The Litter Bug

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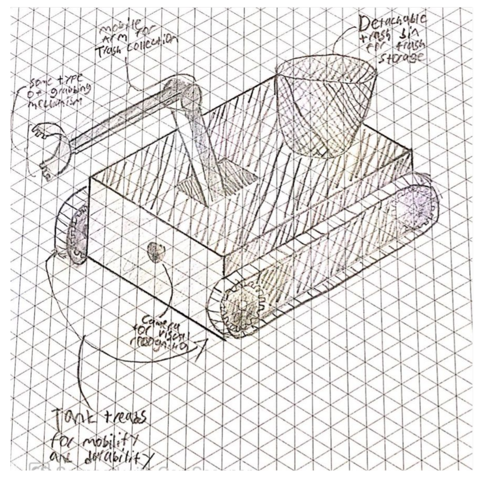
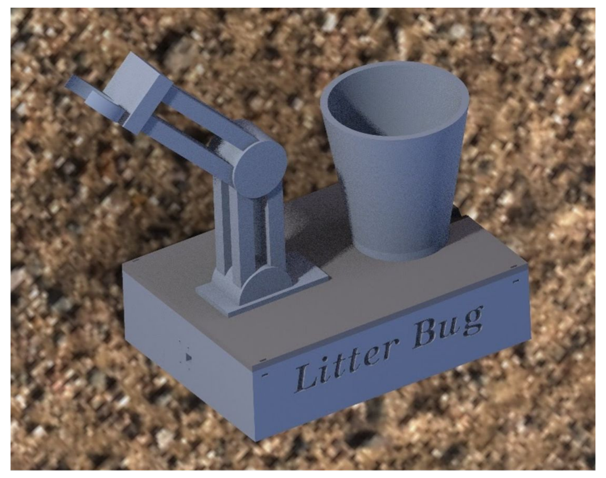
Background

- Litter Bug is an autonomous, eco-friendly robot that picks up litter
  - It uses object detection to recognize trash
  - It drives over to the trash, picks it up, and puts it in an attached basket
- Litter Bug reduces the waste that harms the surrounding environment, watershed, and ecosystem
- It reduces the time and money spent on litter cleanup, as it is easy to use and cheap to build

