16681-A MRSD Project 1 | Individual Lab Report # 4 March 28, 2019

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Individual Progress:

Manipulator: I concluded 90% of the system mechanical assembly for this semester, , as shown in figures 1 and 2. I will be able to dedicate myself to other areas along with the team, while improving the mechanical design in parallel to that.

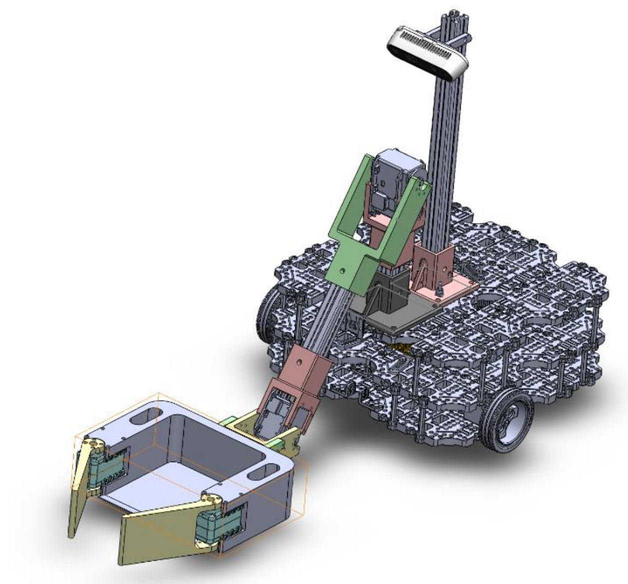

Figure 1 Complete System CAD drawing

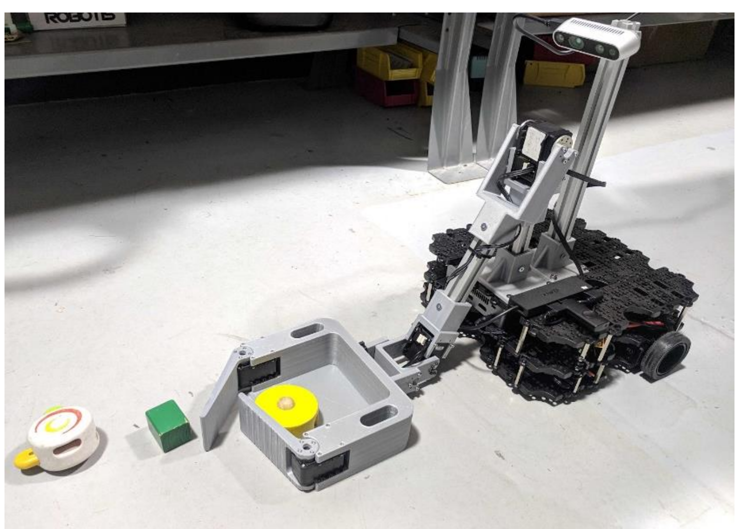

Figure 2 Physical robot complete and in action picking up objects

Steps performed:

1. Servo-motor at wrist replaced. It was a Dynamixel MX-106T and we are now using a MX-28 with a 25.5 Kg.cm stall torque which is enough for our task and weighs only 72g, versus 153g prior. It has also a lower cost than the previous one, $200 vs $500. We had to make an adaptor to be able to re-use the same tray as before, as shown in figure 3:

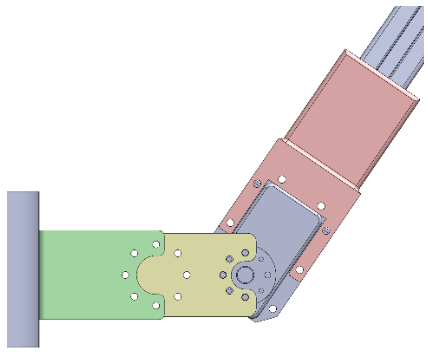

Figure 3 Dynamixel MX-28 adaptor in yellow and new support in light orange

2. The shoulder bracket was extended, so that the shoulder joint can close further without collision with the servo-motor itself, and so bringing the tray much closer to the mobile base for a smaller footprint, as shown in figure 4.

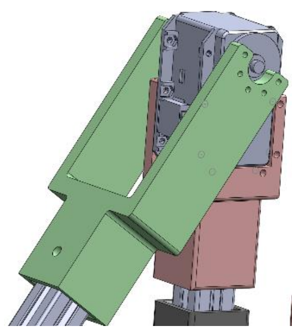

*Figure 4 Extended bracket in green improves clearances and allows increased joint angle**The arm-assembly was attached to the mobile base***

3. A vertical support that serves as the RealSense mount, was fabricated and attached to the base. A special bracket that allows vertical and tilt mechanical adjustability was designed to attach the RealSense to the vertical structure, as shown in figure 5.

