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Team D - HARP
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Individual Progress

This week, I worked on testing the circuit for the current transformer, soldering the printed circuit board for relay control and sensor circuitry, installing Ubuntu on the new laptop and programmatically moving the robot arm from each shelf bin to the order bin without collision detection.

Our previous pressure sensor output had a lot of noise which made it difficult to differentiate between zero suction and partial suction as the resolution of the sensor was low. So we wanted to test if we could use the vacuum motor's current consumption to correctly identify the suction status. Alex measured the current consumption of the shop-vac using a 'Kill A Watt' meter and determined that 12A was consumed when the suction was fully open (no object gripped), 10.5A was consumed with partial suction and 8A was consumed when an object was fully gripped. We purchased a 30A non-invasive current sensor from SparkFun Electronics. This was a current transformer which could be clamped around a single coil to measure the current passing through it. We attached a load resistor of 30 Ohms which would cause an alternating voltage to be generated across the resistor which can be measured using the digital multi-meter.

Our task was to interface this with the Arduino and publish it as a ROS topic. We found an online tutorial (http://openenergymonitor.org/emon/buildingblocks/ct-sensors-interface) which used a current transformer with different characteristics. We had to bias the input by +2.5V before feeding it into the Arduino to ensure we don't apply a voltage outside the allowable input. This biasing was done using a voltage divider circuit. The burden resistor had to be calculated for our current transformer with input range between 8A to 12A.

Prior to soldering the relay control and sensor PCB, I practiced soldering a voltage divider and full-wave rectified on the protoboard for the current transformer circuit.

A key takeaway from PCB soldering was that the Arduino had to be placed into the headers before soldering the headers to prevent mis-alignment. The presentation on circuit board assembly and testing by Luis was very helpful and helped me adequately heat and apply the correct amount of solder on the board. Figure 1 below shows the completed PCB connected to the Arduino and interfacing wires.

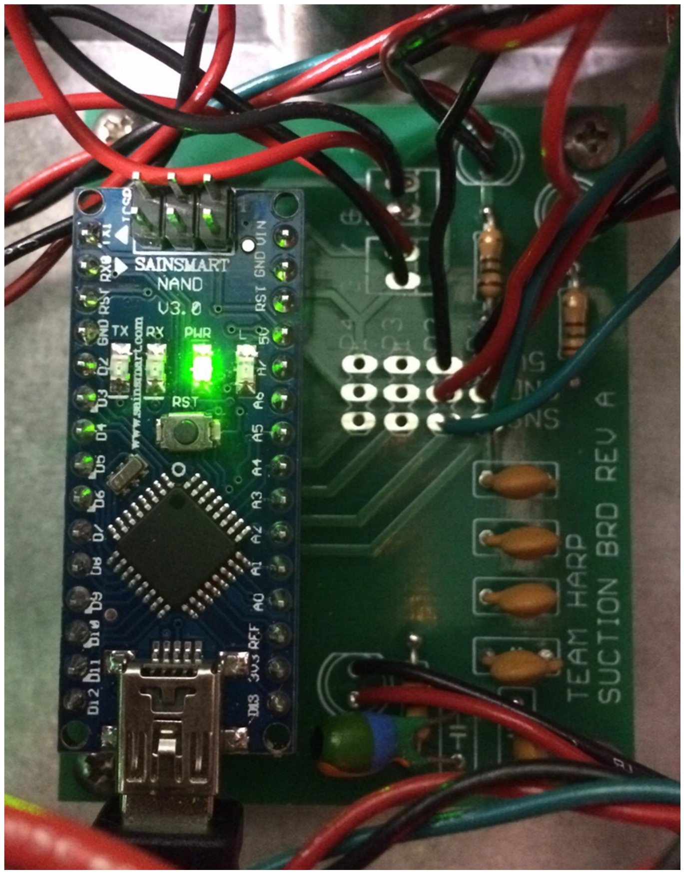

Figure 1: The completed sensor and relay control PCB

We had received our new computer for interfacing the Kinect 2 with ROS Indigo and I installed Ubuntu 14.04 LTS on it. However, its wireless chipset drivers were not included in Ubuntu and Abhishek had to update the packages without using the onboard wireless chipset.

In order to programmatically move the arm from each shelf bin to order bin, we first had to publish static transform frames for the shelf bins. The offset for the transforms was measured from the STL mesh of the shelf. The shelf was displayed on rviz as a marker. We also sunk the shelf by 0.5m to enable the arms of the robot to reach the bins without extending the spine. A smach state machine was created to programmatically move the arm to a shelf bin and then to the top of the order bin using MoveIt planner. This step is repeated for each shelf bin. Figure 2 shows the shelf displayed as a marker and the PR2 arm moving into a shelf bin in simulation.

