Conception and implementation of an interface between microscopic traffic flow simulation and driving and sensor simulation

Master‘s Thesis of Paul Pabst

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Due to multi-facetted reasons like a rising threat of traffic collapse in urban areas or the impact of the traffic sector on global warming, in recent years many cities made it a goal to in-crease the share of cycling in their modal split. To make cycling more attractive one of the most important aspects is to make it objectively and subjectively safer. To do so, it is mandatory to better understand and predict the behavior of cyclists, which is often unexpected and therefore can conclude in dangerous situations. This knowledge can be used for example to help develop and train the algorithms of autonomous vehicles, which then get better at reacting to cyclists, or to help design new traffic infrastructure which allows for better protecting cyclists.

Researching the behavior of cyclists poses a special challenge: since there is no surrounding vehicle frame to which cameras and sensors can be attached, observations are usually bound to static, overhead positions making it difficult to capture the behavior of single cyclists.

A solution is the use of driving simulators. While there are plenty of car driving simulators to research the behavior of drivers there are only few bicycle simulators and those often rely on proprietary software solutions. This thesis focusses on expanding an existing bicycle simulator by integrating CARLA v0.9.9, an open-source driving simulation software developed for the training of autonomous vehicles. To make the integration as accessible as possible open-source software solutions were used whenever possible.

The overarching goal was to understand if and how CARLA could be adapted to visualize a 3D environment, through which vehicles controlled by SUMO, a microscopic traffic simulation tool, as well as a user-controlled vehicle could be moved.

Problems tackled in this thesis were to see how the simulator sensor outputs could be used in CARLA, how vehicle dynamics were implemented in CARLA and how they needed to be adapted to feel like a bicycle. In addition it was studied how the monitors surrounding the simulator bicycle could be used and how a fully operational scenario can be created from a SUMO network as a basis.

By the end of the thesis it was possible to display the virtual environment on all four monitors and use the simulator bicycle to move through this environment. It was also possible to create basic 3D maps from a SUMO network and run a co-simulation of SUMO and CARLA. How-ever, some future work remains: Firstly, a proposed workaround for synchronizing the traffic lights in a CARLA simulation to those in a SUMO simulation needs to be tested. Secondly, after showing how the engine setup and steering can be manipulated, a definitive calibration should be explored.

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