GNG 1103

Deliverable G: Prototype II and Customer Feedback

Group 13

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Introduction

For the last deliverable, the decisions and results of the first prototype were discussed where the main subsystems - the scanner, the UI, and the leaderboard - were first introduced. This deliverable emphasizes on the decisions and results of the second prototype which is built upon the first prototype. The purpose of this prototype is to use the feedback that the client provided and make improvements and modifications to our product. The team performed prototype tests to obtain results and collected feedback from different individuals in order to determine the state of the application.

Prototype 2 Testing Plan

Prototype 2 Objectives – the 'Why'

What are the **specific** test objectives?

The objective of this prototype is to successfully meet as many of the client's needs as possible. This prototype test is required to ensure that the client's feedback that was received is used to improve the future application, and to see that the scanner and the navigation of the application are functioning. For the scanner, the objective is to determine a more precise scanning method to identify the recyclable items so it is more accurate, since other methods that were applied were not working appropriately. In addition, we will continue working on the navigation and developing the leaderboard.

What **exactly** is being learned or communicated with the prototype?

This prototype focuses on building upon the basic subsystems from the previous prototype, the first prototype.

What are the possible types of results?

As mentioned in Deliverable F, we could experience many possible outcomes during the prototype testing process. The results obtained could be satisfactory or unsatisfactory.

How will these results be used to make decisions or select concepts?

The results of this prototype testing will indicate issues where the team will need to focus on resolving to continue developing the application. Since a client meet is not scheduled for this prototype, the team will meet with the TA for suggestions or any concerns that they may have regarding the product.

What are the criteria for test success or failure?

The criteria for test success would be to receive positive feedback from the TA or from other individuals. Receiving negative feedback would result in failure. Another criteria for success is to

identify where improvements are required, the scanning method. Not doing the improvements would result in failure because the team would proceed on developing an application where the information provided to the user would be inaccurate, and therefore, the application would not fulfill the main need of the client, which is to accurately identify the type of recyclable material.

Prototype 2 Process - the 'What' and 'How'

Describe the prototype (e.g. focused or comprehensive) and the reason for the selection of this type of prototype.

This prototype is intended to be a comprehensive prototype that assimilates the functional subsystem prototypes created for Deliverable F. After determining what features were possible independently, this comprehensive prototype will serve as an early version of the complete app.

Describe the testing process in enough detail to allow someone else to build and test the prototype instead of you.

The testing process involves assessing if the current prototype meets the previously established design specifications. To create and test the comprehensive prototype, the tester must have access to unity and a basic knowledge of unity and C#. After completing the prototype, the unity project is then to be assessed against the design metrics to determine how well it meets the standards outlined in deliverable C.

What information is being measured?

The information being measured through testing is mostly qualitative or yes/no answers assessing whether or not the prototype meets the client's needs.

What is being observed and how is it being recorded?

The tests are mainly to observe if the intended features are functional and how well the prototype caters to the client's needs. The results for the comprehensive prototype are to be recorded in a table comparing the protype's performance to the design metrics.

What materials are required and what is the approximate estimated cost?

This prototype has no physical materials associated with it. A functioning personal computer and unity engine are the only necessary materials.

What work (e.g. test software or construction or modeling work or research) needs to be done?

This prototype will require team members to research how to use Unity to implement the features off the app. Research into the optimal types of Vuforia targets to use for the item scanner is also necessary.

Prototype 2 Schedule - the 'When'

How long will the test take and what are the dependencies (i.e. what needs to happen before the testing can occur)?

