

User and Product Manual Instructions

This document is a user and product manual. The client or future developers use this document to operate, maintain or reproduce the product.

GNG1103
Design Project User and Product Manual

Sort It!

Submitted by:

Sort It Industries, Group 4

Daniel Deiros Hernandez, 300166389

Kayla Bariteau, 300172515

Ammar Shakir, 300173683

Sydney Vanderburg, 300185690

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University of Ottawa

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
AR	Augmented Reality
VR	Virtual Reality
VS	Visual Studio

1 Introduction

This User and Product Manual (UPM) provides the information necessary for common users and future developers to use the application Spot It! effectively and for prototype documentation.

This document has been separated into multiple sections for another individual to easily access critical details to implement the same model as we have established—the beginning section details what future users will require to use the system.

Essentially, we constructed a blueprint and the fundamental basis for our application for potential users. The following section outline shows the use of the primary system and all of the adjacent subsystems.

An additional section breaks down the user's steps to utilize the application to its fullest potential. If the user or the client runs into any issues regarding our application's operation, this is the section they will be required to look up.

In terms of how to maintain the application along with how to optimize the performance of it will be detailed in the following section. As this is a technological product, there are troubleshooting and bug fixes that the client or reproducer should know.

The following section discusses all of the product documentation, including all required materials and the costs, and a comprehensive list of instructions.

The last section details the avenues for future work if teams or the client themselves would aim to implement these components.

2 Overview

Growing landfills are a huge problem in our country. It is estimated that Ontario will run out of landfill space within the next decade (“Opinion | Ontario Must Face up to Its Looming Waste Crisis”). Currently, only 8 percent of waste generated in Ontario is diverted to blue bin programs, and 92 percent of waste still ends up in landfills (“Opinion | Ontario Must Face up to Its Looming Waste Crisis”).

This 8 percent could see a drastic increase if users started correctly and reliably sorting their items into the correct waste bin. Canadians tend to recycle just 9 percent of the things that are designated recyclable (comms).

There is a fundamental need for citizens to organize their recyclable materials in the most straightforward possible manner such that recycling bins are used correctly, and waste in landfills is drastically reduced.

Our product differs from those that are already on the market as it uses a combination of AR technology to assist users in sorting their recyclable items into their correct bins and a game-like feature that will entice users to continue to use the application as well as allow them to learn independently about recycling.

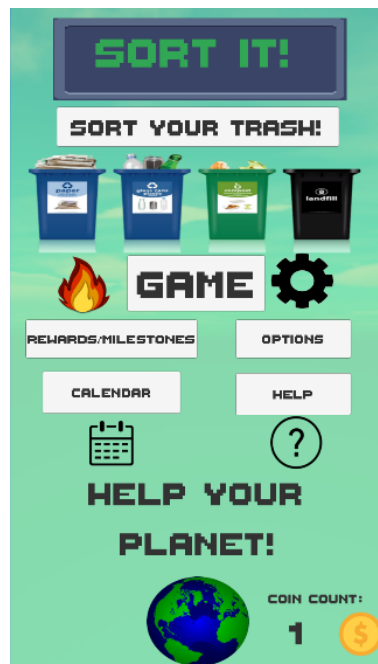


Figure 1.1. Final Prototype Picture

2.1.1 The Home Page

The home page is what will open up when the user first opens the app. It will have a background and the app name, as well as a few buttons. The different buttons will bring the user to the various pages. The most prominent button is the “Sort It!” button to go to

the scanning page. There is also a button for the rewards page, the game page, the calendar page, the options page and the help page. The background can be a custom one, which can be unlocked. The rewards market/ Achievements section will go further in-depth.

2.1.2 Scanning Page

The sorting page is the main page of the app. It is where the scanning and the mini happen. The user will first open the app to scan their objects. Once the item is scanned, the app will render the words “black” or “blue” over the top. The user then has the correct bin to place their item in and can exit to the main screen or continue scanning.

2.1.3 Game Page

This page features an interactive game where users can drag items to sort them into the correct bin to gain rewards points, which they can then claim in the rewards market.

2.1.4 Calendar

The calendar will inform the user of the dates when recycling is being collected in their city/area. The user will manually input their location, and the application will automatically collect data regarding their city’s recycling policies. Furthermore, the user can manually input the dates that they deem necessary, and the app can remind them of those too.

2.1.5 Rewards Market

In the rewards market, the user will be able to purchase colourful backgrounds for the home page and the game. Also, the user will be able to see their achievements they’ve gained for successive daily logins (streaks) as well as their total scans to date.

2.1.6 Options

Here, the user will adjust some simple settings such as volume control and address to optimize the users’ app experience.

2.1.7 Help

This page features buttons that will lead users to information about the central functioning of each page.

2.2 Cautions & Warnings

Warning! This application requires a functional camera and can not be used to its full extent without one.

3 Getting started

When you first open the game, you'll be presented with the progressive daily reward pop-up. This reward gives you coins depending on how many days in a row you've logged in, with the maximum being 7. Refer to **Figure 2.1**.

