Project Deliverable H:
Prototype III and Customer Feedback

GNG 1103 - Winter 2021
Faculty of Engineering - University of Ottawa

uOttawa

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Due Date: March 28th, 2021

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1 Introduction

The objective of this deliverable is to continue developing our product. We will be creating our third prototype which will include improvements from our second prototype, adding new features and image targets. We are looking to improve the usability of our application and make it appealing to use for our targeted audience. In order to complete our third prototype, we will develop a prototype test plan that will include various test cases to determine if we achieved the desired results. Furthermore, we will take into consideration the problems we faced in the second prototype and fix these for the current prototype at hand. Also, we will speak to potential users and ask for their feedback and how our application can fit their specific needs. After completing the prototype, we will document the next steps required to improve our third prototype based on the feedback received from potential consumers. We will make final adjustments for our final product before the Design Day.

2 Prototype Test Plan

2.1 Prototype Test Plan Chart

Test ID	Test Objective (Why)	Description of Prototype used and of Basic Test Method (What)	Description of Results to be Recorded and how these results will be used (How)	Estimated Test duration and planned start date (When)
1	AR image recognition development.	Test to see if our new image targets are working in an efficient manner.	If the new targets are correctly recognizable and do not interfere with the previous image targets, the test is successful.	2021-03-(25 minutes)
1.1	Recognize the Play-Doh container. This will be used as a test if recycling information pops up.	Utilize Unity to recognize the Play-Doh container. The application will have a short description saying what the object is, what the disposal method is, and any other key notes.	If this target is uniquely identifiable with 100% accuracy, it is deemed successful.	2021-03-(5 minutes)
1.2	Recognize the Chunky soup can. This will be used as a test if recycling information pops up.	Utilize Unity to recognize the Chunky soup can. The application will have a short description saying what the object is, what the disposal method is, and any other key notes.	If this target is uniquely identifiable with 100% accuracy, it is deemed successful.	2021-03-(5 minutes)
1.3	Recognize the	Utilize Unity to recognize	If this target is uniquely	2021-03-

	WhiteClaw can. This will be used as a test if recycling information pops up.	the WhiteClaw can. The application will have a short description saying what the object is, what the disposal method is, and any other key notes.	identifiable with 100% accuracy, it is deemed successful.	(5 minutes)
1.4	Recognize the Tums container. This will be used as a test if recycling information pops up.	Utilize Unity to recognize the Tums container. The application will have a short description saying what the object is, what the disposal method is, and any other key notes.	If this target is uniquely identifiable with 100% accuracy, it is deemed successful.	2021-03- (5 minutes)
1.5	Recognize the Rice Krispies box. This will be used as a test if recycling information pops up.	Utilize Unity to recognize the Rice Krispies box. The application will have a short description saying what the object is, what the disposal method is, and any other key notes.	If this target is uniquely identifiable with 100% accuracy, it is deemed successful.	2021-03- (5 minutes)
2	Internal settings menu functionality.	Test every option we implement into the settings menu to see if they function the way they were designed.	Every setting should be independent of one another. Test is deemed successful if any combination of personalized settings is actually executed by the app.	2021-03- (minutes)
2.1	Track rewards function is working.	Turning on or off this setting should allow the user to choose if they want their recycling history kept or not.	Test is deemed successful when the setting for rewards tracking is on it will do so, vice versa for when the setting is off.	2021-03- (10 minutes)
2.2	Test if camera access is functional.	Turning on or off this setting should allow the user to choose if they want their camera to function or not.	Test is deemed successful if the camera does not turn on while the setting is off. If the camera turns on when the setting is on, the camera should be able to turn on.	2021-03- (10 minutes)
2.3	Test if the sound option is functional.	Turning on or off this setting should allow the user to choose if they want sound alerts within	Test is deemed successful when there is sounds on the app if the button is on and no sounds when the	2021-03- (10 minutes)

		the app to be on or off.	button is off.	
3	Information menu functionality.	Information menu displays information such as statistics and recycling calendar.	Test is deemed successful if it displays this information.	2021-03- (20 minutes)
3.1	Verify that the tutorial section of the application is able to play the video and redirect to the FAQ section	Verify that the tutorial video of the application can be played successfully and when the FAQ button is selected, it will redirect to a page with possible application FAQs.	When the tutorial video is played, it can successfully run without delay or issues it is successful. When the FAQ button is selected and it redirects the user to the FAQ page, the test is successful.	2021-03- (10 minutes)
3.2	Verify the recycling day calendar is clicked on and then redirected to the City of Ottawa recycling calendar.	Clicking on the calendar icon in the information menu tab should be able to redirect the user to the City of Ottawa recycling calendar. This has been done because in different areas within Ottawa, there are different recycling schedules.	The test is successful if the calendar icon can be inserted and when redirected, it will go to the City of Ottawa recycling calendar.	2021-03- (10 minutes)
4	Rewards menu functionality	If the GreenAR Leaderboard, shows the scores and rankings of competitors.	When rankings and user's score are displayed, the test is deemed successful.	2021-03- (40 minutes)
4.1	Make sure the rewards are accurately calculated with the amount of recycling that is done (increases by 1 point every time an item is recycled	Test that the user's score is accurate. 1 point represents one item that is recycled into the blue or black bin.	The test is deemed successful if the app automatically adds each item properly to the user's scoring.	2021-03- (20 minutes)
4.2	Make sure the user can login their username and have their information stored in the Dreamlo database.	When the user enters their login information, they will be able to earn points when they recycle.	Test is deemed successful if the login works.	2021-03- (10 minutes)
4.3	Top 5 users' scores	When the user sees the	Test is deemed successful	2021-03-

	will be displayed in the GreenAR Leaderboard.	top 5 user' scores, it is displayed vertically.	if the top 5 user' score is displayed easily and clearly to the user.	(10 minutes)

2.2 Stopping Criteria

The following section is to set stopping criteria for each test objective defined in section 2.1 of this deliverable. Stopping criteria is defined as the criteria that will allow us to end each test we perform for prototype II. Each test will be deemed successful when we are satisfied with the results achieved from our testing objectives.

Test ID	Stopping Criteria
1	If all image targets (1.1, 1.2, 1.3, 1.4, 1.5,) are recognized and the correct information is displayed while presented in random order, we can conclude this test.
2	Internal menu settings functionality is deemed successful when all subtests of TEST ID 2 are successful. Upon clicking each settings menu on or off, the app will be able to follow through with that request. For example, if the sound setting is turned on, the app will have its sound on (ex. Camera flashing sound). When the sound setting is turned off, the app will not have any sound effects. Same goes for all other settings menu options.
3	The information menu functionality is deemed successful if all of the subcategories of Test ID 3 are successful. All information within the information menu must be accurate to the best of our ability. For 3.1, the test can be concluded when the tutorial video can be played successfully 2 times. Between each time the video is played, the application will be closed and reopened. For 3.2, once the user clicks on the calendar icon and it redirects to the City of Ottawa recycling calendar, the test is stopped if it was repeated 3 times successfully.
4	The rewards menu is deemed successful and testing can be stopped if the user's score is properly tracked meaning that 1 point is added to the user's total score each time they analyze an item. Also if the user can see their opponents/competitors and rankings, the test is deemed successful.

