Volvo Group Trucks Technology

Master Thesis proposal:

Motion Prediction of control envelope with 1 second horizon including model uncertainty and sensor uncertainty

Proper motion predictions are necessary to perform to assure safe transports with commercial heavy vehicle combinations with high productivity. The vehicle motion mgmt (VMM) needs do motion estimation, motion prediction and motion coordination of the Motion Support Devices (MSD), see Fig 1. In motion prediction, the future motion of 1s horizon is predicted using current automated or manual driver inputs. These inputs can either be predicted to change or kept constant during the predictions. Along with the motion, the uncertainty (e.g., covariance) associated with the prediction is also estimated. This takes into account the uncertainties in the vehicle model, the driver inputs and also the motion estimation at the current instant which serves as the starting point for the prediction. Multiple parallel predictions are foreseen conducted to avoid to reach the control envelope. This to avoid severe situations such as roll over, see Fig 2, understeer, oversteer, jack-knife, or trailer swingout. If the motion prediction is foreseeing a roll-over or understeer situation with a high degree of certainty in the next prediction horizon, the vehicle longitudinal velocity ($v_{x,max}$) capability and acceleration capability ($a_{x,max}$) to the Traffic Situation Mgmt (TSM) is limited before the event occurs.

Fig. 1. Vehicle Motion Mgmt, schematic figure of system layout.

Fig. 2. Roll over lateral force limit usage on a tractor semitrailer combination.

The purpose of this master thesis contains three parts:

1. Derive what motion (and uncertainty) predictions is priority e.g. roll over and understeer and how to set up parallel motion predictions in python and c++.

2. Show in simulation how motion prediction are designed with limiting control envelope and how motion coordination is conducted, run in close loop with high fidelity vehicle plant model.

3. Test in physical tractor semitrailer, especially avoid understeer, oversteer, jack-knife, and swing out in winter conditions (winter testing also conducted in simulations).
Göteborg, 2021-09-22

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:

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