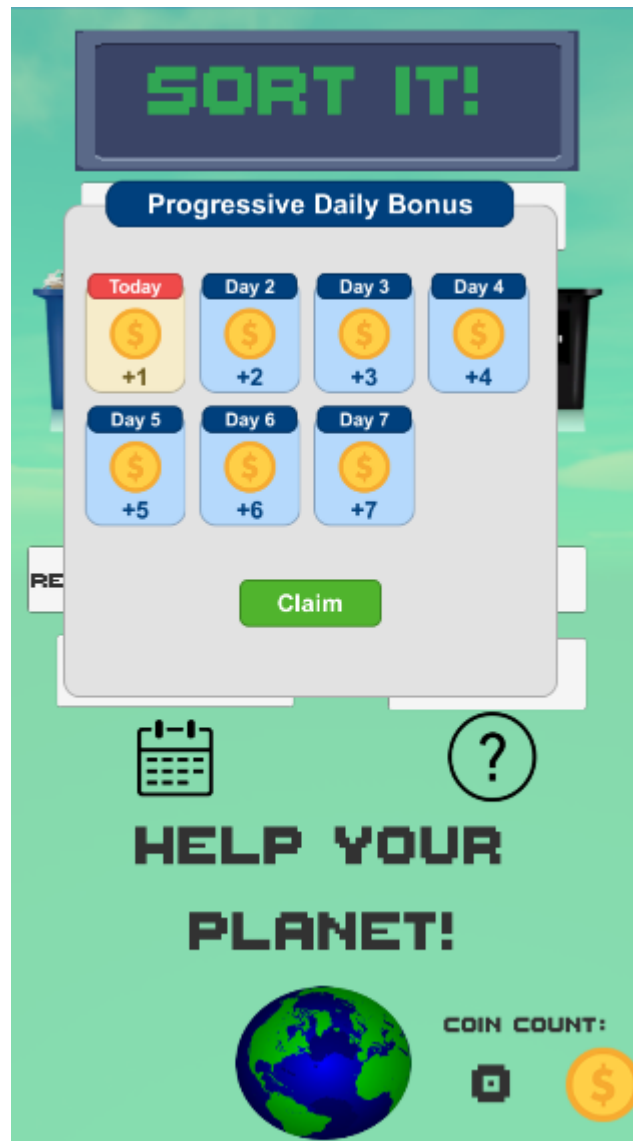


Figure 2.1: Progressive Daily Reward Pop-up

Once you exit the pop-up, you'll be introduced to the home screen. There are many buttons here, but it's very simplistic. At the top of the screen, you'll see a button where you can sort your trash. This will bring you to Vuforia AR (Augmented Reality), and your camera will turn on, and you scan your trash. Each button will be discussed more in-depth further along with the manual. You should also see a big GAME button in the middle of the screen. Here, you can play simple games which improve your understanding of where items should be placed. You also earn coins, which will be discussed in more detail later. Under the game button, you'll see four

more buttons. The Rewards/Milestones button brings you to a page where you can spend your coins, as well as see if you have picked up any milestones along the way. You receive coins depending on how impressive your milestone is. You'll see two input boxes on the options page where you can enter your name and address. These will be used for the calendar button. If you haven't noticed yet, there is music in the background. You can turn this music down in the options menu. In the calendar, you'll see your city's recycling schedule. The help button will allow the user to choose from Game Page Info, Rewards Page Info, and Calendar Page Info, where a short description of each will be given. In the bottom right menu of the home screen, rewards page, and game, you'll see your live coin count in the bottom right. Refer to **Figure 2.2** to see the home page.

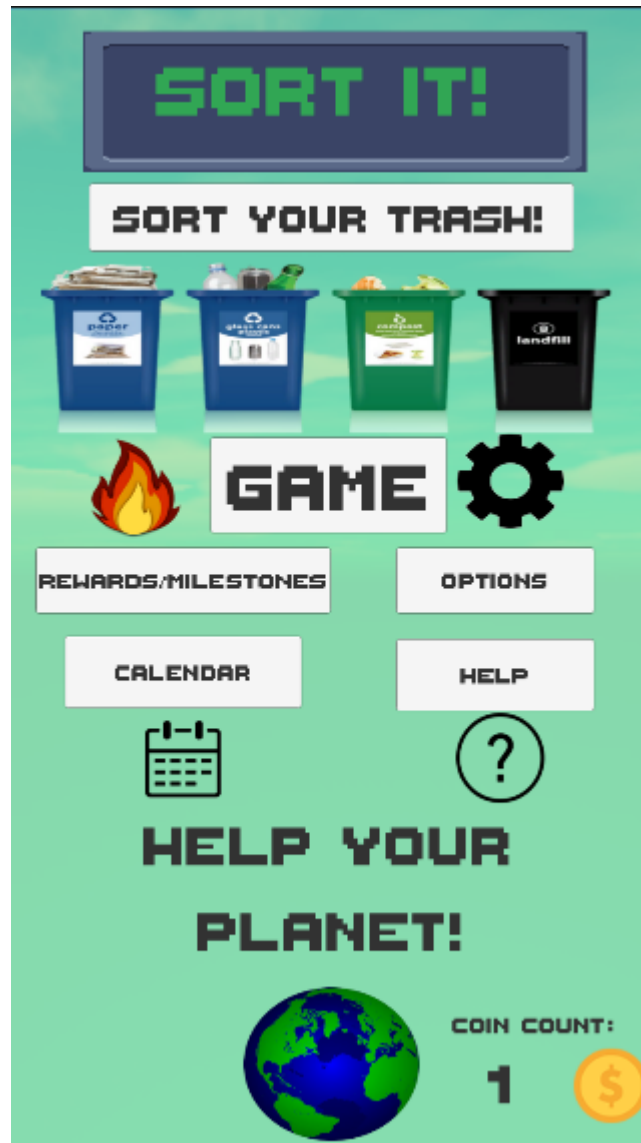


Figure 2.2: Home Screen

Let's get more in-depth with each button now. First, we'll start with the AR Sorting. Simply show a piece of trash to the camera, and the program will acknowledge the item and inform you whether it is a blue bin or a black bin. Refer to **Figure 2.3** to see an example.



