Impekcycle
Group 9-11

Shen Jiaqi 3A3(24, Group Leader)
Pek Yu Xuan 3A3 (22), Zechariah Wong Shin Jaan 3A3 (31), Zhong He Cheng 3A3 (32)

Introduction

Description of ideas/issues/Thesis Statement

Only 9% of all plastic ever made has been recycled, with a portion of the 91% waiting to be recycled. Singapore's recycling rate is low, an overall recycling rate of around 60% from 2011 to 2020, while domestic recycling rate was 19% in 2019, below the European Union, with domestic recycling rate of 46.4% in 2017. Some of the 'recyclables' cannot be recycled at all. For example, only 50% to 60% of the waste collected by SembWaste is suitable for recycling. A study by the Singapore Environment Council (SEC) in 2018 found that 70% of respondents were unsure what was recyclable. The sorting of recyclables is inefficient, done by humans, so the objective was to create an object recognition code to increase efficiency.

Rationale of project

The rationale of our project is to create an object recognition code to help people know which bin to place their recyclables in.

Focus and significance of project

Our main focus is helping the environment through making recycling more efficient, accomplished by making it convenient for people to recycle, and the process of sorting through recyclable materials effectively.

Scope of the project

This object uses Opencv and YOLOv3, along with a laptop webcam to identify the object. Text to tell the users where to recycle the object would be shown accordingly.

Literature Review, Theoretical Framework and Reference Models

RecycleNSave

One similar model currently available is RecycleNSave, a ‘smart’ machine that helps with recycling, with a goal of encouraging recycling used plastic drink bottles and aluminium cans. Its strengths is that the materials are immediately processed on-site. However, it is rather slow, each can and bottle scanned one at a time to be processed within. It also only allows for cans and bottles to be recycled inside.

Bin-e

Another auto-sorting recycling machine is Bin-e, an IoT (Internet of Things) device that sorts and compresses recyclables into 4 (Paper, Plastics, Metals and Glass) components. Its strength is that everything is done automatically, without sorting required. Another strength is that compressing the recyclables reduces space needed. However, it is too expensive. The recycling bin used for public areas costs over $800 Singaporean dollars, with an additional subscription fee of over $200 Singapore dollars for the smartphone app to arrange collection services. This is extremely expensive, unsuitable for large-scale production and use.

Points adopted:

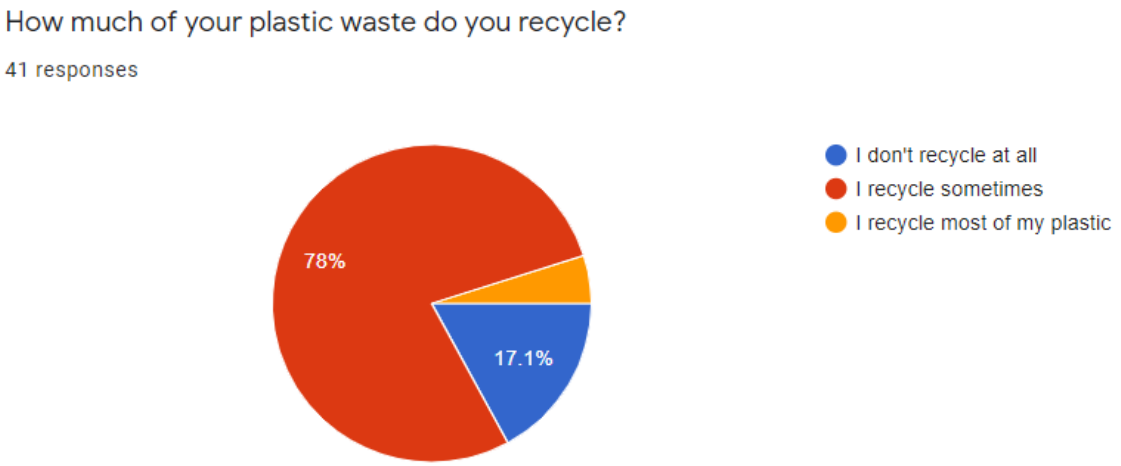
The list of identifiable objects were commonly cans, bottles and paper, which are also under the components paper, metals and plastic, so they were the ones focused on.

