

Master thesis proposal within research project MICA2: Modeling interaction between cyclists and automobiles 2

How does a driver overtake a cyclist in the presence of an oncoming vehicle? – Virtual reality experiment to understand driver overtaking behavior

<p><i>Research project title</i> How does a driver overtake a cyclist in the presence of an oncoming vehicle? – Virtual reality experiment to understand driver overtaking behavior</p>
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<p><i>Keywords</i> Interaction, cyclist, overtaking, comfort zone boundaries</p>
<p><i>Mandatory requirements</i></p> <ul style="list-style-type: none"> • Good knowledge about MATLAB/python or equivalent software • Fluency in English • Good statistics skills <p><i>Optional requirements</i></p> <ul style="list-style-type: none"> • Basic knowledge about experimental setup, driver behavior analysis, driver modeling, and simulator studies
<p><i>Workplace</i> This is a research project to be performed at Chalmers University of Technology, within the group (RUVI) Road-user Vehicle Interaction (a division of Vehicle Safety). The workplace will be Lindholmen, Veoneer Research in Vårgårda, and VTI Lindholmen.</p>
<p><i>Learning objectives</i></p> <ul style="list-style-type: none"> • Analyze data collected in the test track • Assess the influence of situational parameters on drivers' braking and Steering reactions
<p><i>Highlight</i> Work with a relevant and current research topic (automated driving)</p>
<p><i>Number of students</i> 2</p>
<p><i>Scholarship provided</i> Yes, at the completion of Master thesis</p>

Background

The increasing number of cyclists challenges the operational design domain of advanced driver assistance systems (ADAS). The concept of being safe and comfortable can be correlated to comfort zone boundaries. Understanding the comfort zone boundaries and how the interaction between road users affects overtaking can help develop Intelligent vehicle systems, which aim to prevent collisions, which may benefit cycling safety [1].

Several studies have been carried out to understand the driver behavior during overtaking using data collected in the real-life traffic [2], using test track data [3], using Naturalistic data collected in European roads [4], and using simulator setup [5]. However, these studies do not include a critical situation with cyclists to understand the driver's evasive behavior during an overtaking scenario. Therefore, using a virtual/augmented reality setup will enrich existing data on drivers' evasive behavior during overtaking.

Objective

The main objective of the thesis is to carry out a data collection in the test track using a virtual/augmented reality setup to understand the parameter that influences the overtaking behavior. An experimental protocol is created by combining different independent factors by using a suitable experimental design. These factors are tested by using Volunteers recruited at Veoneer. Statistical analysis will be carried out on the data collected to understand the factors influencing the overtaking behavior of the driver. The study results will contribute to improving driver and system models for overtaking scenarios in the project MICA 2 - Modeling interaction between cyclists and automobiles 2.

Research project work

The student(s) will plan, set up, collect, and analyses participant data from a test track study. The detailed plan of the research project includes the following steps:

1. Review the literature about comfort zone boundaries with the cyclist in overtaking scenario, Virtual/Augmented reality data collection methods
2. Recruit participants for the data collection
3. Collect participants data about overtaking behavior
4. Extract relevant metrics for different phases for overtaking the cyclist from data
5. Present the findings in the final presentation
6. Write the final thesis report

References

- [1] J. Duan, R. Li, L. Hou, W. Wang, G. Li, S.E. Li, B. Cheng, H. Gao, S. Eben, B. Cheng, H. Gao, Driver braking behavior analysis to improve autonomous emergency braking systems in typical Chinese vehicle-bicycle conflicts, *Accid. Anal. Prev.* 108 (2017) 74–82. <https://doi.org/10.1016/j.aap.2017.08.022>.
- [2] M. Dozza, R. Schindler, G. Bianchi-Piccinini, J. Karlsson, How do drivers overtake cyclists?, *Accid. Anal. Prev.* (2016). <https://doi.org/10.1016/j.aap.2015.12.008>.
- [3] A. Rasch, C.-N. Boda, P. Thalya, T. Aderum, A. Knauss, M. Dozza, How do oncoming traffic and cyclist lane position influence cyclist overtaking by drivers?, *Accid. Anal. Prev.* 142 (2020). <https://doi.org/https://doi.org/10.1016/j.aap.2020.105569>.
- [4] J. Kovaceva, G. Nero, J. Bärgrman, M. Dozza, Drivers overtaking cyclists in the real-world: Evidence from a naturalistic driving study, *Saf. Sci.* (2018). <https://doi.org/10.1016/j.ssci.2018.08.022>.
- [5] G.F. Bianchi Piccinini, C. Moretto, H. Zhou, M. Itoh, Influence of oncoming traffic on drivers' overtaking of cyclists, *Transp. Res. Part F Traffic Psychol. Behav.* 59 (2018) 378–388. <https://doi.org/10.1016/j.trf.2018.09.009>.