

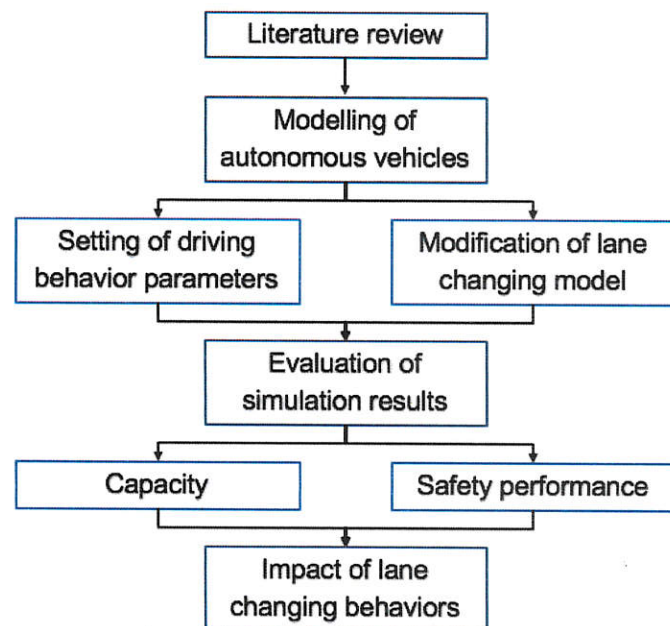
Analysis of the Impact of Lane Changing Behavior on the Capacity of Freeway Segments

Master's Thesis of Jie Zhu

Mentoring:

