This is important as if you can't even use the app, no one else will either. They are keeping everything front and centre and making the point that the features that were a part of the requirements specs are the ones a user will expect.

It can be said that technology can change and evolve, which might us be left behind. But the critical area to consider is that if users find the appeal, they want the product, so it is essential to keep a close eye on the requirements specs. While not all of them have been met for this project, it is possible that down the road, it can be a fully viable solution to creating a better atmosphere for home cooking and reducing food waste. Those are the goals, and we aim to look forward to having a product that will outlast the current situation.

3.0 Conclusions

Overall, the experience working with advanced machine learning algorithms have taught me a lot. The utility of such technology has a broader scope than even my project. For the project thought, the utilisation of the technology was minimal and is a point to consider looking into the future. The project's overall progress has gone well, with setbacks here and there due to inexperience with the technology.

The main upside to using machine learning technology is to use it to conduct greater levels of research. A point that came across in my research is to use the system to analyse the nutritional benefit of certain food groups. This information would be a key selling point for a project like this and is something I would pursue in the future.

However, a great deal of effort went into creating the data models and gathering the data. Some of my requirements were too specific for there to already be data on, but it was managed with care to proceed as smoothly as possible with the project.

The experience gathered through testing and troubleshot has also benefited the outcome of this project and a handful of ones that can happen in the future. While my testing methods aren't conventional, they are best suited to me because they work for me. However, there is a reason why the testing methods exist, and it's a point I will carry on from this project.

4.0 Further Development or Research

Further research and development is a critical area that I am looking forward to because there are many more possibilities regarding personal and commercial applications for such technology. The following steps are to understand the nature of machine learning better and go beyond the scopes of the commonly known ones and into more advanced niche levels of tech.

An area keen on my list is to do more research and maybe create an advanced prototype on an object detection system for the blind. Something less likes a walking stick and more towards artificial intelligence-based echolocation—a more detailed version of echolocation. I have had this thought since I researched object detection as it has intrigued me on how this technology can be pushed to do.

In my closing thoughts, this and many other projects have significantly shaped the idea of technology as a valuable part of society more than what's heard on the news. However, everything will have its detractors and sceptics, so it is best to learn more and understand the nature of where this will lead me.

5.0 References

TensorFlow. 2020. Image Classification | Tensorflow Lite. [online] Available at: <https://www.tensorflow.org/lite/models/image_classification/overview> [Accessed 20 December 2020].

TensorFlow. 2020. Object Detection | Tensorflow Lite. [online] Available at: <https://www.tensorflow.org/lite/models/object_detection/overview> [Accessed 20 December 2020].

Fruits 360 (no date). Available at: https://kaggle.com/moltean/fruits (Accessed: 30 July 2021).

Keras: the Python deep learning API (no date). Available at: https://keras.io/ (Accessed: 20 July 2021).

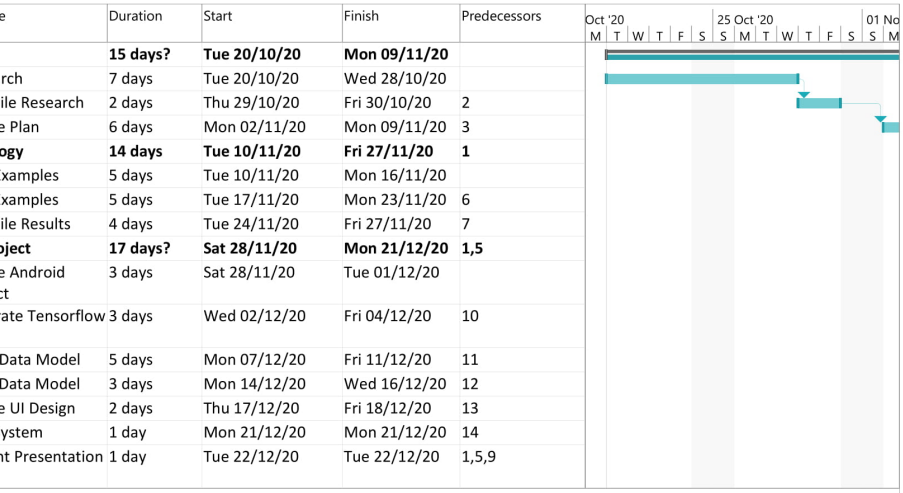
Warren, T. (2021) *Here's a first look at Microsoft's xCloud for the Web*, *The Verge*. Available at: https://www.theverge.com/2021/2/15/22283739/microsoft-xcloud-web-screenshots-cloud-gaming-streaming-browser-features (Accessed: 31 July 2021).

