Deliverable G – Prototype II and Customer Feedback

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Introduction

Now that a detailed proof of concept of the application has been completed, the next step of prototyping can commence. The second phase is the construction of a rudimentary model of our application composed only of basic functions. The most important element of the app, the scanner, will be the main focus of this deliverable. Getting it functional is the goal of prototype II as it is the most important element of the proposed solution. The initial Vuforia image database will also be created as it will be the backbone of the scanner. These two components will then be tied into a rudimentary UI intro screen so that the basic app can be tested against the chosen criteria and metrics. As with every prototype, the risks and costs associated to it will also be discussed, as well the next steps of the prototyping phase.

Project Risks and Contingency

An obvious risk is the app failing to function as intended. Subsections of this risk are limited to the database of images being insufficient, the code not working properly, as well as the UI being broken. All of these risks have relatively simple fixes. The database can be improved by adding more images, the code can be debugged, and the interface can be modified if need be.

Another risk to consider is the potential for prices of services changing. Services include software engines like *Unity* and *Vuforia*, as well as the listing for the Apple/Samsung store, which rests at $100/year. For the time being, *Unity* and *Vuforia* are free. However, if the software used to code and implement this project begins to cost money, then the overall cost of development will increase. In this case, it may be necessary to find some other medium through which to code the app or create the UI, as any money used on *Unity* or *Vuforia* will exceed the cost limit.

In terms of scheduling risks, everything stated above, if it were to happen, would require time to fix. So, any risk to the project's success invariably affects the schedule laid out.

Project Costs

Material/Tool	Cost
Programmer/ developer	Free
Unity	Free
AR Tool (Vuforia)	Free
Recycling material for testing	Free
Total	0$

Since the project is still in the prototyping phase, there are no costs associated with it. Once the project is finalized, the only legitimate cost to be considered will be to put the application up to be downloaded. Additionally, if the project needs outsourcing for its completion, another cost can be added. However, in its current state the total cost of the project remains at a sum of zero.

Description of Prototype II

Prototype II consisted of two main elements: the creation of an initial *Vuforia* database and development of a rudimentary scanner app for a phone.

Vuforia is utilised to create a database of images that the app will compare with the item being scanned. Solely recyclable items are stored within the library, so if the item is not similar to any of the photos 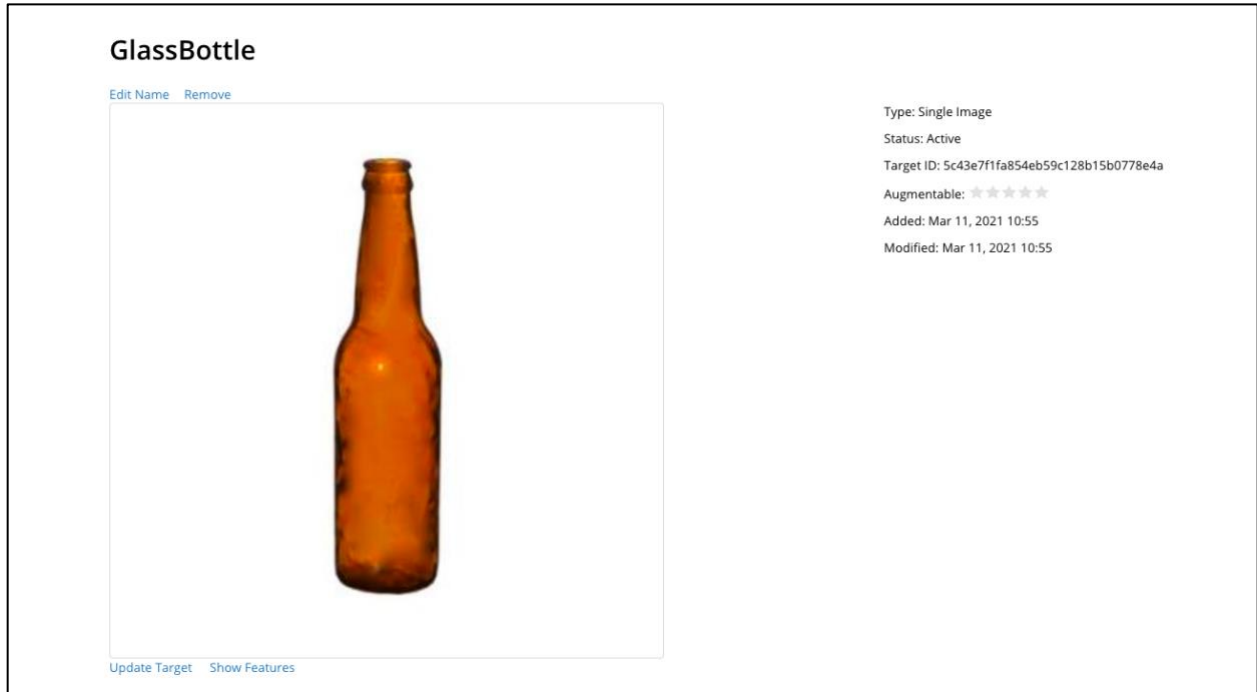in the database, then the item will be concluded to go in the garbage. The *Vuforia* image library created for the app appears as so:

