Sustainability Assessment of Acceleration Control of Automated Vehicles at a Curved Section

Master's Thesis of Verena Hollfelder

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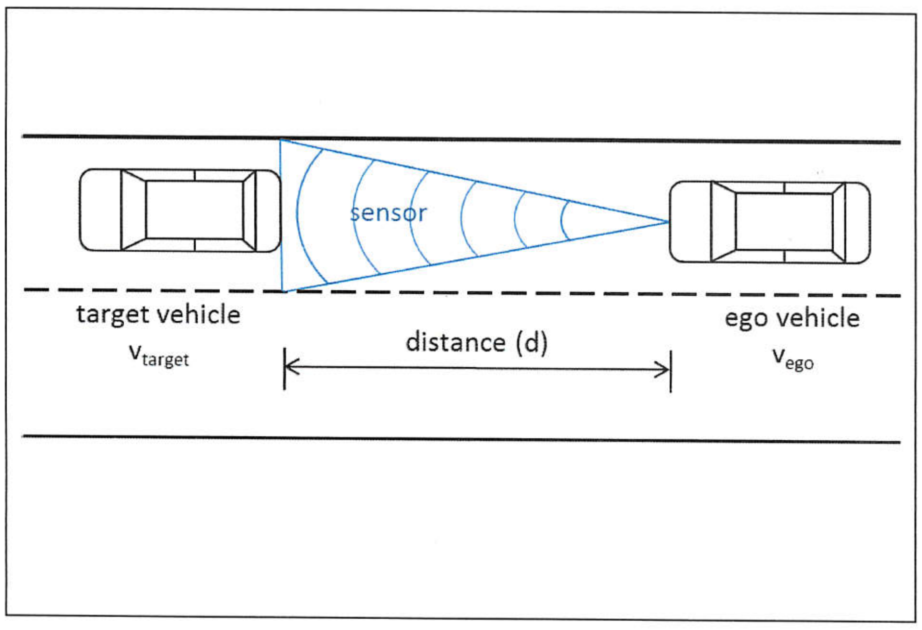
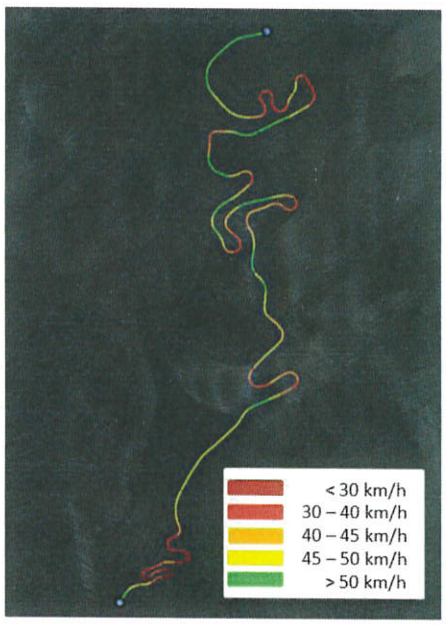
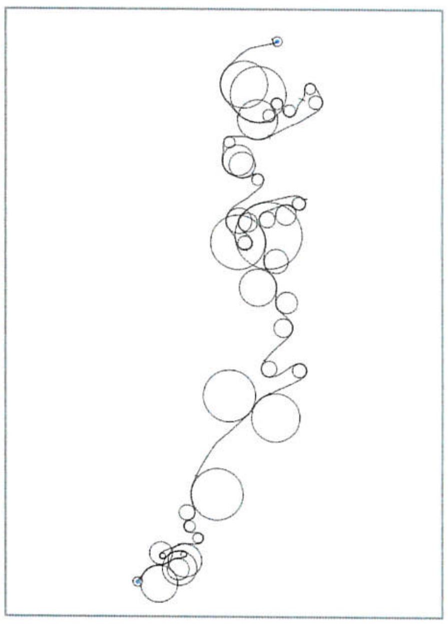
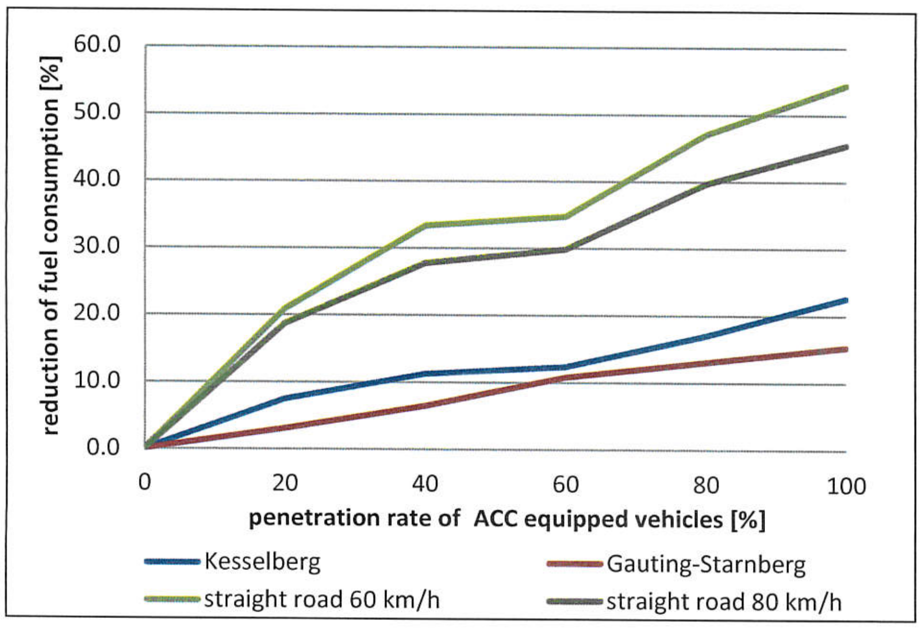