Why you might want to play Google Stadia in Microsoft Edge (2021) *Windows Central*. Available at: https://www.windowscentral.com/google-stadia-microsoft-edge (Accessed: 2 August 2021).

6.0 Appendices

6.1. Project Plan

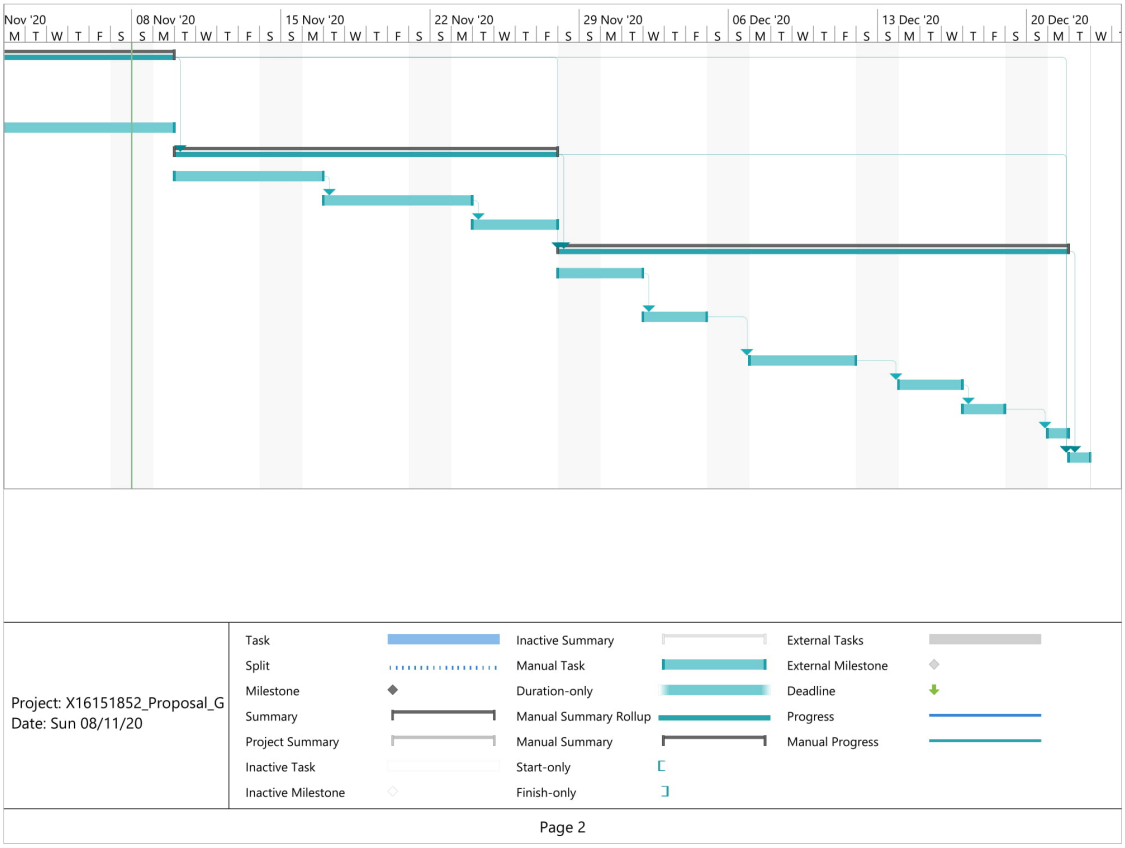
ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Plan**	**15 days?**	**Tue 20/10/20**	**Mon 09/11/20**	
2		Research	7 days	Tue 20/10/20	Wed 28/10/20	
3		Compile Research	2 days	Thu 29/10/20	Fri 30/10/20	2
4		Create Plan	6 days	Mon 02/11/20	Mon 09/11/20	3
5		**Technology**	**14 days**	**Tue 10/11/20**	**Fri 27/11/20**	**1**
6		Find Examples	5 days	Tue 10/11/20	Mon 16/11/20	
7		Test Examples	5 days	Tue 17/11/20	Mon 23/11/20	6
8		Compile Results	4 days	Tue 24/11/20	Fri 27/11/20	7
9		**Start Project**	**17 days?**	**Sat 28/11/20**	**Mon 21/12/20**	**1,5**
10		Create Android Project	3 days	Sat 28/11/20	Tue 01/12/20	
11		Integrate Tensorflow Lite	3 days	Wed 02/12/20	Fri 04/12/20	10
12		Train Data Model	5 days	Mon 07/12/20	Fri 11/12/20	11
13		Build Data Model	3 days	Mon 14/12/20	Wed 16/12/20	12
14		Create UI Design	2 days	Thu 17/12/20	Fri 18/12/20	13
15		Test System	1 day	Mon 21/12/20	Mon 21/12/20	14
16		Mid Point Presentation	1 day	Tue 22/12/20	Tue 22/12/20	1,5,9



