

Alex Brinkman

Team D: Project HARP (Human Assistive Robotic Picker)

Teammates: Abhishek Bhatia, Lekha Mohan, FerozeNaina, Abhishek Bhatia

ILR #2: Progress Report

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## 1. Individual progress

This week, my progress was focused on developing a software specification, adding content to the website, adding functionality to the suction system, and helping with the computer setup. We decided it would be a good idea to develop a specification detailing our planned software architecture and interfaces before starting the software development. Having prepared similar documents in my past life at Caterpillar, I happily took on this task. The specification outlines the functionality of the main state controller which will leverage the SMACH library for executive task planning already ported over to ROS and has been demonstrated successfully on the PR2. The next layer in the software architecture consists of numerous supporting ROS services that will be invoked when the robot state changes that will handle the perception tasks and issue robot motion commands. The third layer will run as ROS nodes and will be responsible for interfacing with the perception sensors, robot base using the navigation stack, and the PR2 arm planning group to name a few. The spec goes on to detail the workspace setup, Github workflow, C++ and Python coding guidelines, and lessons learned.

Next, I added the content from our conceptual design review to the website. I wanted to gain experience building websites so I volunteered to take on this task. We plan to update the website on a weekly basis to reflect the latest status updates and display our weekly goals.

To better understand the needs of a suction system, we designed and made a bench setup to see how well suction cups work on picking up some sample items. We decided to source a pressure sensor to measure the real pressure drop from a low-flow, low-pressure pump and contrast it with a high-flow shop vacuum. I created the circuit to interface the sensor with an Arduino and used `rosserial_arduino` to run the Arduino as a ROS node, allowing us to stream the measured vacuum pressure in real time. Eventually, we plan to use a relay to turn the vacuum on and off when necessary using this setup. Figure 1 shows a trace of the suction pressure and shows a pressure drop as it contacts different items.

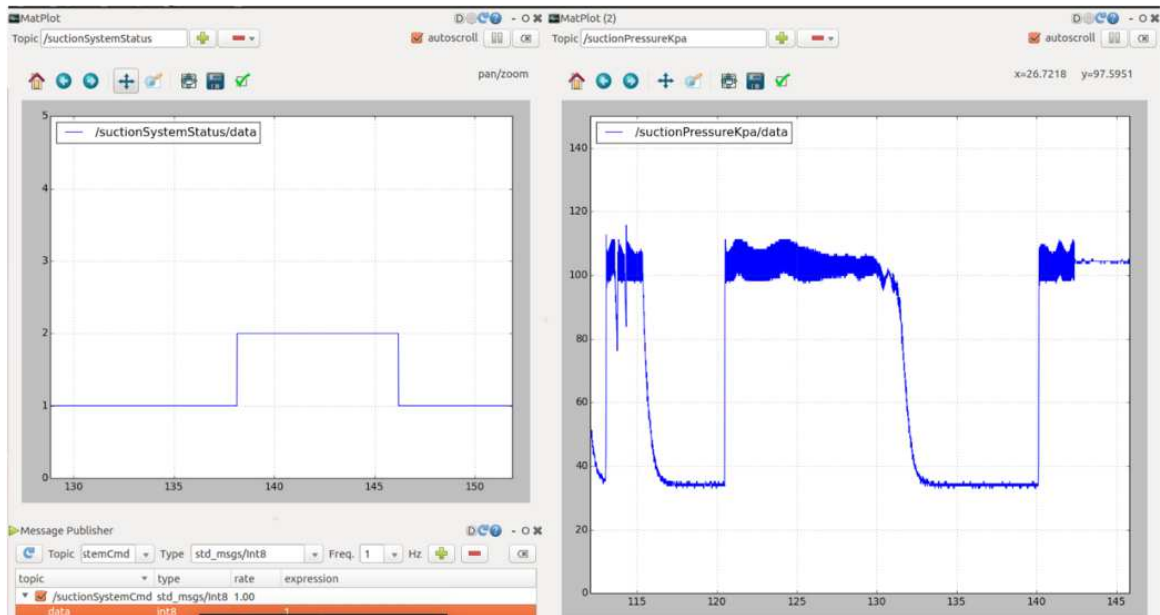


Figure 1: Suction System Pressure Trace

Finally, I contributed to our workspace system. We gained approval to use last year's computer for our project and set it up in at our lab station for better accessibility. We had to revert to a clean Ubuntu 14.04 install and I helped getting the ROS workspace established.

