Prelab 1b: Trajectory Planning with Two-Link Arm

Overview

For Lab 1b, you will plan a trajectory to get through a simple maze. This will require a custom trajectory to go from start to finish without touching any edges. Similar to Lab 1a, you will need to use inverse kinematics to follow your planned trajectory. In the figure on the next page, you are given the shape of the maze boundary as well as the start and finish lines. Scoring will depend on both how far you successfully get in the maze and how fast you can get through the maze. The teams with the best performance will receive a small extra credit bonus on their grade for Lab 1b.

Objective

1. Get from start to finish without touching the maze walls.
2. Complete the maze in a timely fashion.

Scoring for extra credit

This week's lab is designed as a contest between lab groups. The scoring formula, which is designed to reward both speed and accuracy, is given below:

$$S = \frac{d_{traveled}}{d_{total}} \cdot \frac{d_{traveled}}{t_{traveled}}$$

In words, this is the fraction of the maze you complete times your average speed. A run through the maze terminates as soon as one of following three events occurs:

- The actual laser path illegally crosses a maze wall,
- the time since leaving the start line exceeds 10 seconds, or
- the laser successfully crosses the finish line.

Note: *performance of the true system* determines scoring – not the readings of the encoders. A trial must be recorded via video (e.g., cell phone), so that the full path can be re-checked by your TA, who will then score the run. Dotted lines and small marks along the walls of the maze will be used to determine d_{total} in scoring.

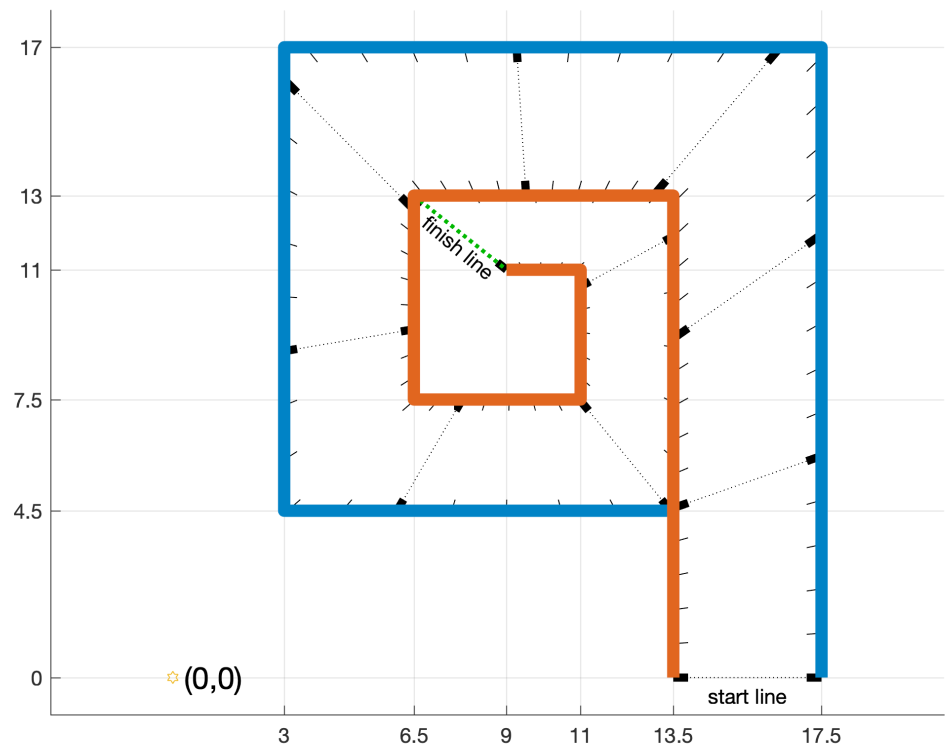
Prelab 1B assignment

1. Create a (x,y) trajectory to navigate the maze.
2. Use inverse kinematics to create a trajectory for motor angles.
3. Using your simulink model using the simulated motor plants from Lab 1a, simulate a response using PD controller for the two link arm.
4. Finally, use forward kinematics to plot the simulated Cartesian (x.y) laser trajectory.

➔ Submit an m-file and a pdf-file (containing required plots) on GauchoSpace.

Extra Credit:
The 1st, 2nd, and 3rd will receive 10%, 5%, and 2.5% extra credit on Lab 1B, respectively.

Below is the simple maze. You may plan to start anywhere on the "start line" and should exit the maze at the "finish line" without crossing the side walls within the maze. Units below are cm, with (0,0) located at the axis of the first motor. Any time required to get from the initial configuration of the arm to the start line does not count toward the total time. The timer starts once the beam actually starts to move from the start line.



Below are two different possible example solutions for (x,y) trajectories. At any "corners" and/or sharp turns in your path, you will likely wish to plan for the laser to go more slowly along the path! (Just as with steering a vehicle around a sharp corner, the physical system needs some time to decelerate and accelerate.)

MATLAB functions such as **ginput** and **spline** may help. If you pick waypoints in MATLAB graphically (with ginput), you can use then to create a smooth path using polyfit or spline. (Use "help ginput", etc., to explore these functions.)