Volvo Group Trucks Technology

Master Thesis proposal:

Standardized Automation API for Motion control including vehicle model for 10-20 s predictions for all Volvo group vehicles.

Vehicle automation will be de facto a standard within transport industry the upcoming decade. That means that different companies and partners will use the vehicles in automated transports with high automation level. This is of interest in all types of land, sea, and air vehicles. For Volvo group following vehicle types shown in Fig 1 are developed for full automation. The vehicles will be equipped with a centralized motion control unit that will provide application programming interface (API) which allows a tactical and strategical authority and control of the vehicle combination. For a standard truck or bus one common motion management (VMM) interface is to use curvature request (c\text{req}) or steer angle with an acceleration request (a\text{req}) interface, see Fig 2. The automated interface will give the status and capabilities such as longitudinal velocity (v_{x,max}) capability and acceleration capability (a_{x,max}) to the Traffic Situation Mgmt (TSM). These capabilities will be limited if the control envelope of the vehicle combination is predicted to be jeopardized or the operational design domain is setting maximum motion limits.

The Automated Driving System (ADS) with tactical responsibility can use multiple ways to plan its future driving either by machine learning or with model predictions or in combination. Therefore it is important to be able to provide a Vehicle Motion model including a representative vehicle plant model for these predictions. Both for offline development of the ADS but also during real-time, to be able to do predictions of about 10-20s with the VMM SW in the loop.

The purpose of this master thesis contains three parts:

1. Go through what vehicle types are likely to be automated within Volvo Group, Buses, Construction Equipment Penta, and Volvo Trucks. Go through systematically steered axles, steering in joints, other steer mechanisms like three wheeled dollies in truck units.

2. Propose a generic TSM/VMM API with requests status and capabilities, how are motion limitations in (1) added as e.g. constraints to the motion API?

3. Build in c++ software the TSM/VMM API and simulate on multiple different types of vehicles found in (1). Try the interface on physical vehicle; construction equipment machine vehicle 4x4 with both axles steered and with two e-axles.

The thesis work will include control theory, vehicle dynamics and optimization. The work will be carried out at Volvo Group Trucks Technology. The thesis is recommended for one or two students with control analysis profile with good mathematical skills. Thesis start: Jan 2021.

If you find this proposal interesting, send your application with CV and grades to: peter.q.nilsson@volvo.com

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Fig. 1. Different Volvo group vehicle types not limited to public road or ground vehicles.

Fig. 2. Vehicle Motion Mgmt, schematic figure of system layout.