

FIU

Applied Research
Center



DOE-FIU Cooperative Agreement Annual Research Review - FIU Year 3

Automation of Waste Segregation Using Robot Manipulator

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*Worlds
Ahead*

Advancing the research and academic mission of Florida International University

Overall Needs:

- Currently personnel are utilized to segregate low-level waste in a space efficient manner.
- Automation of this task would enhance the safety of the personnel and increase the speed and efficiency of the work.

Objectives:

- Create an end-to-end solution for waste segregation of low-level waste that have arbitrary geometric and inertial characteristics.
- Leverage state-of-the-art algorithms in fields such as manipulator kinematics, deep reinforcement learning, and computer vision in order to equip a robot arm with the ability to sort waste.
- Investigate other avenues for enhancing the performance of the solution.



FIU Year 3 Highlights:

- Integrated a segmentation machine learning model made by DOE Fellow Aris Duani Rojas into ROS2 via topics and custom tree nodes for the UR3e's behavior tree.
- Developed a C++ program to take input from the segmentation model and the depth camera's data and reconstruct a point cloud of identified objects in a 2D image.
- Interned at the Engineer Research and Development Center (ERDC) for the Army Core of Engineers and developed software for collaborative task management between a fleet a robots.

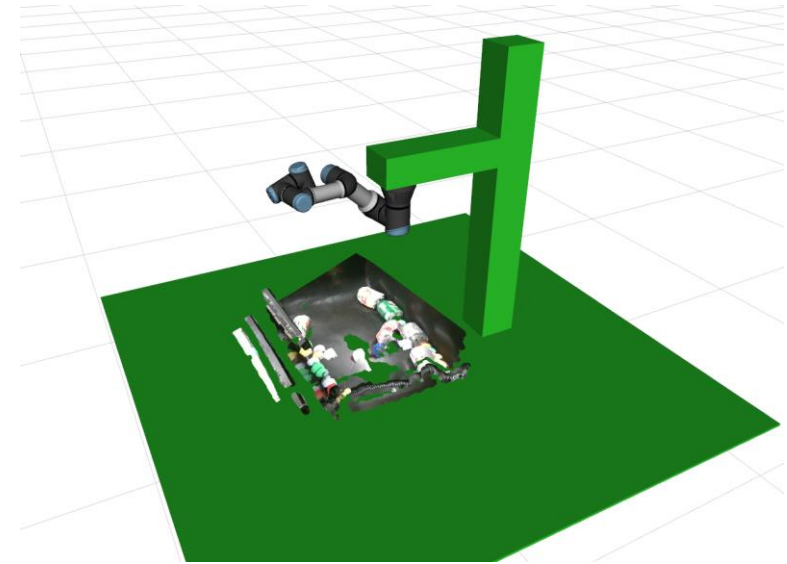


Figure 1: Visualization of live robot data such as depth camera points, URDF, and virtual kinematic constraints



Figure 2: Live results from segmentation model looking inside the simulated waste bin

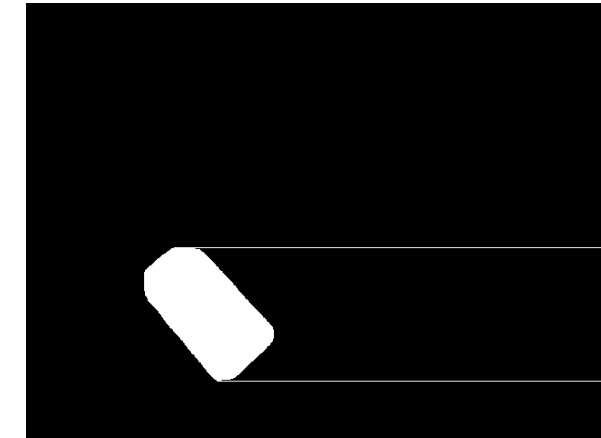


Figure 3: Point-in-polygon algorithm was used to determine which depth image points to isolate for point cloud

Waste Segregation Progress:

- Software for object detection, isolation, and point cloud building is intended to work time step by time step so that multiple angles can be captured with the moving robot arm.
- Segmentation is capable of making errors; however, it is exceptionally rare and appears to be very robust.
- The point cloud reconstruction using depth camera data still has issues to be worked out.