2.3 Test Results

Test ID	Test Results
1	It has been concluded that all of the test items have passed the stopping criteria. When putting the Play-Doh container in the camera view, the analyze button pops up and when clicked on, it displays relevant information on a separate page. When putting the Chunky soup, WhiteClaw can, Tums container, and Rice Krispies cereal box in the camera view, the analyze button pops up and when clicked on, it displays information such as what the item is, the method of disposal (blue bin, blue bin, blue bin, black bin, respectively), and other key notes ("rinse before disposing). This was repeated 3 times in random order and the application functioned as desired.

2	All the tests within this section have been completed and successful in achieving the desired results. All of the buttons are present and clickable. Due to the limited time constraint, we were only able to implement three settings, which are track rewards, allow camera access, and allow sounds. The sounds button worked as whenever the camera shutter button was clicked, it would make a shutter sound. When the sound button was turned off, the sound would not work anymore. As a result, this was successful.
3	In the information menu, for the Frequently Asked Questions (FAQs), there are 5 commonly asked questions with their corresponding answers. The user will be able to locate this page with ease. Furthermore, the tutorial video on how to use the application was inserted and successful. For the recycling calendar, the test was deemed successful as when the calendar icon was clicked on, it redirects the user to the City of Ottawa recycling calendar page.
4	When testing the functionality of the rewards menu, all the tests performed were successful. Everytime the user recycles an item, they can click the recycling button to collect their 1 point. It will be displayed in the GreenAR Leaderboard. The test for the user to login into the app and accumulate their points works well. In the GreenAR Leaderboard, the top 5 scores can be viewed easily and is aesthetically pleasing. The rewards menu is simple and easy to navigate.

3 Prototype III

3.1 Analysis Strategy

Prototype II gave us a grandeur idea of what is needed to be added or modified for Prototype III. Prototype II allowed us to receive feedback about our first implementations of our several new screens, as well as feedback surrounding the user-friendliness and the UI design. A similar analysis strategy was used as with prototype I. Main design/feature changes were identified and compiled into a listing that we have completed for Prototype III. Within this listing, full implementation of all screens were completed, alongside slightly tweaking the design aspects to improve the overall aesthetics.

3.2 Improvements made from Prototype II

1. From prototype II, more image targets were incorporated into the application. We are now able to detect more items with the image recognition. We are looking into using AI or reverse image search to be able to recognize recyclable objects. This is to have a wider variety of image detection. Due to time constraints, we may not be able to implement this.
2. The overall aesthetics of the application was improved.
    a. Our application is consistent in its simple recycle based colour scheme and design.
    b. All button icons indicate a clear meaning while maintaining simplicity.
3. The internal settings menu was updated during this prototype. For this menu, we have decided to keep 3 settings menu which are tracking rewards, allowing camera access, and allowing sound. The other settings menu that were created in prototype II have been taken out as due to the time constraint, it is not feasible for us to complete this and given our limited resources.
4. We were able to add clickable on/off toggles for each setting we want to incorporate. So far, the settings that are functional are the 'sound' option, allowing camera access, and the tracking rewards.

5. The user is able to navigate the information menu with a sliding motion. During this prototype, we have added the tutorial section of the application along with a video. We also added a FAQ section as well as a garbage disposal calendar section.
6. The rewards menu was implemented in this prototype and we were able to complete this using Dreamlo. Every time a user clicks the "I Recycled" button, 1 point will be accumulated to the total amount of points the user has already accumulated. The user can view their score along their competitors on the GreenAR Leaderboard. The user will be able to view the top 5 users.

3.3 Analytical/Numerical/Experimental Model

Though both the analytical and numerical model are inapplicable in this scenario, the experimental model route was taken with such model being Prototype II. Prototype II testing allowed the team to derive any possible shortcomings or bugs that needed to be addressed, along with what kind of features/design elements were needed to be implemented for Prototype III. From the experimental model, some examples of shortcomings that were in need of improvement were the writing style used in some of the identification panels, the completion of all panels within the information menu, reduction of settings menu to pertain to what the app requires in terms of options, and lastly, the completion of the rewards menu. Overall, the use of an experimental model as our Prototype II proved to be effective in aiding in the analysis which in turn much improved the outcome of Prototype III.
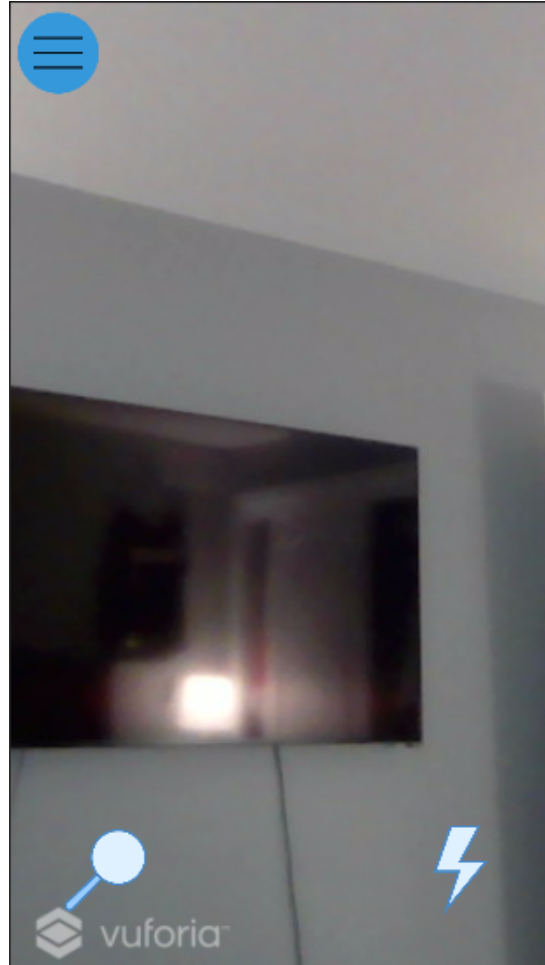
3.4 Prototype III Description and Screenshots

Figure #1: Screenshot of Introduction Screen

Description:

In Figure #1, we have created an introduction screen on Unity. This screen includes our application logo, the application slogan, and a physical start button that the user will have to press on in order to proceed to the main screen.

Figure #2: Screenshot of Main Screen with No Object in Camera's view

Description:
Figure #2 shows a screenshot of what the main screen looks like before any recyclable items are detected in its camera view. The bottom right features a flash toggle. If an object cannot be recognized, the flash toggle can be used to help the camera of a mobile device get a better view of an object. The bottom left of the screen has a search button. In Prototype I, when the search button is selected, the application will redirect to the City of Ottawa regular waste disposal practice website. In this prototype, it includes cosmetic improvements from prototype II.

Figure #3: Screenshot of Play-Doh Image Target in Main Screen with Analyze button

Description:
Figure #3 demonstrates the Play-Doh container displayed in the camera's view before the analyze button is selected.