The Study & Methodology: Ideation, description of study

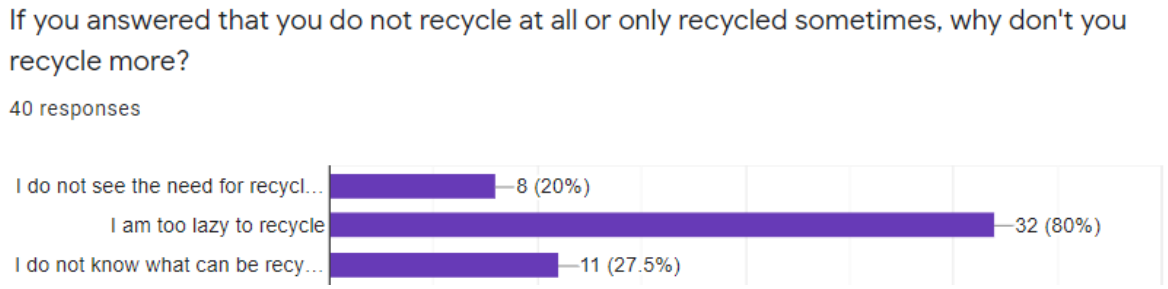
It is necessary to reduce the workload of workers in waste management facilities through reducing non-recyclables that end up at waste management facilities, while encouraging more people to recycle. This project is meant to tell people where to recycle, preventing people from accidentally recycling non-recyclables and reducing the need for workers to sort recyclables.

Investigations, surveys (Needs analysis and user feedback), experiments, research methods (development platform, tools used)

Our survey found that only 2 out of 41 respondents recycled most of their plastic, only 4.9% of our respondents. 78% of respondents recycled sometimes while 17.1% did not recycle at all, showing how recycling is not very common in Singapore.



Respondents state the reasons they do not recycle most of their plastic. 11 respondents, more than a quarter, indicated that it was because they are unsure of what can be recycled.



Conclusion from survey

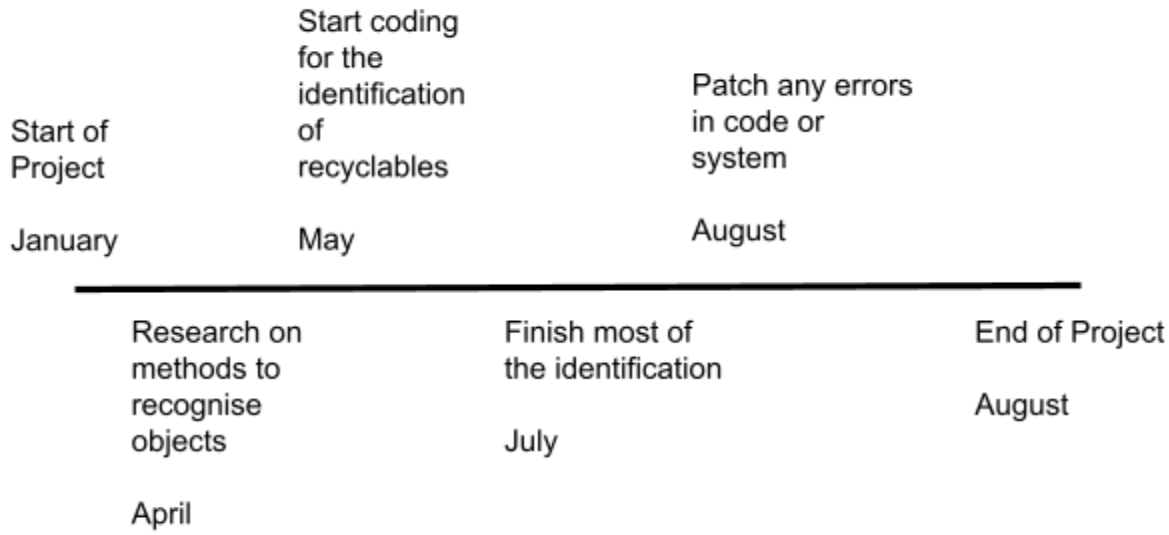
It can be concluded that many people do not recycle due to a lack of knowledge of what can be recycled, and would appreciate a programme that can identify objects for them for recycling.

