Extension, Implementation and Validation of a Driver Model for Bicycles in VISSIM

Master's Thesis of Georgios Grigoropoulos

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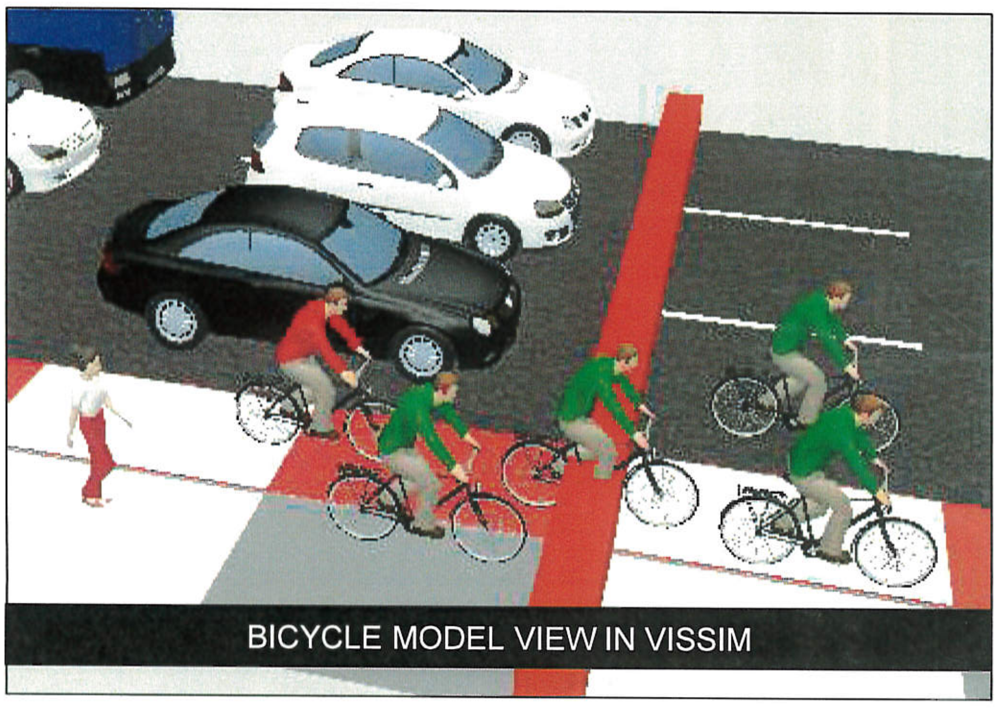
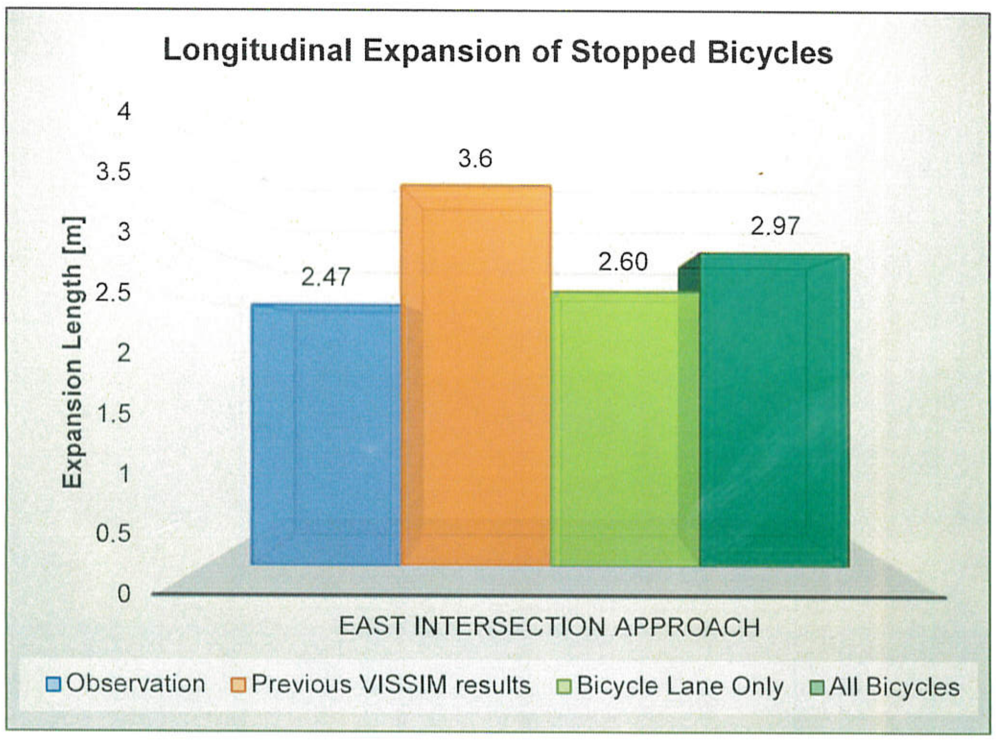
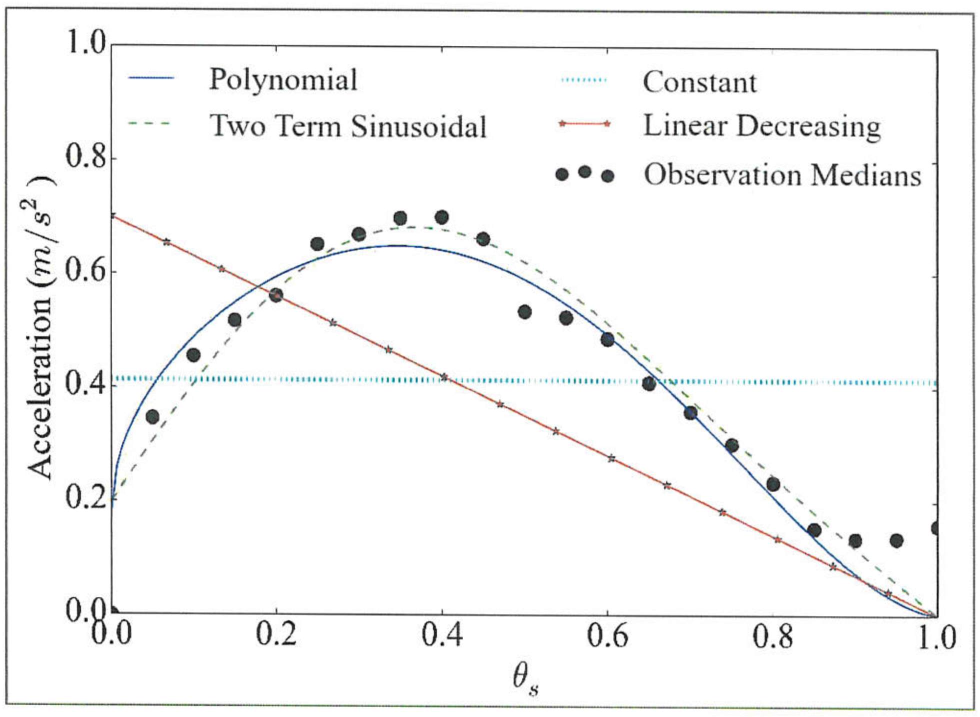


