Feroze Naina M Dheen Mohamed Ismail
Team D - HARP
Teammates – Alex Brinkman, Rick Shanor, Abhishek Bhatia, Lekha Mohan
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Individual Progress

Since the last project review, I worked primarily on integrating and testing the entire grasping subsystem and collecting data for failure analysis.

The code I had previously developed was sorting grasping patch quality based on their alignment with the vertical Z axis. However, it was not evaluating the proximity of the grasp surface's normal to the centroid of the point cloud. As a result, if points from the shelf were accidentally segmented along with the item (which is a common occurrence as the cardboard shelf is deformable), the grasping points would lie on the shelf causing the suction gripper to grasp the shelf itself.

To remedy this, I added a modified centroid approach for computing correct grasp surfaces. The median X and Y position of the pointcloud was computed. A weight inversely proportional to the distance of a given grasping patch from the computed median X and Y was added to the grasping quality metric. The median was computed instead of the mean as it was more robust to noise and incorrectly filtered point clouds. Figure 1 shows the simulation and actual robot side by side. The top 6 grasp points for the Cheezit box are visualized in the left image using red arrows. These grasp points are closest to the centroid.

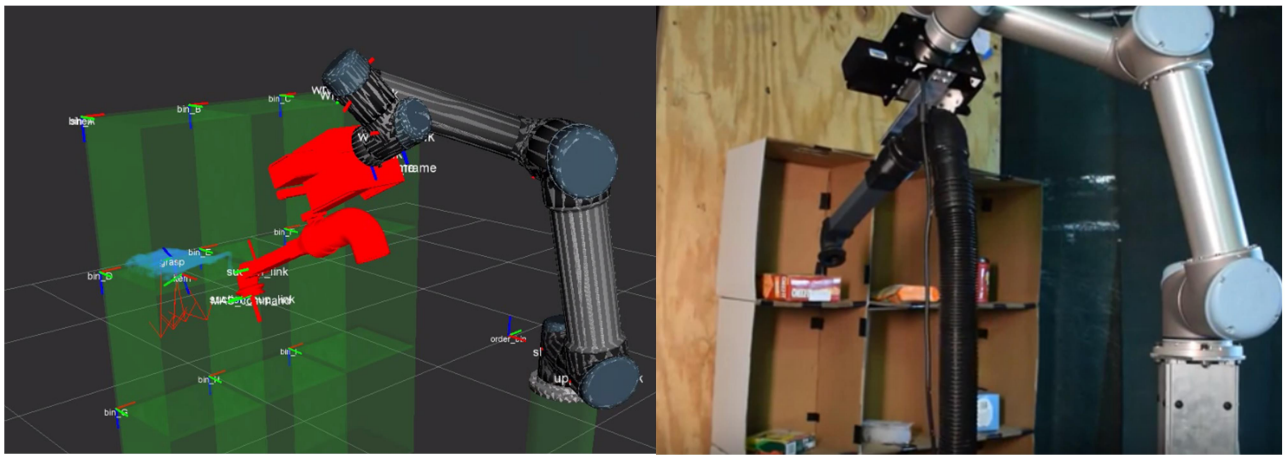

Fig 1: Simulation robot and actual robot.

During integration, I ran into a few small bugs and issues which were fixed. The cardboard shelf was not get getting filtered correctly as it deformed under load. A decision was made to use only the top 6 bins of the shelf as the bottom 3 were badly deformed.

The suction gripper's pressure sensing system was giving false negatives particularly in case of objects such as the box of Oreos as the plastic cover was stretchable. As a result the arm continued to iterate through the grasp points with the item attached to the end effector, damaging the shelf and the item. Alex fixed this by changing the threshold values.

For failure mode analysis, I created a spreadsheet to keep track of items, orientations, success rate and issues. I obtained consistently good results for the rigid objects such as the box of straws, Oreos and Crayola. I also got good results for deformable objects like the bag of feline treats.

I created scripts to automate launching all the ROS nodes and launch files in the correct order with delays. This will become essential when we switch and test the system with different perception and grasping pipelines. I also tested and debugged trajectory playback to speed up arm planning.

Challenges

The main challenge I faced was handling shelf filtering errors. I had to manually tune the minimum and maximum shelf limits in the x, y and z directions to segment out the shelf and these values changed for every bin.

There is also a 1 inch offset between the real end effector position and the simulation due to localization errors. This will be resolved when we switch to the rigid shelf.

Objects with translucent or shiny surfaces cause the Kinect to generate badly warped point clouds. An example of this is the box of outlet plugs which works only if the back-cover is facing upwards. In figure 2, the left orientation produces a badly distorted and unusable pointcloud. The right orientation produces a usable point cloud for generating grasping surfaces.

Fig 2: Box of outlet plugs

Our current grasping system cannot handle small items such as spark plugs due to localization issues.

Team Work

Alex helped me test and tune parameters for the shelf bin. He developed trajectory playback of arm to improve the planning speed. He also worked on setting up the pipeline to acquire and segment out green-screened images of various items using the turntable.

Rick, Lekha and Bhatia are continuing to work together to improve perception pipeline particularly for multi object identification and segmentation. Rick is working with Venkat from SBPL to modify their perception algorithm 'PERCH' to run with our system. Lekha worked on literature survey to develop methods for viewpoint estimation and object detection using convolutional neural networks.

Plans

We received the official competition shelf and items on 29th March. We have assembled the new 12-bin shelf and will be modifying our perception and grasping subsystem to accommodate this. Since the shelf is rigid, we expect to obtain better localization. Rick, Lekha and Bhatia will continue working on the perception system for handling multiple items.

I will work on increasing the accuracy of reaching the grasping point. This is particularly important as the new shelf is narrower and items would be closer together – we may accidentally pick up the wrong item or pick two items at a time.

Since the new shelf bins are deeper with non-symmetric dimensions, I will be working on changing the arm trajectory waypoints for this. I will also be working on creating a grasping strategy for translucent objects using only 2D RGB data from the Kinect.