A separate test planning Gantt chart can be created to help make sure that the testing fits with the overall project schedule or it can be defined as part of that schedule (i.e. as a sub-task).
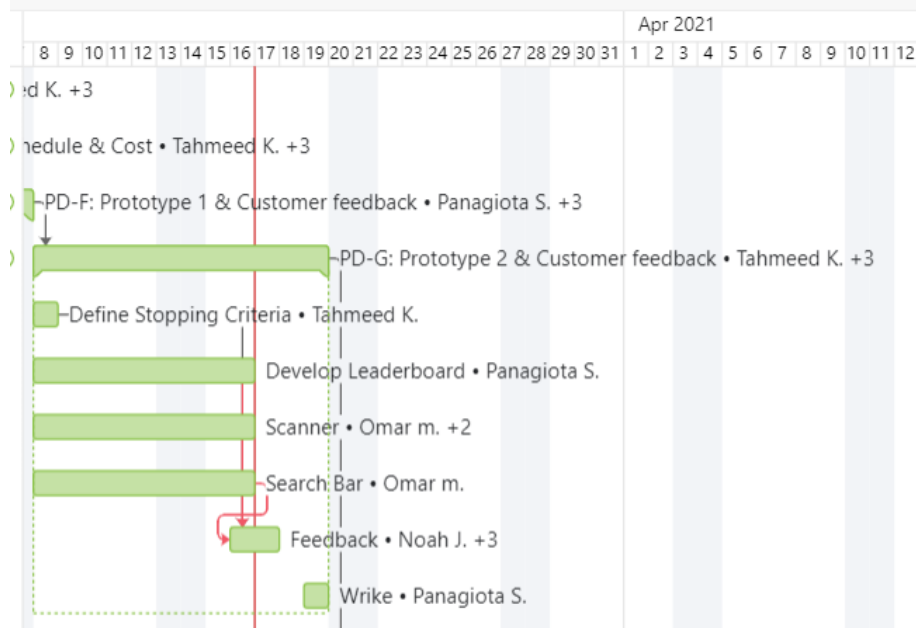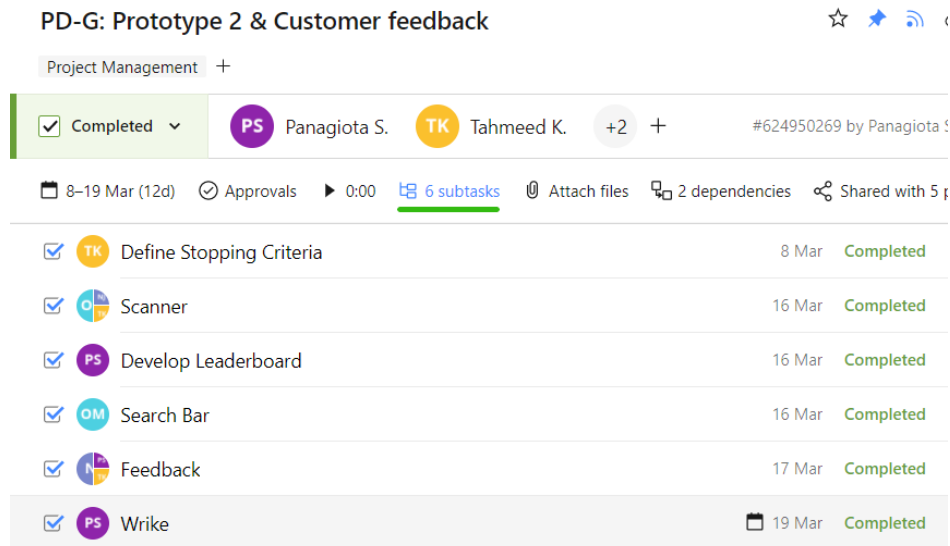

Figure 1a: Gantt Chart

Figure 1b: List View

When are the results required (i.e. what depends on the results of this test in the project plan)?

The results are required before this Deliverable G is due, by March 19th. In order to develop the third and final prototype, the results of the second prototype must be obtained. Therefore, the third prototype depends on the second prototype.

Prototype Schedule, Testing and Analysis:

The following table outlines the timeline, and methods of testing for each subsystem modelled in this prototype.

