Lekha Walajapet Mohan

Team D: HARP

Teammates: Alex Brinkman, Rick Shanor,Abhishek Bhatia,
Feroze Naina

ILR06

Jan. 28, 2015

I. Individual Progress:

For this week's progress I was working on improvising the perception algorithm and integrating the input handling and state machine controller. As our Fall Validation Experiment got over, we realized that our perception algorithm had an efficiency of 58% which doesn't meet our performance requirements as well as our Amazon Picking Challenge qualification. Rick and I decided to test merging of point clouds and see if we could get denser point cloud for identification. The method that I undertook was first registering two views of the point clouds using Iterative Closest Point algorithm and then merging them.

Algorithm for the Iterative Closest Point :

- For each point in the source point cloud, find the closest point in the reference point cloud.
- Estimate the combination of rotation and translation using a mean squared error cost function that will best align each source point to its match found in the previous step.
- Transform the source points using the obtained transformation.
- Iterate (re-associate the points)

This would align both the clouds and for merging them, it took their cloud points, added them for a denser cloud and projected it. It's results were favoring the denser point cloud as shown in the image below. We had twice the number of original points due to merging, whose statistics are listed below.

Figure 1. Unmerged ICP point cloud

Figure 2. Merged Point Cloud

Results:
Source Cloud(Figure 1): 84418 points (before merging)

Merged Cloud(Figure 2): 166995 points

My next task was to have the input output handling for the state machine controller. SMACH is a task level architecture for controlling the robot behavior. It is integrated with ROS and is an independent Python library to build state machines for our pipeline. The work order and bin contents are made into a JSON(Java Script Object Notation) file , I parsed it in order to read the work order, where the target items that made available for the robot to pick. I integrated the program into the state machine controller so that all the bin contents are read by the state machine controller and is available for the perception pipeline.

The output has a structure node that encapsulates the information of bin contents, target items, number of items, bin number. We can retrieve the data as per the JSON work input order.

II **Challenges**

Biggest challenge that I faced for this week was to design an algorithm that would render best merging point cloud. I took help of online forums and team mates to brainstorm the best merging methods and am still not sure if this is the most optimal way to go about it . Apart from personal challenges, the biggest challenge as a team that we faced was the latest updates in Amazon Picking Challenge, the first one being the change of hardware platform from PR2 to UR5. UR5 definitely seemed to perform better than PR2 for the required project scope and we are expecting our hardware to arrive by the coming week. The next biggest challenge was porting code from PR2 to UR5. It required modifications for us to migrate to the new hardware.

III **Team Work**

Alex was working on prototyping the end effector for the UR5. Owing to the design of UR5 he has designed a new mount for the Kinect. Keeping in mind the multiple views of the object

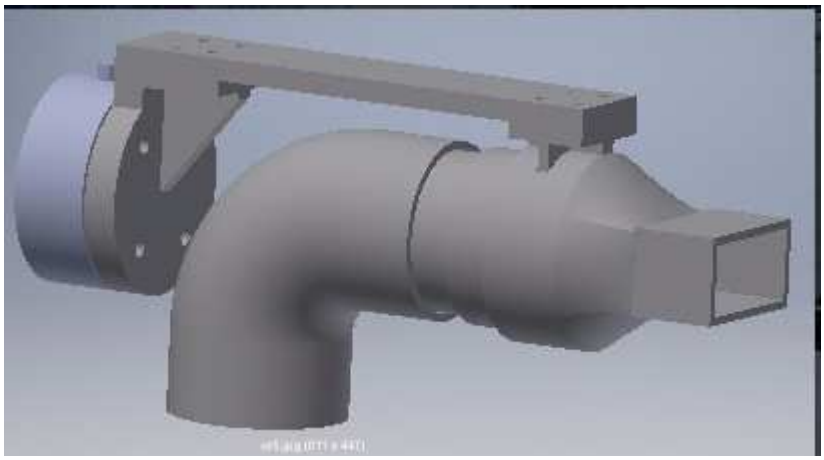

Figure 2 – CAD Model of the end effector

Rick was working on particle filter algorithm for the localization process. He was also working on CAD modeling the shelf for collision modeling and trajectory planning. We both together are working on improving the perception where I am evaluating various grasping algorithms for the point clouds. Feroze worked on designing the collision model and creating mesh models in the form of STL files. Feroze also worked on publisher for giving an estimate of allowable region for the end effector to travel. Abhishek was worked on collision model along with Feroze. He was experimenting with Object Recognition Kitchen by willow garage, which encapsulates several object recognition techniques. As we have possible cases of occlusion and cluttered environment, he had started evaluating the performance using ORK.

IV Future Plans

Our future plan is to build ground truth models once the list of items are released. We are also evaluating our performance with packages like ORK and SimTrack that essentially give greater dense clouds and will be helpful to build ground truth models for the objects. As we are expecting our UR5 to arrive in a week, we will also be religiously involved in its installation and build, creating Kinect mount, prototyping and testing the end effector. As per Prof.Maxim's guidance, we are also planning to integrate the SBPL's planner for UR5 for smooth path planning. As Amazon Picking Challenge has introduced a new stowage task, we will be developing and brainstorming strategies for stowage task in future.