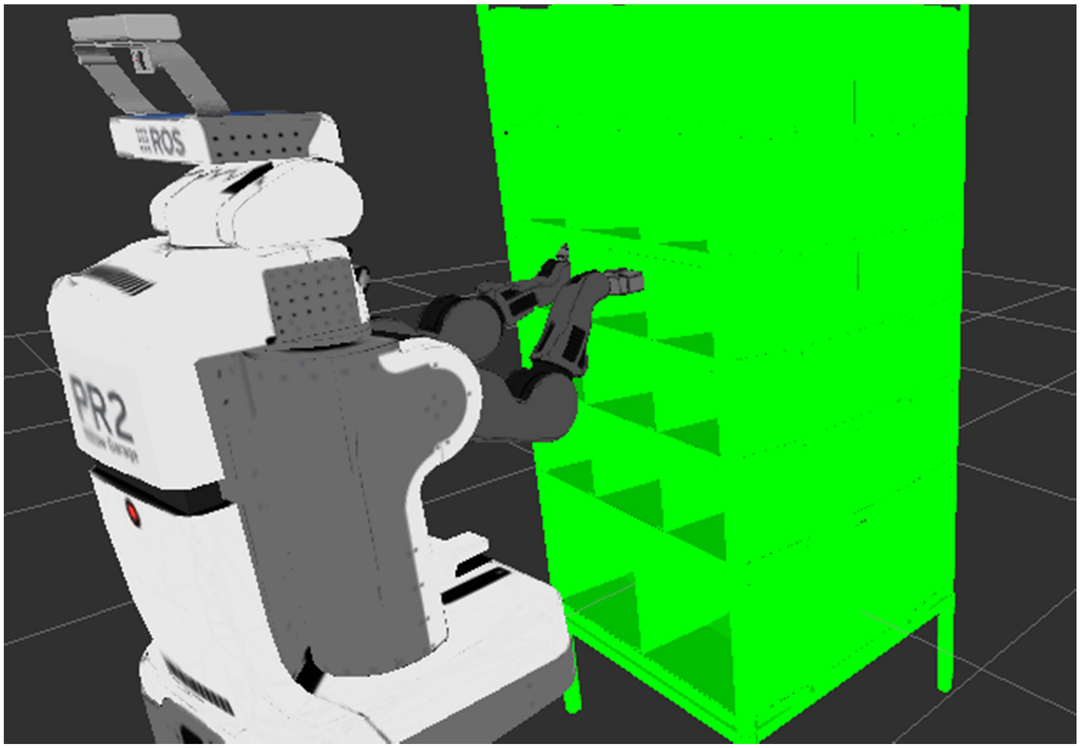

Figure 2: PR2 arm moving into the shelf bin in simulation

Challenges

The biggest issue I faced in the last week was soldering. Since we had only one PCB, I had to ensure that it would not accidentally get damaged. After attending Luis' presentation I realized I was not heating the terminals properly and was creating 'cold joints' with loose connections. I went through a few YouTube videos to correct my technique.

While soldering the PCB, I had switched the +5V and GND terminal of the sensors. As a result, a pressure sensor was damaged and we had to use a replacement part. We re-soldered the wires into the correct terminals.

While designing the circuitry for the current transformer circuit, we attempted to rectify and filter the incoming voltage. We decided to use a simple RC low-pass filter. Determining the resistance and capacitance for this filter circuit was challenging and we had to approximate the values to match available components. Ultimately, we decided to revert back to using the pressure sensor.

Team Work

For PCB soldering and current transformer sensor circuit, I collaborated closely with Alex and Rick. They had worked together to drill the mounting holes for components onto the aluminum enclosure and had also setup up the relays and cables inside the enclosure. Rick and I tested the PCB after I finished soldering it.

Rick worked on creating a moving average filter for the pressure sensor. He also worked on the perception algorithm to obtain pose and grasp position estimates for items.

Alex worked on creating the ROS server to control the base movement. He also finalized the code for the ROS suction node which publishes a topic on gripping status.

Lekha worked on determining the xyz position of points from Kinect and is working on publishing ROS messages about prior knowledge of bin items and position.

Abhishek setup the wireless drivers on the new computer. He also setup the Kinect, obtained point cloud and compared it with Kinect2 data to check the differences in point density and resolution.

Plans

Our plan for the next week is to work towards successfully completing the Fall Validation Experiment (FVE). For the FVE, I will be working on integrating our system into a full hardware-in-the-loop simulation.

We will add neck and spine movement, and suction gripper control to the platform. The gripper will also be tested on newly acquired items. We will be working towards improving the performance of our perception system using real-time Kinect data in order to meet the performance requirements.