INSA Toulouse

Course "Inverse problems, data assimilation, learning" by J. Monnier.

Programming Practical

Optimal control of a 1D vehicle dynamic

1 Introduction

Optimal control of a dynamical model enables to plan an optimized vehicle trajectory, given a future target trajectory. This is dynamic optimization, it is also sometimes called model predictive control.

The common strategy to solve dynamic control problems is to numerically integrate the dynamic model in discrete time intervals.

Next, the numerical model solution is compared to the desired trajectory (the target), the difference is minimized by calibrating / tuning the control variable.

Recall that the control variable is an input parameter of the dynamic model. One way to proceed is to apply this strategy time step by time step; this is the direct method which is implemented here.

Objective: Compute a control that automatically regulates a vehicle velocity.
Method: Direct dynamic method.

2 The optimal control problem set up

Please consult the course manuscript.

3 The numerical strategy

Please consult the course manuscript.

4 Your tasks

- Download the Python code available on the course Moodle page. Read it to understand it.
- Synthetize (write) the algorithm which is employed to solve the problem.
- The few points to address:
  - ▷ Highlight the influence of the weight parameter α.
  - ▷ Highlight the influence of the regularization term expression.
  - ▷ Highlight the influence of the control time lenght M.
  - ▷ Compute the optimal strategy given a maximal "reasonable" acceleration (based on a police you will fix yourself).
  - ▷ Are the control time grid and the dynamic system time grid necessarily the same ?
  - ▷ Does it exist a control which make vanish the cost function term J_{misfit} ?
  - ▷ Is the optimal control unique ?