Varying Bicycle Infrastructures - An Interconnected Simulator Study for Inspecting Motorist-Cyclist Conflicts

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Abstract – *In this research, we estimate the influence of different bicycle infrastructure on the severity of motorist-cyclist conflicts via an interconnected simulator study. Our focus is a specific conflict type: motorist is turning at an intersection and the cyclist is going straight, crossing the intersection based on previous evaluations from literature. Additionally, we reason on previously-conducted bicycle simulator studies and adapt specific methodological components of investigation area depiction in VR and scenario definition. In the end, we present four scenarios of a case study based on a signalized intersection in Ingolstadt, Germany, where we inspect motorist-cyclist conflicts in an interconnected simulator environment. After every simulator run both test subjects will be teleported to specific starting positions.*

Keywords: *Interconnected Simulator Studies, Bicycle Simulator, Traffic Safety, Motorist-Cyclist Conflicts, Visibility Fields.*

Introduction

Bicycle Infrastructures consist of manifold possible options of implementation, especially in urban environments. As there are numerous established infrastructural types of bike lanes and bike ways, but as well numerous novel, such as bicycle highways with extended traffic control strategies prioritizing cyclists, there are manifold factors influence the general traffic safety of cyclists (Kuehn, Hummel et al., 2015). The latter mentioned bicycle highways aim to reduce the number of interactions with other road user types for reducing conflicts and accidents. In urban areas, motorists interact with cyclists more often and are responsible for most of their severe accidents. At specific classes of infrastructure designs, specific types of manoeuvres and interactions happen more often (Gerstenberger, 2015). This is specific for different urban environments, but certain similarities such as conflicts typical for road user types at infrastructure classes. Within an already implemented interconnected simulator framework, we design scenarios of one and the same signalized intersection (based on a present 3D model of an intersection in Ingolstadt) with right-turning motorists and straight-ahead-cycling cyclists. As indicated in (Kolrep-Rometsch, Leitner et al., 2013), this urban scenario still poses serious hazards to vulnerable road users, as motorists occasionally disregard their right of way. One potential line of reasoning for increased risk in this scenario is that according to empirical data a noteworthy proportion of 20% of motorists omit performing a shoulder glance. However, considering common traffic volumes in this scenario and the resulting interaction frequency, a failure probability of 20% alone would lead to a severe overestimate of accident risk. This suggests that failure is likely to be rooted in more complex cognitive interactions within motorists. In this simulator study we want to study such cognitive interactions. To this end, we first focus on the factors visibility fields and visibility obstacles of both types of road users. We do not focus on gestures and head movements of the cyclist. To this end, we use VR glasses at the bicycle and the vehicle simulator.

Methods and Approach

Based on an interconnected simulator study application, we implement a scenario, where right turning motorist test subjects are conflicting with cyclist test subjects going straight at an intersection, with and without traffic light signalling. Literature reveals that this is one of the more critical conflict types, which appears more often at urban intersections, especially in Germany (Richter and Sachs, 2016).

A case study in Ingolstadt – implemented scenarios

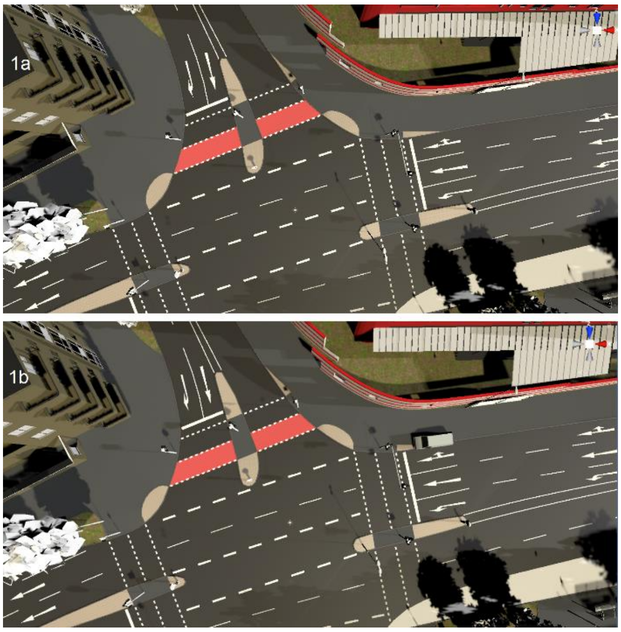

Figure 1. Intersection at the Hindenburgstr. and Ringlerstr. in Ingolstadt, Germany, with scenario (1a) present state, and (1b) present state with visibility obstacle (van)

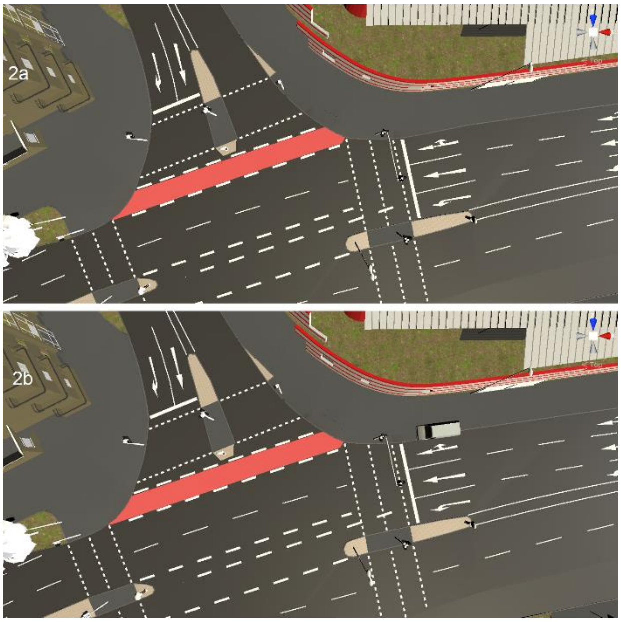

Figure 2. Scenarios with modified bicycle infrastructure, with (2a) removed street refuges, and (2b) removed street refuges with visibility obstacle (van)

We define four scenarios at a real investigation area: the signalized intersection at the Hindenburgstr. and Ringlerstr. in Ingolstadt, Germany. In all scenarios, pictured in Fig. 1 and Fig. 2, the motorist is coming from the upper-right entry and uses the right-turning lane to the upper-left exit. The cyclist is always coming from upper-right and continues cycling straight towards the lower-left exit. Scenarios 1a and 1b in Fig. 1 show the present state with and without a visibility obstacle, which is in our case a van standing between the right-turning motorist lane and the bike lane. Scenarios 2a and 2b in Fig. 2 are also varying in the presence or absence of a van. Additionally, scenario 2a and 2b have modified bicycle infrastructure with removed street refuges for enabling straighter cyclist test subject trajectories compared to scenarios 1a and 1b.

Future Work

Furthermore, we plan to conduct additional traffic observations via video data acquisition for recording mixed traffic with a higher proportion of e-scooter drivers. In this context, a study has already been conducted as part of a research project in which e-scooter riders had to cross an intersection where there was a possibility of being hit by right-turning vehicles. The human behaviour of e-scooter riders at intersections was to be investigated. However, since some subjects reported problems with realistic behaviour while playing the simulation, we want to implement the e-scooter driver as a novel additional scenario. In this case, the bicycle simulator is replaced by an e-scooter simulator and the result can be compared with the e-scooter study mentioned above, where participants controlled the rider with a mouse and keyboard.

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