Target Name	Type	Rating	Status	Date Modified
StarbucksGlass	Single Image	★★★★☆	Active	Mar 11, 2021 10:59
CokeGlassBottle	Single Image	★★★☆☆	Active	Mar 11, 2021 10:57
GlassBottle	Single Image	☆☆☆☆☆	Active	Mar 11, 2021 10:55
SpriteBottle	Single Image	★★★☆☆	Active	Mar 11, 2021 10:51
CokeBottle	Single Image	★★★☆☆	Active	Mar 11, 2021 10:50
FantaCan	Single Image	★★★☆☆	Active	Mar 11, 2021 10:46
PepsiCan	Single Image	★★★☆☆	Active	Mar 11, 2021 10:42
CanDryCan	Single Image	★★★★☆	Active	Mar 11, 2021 10:41
SpriteCan	Single Image	★★★★★	Active	Mar 11, 2021 10:40
CokeCan	Single Image	★★★★★	Active	Mar 11, 2021 10:39
DasaniBottle	Single Image	★★★★☆	Active	Mar 11, 2021 10:36
RealCanWater	Single Image	★★★☆☆	Active	Mar 11, 2021 10:34
FijiBottle	Single Image	★★☆☆☆	Active	Mar 11, 2021 10:33
NestleBottle	Single Image	★★☆☆☆	Active	Mar 11, 2021 10:30

The rating of each item is given based on the difficulty of recognition by the scanner. The items with higher ratings will be recognized by the scanner with ease, whereas the items with lower ratings will be harder to identify by the scanner. There are a number of factors that determine the rating of the photo of the items. The item must be rich in detail for the scanner to recognize the item better. There also must be a good contrast of colour between the item and the background of the photo. The glass bottle is an example of an unrecognizable item:

GlassBottle

Edit Name   Remove

Type: Single Image
Status: Active
Target ID: 5c43e7f1fa854eb59c128b15b0778e4a
Augmentable: ☆ ☆ ☆ ☆ ☆
Added: Mar 11, 2021 10:55
Modified: Mar 11, 2021 10:55

Update Target   Show Features

The glass bottle has a rating of 0 stars due to the lack of detail on the item. Since this is a generic bottle without any specific labels, images, or logos, *Vuforia* does not have any special features to identify the item. As seen below, there are very few trackers (yellow pluses) generated:

