Individual Lab Report #04

Changsheng Shen (Bobby)
Team D (CuBi)

Teammates: Laavanye Bahl, Paulo Camasmie, Jorge Anton Garcia, Nithin Meganathan

March 28, 2019

Individual Progress:

Since the last progress review, we have finished the assembly and integration of the grasping subsystem and the mobile base subsystem. The Dynamixel motors of the manipulator have been configured, tuned and integrated with the ROS based software system on the robot. The Intel RealSense depth camera has also been mounted onto the robot such that we can start the preliminary validation process of the object picking pipeline. Figure 1. below shows the assembled, wired-up CuBi robot carrying three different toys in its tray.

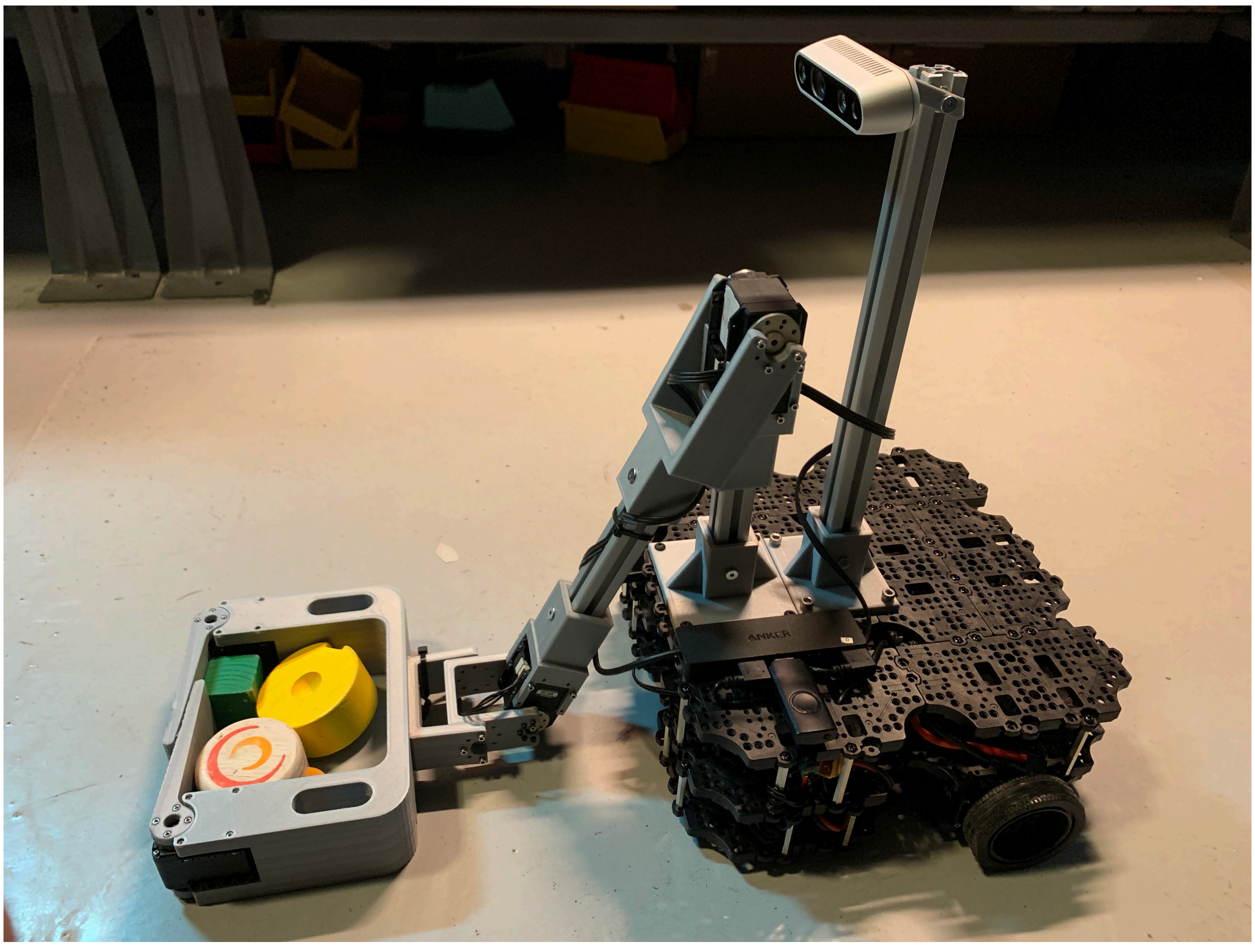

Figure 1. Integrated CuBi: Mobile Base, Manipulator and Depth Camera

I spent most of the time working on calibrating the Dynamixel motor's initial positions, integrating the motor control program into the existing software system, as well as implementing the command-based control loop for joint movements of the manipulator. The manipulator supports three modes of movements:

1. Open / close the front tray to capture and bring objects in.
2. Raise up / put down the entire arm with the tray.
3. Flip the wrist where the tray is connected to, to dump objects into the storage area

In order to abstract these three movements into a command-based control logic, first I calibrated the motors to find their zero positions and the relative positions corresponding to all these different states of configurations. Then I implemented a movement handler that listens to the high-level commands on a specific ROS topic, and publishes target joint state messages to the motion controller to control each individual joint. I also modified the remote joystick driver program such that we can use different buttons to command the manipulator to perform different movements.

Besides, since our robot had just been assembled together and the Hokuyo LiDAR is not mounted yet, I started some preliminary work on the LiDAR localization and mapping subsystem based on my previous work, on a different robot-sensor configuration and a few dataset s collected. Below, Figure 2. shows a 2D down-projected occupancy map of the A-Floor of Newell-Simon Hall, built by a mobile robot equipped with a Velodyne PUCK LiDAR using a modified version of Google Cartographer.

