Individual Lab Report #05

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Team D (CuBi)

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Individual Progress:

To get well prepared for the Spring Validation Demonstration, we have been doing extensive integration work in the past two weeks. Individually, I have done the following tasks:

1. Assembled, tested, mounted and wired up the power distribution PCB.
2. Re-assembled the mobile base to organize new hardware components and an extra battery.
3. Resolved the lack of traction issue while moving on the ground.
4. Resolved the network connection issue of NVIDIA Jetson TX2.
5. Set up and mounted NVIDIA Jetson TX2 into the system to replace Intel NUC.
6. Validated the accuracy of wheel odometry.
7. Modified the joint controller program for manipulator joints, added a few new modes of operation into the finite state machine.

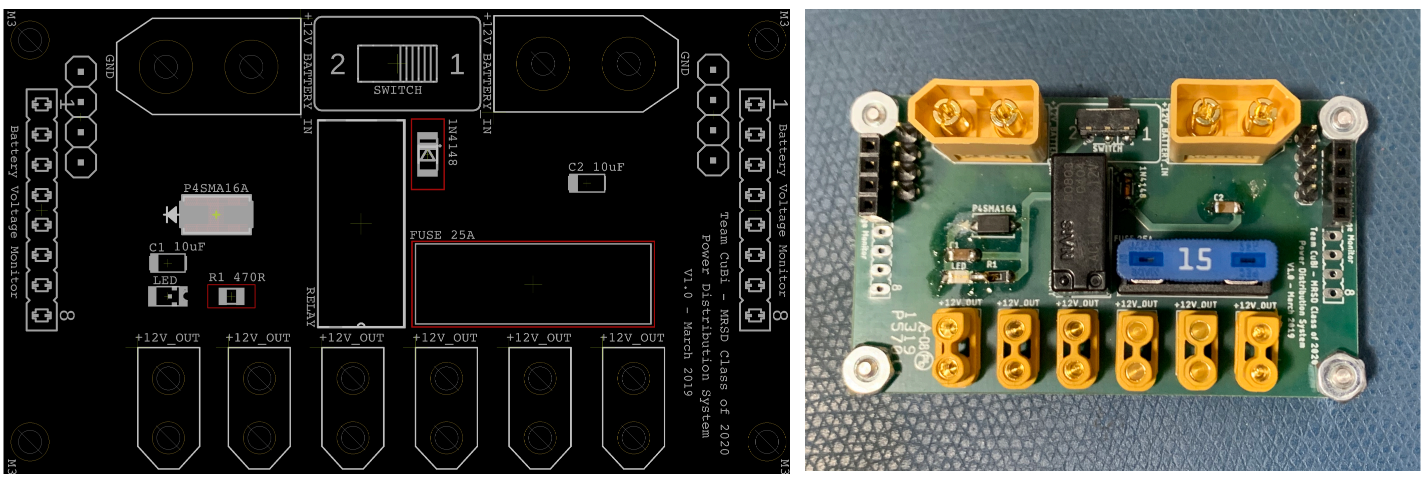

Figure 1. Design and Assembly of the Power Distribution PCB

In order to meet the system requirement of 1 hour continuous operation, we decide to use a dual-battery input for our system. In addition, there are various hardware components that require a 12V power input, including the onboard computer, the power hub for servo motors and the microcontroller board. By modularizing and unifying the connectors with a power distribution system, it makes the electronics system easier to manage and to debug with. Several protections are also integrated into the power distribution PCB. Figure 1 shows the design and assembly of the PCB. More details will be shown and explained during the demonstration session for the PCB next week.

We noticed that sometimes the two wheels of the mobile base may fail to provide enough traction to drive the robot when the manipulator arm is raised. It is because that the manipulator put too much weight on the front, which slightly lifts the driving wheels on the back. Therefore, we decide to flip the top layer to put more weight right on top of the wheels. In addition, we decide to replace the Intel NUC with NVIDIA Jetson TX2, since we may need GPU acceleration for our computer vision algorithms. A new mounting place is required because of the height of the carrier board and the heat sink. We also plan to place an extra IMU on the bottom layer in the middle of the robot, and a Hokuyo LiDAR on top to provide more information for inertial localization and navigation. Given all these modifications needed, Paulo fabricated a few 3D-printed mounting brackets for them. Then I disassembled, re-organized and re-assembled the entire robot, with everything properly mounted with the brackets, and cleaned-up the wiring for easier maintenance. Figure 2 shows the fully-assembled robot.