Project: X16151852_Proposal_G
Date: Sun 08/11/20

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

Page 1



6.1. Ethics Approval Application (only if required)

N/A

6.2. Reflective Journals

Reflective Journal

Sandupa Nilanjana Jayasiri Ampe Mohottige

X16151852

Software Project

What? Returning to the situation.

1. Finished project proposal video.
2. Research on project topic (Recipes).
    a. What are the legal aspects of using recipes?
        i. Food Items cannot be copyrighted.
        ii. Instructions on how to cook the food can be copyrighted.
    b. Where to get the data on recipes?
        i. Paid data sets/APIs.
            1. Bigger set of recipe data.
            2. Better quality of data.
            3. Pricey per data set/API calls.
        ii. Open data sets/APIs.
            1. Much smaller data.
            2. Quality of data is hit or miss as images, instructions and cooking times are sometimes missing.
            3. Restricted to a few API calls per day but it is free.

So What? Understanding the Context.

The current situation that has emerged from the above research include.

1. Choosing which steps to take from the research gathered.
2. Going through the data sets to see if or not they will become viable in the future.
3. Any more legal avenues left to worry about.

The overall good coming from the research is that I have a good idea of where to look for relevant data. This will help me to answer any questions proposed by my supervisor.

Now What? Modifying Future Outcomes

My next objectives are to start research on the technologies outlined in my proposal video. These include.

1. TensorFlow for Mobile (TensorFlow Lite).
2. Android (either Java or Kotlin) Development or Flutter.
3. Python API development.

It is best to start as soon as possible so that the remainder of my development revolves around the core development over understanding the technology.

Reflective Journal 2

Sandupa Nilanjana Jayasiri Ampe Mohottige

X16151852

Software Project

What? Returning to the situation.

From the research conducted, I have identified two possible API's containing data to use to find information on the recipes. One of them allows free use of the API but is limited to one ingredient per query when searching for a recipe. However, they do have some conditions that favour student usage of the API. I have been in communication with the developer to discuss more usage terms and hopefully can come to a reasonable agreement.

The other resource is a paid service that allows an adequate level of power tools to get results from the API. The payment scheme is pricey in the long term, but the quality of the data still outmatches the first option. Neither service allows the data to be cached, which would speed up query searches on my project, but they have an understandable reason to safeguard their data from being cached.

As for TensorFlow Lite implementation on Android, the package is very complex, and the documentation is limited to the examples already provided by the development team. An alternative method would be to build a web application that can allow access to the system on the browser of a mobile or desktop device. It would be a more efficient use of resources as it will enable the project to work on any platform that has a web browser cable of rendering the website. In contrast, an android application is only limited to one platform.

So What? Understanding the Context.

On the 30th of November, I had a meeting with my supervisor to discuss what I have gathered. With a good question and answer session, I was able to understand a lot on the path I want to take with the project. I brought up the question regarding the transition from a single platform application to an open web platform, and my supervisor encouraged me to do what I feel the project needs.

