

Traffic Analysis project description

Microscopic traffic simulation of bicycle traffic

Background

Microscopic traffic simulation is a useful tool in the planning of an efficient traffic system since it offers a safe and cost-effective way to evaluate the effects of changes in the traffic system, e.g., when traffic flows increase or the traffic composition changes. Consequently, microscopic traffic simulation is commonly used to reliably analyze traffic performance in different types of infrastructure. However, this type of modelling support is largely lacking for bicycle traffic, which impedes the planning of efficient and attractive infrastructure for bicyclists.

Commonly used simulation software, such as SUMO or VISSIM, often adapt models originally developed for motorized traffic by adjusting parameters to simulate bicycles as slow-moving cars. This approach may not accurately capture some of the unique characteristics of bicycle traffic, limiting its effectiveness in traffic planning.

Bicycle traffic performance is strongly influenced by features of the infrastructure such as path width, slopes, and curves. Video-based data have been collected on a busy bicycle path in central Stockholm to capture cyclist behavior under different conditions, including a narrow stretch, a short downhill/uphill segment, and a 90-degree curve. This type of data contains observations of the lateral and longitudinal position, speed, acceleration of bicyclists, which allows for an evaluation of how well current traffic simulation software can represent the bicycle traffic performance. Such insights are not only essential for enhancing the reliability of simulation tools when applied to bicycle traffic but also for detecting gaps in the existing modeling approaches and investigating ways to improve simulation accuracy.

Project aim and purpose

The aim of this project is to create a microscopic simulation model for bicycle traffic in existing traffic simulation software (e.g., SUMO or VISSIM), utilizing available video-based trajectory data for calibration. Furthermore, the project seeks to identify potential limitations in the simulation software of choice, offering insights into future enhancements in bicycle traffic simulation.

Organization

Project supervisor: Guillermo Perez Castro, guillermo.perez.castro@liu.se

Co-supervisor: Johan Olstam, johan.olstam@vti.se

Project Group

The project should be conducted by a group of at least two and at most four students.

Goals and requirements

To assess the accuracy of the simulation model, the project will involve comparing traffic-related metrics (e.g., lateral position, speed, acceleration) between the model outputs and empirical data. To do so, the project covers the following steps:

- Data analysis. Analyze the collected trajectory data to extract key traffic-related metrics such as lateral position, speed, and acceleration. Students should compute and visualize aggregate measures (e.g., mean speed, density, and flow) and distributions (e.g., histograms of lateral position, speed, acceleration) of these metrics. This analysis will provide baseline data for comparison with the simulation outputs.
- Develop the simulation model. Create a microscopic simulation model of the bicycle path at Munkbron in central Stockholm using commercially available software such as SUMO or VISSIM. The geometric characteristics of the bicycle path, including width, curves, and slopes, will be provided.
- Generate traffic demand. Based on the available data, create the traffic demand for the simulation. The data includes 24-hour observations collected over three weekdays. It is up to the students to decide which time period (e.g., morning or evening peaks) to focus on for the simulation.
- Calibrate the simulation model. Use the collected trajectory data to calibrate the model by adjusting parameters (e.g., desired speed/acceleration, minimum lateral clearance, etc.) to ensure simulated behavior, i.e., lateral position, speed, and acceleration, closely match the real-world observations. Students should iteratively adjust these parameters and compare outputs to find a good fit.
- Validate the model. Validate the calibrated model by comparing the simulation outputs with empirical data not used during the calibration phase.
- Analyze and discuss model accuracy and limitations. Evaluate the accuracy in replicating bicycle traffic. Identify any discrepancies between the model and the real-world data to highlight limitations in the current simulation approach.
- Document the findings, including the calibrated parameters, the accuracy of the model, and any identified limitations.

Project grading

Except for the common requirements related to course grading specified in the course information, project specific grading is given according to the scale Fail; 3,4, or 5 (or the corresponding ECTS grade).

For grade 3, at least the following steps have to be carried out:

- A detailed project specification and time plan, carefully written in English.
- Create the geometry and traffic demand of the simulation model.
- For both the empirical data and simulation outputs, present and discuss descriptive analysis of lateral position, speed, and acceleration in relation to at least 1 element of the infrastructure (path width, slopes or curve), and for at least 1 one time period (e.g. morning peak).
- Present and discuss the calibration process. The calibration process is structured and well-documented.
- A final report carefully written in English and an oral presentation of the project results.

For the grade 4, the grade 3 steps have to be carried out with very good results and the following steps have to be carried out:

- Present and discuss descriptive analysis of lateral position, speed, and acceleration in relation to path width, slopes and curve, and for at least 1 one time period (e.g., morning peak).
- Demonstrate an understanding of relevant parameters for calibration and their effect on the simulation output (how to adjust them effectively).

For the grade 5, the grade 3 and 4 steps have to be carried out with extremely good results and the following steps have to be carried out:

- Present and discuss descriptive analysis of lateral position, speed, and acceleration in relation to path width, slopes and curve, for different time periods.
- Present and discuss the validation process.
- Identify and discuss specific gaps in the chosen software capabilities and suggest directions for further research or software development.