An increasing number of vehicles is one of the most contributing factors to air pollution which has a significant impact on health issues in urban areas and global climate change. It is obvious that traffic emissions have to be reduced to avoid these social issues. New technologies such as Advanced Driver Assistance Systems (ADAS) support drivers autonomously by warning drivers or interrupting driving controls. These ADAS technologies lead to a more efficient way of driving in terms of emission and fuel consumption by reducing abrupt acceleration and deceleration. Under the ICT Emissions project sponsored by the European Union, various driver assistance systems and infrastructure communication systems were tested concerning their emission rates. While the advanced driver assistance systems, including an Adaptive Cruise Control (ACC) system (see figure left), were tested under urban situations, they were not applied and tested under rural situations including significant curvatures and inclinations.

Therefore, this research aims to analyse and evaluate the impact of ACC on CO_2 emissions and fuel consumption, especially at curved and inclined road sections. In order to develop an appropriate test environment, the microscopic traffic simulation model Aimsun, is used to develop road geometries and simulate ACC including vehicle sensor functionalities and control algorithms. Two different road sections, Kesselbergstraße between Kochelsee und Walchensee (see figure right) and the road between Gauting and Starnberg are modelled in Aimsun to represent the real world scenarios. In addition, for a more comprehensive analysis, a hypothesized scenario consisting of various road curvatures and vehicles' desired speeds is also developed, according to the Guideline of Rural Road Design. This represents an ideal scenario conforming to the safety standards of the guideline.







With these real world and hypothesized scenarios, the ACC controlled vehicles are simulated in Aimsun and the performance of ACC is assessed by a fuel consumption model and an emission model.

All scenarios are evaluated by comparing straight road scenarios with different penetration rates of ACC equipped vehicles (see figure left). Additionally they are tested for different traffic flows, inclinations and curvatures. The results show that the efficiency of Adaptive Cruise Control significantly depends on the acceleration rate attributed by the variation in speed limits. Importantly, the ACC control is efficient for all penetration rate cases, but it decreases by a larger variation in speed limits and number of curvatures.