The R.M.U. Garbage Sorter

The R.M.U. (Recycle, Make, Use) Garbage Sorter

Kimiya, K.P., Pahlevan

The University of Victoria, kimiyap@uvic.ca

Riya, R.S., Sood

The University of Victoria, riyasood@uvic.ca

1 INTRODUCTION

As the modern world shifts to sustainable lifestyles, waste management issues are becoming more significant. Even though the idea of recycling has been introduced and recyclable materials have been distinguished from non-recyclable ones, there are still a number of drawbacks. This is evident in everyday homes as well as larger recycling facilities, where the material separation step of the recycling process is still carried out manually. Owing to this, a lot of recyclable items occasionally end up in landfills since they are unable to be recycled. Recycling and garbage management have gained a lot of attention in recent years as environmental concerns have grown. For example, “plastics and metals, including aluminum, are materials that are not biodegradable and can persist in the environment for centuries” [6], hence they can greatly harm the environment.

On the other hand, many materials can be reused. It is illustrated through research that, “[r]ecycling and reusing materials can reduce the amount of waste sent to landfills and the demand for new natural resources", [6]. For instance, copper is a material that can be recycled and reused multiple times [1]. This, “[reduces] the need for new copper mining and ultimately [reduces] the potential harm to land and the environment from mining activities" [6]. By reintroducing used copper into the economy, CO2 and energy use are reduced since less energy is required to use recycled copper [1].

This has motivated us to develop the RMU Smart Garbage Sorter, an automatic garbage sorter that not only separates recyclable materials, from non-recyclable but it also keeps track of the gathered recyclable materials and prompts the user with DIY project that can be built using the objects they have available. This garbage sorter has been developed by machine-learning technology using the Google Teachable Machine as well as electronic components such as Arduino Uno and a Stepper Motor. It promotes a more sustainable lifestyle and one that is more economical by coming up with practical uses of recyclable materials.

2 RELATED WORK

We came across multiple similar projects that had the same motivation as ours. For example, Shangke Wang, "[enabled] Social Internet of Vehicles devices to achieve the purpose of intelligent and autonomous garbage classification in a public environment" [4]. Another article by Abuga and Raghava discusses the development of a smart garbage bin mechanism that utilizes sensors and cloud computing technologies that can be helpful for a waste management system in smart cities [5]. Another garbage sorter project was developed using laser technology as well as glass and metal sensors to automate the separation process [2]. These projects helped inspire us to think along these lines when designing, creating and implementing our garbage sorter.

3 DESIGN AND PROTOTYPING

In contrast to the projects mentioned above, rather than being used in a smart city or in the public, the R.M.U. Smart Trash Sorter is made to be used in a typical home. Our team's design for a garbage sorter includes the following features: alerting the user when the trash is getting full; telling the user when it's time to get creative and start reusing; identifying and determining whether or not a waste product is recyclable; and finally classifying the item into the appropriate category. The user also gets access to a mobile app feature that can notify them when their smart bin is approaching close to being full. Moreover, the mobile app keeps track of the recyclable items and comes up with arts and crafts or DIY activities and takes the user through all the steps on how to reuse their recyclable items.

3.1 Electronics Set-up

The electronic materials used in this project are as follows: Arduino Uno, breadboard, LCD1602 Modular, button, 1K resistor, servo motor, and jumper wires. As there are two alternative bin options—non-recyclable and recyclable—we employed a servo motor to control the bin to which the material is sent. A button is also incorporated that is intended to reset the count when the bins are empty. We used the LCD display to inform the user of how many items they have in each bin and whether either bin needs to be emptied. A Tinkercad diagram of the wiring's implementation is shown in figure 1.

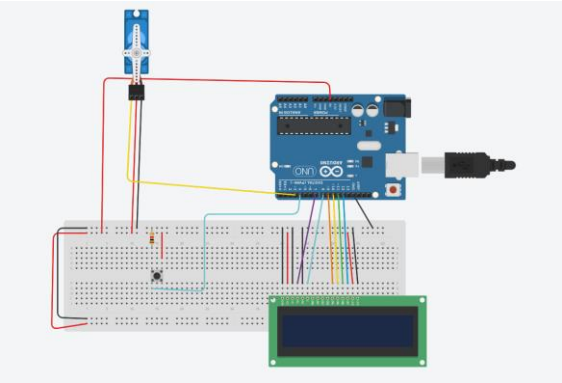

Figure 1: Tinkercad diagram of the electronics implementation

3.2 Machine-Learning Set-up

In order to train the garbage sorter, we decided to use the Google Teachable Machine and paired that up with PictoBlox to add electronics and code within this tool. We decided on three main categories for recyclable materials for our prototype: electronics, aluminum and cardboard. We chose the following materials to set up with the google teachable machine: a

light string containing batteries, a soft drink can, and a cardboard juice box to demonstrate the functionality of our project. For the garbage category, we trained the machine with a mask, tissue, and candy warp.

