Investigating the Impacts of Autonomous Vehicles on the Macroscopic Parameters of Traffic

Master‘s Thesis of Alexandra Thoma

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Introduction

The world of transportation is about to make the next huge evolutionary step by introducing the Autonomous Vehicle (AV). The AV is expected to increase road safety, by diminishing the human error, adopt smaller headway and an overall smoother driving behavior.

However, the newly introduced driving characteristics trigger new challenges with regard to the traffic system. More specifically, it is highly important to investigate how the traffic flow is going to be affected by the mixed traffic and in the end by the AV itself.

Research Questions

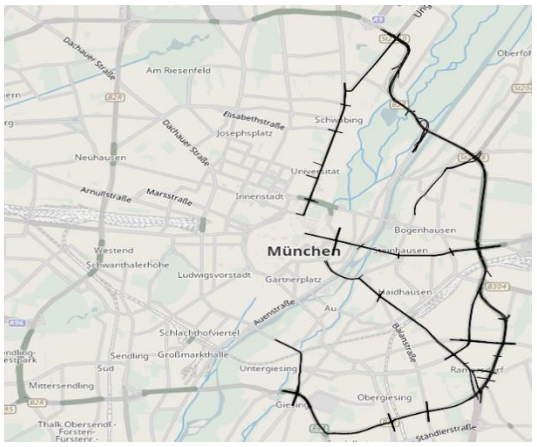
- What are the impacts of the AVs on the parameters of the Fundamental Diagram (FD)?
- How are the different penetration rates of AVs going to affect the macroscopic parameters of the Fundamental Diagram (FD)?

Methodology

In order to answer the research questions this study deploys the Vissim microsimulation software for the simulation of 6 scenarios. The case of study is the eastern part of the Munich Ring Road.

Scenario	Regular Vehicle	AV	Nr. of Simulation runs	Time interval [min]
1	100%	0%	10	5
2	80%	20%	10	5
3	60%	40%	10	5
4	40%	60%	10	5
5	20%	80%	10	5
6	0%	100%	10	5

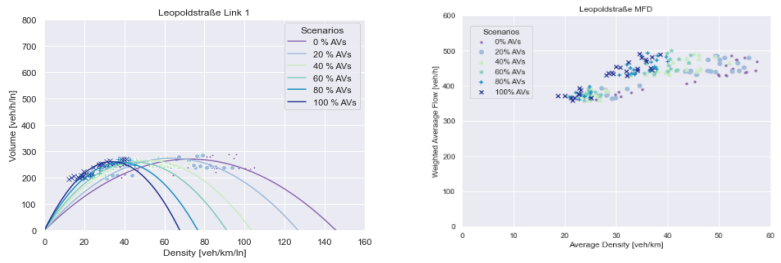
Volume and density data will be extracted separately from Vissim for each scenario and subsequent links on one urban road and on the Ring Road, which are located before intersections will be chosen. For each of these links a volume – density diagram for one lane will be created in order to evaluate the impact of the AVs on the FD. Furthermore, one MFD for the urban road and one for the Ring Road will be created, based on the weighted average of the volume and density per lane. Furthermore, by extracting the average delay and queue length at an intersection lever, the intersection performance will also be evaluated.



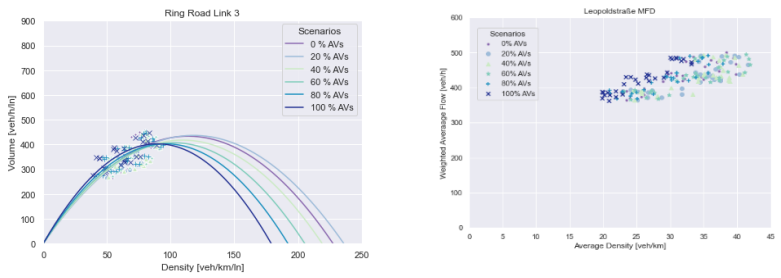
Simulated Network in Vissim

Results

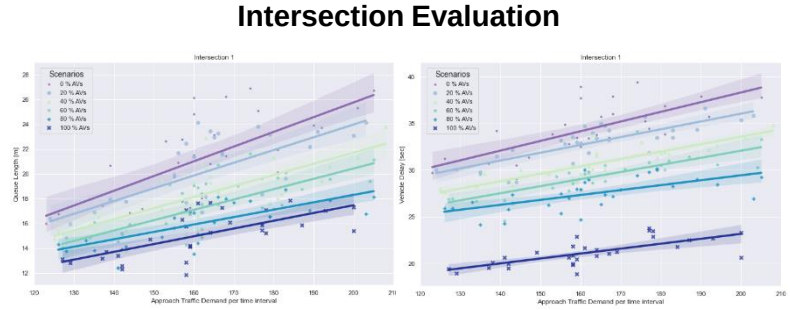
Urban Road Evaluation



Ring Road Evaluation



Intersection Evaluation



The obtained results, in particular the FDS, show that overall the AVs have a positive impact on traffic. However, there are cases, where the low penetration rate is deteriorating traffic, and one case of a ramp segment, where the AVs had a constantly increasing negative impact. Furthermore, it is appearing from the MFDs, that the AVs are more beneficial in low penetration rates to the urban link than the Ring Road. Lastly, the intersections perform besically analogously better as the amount of AVs increases in the fleet.

Conclusions and Recommendations

Overall, the existence of AVs in the network has a positive impact. It is important to note that the reason of the negative effect of low penetration rates on a few specific single links only are unclear and should be further investigated. Moreover, further research focusing on the MFD behavior and including critical sections of the road network (e.g. on-off ramp) would be of interest.

References

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