Individual Lab Report #02

Changsheng Shen (Bobby)
Team D (CuBi)

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

February 21, 2019

Individual Progress:

Assembly:

1. Assembled of TurtleBot3 Waffle Pi as the mobile base.
2. Mounted an Intel NUC onto the chassis as the onboard computer.

Hardware Integration:

3. Made cables and connectors for all onboard electronic systems.
4. Designed the draft of power distribution PCB that will be used on the robot.

Software:

5. Set up software development environment for onboard computer.
6. Set up wireless network for remote access and control.
7. Implemented a ROS package for controlling the mobile base remotely with joystick.

Logistics:

8. Evaluate, select and order various components for the project.

As the mobile base we use for our project, the TurtleBot3 Waffle Pi is a modular, ROS-compatible platform designed for educational and research purposes. I finished the assembly of the TurtleBot, and replaced the onboard computer to an Intel NUC i7 to satisfy the need of computational power for localization, mapping, planning, navigation and vision algorithms running onboard. In addition, one of our requirements stated that the system should be able to operate consecutively for at least two hours once fully charged. Given all the extra computers, actuators and sensors we planned to install, I calculated the power consumption of the system and replaced the default battery (1800mAh) with one with much larger capacity (5700mAh). I also made several cables and power connectors to connect all the components on the robot. In case we need to add more components on the system, and to provide extra protections such as short circuit, over-voltage and reverse-voltage protection, I also designed a draft of a power distribution PCB for the system.

For the software portion, I set up the software development environment for the onboard computer with Ubuntu 16.04, ROS Kinetic, Chrony, and a few other essential packages installed and configured. I set up the wireless network such that the onboard computer will boot as a WiFi access point. In this way, we can connect to the onboard computer remotely via SSH for debugging, instead of connecting to a external monitor every time. I also implemented a ROS package for remote control of the robot, consisting of a joystick button mapping scheme and a command velocity smoothing mechanism. To ensure the smooth movement of the mobile base, a command velocity smoothing mechanism was embedded in the package. It subscribed input velocity commands from joystick readings, and published a ramped command velocity message to the robot, based on a constant acceleration\deceleration rate. The package was written in a way such that tunable parameters were subscribed from ROS parameter server and would be loaded through launch files.

Last but not least, I was in charge of evaluating, selecting and ordering components and other miscellaneous items for our project.