3.3 Algorithm

The algorithm for this system was developed in the PictoBlox program in order to connect the code with the trained machine. Figure 2 shows the set-up section of the algorithms where the display monitor and the servo motor, and the recognition window are activated. Then the button was set up as per figure 3 with the function of resetting the item counts once the bins are emptied.

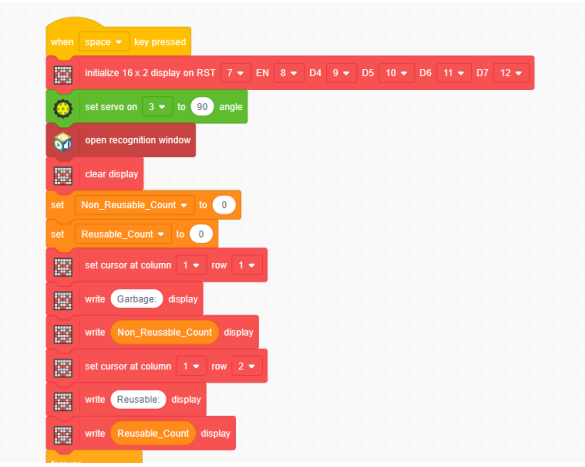

Figure 2: Set-up section of the algorithm implementation

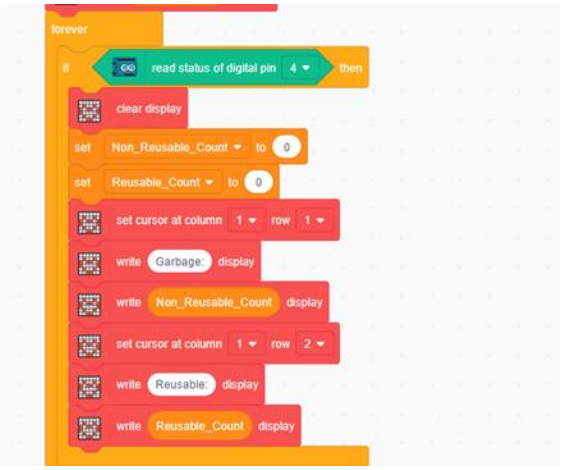

Figure 3: button implementation

We then implemented algorithms for two scenarios: when the object placed in the bin is recyclable and when it is not recyclable. We used the trained machine to determine this. Figure 4 demonstrates the case for non-reusable items, and figure 5 demonstrates the case for reusable items. The state of each bin is also updated in this process. For the implementation of the rest of the items, we used the same process. In the end, the algorithm in figure 6 was implemented to notify the user when either bin is full.

