RRRobot! (Reduce, Reuse, Recycle)

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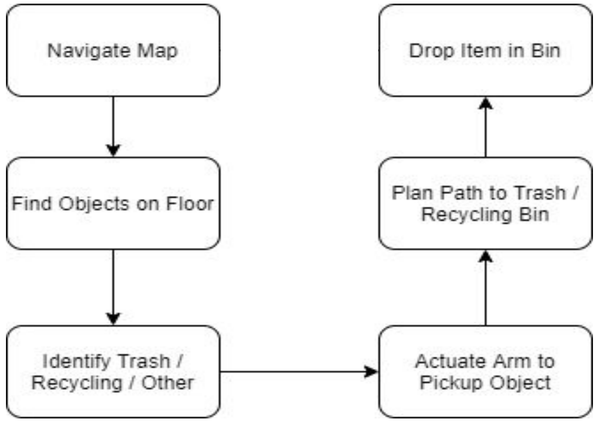
Motivation

Garbage sorting is very important for the sustainability of the environment. This is not an easy task as sometimes we put a snack wrapper into “recyclable” carelessly because we are limited in time. We may even be confused about whether an item is considered trash, recyclable, or compostable. This leads to a large burden on workers in recycling plants who need to reclassify garbage, which is very tedious. Luckily, robots and machine learning can help us automate this process.

Deliverables

- MBot with an integrated RexArm, and a depth-sensing camera
- Software to locate obstacles, classify trash/recyclables, manipulate end-effector, plan a path through the environment, and accurately control the robot’s movement

Process Flow

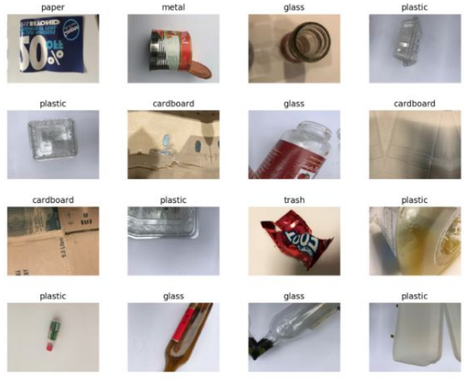


Methods

Image Classification

Image classification is a common application of computer vision. Neural networks trained on large datasets of images can be used to place new images into categories. Our robot will use a neural network to identify objects that it encounters in the environment and properly dispose of them according to their classification.

ImageNet from the Stanford Vision Lab is an image dataset containing millions of labeled images. Using a neural network pre-trained on this dataset and then fine-tuning on the objects we may encounter will help us improve the accuracy in garbage sorting.

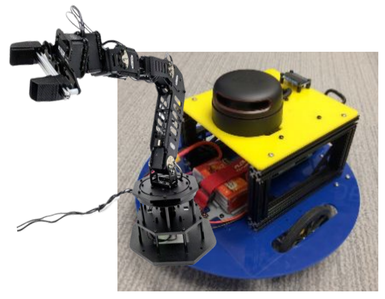


Inverse Kinematics

After identifying an object, we need to employ inverse kinematics to control the arm to grasp it and to put it into the correct trash box.

Criteria for success

- Robot should plan a path around obstacles and avoid collisions
- Correctly classifies trash and recyclable items, and knows what items to leave alone
- Can grasp items of various sizes and shapes
- Reliably identifies garbage can and recycling bin, and places items in the correct location
- When placed in a cluttered area, the robot should clean all trash and recyclables off the floor



Challenges

- Navigating environment
  - Lidar may be too high to sense small objects on floor like plastic bags
- Sensing & Classifying Objects
  - Do we need to collect a dataset of disposable objects and hand label them?
  - Will publicly available datasets be sufficient?
- End Effector Design
  - What design will allow robot to grab objects of all shapes, sizes, and orientations?
  - Where will we source the end effector from?
  - Do we need to 3D print a custom end effector?
- Robot Arm Manipulation
  - How will we fuse sensor data from lidar and camera?
  - Controlling MBot movement and robot arm movement relative to MBot may be difficult