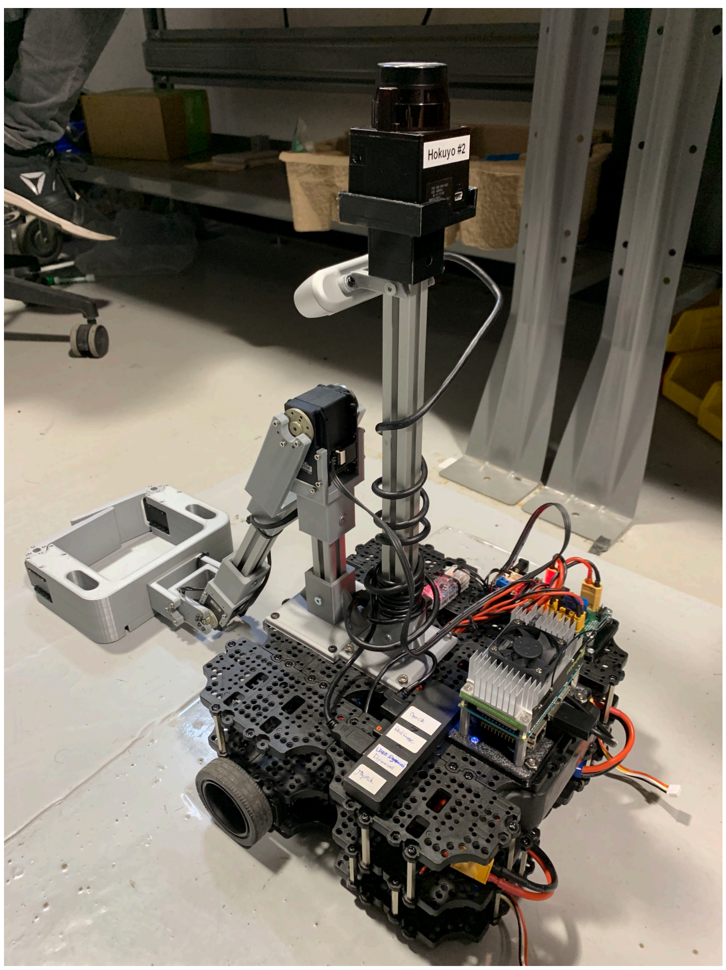

Figure 2. Re-assembled CuBi

After finishing assembling the robot, we tested the accuracy of wheel odometry and improved the joint controller program for the manipulator. Wheel odometry was good enough to satisfy our requirements. We planned to write a extended Kalman Filter to fuse multiple sensors information together to provide an accurate state-estimation of the robot in the future. For the manipulator, we pre-calibrated the joints positions and coded them into our program to make a finite state machine that supported various modes of operation, including:

1. Move Mode: the front tray is slightly raised up from the ground to ensure the base moves freely on the ground without dragging it.
2. Pick-up Mode: the front tray is lowered to “push into” the ground, and finger paddles are open to pick up objects.
3. Raise Mode: the shoulder joint raises the entire arm up with the tray, preparing for dropping the toy to a designated location.
4. Drop Mode: the wrist joint moves the tray towards the ground, and then finger paddles open to drop the object in the tray. After dropping the objects, the joints will go back to the initial position.

Challenges:

Mentioned in the previous ILR, the network connection issue of the NVIDIA Jetson TX2 has been successfully resolved through contacting CMU computing service, asking them to re-enable the network access for the device.

Another challenge that we are facing currently is to install the Intel RealSense driver library and SDK. The major issue is that the official Intel RealSense driver library is compiled for x86 architecture. However the NVIDIA Jetson is based on ARM architecture, and most of the tutorials and instructions available online do not apply.

Since we are using the newest model of the Intel RealSense RGBD camera (D435i) with IMU available, and we also need CUDA support of the libraries in order to accelerate our computer vision algorithm using parallelization, it requires a more complicated process to have everything set up properly on the NVIDIA Jetson TX2 platform. We followed an installation instruction for Jetson, compiled and loaded a special version of Linux system kernel, and then installed the libraries. However there were some unexpected, low-level kernel error during the process, which was a little tricky to debug. After proceeding through it, the Intel RealSense camera still did not work.

As one of the major subsystems, the vision subsystem needs to be integrated as soon as possible for the upcoming Spring Validation Demonstration. We will be focusing on resolving this issue during this weekend.

Teamwork:

We have been working together a lot to integrate different subsystems.

More specifically, Paulo and I worked together to design brackets for the onboard components. We discussed about their placements to make sure that they are easily accessible and do not interfere with each other. We also discussed about a possible new design to shrink the size of the robot, which need to be further discussed with the whole team in details.

Jorge, Nithin and I worked together to program the Dynamixel motors for the manipulator. We resolved a few issues regarding the joint limits and the control software robustness. We calibrated the joint motor positions and programmed extra modes of operation into the state machine, as described in the previous sections.

I also discussed with Laavanye regarding the plan to integrate the vision subsystem together with the planning subsystem, not only for the upcoming Spring Validation Demonstration, but also for the big picture in the future from a software architecture design perspective.

Future Plans:

We will be integrating all the subsystems together and testing for the Spring Validation Demonstration. My individual working plan for the next two weeks is:

1. To install Intel RealSense driver library and the ROS wrapper on NVIDIA Jetson TX2.
2. To improve the software robustness for the entire system by adding failure recovery mechanisms.
3. Finish implementing and testing the initial motion planning pipeline, including feedback from wheel odometry and relative AR tag locations from the vision subsystem.
4. Set up the scenario for SVD testing together with the team.