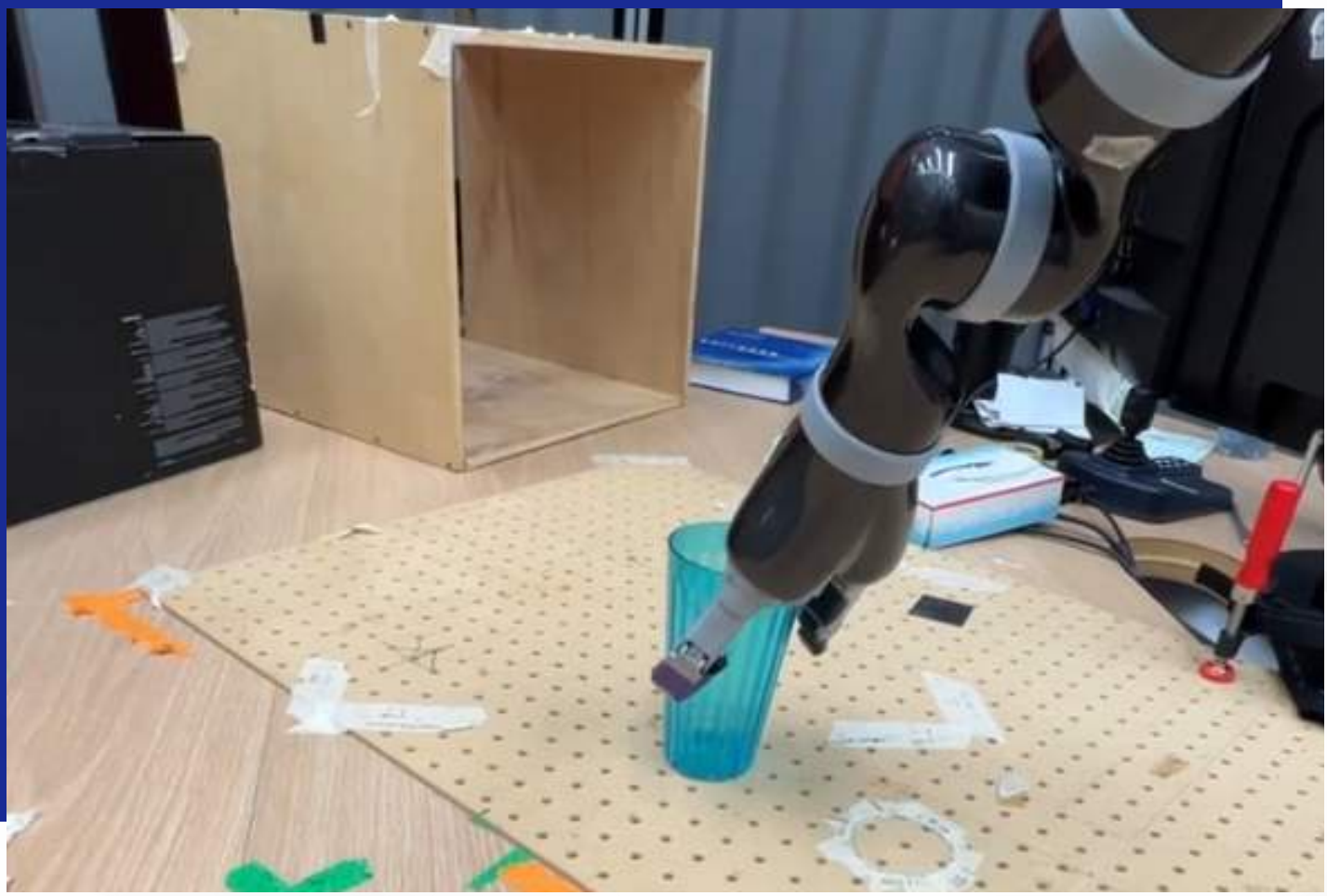


ENABLING AUTONOMOUS GRASPING WITH THE JACO ARM FOR ACTIVITIES OF DAILY LIVING

Case study

Northwestern University

KINOVA

The challenge

Implement Autonomous Grasping for Assisting in Activities of Daily Living Using the Kinova Jaco Arm

While teleoperation can be great for many robotic grasping tasks, it is still limiting because of the burden on the user to control the arm, direct its movement, and get the right grasp angle. With autonomous grasping, we can circumvent these issues. For activities of daily living (ADLs), having the option for generalized autonomous grasping can help users with a range of tasks. The goal driving this project was to implement a method for autonomously performing general grasping tasks that can be applied to future research in the lab.

