EE183DA (Winter 2017)

Design of Robotic Systems I

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Lab assignment 5
Due 2pm Thu. Mar. 9, 2017

1 Lab Overview

1.1 Objectives

In this lab, you will continue to implement the computational infrastructure necessary to command a simple 2 wheeled robot. Using your state estimator from the previous lab along with a description of the system dynamics, you will develop a controller designed to get your robot to a desired goal state.

You will be working in your project teams. You will be responsible as a team for dividing the various tasks of this project between all members. Your grade will be based both on team and individual performance.

1.2 Deliverables

As a team, you must submit a well documented git repository of your code.

As an individual, you must submit a participation questionnaire indicating the contributions of each team member to the team results. You may also submit further documentation describing your mathematical formulation, algorithms, experimental setup, experimental results, and final performance for extra credit. This additional documentation can take the form of either a lab report as in lab 1, web site as in lab 2, or academic poster as in lab 3. You will be assessed on both the clarity and completeness of your content.

Upload a link to your code repository / website along with a pdf of your report / poster (if applicable) on CCLE by 2pm Thu. Mar. 9, 2017.

Submissions that are up to 24 hours late will be accepted for a 10 percentage point reduction in final grade. No submissions will be accepted more than 24 hours late.

2 Lab specification

2.1 Robot model

You will again consider the 2 wheeled robot from lab 4.

2.2 Trajectory planning

Consider the state of the robot as it moves through some arbitrary 2D environment. The environment will contain obstacles: at minimum, the environment will be a tabletop, and the edges of the table can be represented by obstacles to ensure the robot doesn't fall to the floor. You may also want to consider other geometric obstacles placed on the tabletop.

Further consider a goal state that the robot must achieve. For instance, the simplest such goal state would be a position within the operational space, i.e. achieving a prescribed x, y, θ for the robot. For additional challenge, you may also want to consider additional types of goals, such as maintaining a given distance from some object in the environment, or following a curve at a defined velocity.

Compute a plan to take the robot from a given initial state to the desired goal state, and use that to implement a controller specifying the inputs to the actuators as a function of time.

2.3 Experimentation

As in lab 4, you have the choice of doing experiments and analysis in simulation or with a real life robot.

If you choose to go the simulation route, you will need to implement realistic models of your sensor and actuator response (including noise) to generate simulated state evolution and sensor measurements given your generated control inputs. Generating these models will likely require some data collection from physical sensors and actuators.

If you would prefer physical experimentation, you will need to come up with a communication scheme to exchange control commands and sensor measurements between the robot and your controller.

Either way, run some examples that demonstrate the performance (in terms of goal accuracy, computational efficiency, and trajectory efficiency) of your control algorithm as your robot tries to achieve various goals. You may find your state estimator from lab 4 to be of use. Clearly describe the experiments that were run, the data that was gathered, and the process by which you use that data to characterize the performance of your controller.

What can you conclude about your controller? What are the main sources of error in achieving your goal state? How would you improve on this performance?