Figure 2.3: An Example of the AR Sorting

For every image you scan, you gain a coin. Once you're done scanning all the objects you want, you will see a button on the top of the screen, which will bring you back to the main menu.

Let's look at the game next. Here, you will be directed to sort items of trash into the correct bin. Until you place the item in the right bin, the item will continuously go back to its starting location. When you place the object in the correct container, you'll gain a coin. You can advance levels at any point. Refer to **Figure 2.4** to see the level of the game completed.

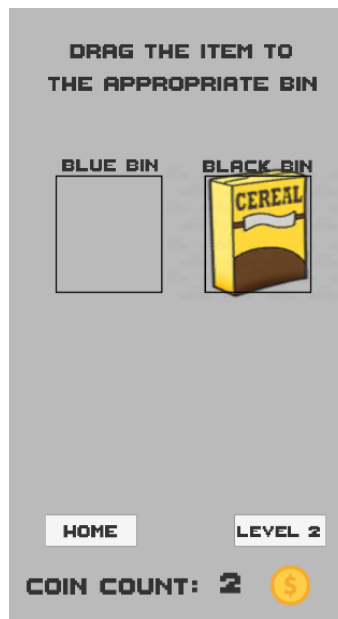


Figure 2.4: Level 1 Completed

Now let's understand the Rewards/Milestones page. Once you have enough coins, you can purchase home screen backgrounds. There are currently three backgrounds to choose from: red, blue, and purple, which cost ten coins, 20 coins, and 50 coins, respectively. The buttons to buy the

backgrounds will be locked until you have enough coins. Refer to **Figures 2.5, 2.6, 2.7 and 2.8** to see how a user can go about buying a new home screen colour.



Figure 2.5: Rewards Page before having enough coins



Figure 2.6: Rewards Page after having enough coins



Figure 2.7 Rewards page after purchasing and equipping purple.

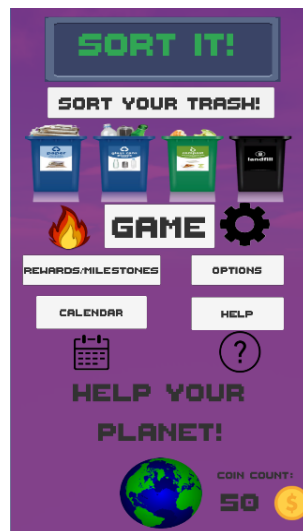


Figure 2.8: Home Screen after purchasing purple background

Also on the rewards/milestones page are the milestones. These show up after you scan a certain number of images. For each milestone, you will receive coins equivalent to the images you scanned. For example, five images scanned means five coins (apart from the coins you receive individually from scanning images). Refer to **Figure 2.9** to see the rewards page after collecting a milestone.

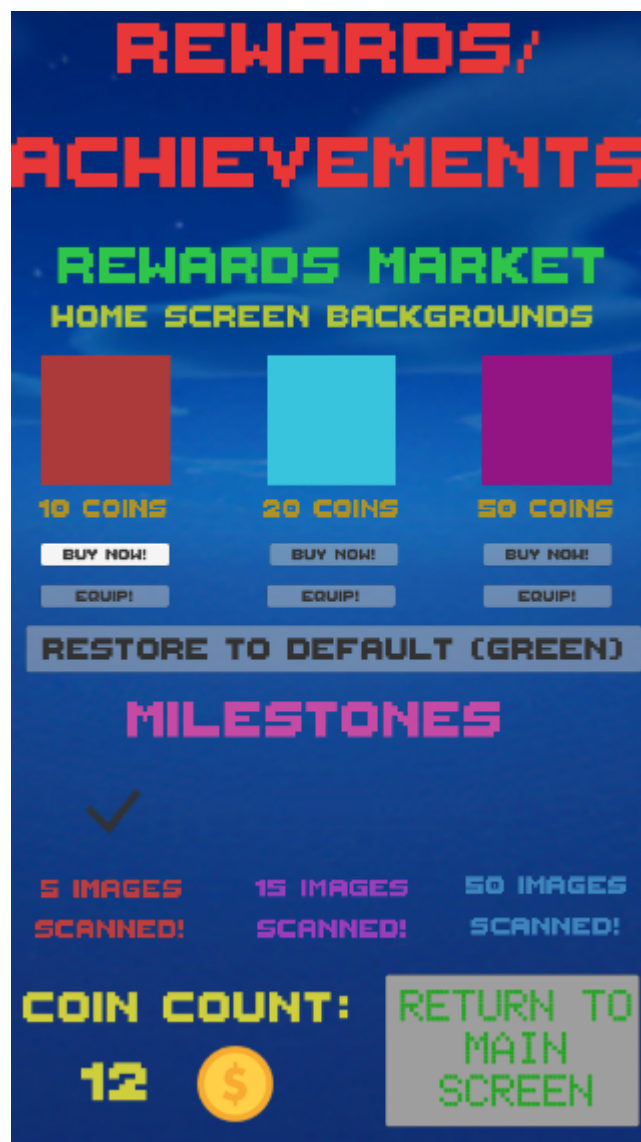


Figure 2.9: Rewards/Milestones Page after collecting a milestone

On the options page, you can enter your name and address to be used in the calendar. You can also edit the volume of the music. Remember to save your changes. Refer to **Figure 2.10** to see an edited options page.