Table 1: Timeline and Testing

Test ID	Subsystem	Description of Prototype used and of Basic Test Method	Description of the Results to be Recorded and how these Results will be used	Estimated Test Duration and Planned Start Date
1	Scanner (Single Image)	Testing if the single image target scan on vuforia can target barcodes and/or recycling information contained on the packaging of the material. Various recycling symbols include: Barcode Recycling Arrows Large Text	Optimize the inputted length of the object What could be scanned easily or not	March 4-6
	Scanner (Cylindrical)	Testing if the cylindrical image target scan on vuforia can target different cylindrical objects such as different water bottles.	Most efficient distance of scan Constantly grabbing the image	March 4-6
	Scanner (Other)	Testing and developing other types of scanning such as model and object targets.	Acquiring 3D Models, CAD and .obj files Testing scannable items	March 9-10
2	Leaderboard	Testing if the score number	The score	March 4-6

		increases by one when the user presses the button.	increased and was displayed on the screen. This will be built on for the development of the leaderboard.	
3	User Interface	Construction of main app scenes and navigation bar to switch between them. Creating buttons and pop-ups to be used later for implementing search, scan and leaderboard features.	Does the UI function and scale appropriately to mobile devices? Use these results to adjust scene sizes and scaling options. Is the UI visually appealing and easy to navigate? Use this feedback to alter and improve the look of the UI.	March 4-7

Prototype 2

Leaderboard
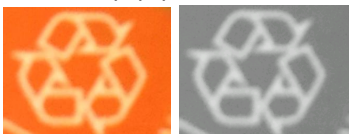
As mentioned in the previous deliverable, the team agreed that CloudOnce would be used for the development of the leaderboard. After doing research, it was determined that developer accounts were required in order to proceed. Since the application that we are developing is for Android and IOS devices, two developer accounts are required where a fee has to be paid for each one. The fee for the developer account for Android devices was paid ($25 USD) and the account was created. However, the developer account for the IOS devices was not created because the fee exceeded the maximum price limit ($99 USD per membership year). Because

we were only able to pay one of the two fees, the team will discuss whether finding another way to implement the leaderboard is necessary or reconsider the idea of the leaderboard since the application aims for both Android and IOS devices.

Scanner

We tested various types of image targets that contained a symbol or shape that distinguishes where the item should be disposed of. This includes symbols such as the recycling triangle, the plastic recycling symbol (Shown in figure Xc), barcodes and various cylindrical targets.

Table 2: Scanning Targeting Results

Target Used (Augmentation Rating 0-5)	Type of Target	Width (m)	Distance it Tracked from (m)	Comments
Orange Recycling Symbol (Edited to increase contrast) (0)	Image	3	N/A	No trackable Features at all. May be due to resolution/blurry-ness or the symbol may not be augmentable.
Dark Green Recycling Triangle (0)	Image	4	N/A	No trackable features at all. This test made us suspect that the symbol by itself is not augmentable by Vuforia
Dark Green Recycling Triangle Shrunken (4)	Image	4	N/A	Interestingly, resizing the image so it takes up approximately half the area of the screen makes it far more augmentable than the previous case. Despite this, the symbol was not trackable because the object that uses this image did not have the

				large white borders around the symbol.
Plastic Recycling Triangle on Pantene Bottle (0)	Image	4	0	No trackable features at all. This was expected though, as the target used has very low contrast
Tin Can (0) Side:	Cylindrical	N/A	N/A	Is not recognized by scanner possibly due to the lighting and symmetry
Soup Can With Logo (2)	Cylindrical	N/A	0.1-1.5	Able to track the logo somewhat accurately Could not track the logo at all when it was slightly tilted
Bar Code on Neutrogena Bottle (2)	Image	3	0.1-1.0	Was able to track barcode

				somewhat accurately, but the scanner picked up the symbols around the barcode rather than just the barcode itself. Thus, the barcode isn't actually being augmented
	→ It also works with a filled container.	4	0.23 - 1.32	Able to track and identify the general shape of a cylindrical bottle, regardless of the plastic wrapper around it.

		5	0.23 - 1.32	Able to track the general shape, but requires smooth surface area.
	→ It also works with an empty container.			

Based on testing by both Omar and Tahmeed, the group has decided to rely less on image and cylindrical target scanning due to tracking problems and unsound reasoning.

