

Master's thesis project

Statistical models of cut-in manoeuvres to improve the design of automated vehicles

Research project title

Statistical models of cut-in manoeuvres to improve the design of automated vehicles

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Workplace

This research project is performed at Chalmers University of Technology (Crash Analysis and Prevention group, division of Vehicle Safety). The workplace will be at SAFER.

Background

During the introduction phase, automated vehicles (AVs) will interact with manually-driven vehicles (MVs), in a mixed traffic environment. In order to promptly respond to unsafe behaviour of MVs, it is important for AVs to identify the arise of conflicts as soon as possible, based on some externally measurable variables. One of the scenarios which could result in a conflict for AVs is the cut-in manoeuvre: in this scenario, the MV cuts in front of AV. This is the scenario under investigation in this thesis.

Objective

This thesis aims to provide statistical models of safety-critical cut-in manoeuvres performed by MVs. The dataset used for the modelling is SHRP2, collected during a Naturalistic Driving Study (NDS) in the United States. The events retrieved from the dataset consist of safety-critical situations (near crashes) in which the Principal Other Vehicle (POV) cuts in front of the Subject Vehicle (SV)¹.

First, the students will further develop the model of uncertainty associated to the annotations of Naturalistic Driving Data, for the considered scenarios. This will be done by performing the annotations of additional events, using the same methodology described by Shams El Din (2020). Once the model of uncertainty includes the additional events, the students will work on the annotation tool, to increase the precision of the annotations. Finally, the students will build statistical models of the cut-in scenarios, by consider the model of uncertainty earlier developed.

The detailed learning objectives for the thesis project are the following:

- Extract, analyse and interpret kinematic and behavioural data collected during Naturalistic Driving Studies (NDS).
- Develop models describing the kinematic interaction between vehicles, during safety-critical cut-in manoeuvres.
- Evaluate the impact of the work on the design of active safety systems and automated driving.

Research project work

A NDD sample of around 86 safety-critical cut-in manoeuvres was extracted from a previous work (Shams El Din, 2020). In the same work and in a previous students' project (Shams El Din et al., 2020), an annotation tool was also developed, to retrieve variables from NDD.

¹ SV is used in the document to name the instrumented vehicle in the Naturalistic Driving Data, while the POV is the vehicle changing lane in front of the SV

In this thesis project, the students will use the knowledge acquired in the previous work (Shams El Din, 2020; Shams El Din et al., 2020), to: a) further develop the model of uncertainty associated to the annotations of Naturalistic Driving Data; b) create a statistical model of safety-critical cut-in manoeuvres. The detailed plan of the research project includes the following steps:

1. Review the literature about statistical models of lane change manoeuvres.
2. Conduct annotations of the events, to retrieve relevant variables.
3. Improve the model of uncertainty associated to the annotations, by adding further events to the current model.
4. Develop statistical models describing the safety-critical cut-in manoeuvres performed by the SV.
5. Write the final thesis report and present the results.

References

- Shams El Din, A. H. (2020). *Statistical modelling of critical cut-ins for the evaluation of autonomous vehicles and advanced driver assistance systems*. Master's thesis. Chalmers University of Technology.
- Shams El Din, A.H., Takkoush, M., Pettersson, N., Hulkunte Gopinath, S. (2020). *Variables extraction and trajectory reconstruction for modelling driver behaviour*. TME180, Final report. Chalmers University of Technology.