Dynamics and Control of Vehicles and Robots

Design of Vehicle Dynamics Control: project instructions.

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1. Overview

This document describes the course project on vehicle longitudinal and lateral dynamics control. The goal of the course project is to implement the basic notions of vehicle dynamics control learned in class, designing the structure and the tuning procedure of ABS and ESP control with a Software-in-the-loop (SIL) approach.

2. General Information

In the following we list the main information and rules for the project; read them carefully and if you have any questions or doubts write an email to Francesco Biral (`francesco.biral@unitn.it`) or Luca De Pascali (`luca.depascali@unitn.it`).

- the fulfillment of the requirements of this project allows to automatically pass the oral exam on the Vehicle Dynamics Control part;
- when you will complete the project, you have to deliver the Matlab and Simulink files where your controller has been implemented and a brief report summarizing the main results;
- you can do the project alone or in teams of up to **three** members; in either cases you will discuss the project results individually during the oral exam;
- you have to deliver your project (files and report) at least 2 days before the oral exam;
- you can do the oral exam (and discuss the project) in every exam session regardless of when you did the written exam, but **within September 2018**.

3. Instructions

You have to unzip the folder `Control_Design_Project.zip` where you will find the Matlab scripts and Simulink model containing the full vehicle model of a small-size car. Car data are contained in file `getVehicleDataStruct.m` and the tire equations are contained in `pacejka_model.m`. Initial conditions can be assigned with the function `getInitialConditionsDataStruct.m`
The goal of the project is the design of ABS and ESP control modifying the respective Subsystems in the Simulink model `FullVehcileModel_ABS_ESP.slx` and assess their performances on the four standard maneuvers defined in the file `mainVehicleModel.m`, namely *full brake maneuver*, *double lane change*, *double lane change*and finally *constant cornering with acceleration (US test)*. You can use only the signals measured by the sensors (IMU, Encoders and Input Measurements) for the feedback of your control scheme, but you can inspect all the signals output from the vehicle (this is useful to debug your code and see how your controller is working).

3.1 ABS Control

Anti-lock Braking system (ABS) design depends on the type of actuators (brake) available in the car. In this project you can choose the type of brakes mounted on the car and design the controller accordingly: you can choose between continuous dynamics actuators (Electro-Actuated Brakes) in brake-by-wire systems, or discrete dynamics actuator (Hydraulic Actuated Brakes) that are the standard choice in nowadays passenger cars.

3.2 ESP Control

Electronic Stability Program aims at controlling the lateral dynamics of the vehicle. Here, the control objective is a design choice; indeed, you are supposed to define the specifications of your controller (yaw rate control, side slip angle control, yaw angle control or a combination of them). The vehicle has an active steering system, namely you can use as control input directly the steering angle bypassing the driver intentions. You can obviously follow the examples presented in class and provided in the dedicated Google Classroom section.