Firstly, our group experienced many tracking and augmentation problems with image targets. Most recyclable products have a symbol known as the recycling triangle (Figure 2a). From multiple tests with both image and target scanning, this symbol alone is not augmentable at all as shown in Figure 2b to 2d. The yellow blips on the image target indicate the augmentable features Vuforia's scanner looks for. None of the full-size recycling triangle image targets had those augmentable features. Tahmeed suspects because the images have low contrast, the symbol has very little sharp edges and has a repeating pattern. According to Vuforia's Image Target Best Practices web page, the scanner cannot track images with these characteristics well, if at all [1]. The only time the triangle was recognizable was if there was surrounding text or if it only took up part of the frame.
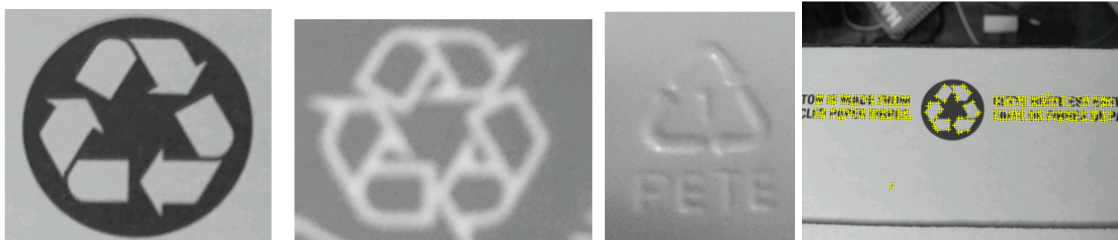

Figure 2: a) Recycling Triangle Xb) - d) Non-autmentable Image Tracking

Vuforia also mentioned that when scanning images for features, it has an exclusion buffer region that spans approximately 8% of the image's width. Based on this, Tahmeed added white borders and progressively reduced the size of the image until the image had a high

augmentable rating. From testing, the final image target took up approximately 50-60% of the actual target and had an augmentable rating of 4/5.
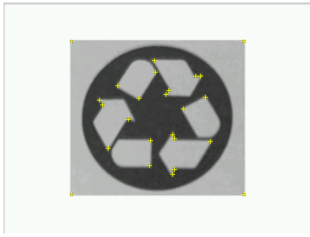

Figure 3: Shrunken Recycling Triangle

However, this image wasn't augmentable with the packaging Tahmeed used in the first place because the packaging doesn't have white space around the recycling triangle like the image target suggested. If there was a way for the image target to have a transparent border around images, the target might have been augmentable.

After this, Tahmeed tried using a barcode as an image target, and it suffered a similar fate to the recycling triangle due to the barcode having too many repeated patterns. As shown in Figure 4, the scanner could not pick up the features of the barcode and picked up the surrounding text instead. Since vuforia cannot track barcode features even under optimal lighting, barcodes cannot be used to feasibly scan items.
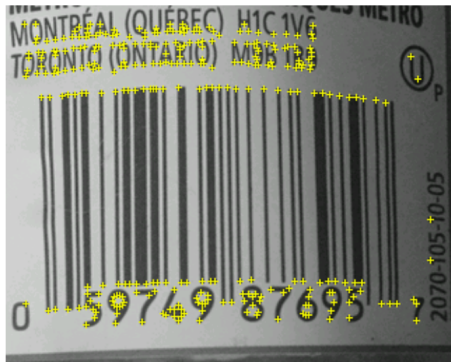

Figure 4: Barcode

The cylindrical targets tested by the group had better success, but could potentially fall to the same pitfalls as image tracking since they require a wrapper of some sort around the target itself. However, cylindrical targets remain reliable for cylindrical-shaped objects even under less than optimal lighting conditions.

Even if the image and cylindrical target scanning were to work perfectly, Noah noted that the user would have to know what type of product was being targeted and give some sort of easy identifier to the object (a standout sort of logo) to achieve notable scanning results. Items in general do not have a designated symbol indicating where the item should be recycled to (other than the numbers 1-7 for plastic items or barcodes). Our group decided in prototype 1 that the final application would not track barcodes because we would need a database or server to store all the barcodes into, which would increase the maintenance costs and overall project costs.