Figure #4: Screenshot of Play-Doh Image Target Displaying Corresponding Recycling Information (Redirected from Main Screen)

Description:
Figure #4 demonstrates the information displayed after the analyze button is selected. In this example of the Play-Doh container, it displays the name of the item, disposal method, and reminding the user to rinse the item before disposal. Alongside this shows an icon that represents where to dispose of these items. In this case, the disposal method is the garbage so it shows an icon of the garbage. At the bottom of the screen, it displays how many points were earned by this recycle. We have also implemented a "I Recycled!" clickable button. Upon clicking this button, the user is redirected to the main screen.

Figure #5: Screenshot of Chunky Soup Can Image Target in Main Screen with Analyze button

Description:
Figure #5 demonstrates the Chunky Soup can displayed in the camera's view before the analyze button is selected.

Figure #6: Screenshot of Chunky Soup Can Image Target Displaying Corresponding Recycling Information
(Redirected from Main Screen)

Description:

Figure #6 demonstrates the information displayed after the analyze button is selected. In this example of the Chunky Soup Can, it displays the name of the item, disposal method, and reminding the user to rinse the item before disposal. Alongside this shows an icon that represents where to dispose of these items. In this case, the disposal method is the blue bin so it shows an icon of the blue bin. At the bottom of the screen, it displays how many points were earned by this recycle. We have also implemented a "I Recycled!" clickable button. Upon clicking this button, the user is redirected to the main screen.

Figure #7: Screenshot of White Claw Can Image Target in Main Screen with Analyze button

Description:
Figure #7 demonstrates the White Claw can displayed in the camera's view before the analyze button is selected.

Figure #8: Screenshot of White Claw Can Image Target Displaying Corresponding Recycling Information
(Redirected from Main Screen)

Description:
Figure #8 demonstrates the information displayed after the analyze button is selected. In this example of the White Claw Can, it displays the name of the item, disposal method, and reminding the user to rinse the item before disposal. Alongside this shows an icon that represents where to dispose of these items. In this case, the disposal method is the blue bin so it shows an icon of the blue bin. At the bottom of the screen, it displays how many points were earned by this recycle. We have also implemented a "I Recycled!" clickable button. Upon clicking this button, the user is redirected to the main screen.

Figure #9: Screenshot of Tums container Image Target in Main Screen with Analyze button

Description:
Figure #9 demonstrates the Tums container displayed in the camera's view before the analyze button is selected.

Figure #10: Screenshot of Tums container Image Target Displaying Corresponding Recycling Information
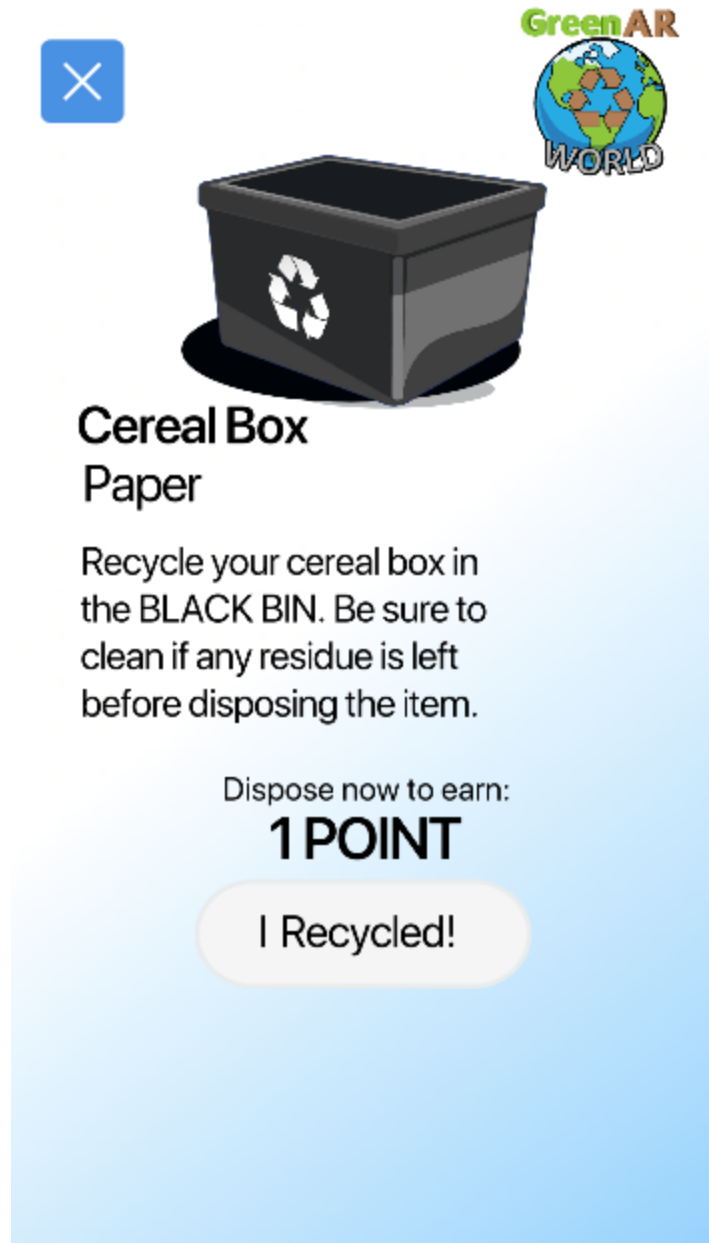**(Redirected from Main Screen)**

Description:
Figure #10 demonstrates the information displayed after the analyze button is selected. In this example of the Tums container, it displays the name of the item and disposal method. Alongside this shows an icon that represents where to dispose of these items. In this case, the disposal method is the garbage so it shows an icon of the garbage bin. At the bottom of the screen, it displays how many points were earned by this recycle. We have also implemented a "I Recycled!" clickable button. Upon clicking this button, the user is redirected to the main screen.

Figure #11: Screenshot of Rice Krispies Box Image Target in Main Screen with Analyze button

Description:
Figure #11 demonstrates the Rice Krispies cereal box displayed in the camera's view before the analyze button is selected.

