ME597 Autonomous Mobile Robotics

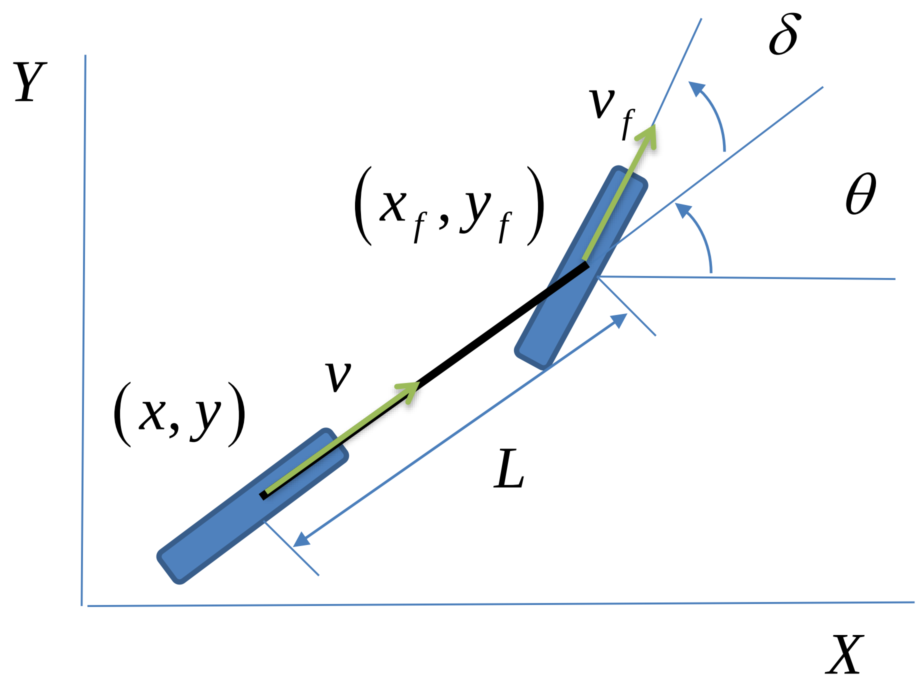
Homework Assignment #2

Posted: November 16th, 2015

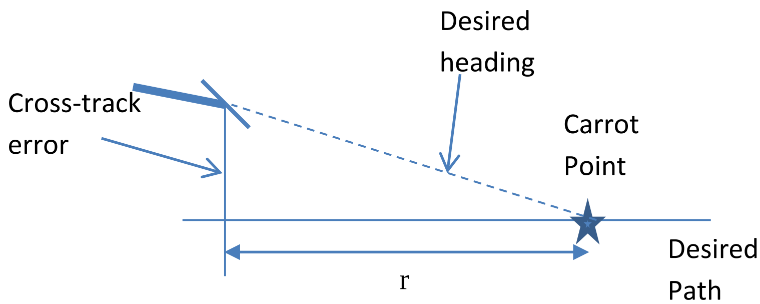
Due: December 4th, 2015

Submit using UW-Learn dropbox, please submit a single pdf file. Groups of two are permitted. For each portion, write out your methodology and equations first, then implement the simulation in Matlab and provide both the write-up and results plots as your answer. There is no need to submit your Matlab code.

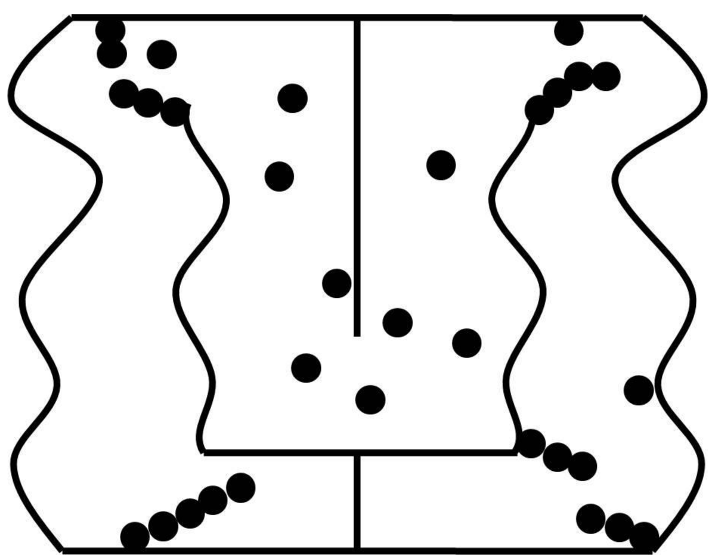
1. Define the bicycle motion model for an Ackermann steered robot as shown in the configuration below (and presented in the motion modeling lecture notes). Use rear wheel speed *v* and steering angle δ as the control inputs and include additive Gaussian disturbances of standard deviation 0.02 m on x, y position and 1 degree on Θ in the motion model and an update interval of 0.1 s. The length L = 30 cm and the steering angle is limited to +/- 30 degrees. Holding the speed input at 3 m/s and setting the steering angle to δ = 10 – *t* degrees, simulate the motion of the vehicle for 20 seconds.



2. Develop a carrot following controller. The way this controller works is you define a "carrot", or point on the desired trajectory line a fixed distance, r, ahead of the closest point on the line to the current robot position. You then apply a P or PD control to the steering to align the heading of the vehicle with the direction of the carrot point. Incorporate this controller into your simulation, and present results for the robot tracking a 20 m by 5 m rectangle at 3 m/s. Select an appropriate value for r and the controller gains so that the vehicle tracks a line segment reliably. Plot x-y results with the desired rectangle and the path of the vehicle.



3. Using the map provided with the homework (IGVCmap.m and IGVCmap.jpg), identify a planning strategy that can be used in conjunction with the carrot planner of part 2) to navigate the Intelligent Ground Vehicle Competition auto-navigation course. The files provided construct the IGVC map and store it in a 926x716 element grid, where each cell represents a 10 cm X 10 cm area of the course, creating a 92.6 m X 71.6 m environment. Implement your planner and present a combined motion planning solution that finds a straight-line path through the environment, then uses the carrot planner to locally drive the vehicle to the goal location. The start and end locations are (4.0 m, 0.5 m, 3.14159 rad) and (5.0 m, 1.0 m, not defined) for x, y and θ.



4. Discuss at least three limitations of this approach: what assumptions have we made to simplify the real problem of navigating a robot through the IGVC auto-navigation course, and what modifications could you make to resolve each issue.