GNG 1103 Project Deliverable E

Universal Recycling Sorting

BOM, Detailed Design, Prototype Testing

Submitted by

GNG 1103-C01, Group 2

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1. Introduction

The project of "Waste Management" was a project assigned to the teams by the client Mitch Bouchard. Mitch Bouchard is part of a family business in the field of mechanical part supply. This project has a goal of improving the quality of recyclables and decreasing waste in landfills by creating a system to assist people in sorting their recyclables properly. Though many individuals believe that recycling is enough to make a change in the world this is not the case when looked at on a large scale. Many recyclables are missorted and end up in landfills and/or shipped overseas to countries that have more room for landfills than Canada does. In fact, many people do not know how to recycle and opt for throwing everything into the garbage instead resulting in further pollution in our environment. Creating a product to help people learn and understand how to sort their recyclables and garbage easily could help in the big picture of managing and reducing the amount of waste on the planet.

Previously the team was tasked with identifying and developing the client's needs and wants, the problem statement, a list of metrics and some benchmarking of similar products on the market. The client's needs were identified during the client meeting in the form of statements, these were then used to develop a list of needs and wants for the product (user friendly, cost effective, determines eligibility of items to be recycled, determines items respected disposal location and that the product is versatile and can be used by a wide variety of people) the need and want statements would guide the team in creating a product that would meet the client's expectations. From these needs and want statements a problem statement could be developed: A need exists for people to reduce waste in landfills by creating a user friendly, cost-effective product that helps customers and users to recycle correctly and efficiently. Once the problem statement was defined metrics were determined to express the client's needs in the form of attributes that are measurable. Benchmarking was done to explore other products on the market that may meet the client's needs and wants then target specifications and determined a set of design criteria were determined. Finally, a brainstorming session was held to identify the main subsystems and concepts for them, a final design idea was also determined.

This report has the focus on reporting the next steps for the prototyping phases including a schedule and description of each prototype and how and when it will be tested. An analysis of the systems critical components, a detailed design of the system and the bill of materials (BOM) are also developed in this report.

2. Analysis of Critical Components

Tensor flow is a Python library used for machine learning. How it works is there is a large database of ‘known’ images. TensorFlow will match an input image based on ‘known’ images and will approximate with great accuracy what that image is based on the ‘known’ images. For example, if you have a large database of pictures of cats and dogs and if you were to input an image of a dog to tensor flow, it will approximate what that picture is based on all the known pictures of dogs and it will tell you that it is a dog.

In case TensorFlow depicts the wrong image, we will have a feedback loop. The feedback loop will ask the user if the scanned image is correct as depicted in **Figure 3**. If the guessed answer is correct, you will say yes, and that image is added to the database to improve accuracy. If the guessed answer is wrong, you will say no, and it will prompt you to tell you what material it is and that new answer and picture will be added to the database to improve accuracy.

The disposal location determination system is an extra component we would like to add if there is time. Our idea is to use google maps re direct or manual input to show where and when to dispose of your waste.

3. Scheduling

Scheduling is done to ensure that all tasks are completed in a timely manner and that all deadlines are met. This will ensure that the problem is solved and that all the needs and want statements of the client are met to a high standard.

3.1. Prototype Scheduling

The prototype schedule is created to assist in defining goals and deadlines for each of the steps in order to create a functioning final product that meets the client’s needs and wants. The different prototypes are detailed below including what is being tested and the dates for which the must be completed. These dates are also detailed in the project plan (Wrike).

3.1.1. Prototype 1

The first prototype would be a low feasibility prototype. This prototype would not include the coding functions but would be a demonstration of the appearance and functionality of the program. Each of the screens would be designed to test whether the program is user friendly and easy to navigate without prior knowledge of the product. This prototype should be completed by March 5th to ensure that there is time to perform Alpha and Beta testing.

3.1.2. Prototype 2

The second prototype would be a higher feasibility prototype. This prototype would test if the item scanning is efficient and functioning. The goal of this prototype would be to design

the tensor flow system and ensure that it can identify the material correctly. These steps would be completed by March 12th to ensure time for testing the software.

3.1.3. Prototype 3

The third prototype would also be a higher feasibility prototype, it would focus on the creation and efficiency of the feedback loop system. For this prototype the feedback loop would be created as well as the system to identify which bin the material should be placed in. This would be to test the efficiency of the feature as well as if it is functional in helping the system learn and correct itself. The estimated goal for the completion of this prototype is March 28th in order to leave time for the testing of the prototype.