Figure #12: Screenshot of Rice Krispies Box Image Target Displaying Corresponding Recycling Information (Redirected from Main Screen)
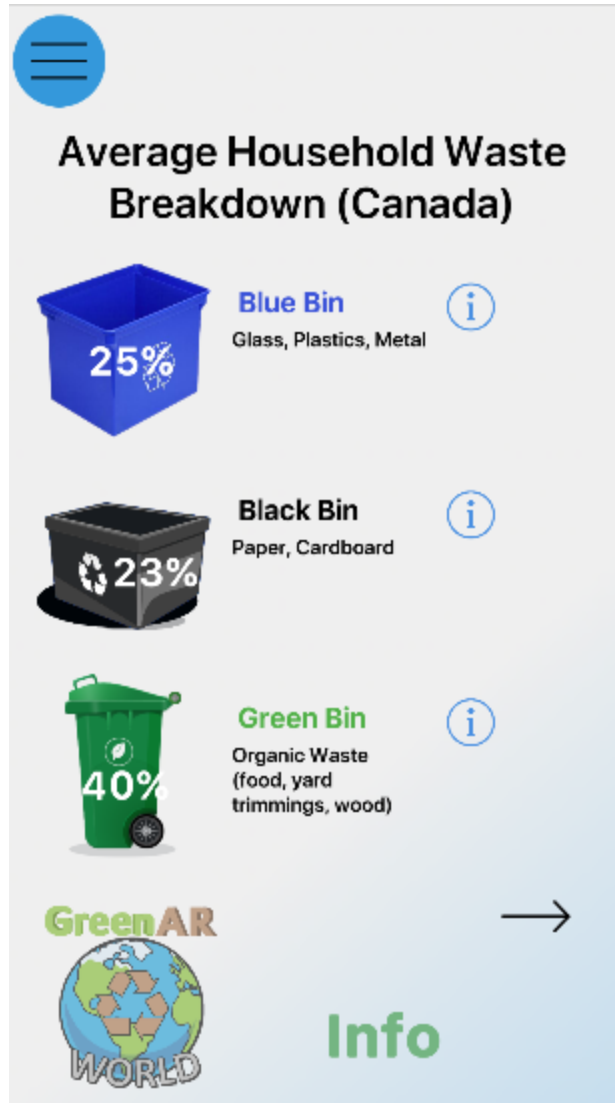
Description:
Figure #12 demonstrates the information displayed after the analyze button is selected. In this example of the Rice Krispies Cereal Box, it displays the name of the item, disposal method, and reminding the user to rinse the item before disposal. Alongside this shows an icon that represents where to dispose of these items. In this case, the disposal method is the black bin so it shows an icon of the black bin. At the bottom of the screen, it displays how many points were earned by this recycle. We have also implemented a "I Recycled!" clickable button. Upon clicking this button, the user is redirected to the main screen.
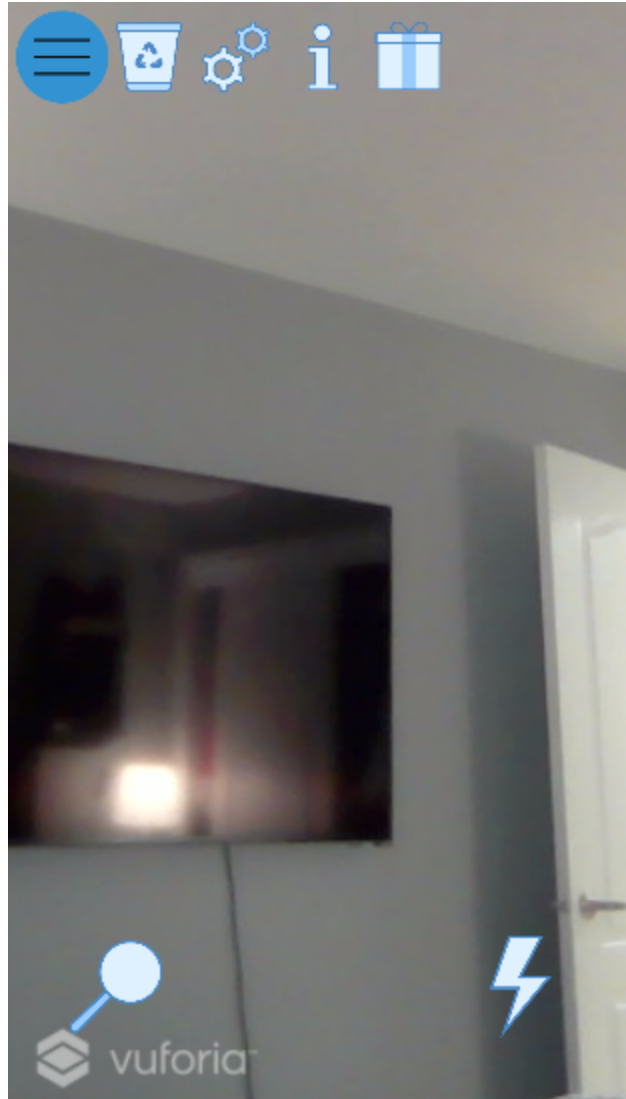
Figure #13: Screenshot of Main Screen with Collapsible Menu Opened
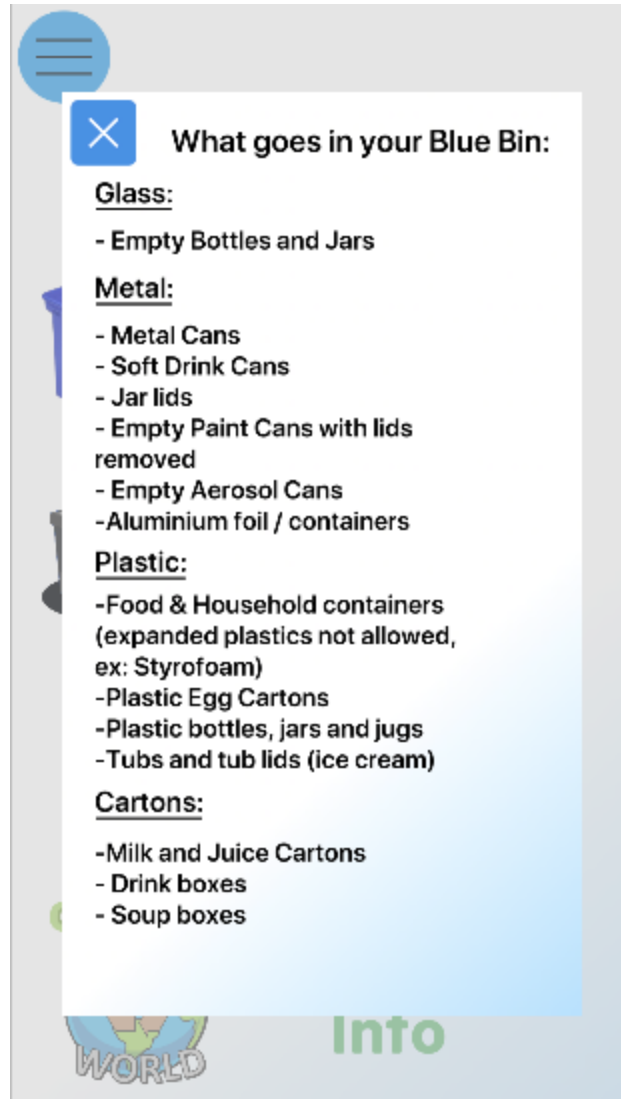
Description:
Figure #13 demonstrates the camera view with a collapsible menu located at the top left of the screen. These setting icons going from left to right are recycling icon, internal settings icon, information menu icon, and the reward menu icon.