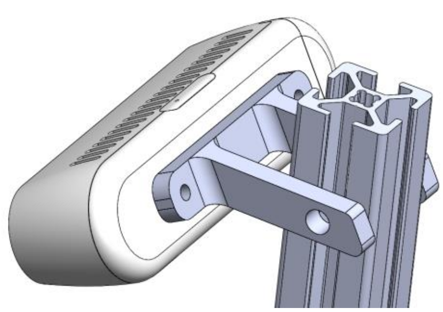

Figure 5 Intel RealSense sensor mount

4. Testing was performed using remote control to move around the room, grasping objects, taking the tray from the ground up, and moving it back down to its home position. The wrist motor angle is calculated as a function of the shoulder angle, so that tray remains at horizontal position during picking and lifting stages.

Challenges: The main challenge was the amount of parts that I had to re-design, adapt and improve to accommodate the change in servo-motors. Designing in a way that all parts would fit properly, with no collision and with a proper weight distribution was a somewhat difficult issue. The time constraint considering that I had to 3D print many parts and source proper hardware was also challenging.

Next:

- We will design and 3D print a Hokuyo lidar support to be attached to the top of the pole, right above the RealSense sensor
- We will test the assembly for rigidity and strength
- We will test the mechanism and grasping concept on many different objects of possible sizes, shapes, weights and in multiple units
- We will consider adding a force sensor to the paddles in case objects get stuck or if robot pick more objects than it fits on the tray given its orientation

Team Progress:

Laavanye developed the initial robot URDF with modularity to make it easier to add more features as we build the robot. Currently, it contains the base the camera mounted with the various transforms published and visualizations with rviz.

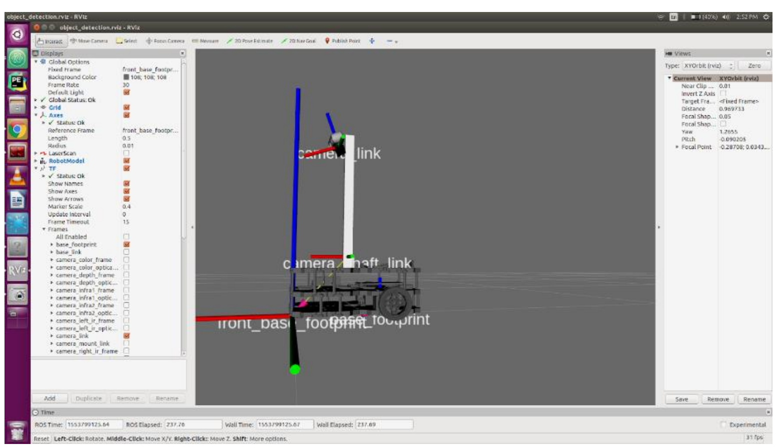

Figure 6 Interim robot URDF in rviz

He also worked on fitting oriented 3 D bounding boxes on the objects with their pose and dimension estimates relative to base of the camera. We get a lot of false positives and will be improved.

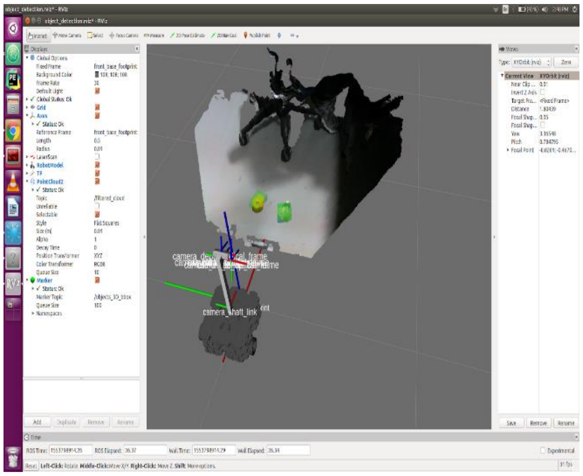

Figure 7 Bounding box around detected objects

Jorge, Nithin and Bobby resolved the Dynamixel motors issue and achieved control through ROS. Changed the connectors used to power and communicate to the motors and each motor was configured individually. Then motors were connected in series and publisher and subscriber nodes were created to send commands to the motors

Challenges:

Laavanye will have to work on classifying objects by shape and size and also consider how to detect by using computer vision only, edge cases of objects getting jammed during grasping.

Jorge, Nithin and Bobby have experienced substantial problems to make the Dynamixel work, but were finally able to overcome that, by using proper ROS packages, Robotis hardware and going through a systematic approach to re-set all motors to the correct baud rates and serial ID.

Next Steps:

Laavanye will continue with his work on classifying objects by their size. He will also give consideration to planning of picking objects of different shapes and sizes and avoid exceed the maximum capacity of the tray.

Jorge, Nithin and Bobby will move on to further develop controls, mapping and planning for our robot. Now that we actually have a robot, these areas should move substantially faster.