Methodology Development for the Calibration of Microscopic Traffic Simulations Focusing on Connected Automated Driving

Master‘s Thesis of Marc Julio

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Figure 1: Case Study area in Munich

The Connected and Autonomous Vehicle (CAV) is a technology under development that allows self-driving and, by consequence, does not need human interference. These vehicles will be gradually implemented in the road traffic, and they are expected to impact road traffic. Due to this fact, one needs to anticipate it with existing tools like Microscopic Traffic Simulations (MTS). Nevertheless, MTS needs to have an appropriate calibration to produce correct results. To achieve an accurate calibration, one needs to use field data, but they currently not exist on a large scale for CAV. Therefore, in this thesis, artificial data are produced to perform CAV calibration in MTS. These synthetic data are produced by simulating different scenarios with using CAV modelling from the CoEXist project. In this project, two CAVs drove in real-world condition and permitted to model CAVs in MTS. These study results permitted to model CAVs in VISSIM by modelling three levels of autonomous driving, Cautious, Intermediate and Aggressive driving modes. Therefor these three driving modes are adapted in AIMSUN to develop the methodology of CAV calibration of MTS.

Research Objectives

- Identify the existing modelling of CAVs with the different MTS software and adapt the findings to model CAVs in AIMSUN.
- Introduce a framework to calibrate different levels of automated driving in AIMSUN.
- Identify the needed real-life measurements to calibrate CAVs in an MTS thanks to results found in the simulations done within this study.

Research questions

- How can one adapt the latest findings of CAV behaviour to the driving models of AIMSUN Next?
- How to calibrate the CAV behaviour in Microscopic Traffic Simulation models?
- What driving parameters are the most important in the driving models to represent CAVs to identify what real-life measurements will be needed?

Scenario	HDV	CAV Cautious	CAV Intermediate	CAV Aggressive
1	75	25	0	0
2	50	50	0	0
3	25	40	35	0
4	0	33	33	33

Table 1: Proportion of the percentage of each sort of vehicle to be calibrated

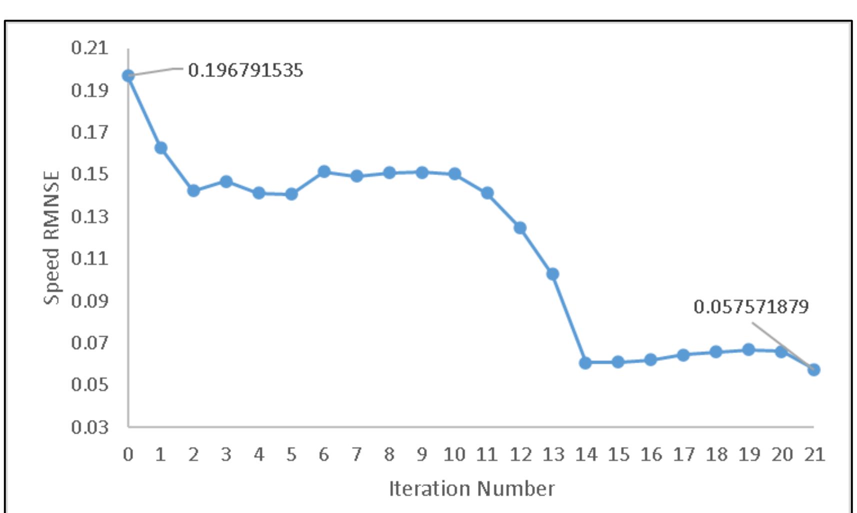

Figure 2: Evolution of all vehicles' speed Root Mean Normalized Error in Scenario 2

This thesis produced a first methodology of adapting the VISSIM CF parameters values found in the CoEXist project with the AIMSUN CF parameter values. Then a second methodology was developed by producing synthetic data thanks to the CAV modelling made in the first step. Then the thesis presented the application of the Simultaneous Perturbation Stochastic Approximation (SPSA) algorithm to calibrate scenarios composed of different proportions of Human Driven Vehicles (HDV) and sorts of CAVs (see table 1). The SPSA algorithm was used sequentially for each sort of vehicle to be calibrated and produced excellent results by satisfying every calibration and validation criterion. Finally, the calibration of the CAVs was made using three different driving modes, Cautious, Intermediate and Aggressive. This distinction forced us to calibrate each vehicle step by step. Therefore, one needs aggregated data for each kind of vehicle; this can be possible by stating that the CAVs can communicate with the infrastructure via Vehicle To Infrastructure (V2I) technology. Thus, this measurement technology should be used to calibrate CAVs in MTS. Finally, the continuation and extension of this study should ideally focus on the CAV calibration with real-world data to check if this developed methodology is relevant.