3.2. Testing Scheduling

There will be a series of test for the prototype to ensure that it is working properly for the client wants and needs. There are 3 main components, of the app that we will be testing: User Friendliness, Scanning Ability and Feedback loop. We will do this through alpha and beta testing to ensure that our product is up to the requirement that the user wants.

9.2.1 User Friendliness

User friendliness is a key feature of the app that will make the user more inclined to use the app more. This is going to be tested in the prototype in terms of how fast and easily can the user access the app and use it for its main purpose. Also, we will use beta testing and get the app tested by other people to ensure that they also believe that the app is user friendly and meets their standards. This stage of testing must be completed by the 7th of march.

9.2.2 Scanning Ability

The scanning ability is the most key feature of the app and it is essential to work for the app to work right. We need to ensure that the camera can identify the product and the material, using TensorFlow and extensive machine learning software's to ensure that the product is to user needs. We will test this feature thoroughly with different materials and get the app to scan them. Also, we will use this time to ensure that it has a decent accuracy rate, and that the app is informing the user of the correct bin. This stage of testing is to be completed by March 14th.

9.2.3 Feedback loop

The feedback loop is essentially in our app for the purpose of a user interactive app. Basically the feedback loop asks the user a series of questions in terms of the condition of the recyclable material and verifies if that material can even be recycled (ex. Pizza box with grease stains). We will thoroughly test this feature by inputting different answers and ensuring that the app provides us with the correct results. This stage of testing is to be achieved by March 30th.

4. Cost Estimation (BOM)

For this project, the team is allocated with $100. This money is to be used for the materials or components that will be used for the prototype. A bill of materials is used to organize these components into a list that will simplify the process of reimbursement from the project managers.

Table 1. Bill of Materials

Component	Cost
TensorFlow	**$0**
Google Maps api	**$2-$7 monthly**

Since our product will likely be using TensorFlow, which is an open-source platform, no payment will be required.

The price of the google maps api that will be implemented within the app varies depending on whether the map will be static or dynamic. For static maps, the price is $2 per month, while dynamic maps cost $7 per month.

5. Detailed Design (what and how)

Home Screen

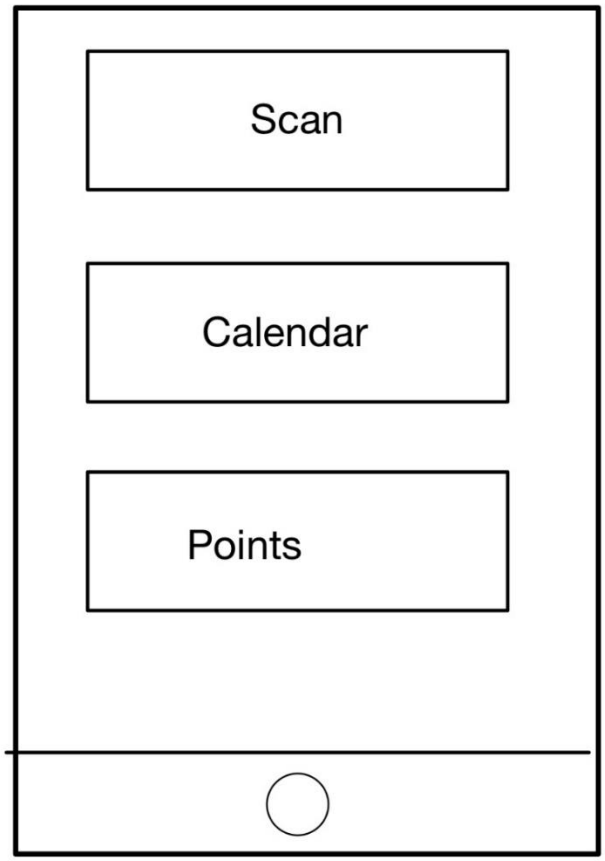

Figure 1: Home page

The app's home screen shows three blocks showing scan, calendar, and points options to the user. Scan brings the user to the scanning section, which is the main objective of this app. Other

blocks are additional blocks to the main function of the app. Calendar is a feature where users can input what day their recycling gets picked up and gives them a reminder to put it on the curb. Furthermore, lastly, points show users points earned by recycling. The thought behind having points is encouraging users to recycle more.