For modelling the speed behaviour of bicyclists, the bicycle dynamic behaviour model is introduced. Out of a number of different modelling approaches for simulating the acceleration and deceleration profiles of bicyclists and based on the bicycle speed data gathered at the four intersections in Munich, it is found that the polynomial model describes the acceleration profiles of bicyclists with the greatest accuracy. At the same time, the constant model describes more accurately the deceleration of bicyclists to a stop and the acceleration and deceleration profiles of bicyclists that are part of their normal speed fluctuation. Additionally, the bicycle oscillating movement model is introduced, which captures the constant changes in the lateral position of a bicyclist as a result of the his/her constant effort to balance the bicycle. The bicyclist balances the bicycle mainly through constant changes in the steering angle. At the same time the amplitude of the steering angle variations is based on the bicycle speed and is affected by the camber angle of the bicycle front fork. As a result, the bicycles follow realistic unique waveform paths during the simulation.



Modern microscopic traffic simulation tools are more oriented towards the modelling of motor vehicle traffic and their capabilities in modelling bicycle traffic and mixed traffic conditions are limited. The aim of this thesis is to develop a bicycle dynamic behaviour model and integrate it into the Bicycle Model that has been developed by M.Sc. Heather Twaddle. Bicycles simulated by the Bicycle Model have the ability to change among different types of infrastructure depending on the present traffic situation and interact with all types of traffic participants in the simulation. They can also choose their desired stop position at the traffic light area regardless if this position is before or after the stop line. Additionally, the behaviour of the simulated bicycles is variable depending on the presented traffic occurrences, which is reflected in the simulation through the variability in the dimensions of the bicycles' safety zone. Finally, the new version of the Bicycle Model will be connected with the microsimulation traffic software VISSIM and validated using bicycle trajectory data gathered at the four test intersections of UR:BAN in the Munich City Area.



The bicycle traffic at the east approach of the intersection Marsstraße and Seidlstraße was simulated using the Bicycle Model in VISSIM. Overall, the Bicycle Model can simulate bicycle traffic with sufficient accuracy. Specifically, it was found that the bicycle dynamic behaviour model can simulate the acceleration and deceleration profiles of bicyclists with high accuracy. Additionally, the Bicycle Model is able to reproduce the longitudinal expansion and density queuing bicycle groups at the intersection approach with high accuracy. However, the lateral expansion of bicycle groups is greater than in the observations. The simulation results for parameters that also considered the lateral expansion of the stopped bicycle formations were not comparable with the results of the previous simulation or the observation data, since the model provided the bicycles with the ability to move to the sidewalk. Also, the Bicycle Model forces bicycles to overtake slower moving or stopped traffic participants and move as close to their desired stop position at the stop line as possible, while at the same time they are not able to make long term predictions regarding the success of their actions.