Additionally, this functionality would render our app too similar to our leading competitor, Junker, which also uses barcode scanners to identify items and appropriate bins.
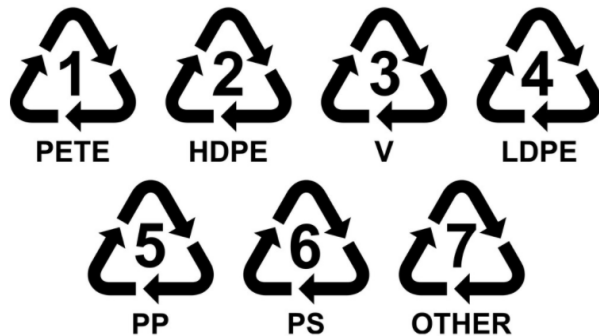

Figure 5: Recycling Symbols

Based on general group consensus, we have decided to rely on Vuforia's model and object tracking to scan and identify items, with cylindrical and image targets for items with specific symbols or logos. The biggest hurdle associated with this is getting the CAD models and object files for the 3D targets. For the next prototype, we plan on testing items with the same symbol, but different shapes and materials and seeing if the scanner could distinguish between these items.

User Interface

The five main scenes of the app have been created and switched between in possible with the use of the navigation bar at the bottom of the screen. The user scene is intended to display the user's name along with a breakdown of their recycling activity. As of this prototype, only the total number of items they have recycled tally is functioning. The user's name is what will be shown on the leaderboard and is to be abed in the near future. The tallies for items recycled are what is going to be used for the leaderboard.

The search scene offers two methods of searching for recyclable items, the text input field and the buttons. The text input field creates a drop down list of suggested results based upon what the user has typed. Selecting a result will open that results's database page. The search buttons ask the user to select a material and open a scrollable list showing the names and images of items made from that material. Clicking on an item in the scrollable list will open that item's database page.

Database pages display the name and image of an item, the bin that item goes into, additional information on that item and a link to Ottawa's waste database for more information. To exit a database page, the user presses the red X at the top right corner of the screen. The X opens a pop-up asking the user if they recycled the item from the database page they just closed. If the user selects yes, the tally on the use scene is updated.

The options scene has 4 cells that will each provide different functionality. The replay tutorial will restart the tutorial. The language toggle feature will switch all the text in the app between english and french. Privacy settings involve the app's use of the user's Google Play Games and Game Center for the leaderboard and will allow the user to disable publicizing their recycling information. The city waste explorer button serves as a link to the city's recycling guidelines. As of this prototype, only the was explorer button is functioning. The other features are to be added in the future.

The scanning scene is an AR camera overlay that displays the name of the item being scanned at the top of the screen once the item is recognized. Two buttons at the bottom of the screen are to open the recycling database page for the scanned item and tell the user what bin to play the item in. A pop-up asking the user if they have recycled the item will appear 5 seconds after the item the user is scanning has been identified.