OpenCV-python and YOLO object detection were used to complete our project. Using a cfg and a weights file, YOLO is able to identify objects by placing them in various classes, which is decided through the classes.txt file prepared. The code sorts the input from the webcam frame by frame to place grids to identify items.

Members role and job distributions

- Shen Jiaqi 3A3 (24) - Leader, coded the foundation of the programme to utilise YOLO for object recognition, helped to organise discussions with our mentor to improve on our project, and identified shortcomings in our program to patch errors.
- Zhong He Cheng 3A3 (32) - Researched on how to identify custom objects and coded the programme to create the cfg and weights files to do so.
- Zechariah Wong Shin Jaan 3A3 (31) - Helped to code the OpenCV and YOLO program to identify plastic bottles, and helped to carry out the machine learning process to identify custom objects
- Pek Yu Xuan 3A3 (22) - Wrote and organised the written report, helped to carry out the machine learning process to identify custom objects.

Project timeline



Outcomes, Analysis & Discussions

Code: The object recognition code made is capable of identifying recyclables from a mass of other objects.

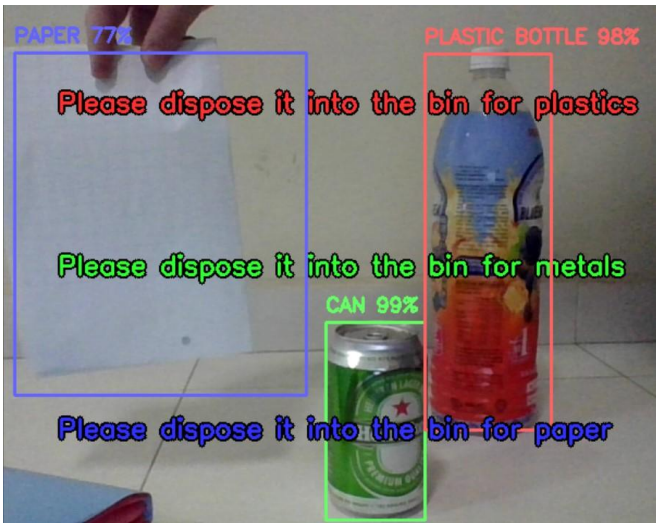
System (Camera and Screen): Shows the person what the recyclable is on the screen. The screen will direct the person where to place the recyclables

Our project can identify recyclables people would be holding, informing them to dispose of it into respective bins to help sort their recyclables into categories such as plastic, to place the materials in the right bin.

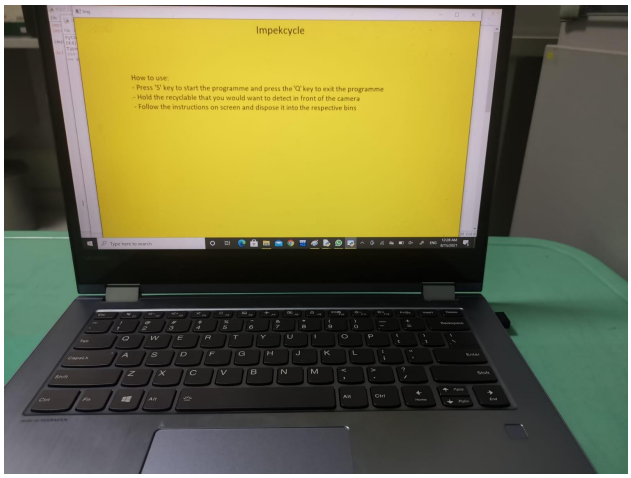
This image shows the program recognising the can when placed in front of the bin.

The object recognition is capable of functioning with interferences, seen by the file, calculator and phone not wrongly detected by the program.