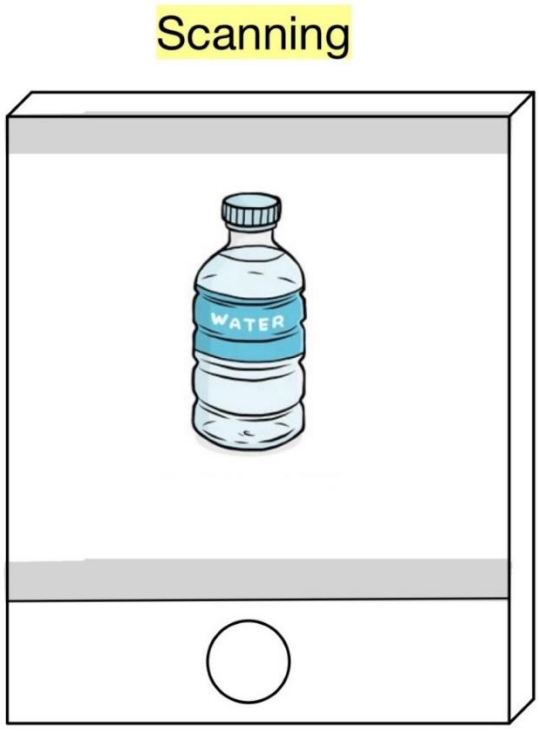

Figure 2: Scanning the object.

Figure 2 demonstrates an object being scanned to determine its recyclability. The object gets scanned, and the algorithm returns a result, I.e., a PET bottle. The algorithm compares this object with many other objects that it was trained with and returns a probability like 95% PET bottle.

Figure 3: Asking the user whether scan was correct.

The app should ask the user whether the result was correct since there is a margin of error, as mentioned in figure 2. Then the algorithm will send the user to a different page depending on the answer. If the answer is yes, then it will show the user where to put the PET bottle. If the answer is no, then it will ask the user to type the material.

Figure 4: Tells the user which bin he/she should use.

If the answer is yes, then the algorithm searches that material in the database. Moreover, if it matches with a category, then it tells you to use that bin. If it does not, then it tells you to use the landfill bin. Figure 4 depicts the result algorithm returns in the case of a PET bottle.

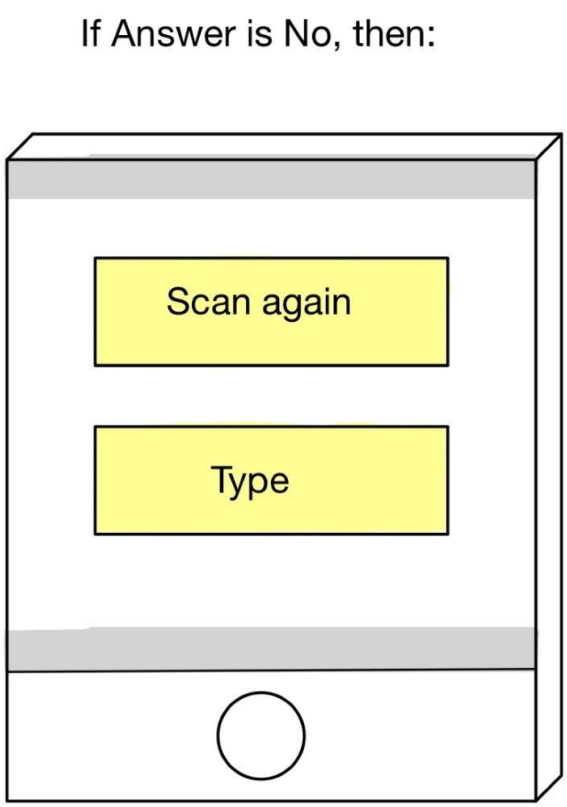

Figure 5: Asks the user whether user wants to type the material or scan it again in case of a failure in the first scan.

Figure 5 depicts the page that the app would return if the answer were no after an unsuccessful scan. Then the user can choose between Scan again and Type. If the user types a material found in the database, then the app returns the page shown in Figure 4. The more users use the app, the more the app will improve the probability of showing the right result.

6. Conclusion

After determining the client's needs and wants, as well as listing the metrics and benchmarking a few comparable products readily available on the market, the team was able to come up with several specifications for a product that meets the client's expectations. Using this information, we were able to develop data for the critical components of each proposed prototype, while providing a testing schedule for the prototypes. A detailed design of the functionality of the system was also developed from this information as well as a bill of materials that should provide an estimate for the price of the components used in the prototype.