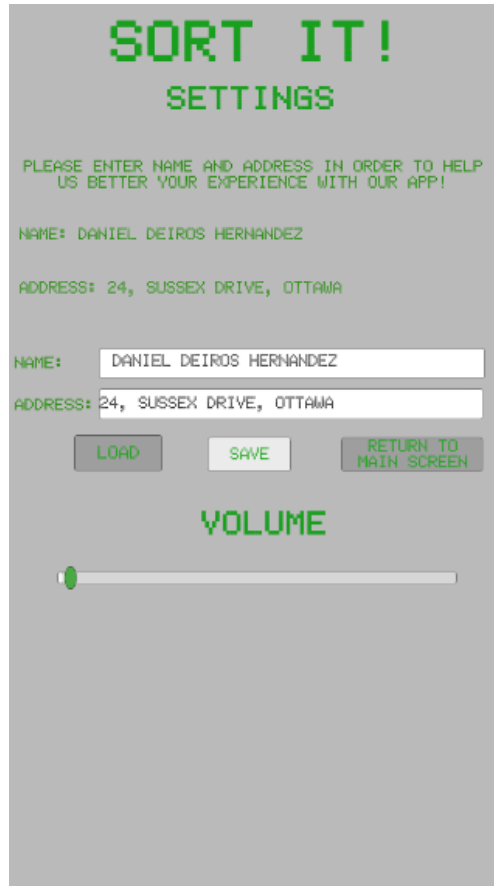


Figure 2.10: Edited Options Page

On the calendar page, you can see your city’s recycling schedule so that you can keep track of when you need to have your recycling outside. Refer to **Figure 2.11** to see the calendar page.

SORT IT!

CALENDAR

RETURN TO
MAIN SCREEN

CHOOSE GARBAGE AND RECYCLING COLLECTION
CALENDAR AND ENTER YOUR ADDRESS

Menu ▾



FR

i State of emergency: Latest vaccine and COVID-19
Information

Did you know that our waste collection operators walk a half marathon every day while lifting the weight of an adult elephant? Now imagine doing this during a snowstorm or freezing temperatures... Here's a BIG thank-you to those who picked up our waste all winter long. You guys rock!

April 2021

today



Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30 Black bin Green bin Yard trimmings	31	1	2 Good Friday	3
4	5 Easter Monday	6	7 Green bin Yard trimmings Blue bin Garbage	8	9	10
11	12	13 Black bin Green bin Yard trimmings	14	15	16	17
18	19	20 Garbage Blue bin Green bin Yard trimmings	21	22	23	24
25	26	27 Black bin Green bin Yard trimmings	28	29	30	1
2	3	4 Garbage Blue bin Green bin Yard trimmings	5	6	7	8

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Powered by R2Collect



Figure 2.11: Calendar Page

Lastly, the help page informs you about the game, rewards and revisits any page calendar. Click on each button for a brief description and more information on each. Refer to **Figure 2.12** to see the help page.