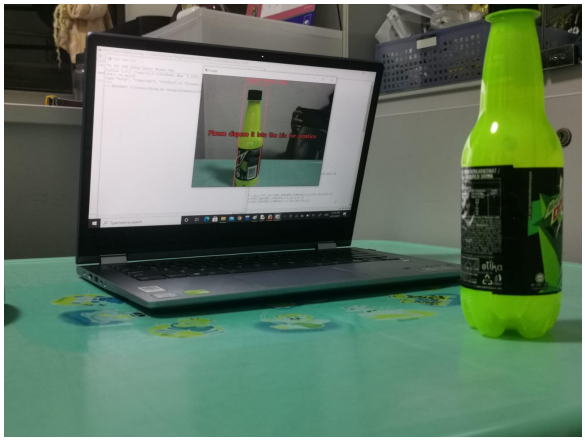
The image below shows all three recyclables detected at once. The rectangular boxes and text are colour-coded to not confuse users when there are too many recyclables on screen at once.



The image below shows the setup, and it is user-friendly with the instructions



The image below shows how the user can use the program to detect the recyclable



Implications and Recommendations

It may not be effective in encouraging people to recycle more, as they may still feel that it is too time consuming. This programme would also not be completely automatic, requiring the user to place the materials into the right bins.

The system itself may be fragile as the camera may get damaged.

The system could be made automatic, with further improvements to the code added to sort the items automatically.

Reflections

Shen Jiaqi [3A3 (24)]

I have learned a lot more about object detection and identification, which was interesting and could be useful in the future. I have also gained experience in leadership. It made me more aware of the responsibilities that leaders have, such as coordinating group members' work and communicating with the group's mentor.

Pek Yu Xuan [3A3 (22)]

I have learnt the importance of applying one's strengths and distribution of tasks. I am not too capable in the coding component of the project, so my part was mainly in the presentations and written work, alongside research to help ease some workload and not cause more trouble in the area of coding.

Zhong He Cheng [3A3 (32)]

Being one of the main coders in this project has allowed me to understand how difficult it can be to research on ways to make the programme work. Since this was also my first time being one of the coders, it was definitely challenging. However, it has allowed me to further enhance my skills in computing to learn new things.

Zechariah Wong Shin Jaan [3A3 (31)]

I've learnt the importance of staying on task. By staying on task and doing our work before the tests came by, we avoided the problem of not meeting the deadline. Thus, our quality of work would not be affected by time constraints, and thus we managed to finish the project.

Bibliography:

1. A whopping 91% of plastic isn't recycled. (2018, December 20). National Geographic News. https://www.nationalgeographic.com/news/2017/07/plastic-produced-recycling-waste-ocean-trash-debris-environment/
2. CNA. (2020, July 31). What happens to the trash you toss into the recycling bin? YouTube. https://www.youtube.com/watch?v=REEdz8jE6NA&ab_channel=CNA
3. RecycleNSave.sg. (n.d.). RecycleNSave.Sg -. https://recyclensave.sg/
4. Roberts, F. (2017, October 5). Smart bin from Polish start-up Bin-e set to sort UK recycling problems. Internet of Business. https://internetofbusiness.com/smart-bin-bin-e-recycling/
5. Academy, C. (2020, May 28). Python: Real-time Single & Multiple Custom Object Detection with Colab (GPU), Yolov3 and OpenCV. YouTube. https://www.youtube.com/watch?v=DLngCtsG3bk&feature=youtu.be
6. OpenCV Python Tutorial #1 - Introduction & Images. (2021, February 9). YouTube. https://www.youtube.com/watch?v=qCR2Weh64h4&list=PLzMcBGfZo4-lUA8uGjeXhBUUzPYc6vZRn&ab_channel=TechWithTim
7. YOLO v3 EASY METHOD | OpenCV Python (2020). (2020, June 26). YouTube. https://www.youtube.com/watch?v=GGeF_3QOHGE&ab_channel=Murtaza%27sWorkshop-RoboticsandAI
8. Ang, H. M., Co, C. (2020, August 1). *IN FOCUS: 'It is not easy, but it can be done' - The challenges of raising Singapore's recycling rate.* CNA. https://www.channelnewsasia.com/singapore/in-focus-singapore-recycling-sustainability-blue-bins-waste-1339091
9. Google Survey Form: https://docs.google.com/forms/d/119PZRjTfDUM_MQz2TpJVp6vq-UX40ZXCEIzW4Il7MiM/edit?usp=sharing