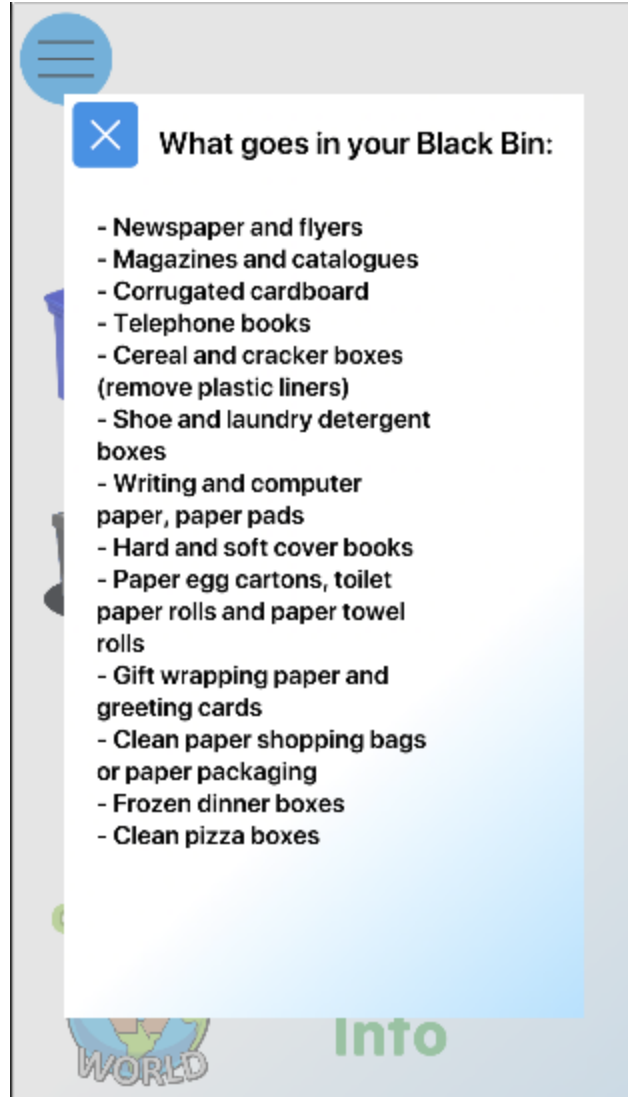**Figure #14: Screenshot of Information Menu (Page 1)**

Description:
Figure #14 demonstrates the first page of the information menu. This page shows statistics about the average household waste breakdown in Canada. This page displays the percentage of blue bin waste, black bin waste and green bin waste produced by a Canadian household. Beneath each bin is a brief description of what items can be recycled in each disposal bin.

Figure #15: Screenshot of Information Menu (Page 1.1)

Description:
Figure #15 demonstrates the first page of the information menu after the "i" button is selected beside the blue bin. It expands upon some examples of items that can be disposed of in the blue bin.
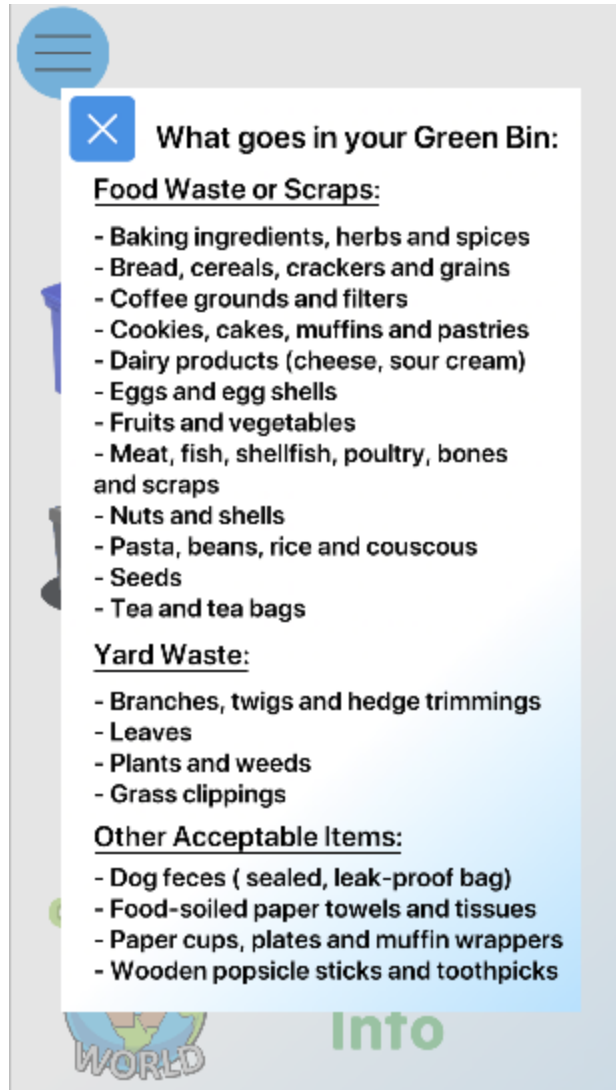
Figure #16: Screenshot of Information Menu (Page 1.2)

Description:
Figure #16 demonstrates the first page of the information menu after the "i" button is selected beside the blackbin. It expands upon some examples of items that can be disposed of in the black bin.
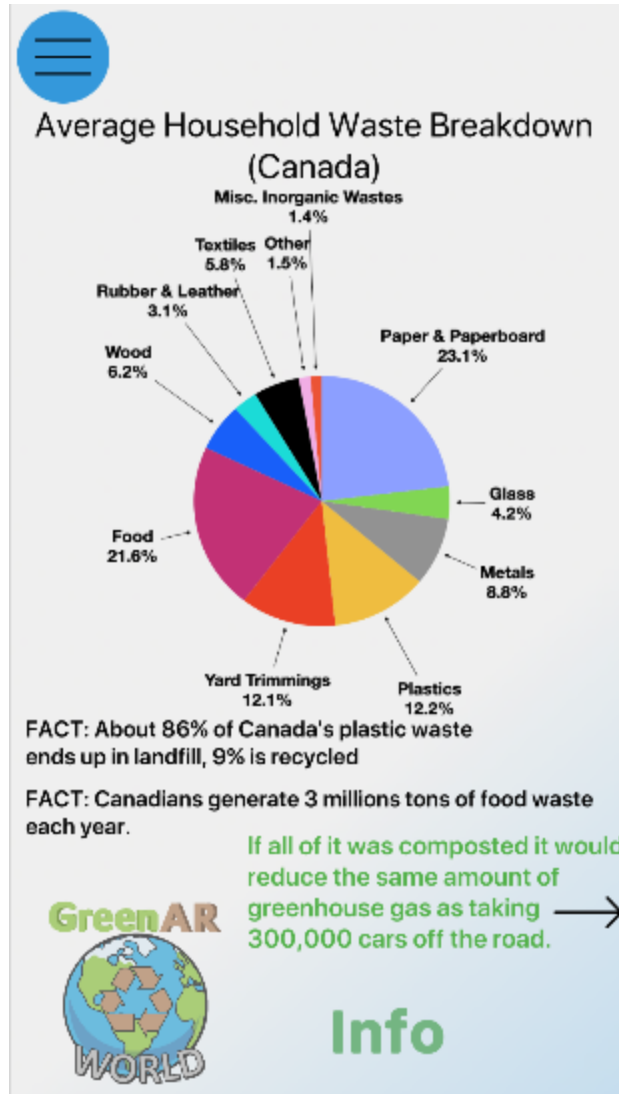
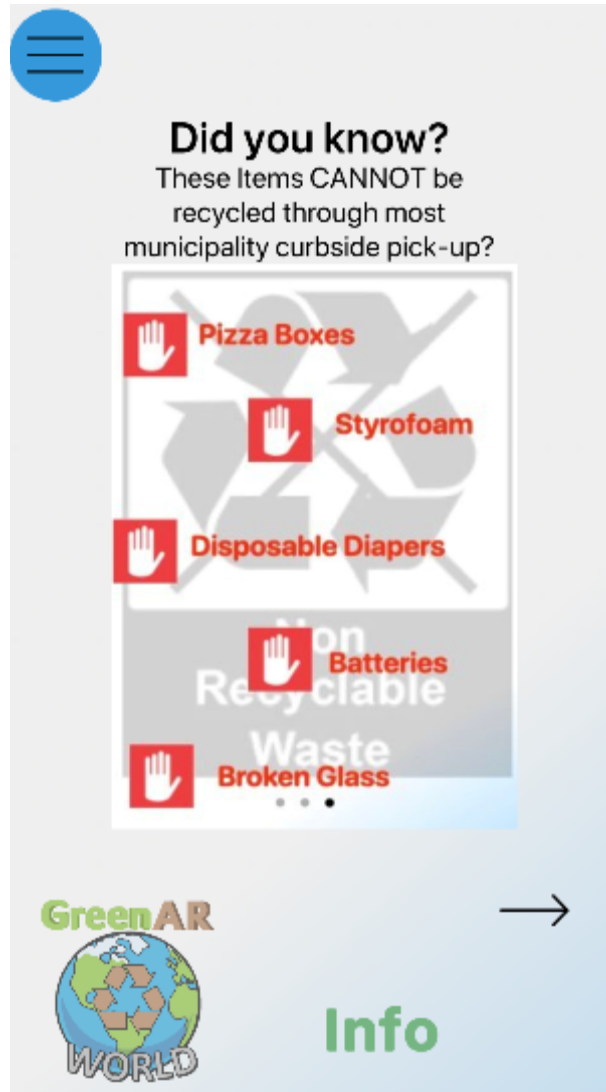**Figure #17: Screenshot of Information Menu (Page 1.3)**