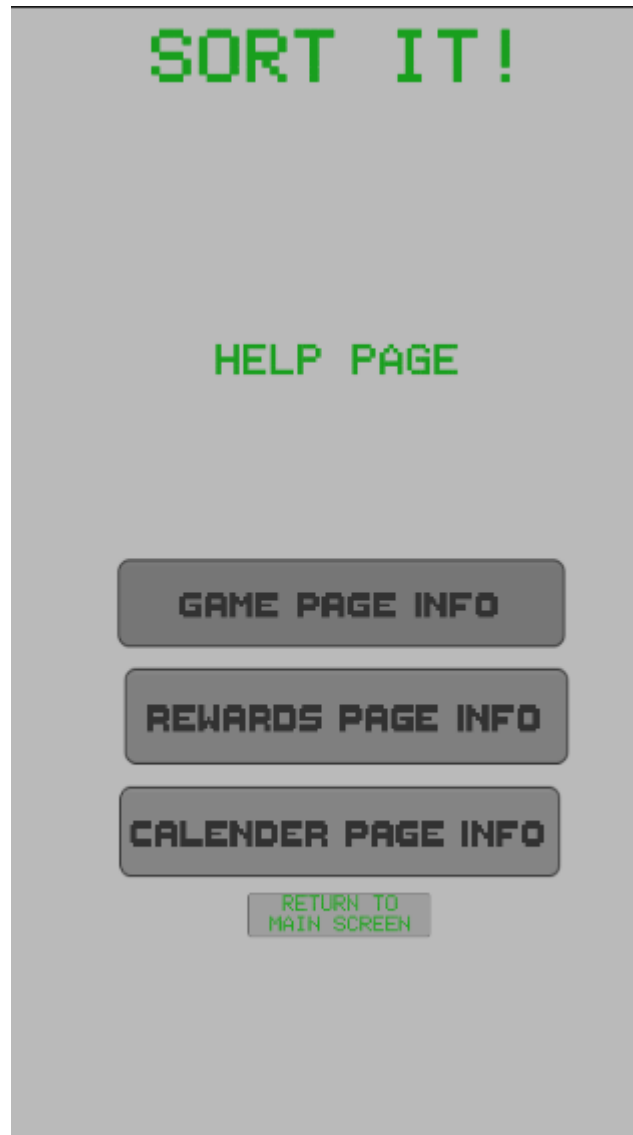


Figure 2.12: Help Page (before clicking a button)

At any time, the user can return the main screen and revisit any page.

3.1 Set-up Considerations

The equipment used all relate to Unity (a game editor, where the app was created) and Vuforia. Nothing else external or physical was used apart from the scanned items used in Vuforia (the AR system). Unity uses C# as code, which the group used to create scripts to code the game.

3.2 User Access Considerations

The application is simple enough for users of all age groups to use. The app's restrictions relate to Vuforia, which needs to have the data inputted before use. This means that all the images to be identified must be already included in the AR software system to recognize the item.

3.3 Accessing the System

No passwords are required to access the application. Simply press play on your laptop/PC, and the application will load.

3.4 System Organization & Navigation

As mentioned above, the system is all linked together by the home page. Every scene (new page) has a button to return to the home page, where you can access other scenes. Refer to **3** to see the functionality of each scene.

3.5 Exiting the System

To exit the system, simply close the app or click the play button again.

4 Using the System

4.1 Given the System

4.1.1 Home Page

Within the home page, many buttons have the function to change pages or exit a page. As soon as the app is turned on, there is a progressive daily bonus that pops up. When you click the claim button, you gain the number of coins for the given day. After you claim your daily bonus, you need to click the exit button, a red x on the top right corner. When that button is clicked, then the progressive daily bonus disappears, and the rest of the home screen becomes visible. There are six buttons on the home screen: sort your trash, game, calendar, options, help, and rewards/milestones. When you click the sort your trash button, it goes to the scanning screen. When you click on the game button, it goes to the first level of the game. When you click on the calendar button, it goes to the calendar screen. When you click the options button, it goes to the options screen. When you click on the help button, then it goes to the help screen. When you click on the rewards/milestones button, it goes to the rewards/milestones screen.

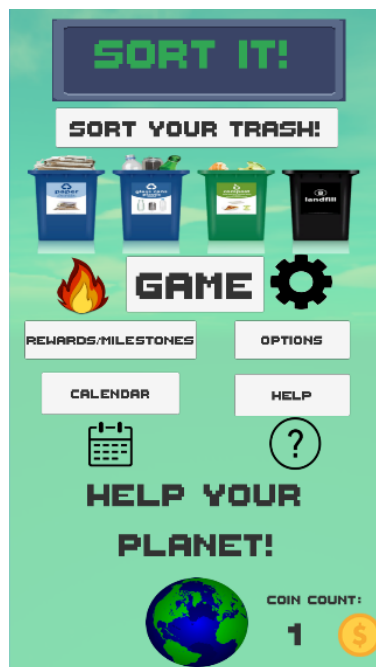


Figure 3.1. The Home Page

4.1.2 Scanning Page

Within the scanning page, there is only one button. This button will allow the user to go back to the home screen once finished scanning their items.

4.1.3 Game Page

On the game page, there are two buttons and a dragging feature. One button is labelled “Home,” this button, once clicked, will return to the home screen. The other button is labelled “Level #,” this button will allow the user to go to the next level. The level number is labelled depending on which level is next. The dragging feature allows the item on the screen to be moved once clicked and will stop once it is unclicked or in the correct box.

4.1.4 Calendar Page

When the calendar page is clicked, there will be a UI web link to the City of Ottawa recycling website.

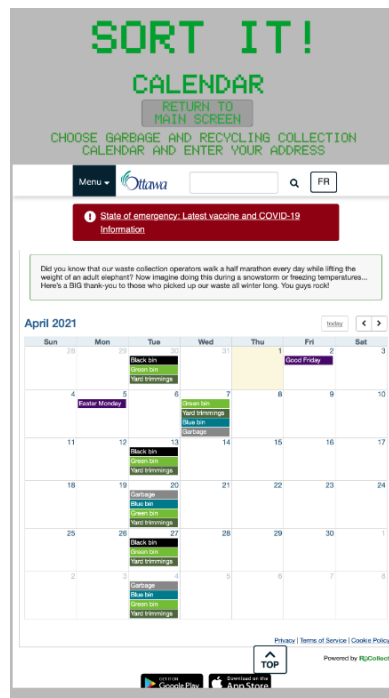


Figure 3.2 The Calendar Page

4.1.5 Options Page

On the options page, there are two areas to type, three buttons and a slider. The areas that can be typed in must be clicked first then you can use your keyboard to type in the asked for information. The three buttons are load, save and return to the main screen. ‘Load’ allows more people to be registered in our system. ‘Save’ enables each user to be kept in the system. The return to the main screen button allows people to go back to the home screen. When the user clicks and slides it to either side, a slider controls the game’s volume level.