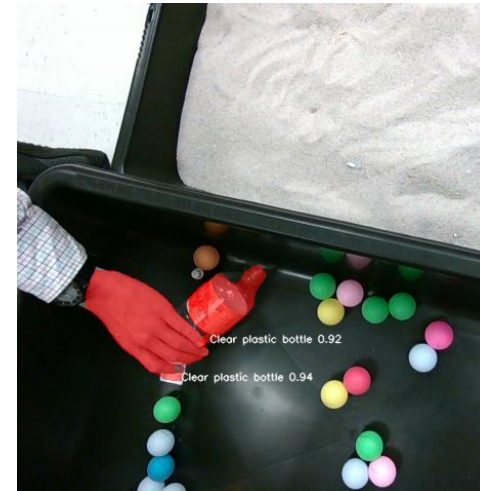


Figure 4: Mistake that segmentation model can make

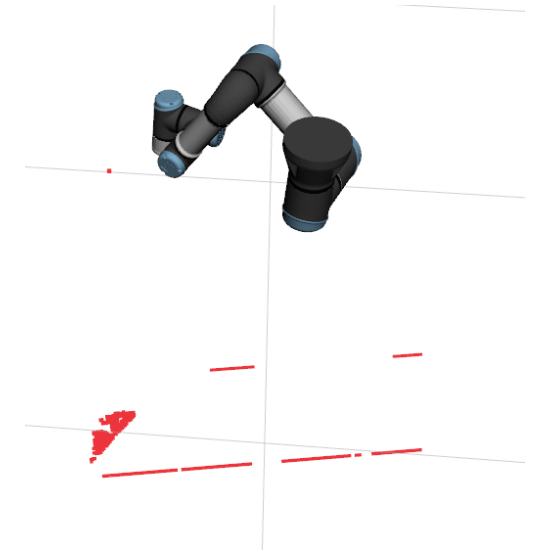


Figure 5 : Imperfections that occur as a result of single object point cloud reconstruction

2023 Internship at ERDC:

- Utilized two large mobile robots to develop fleet management software in C++ by centralizing a task board node on a parent robot using a parent-children paradigm.
- Tested various experimental uses of tools such as the ROS2 domain-bridge and ROS1 bridge.
- Gained invaluable experience in computer networking, ROS2, and other fields.

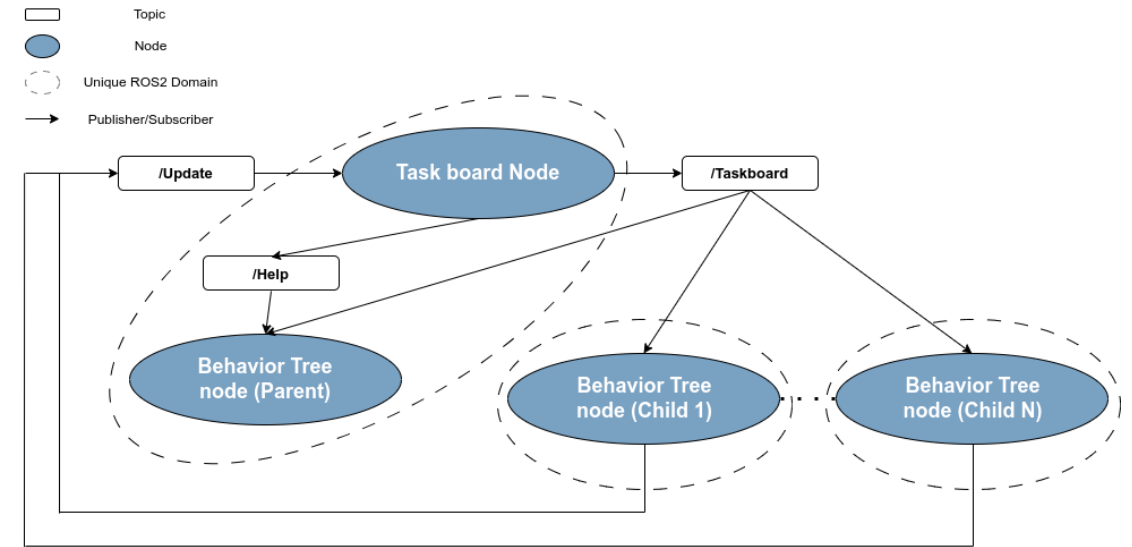


Figure 6: Diagram of task board node and how it enables communication between platforms



Figure 7: Two robots used for testing the task board software stack

Future work

- Bring together all software developed for the UR robot and begin testing simulated waste segregation.
- Fix issues experienced with collaborative robot software, bring multiple platforms at ARC up to speed, and integrate into the developed stack.
- Make a path forward for PhD dissertation proposal that utilizes work from both projects.



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Thank You. Questions?