Description:
Figure #17 demonstrates the first page of the information menu after the "i" button is selected beside the green bin. It expands upon some examples of items that can be disposed of in the green bin.

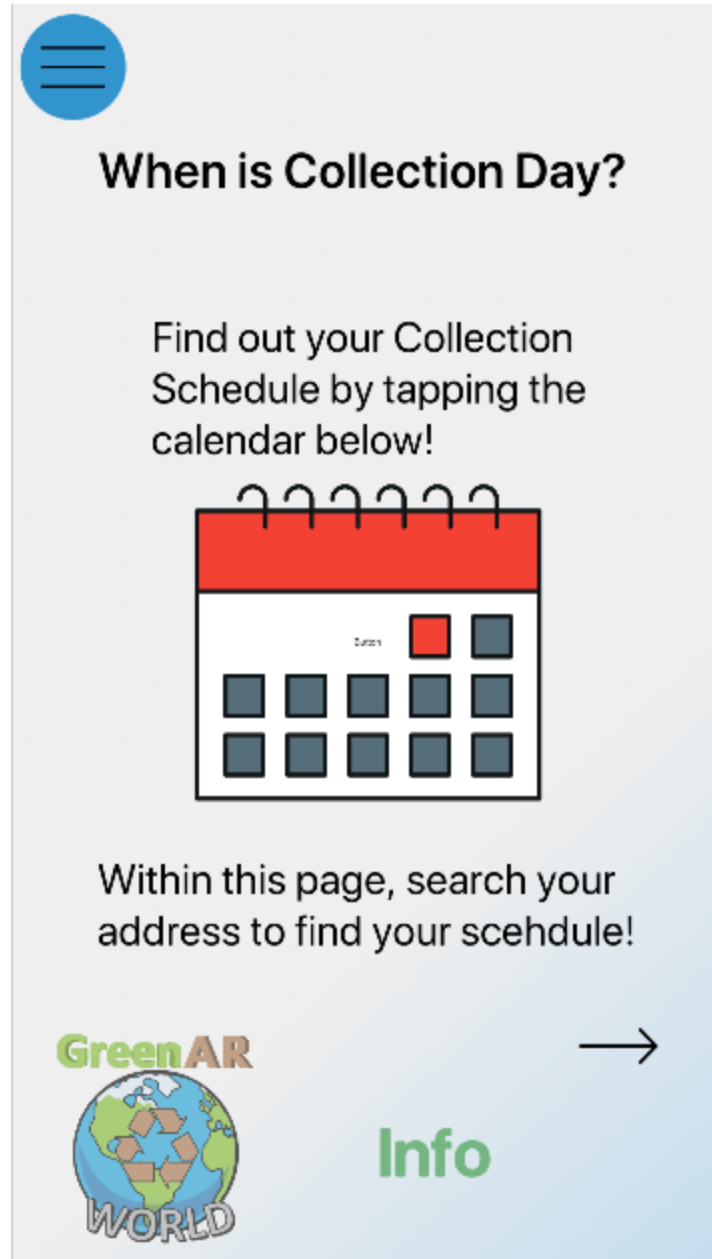**Figure #18: Screenshot of Information Menu (Page 2)**

Description:

Figure #18 demonstrates the second page of the information menu. To navigate to this page from page 1, users can use a swiping motion to the left. This page shows more in depth statistics of the average household waste breakdown in Canada by utilizing a pie chart. Beneath the pie chart shows various facts about recycling. This information is included in hope of getting users to realize the importance of recycling.

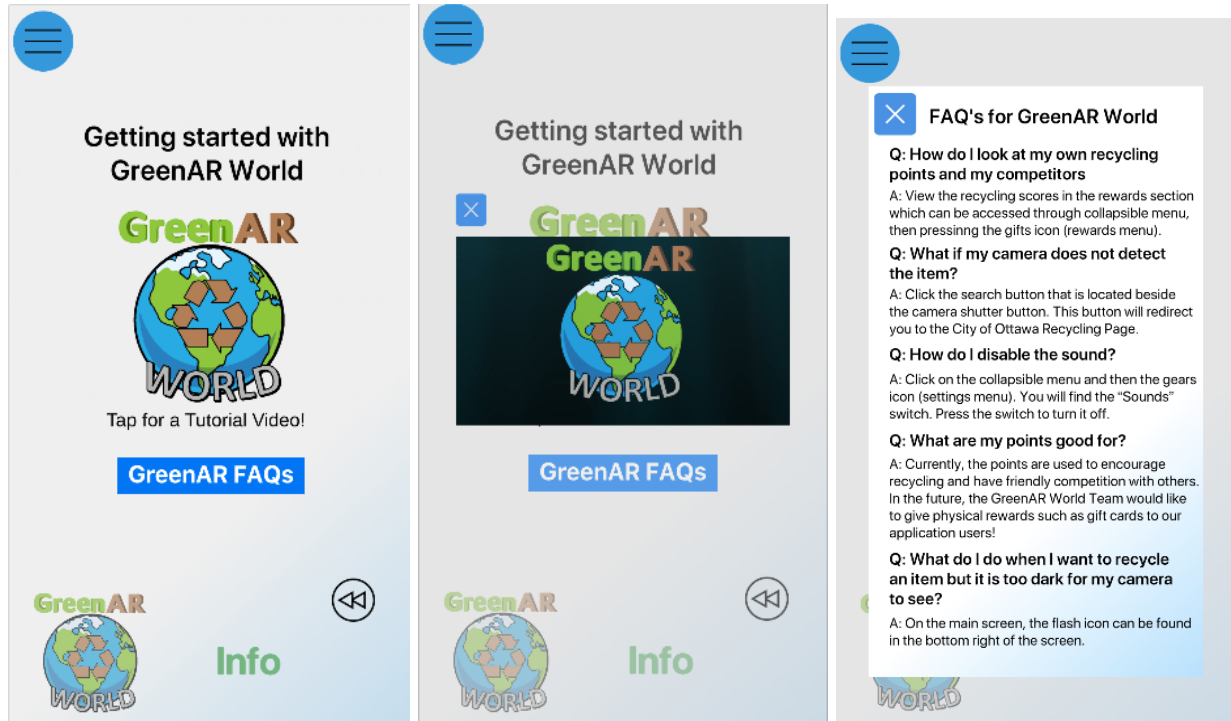**Figure #19: Screenshot of Information Menu (Page 3)**