4.1.6 Help Page

There are four buttons on the help page: game page info, calendar page info, rewards page info, and return to the main screen. When the game page info button is clicked, it goes to the page and once on the page, there is a back button that sends the user back to the help page. When the calendar page info button is clicked, it goes to the page and once on the page, there is a back button that sends the user back to the help page. When the rewards page info button is clicked, it goes to the page and once on the page, there is a back button that sends the user back to the help page. The return to the main screen button allows people to go back to the home screen.

4.1.7 Rewards and Milestones Page

There are eight buttons on the rewards and milestones page; buy now, equip, restore to default, and return to the main screen. There are three different buttons labelled buy now; these buttons will become available once you reach the required amount of coins. When the button 'buy now' is clicked, you will own a specific background colour. There are three different buttons labelled 'equip'; these buttons will change the background colour of the backgrounds that are held. When 'restore to default' is clicked, the changed background colour will return to the original green colour. The return to the main screen button allows people to go back to the home screen.



Figure 3.3. The Rewards/Achievement Page

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

The error messages are given are that something is already initialized and cannot be initialized again. These errors belong to GameFoundationSdk, which allows you to claim your daily coins. Therefore if you try to claim coins within the same 24 hours, it will not let you do so.

5.2 Special Considerations

There is a bug within the code at a particular game level that allows you to gain many coins when dragging an item.

5.3 Maintenance

Regular updating should be done to the app to keep the app running well and allow users to do more. The updating will involve debugging and adding more functions. To improve the app, we will add more recyclables that can be recognized, more game levels, adding notifications, providing more information on recycling, and expanding to other locations.

5.4 Support

Users can get emergency assistance and system support through the help page. Answers to frequently asked questions will be there, but there is an area for the user to contact support if not. The names of people and emails of the staff for contact are Sydney Vanderburg (svand108@uottawa.ca), Kayla Bartieau (kbari020@uottawa.ca), Daniel Derios Hernandez (ddeir094@uottawa.ca) and Ammar Shakir (ashak088@uottawa.ca). Identified problems with the systems should be reported through contact support. If security incident handling is specified in the design, we will assess them to determine the appropriate next steps for mitigating the risk. Then we will respond to the incident by containing, investigating, and resolving it.

6 Product Documentation

The final prototype was built by adding more and more features to our original prototype. Our initial prototype consisted of a basic home page and the scanning page. We then added more and more features such as a game page, a rewards page, options page, calendar page and a help page. Some sacrifices were made, such as settling on two separate pages for a scanning page and a game page that did not have much in common. The original plan was to have a sorting game based on the scanned objects that were not easily possible, as we found when making the app. We settled on two separate pages with common household items to increase the game's relationship and the app's scanning component. Another feature that had to be settled on is excluding a leaderboard for all of the user's city. This was scrapped as no one in the group had previous knowledge on the topic, and our expertise in programming limited us from making this feature.

Many of the pages were made using built-in features of unity such as simple unity graphics, buttons, and Visual Studio to make some features work in the app. The knowledge of building the app either came from techniques and skills learned in classes or from online sources such as videos and forums. The app's overall construction was done by splitting the work up between group members and giving each member the responsibility to finish the assigned tasks. A thorough breakdown of how the app was made can be seen in this section's following subsections (6).

The reasoning for a lot of the features is based on the client's needs. For example, the scanning page exists as the client wants an app that can scan images and tell the user which bin to put their recycling into. This is what provoked us to make a page that scans the objects that the user has. Another example is the game where the client wanted a small game to keep the users enticed and want to play. Some app components are based on the criteria that we wanted in the app as a developer. For example, we wanted there to be some kind of reward system as most people want to be rewarded for recycling. This is why the rewards page exists and gives the user some small rewards for using the app and letting them know how much they have used it. Another example is the inclusion of the music, the help page and the options page. We thought the app could be a little more enticing to play, and by adding music, we would create a better user experience. The same goes for the help page, where we could improve the UX by giving help to the users when they needed it. A feature inspired by the client's needs and our market research of competition is the calendar page. This is something that most competing apps on the mark had, and we did not want our app to not have a feature compared to our competition. The client also inspired this by needing to make users recycle the most efficiently. The client left this to us to determine how to implement this, and by looking at the competition, having a calendar would remind users that they have to put their recycling and garbage out to the curb. This could mean more things are getting recycled than what the app is scanning. For example, if the user puts something into the blue bin without using the app, they will be reminded to recycle all the items in the blue bin by the app, even though some things might not have been recycled using the app. That is the decisions and thought process behind the features of the app. More details on the actual construction of the app can be found in the following sections.

6.1 Unity

6.1.1 BOM (Bill of Materials)

Table 2.1. Bill of Materials for Unity

Description	Total Amount (\$)
Unity Store Receipt	18.78
Unity Collab Receipt 1	20.04
Unity Collab Receipt 2	20.04
Total	58.86

6.1.2 Equipment list

- Unity
- Unity Collab
- Vuforia
- Personal Laptops

6.1.3 Instructions

Unity is a free app that is used to make applications and games. We also used it to make our app. The first step was to download unity, create a new project, and ensure that the target platform is set to android, IOS and Windows (or MAC if on a MAC). The basic app design was something that was learned in class; however, a lot of features that were used were learned from online resources. Another resource that was used is called unity collab, which is a feature that allows us as a group to work on the same project without any external applications. This is a paid unity feature; however, it is vital for development in a group setting. All required coding for the app was done in C# using the IDE called Visual Studio.