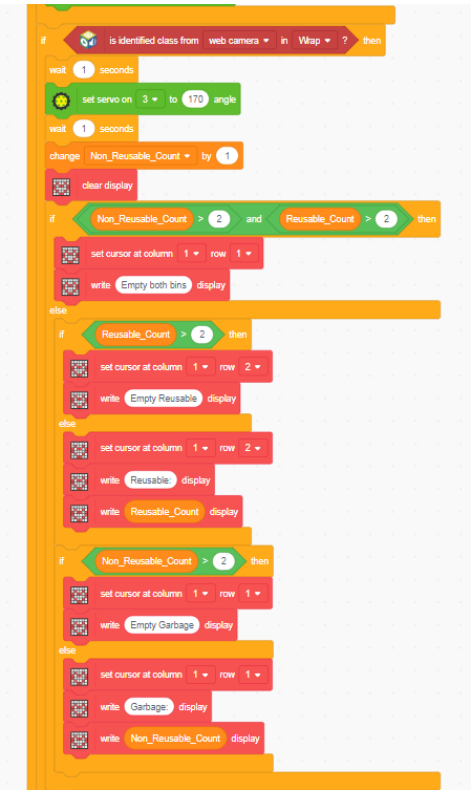

Figure 4:The case of a non-reusable item

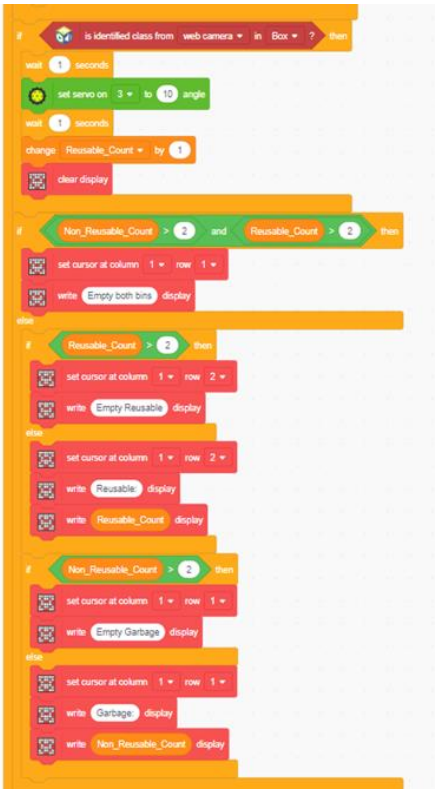

Figure 5: the case of a reusable item

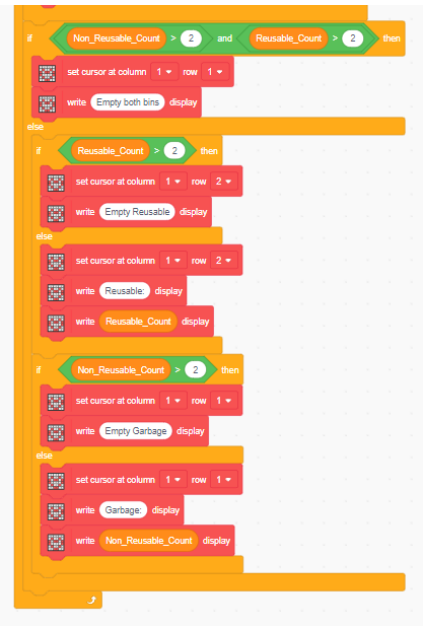

Figure 6: Displaying the state of each bin

3.4 Construction

A physical model of this system is demonstrated in figure 7. A laptop is used to run the code and its webcam is used to connect the system to the trained machine. The servo motor was placed in front of the webcam and a bin separated into two sections, placed underneath. Four canvas pieces were used to create a body.

Figure 7: physical model including electronics

3.5 Electronics Set-up

The R.M.U. Smart Garbage Sorter made by our team also has a mobile application which enables users' ideas to reuse their reusable material to either complete arts and crafts or DIY projects. The mobile application made is still in the prototype stage. The prototype shown in figure 8 is made with Figma.

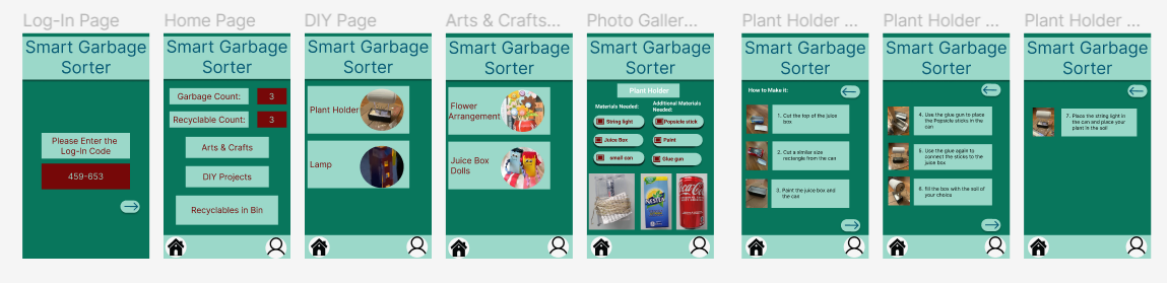

Figure 8: Figma mobile application

Figure 9 shows the same prototype with all its functioning buttons that takes you through the wireframe's flow.

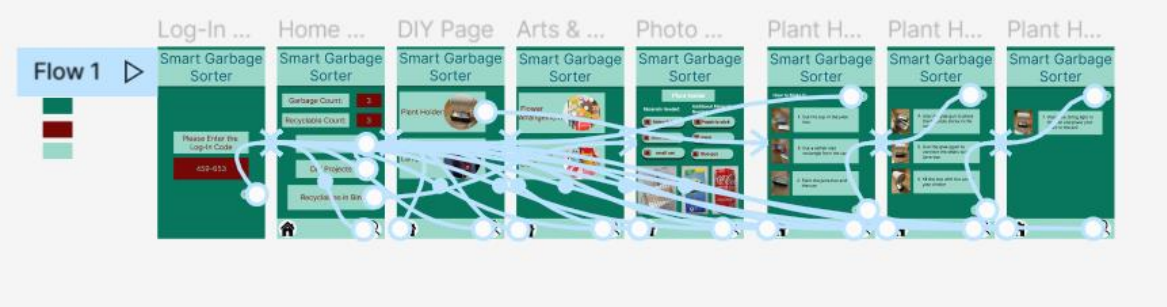

Figure 9:Figma mobile application with workflows

Here is a walk-through of using the R.M.U. Smart Trash Sorter for a DIY project. The user will first arrive at the Log-in page where they can log in by entering the code on the sorter as displayed in the sequence of images in figure 10. The user will then be taken to the homepage, where they may select the "DIY Projects" option to view DIY projects available to them based on their gathered material. By selecting a project, the user will then be shown the steps on how to create the project as in figure 11.

