16682-A MRSD Project 2 | Individual Lab Report # 6 September 12, 2019

Paulo Camasmie | Team D – CuBi

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

Individual Progress:

I am focusing on the following goals this semester, as the best means to contribute to my team and the successful completion of the CuBi project:

1. Mechanically: build robustness, and precision for efficiency and risk mitigation
    a. During my internship, I had several discussions about manipulation techniques and manipulator designs. The most interesting idea was to emulate Festo's elephant trunk manipulator, Fig1, which uses an underactuated flexible griper to gently comply to object of many shapes. I had the chance to work with a version of it and was very impressed. However, the consensus was that if we are not looking for orienting the objects to specific poses, and instead are just interested in scooping them up from the floor and deliver them arbitrarly, then our current "caging" strategy is still the simplest and most robust.
    b. I am considering adding tray capacity to pick up two objects at a time or improve the current paddles and tray design to make sure that wo objects will not get stuck during picking.

Figure 1 Festo Elephant Trunk Manipulator

2. Aesthetics and Functionality:
    a. One idea is to add laser cut translucid side plates to the body of the robot, Fig2, to make it look more finished

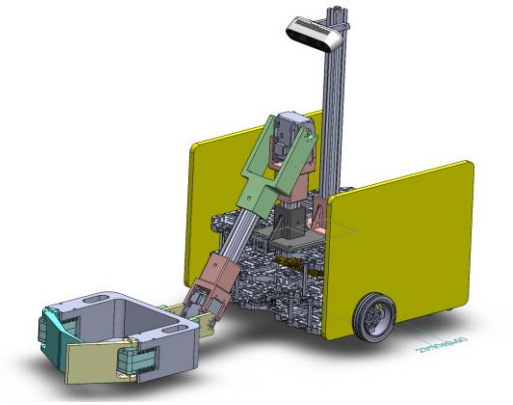

Figure 2 Proposed translucent side plates

b. We have also considered adding a trunk to CuBi so that it could carry multiple objects.

3. Collaborate in the implementation of other areas where I can learn further and offer expertise, such as state estimation, planning and controls.
4. Risk mitigation
    a. I designed a caster adapter and placement, Fig 3, at the back of the robot, to improve traction, speed, and reduce drifting. Right now, the robot has two very small casters, and since we have been using CuBi on carpet primarily, I believe that this is a substantial source of drag to our base. One of our goals this semester is for the robot to look and move faster and smoothly. This added caster Fig 4, should contribute to that effort.

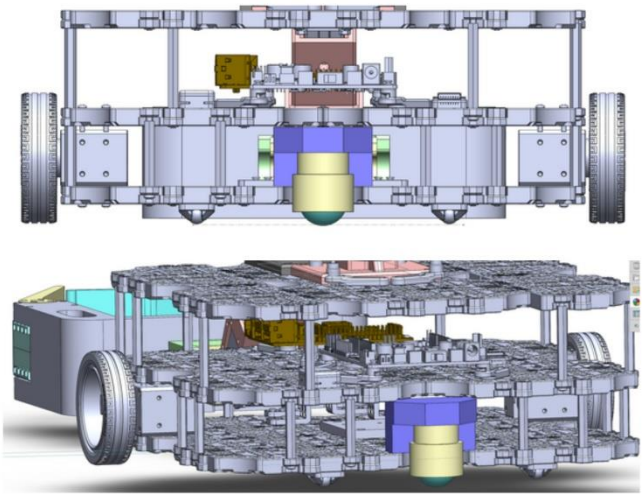

Figure 3 Caster placement in yellow, bracket in purple

Figure 4 Caster to try with this setup

Challenges:

- It is very hard to make the robot more aesthetically pleasing, or "clean" looking, considering the many functional components that are mounted on it, such as the vertical post for the lidar and camera, and the back screen, Fig 5.
- It is hard to add any kind of trunk to it, for the same reason as above.

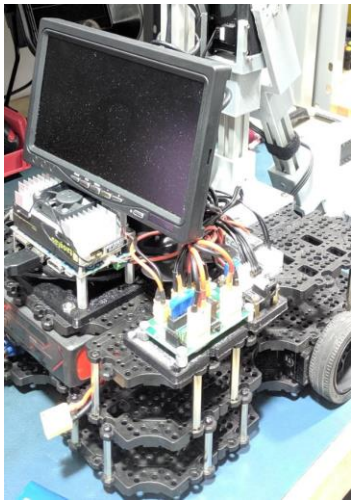

Figure 5 Screen and components crowding the top surface

Next Steps:

- Finish caster bracket design, 3D print and install it. Test it and iterate if necessary
- Discuss with team side plates idea and pursue it if there is consensus
- Go over complete code with team and contribute with software
- Collaborate with Bobby and Laavanye on SLAM and state estimation to use new skills learned in SLAM class
- Collaborate with Jorge and Nithin on planning, state machine and any other hardware

Team Progress:

The team made substantial progress in these first few weeks of class. On the management front, we put a lot of focus to make sure that we will run a very smooth and effective systems engineering this semester. Technically, we also had some notable achievements, as follows:

Laavanye cleaned up all our GitHub repository. He also continued to work with the RealSense camera segmentation and classification algorithms. He continues to study relevant papers and is also focusing in adding to the SLAM effort.

Bobby did extensive work and implemented a primarily SLAM package to CuBi, Fig 6. He ran the robot on the fourth floor of NSH, Fig 7, and collected an initial map.

Jorge, Nithin did a lot of work in the project management side. They also fixed issues we were having in our state machine and the robot wrap around yaw, that sometimes kept the robot from operation normally, by oscillating about a position for a few seconds, before pursuing the next object. They also work on ideas on how to implement AR Tag at the robot base to reset drift.

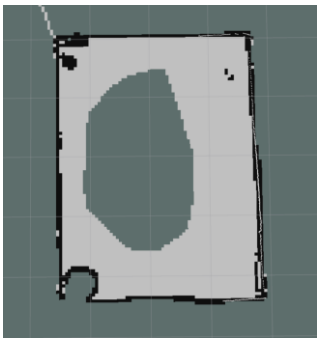

Figure 6 Actual data collected with CuBi in simple room

Figure 7 CuBi running SLAM

Team Challenges:

Laavanye's had a few issues trying to help with SLAM by implementing a more robust package.

Jorge and Nithin had issues implementing the AR tag to reset drifting since they have to come up with a strategy to set a transform between the robot and the AR Tag every time the robot returns to the AR Tag.

Bobby could not, I a short period of time, achieve closed loop or precision with the first basic implementation of SLAM. He also had to deal with battery maintenance and charging issues.

Next Steps:

Laavanye will improve our current vision algorithm and look into ways to add classification to help with obstacle avoidance.

Jorge, Nithin will try a strategy for the AR Tag drifting reset by starting the robot facing the AR tag and so locking the transform of the odometry frame with respect to the world frame of the AR tag and using that to reset odometry every time the robot returns to the base.

Bobby will fine tune parameters of our current slam