Motion Planning and Control Homework

Vehicle Dynamics, Planning and Control of Robotic Cars

Gastone Pietro Papini Rosati & Mattia Piccinini

EIT Digital
University of Trento

2021

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.
You are supposed to attach the solution of the following homework in the final report that you are going to deliver before the oral exam.

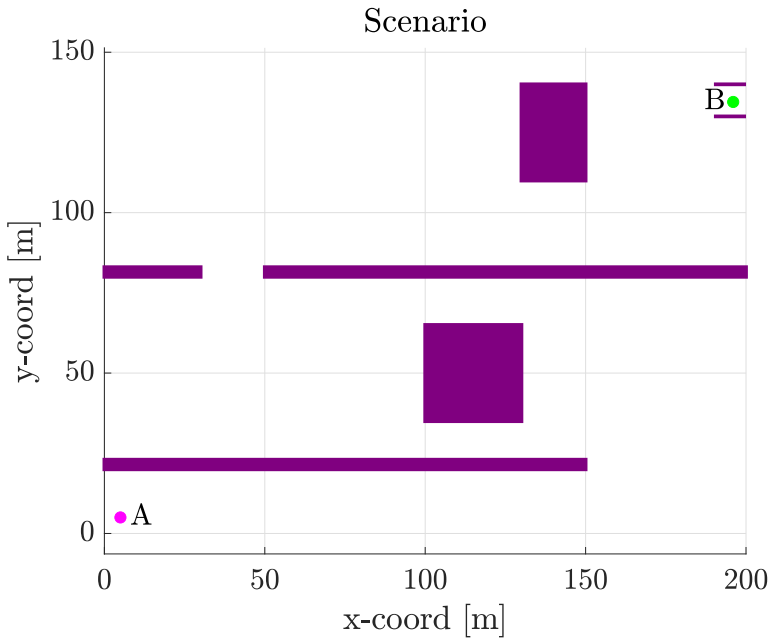
Notes

For this homework, you need to install the following MATLAB toolboxes:

- Clothoid toolbox, developed by Prof. Bertolazzi: `https://github.com/ebertolazzi/Clothoids/releases`
- Automated Driving Toolbox
- Image Processing Toolbox
- Computer Vision Toolbox

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 a speed of 20 km/h.



Exercise 1 - route planning

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

- Copy the code of your vehicle model SIMULINK block (from assignment 3) inside the vehicle model block of the file framework_sim.slx.
- Optimize the route planning task using the RRT* algorithm. You can refer to the file `routePlanner.m`, which provide a MATLAB implementation of the standard 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).
- The vehicle *may* be driven at constant speed along the path computed with the RRT*. Point out what happens as the speed is increased: what are the bottlenecks for the minimum travel time? Is the quality of the RRT* path one of the bottlenecks? Do clothoids help?

Exercise 2 - lateral control

- Use the lateral controllers implemented for the previous homework to drive the vehicle model along the path computed (off-line) with the RRT*. Compare the performance of the lateral controllers.
  Again try to optimize the parameters of each lateral controller, point out pros/cons of each control policy (evaluate the path tracking error statistics, quality of the resulting steering angle, behavior when increasing the vehicle speed etc).