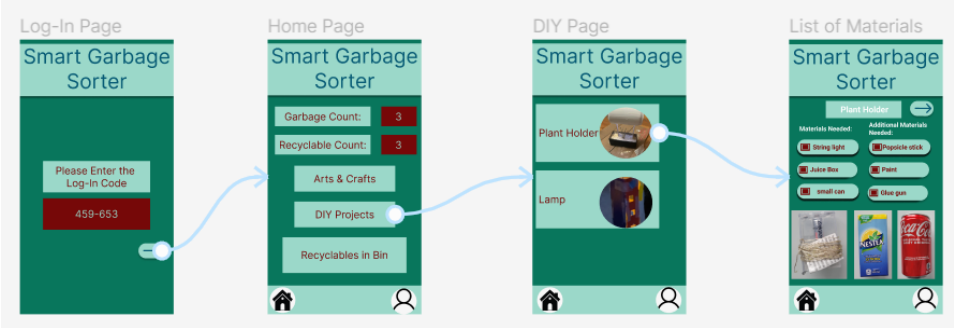

Figure 10:Mobile application taking the user through DIY steps (part one)

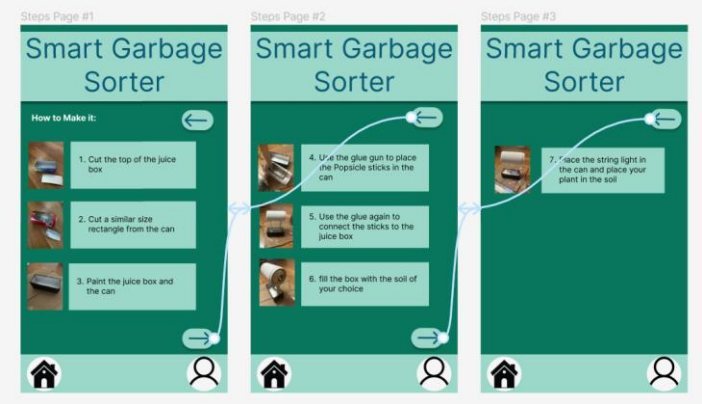

Figure 11:Mobile application taking the user through DIY steps (part two)

4 DESIGN FICTION

The following is a narrative that illustrates the functionally and use case of this system. Scenario: Lara is a university student who uses the R.M.U. Smart Garbage Sorter and has the phone application set-up on her phone. Since her room does not get much natural light, she has been thinking of purchasing a plant holder with built-in LED lights that helps the plant grow in low-light environments such as her room. Lara values a more sustainable way of living, therefore, instead of purchasing a brand new plant-holder, she decides to look through the R.M.U. phone application to see if she can make one herself using the recyclable material that the bin has gathered. Looking through the DIY Projects section of the app she discovers that she can build a plant-holder with material she has available. She gathers the material needed from the bin and follows the instructions given by the app. Not only is she able to reuse recycled material to practice a greener lifestyle, she is also able to save some money by making things such as this plant-holder herself.

5 CRITIQUE

There are a number of limitations associated with this project. First is the issues regarding the machine-learning technique. Since there are a variety of objects that vary in terms of shape, colour, and more, it can be quite a difficult task to train a machine while taking all these objects into account. With this project we have aimed not only to identify and keep track of conventional recyclable materials but also materials such as batteries and other electronics that can be used in crafts and DIY projects as well, which adds another level of complexity. Second is the limitation of size. Due to the dimensions of the current model, there are only certain types and sizes of materials that fit the bins. Lastly is the detection method used to determine whether either bin needs to be emptied. Due to the size of the objects used, a method of counting the number of objects is used to determine if a bin is full. However, by changing the dimensions of the bins and introducing objects with more size variations, this could be an unreliable method and generate false notifications.

6 FURTHER IMPROVEMENT

Drawing on the limitations of this project as well as our own observations, there is much potential to expand and improve this project going forward. Firstly, in order to resolve the complexity regarding using machine-learning in order to sort the material, an alternative system can be developed which is able to sort the objects not only based on what they are, as per this project, but also by detecting what the object is made of. This would make it easier to expand this project to detect and sort more materials than we currently have included. Secondly, an alternative system to identify whether a bin is full and needs to be emptied. For instance, using the sensor that can detect how close the objects are to the top of the bin can be a more effective method in an expanded version of this model.

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