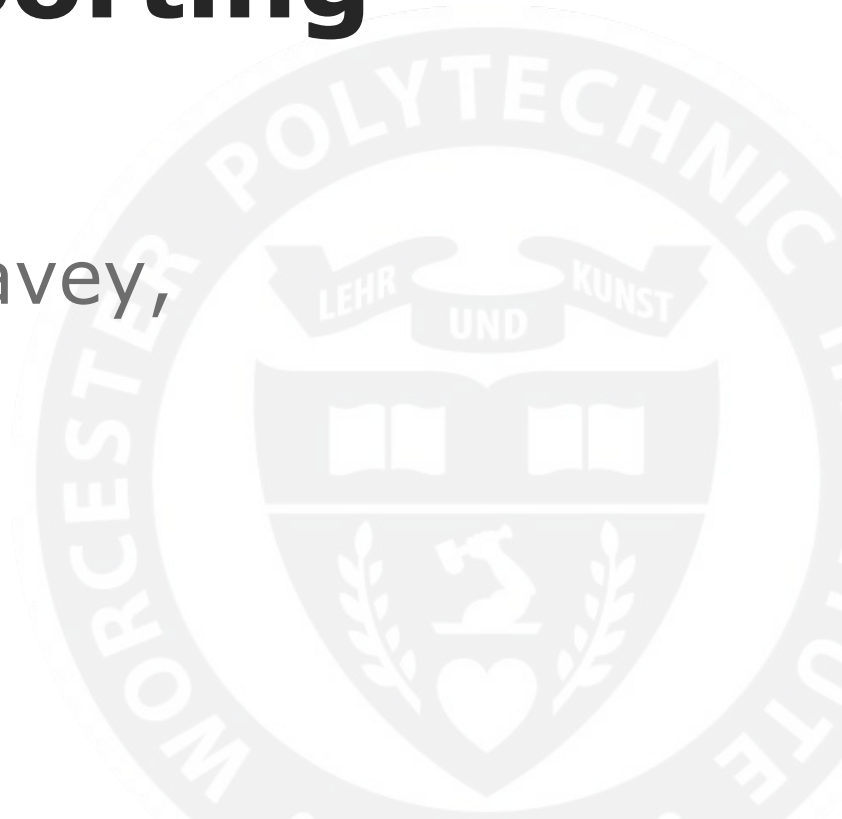




WPI

Robotic Waste Sorting MQP

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Abstract

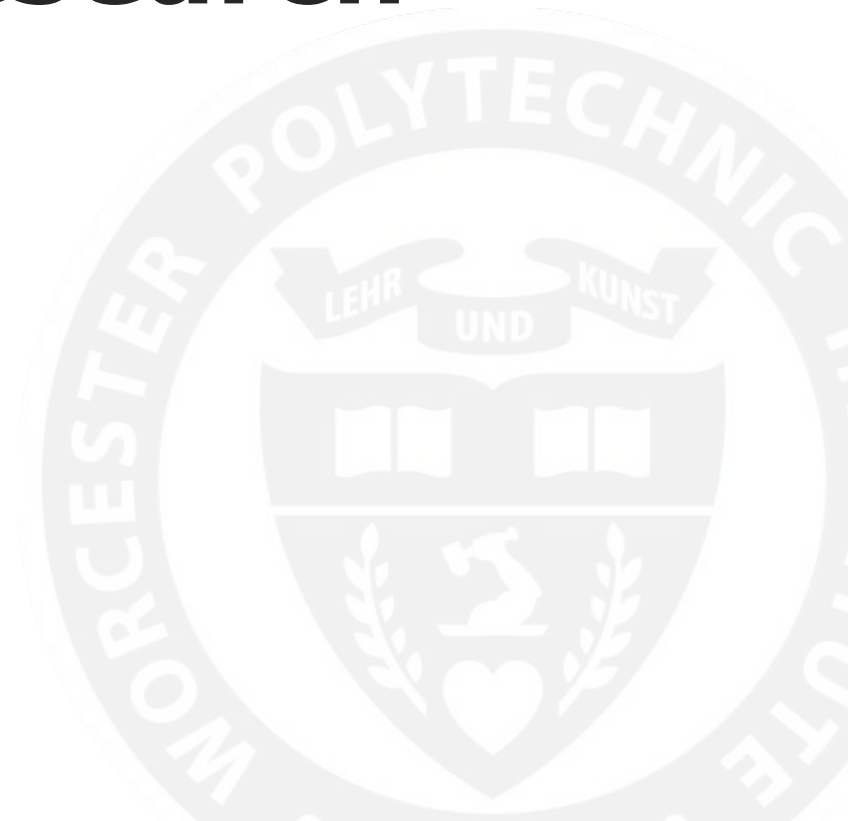
What is Single-Stream Recycling?