He also provided me with information on resources that might be useful for TensorFlow Lite development on mobile platforms. The resources proved to be very inciteful, and hopefully, with a few more research, the prototype will start to take shape. The beginning portions of the project have begun from my research and the resources provided by my supervisor.

Now What? Modifying Future Outcomes

The next steps, which was a point discussed with my supervisor, is about the datasets that are required by TensorFlow Lite to recognise images or objects. It is separate from the ingredients datasets/API as this is needed for TensorFlow to work. So far, the search has yielded many results, and hopefully, the usage terms will be satisfiable to the project without bringing in legal or ethical issues.

The other step is to refine the prototype in preparing for the demonstration of a working system for the midpoint presentation submission. A copy of the system will be given to my supervisor first so he can provide me with feedback before finalising my work.

Reflective Journal 3

Sandupa Nilanjana Jayasiri Ampe Mohottige

X16151852

Software Project

What? Returning to the situation.

The midpoint submission has been submitted and a semi-working prototype built. A basic understanding of image recognition technology and mobile platform utilisation of TensorFlow completed. The next logical steps are expanding what has already been created and implementing more working functionality.

So far, the API's testing cases have shown right to adequate results, and the viability of the API has been deemed to be enough for the project. However, future development might not be viable with the given API, and commercial use is uncertain.

So What? Understanding the Context.

My supervisor said that mobile development is quite complicated, but the resources and documentation are vast and plenty. The idea is to understand and pick out components that value my project over the coming months. Producing a functional app will be the priority over probable design for now. The design aspects will need to more in-depth look through.

This will refer to already available designs to understand the right balance of design characteristics for the application. Research on UI design has already been done and open for public consumptions, so I do not need to reinvent the wheel here. Proceeding with this knowledge will help around the end of the finished product.

Now What? Modifying Future Outcomes

From now onwards or from the midpoint presentation on was to start implementing more functionality into the software and testing the functionality. In the case of the API, try to see how many calls are possible per day to get a good idea of the application's scale. Also, with image recognition, training more data to recognise more objects is another area to keep building upon so it will have a good list of products that it can recognise.

With this knowledge in mind, the future outcomes are to keep developing the software to the point that it can be considered finished but fully functional enough to upload to Google Play Store to get user feedback. This step is not required but would help me understand my limitations when doing complex projects.

Reflective Journal 4

Sandupa Nilanjana Jayasiri Ampe Mohottige

X16151852

Software Project

Note: I missed the January 1st Upload, so I am adding it here.

What? Returning to the situation.

With a new supervisor appointed to me, I have continued from the time my mid-point results have been issued to continue developing the application. The concept is working, but I am facing more issues than expected and continually working to solve them. The problems are with the API integration. The API I have chosen is becoming unresponsive in critical tests conducted over a week. There are also issues with TensorFlow integration that were not picked up initially due to continually being updated by the developers.

So What? Understanding the Context.

The problems outlined might be the cause of my lack of knowledge in some areas of the project more than the technology itself, so I have started a more thorough analysis to solve these issues out as soon as possible. Some areas' logic is complicated than what I had anticipated from forums and videos on the Web. The developer documentation is also very hit or miss, contributing to my frustrations in many cases. I am still confident I will figure as much as possible out to have a working system.

Now What? Modifying Future Outcomes

This month will focus on my understanding of the resources available and working to solve the issues as soon as possible. I have considered altering some areas of the project that are not possible and need a new directive. The new direction being the switch from Mobile to Web. Hopefully, a good outcome can be sorted from this.

Reflective Journal 5

Sandupa Nilanjana Jayasiri Ampe Mohottige

X16151852

Software Project

What? Returning to the situation.

Looking back, I have gotten the API to be functional enough to warrant keeping it as an option. I have looked out for other options, but they are far too limiting and can become pricy to maintain during development. As for TensorFlow, it has become a nightmare to work with. The documentation is all over the place, with little to no single step ways to implement it into a new project. Instead, we must use the pre-built image, which is confusing to comb through. They also add features weekly, to which I have entirely stopped pulling from their repo as I am already finding it challenging to work with the existing code.

So What? Understanding the Context.