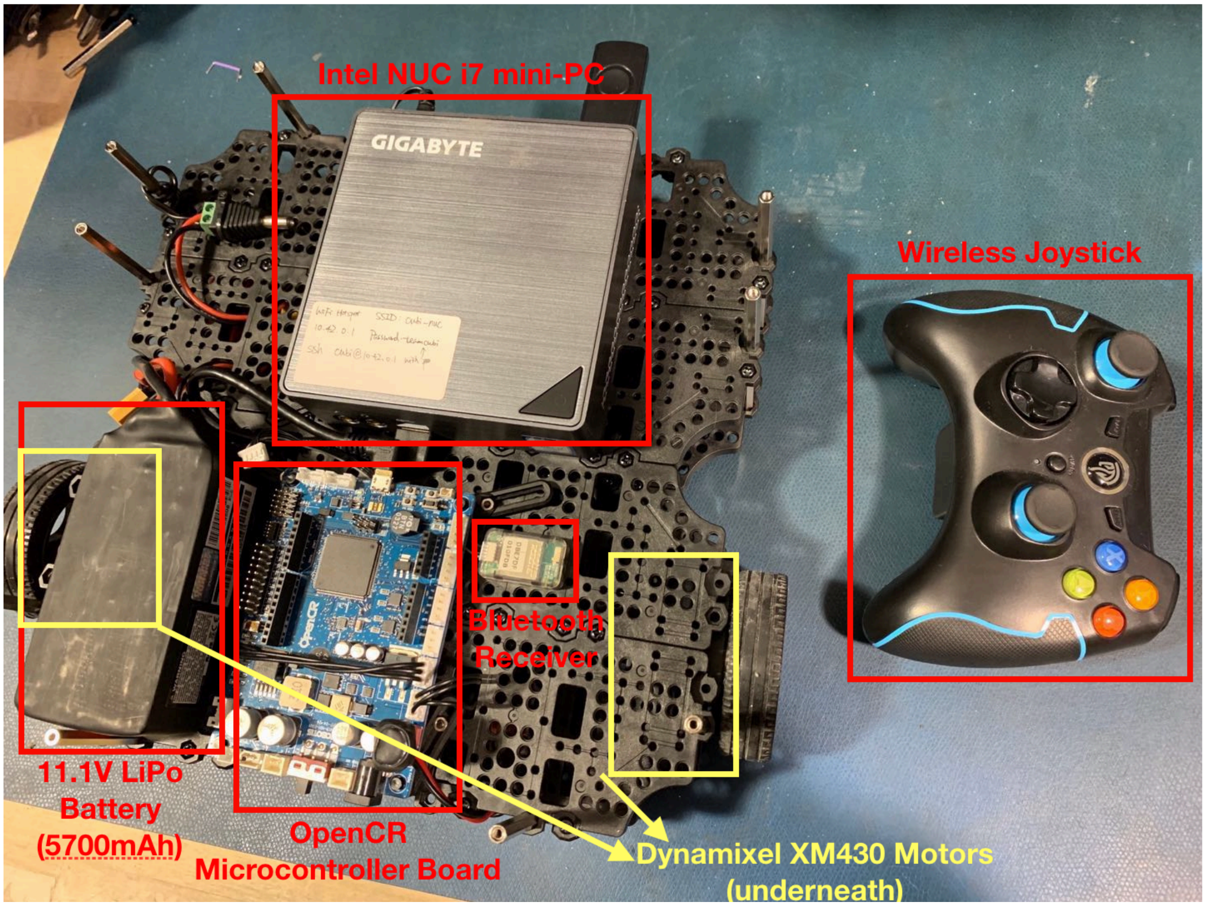

Figure 1. Illustration of the Mobile Base based on TurtleBot 3 Waffle

Challenges:

One challenge that I encountered was the design of the power distribution PCB. Although having the knowledge of basic electronics and circuit design, I had no experience in designing an efficient power system with multiple levels of protection, such as over-voltage and reverse-voltage protection. Therefore, I studied several pieces of online resources of similar design schematics. I also consulted Lu Li, a senior hardware engineer of the Biorobotics Lab, for his advice and some empirical tricks with such kind of PCB design. Finally I was able to design a draft system diagram and schematic for the power distribution PCB that is customized for our needs. The layout, analysis and design review will be finished within the next few weeks.

Teamwork:

Laavanye Bahl:

Laavanye was working on point cloud segmentation and object classification using the Intel RealSense RGBD camera, which is critical for the grasping pipeline. We worked together to choose the camera model, regarding their categories and specifications based on the design requirements of our project.

Paulo Camasmie:

Paulo was working on the design and assembly of the gripper. He designed, prototyped, tested and iterated multiple generations of gripper. We worked together to discussed about the pros and cons for each design draft, as well as the placement and integration of the gripper with the mobile base.

Jorge Anton Garcia:

Jorge was mainly working on the project management, including scheduling and task coordination. He also worked on the control of the Dynamixel motors for our chassis and gripper, together with Nithin. We also discussed about the hardware-software architecture for our system.

Nithin Meganathan:

Nithin was working with Jorge on the PID controller and interface for the Dynamixel motors. We discussed about the communication protocol between onboard computer with ROS and the microcontroller board for low-level motor control.

Future Plans:

The next goal of our project team and myself will be mainly focused on the integration of gripper and mobile base. We shall finish implementing the controller for all motors, and integrate it with the ROS-based driver program running on the onboard computer. A major milestone is to be able to control the mobile base and the motors individually with a wireless joystick, and to be able to pick up a few objects on the ground. We shall mount the cameras onto the mobile base and collect data for training and debugging purpose. In addition, I will start implementing the basic framework and pipeline for localization and mapping. I will try evaluating several available open-sourced algorithms by testing them on public datasets. If we are able to obtain our own dataset by running the robot indoors with sensors mounted, it will also be evaluated.