Alex Brinkman

Team D: Project HARP (Human Assistive Robotic Picker)

Teammates: Abhishek Bhatia, Lekha Mohan, Feroze Naina, Abhishek Bhatia

ILR #5: Progress Report

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1. Individual progress

This last week I contributed to the base controller, worked on the URDF PR2 model, started integration on the electronics and suction system feedback, and started development on the torso controller.

The base controller was developed using the low-level PR2 controllers. The controllers accept a Twist message that contains linear and rotational velocity commands. We will need to be able to send a position setpoint to place the robot in the world so a closed-loop controller is needed. The odometry from the wheel sensor is used to update the TF tree and this feedback is used to make a closed loop position setpoint controller for the base controller. I wrapped this functionality into a ROS server to allow calls from the state controller.

Next, I worked on integrating the customized URDF into the robot move for arm motion planning and collision avoidance. This integration proved very problematic for the MoveIt! arm planner and eventually had to be postponed to focus on more pressing deliverables.

After assembling the electronics, I worked to integrate the Arduino serial node with the suction control electronics and tested and debugged the pressure feedback from the vacuum system. We finished assembly of the electronics and wiring once we received the PCB and ensured the electronics worked correctly. We acquired pressure data to create a signal filter to provide feedback to the state controller. I suggested we look for a cleaner signal and we attempted to measure motor current rather than pressure to investigate

Finally, I developed a torso controller interface to extend the PR2 spine to be able to reach higher shelves. This is currently in progress.

2. Challenges

The main problem with the base controller is set point overshoot which we think stems from the simulation feedback. The controller feedback is based on the TF model which we think is not updating fast enough in simulation. We have decided to not invest time debugging the TF update rate in simulation because there is a good chance this will not be a problem on the actual PR2. For now, we are addressing this issue by adding a delay and letting the system settle down to the target set point before continuing with other actions.

The URDF models for the suction end-effector were added last week, however integrating our custom changes with the MoveIt! controller did not work out. Every time we modified the kinematic chain to include an additional link or virtual frame the ROS move_arm group would fail during startup. Since this work was not our focus, these efforts are postponed for now.

The challenge with the suction system now is getting a good signal that indicates when an item has been picked up by the suction end-effector. Currently we are using a

pressure sensor with an absolute range of 0 – 700 kpa. The vaccum line will drop to approximately 90 kpa when fully restricted and with the end effector the nominal pressure is approximately 95 kpa. This means we are using 1% of the pressure sensors operating range and need to find changes in that range to find objects where the seal is not perfect. We were hoping to get a better signal from measuring the current from the vacuum motor so we procured a current sensor and wired it in. We discovered the changes in current for partial sealed items was not a better indicator than the pressure signal. The current response is shown in Figure 1 and shows good detection of fully sealed grasps but lacks the ability to detect partially sealed grasps.

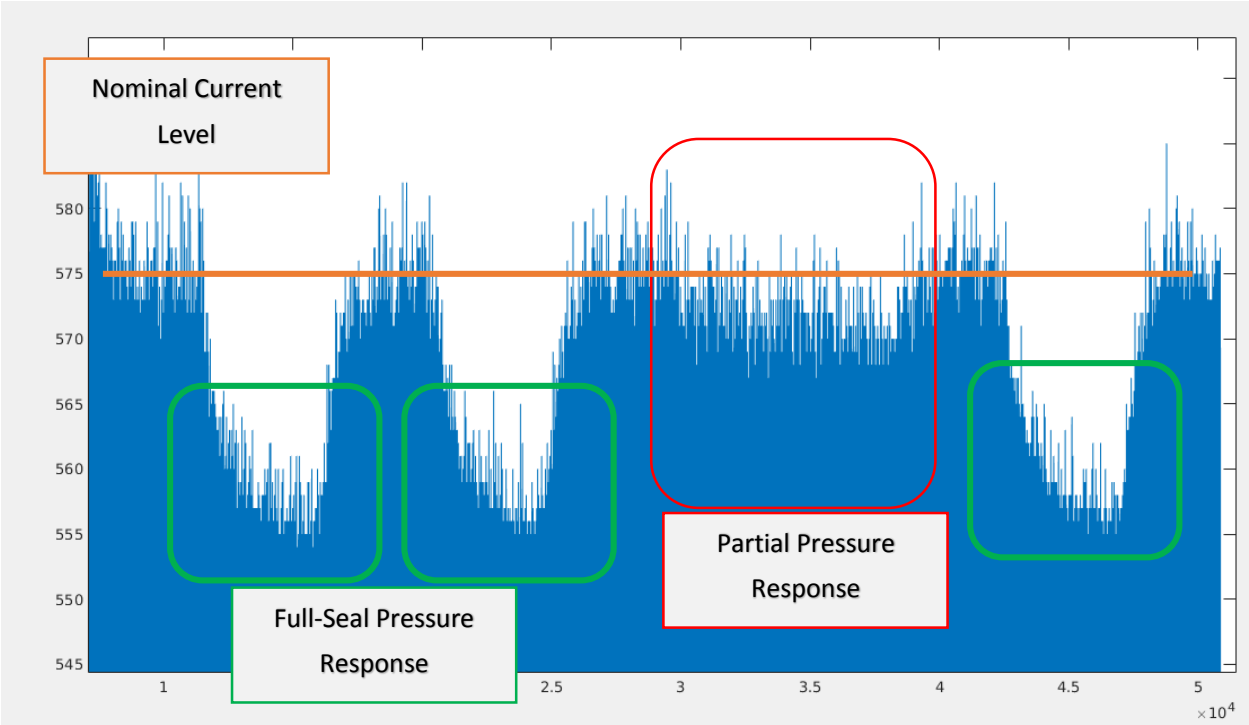

Figure 1: Time Trace of Current Signal

Additionally, we captured data and implemented a filter that can detect partially sealed items, so for now the plan is to use the pressure signal from the vacuum line and are hoping to find an affordable pressure sensor with better resolution in this operating range.

3. Teamwork

This week I worked closely with Feroze to help him add functionality to the state controller and generate the shelf model in Rviz. We laid out a daily work plan to get to the deliverable and were in constant contact as we developed the move base server, the shelf models, and integrate more functionality in the state controller. Rick, Froze, and I worked at developing the suction filtering, current sensor data circuit and data

capture, and suction development. Abhishek, Lekha, and Rick continued to work toward the final perception pipeline. Abhishek is working on getting the new laptop integrated with the Kinect2 in linux while Rick is refining the core algorithim. Lekha contributed by adding an approximate grasping position from the pointcloud We all have our priorities aligned with the Fall Validation experiment for December 3rd.

4. Plans

I plan to add Arduino recovery behavior to the state controller in the event the microcontroller briefly losses connection with ROS. I'll will be coordinating with Feroze and Abhishek to add auxiliary functions to the PR2 like torso extension, head movement, and gripper control. I'm planning to also do a lot of testing on the gripper system to ensure it accurately detects items through the filtered pressure feedback ahead of the FVE and tune system performance to meet our performance requirements.