Master Thesis Proposal

Safe Estimation of Vehicle Side-Slip for Autonomous Heavy Vehicle

Background Side-slip is a fundamental motion state that is used to control the vehicle, i.e. for controlling the path and the lateral stability of the vehicle. The classical method is to estimate side-slip by combining vehicle dynamics models with measurements of accelerometers on-board the vehicle. Due to parameter uncertainties in for example tires and accelerometer drift, it is in general difficult to estimate side-slip with high accuracy. For autonomous vehicles there is a need for side-slip estimates with a high level of functional safety. This means than the side-slip estimator should estimate correctly to not generate any hazard threaten the vehicle.

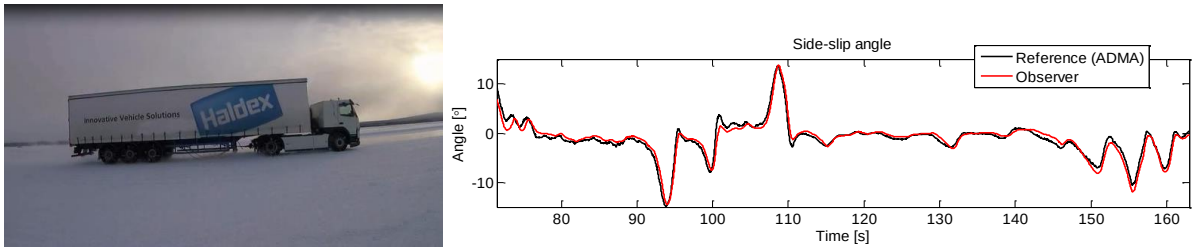

Fig 1. A Tractor semi-trailer truck with an UKF estimator and reference output from [1].

Objective The objective is to design a filter to estimate side-slip used for autonomous heavy vehicles. The design should primarily focus on being safe, e.g. not producing outliers. Important is to estimate the variance of the estimate to address to the vehicle motion controller about the side-slip uncertainty. A tool for formal verification of the estimator should also be designed to understand the space of admissible parameters of sensors and vehicle to fulfill safety requirements. This tool should in turn be applied to formulate requirements of e.g. box constraints of tire parameters and mass distribution.

Scope and Method The first part of the thesis is to perform a literature survey in side-slip estimation and then design at least one filter e.g. EKF, UKF, particle filter etc. An earlier master thesis have been carried out [1], However, the reliability and requirements were not included in the earlier thesis. The requirements of the side-slip will be given as input for the new master thesis. Experimental data including ground truth, will be given. Particular focus will be put on a tractor semi-trailer combination. Next part is to develop the formal verification tool and formulate requirements.

The duration of the study will be 20 weeks (30 ETCs, MSc thesis). The work will be carried out at Volvo Group. The outcome has potential to be published in a scientific journal or conference (depending on quality and ambitions). Suitable background is vehicle dynamics, control theory, signal processing. Both Mechanical and Signal processing engineering are valuable. Start date is Jan 2019.

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[1] M. Arrambide and Erik Durling, “Design of a side-slip observer for single-unit heavy trucks. A non-linear model-based approach with an unscented Kalman filter”, Master Thesis, Report No. EX031/2010, Chalmers, Gothenburg, Sweden, 2010.