16681-A MRSD Project 1 | Individual Lab Report # 5 April 11, 2019

Paulo Camasmie | Team D – CuBI

Teammates: Jorge Anton, Nithin Meganathan, Changshen Bobby Shen, Laavanye Bahl

Individual Progress:

Robot Mechanical Systems Integration

After completing the design and construction of the manipulator as initially intended, I was then involved in designing and building the other mechanical and assembly parts needed to complete the integration of a few CuBi parts and sub-systems:

In collaboration with Bobby, we determined what boards needed brackets to be mounted on the Turtlebot. Since the drilling on the PCBs were different from the Turtlebot, we found that the IMU, the CuBi PCB and the Jetson carrier needed an adaptor. I took care to design them in a way that they would fit properly on the base, as in figure 1, and took special care with the IMU that needed to be located at the center of the base. I then 3D printed them in black nylon as in figure 2.

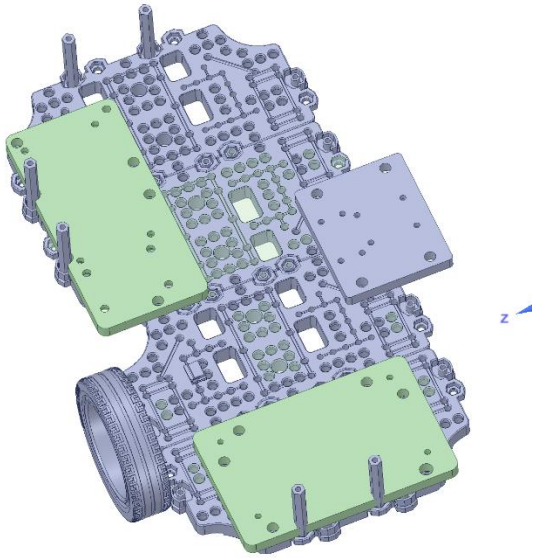

Figure 1 Adaptor drawings matching to the Turtlebot base

Figure 2 PCB and Jetson carrier mount adaptors

I also designed and 3D printed the Hukoyo mount for the bot as can be seen in the complete assembly in figure 3.

Figure 3 Complete CuBi assembly with Hokuyo lidar on top and Jetson carrier as highlighted

Challenges Before Progress Review: In the absence of actual drawings provided by the manufacturers, it was bit challenging to measure all the boards mounting holes because they have very small dimensions. As I printed the parts there, in some cases, as small mismatch of the hole position. We were able to overcome that by enlarging a few of the holes strategically. As we were approaching progress review date, there was a lot of activity with the printer. When it came our turn, we realized that we were out of PLA 3D printing material in the lab, and so we had to use black nylon material, which behaved a little different than I expected. I am not sure if the precision problems were caused by the material since it requires more heat and takes longer to print. Also, the parts took longer. Considering the short deadline, that situation was a bit stressful. But it in the end everything worked fine.

Challenges During Progress Review & Follow up actions: Since this is the last ILR I wanted to comment that we experienced challenges during the review where our gripper—tray plus paddles—behaved in a less than desired manner, since it got stuck when trying to bring a small cube to the tray. Even though our gripper was working fine when we were operation the paddles independently, they were not working properly when actuated at the same time. Before expecting to use AI inferences—software—to improve our picking strategy, it is better if our grasping system is mechanically sound—hardware. I already re-designed new paddle sizes to improve its ability to bring objects onto the tray without trapping the object between the paddles. Additionally, for the medium-sized paddle, I flipped the surface orientation of the part so that it would have a slick and better looking surface at the outside of the product and a coarser surface where it interacts with the object, as in figure 5, as an attempt to prevent objects from slicking across the tray as they are grasped.

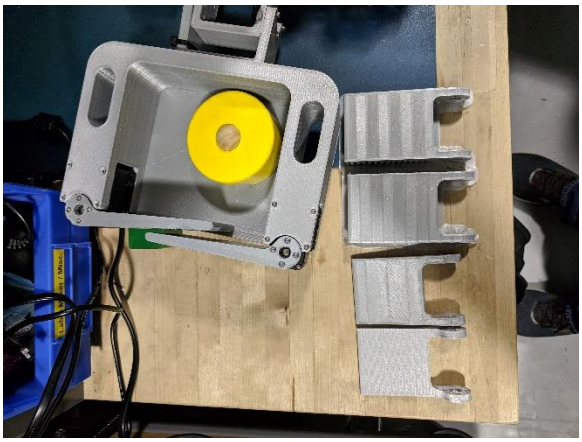

Figure 4 New Paddle Sizes to improve grasping

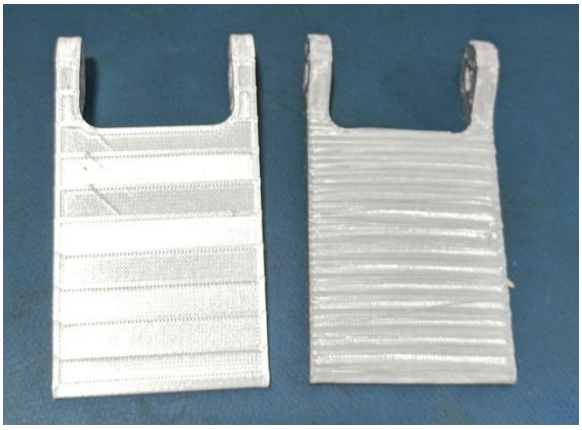

Figure 5 New paddle size with slick surface outside and coarse surface inside

Next Steps:

- adjust and optimize lengths of arm aluminum members so that the tray will seat flatter on the ground to:
    - improve grasping by diminishing the step size between the floor and the tray
    - have a more compact configuration, with center of gravity closer to the axis of rotation of the wheels to prevent the robot to tilt forward as it lifts weight
- finish building URDF for complete system
- validate and improve paddle sizes and re-designed system as necessary
- work with team on other areas: perception, planning, controls

Team Progress:

Laavanye continues to do a lot of progress with the segmentation of the objects. The challenge has been to make the algorithm adapts to different backgrounds and ignore large objects such as couches. I have collaborated with him on the autonomy assignment which will feed into the CuBi project. I have worked heavily into camera calibration and how his image detection translates in the robot base coordinates.

Bobby and I worked a lot together this week, in coming up with the brackets for the PCBs and the Hokuyo. While I worked a lot in the complete re-design of our website and its content, Bobby was key to polish the content up, make sure that we were meeting all the requirements and submit.

Jorge, Nithin did a lot of work on the Dynamixels, specially the new DX-28 at the wrist which was giving us joint limit problems. They changed it to continuous joint configuration. Also the paddle Dynamixels were re-assembled to line up the zero joint position with our mechanical assembly. I have not interacted with them directly too much since they are working on a separate part of the system.

Challenges:

Laavanye's main challenge is the robustness of the object detection system in different environment—backgrounds and light conditions

Jorge, Nithin and Bobby had issues with objects trapped between the paddles

Next Steps:

Laavanye still need to improve robustness of the object detection system in different environments by using visual learning techniques

Jorge, Nithin and Bobby will incorporate in the algorithm the detection if objects are stuck by checking the disparity between desired joint configuration to current joint position. If the motors stop getting close to the goal, they should be able to stop the motors programmatically.