

16682-A MRSD Project 2 | Individual Lab Report # 7 September 25, 2019

Paulo Camasmie | Team D – CuBi

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

Individual Progress:

Below are the areas and tasks that I have been focusing the most during the last two weeks, to improve CuBi's performance and functionality:

1. In the last report, I raised the option of exploring different kinds of gripping techniques to potentially enhance CuBi's capabilities. After discussing with my team, we all concluded to keep our current "caging" manipulation strategy and tray design, Fig 1, since it is the best option.
2. I also discussed with my team if there was indeed a desire to pickup two objects at once, and the consensus was that it would increase too much uncertainty to the task of manipulation, considering that in some edge cases, objects could be positioned in specific orientations to jam the paddles. It was decided to remain with current single object picking strategy.
3. I successfully designed, 3D printed, and installed the rear caster to CuBi, Fig 2. It reduced the rolling resistance to the mobile base noticeably. I noticed that it did reduce the linear drift but seemed to have increased the angular drift. I believe that is due to the very low friction of the lab floor. I want to do more testing on carpet which is mainly where CuBi is designed to operate. I am confident that this is an improvement though.

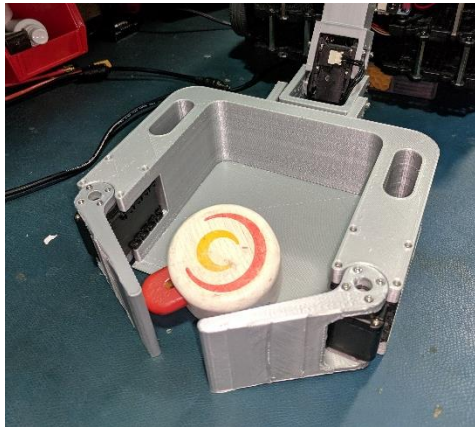


Figure 1 CuBi tray and "caging" strategy

4. I have presented my team with the idea and drawings of the laser cut translucent side plates attached to the body of the robot to make it look nicer and cleaner. However, we all decided that it does not improve the robot aesthetically so much, and that it would block access to important functional areas such as batteries and switches, and so we decided to not pursue that idea. We also like the current way the robot looks functional.
5. I presented the team and discussed the idea of adding a trunk to CuBi so that it could carry multiple objects. Even though all of us like the idea as the ultimate solution for a commercial product, everyone understands the challenge of adding a trunk considering that it would be

obstructed by the lidar and camera pole as well as the rear screen, and so we decided not to pursue that idea.

6. In the software front, since I will be responsible to develop the code for the manipulator fail-safe recovery when objects get jammed, I started looking into CuBi's current software topology. I identified the ROS topics that I will have to use—joint State for motors 3 and 4—that contain the torque feedback. I then started planning how I will implement the routine to override the paddle toggle action.

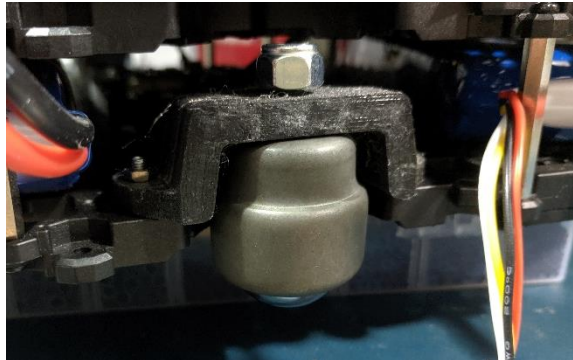


Figure 2 Rear caster installed

Risk Mitigation

- I am bit concerned with the overall mechanical integrity of CuBi. I am hoping that it will not “fall apart” during a presentation. I have been consistently checking for mechanically fastened connections and the longevity of 3D printed parts. I noticed that some M2.5 screws and nuts that belong to Dynamixels, “walked away”. I believe that is because we tried different paddles and grasping strategies last semester, and the team had to assemble and disassemble parts quickly, without fully putting them back together. I am planning a complete inspection on CuBi
- Working with vision and the lidar, the team gave me feedback that there is excessive vibration to the sensor pole. I will investigate areas to make it stiffer, eventhough I have no good ideas yet, without changing the assembly substantially. The reason is that I used a very “skinny” 20 x 20mm 8020 vertical member, which offer enough strength, but not enough stiffness for the job.

