Platforms and algorithms for autonomous driving - Second part
AA 2023/2024
Assignment 3 – Vehicle motion planning
Due date: XX-1-2024, 6:00 pm

The purpose of this assignment is to learn about optimization-based motion planning algorithms.
In this assignment you need to use the simulation model and the vehicle motion controllers (lateral and longitudinal) designed in Assignment 2. The same vehicle physical parameters can be used.

1. **Path following (Points: 6)**

   Consider a reference path consisting of a 200 *m* straight followed by a circle with 1000 *m* radius.

   Design a receding-horizon path planner based on a kinematic vehicle model with the reference path defined above.

   Simulate the path planner, together with the path follower developed in Assignment 2, when the vehicle travels at constant speeds ranging from 30 to 90 Kph, starting from 2 *m* away from the reference path.

   Concisely comment the obtained results.

2. **Turning at an intersection (Points: 6)** Consider a reference path corresponding to a 90° left-turn at a cross intersection.

   Use the path planner designed at the previous point, together with the lateral and longitudinal controller developed in Assignment 2, in order to make the left turn at a speed of 30 Kph with a maximum deviation from the reference path of 1.5 *m*.

   Freely chose the length of the straight path before the intersection.

3. **Static obstacle avoidance (Points: 7)** Consider the reference path at point 1. Assume such reference path is the lane centerline of a two-lane road, where each lane is 3.5 *m* wide.

   Place two static obstacles at the straight and the circle, respectively, completely occupying the rightmost lane, where the vehicle is initially traveling.

   Simulate your path planner, together with the lateral and the longitudinal controller developed in Assignment 2, while performing a double lane change maneuver to avoid the collision with the obstacles, while traveling at constant speeds ranging from 50 to 90 Kph.

   Concisely comment the obtained results.

   For each simulation show the following signals

   - the vehicle position and heading in the global frame, along with the reference path, obstacles and lane boundaries,
   - the slip angle,
   - the steering angle,
   - the vehicle longitudinal speed,
   - the commanded acceleration,

   Both simulink and Matlab simulation code are accepted. You should provide

   - an initialization and simulation script `taskX_init.m`, which define the necessary parameters and run the simulation code,
   - a plot script `taskX_plot.m` plotting the requested signals.

Additional files should be provided with the name `taskX_xyz.m`.

Important!!! While the MPC and MPT toolboxes are allowed, you are **NOT** allowed to use any other toolbox (e.g., Mathworks Navigation Toolbox, Automated Driving and similar) directly solving the path planning and following problems in this Assignment.