Looking at this, I am considering shifting my focus to a Web-based application made for mobile platforms. The web implementation of TensorFlow has a better implementation, in my opinion than what mobile is using. I will discuss this with my supervisor to make sure.

Now What? Modifying Future Outcomes

- Make a new prototype.
- Run more tests.
- Showcase it to the supervisor.

Reflective Journal 6

Sandupa Nilanjana Jayasiri Ampe Mohottige

X16151852

Software Project

What? Returning to the situation.

Working off last months decision to switch platforms from android to the Web, my supervisor has agreed to make the change due to time constraints. Working with the system has proven much easier using the TensorFlow package for Python. A slight alteration was also made to rely on image classification rather than the heavier object detection, which might be slowed down by the local or hosted hardware available to me as a student.

So What? Understanding the Context.

With all this in mind, I have taken steps to create a fully functional model of the system, working to showcase it to my supervisor. The model will consist of all the operational systems working. The only emission will be clean UI elements. This can be focused on later as it is essential to get the system functional and working without issue.

Now What? Modifying Future Outcomes

The following steps are to create the fully functional demo and to work on the UI elements. The system will be using a web framework for Python called Flask. The web elements will be created using bootstrap since time is running out. Making brand new features using CSS and SASS will take longer so using the Bootstrap libraries will drastically cut down the time. Bootstrap will also produce a pleasing user interface for users and scale to mobile devices, which is a focus of the project.

Reflective Journal 7

Sandupa Nilanjana Jayasiri Ampe Mohottige

X16151852

Software Project

What? Returning to the situation.

The demo stage has been postponed, and instead, the focus was to make a fully functional system with proper UI elements. The system's primary functionality has been achieved, like the image classification section, while small features like recipe sharing have not yet been implemented. Documentation will also continue from now till submission.

So What? Understanding the Context.

The issue faced last time was that I could not create a working demo on time due to other modules. Instead, I have focused on completing the final development phases of the project. Since time is running out, I have also applied a heavy focus on completing the documentation.

Now What? Modifying Future Outcomes

The next step is to finalise the project in terms of code and host the system. Working on the document is also essential as it carries the bulk of the project's marks. With all this done, hopefully, I can let my supervisor see the results. I was unable to meet him often due to ongoing CA's and TABA's from other modules that kept eating into my schedule with him.

National College of Ireland

Project Proposal

EZ Food

08/11/2020

Software Project

Software Development

2020/2021

Sandupa Nilanjana Jayasiri Ampe Mohottige

16151852

x16151852@student.ncirl.ie

Contents

1.0 Objectives

The two main objectives the project is targeted towards is to initially get people to cook from the ingredients they have left in their household and as a result the second objective is to try and reduce food waste by giving leftover ingredients a purpose other than to be disposed.

2.0 Background

In this current climate, a lot of people are stuck at home and are usually busy with work or studies. A lot of the times a good meal is hard to justify during a busy schedule. With this project the aim is to provide people with simple recipes that they can cook in the least amount of time. With time being an issue on many people's mind right now, providing a simple meal that they can prepare in as little time as possible can become really appealing selling point to many people.

Health factors of the meal will also be considered to give confidence to users. With people becoming health conscious over the years and especially being stuck at home influencing people's physical and mental health, it's a good idea to provide as many good distractions such as cooking and eating to get people's hearts up. All of these will accumulate to strengthening the two main objectives of the project.

A quality of life addition to the application will be to give users the ability to save any recipes they have found and share the recipes with other users on the platform or through social media. Their will be a separate section that will list all saved recipes and users can share from there or when finding recipes initially.

3.0 Technical Approach

The main functionality of the project is for the user to point their mobile device (with the application open) at any ingredients lying around their house and the app will simply list down recipes that they can make in the shortest amount of time. The priority of recipes listed will depend on the complexity of the recipe and the time taken to make it.

