Overview

For maximum effectiveness, recyclable materials must be sorted. However, most places have single recycling bins or people do not pay attention to proper sorting. Sorting later is an expensive and labor-intensive task. The goal of this project is to create an open source image recognition library that will be able to recognize recyclable objects such as soda cans in an image of, for example, a conveyor belt carrying recyclable materials. Such image recognition would help to properly deal with recyclable materials by helping to sort them.

There are a number of existing tools to aid in image recognition. For example, OpenCV\(^1\) has many libraries involving facial recognition. We may be able to use some of these tools to help create a library for recyclable object recognition. I will begin by researching some of these tools and systems and learning about them. I will use several of these tools and see what can be accomplished with them. Then, I will begin to write code to create the new open source library for recycling. This part of the project will have several phases.

Phase 1

I will begin by finding a way to detect and recognize objects, such as bottles or cans that are in good condition. This initial step will require the program to detect the location of the object in an image and then analyze the shape in relation to some known shape characteristics in

\(^1\) http://opencv.org/
order to determine the identity of the object. This will be useful in separating cans from bottles from other recyclable materials.

**Phase 2**

The second phase of the project will be to use optical character recognition (OCR) to read the labels on cans and bottles and parse the information. This can be used to find the exact product or brand, in order to study what products are most often recycled at a location, and also to determine whether or not the item can be redeemed for money. This will be useful, because it would allow the system to pay for itself by finding redeemable cans and bottles to earn money.

**Phase 3**

The third phase of the project will be to identify objects that are not in good condition, such as squished or broken cans or bottles. These objects cannot usually be redeemed for cash, but they still must be separated correctly to recycle. This will be more difficult than identifying bottles and cans in good condition, because the items will have much more varied shapes. This will involve analyzing what damage might occur to these items and in what ways they can commonly be misshapen.

**Hardware**

The project will begin using still images of items on a light background, so that image recognition is initially simplified, but at some point, we will move to use a camera attached above a surface that will either film or take snapshots of the items going underneath it. This will make image recognition more difficult, as the background will no longer be completely white and the objects will not be exactly centered, but we may be able to see more angles of a particular item, and thus be better able to read labels or infer shape. Eventually, the setup will
also have an arm that will be able to move the objects. This can be used to separate cans and bottles into two different piles in order to sort the recycling. It can also be used to reorient a particular object or to see a different side of it. This may be necessary to read an entire label or to find information about redeeming the item. That information is not always found in the same place on an item, so the system would do best to be able to find it.

**Future Steps and Application**

If this project succeeds, there are many applications for it. The incorporation of robotics will allow the system to sort recycling by type so that the labor-intensive task of dealing with incorrectly segregated recycling can be eliminated, thus making recycling more efficient and sustainable. It will also be able to earn money by separating out items that can be redeemed for cash. This way, it will be able to identify enough of these redeemable items that it can pay for the hardware and electricity needed to run it, thus making it a more attractive system for real recycling companies who may not otherwise want to spend money on it.

**Deliverables**

At the end of the project, open-source code for doing the image recognition tasks will be made publicly available. A short project report describing the use of the code will also be prepared.