The leaderboard scene currently does not feature anything. The group has recently made the purchases necessary for the CloudOnce plugin and will focus on developing a functioning leaderboard for the next prototype.
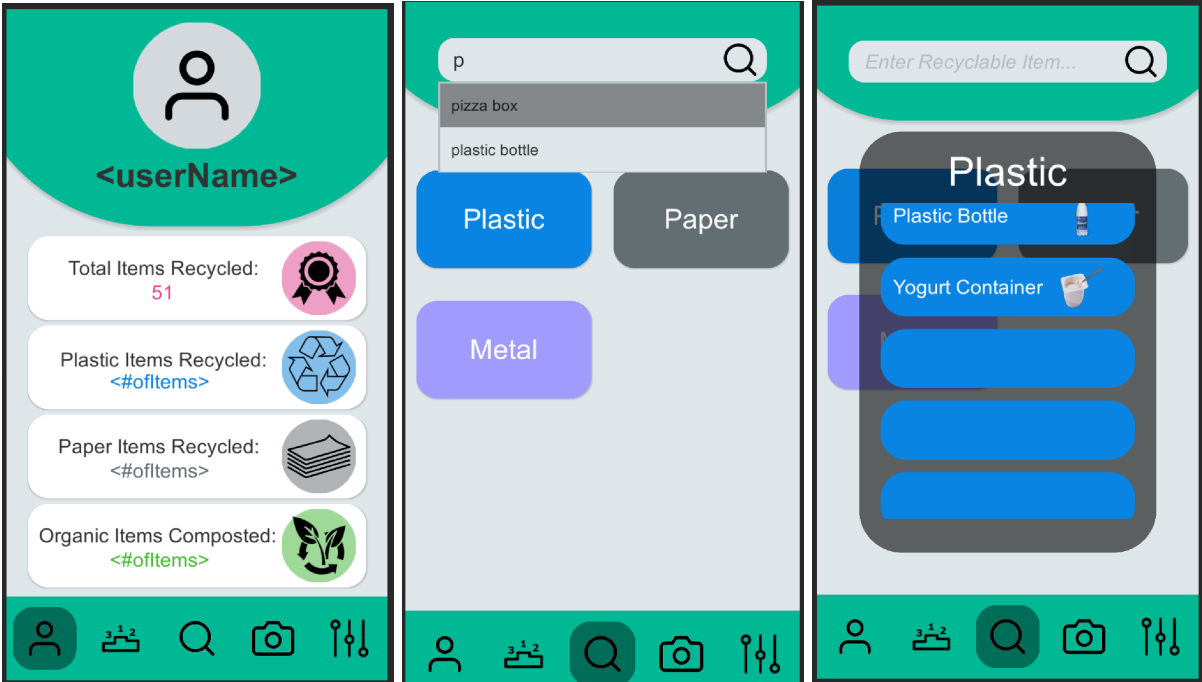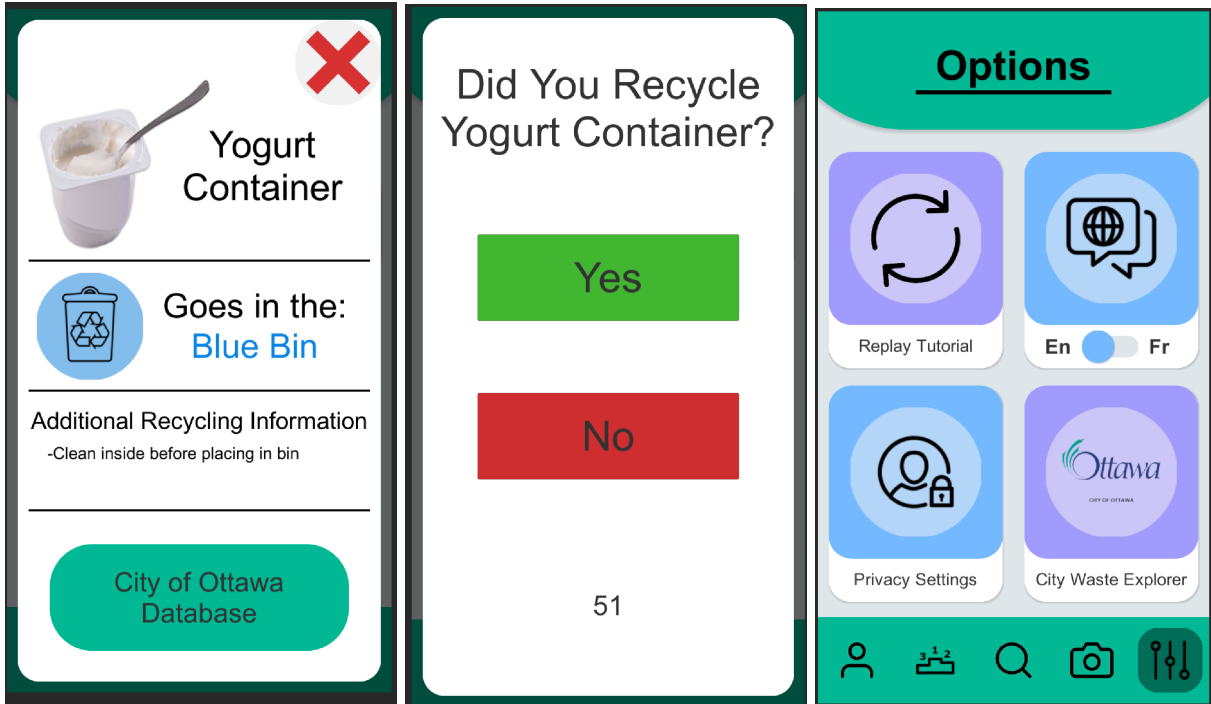

