Research project

Influence of bearing angle and bearing angle rate on driver response to approaching vehicles in intersection straight crossing scenarios

Research project title Influence of bearing angle and bearing angle rate on driver response to approaching vehicles in intersection straight crossing scenarios
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Keywords driver modelling, driver behavior, intersection, driving simulator study, active safety systems
Mandatory requirements • Proficiency with MATLAB and good analytical skills • Fluency in English *Optional requirements* • Basic knowledge about driver behaviour analysis and driver behaviour modelling • Previous knowledge of Open DS
Workplace This is a research project to be performed at Chalmers University of Technology, within the group Accident Prevention in the Department of Applied Mechanics (division of Vehicle Safety). The workplace will be SAFER, located at Lindholmspiren 3.
Learning objectives • Plan and perform a driving simulator study • Design the scenarios in the driving simulator • Analyze data collected in driving simulator • Assess influence of situational parameters to drivers' braking reactions • Update an existing driver behaviour model for rear-end scenarios
Highlight • Work with a relevant and current research topic (automated driving)

Number of students 2	Scholarship provided Yes, at completion of Master's thesis

Background

In January 2016, the Swedish automotive industry (AB Volvo, Volvo Car Corporation and Autoliv) in collaboration with universities / research institutes (Chalmers and VTI) started the project *Quantitative Driver Behaviour Modelling for Active Safety Assessment Expansion* (QUADRAE). The aim of the project is to **develop and validate models of driver behaviour** that are needed in current and future simulation tools for virtual testing of active safety and automation. Within the overall project, an important sub-task is the **modelling of drivers' behaviour in safety-critical events during semi-automated driving** and this project contributes to this sub-task.

Objective

It is assumed that drivers make assessments if they are on a collision course with principal other vehicles (POVs) by the relative change of positions to each other (Bertholon, 1993): in a rear-end scenario, when the projection of a POV remains located in the same windscreen position and looming is present, the vehicle is on collision course. In a straight crossing intersection scenario, with POV moving in perpendicular direction, the location of the projected vehicle on the windscreen changes (bearing angle is not constant and exceeds a certain angular rate). The value of the bearing angle and bearing angle rate will determine, if the Subject Vehicle (SV) and POV are on a collision course (Bootsma et al. 2016; Mathieu et al., 2017). Therefore, vehicle drivers will adjust the vehicle speed so that change of the bearing angle is above a comfort threshold – threshold which will avoid the collision between SV and POV - and the bearing angle is not zeroed out.

The objective of the study is the collection of data that supports driver brake behaviour modelling when approaching an intersection with crossing vehicle(s). In detail, this study aims to identify the comfort threshold for the bearing angle rate for brake initiation when the displacement axis is fixed. Further, the effect of visual obstruction, other traffic participant, and distraction will be investigated to evaluate, if a reduced observation time of the POV will have an effect of the threshold for the bearing angle rate.

The results of the study will contribute to the definition and development of driver modelling in the QUADRAE project.

Research project work

The student(s) will plan, design, and conduct a driving simulator study in which the participants will be asked to approach an intersection in a driving simulator at a constant given speed. The experimental design is based on repeated measure multifactorial design (Box et al., 2005; Lee, J, D. 2011). Driving scenarios are built up based on the experimental design in an open source driving simulator OpenDS (OpenDS, 2017).

The detailed plan of the research project includes the following steps:

1. Review the literature about drivers' models of driver behaviour in critical situations
2. Plan the experimental design and recruit participants
3. Design the scenario to be implemented in the driving simulator
4. Assess influence of situational parameters to participants' braking reactions in the designed scenarios
5. Update and existing rear-end driver behaviour model to application in simplified straight crossing path scenarios
6. Write the final thesis report

References

Bertholon, C. (1993). Curvilinear Approach to an Intersection and Visual Detection of a Collision. *Human Factors*, *35*(3), 521-534

Bootsma, R.J. et al. (2016). Fractional-Order Information in the Visual Control of Lateral Locomotor Interception. *Journal of Experimantal Psychology*, 42(4), 517-529

Mathieu, J. et al. (2017). Judging arrival times of incoming traffic vehicles is not a prerequisite for safely crossing an intersection: Differential effects of vehicle size and type in passive judgement and active driving tasks. *Acta Psychologica*, *173*, 1-12

Box, G.E.P., Hunter, J.S., Hunter, W.G. (2005). *Statistics for Experimenters. Design Innovation, and Discovery*. Wiley, 2nd edition

Lee J D. (2011). *Handbook of Driving Simulation for Engineering, Medicine, and Psychology*. CRC Press

OpenDS (2017). https://www.opends.eu/