Individual Challenges:

- Adding the new caster at the exact height—just one or two millimeters more than the existing caster—posed a challenge because of the difficulty of measuring small spherical parts on the robot assembled. For that reason, the caster mount placed it slightly lower than I planned, Fig 3. I was very concerned with this fact and discussed it with Bobby who assured me that he would be able to calibrate the IMU for that additional pitch. However, when I finally measure it with a level, I observed that the base has only one degree of pitch forward. Meaning that with the original caster, the base was probably tilted backwards. Therefore, this unplanned change might improve our IMU reading.

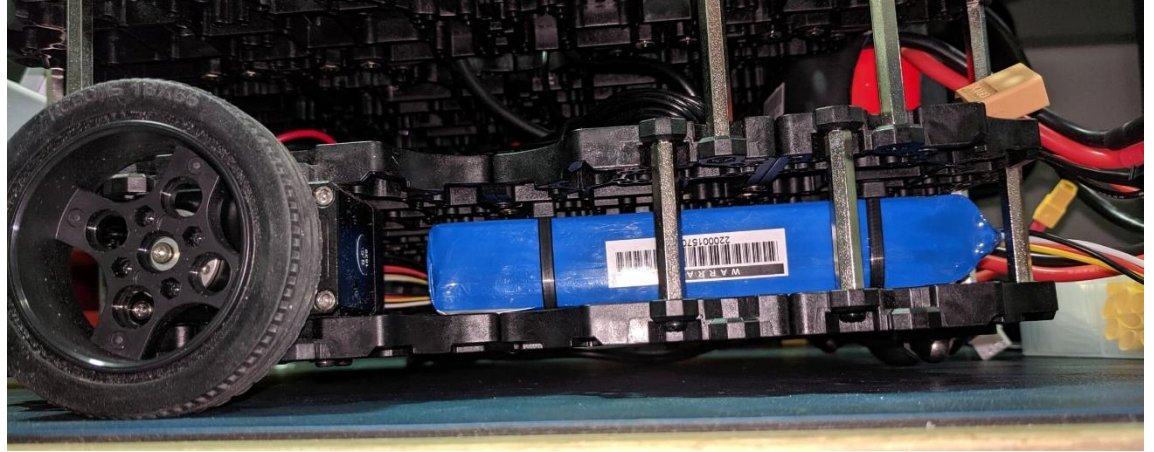


Figure 3 Mobile base with original casters away from the ground

Individual Next Steps:

- Improve the mechanical integrity of CuBi
- Add in code a failsafe routine for grips—as mentioned above—when closing to detect increased torque in the event that objects get jammed between paddles

Team Progress:

Laavanye and Bobby succeeded in mapping a room using both the RealSense RGBD camera and the Hokuyo lidar. It was clear that the Hokuyo map is much clearer and more precise, however the map obtained from the camera capture many more features of the environment including obstacles. A fusion of both will be probably our solution. I want to tag along and understand the libraries they are using and implementation.

Jorge and Nithin put a lot of work on resetting the robot frame by using an AR tag, with the objective of mitigating the natural drifting of the mobile base. The AR tag will first be placed on the floor and later on the box. I want to help with the problem of transforms since this is an area that I feel very capable of contributing.

Team Challenges:

Laavanye and Bobby faced challenges getting a really high-quality image of the RealSense, and they think that maybe is because of the current camera's high and skinny support is experiencing excessive vibration.

Jorge and Nithin had issues implementing the AR tag drifting resetting, since they found complications in the code, and the problem of dealing with the transformations a bit more involved than anticipated.

Team Next Steps:

Laavanye and Bobby will try to implement SLAM and sensor fusion to a point that CuBi will be able to locate itself in the room.

Jorge, Nithin will finalize the AR tag odometry reset, and will then focus on planning by starting with a lawn-mower strategy as a simple heuristic for CuBi to explore the environment.