The approach

In the initial stages of this autonomous grasping project, Ava Zahedi, a graduate student pursuing a Master of Science in Robotics at Northwestern University, found that MoveIt has Deep Grasps, a demo that uses neural networks with MoveIt Task Constructor to simulate autonomous grasping on a robot arm. This used ROS Noetic, which integrated well with the existing codebase the lab was using with the Jaco. This was deemed a good starting point for this project, but the Deep Grasps demo required some adjustments to reach a usable state.

After the necessary changes, she was able to adapt Deep Grasps to the Jaco arm, then progress beyond the demo to get the Deep Grasp demo working on hardware. After that, she incorporated new functionalities on top of the modified base demo to work with objects in the real world and make the pipeline as autonomous as possible.

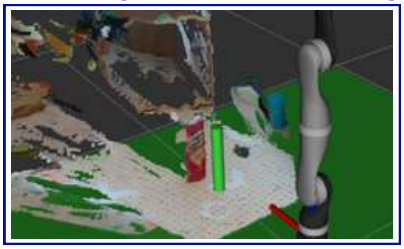
The key objectives

- Generate grasp poses for the Jaco to move to.
- Have Deep Grasps work on hardware in addition to simulation.
- Identify objects and their locations in real time, and be able to pass them into the neural network.
- Incorporate her solutions with existing internal Jaco code.

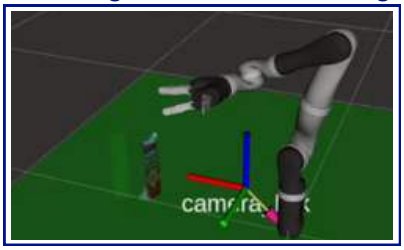
The results

She was successfully able to adapt MoveIt Deep Grasps to the Kinova Jaco arm. She was also able to move beyond simulation and run the included demo on the real Jaco arm. Furthermore, she added live object detection using a RealSense camera, so a range of objects could be grasped using this pipeline. The RealSense provided her with RGB and depth images as well as point clouds. This vision system included live point cloud generation, segmentation, and filtering based on objects detected and semantically labeled using YOLOv8.

