EE346 - Mobile Robot Navigation and Control

Spring 2022
Laboratory #6 (8%)
Due Date: Wednesday May 25, 2022
Lane Following and LiDAR-Based Navigation with TurtleBot3

Objectives

- Calibrate a real camera and use it to perform lane following
- Perform robot navigation with the LiDAR sensor using ROS Navigation Stack

Part I: **Camera Calibration (10%)**

Review Part I of Lab 3 on camera calibration. Read 8.3 of the textbook to learn about and test the API (application programming interface) to the Raspberry Pi camera, which should be transparent with respect to your experience in Lab 3. The follow the camera calibration procedure in that lab to calibrate the Pi camera on TurtleBot3. Save the camera intrinsics in a yaml file, and upload it as well as the images you used for calibration to your course GitHub site for the TA's to check.

Part II: Lane Following with TurtleBot3 (50%)

In this part of the lab, your TurtleBot3 should drive around a racetrack marked by two black lines, shown in the figure below, and come to stop at an Aruco marker (#0) after traversing the track twice. First, review Lab 4 on robot lane following. Then revise your code so that your TurtleBot3 can follow the track in the counter clockwise direction. Your robot should start at the position labeled "start", go around the track for two laps, i.e., visit each of the four arrows in the oval twice, before exiting the track to reach the position labeled "finish". It should come to a full stop with 5cm of the Aruco marker that is placed in the middle of lane near "finish". Your robot should complete the two traversals of the track as quickly as possible. You can have two official runs and the fastest time of the two will determine your placement in the class with respect to the other groups. If you complete the task, you will receive 25%. The other 25% will depend on your placement within the class.

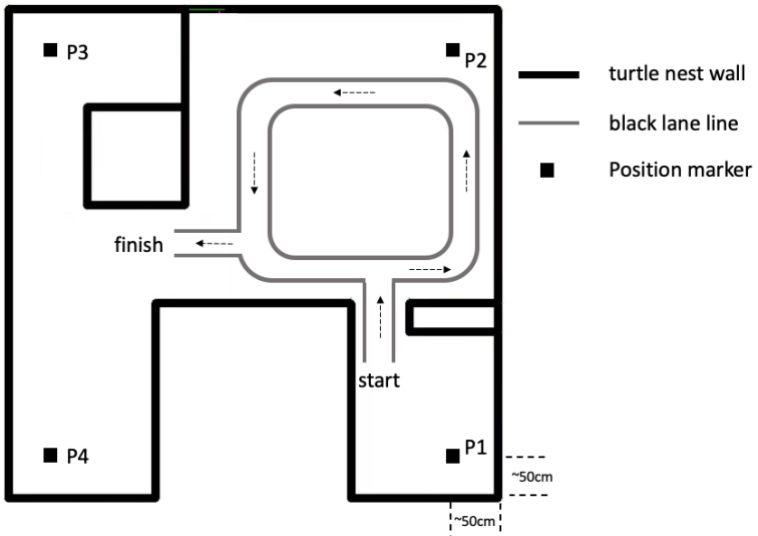

Figure 1: Robot environment with the racetrack to traverse and positions to visit

Part III: **LiDAR-Based Navigation (40%)**

In this part of the lab, you will program TurtleBot3 to perform navigation in the robot environment in the lab with the help of the LiDAR sensor. First, build a grid map of the robot environment in the lab with GMapping, as has been done in Lab 5. Make sure that the map is of satisfactory quality. Manually refine the map if necessary. Second, using the grid map, your robot should start from P1 and visit P2, P3, and P4 in turn, before returning to P1. Each successful visit is worth 10%, and your robot must reach the positions accurately, by covering the white markers on the floor with any part of its body. Failure to do so will result in a reduction of 2-10%, depending upon how many robot radii the robot is away from the desired position. You will have two opportunities to demonstrate your implementation, and the best performance is used to determine your mark.
(*Hint: if leaving and returning to the "room" of* P1 *proves to be difficult through the narrow corridor, consider following the available lane to guide the robot into and out of the room*.)

Submission

Within the GitHub site (which belongs to either of the two group members), create a directory for Lab 6. Within the directory, create a subdirectory for each of the three parts. For Part I, you should upload the yaml camera file and the calibration images. For Parts II and III, you should upload the package you have built to complete these parts. Inform the TA's of the URL of your GitHub by the due date.

Marking

The three parts are worth 10%, 50%, and 40% respectively. All parts are to be completed in groups. Marks received by each group member depend on their contributions to the completion of the lab.