Figure 6: User and Search Scenes

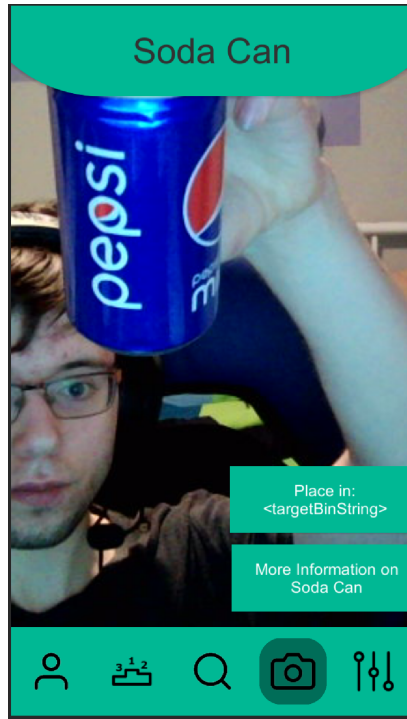Figure 7: Database Page, Prompt Pop-up and Options Scene

Figure 8: Scanner Scene

Prototype 2 Progress and Test Results

#	Specification	Target Value	Test Result
Functional Requirements			
1	Compatible with common operating systems (IOS & Android)	Yes	Android Yes IOS not tested
2	Uses camera features to facilitate recycling	Yes	Scanner uses Vuforia AR plugin to identify objects with phone camera
3	Ability to accurately identify waste items	Yes	Search and Scan features work only for a limited selection of items
4	Outputs recycling method for a waste item	Yes	Database Pages state which bin to place an item in
5	Provides information about locations for disposal of irregular recyclable items	Yes	No
6	Identifies which bin to use for different recycling methods	Yes	Database Pages state which bin to place an item in
7	Adjusts recycling method for contaminants	Yes	Database Pages give additional information about contaminants
Constraints			
1	Budget	<$100	$99 IOS Game center (not within budget) $25 Google Play Games
2	Storage	<1000 MB	115 MB (so far)
3	Device Requirements	IOS 12.0+ Android 5.0+	Android 7.0+ IOS 11.0+
4	Display Size	Any Screen Size	App fits to screen size

Non-Functional Requirements			
1	User-friendly navigation and interface	Yes	User interface in need of modifications
2	Clear and concise tutorial	Yes	No tutorial exists yet
3	Multi-language	English & French	Only english at the moment Toggle button to switch language exists but is not yet functional
4	Usable in different places (not limited to municipality/city/town)	Yes	Only Ottawa currently
5	Tracks how much user is recycling	Yes	Only Tracks Total Number of Items

Feedback

Client:

The client stated that the scanner should provide a clear indication when the item the user is trying to scan is identified. The client suggested a change in color when an item is identified correctly in addition to the text in the scene header being updated.

Juan:

Language Features:
"To implement the language feature, get a text file that gets sent out with the build that contains all the french text. In the options, there will be a toggle from English to French, and when it is set to French, the scene refreshes and the entire game is set in French."

"The footer for the app seems a little large."

"Familiarize yourself with anchoring features to appropriately scale UI elements, especially on mobile platforms."

"Add boolean for the debug."

"Don't use updates for loading player data. Best practice: Use an IEnumerator to optimize in-app performance. Don't use the update function if you don't need to."

Conclusion

In this deliverable, the subsequent model was created by following the model arrangement that was recently made in Deliverable F just as improving and adding more highlights to those carried out to model one. For this deliverable, tests were performed for the principle functionalities of the second model to meet the customer's criticism. The model was created to be superior to the first and to give us a reasonable picture regarding what the end result will be. The criticism that was gotten for every functionality will be mulled over to execute the future models.

References:

unity. "Best Practices for Designing and Developing Image-Based Targets." *Best Practices for Designing and Developing Image-Based Targets | VuforiaLibrary,* library.vuforia.com/features/images/image-targets/best-practices-for-designing-and-developing-image-based-targets.html.