Description:
Figure #19 demonstrates the third page of the information menu. To navigate to this page from page 2, users can use a swiping motion to the left. This screen displays information about items that cannot be recycled through municipality curbside pick up. We hope to add more information or a redirect on how these items can be properly disposed of in the future prototype.

**Figure #20: Screenshot of Information Menu (Page 4)**

Description:
Figure #20 demonstrates the fourth page of the information menu. To navigate to this page from page 3, users can use a swiping motion to the left. This screen displays a clickable calendar where upon clicking, will redirect the user to the City of Ottawa recycle calendar website. Here, users can input their address and retrieve the correct recycling schedule for their area.

**Figure #21: Screenshot of Information Menu (Page 5)**

Description:
Figure #21 demonstrates the fifth page of the information menu. To navigate to this page from page 4, users can use a swiping motion to the left. This screen shows a tutorial video where users will be walked through how to utilize the GreenAR World app. To open the tutorial video, users will have to click on the GreenAR World logo in the middle of the screen. The first screenshot represents the app before the logo is selected. The second screenshot represents the app after the logo is selected. The video will begin to play. This page will also have a FAQ section where the most commonly asked questions and answers are displayed. The FAQ section is shown in the third screenshot.
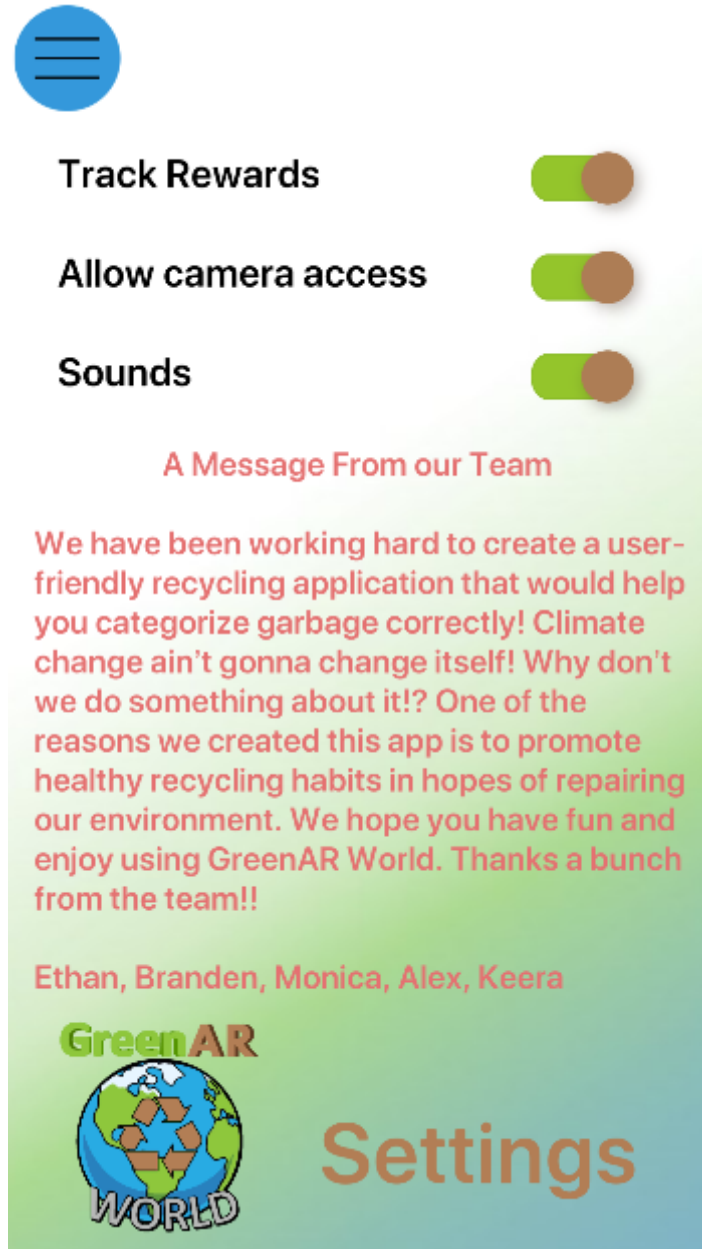
Figure #22: Screenshot of Settings Menu