Edit Name   Remove

Update Target   Hide Features

Items with higher ratings tend to have detailed labels and logos. A prime example of this is the sprite can as seen below:
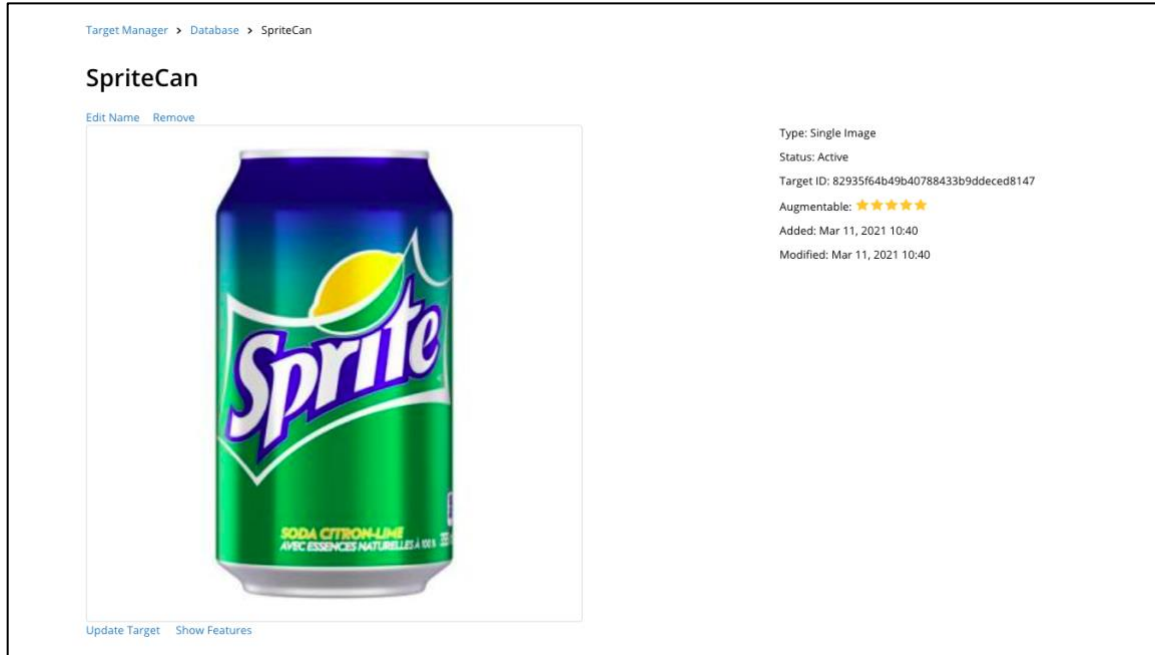
It has a rating of 5 stars, which means that the scanner will easily recognize the item. The number of features, colours, and logos makes it easier for the scanner to identify the item.