A system in which **recyclables** of all kinds (including plastics, paper, metal, and glass) are placed in a **single** curbside bin by consumers.

Our Project

This project contributes to the long-term goal of developing a waste-sorting robot to efficiently sort single-stream recyclables. Our goal for this project was to develop a test bed suitable to simulate a real-world recycling plant environment containing a robot capable of identifying and removing cardboard from a stream of mixed recyclables. At the conclusion of our project, we succeeded in constructing an X-Z Cartesian platform together with its rail system and steel frame housing, a five-joint linkage arm that is mounted on the Cartesian platform, and a three-jaw gripper designed for effective cardboard picking.

Background Research



Current State of Recycling

- China's National Sword Policy
 - Enacted in January 2018
 - Strictly regulated recyclable waste imports, allowing for no more than 0.5% contamination
- 45% of global recyclable waste exports had previously been imported by China
- Cleaning and sorting down to 0.5% contamination is often prohibitively expensive
- Recyclable waste is being sent to landfills or third-world countries
 - Recyclables, including plastics, are often burned in these countries instead of being processed

Consequences of Single Stream Recycling

Benefit

Increased recycling rate

Consequence

Decreased quality of the materials recovered



Rejection from waste processors

Adjustment

Employ human workers as sorters

Error

Unfortunately, these workers are exposed to intense stress, dangerous machinery, and hazardous materials



Current Robotic Solutions

MIT RoCycle

- Detects size and stiffness of item by grip
- Slow moving, grabs one item at a time
- Uses existing baxter platform