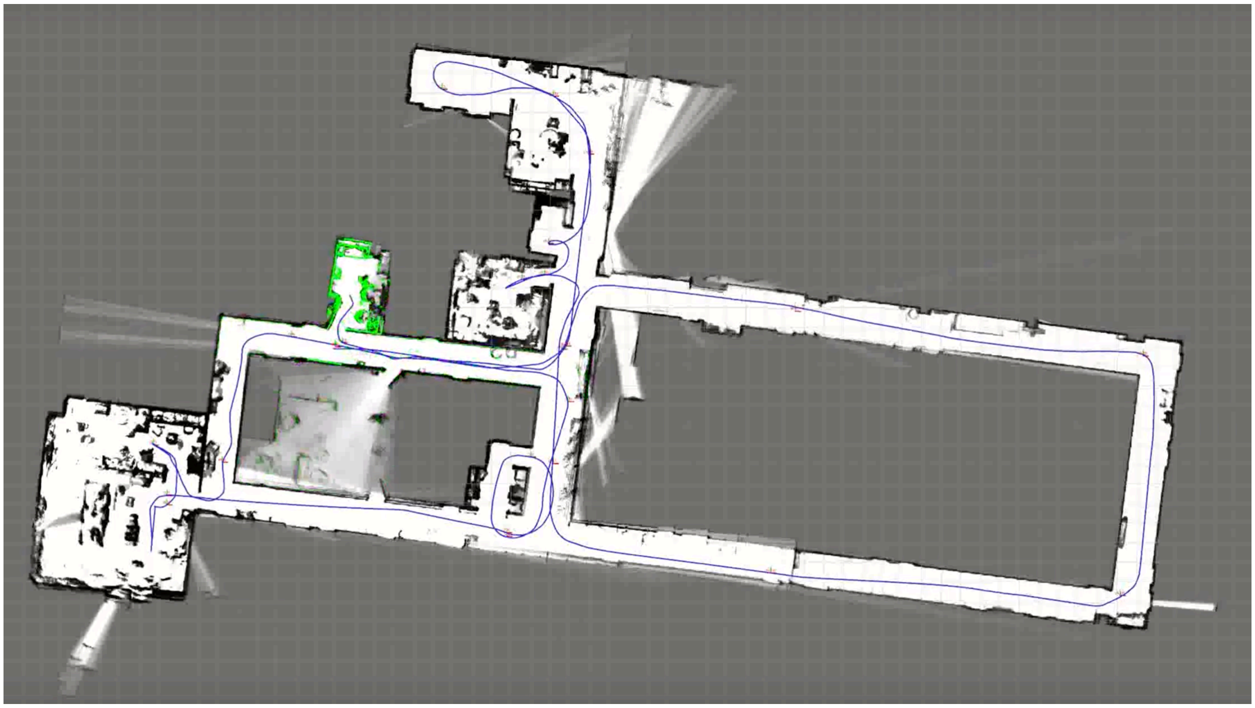

Figure 2. 2D Down-Projected Occupancy Map of the A-Floor of Newell-Simon Hall

Note that this result is achieved using a high-end sensor and a larger robot. Our next step is to migrate this algorithm pipeline to adapt to our system, and to achieve a comparable outcome.

Challenges:

We have successfully resolved the issues with Dynamixel motors. However, we have encountered an unusual network connection problem while setting up the NVIDIA Jetson TX2.

Ideally, all the computing devices should be able to connected to the CMU-SECURE Wi-Fi network. It enables unlimited access to the outer internet and local peer-to-peer secure shell (SSH) connection between two computers, which is convenient for us to program, test and synchronize our robot through a remote PC. However, when we tried to make the NVIDIA Jetson TX2 connected to the CMU-SECURE network, it was assigned a private IP address, which blocked the access to outer internet. Initially we suspected that it was a Linux software driver issue related to the wireless network card, so I tried re-flashing the firmware of it, but the issue remained presented. Since there is no LAN set up in the MRSD lab, we also tried connecting to the CMU-DEVICE network, which is designed for embedded devices. But the connection was unstable and could not be used.

After trying everything mentioned above, we were almost sure that it was a device-specific problem. We then contacted CMU computing services, and got a reply saying that this device was identified as a vulnerable device and got kicked out of the internet with a "quarantine" IP address assigned, around a year ago. They stated that they would be coordinating with the internet security office to resolve this issue, hopefully by the end of this week.

Teamwork:

We have been working together a lot to integrate different subsystems, and to demonstrate the capability of the manipulator.

More specifically, Paulo and I discussed about the placement of components on different levels of our robot, such that they would not interfere with the mounted manipulator.

Jorge, Nithin and I worked together to resolve the issues of the Dynamixel motors, to reconfigure their ID and baud rate, to tune the PID gains, and to calibrate the motor's initial and limiting positions.

I also discussed with Laavanye regarding the plan to integrate the localization and mapping system with the perception system to extract the poses of every object to pick-up, and to utilize the data from Intel RealSense depth camera to improve the quality and accuracy of the map.

Future Plans:

As the milestone for next progress review, as well as the preparation for the Spring validation, we are aiming at demonstrating the the system's capability by picking up two to three toys autonomously, in a pre-mapped indoor area.

In order to achieve the goal mentioned above, my individual working plan for the next two weeks is :

1. To work with Paulo to mount the Hokuyo LiDAR onto the robot

2. To integrate the software system with a multi-sensor setup, including motor encoders, RGBD camera and 2D LiDAR

3. To collect data, migrate and test the LiDAR SLAM algorithm pipeline on our system setup.

4. To write a simple feedback-based trajectory follower for the robot to execute pre-defined paths.

5. To improve the robustness of the software system to handle exceptions such as subsystem module failure, motor overloading error, etc.