Modelling of Automotive Systems

509H3

Project 1

Project 1 Simulation of Vehicle Propulsion Performance

Introduction

Early ideas for new vehicles are often simulated using simple models that allow comparison of fuel consumption and emissions. In studies to investigate future fuels, air quality, and new technology, the models are adjusted to reflect the major effect of the new technology and are compared by operating the models over one of the standard drive cycles. While there is a wide choice of drive cycles that represent particular local conditions most simulation is done with one of the cycles used for type testing (NEDC and FTP-75).

There are two types of cycle simulation – a backward simulation uses the power requirement corresponding to the current position in the cycle as the basis for the engine and drivetrain state. The fuel consumption is calculated at each time step and integrated over the cycle. The forward simulation is more realistic and usually includes a representation of the driver. It is useful for detailed evaluations of vehicle systems and their behaviour under realistic control scenarios.

Project Objective

Compare the performance of a diesel and petrol engine powered car using a *backward* type of vehicle simulation. Test your design of car over both the European (NEDC), American (FTP-75) and the "hard driving" US-06 test cycles and analyse the differences. You will then implement a hybrid version of each type of vehicle using, in turn, a battery and a super-capacitor. A battery will store excess energy generated by the engine and will store some braking energy. A super-capacitor can absorb and discharge energy at higher rates, but has no long term storage capacity.

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Procedures

1. Read the QSS toolbox manual and identify the structure of a vehicle simulation.
2. Check the availability of driving cycles for simulation. The NEDC and FTP-75 are already provided in the QSS-TB files, but you will need to find US-06 cycle and work out the way to input to the model.
3. Use data for a current production VW Golf and specify which one. You don't have to adjust the engine data. These represent a downsized gasoline engine. Increase the swept volume of this engine to 1.2l, and include in your report a comment on the equivalent naturally aspirated performance.
4. Be aware examples of models and plotting files are provided with the QSS toolbox. For the driving cycles whose gear number is not given, you can use CVT transmission model.
5. Assemble the vehicle model and check the physical values it produces to be reasonable values. (As you can't do a validation with a real car you must do "credibility" checks on the values.) In particular check the fuel consumption and speed-torque distribution chart where possible.
6. Use the optimization toolbox function calls to identify the best set of gears for respectively the NEDC and the FTP 75 drive cycles. Plot the resulting speed and torque distributions on the engine map and comment on the likely driveability of the vehicle. Make sure you quote the fuel consumption improvement due to the improved gearing.
7. Create a model of a series hybrid with respectively a battery and a super-capacitor. Minimise the cycle fuel consumption by selecting the battery capacity and the super-capacitor maximum charge storage. (Note: in the model, the output of the battery is charge, different from that of the super-capacitor: voltage)

The project will be based solely on the basis of the written report. The recommended length of the report is 8-10 pages with diagrams.

Note: Character "°" should be removed from the original *.m file if encounter error in running MATLAB.