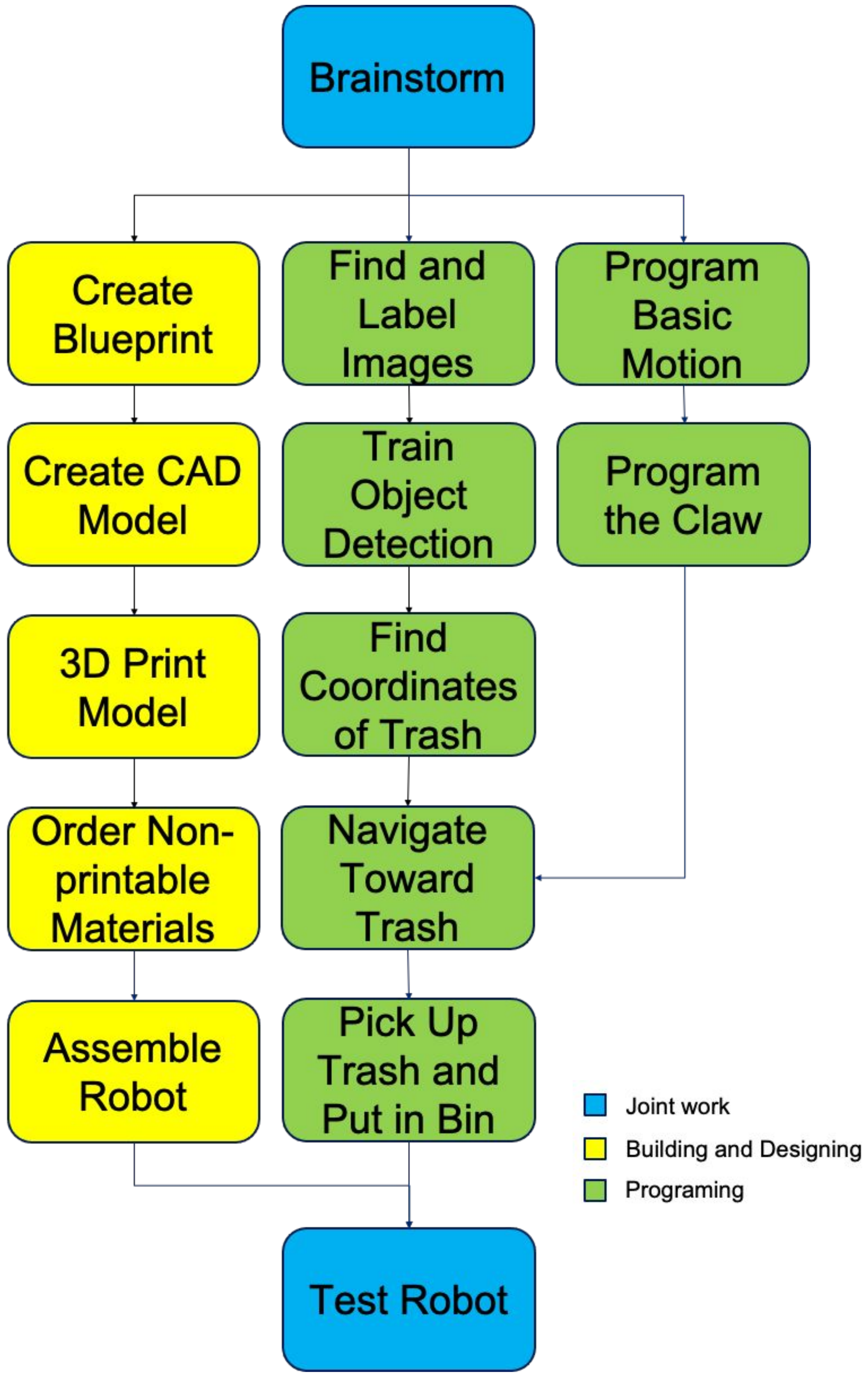
Designing and Building the Robot

- Sketched 3D drawings to visualize our initial ideas
- Designed detailed Computer Aided Design (CAD) models based on initial designs
  - Included a detachable basket by creating a clip-in system with a spring.
  - Created motor, camera, & Raspberry Pi holders, easy attachment systems, and wiring paths.
- Designed a base for the body, but ended up using a prebuilt base with motors
- incorporated reusable zip-ties as fasteners
  - Sustainable, reusable, & easy to take off to work on inside of robot
- 3D printed models described above
  - Used eco-friendly PLA Plastic as printing filament

Programming the Claw

- The claw moves toward a set of coordinates relative to its base
  - Assigned frames to each joint to identify the location of the end point relative to the base
  - Created a function that inputs the angles of each joint using the frames and outputs a set of coordinates
- Used machine learning to calculate the angles from the coordinates with a regression model
  - Predicts the angles from any set of coordinates you input
- Coordinates of the trash are then received from the camera so the arm can pick up the trash



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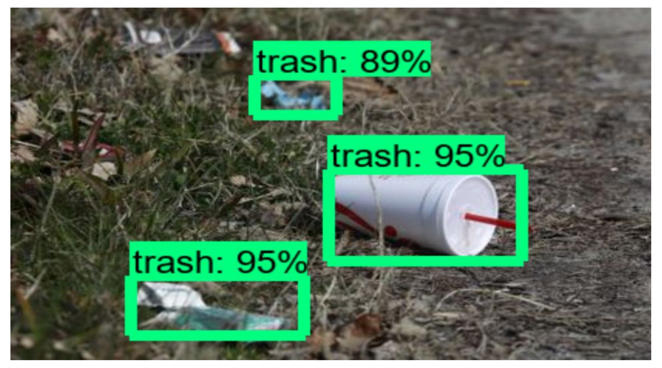
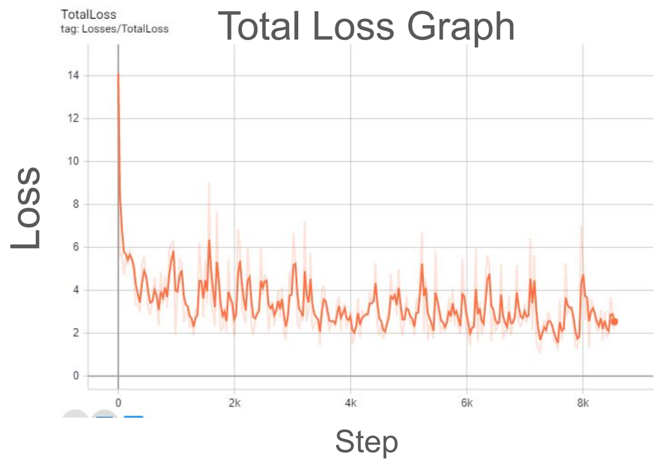
Litter Bug

