Motion Planning and Control Homework

Vehicle Dynamics, Planning and Control of Robotic Cars

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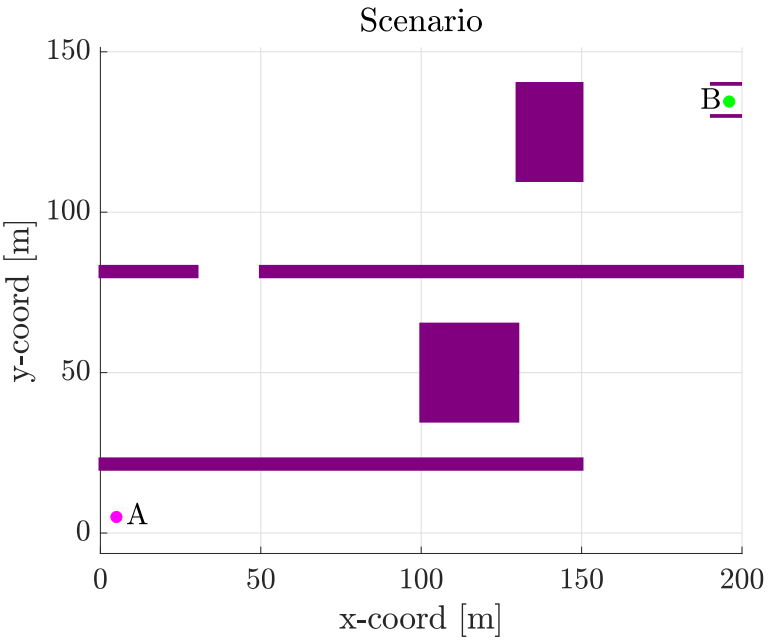
Assignment

This homework gives you the possibility to optimize the implementation of a path planning and control framework for self-driving vehicles. All the following exercises can be carried out using the MATLAB & SIMULINK files that were provided.
Note: For the groups of students that are going to deliver their report by the 20^{th} of January 2020, there will be the opportunity to compete for being awarded with an extra bonus of up to 4 points on the final mark. The best report will be selected basing not only on the results achieved, but also on the quality of the results discussion, methodology, conclusions and related comments. The bonus may also slightly depend on the previous two assignments.

Problem Description

The main target consists of driving in the *minimum time* an autonomous car from an intial point A to a parking lot B. The scenario includes fixed obstacles that the vehicle must avoid. The car must arrive to the parking lot with zero speed.



Exercise 1 - route planning

Exercise 1 deals with route planning. It is required to complete the following tasks:

- Optimize the route planning task using RRT*. You can refer to the file `routePlanner.m`, which already implements RRT*. You may change all the parameters related to the algorithm (e.g. n°of iterations, connection distance) and partially to the vehicle (e.g. max allowable steering angle).
- Decide if an interpolation (already implemented) of the generated route may be useful or not, and in case try to optimize the interpolation.
- Discuss if and why a clothoid fitting (already implemented) of the route points may be better than Dubins paths.
- Discuss the efficiency of RRT* for route planning (consider computational time, route quality etc).

Exercise 2 - motion control

Exercise 2 deals with lateral motion control. The target is to let the vehicle follow the reference path computed with RRT*. As far as longitudinal motion control is concerned, you may use the provided PID controller without modifying it. You are free to choose the vehicle speed profile.

- Optimize the parameters of the pure pursuit, Stanley and clothoid-based lateral controllers (already implemented).
- Implement the preview point lateral controller.
- Compare the performance of the 4 lateral controllers. In this regard, consider the path tracking error (e.g. max error, mean error, etc), but also the resulting steering angle profile. Take into account how each controller behaves when increasing vehicle speed. Try to point out which are the most important paramenters for each algorithm and their effect on path tracking.
- On the basis of your results, underline the pros and the cons of each algorithm.

Notes

You may propose more than one possible solution to the path planning and control problem, but it is important that you discuss the advantages and downsides of each implementation, in terms of computational time, quality of the solution, feasibility for a real vehicle, and possible use cases.