The app is broken up into a few main pages. The home page is the main page that unites all the other pages. Info for the home page can be found in section 4.1.1 of this document. The home page's development was a long and iterative cycle that consisted of adding multiple buttons, multiple scenes, and graphics. Most of these settings were added using essential functions of unity and doing some coding with C#.

The second page is the game page. This page contains the main game of the app. It is a separate scene from the home page and uses a button to go to this page. The page consists of small images created in a particular application coded to move around by the app user. There are a few buttons in the game where one button leads to the next image (done using a built-in button

maker), and the other is a button that leads back to the home page, which is done using VS. More details about the game can be found in section 4.1.3. Another feature is the rewards obtained from scanning. When a user correctly sorts the objects, the game will reward a coin to the user, available on the game page and other pages as it is a global (in terms of the game) currency.

The scanning page is another vital page that is in the app. The scanning page uses Vuforia to detect objects and tell the user which bin their recyclables go into. The page also has a home button which is coded similarly to the other buttons. The overall graphics are made with simple inbuilt graphics, and the video feed (from the camera) is from Vuforia. More info on the scanning page can be found in section 4.1.2.

The rewards page is also a significant page that features the main game currency. The currency is a game feature that was built using the help of online resources. Many buttons do various features made using VS code (such as the home button) or were made using the primary inbuilt button maker. Another critical feature in the rewards page was the ability to configure the colour of the background, which is also done using VS code. More info on the rewards page can be found in section 4.1.7.

Other pages, such as the options page, the help page, and the calendar page, are all done using simple built-in unity features such as text and buttons. There is an additional feature on the options page for the user to load their address. This information will be stored by the app and used to load a calendar of Ottawa’s city for recycling days based on address. This feature uses an inbuilt feature called unity webview; however, it seems as though this feature does not work too well on Windows computers. More info on these pages can be found in sections 4.1.4-4.1.6.

6.2 Vuforia

6.2.1 BOM (Bill of Materials)

Table 2.2. Bill of Materials for Vuforia

Description	Total Amount (CAD\$)
Vuforia	0.00
Total	0.00

6.2.2 Equipment list

- Vuforia
- Unity
- Unity Collab
- Personal Laptops

- Lots of images of items in the house

6.2.3 Instructions

Vuforia was used to recognize images for the AR component of the app. Vuforia is an add-on to unity that allows a developer to app images (targets) to identify.

To add target images, we first had to take pictures of recyclable items such as cereal boxes and plastic bottles. The photos had to be of a high resolution (IE: from a modern smartphone camera) and clear. After the images are taken, they are then uploaded to Vuforia as targets for the add-on to match something.

The next step was to make the app recognize the item it is scanning to make sense of its context. We decided that overlaying text on the items is an excellent way to do that. The process of this was done by overlaying the correct recycling text over the images of the objects. For example, a “Blue” text was added over the plastic water bottle’s image as a plastic water bottle is recycled in the blue bin. Similarly, a “Black” text was added over a cereal box’s image as recycled in the black bin. The following text overlays can be observed in figure 6.2.3.

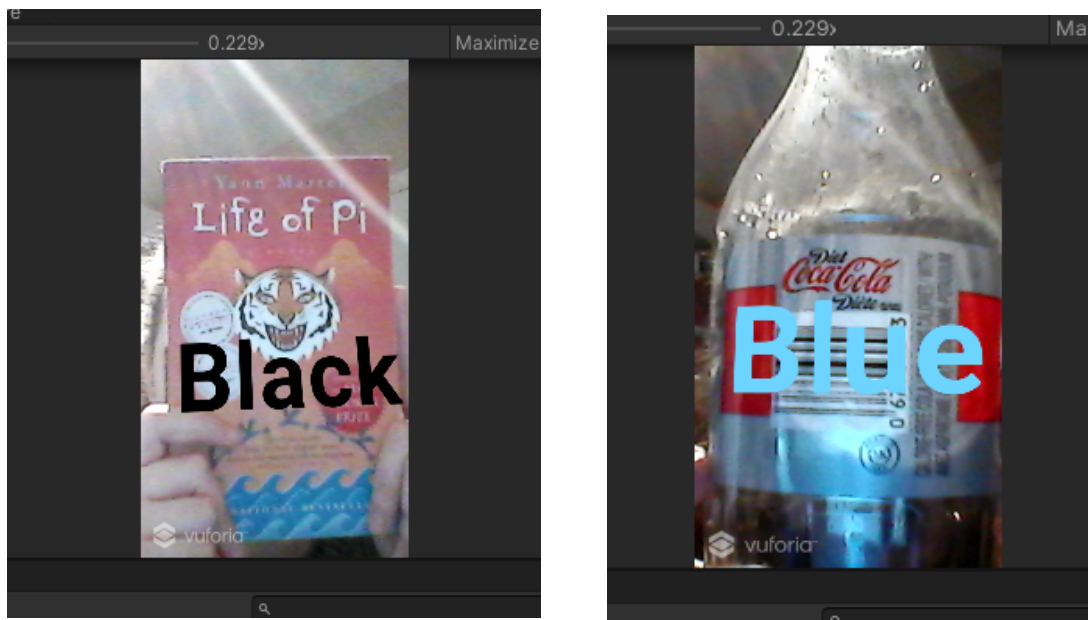


Figure 4.1. : The app identifying recyclable materials

6.3 Testing & Validation

The testing that was done is simple testing of the app. We used the built-in feature of unity to run the app on our computers. We then tested each page and every app component to see if the app was running correctly. Unfortunately, we could not try on a mobile device as the remote app feature of unity did not work for our group and restricted us to testing on our computers.