Object Detection Neural Network

Trained model on Windows 10:

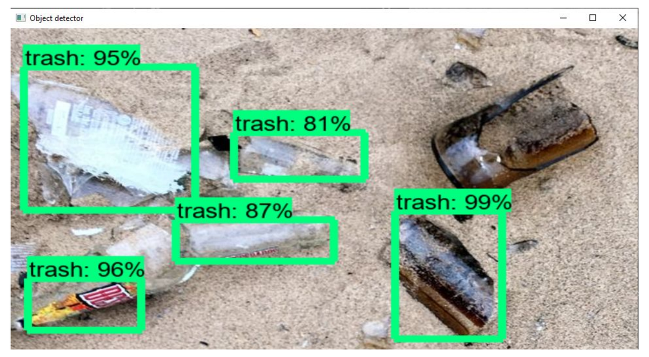
- Found and labeled 1,500 images of litter using LabelImg
  - Cardboard, bottles, cans, wrappers, etc
- Trained a Tensorflow Lite (TF Lite) object detection neural network (a quantized SSD-MobileNet-V2 model)
  - Generated TFRecords as input data
  - Created Label Map (defined class names & IDs) and configured training (defined the model and parameters)
- Ran the training for 8,500 steps until the loss was consistently around 2.00

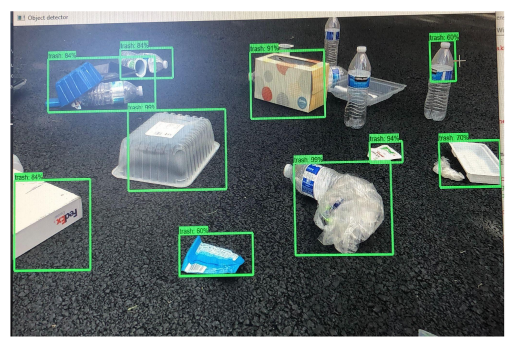
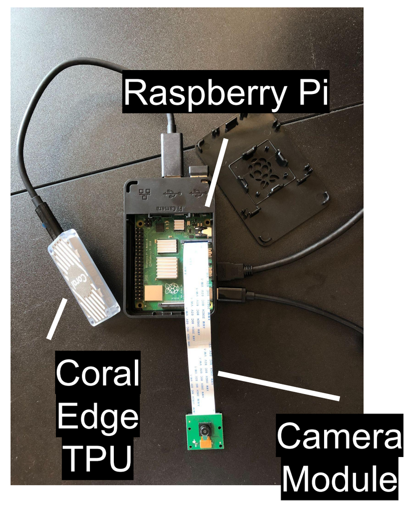




Ran model on Raspberry Pi:

- Converted model to work with TF Lite interpreter
  - Created a new TF Lite Label Map
- Set up Camera Module, Tensorflow Lite, and OpenCV on Raspberry Pi
- Set up Coral Edge TPU (Sped up the model)
- Ran model on photos, videos, & through Camera Module
  - It could accurately detect most trash with a bounding box, but often had false positives
  - It works better in videos & at a higher angle



Navigation

- The robot inds coordinates of the object detection bounding box
- It detects if the box is in the left or right of the screen
- The robot adjusts itself so the object is in the center of the screen
- It moves forward, continuously adjusting itself
- When it is about 30 cm away from the object, it stops

Future Work

- Gather a bigger, more inclusive training dataset
- Train model to detect objects other than trash to reduce false positives
- Assemble the robot and test the sensors
- Test if the robot can efficiently navigate to the trash (we had optimized publicly available code for our purposes)
- Test if the claw can pick up different types of trash (bottles, cans, wrappers, etc.)
- Test if the robot can withstand various conditions and locations (sidewalk, rain, etc,)