Volvo Cars Thesis Work Proposal

Title
Centralized Yaw and Lateral Motion Control for Future Electric Vehicles

* Location	* Category/SubCategory
Göteborg	**96130 Vehicle State & Lateral Control**

Description of thesis work

Background:

Along with the vehicle fleet electrification across the global vehicle industry, increasing number of active vehicle motion control functions have been invented and developed, to enhance safety, comfort and efficiency during driving. Future electric vehicles are expected to reach a new level of sensors concerning environment perception and vehicle motion sensing, as well as different actuator configurations concerning electric motors and active chassis. The energy consumption of all these sensors and actuators should therefore be balanced with the driving dynamics for both manual and autonomous driving scenarios. Meanwhile, the redundant sensor and actuator set-up opens new opportunities for designing the fall-back control modes in a smoother and safer way.

Scope:

The main work expected here is to design and implement a centralized framework for vehicle yaw and lateral control in manual driving, as well as a handful AD/ADAS scenarios. *Centralized* means that all the motion requests are located centrally at the vehicle motion control layer, where one specific actuator request e.g. target steering angle will be generated and sent to the steering actuator control module. The goal is to fulfil the manual and AD driver requested trajectory in a most energy-efficient and safest way when deploying different actuators. When it comes to a more dynamic driving manner, how the framework here work together with today's vehicle stability control functions will also be investigated.

The thesis work will include the following parts:

- Literature review across the state-of-art design methods for energy-efficient yaw and lateral control, including previous study done at Volvo Cars.
- Evaluate the two popular trajectory/path tracking control methods for reference curvature calculation, i.e. pure pursuit and Stanley Controller, using simulation and test vehicle.
- Based on the numerical optimization results, determine the most energy-efficient reference motion states from the curvature references in path tracking controller. Verify in simulation and test vehicle.
- Based on the reference motion states, determine the required vehicle yaw torque. Allocate the yaw torque together with the existing longitudinal torque request, concerning the different energy losses in all actuators.
- Evaluate the yaw and lateral control capability and performance if e.g. steering actuator is broken, by using other available actuators on board.

- *Closed-loop verification using the CarMaker simulation environment will be provided by Volvo Cars.*
- *A rapid-prototype test vehicle with four electric motors (possibly steer-by-wire and rear-wheel steering), will be available with dSPACE MicroAutoBox platform installed.*

The duration of the study will be 40 weeks (60 ETCs, MSc thesis). The work will be carried out at Volvo Car Corporation.

Suitable Student background

Vehicle Dynamics and Motion Control. Both Mechanical and Control engineering are valuable. Experience with optimal control methods for vehicle application is a merit. Experience using Simulink is a merit.

Starting date	Number of students
Aug 2021	2

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