trash.py - A smart system ensuring proper waste sorting and eliminating user decisions

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ENGINEERING HONORS PROGRAM
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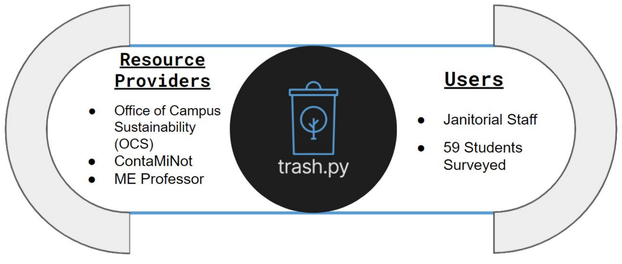
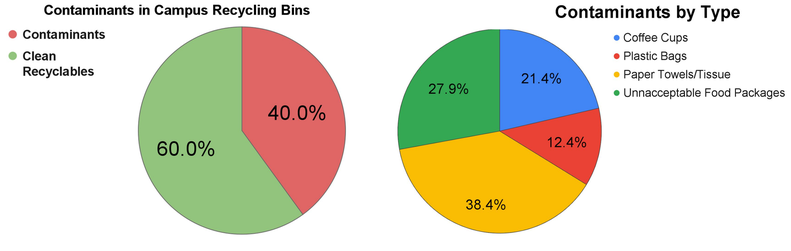
INTRODUCTION

For proper waste processing, the trash cans at the University of Michigan need to separate waste into different categories. These categories include landfill and recycling, and sometimes some others. The current burden for separating this waste is placed on the trash can user, with different labeled receptacles being provided for the user to decipher and manually separate their waste between. Relying on users to properly classify their waste causes problems. Some users do not care enough to throw their waste into the proper receptacles, resulting in the recyclables becoming contaminated, and potentially recyclable items being taken to a landfill. Additionally, one of the receptacles could become overfull, resulting in the users just throwing all their waste into the only available receptacles. We aim to address these problems by redesigning the trash cans at the University with an autonomous waste separation system. The bin will be able to detect whether an item dropped into the bin by a user is meant for landfill or recycling, and then navigate that item to the proper storage receptacle contained within the bin. **We aim to have a trash can that yields more valid/clean recyclables than the current system at the University.**

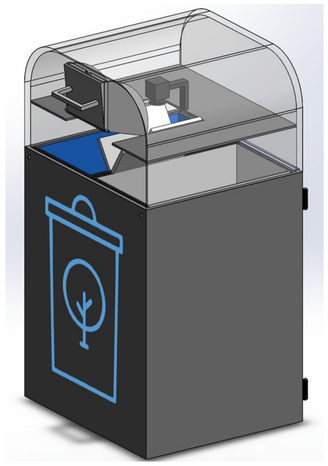
APPROACH



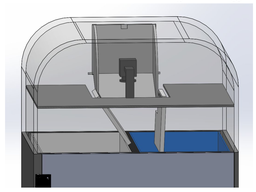


We obtained a lot of data and found that 40% of recycling is contaminated at UM. We also analyzed the data and found the largest contributors to this contamination. We used these findings to inform our design decisions

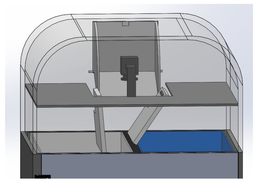
DESIGN CONCEPT



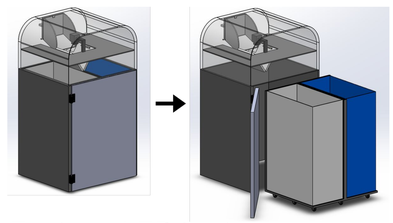
Case #1: Recycling



Case #2: Trash



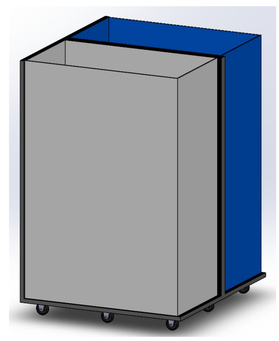
Feature: Roll out bin rack



Feature: LED lights

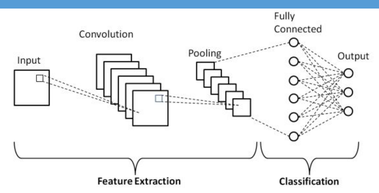
Green: Working properly
Orange: Full bin
Red: Not working / need Maintenance

Feature: Weight Sensing



Detects when respective bin is full and notifies staff

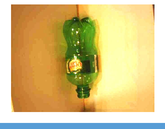
CONVOLUTIONAL NEURAL NETWORK



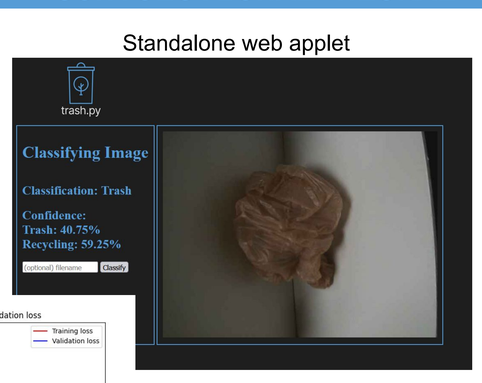
Generalization

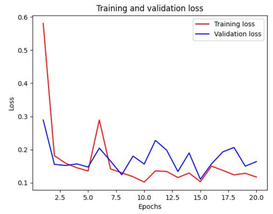
How does a NN trained on this…

Perform on this?



Standalone web applet





Problem: Class-Imbalanced Data
Description: The Number of data for each class in your dataset are different by many orders of magnitude (137 Trash, 2314 Recycling)
Solutions:

1. Random Over-Sampling(ROS)
   Pros: More Data
   Cons: More training time, Prone to Overfitting
2. Random Under-Sampling(RUS)
   Pros: Less training time
   Cons: Less data to train with

We fixed overfitting issue by slightly altering all copies added of the underrepresented class

CONCLUSION

After testing both our deep learning model as well as our staging area prototype, we can confidently vouch for the feasibility of our idea.

Validation Accuracy: 93%
User decisions are only accurate 60% of the time
Increase of 33%

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Projected equivalency of **873 tons** of Recycling per year

We hope to continue development and are already in talks with C-SED about deploying a trash.py smart-bin in their offices for testing.

MOVING FORWARD

Launch trash.py bin on campus

Add Compost to the sorting system

Educate users on recycling

ACKNOWLEDGMENTS

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