Samurai

- Delta Robot arm
- Suction cup gripper
- Detects objects with vision

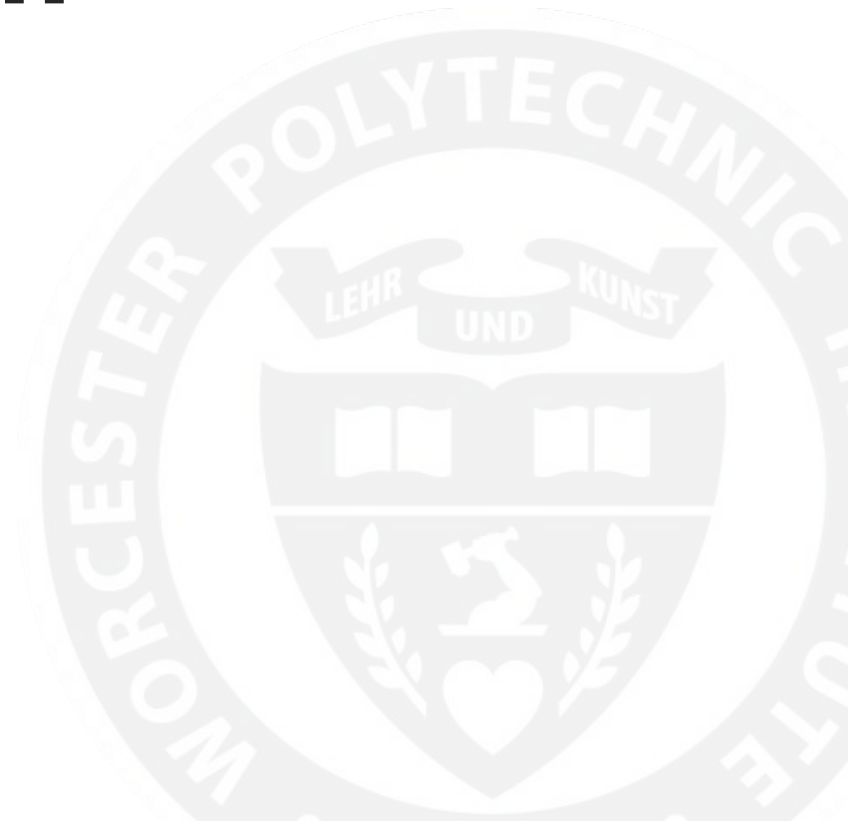


BHS Max-AI AQC - CoBot

- Designed to work alongside human workers
- 2 arms tracking separate objects



Design and Implementation

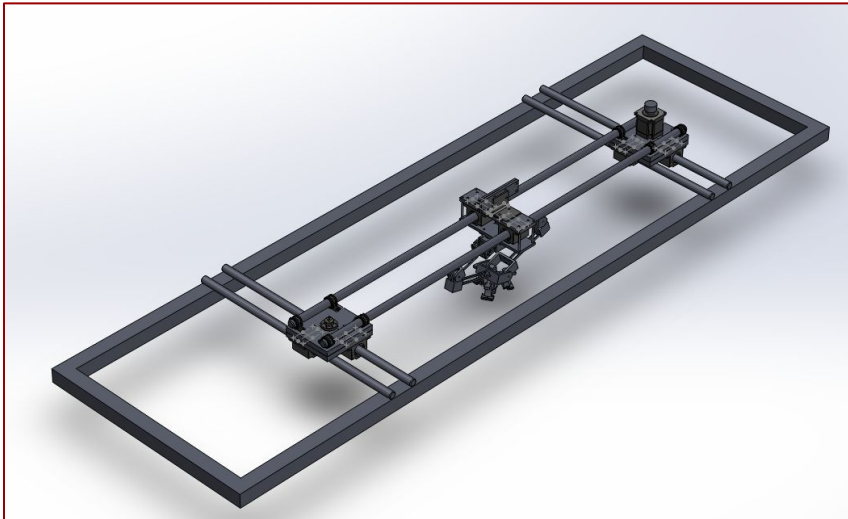


Design Criteria

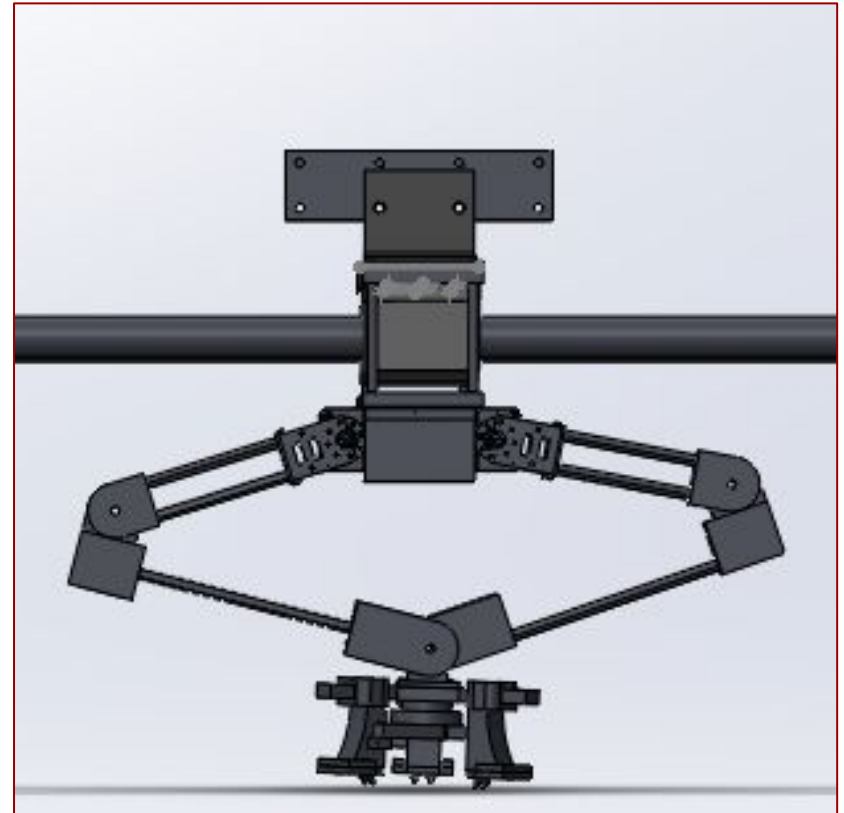


Mechanical Components

Frame



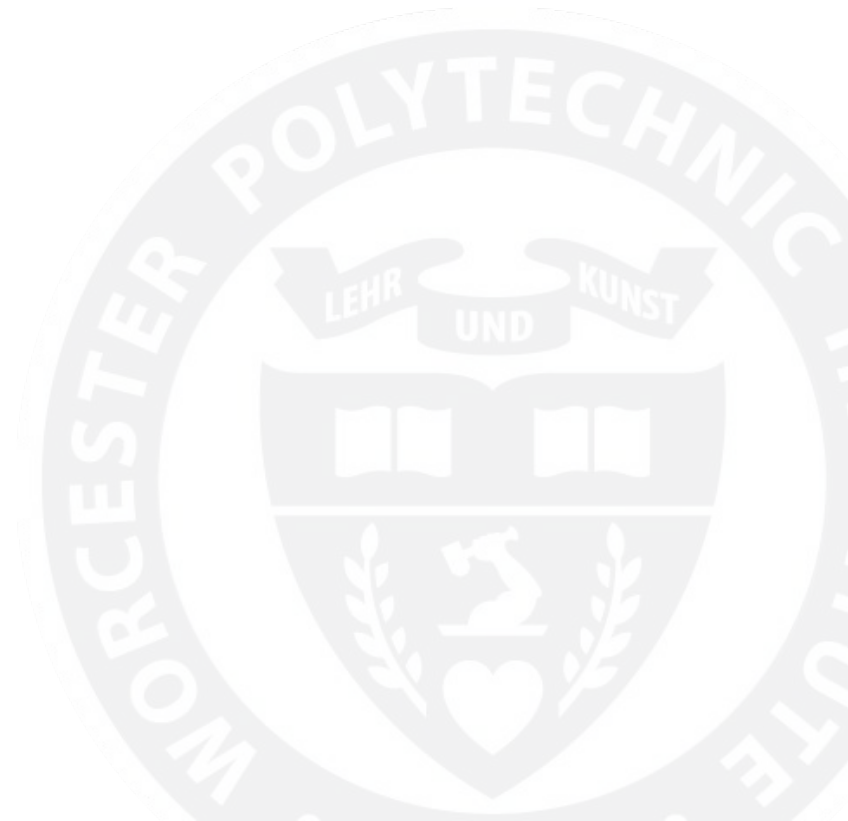
Arm with Gripper



Control System

- Software Control
 - ROS Melodic using Python 2.7
 - PC with Ubuntu 18.04 as the ROS Master
 - Raspberry Pi 4b with Raspbian Buster using ROS
 - Teensy 3.6 Microcontroller running Arduino C/C++
- Actuators
 - Stepper motors for X-Z Cartesian motion
 - Dynamixel servos for arm and gripper with integrated PID control
- Safety
 - Stepper motor limit switches
 - Emergency stop functionality utilizing AC relay circuits

Conclusion



Conclusion

- Our team was successfully able to design, purchase components, and begin assembly of the robot and test bed.
- We gathered extensive information about the current state of recycling to fully understand the problem in order to find the best solutions.
- Given more time on campus, our team would have completed assembly and implemented software capable of moving the robot's end effector to cardboard pieces and pick them up.