For this prototype, a simple main screen was created as seen below:
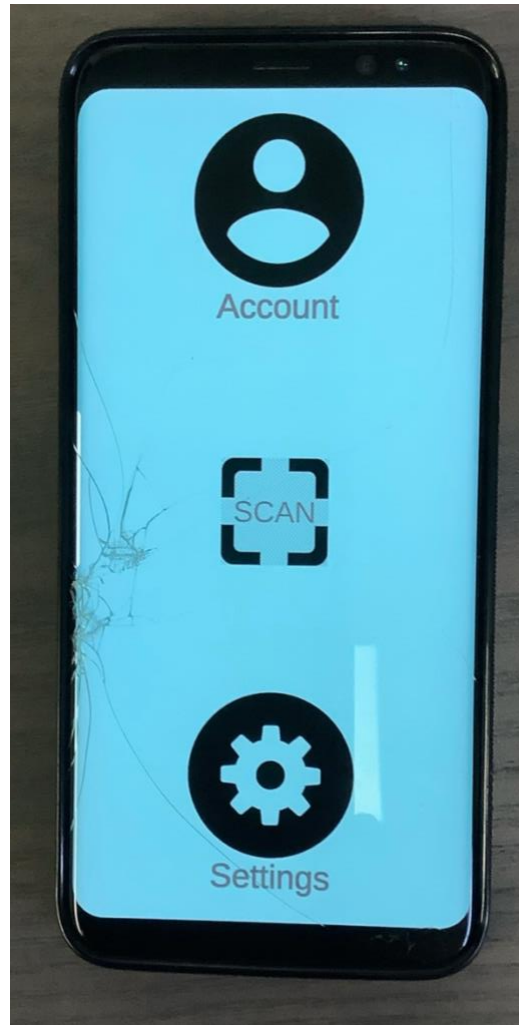
In the final version of the app, this screen will become the "Home" screen after further refinement. This screen has 3 buttons: account, scan and settings. The most important one is the scan button. Once pressed, it will bring the user to the scanner as seen in the figure below. The other two buttons are non-functional for this prototype; in the next version they be linked to an account's page, where all the information about the user's account will be displayed, and to a settings page which will give further instruction on how to use the app and helpful links to a recycling guides from the City of Ottawa.
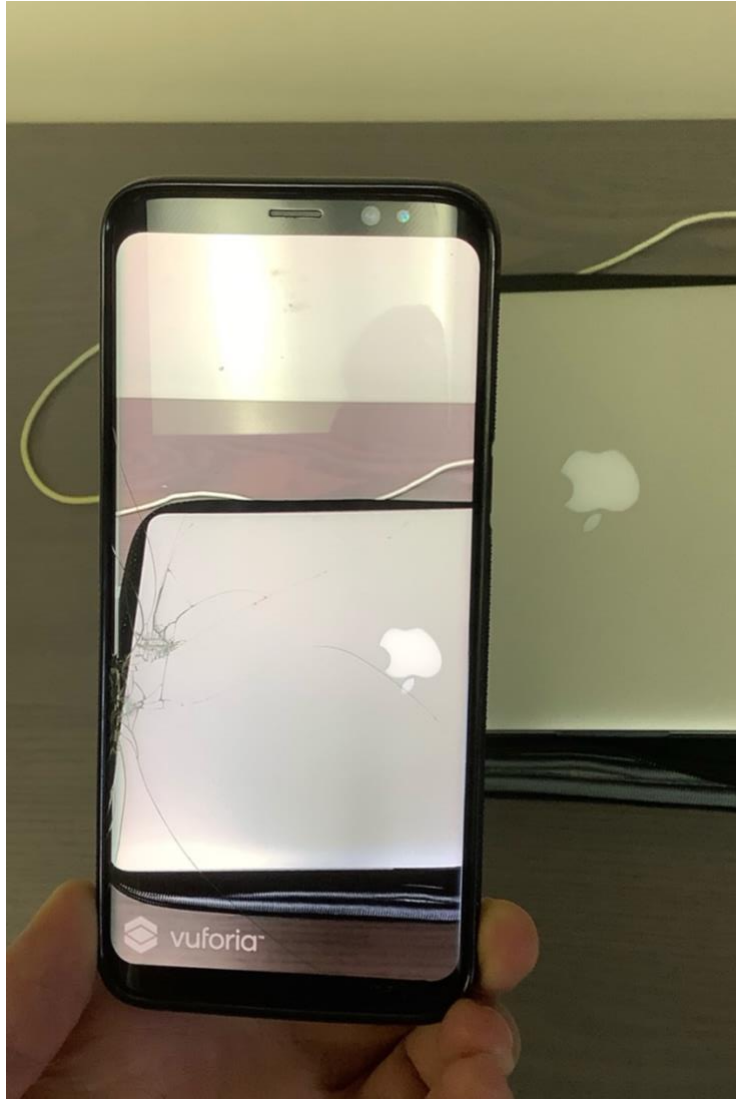
For the purpose of this prototype, the scanner was tested with a sample object, which was an Ottawa Senator's hockey puck. Once the scanner had found the puck, it was programmed to display a green smiley face over it. In the next prototype, once an item is recognized, the green smiley face will be accompanied with instructions on which bin to place the item. In addition, if the item is not recognized, a red "X" will be displayed with instructions on where to dispose it (in this case, it would be in the garbage). The hockey puck was also only used for this stage of prototyping, the following stages will see the implementation of the recyclable item database as discussed above.

As it can be clearly seen in the picture above, once the item is recognized by the application, the green smiley face appeared over it.

Testing

For the second prototype, there are three criteria that will be tested: performance time, complexity and effectiveness. Out of all the criteria chosen for this project, those 3 were deemed the most important for the success of the project, as defined in Deliverable C (highest weights). Thus, their testing is critical to determine the progress of the prototypes.

