Design Project

This project asks you to design some of the basic components of an autonomous car: the cruise control system. For the parameters of the vehicle model (masses, lengths, etc), look up or estimate numbers for your car if you own one, or the car of a family member. This assignment draws most directly on knowledge of linearisation, first and second-order systems and their control.

The approach you should take is that your boss at your first job after graduation has asked you to prepare design proposal. Therefore the report should be of a professional standard.

We suggest you design and test your controllers using simple linearised models, but then also simulate on the true nonlinear coupled dynamics to verify performance.

1 Project Description: Cruise Control

We assume an engine controller has been designed, so that the control input is the force demanded from the engine.

$$m\dot{v} + \frac{1}{2}A\rho c_D v^2 = u + d \tag{1}$$

Here ρ is density of air in kg/m^3, C_D is a dimensionless drag coefficient, and A is cross-sectional area of the vehicle in m^2 (looking from the front). Reasonable values for c_D for a car are about 0.25 to 0.45 (Wikipedia has an interesting list). For your car, look up, measure, or estimate A and c_D.

1. Design a controller that will precisely achieve the desired speed even if there are constant disturbances.
2. Examine the dynamics of changing from one target speed to another, e.g. 60, 80, 110 km/h.
3. Analyse your controller's response to a disturbance force corresponding to a sudden transition from flat ground to a very steep uphill slope of 35% grade.
4. Examine the effect of uncertainty in mass (e.g. due to the number of passengers).

For this part, you should start by reading Sec 4.1 of textbook and revising the lecture material on linearisation. You may want to investigate the "Signal Generator" or "Repeating Sequence Stair" blocks in Simulink for some of the reference inputs.

2 Report Format

You must submit a professional-quality report as a machine-readable pdf (i.e. not scanned images) through Wattle.

Your report must be at most 10 pages and must consist of the following sections, where the mark breakdown is indicated. The marks should serve as a guideline for how much space to allocate to each section.

1. Introduction [10%]
2. System modelling and simulations [35%]
3. Controller design and validations [35%]
4. Discussion and Conclusions [10%]

Plus 10% for presentation and clarity.

Deadline: 10am Sep 17, Monday

3 Further Remarks

Unlike your problem sets, your marks will depend not only on technical correctness, but also the way you motivate your design choices, and the way you analyse and present the results.

The report must be entirely your own work, except where clearly indicated otherwise. Any references to external material (papers, books, or websites) must follow the guidelines introduced in Lecture 1.

Please also note that we are not responsible for any delays in the Wattle system. Please submit well before the deadline.