Resolving Interactions among Fully Automated Vehicles and Cyclists in Complex Traffic Situations

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Motivation
Automated vehicles are a key component of future mobility. It is expected that automated vehicles will improve traffic safety and traffic efficiency and enhance travel convenience. At the same time, the share of non-motorized modes of transport, such as the bicycle, grows rapidly in urban networks mainly due to transport policy measures aiming to reduce the number of trips completed by motorized vehicles. Under mixed traffic flow conditions non-motorized user behaviour can be unpredictable, as the non-motorized user intentions are not known to the automated vehicle and due to the inherent movement flexibility of non-motorized users, their behaviour and their actual influence on the automated vehicle’s path cannot be easily foreseen. In the same context, complex traffic situations are often resolved by traffic participants through communicating intentions that rely in a mixture of a complex culturally guided series of interactions. Autonomous vehicles are required to be able to comprehend and interpret these communication forms [1]. As in the future, the number of fully automated vehicles on the roads rises, information exchange and cooperation among fully automated vehicles and bicycles can also become a way of resolving critical traffic situations. As a further step, understanding of basic non-motorized user communication patterns is essential in increasing vehicle autonomy. The potential of establishing cooperation and the development of automated vehicle control algorithms that resolve traffic situations for autonomous vehicles has already been undertaken by various researchers [2]–[7]. However, none of the examined scientific methodologies considers non-motorized road users. The establishment of communication and collaboration among autonomous vehicles and cyclists can potentially provide the basis for improving traffic efficiency and safety on the road.
Objective
The target of this research is to develop a scientific solution for resolving complex traffic situations among fully automated vehicles and cyclists through communication and information exchange among bicycles and fully automated vehicles. The scientific methodology will rely on the short-term prediction of the cyclists' behaviour and the path of the other fully automated vehicles at the intersection’s wider area. In this context, a spatiotemporal model of the wider intersection area is developed for predicting the short-term behaviour of bicycles and fully automated vehicles. Based on the identified traffic scenario, an objective function is then optimized that utilizes this information to implement the most optimal solution in terms of traffic efficiency that resolves the present traffic situation for any number and composition of present bicycles and fully-automated vehicles.

Methodology
The interactions among cyclists and motorized vehicles in complex traffic situations and the communication patterns and methods deployed to resolve such situations are thoroughly studied. A critical traffic situation is selected and complex traffic scenarios involving different user compositions can be introduced in the environment of a bicycle simulator. There it is possible to study the behaviour of a cyclist under different complex traffic situations and assess the effects on traffic efficiency, and traffic safety indicators. Using this data, a framework can be developed under which specific information is exchanged among cyclists and automated vehicle revealing their short-term tactical behaviour and estimates the traffic state. This is used as a tool for resolving complex traffic situations or pre-emptively avoiding them, by optimizing an objective function, in terms of traffic efficiency that resolves the present traffic situation. The developed scientific methodology is then validated in simulator scenarios with a cyclist as a real test subject in a fully automated vehicle environment.

Fig. 1: Methodology

References

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