For the performance time criterion, a metric of 1 minute, with an ideal time of less than 45 seconds, was chosen. The performance time is defined as the time the entire process takes to get an answer, so it starts when you pull your phone out of your pocket and ends when the item is

successfully identified. The application was tested 5 times, and the performances had times roughly between 15 and 25 seconds. In all the tests, the scanner quickly recognized the hockey puck and projected the green smiley face over it. In general, the hockey puck has more details than a typical recyclable item, so it is likely normal recyclable items will take longer to scan, however there is a lot of room between the test times and the desired metric. As such, there should be no issues regarding performance time in the following prototype, but additional testing will be required to confirm this. Thus, the second prototype successfully meets the desired performance time.

The complexity of the current prototype, compared to what was outlined in the third deliverable, is nearly exactly what was planned. On loading the app, there are three options that are clearly defined. The main function represented on the home screen is "scan", which instantly allows the user to begin scanning. The ideal metric set previously dictated that the user should have to have no more than 3 decisions and 5 actions to receive an answer, with an acceptable range of 5 decisions and 8 interactions. As it currently stands, only 1 decision (selecting the "scan" button) and 3 actions (turning phone on, opening app and clicking button) are necessary to receive an answer, which is within the ideal metric set. As the app is further developed and refined, more information and additionally screens will be added, however its core functionality will not change so the final product should have the same complexity as this prototype, which is well within the set metric of 3 decisions and 5 actions.

The effectiveness of the application is measured by how many times it successfully identifies an item. For the purpose of this prototype, only one item was added in the database to test the scanner, a hockey puck. The application management to always identify the hockey puck in the numerous attempts, even if it was sideways or upside-down. This is very promising because it shows the versatility of *Vuforia* and the scanner within the app. The ideal metric was 90% identification, with 70-80% being acceptable, which is within the tested effectiveness of 100%. Granted, the hockey puck is distinctive and had a high star rating in *Vuforia*, so it might not be the best indicator of future performance. Once the recyclable item database is optimized and fully integrated with the scanner in the next prototype, the effectiveness testing will be performed again to determine if it stills meets the target metric.

Future Prototyping and Objectives

There are still many things to add and modify to this prototype. The most important one being the connection of our recyclable item database to the application (instead of the test database of the hockey puck). This database also needs to be refined to increase the rating of the current items to help increase the odds the scanner will identify them, and new items will be added to help expand the items that be recognized.

In terms of the UI, a major overhaul is necessary as only a rudimentary main menu screen was included in this prototype. Several other screens, such as a "settings" and an "accounts" screen will be added in the next iteration. On the scanner screen, buttons need to be added to allow the user to navigate back to the main menu. Once an item is identified, there should be direction on

where to place the item along with the green smiley face so that the user knows where to place the bin. There also needs to be the implementation of a red "X" along with text to indicate to the user the items that should go into the garbage.

These are the objectives for the next prototype (III), however in the future other features can be added such as a working reward system and a system to store the users account information. In addition, the database could be refined further, and more items could be added to it to improve performance.

Client Feedback – Prototype Adjustment & Modification

The first prototype, and early screenshots of the second prototype were presented to the client for feedback. The client was happy with what was shown as earlier, he wanted it to be more obvious when an item was deemed recycle. The team addressed this by having a large green smiley show up over the recyclable item, which the client approved of. The client put emphasis on ease-of-use and user-friendliness, so it must very obvious when an item is recyclable or not. This will be improved upon in the next prototype by having a large red "X" display if the item is not recyclable and if the item is recyclable, there will now be bolded text along with the green smiley face to facilitate user understanding. In addition, a user guide will be added in the settings screen to help users more easily and effectively use the application. A link to the City of Ottawa's recycling program will also be included if the users would like more information about recycling within the municipality. The addition of a link will encourage more people to seek further knowledge if they are curious as it eliminates the effort needed to find this information online.

Conclusion

In conclusion, the second prototype accomplished the goals outlined by the team. A rudimentary and basic application with scanning abilities was constructed and tested. Also, the image library of recyclable items was created and will be further expanded within the next iteration. The test performed on this prototype concluded that this version met the complexity, performance time and effectiveness required to solve the client's need of creating a system that would facilitate the sorting of household recyclable items.

Appendix A