M.Sc. Sabine Krause

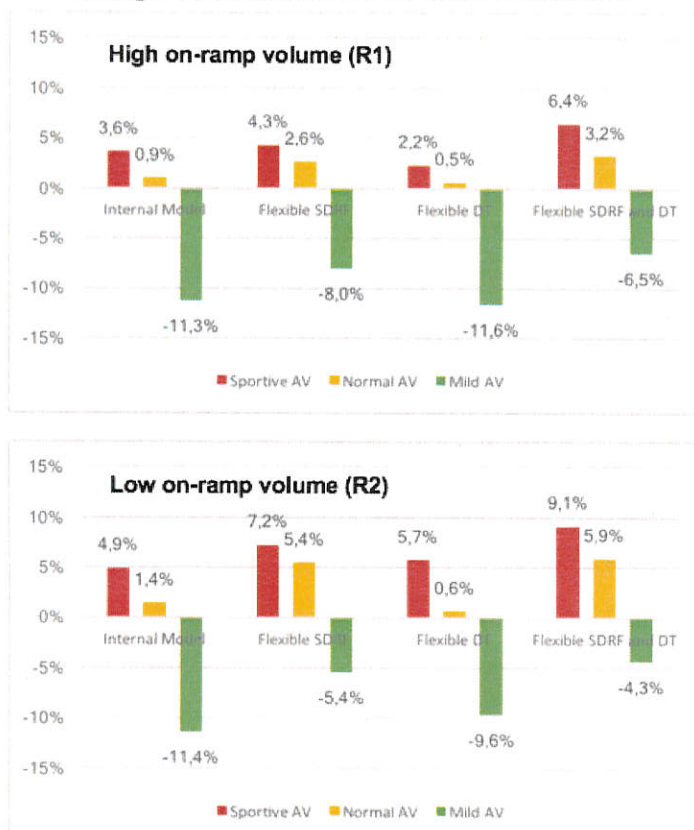
Dr.-Ing. Silja Hoffmann



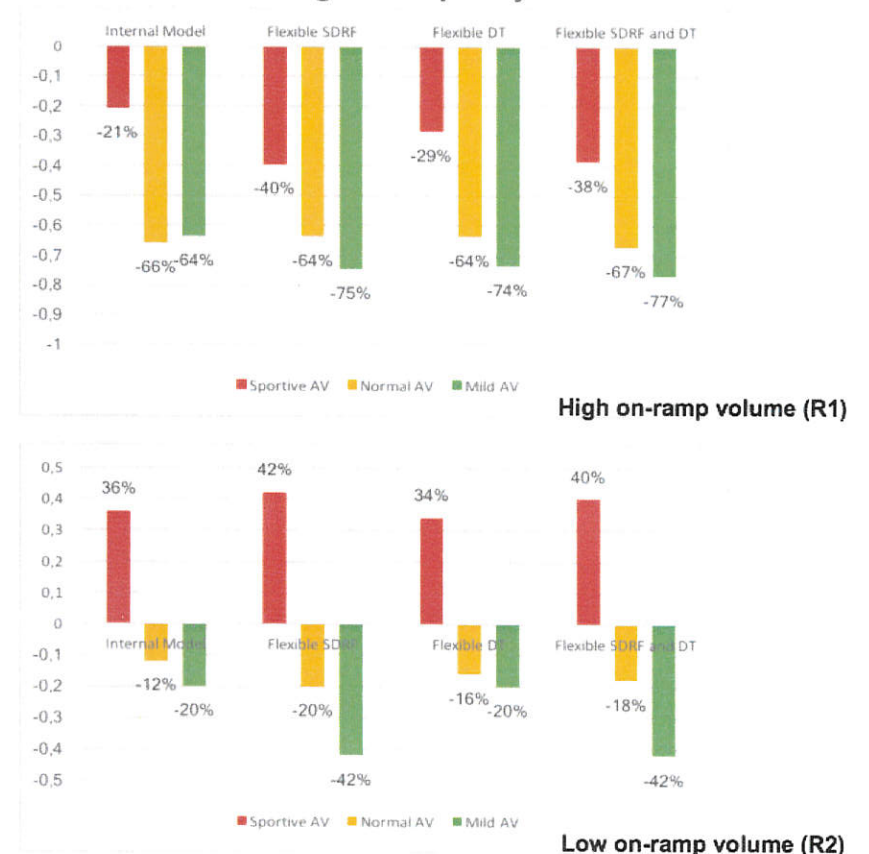
As the theoretical basis for the thesis, a general structure of the automated lateral vehicle control is proposed based on the concept of gap acceptance. On this basis, the various lane changing behaviors of autonomous vehicles are modeled in the microscopic simulation tool VISSIM. The modeled network is a typical freeway merge segment with two lanes on the main carriageway and one lane on the on-ramp, where the lane changing behavior has a great influence on the overall traffic performance. The modeling consists of two steps. First, three driving modes of the autonomous vehicles are distinguished by allocating different values to the driving behavior parameters such as desired speed, deceleration, and desired safety distance. Then, two lane changing parameters of the internal VISSIM model, safety distance reduction factor and deceleration thresholds, are modified with external scripts so that the vehicles are able to adapt their lane changing behavior according to its distance to the emergency stop and the traffic density of the merge section.

Automated driving has become one of the major topics for the mobility of the next decades, since it provides the opportunity of increased safety, enhanced mobility, lower energy consumption and positive environmental effects. Therefore, the impact of the presence of the autonomous vehicles has gained widespread concern. Various studies on the longitudinal behaviors of the automated vehicles have shown that the automated driving, in particular the communicative automated driving, would significantly reduce the headway between vehicles by eliminating reaction time needed for the human driver, and thereby lead to stable platoon driving and improved capacity and safety. However, the lateral behaviors of the autonomous vehicles have not received enough coverage in the literature. The main purpose of this thesis is to investigate the impact of various lane changing behaviors of the autonomous vehicles on the overall traffic performance in a freeway merge segment.

Change in Number of Severe Conflicts



Change in Capacity



Results of the simulation study reveal that the positive effects of automated driving are especially highlighted when the on-ramp volume is low. It would significantly reduce the number of severe conflicts by 75 % and increase the capacity by nearly 10 % in the best cases. The mild driving mode provides the greatest improvement in the safety performance of the traffic flow, whereas reduces the capacity slightly at the same time. On the contrary, the sportive driving mode of the autonomous vehicles is not appropriate for low on-ramp volume, although it may increase the capacity for a bit, because the frequency of severe conflicts is increased by more than one third when the vehicles drive in the sportive mode with a low on-ramp volume. The results also show that it is particularly important for the autonomous vehicles to adapt their desired safety distance during lane changing. This capability would greatly enhance the capacity and safety in the most cases.