ME 133(b) Lab #3: - Mapping & SLAM

Released: Friday, 03/01/2019 Due: Wednesday, 03/13/2019

As discussed in the Lab #3 *Prelab*, in this lab you will experience how to construct an occupancy grid map, and perform simultaneous localization and mapping (SLAM). Your prelab focused on learning how to use *OctoMap* on a previously gathered data set. In your actual lab period, you will gather your own data set. Then, like the pre-lab, you will create an OctoMap from your data. Additionally, you will apply the *gmapping* algorithm to your data set (you can do this in the post-lab period) to build a 2-dimensional occupancy grid map, and compare *gmapping’s* estimate of the robot’s position with the ground truth provided by the *OptiTrack* system in CAST.

As a default, you will drive the Flipper Rover around CAST using a joystick, since the focus of this lab is mapping, and not motion planning. Ambitious students can get extra credit for implementing an automated motion planner to guide the Flipper’s motions around CAST.

# 1. Gather Lidar and OptiTrack Data in CAST (10 Points)

During your lab session, the T.A.s will show you how to drive the flipper rover with a remote control device (i.e, a joystick). You will want to drive the vehicle around the CAST arena so that the bulk of the arena boundary is within range of the Velodyne Lidar.

 While you are driving the flipper around the CAST arena, you should be gathering the Velodyne lidar output, as well as the OptiTrack. You can process this data after the laboratory.

# 2. Octomap of the CAST Arena (20 points)

Using the principles that you learned in the pre-lab exercises,construct the OctoMap of the data that you gatheredin the CAST arena. Capture, and submit with your lab report, a rendering of the OctoMap.

# 3. SLAM (40 points)

In this portion of the lab, you will experience the *SLAM (Simultaneous Mapping and Localization)* process. Students can choose two approach. In the past, we have used the *gmapping* algorithm/package for logged data. ROS has a newer *Cartographer* package that many students will wish to apply, because it is better documented.

* To use *gmapping,* first visit the ROS *gmapping* information page: <http://wiki.ros.org/gmapping> . After installing the package, you will want to use the *slam\_gmapping* node to build a map from you data, and to then get estimates of the robot’s position. You will want to visit the *slam\_gmapping* documentation on how to build a map from logged data: <http://wiki.ros.org/slam_gmapping/Tutorials/MappingFromLoggedData> . You will have to remap the *sensor\_msgs/LaserScan* topic to the Velodyne data output.
* To user *Cartograph*, go to the ROS documentation page: <http://wiki.ros.org/cartographer> . Under the *Documentation* category, click on the “our Read the Docs site”, which takes you to the web page: <https://google-cartographer-ros.readthedocs.io/en/latest/> . This page will walk you through the process of applying *Cartographer* to your ROS bag of data collected in the CAST center.

After you have chosen your SLAM approach, you should use your chosen *SLAM*method, use the method to estimate the position of your robot as you drover the robot around the lab. Create a plot which shows the estimated position of the robot, and the *OptiTrack* measurement of the robot’s position.

# 4. Summary of Deliverables

In summary, your lab report should contain:

* A visualization of the *OctoMap* map of the CAST arena
* A visualization of the 2-D map derived from *gmapping* or *cartographer*
* A visualization of both the SLAM-estimated flipper robot position, as well as the OptiTrack measurement of the flipper’s position.