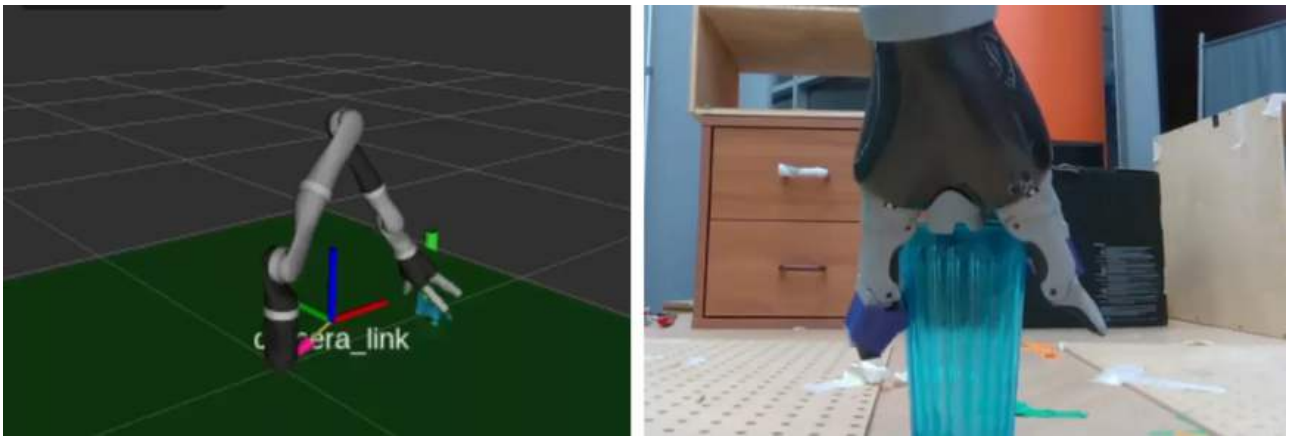
Before segmentation and filtering



After segmentation and filtering



YOLOv8 object detection



Click here to watch the video

All together, the final pipeline is as follows: the user provides an object that they want the Jaco to grasp. Then, with the help of YOLO, when the camera detects that object in its view, its location is identified and used to filter point cloud data. After the point cloud is segmented to be of just the object of interest, it gets passed into Grasp Pose Detection, the convolutional neural network used for generating viable grasp poses. Once a viable grasp pose is selected, MoveIt Task Constructor begins planning a path to reach the object, pick it up, and place it in a predetermined location. If the plan is successful, the trajectory executes.

Overall, the project was a success and accomplished many of the goals she set at the beginning of this journey.

"Robotics has so much potential to improve quality of life, and I'm happy I could work on a project that serves that purpose. Both as a learning tool and a hardware solution for assistive technology, the Kinova Jaco arm has been critical in the success of this autonomous grasping for ADLs project. I'm grateful that Kinova shares my same goals in having dedicated supportive technology."

- Ava Zahedi, MS in Robotics at Northwestern University

A brief description of your university...

The Center for Robotics and Biosystems (CRB) at Northwestern University is a part of the McCormick School of Engineering. There, we have strong research in many branches of robotics. Argallab, led by Dr. Brenna Argall, is the lab I worked with during this project. This lab focuses on assistive and rehabilitation robotics and aims to leverage robotics autonomy to improve human ability.

Your role within the university...

Jaco Grasping Planners was my capstone project while pursuing my Master's of Science in Robotics (MSR) at Northwestern University. The MSR program has a project-based curriculum designed to promote learning by doing and the opportunity to have hands-on experiences in robotics. As a graduate student, I had the unique opportunity to learn from some of the best roboticists in the field and also make contributions of my own through individual and group projects.

A situation you were encountering that required you to seek out a company like Kinova...

When I was welcomed to Argallab for this project, there were already some projects using the Kinova Jaco arm. As an assistive robotic arm, the Jaco was a great hardware option for my project in its goal to help with activities of daily living through generic grasping tasks.

Describe your first impressions of the product...

I was surprised by how lightweight the Jaco arm was and its workspace given its size. I feel that for robots in close interaction with humans, having a non-threatening appearance while maintaining functionality is important, and the Jaco accomplishes this.

The impact of this solution on your project...

Having a high degree of freedom robot meant for assistive robotics was certainly helpful for accomplishing my goal of being able to reach a large workspace and a variety of objects. I was also happy to be able to interface with the Kinova Jaco using Robot Operating System (ROS). I felt more comfortable using a robot that was explicitly meant to be used in an assistive setting, especially because many robot arms are for

environments where the arm is not expected to be interacting with a person regularly. It's one thing to design a solution in concept, but the closer that development is to the reality in which it will be used, the better.

Who would you recommend this product for?

For anyone doing assistive robotics, the Kinova Jaco is a leading option for assistive robot arms. A robot arm specifically designed for this type of task allows for more comfort and flexibility in developing solutions. Additionally, the Jaco can be mounted on a wheelchair, expanding the use cases even further.

KINOVA

Kinova is a global leader in designing and manufacturing robot arm for various applications in the Industrial, Professional, Academic and Medical markets and for Assistive technologies. We have for mission to provide humanity with robots that empower them to achieve the extraordinary everyday.

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The argallab's research lies at the intersection of artificial intelligence, rehabilitation robotics and machine learning. By easing the control burden of assistive machines, the argallab strives to advance human ability through robotics autonomy.

The Northwestern Master's of Science in Robotics (MSR) program features an intense, hands-on curriculum that prepares students for the robotics field with the support of remarkable faculty, abundant resources, and state of the art facilities.