VISSIM Calibration for Urban Freeways

tech transfer summary

To help determine whether urban interchanges are designed to provide adequate roadway capacity, traffic microsimulation tools such as VISSIM must be calibrated to local conditions.

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RESEARCH PROJECT TITLE
VISSIM Calibration for Urban Freeways

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The mission of the Center for Transportation Research and Education (CTRE) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, reliability, and sustainability while improving the learning environment of students, faculty, and staff in transportation-related fields.

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Background and Problem Statement

Providing adequate roadway capacity, particularly in high-volume conditions, is an essential component of mobility, safety, and the stewardship of public funds for transportation. In urban areas, interchange spacing and the adequacy of design for weaving, merge, and diverge areas can significantly impact the available capacity.

Traffic microsimulation tools such as VISSIM allow detailed analyses of these critical areas in complex locations. In order to obtain valid results, however, various inputs must be calibrated to local conditions. The resulting calibration factors can enable a higher level of fidelity in modeling traffic behavior and help balance need with investment.

Two crucial inputs to calibrate VISSIM are standstill distance and headway. Standstill distance, the distance between stopped vehicles, indicates the maximum traffic density on a roadway section, in that vehicles are as close together as possible. Headway, the elapsed time between the front bumper of the leading vehicle and the front bumper of the following vehicle, indicates the capacity of a roadway section; when all vehicles are at their headway, any additional traffic density causes vehicles to begin braking, which in turn causes congestion. Time gap is similar but is defined as the elapsed time between the back bumper of the leading vehicle and the front bumper of the following vehicle.

Camera image processed to obtain standstill distance measurements

Objective

The objective of this project was to obtain basic Iowa-specific calibration factors for the simulation of traffic conditions within an urban freeway merge/diverge environment for use in VISSIM.

Research Description

To determine Iowa-specific calibration factors, urban freeway traffic data from multiple Iowa sources were collected and analyzed. A repeatable methodology for gathering (1) standstill distance and (2) headway/time gap data on urban freeways was applied to locations throughout Iowa.

To obtain headway/time gap data, timestamped individual vehicle data, especially speed, vehicle class, and lane assignment data, were collected using Wavetronix's SmartSensor HD side-fired radar detectors.

Wavetronix SmartSensor HD detector and camera setup for measuring headway/time gap

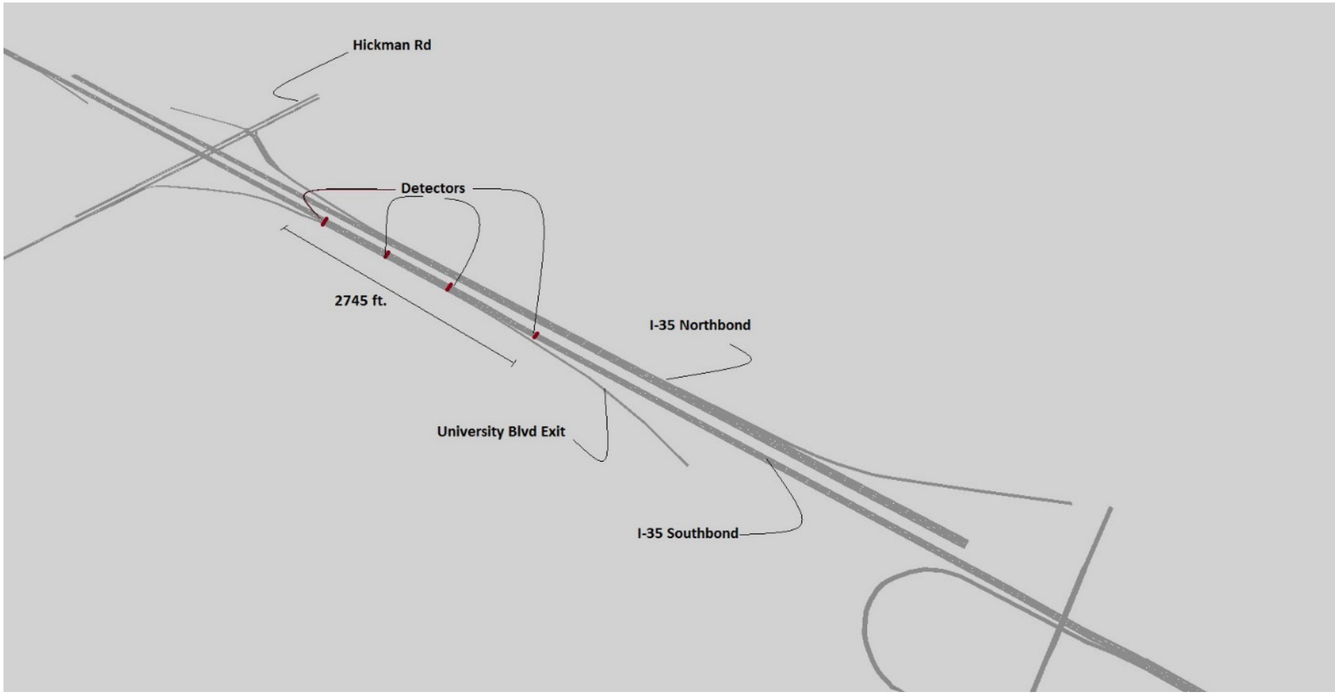
To obtain standstill distances, the researchers accessed the Iowa Department of Transportation (DOT) network of cameras and dynamic message signs (DMSs). A program was used to view DMS message histories, recorded video was downloaded from Iowa DOT cameras, and the distance between stopped vehicles was measured manually using Photoshop CC 2014.

These data were then validated and analyzed using Microsoft Excel and the statistical software R. Standstill distance data were analyzed by comparing group means for different variables using t-tests and examining the distribution of the data. The headway/time gap data were analyzed by filtering to limit the data to mostly following vehicles, comparing the summary statistics of those datasets within the same city and across different cities, and fitting statistical distributions to the data.

A weaving section on southbound I-35 near Des Moines was chosen for modeling and calibration in VISSIM. Sensitivity analyses were performed for various car-following model parameters and look-back distance to determine the impact of driving behavior on the capacity of the simulation. The results were used to manually adjust the model parameters to match the simulation results to the observed traffic conditions. A set of new parameters based on the calibration findings were then input into the model.

Key Findings

- Standstill distance was found to vary from city to city and between different vehicle lead-follow pair types (car-car, car-truck, truck-car, and truck-truck).
- Headways and time gaps were found to be consistent within the same driver population and across different driver populations when the conditions were similar.
- Both standstill distance and headway/time gap were found to follow fairly dispersed and skewed distributions.
- The results of the sensitivity analyses in VISSIM showed that the headway and look-back distance are more sensitive to changes than other parameters.
- Comparing the results of speed, vehicle count, and flow density plots between the observed data, simulation data with default parameters, and simulation data with calibrated parameters showed that the model needed to be calibrated to replicate real-world operations.



Sample network coded in VISSIM for modeling and calibration

Recommendations and Future Research

The standstill distance and headway/time gap findings demonstrate the need to treat standstill distances and headways/time gaps as distributions. In addition, headways/time gaps should be set separately for different vehicle classes. Therefore, it is recommended that microsimulation models be modified to include the option for standstill distance and headway/time gap to follow distributions as well as be set separately for different vehicle classes.

Implementation Readiness and Benefits

The results of the simulations and sensitivity analyses show that the VISSIM model needs to be calibrated to replicate real-world operations. A well-calibrated microsimulation model can enable a higher level of fidelity in modeling traffic behavior and can help improve decision making in balancing need with investment.