Testing the home page was a simple objective. It consisted of clicking every button and making sure the buttons lead to the correct page and that the buttons also disappeared when a new page was rendered. Then we also wanted to see if the new page was correctly generated. We also set the play feature's resolution to match that of a mobile device, which allowed us to accurately see if the images, buttons, and features all scaled appropriately. Another testing feature was that the music playing in the app is playing correctly between pages and is not overlapping.

Testing for the game page is also quite simple. It consisted of playing the game. The testing was done to see if the object could be dragged and dropped to see if it can go into the bins and see if it correctly added currency. This form of testing required the team to play the game repeatedly to spot any bugs or glitches. Additionally, any buttons, such as the home page one, were also tested similarly to the homepage testing.

Testing for the scanning page was done by scanning multiple objects and observing if it correctly identifies the image and displays the correct text. This was also a tedious process that involved numerous rounds of testing objects in finishing the testing.

The testing of the rewards page was similar to the home page as it involved testing all the buttons on the page. The testing was clicking the button and seeing if the app did the correct action. Another source of testing is the milestones. Milestones are achieved when playing the game and scanning multiple items. To test if the milestones worked, the team has to play the game multiple times and check if the milestones were ticking.

The other pages' testing, such as the options page, calendar page, and the help page, was similar to the home page's testing. This means testing the buttons and seeing if the graphics are correct. The primary source of testing was between the options page and the calendar page to see if the address a user enters does display a calendar. We also tested to see if the in-game volume slider worked.

The result of testing is that the vast majority of the features worked correctly. They may not have worked correctly on the first try, but they did work correctly after testing and fixing a bug. Almost all bugs were eliminated, and the app does work quite well from our testing. The one feature that did not work correctly is the calendar page. Unity webview did not work correctly on Windows computers. Some additional testing is required to determine the reason for this; however, we did not have enough time for further testing. The big question was how unity webview was working correctly for IOS but not windows computers, and that was planned to be the main source of testing in the next phase of testing (had there been more time). Those are the results from testing the app.

7 Conclusions and Recommendations for Future Work

Due to the various anomalies and circumstances that the design team faced throughout the project's length, not all of the final product's intended initial features were implemented by the end of the semester.

While the design team included a scanning page in the application's final prototype, the scanning was not linked to the rewards feature. As such, users could not gain rewards for appropriately pre-sorting their items. Adding a game feature to the scanning page is highly recommended.

Another useful feature that was not able to be included in the final prototype is alternative languages. This is a very useful feature as Ontario's population is bilingual, and having this feature would be a great advantage.

Furthermore, more unity among the pages and some aesthetic work could not be entirely fixed before the semester's ending. It is recommended that these features be improved upon or repaired to be more aesthetically pleasing for the application users.

A final recommendation is for at least one member of a future design team to become proficient with the c-sharp programming language. This is often very complicated and necessary to use Unity efficiently.

8 Bibliography

comms. “Canada Recycles Just 9 perCent of Its Plastics - Recycling Council of Ontario.” *Recycling Council of Ontario*, 22 Apr. 2019, rco.on.ca/canada-recycles-just-9-per-cent-of-its-plastics/. Accessed 14 Apr. 2021

“Opinion | Ontario Must Face up to Its Looming Waste Crisis.” *Thestar.com*, thestar.com, 14 Mar. 2019, www.thestar.com/opinion/contributors/2019/03/14/ontario-must-face-up-to-its-looming-waste-crisis.html. Accessed 14 Apr. 2021.

APPENDICES

9 APPENDIX I: Design Files

This document is a final summary of the work on the project “Sort It!” and is a successor to all other deliverables (deliverables A through J). While no document is directly referenced, the UPM relies on all knowledge accumulated through the past deliverables and prototypes.

All deliverables and final prototype can be found on maker repo:

<https://makerepo.com/ottawaammar/859.sort-it>

Table 3. Referenced Documents

Document Name	Document Summary	Submission Date
Deliverable B	Summary of client needs and problem statement	January 31, 2021
Deliverable C	Design criteria and benchmarking	February 7, 2021
Deliverable D	Individual conceptual design and overall group design updated benchmarking	February 21, 2021
Deliverable E	Estimated cost and schedule for the project	February 28, 2021
Deliverable F	Summary of prototype and client feedback on conceptual design	March 7, 2021
Deliverable G	Summary of second prototype and client feedback on the prototype	March 19, 2021
Deliverable H	Summary of third prototype and general feedback from potential users and field experts	March 28, 2021
Deliverable I	Presentation pitch to judges	April 8, 2021
Deliverable J	Final presentation material	April 6, 2021