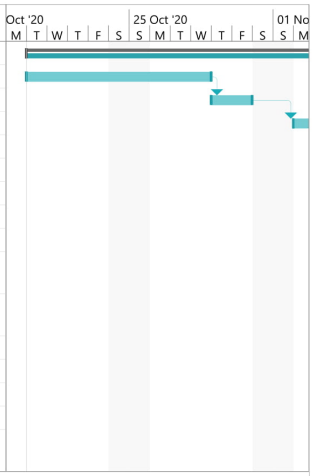
An option in the recipe menu will allow the recipe to be saved with a simple click. Another option will be available to share the recipe with another user.

4.0 Special Resources Required

1. Android Device
    a. OnePlus 6T
    b. **Android 10**
    c. **API Level 29**

5.0 Project Plan

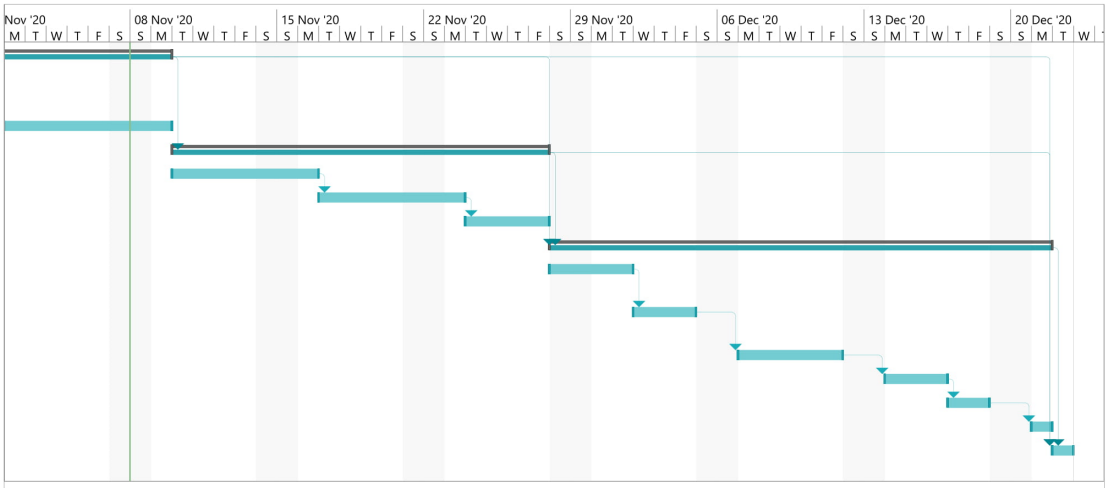
ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Plan**	**15 days?**	**Tue 20/10/20**	**Mon 09/11/20**	
2		Research	7 days	Tue 20/10/20	Wed 28/10/20	
3		Compile Research	2 days	Thu 29/10/20	Fri 30/10/20	2
4		Create Plan	6 days	Mon 02/11/20	Mon 09/11/20	3
5		**Technology**	**14 days**	**Tue 10/11/20**	**Fri 27/11/20**	**1**
6		Find Examples	5 days	Tue 10/11/20	Mon 16/11/20	
7		Test Examples	5 days	Tue 17/11/20	Mon 23/11/20	6
8		Compile Results	4 days	Tue 24/11/20	Fri 27/11/20	7
9		**Start Project**	**17 days?**	**Sat 28/11/20**	**Mon 21/12/20**	**1,5**
10		Create Android Project	3 days	Sat 28/11/20	Tue 01/12/20	
11		Integrate Tensorflow Lite	3 days	Wed 02/12/20	Fri 04/12/20	10
12		Train Data Model	5 days	Mon 07/12/20	Fri 11/12/20	11
13		Build Data Model	3 days	Mon 14/12/20	Wed 16/12/20	12
14		Create UI Design	2 days	Thu 17/12/20	Fri 18/12/20	13
15		Test System	1 day	Mon 21/12/20	Mon 21/12/20	14
16		Mid Point Presentation	1 day	Tue 22/12/20	Tue 22/12/20	1,5,9



Project: X16151852_Proposal_G
Date: Sun 08/11/20

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

Page 1



Project: X16151852_Proposal_G
Date: Sun 08/11/20

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

Page 2

6.0 Technical Details

The Project will utilise the following technologies.

