INDIVIDUAL PROGRESS REPORT

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Team D: HARP

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

ILR02

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I. Individual Progress:

My contribution to the project team for this week was analyzing the game strategy for the Amazon Picking Challenge (APC) and working on the perception subsystem. Myself and Abhishek Bhatia were involved in analyzing the techniques deployed by the previous APC teams. The broad range of hardware platforms, grippers and subsystems used by various teams gave us an insight of several factors that our team should consider for our project. For example, our team decided upon suction gripper and on analyzing the game strategy we realized that suction gripper fails at meshed objects like bin, pencil cups etc.,. This made us think of alternative methods to grasp mesh objects, which also is a performance requirement as per our Conceptual Design Review.

As Research Assistant Professor Maxim has agreed to render his PR2 from his Search-based planning lab for our testing purposes, we are closely collaborating with him and seeking his technical advice for designing our advanced perception system. While I wanted to evaluate few more algorithms, Professor Maxim suggested that base algorithm is sufficient to start with, over which we can build up advanced perception algorithms designed from his laboratory. Hence, we re-evaluated our considerations and I will be closely working with his Ph.D student, Venkataraman who will also be acting as our technical advisor for this project.

I will be working on perception subsystem of my project along with Rick Shanor. We have been evaluating algorithms that would render good matches and recognize objects for a data set of around 1000 images. SIFT(Fig 1) and ORB detectors are most preferable one owing to their accuracy and rotational variance. Scale-invariant feature transform is an algorithm in computer vision to detect and describe local features in images. Oriented Fast and Rotated Brief is basically a fusion of FAST keypoint detector and BRIEF descriptor with many modifications to enhance the performance of feature detector.

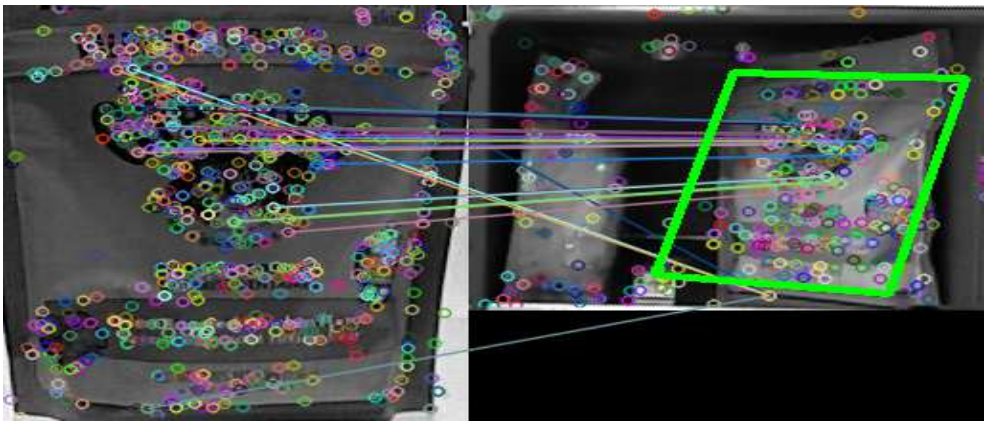

Fig 1. SIFT Feature Detector (Picture Courtesy: Rick Shanor)

In SIFT, we begin by detecting points of interest and convolve it with Gaussian filter and obtain its difference of Gaussian at various scales. Obtaining its maxima/minima renders the locations of interest points. Matches between these key points are obtained from which we analyze the accuracy of matches and noise produced.

II. **Challenges**

I faced many challenges the past week working on perception subsystem. Initially, I found it difficult to choose the right algorithm. I had to analyze the trade-offs in algorithms related to feature matching. With respect to my project, I realized that we didn't need the fastest algorithm, but needed a very accurate one. On experimenting, I also understood that some of the algorithms were rotationally invariant, where we had to look for algorithms that were robust to rotational variations and produced feature matches when images were rotated. As we don't have extensive knowledge in computer vision, we do face problems in various aspects of this subsystem often. My take away is that I need to get insights from more people with expertise in vision. I have been doing that but haven't been able to maintain consistency. I also need to work on time management such that I am dedicating proper 30 hours per week for my project.

My team faced problems in executing their respective subtasks. Abhishek found it difficult to gather more information on technical specifications used by previous team owing to the lack of information from official sources. Rick found it difficult to implement few algorithms from the Point Cloud Library whose debugging consumed time. I feel that this would be the case with any new software that we are trying to get hold on with. As we practice, handling new softwares should be less tedious. Alex and Feroze had problems pipelining perception node in the state machine, but were later able to debug it.

III **Team Work**

Alex and Rick were working on suction gripper(Fig 2) sub task the last week. As we wanted to test how a suction gripper works under various pressure conditions, we bought suction grippers of various sizes for testing. We were able to lift the heaviest object from the Amazon Picking Challenge dataset (Oreo cookie packet) yet, we did have shear force weakening the suction grasping. Feroze was working on setting up the state machine, pipelining various sub tasks of our project and got a dummy model working. Abhishek was working on game strategy analysis along with me, which helped us get a perspective of how to avoid grasp failures. Rick was also working on 3D point cloud data for computing homography and feature matching from Kinect data. As we intend to use Kinect RGB-D camera, this was quite critical in our project and with the help of Point Cloud Library, we will be developing its scope on object detection and later experimenting it under occlusion conditions.

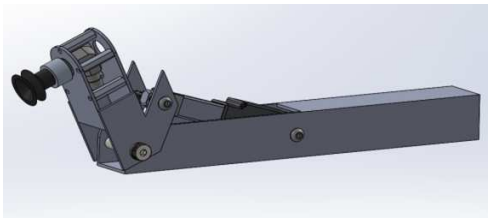

Fig 2. CAD Model of the suction gripper

III **Future Plans**

Alex will be working on establishing SMACH controller. Feroze will be working on moving arm from one point to the other. Abhishek will responsible for navigation of mobility base and Rick will be working on specifications for all the components required for our suction gripper. I will be working on feature matching and homography estimation from 3D point clouds.