Developing a More Effective Open World Assistive Grasping Technique

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Abstract

Many people with motor disabilities are unable to complete activities of daily living (ADLs) without assistance. However, there are very few options for using robotic manipulation technologies to help these people perform the manipulation tasks required by ADLs. To this end, the Helping Hands Lab has developed a robotic system consisting of a robot arm mounted to an assistive mobility device which enables users to grasp and manipulate novel objects in complex environments. Using grasp detection algorithms we can achieve a success rate of 90% in a non-mobile scenario and 72% in a mobile scenario. This project explores the potential of under actuated grippers, such as the Yale Open Hand, to improve these grasping success rates.

Problem Description

Difficulty with performing activities of daily lives has risen in the lives of various generations all around the world (ADLs). One of these activities is lifting up simple objects, which either due to their inability to reach the object or due to lack of motor ability in limbs and joints. A new generation of lightweight and human-safe robot and robot systems are being developed to aid those with difficulty. However, one of many problems within these systems is the grasping feature. The hand system must be able to detect objects placed 2 feet away from Baxter.

Methods

Building Python Script

- To plan the trajectories and motion of Baxter, an IK Solver was used
- After importing the necessary functions and packages, the script was written to allow for simple motion, plug and swap of values, and to enable grasping without calibration

Computational

Establishing Script to Run Grasp Process

- After enabling BAXTER, RVIZ was launched and run
- RVIZ was used to determine the X, Y, and Z coordinates of objects on the table in front of BAXTER
- Once the coordinates were saved, they were plugged into a python script
- The script was later programmed to perform a set of planned functions
- First, the BAXTER arm would go into its home position
- Afterwards, the right arm would navigate on the shortest trajectory and path to the object programmed to pick up
- The arm would reach a pre-grasp position, wait, open its gripper (standard or Model O) and proceed to the grasping position
- After a one second wait, the gripper would pick up the object and retreat back to its home position.

Results

- Figure 11 shows the success rate of each degree orientation for picking up a cube with the standard gripper for three trials.
- Figure 16 shows the success rate of each degree orientation for picking up a cube with the Model O Hand for three trials.

Conclusion

In conclusion, our new grasping technique of multi-surrounding space usage was far more effective than the standard grasping techniques. This is primarily seen between the success rates of the different grasping techniques, one that revolves around the surrounding and one that is contingent upon itself. In grasping a simple block, the standard gripper failed to pick up the block at a 90 degree orientation successfully. However, the Model O hand along with multi-surrounding techniques achieved a 100% grasping rate with only one failure in the second trial of the 135 degree orientation. Moreover, the newly developed technique achieved a homogenous 100% grasping rate for picking up an irregular object such as a book at both 180 and 90 degree orientations, with one partial completion at a 135 degree orientation. Compared to its standard counterpart, the original gripper failed to grasp the book completely. This is primarily due to the undersized fingers. With the Model O, the hands have a larger finger-span and can easily slide along any surface. However, the original gripper is restricted to the size of the object as well as the orientation it comes in to due to its limitations.

Future Plans

The research to find an effective grasping method will continue. To further advance this project, different grasping techniques could be implemented and studied to monitor which technique is most effective. Moreover, experimenting with different objects and platforms would allow for a more seasonal and detailed visualization to the most effective grasping method, technique, and orientation for all objects. With Belief Space Planning and multi-joint hand systems, grasping techniques could be improved and developed for a substantial amount of fields in life and science.

Primarily, the next step of this project would be to incorporate this project (physical and computational system) into the assistive robotic scooter project that is currently in the works. Alternatively, our work will primarily be used to develop the current in place models. This work and technique involving multi-finger gripping could be used for Amazon, NASA, and Google Inc.

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