Description:
Figure #22 demonstrates our settings menu. It displays 3 clickable settings menus that are fully functional. These settings are the track rewards option, allow camera access option, and the sound option. When these settings are turned on or off, the settings should function accordingly. At the bottom of the settings menu, there is a brief message from our team. This message describes why we created this application and that we appreciate the user for helping us reach our goal or better recycling habits.
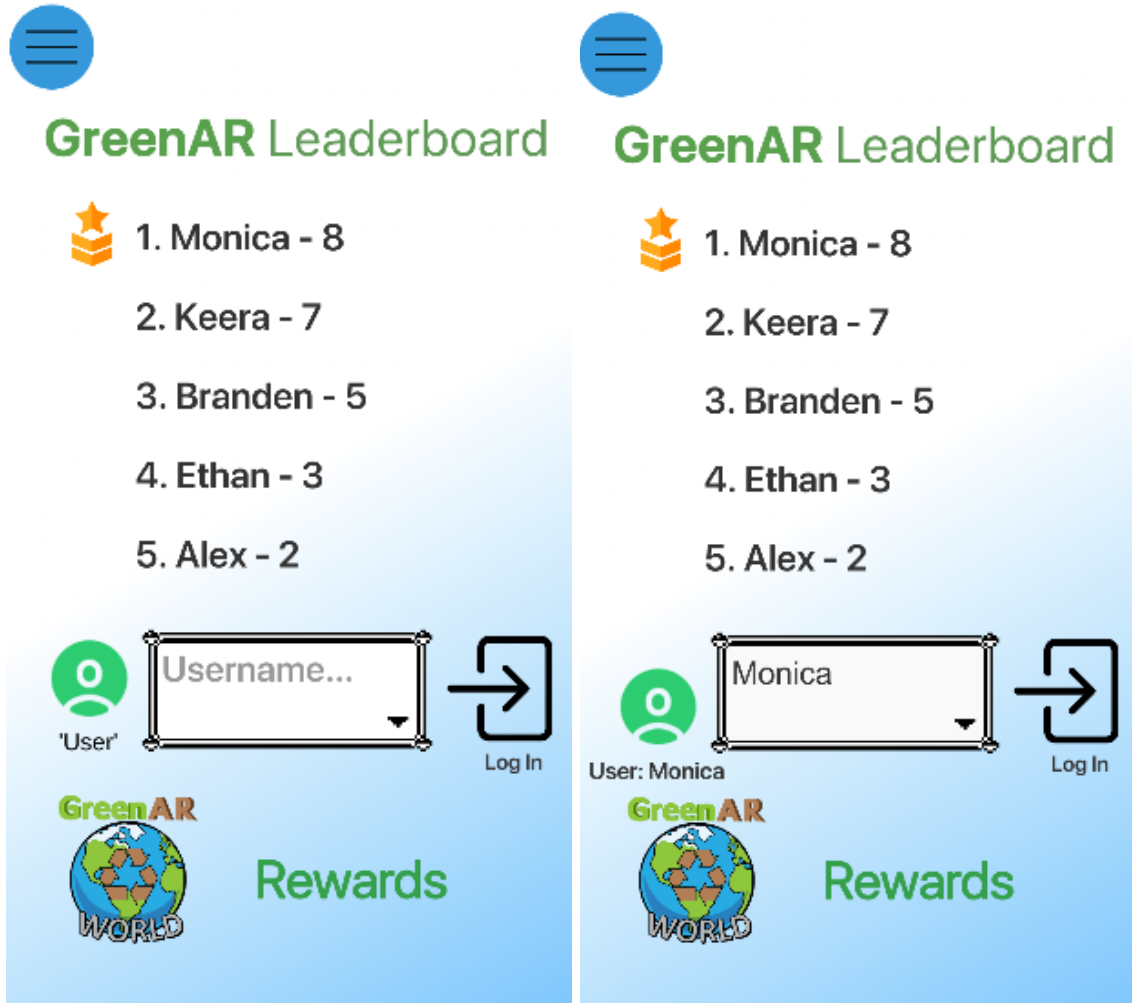
Figure #23: Screenshot of Rewards Menu

Description:
Figure #23 demonstrates a visual representation of our GreenAR Leaderboard which will be used to track the user's scores and their added competitors. Once a user logs in and starts scanning items, their points will accumulate accordingly. To sign in, enter your user name into the username section then click the login button. You will know that you are in the correct profile when under the green user button, your username appears. The other competitors will be organized and ranked based on their scores. The difference between both screenshots is entering the username.

4 Feedback and Comments from Potential Users

All test subjects prefer to be anonymous in their feedback/comments and do not want their name mentioned in our deliverable. Therefore, we have put in all feedback and comments we received and organized them by test subject number. All feedback and comments will be quotation based and will describe as close as possible to what was actually said. We have interviewed a wide variety of people including family members, friends and neighbours. We are unable to interview strangers since we are

currently working remotely. We have received feedback through email, text, social media, phone call and in person for Prototype III.

Test Subject	Feedback/Comments
1	"The additions made to the settings screen are very helpful. Compared to your previous version, it's a lot easier to navigate through the settings and turn certain functions on/off. I also really like the rewards screen that's added, and I feel like others will to."
2	"It's amazing how fast the scanning screen can identify items and give information back related to it. I can also see the schedule that lets the user know when their garbage day is helping out a lot of people, especially myself. Not too sure how the rewards will work but I still like the idea."
3	"The application looks a lot neater compared to your previous prototype. Being able to scroll through the screens by sliding is also a great new feature. I noticed how the scan button is different too and it looks a lot better. I also noticed how there's a user leaderboard implemented in the application and I think it's an amazing idea."
4	"The aesthetics of the application are looking amazing, especially compared to the previous version I used. The blue gradient in the background is simple but easy to look at and I love the logos that were used to represent the settings, information and rewards screen. On top of the application looking nice, it functions really well and is really accurate when scanning items."
5	"Compared to last time I used this app it feels a lot more organized and complete. Being able to see your neighbourhood's garbage day is very helpful as well as the information screen. I can already tell this application will help many people properly recycle as it already taught me a few things i didn't know. The screens transition smoothly and the fact the functionalities are extremely easy to use, I can see people using this app daily."
6	"Scanning items with the application is so easy. Not only does it tell you where to recycle it, I like how it displays what material it is and how it should be cleaned or rinsed before recycling it. The points system that's added is a neat idea and think it could help get kids recycling too while teaching them how to properly do it."
7	"The simplicity of the app and how accurate it is when scanning items makes this application a great addition to my phone. I love instead of having to search up on the internet how to recycle certain items I can just pull out this application and get my answer within seconds. I'm not entirely sure if a points system was needed for an application of this type, but either way it's a unique addition."
8	"The layout is easy to follow and simple for your average user to use. Also, I like how many settings options that were added such as the ability to turn sound on or off, as well as being able to turn the points system off. Due to this application being very simple and easy to use, I can see many people downloading an application like this."

5 Plans for Finished Product Based on Prototype III Results

Almost all the main components of our original design have been fully implemented in prototype 3. With that being said, our team is working towards continuing to improve upon the existing features and enhance the overall app experience for the user. The final product will build upon the current rewards menu framework by including additional features such as a recycling history in which the user can view a comprehensive list of each item scanned in the app. The user will also have the ability to sort the rewards menu by rank based on points or household. When developing prototype 3, our team faced challenges in setting up household competitions with the Unity software. Presently, the GreenAR leaderboard is powered by Dreamlo, however, we believe this feature is an important tool to incentivize recycling and encourage individuals to use the app, therefore we will explore other avenues to program this feature into the final product.

The final product will also include a tutorial video on info page #5 and a completed FAQ section. Furthermore, we plan to continue increasing the image targets within the app using more advanced AR and/or AI technology. The current system of manually inputting each item is severely limiting the scope of the app. For GreenAR World to be successful and fully meet the needs outlined by the client, it must be able to identify an extremely wide range of household items (95%+) much larger than its current capacity.

The settings menu also represents an opportunity for further improvement. Our team hopes to incorporate geo-mapping into future iterations of the GreenAR World app, as well as the ability to have municipality specific results for the analyze and sorting functionality. This is currently beyond the scope of our programming capabilities and relatively limited knowledge of the Unity software.

Lastly, our team would like to implement a physical reward system that coincides with the leaderboard ranking in which the user can win a physical prize such as a gift card or a small gift if they are the top recycler for the week, month or year. Of course, this feature would be dependent upon the availability of further funding as it would be outside of the current $100 budget.

6 Conclusion

In conclusion our team has developed our third prototype and improved many features within our application based on feedback provided from protype 2. Our team increased the accuracy and number of items that the application can identify as well as the overall aesthetics of the app. A rewards screen was also added along with more settings that can be toggled on or off. With this prototype, tests were performed and feedback was collected. Moving forward our team will review the feedback that was given and make necessary adjustments that are needed before presenting our final project

7 Wrike

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=9jinhmspKChuDqz2p4CS8tmlfh4xK8jm%7CIE2DGNJVGY3DALSTGE3A