## 2. Challenges

The main challenges I experienced this week were primarily in getting the software to function correctly on the work station. We want to use a newly released Kinect2 in our perception system since it offers higher resolution images and depth cloud compared to the standard Kinect. Being so new, the Kinect2 is not yet well-supported in Ubuntu or ROS. I installed a library called libfreenect2 to interface with the sensor but was not able to successfully get it working. After consulting with the team, we thought we could work around this by updating to a newer linux kernel but were experiencing problems upgrading. We attributed this to the preexisting system setup so we had the past Pantrybot MRSD team take a copy of their code so we could start from a clean Ubuntu 14.04 build. This successfully solved the problems we had getting the libfreenect2to work with the Kinect2. The next challenge was getting the Kinect2 sensor working in ROS. We found a ROS package called iai\_kinect2 created by Thiemo Wiedemeyer from the University of Bremen but are currently having compatibility problems with OpenCL on our system. We plan to tackle this issue for next week.

The other notable challenge is not technical in nature but still affected our progress this past week. Each of us had to devote a lot of time to midterm exam

preparation yet we were still able to get the work done to achieve all of our objectives. We expect to have more time to devote to the project this week so we have raised our expectations for ourselves for next week.

### 3. Teamwork

This past week, we all spent a considerable time working together in the lab. I predominantly worked with Abhishek and Feroze on the software setup but having the whole team together allowed us to understand what each of us are doing and presented the opportunity to lend a hand if any of us are stuck on a problem. Overall, I think we are working well together and have finally settled into a natural workflow that has adapted to our individual personalities and work styles.

### 4. Plans

Our sponsor, Maxim Likhachev, wants to see our suction system functioning correctly on the 2015 Amazon Picking Challenge item list since we all feel suction is a good strategic approach to the competition. By next Thursday, we plan to teleoperate the PR2 with our suction system to pick up at least 7 items from the item dictionary. To accomplish this we have to revise our initial goals and decided to refocus Abhishek's planned work on the PR2 navigation system in ROS to creating the capability to teleoperate the PR2. I will be working with Rick on ordering and fabricating parts for the suction system, shown in Figure 2, to support the demonstration and finalize the suction system design.

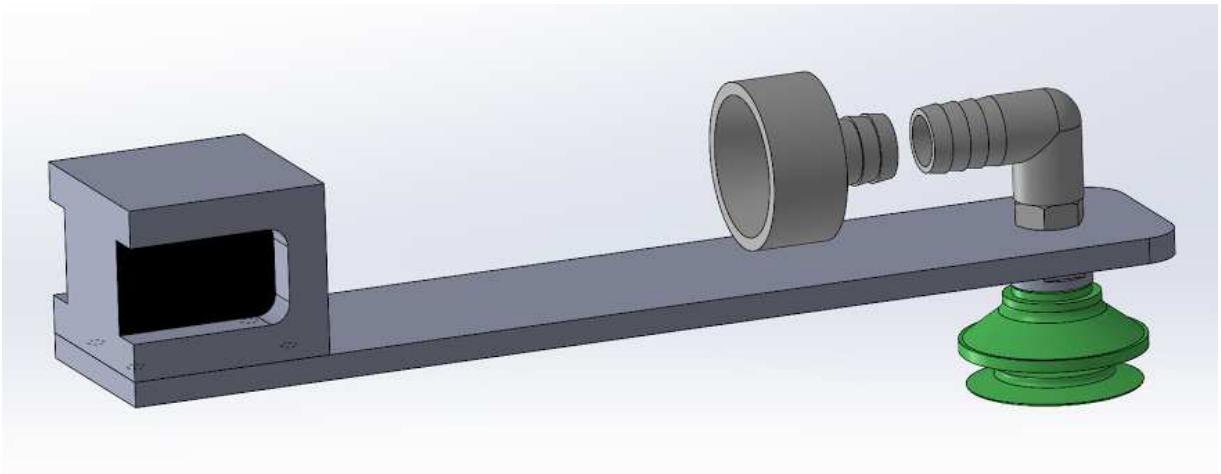


Figure 2: Suction System Prototype for PR2

My focus this week will also be on understanding the SMACH library and creating a first draft of the state machine controller. I expect it will take me approximately ten hours of time to understand the SMACH API and another 15 hours creating the state

machine controller for our project. Additionally, I will be helping Abhishek with the teleoperation of the PR2 as needed and helping Feroze with the Kinect2 OpenCL problem in ROS.

Rick and Lekha will continue to work on the perception system this week and will deliver a working feature recognition algorithm for next Thursday using SIFT for feature matching and RANSAC for pose estimation.