1. Programming languages.
    a. **Java** (Potential switch to Kotlin if viable).
    b. **Python** for **API** Development (In the case an API with adequate data exists, this need not be created).
2. Libraries
    a. TensorFlow
        i. **TensorFlow Lite** for Android.
3. Required Software
    a. **Android Studio**
    b. **Visual Studio Code**
    c. **Java JDK 15**
    d. **Python 3.8**
4. Cloud Services
    a. **AWS EC2** Instance will hold the API and Database.
        i. **Linux** Image (**Ubuntu Server**).
5. Data
    a. Data Sets for recipes can be obtained using.
        i. Data repositories.
        ii. API's.
    b. Data for image recognition can be obtained from.
        i. Manually obtaining the ingredients and training the system.
        ii. Using royalty free images to train the system.
        iii. Using open and free prebuilt data models.

7.0 Evaluation

System tests will include testing what percentage the image recognition technology can accurately identify the ingredient. Tests will include 3-5 round of image recognition where the system will receive inputs on whether the identified result is accurate or not. This method of testing will increase the reliability of the image recognition as in all cases the initial setup will tend to yield poor results.

8.0 Invention Disclosure Form (Remove if not filled)

Please fill in the following sections, if you think your idea is innovative:

1. Title of Invention

EZ Food

2. Inventors

Name	School/Research Institute	Affiliation with Institute (i.e. department, student, staff, visitor)	Address, contact phone no., e-mail	% Contribution to the Invention
Sandupa Nilanjana Jayasiri Ampe Mohottige	National College of Ireland	Student	Apartment 6, The Thomas House, 86/87 Thomas Street, Dublin 8, Ireland D08 FK23 +353 89 220 0709 x16151852@student.ncirl.ie	100%

3. Contribution to the Invention

Each contributor/potential inventor should write a paragraph relating to his/her contribution and include a signature and date at the end of the paragraph.

Code and design of the project will be my own except for open source libraries for image recognition using TensorFlow Lite.  08.11.2020

4. Description of Invention

(Please highlight the novelty/patentable aspect. Attach extra sheets if necessary including diagrams where appropriate). What is novel, the 'inventive step'? For more information on patents, please look at http://www.patentsoffice.ie/en/patents.aspx

The two main objectives the project is targeted towards is to initially get people to cook from the ingredients they have left in their household and as a result the second objective is to try and reduce food waste by giving leftover ingredients a purpose other than to be disposed.

5. Why is this invention more advantageous than present technology?

What is its novel or unusual features? What problems does it solve? What are the problems associated with these technologies, products or processes? Explain how this invention overcomes these problems (*i.e*. what are its advantages).

The use of image recognition to recognise the ingredients.

6. What is the current stage of development / testing of the invention?

Still in research and data gathering phase.

7. List the names of companies which you think would be interested in using, developing or marketing this invention

Tesco Aldi Lidle

8. Funding Partner(s)

Government Agency & Department	N/A
% Support	
Contract/Grant No.	
Contact Name	
Phone No.	
Address	

Industry or other Sponsor	N/A
% Support	
Contract/Grant No.	
Contact Name	
Phone No.	
Address	

9. Where was the research carried out?

Through news articles, blogs and journals available online.

10. What is the potential commercial application of this invention?

Can be used by groceries stores to entice people to buy and cook more using their products.

11. Was there transfer of any materials/information to or from other institutions regarding this invention?

If so please give details and provide signed agreements where relevant.

N/A

12. Have any third parties any rights to this invention?

If yes, give names and addresses and a brief explanation of involvement.

Yes, National College of Ireland will have temporary rights while the project is underway to safeguard the innovation.

13. Are there any existing or planned disclosures regarding this invention?

Please give details.

No

14. Has any patent application been made? Yes/No

If yes, give date: _____ Application No.: _____

Name of patent agent: _____

Please supply copy of specification.

15. Is a model or prototype available? Has the invention been demonstrated practically?

No

I/we acknowledge that I/we have read, understood and agree with this form and the Institute's *Intellectual Property and Procedures* and that all the information provided in this disclosure is complete and correct.

I/we shall take all reasonable precautions to protect the integrity and confidentiality of the IP in question.

Inventor: Sandupa Nilanjana Jayasiri Ampe Mohottige 08.11.202

Signature Date

_____

Signature