Real Time Estimation of Arterial Travel Time and Operational Measures Through Integration of Real Time Fixed Sensor Data and Simulation

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INTRODUCTION

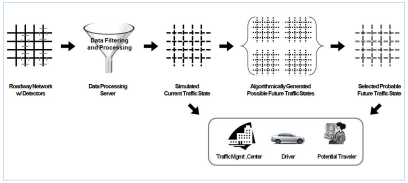
A wide variety of advanced technological tools have been implemented throughout Georgia's transportation network to increase its efficiency. These systems are credited with reducing or maintaining freeway congestion levels in light of increasing travel demands. In Georgia these benefits are primarily gained through the Traffic Management Center's freeway monitoring and quick response in ridding the roadway of any obstacles that may reduce freeway service levels. There have been a number of efforts to leverage the work done by TMCs to provide travelers with more current traffic information such as Georgia 511 and Navigator. In addition, private efforts and partnerships have made the TMC's information more accessible to travelers, aiding their traveler decisions. The effort presented in this report aims to compliment real-time freeway information by addressing the more limited availability of real-time arterial performance measures.

OBJECTIVES

This research project explores the feasibility of integrating real-time data streams with an arterial simulation to support an arterial performance monitoring system. Such information will facilitate increased efficiency in facility utilization by enabling more informed decisions in the use and management of Georgia's transportation facilities. This objective was accomplished by undertaking the following tasks:

- Describe the current state of practice concerning the estimation of real-time arterial performance measures.
- Develop a federated (integrated) simulation test-bed for testing procedures and algorithms.
- Determine the feasibility of integrating point sensor data with simulation to create a data-driven, online simulation tool.
- Develop procedures and algorithms to calibrate an online simulation tool that estimates of travel time and other performance measures in real-time.
- Determine any potential improvements in travel time estimation resulting from sensors placed in atypical locations, such immediately downstream of an intersection.
- Field-test the data-driven, on-line arterial simulation tool on a target corridor.
- Devise method(s) to deliver travel time and other operational characteristics to GDOT and the general public.

METHODOLOGY

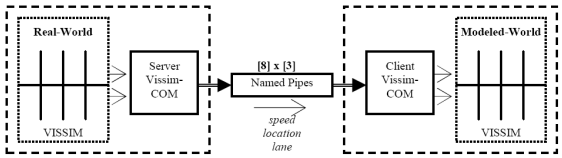


- Network and Detectors: An arterial network where point sensor (i.e. loop detectors, video detection, etc.) detection equipment is available, or may be deployed, capable of transmitting detection data in real-time. Minimum required data streamed from the detector include individual vehicle actuations and speed.
- Data Processing and Communication: The communication infrastructure manages the transmission of traffic data between the point sensors and the data processing unit, facilitates the communication between the data processing unit and the simulation, and broadcasts the current and most probable future traffic states.
- Simulated Environment: VISSIM, distributed by PTV, with a COM (Component Object Model) interface is utilized.
- Test Bed: Video cameras were selected as the point sensors and ten video cameras have been installed in a test bed located next to the Georgia Institute of Technology campus. A Video Detection System (VDS) with the accompanying hardware and software, facilitated the real-time transmission of event-based traffic data to a remote location. The ten cameras that have been installed transmit their video via fiber optic cable to the data processing unit. This unit then processes the videos and sends all the relevant traffic data via wired or wireless connection to a client personal computer. This client then parses the data stream and inputs it accordingly into a VISSIM model of Georgia Tech's campus.

EXPERIMENTS

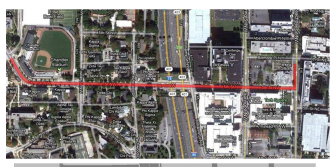
#1 PROOF OF CONCEPT

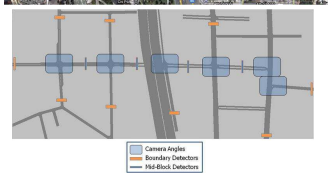
- One instance represents the "real-world" or field and the other attempts to replicate the "real-world" simulation in real-time (referred to as the "modeled-world").
- This experiment explored a methodology to develop a data-driven online simulation tool to deliver real-time performance measures with the aid of microscopic traffic simulation.
- The results from this experiment demonstrated that the modeled-world is capable of reflecting the performances measures of the real-world with a relatively high level of accuracy.

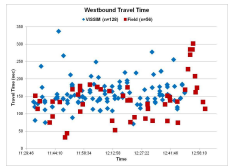


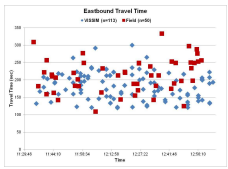
#2 FIELD TEST WITH TEMPORARY DETECTORS

- A VISSIM model - 5th Street / Ferst Drive corridor in the midtown Atlanta area on the Georgia Tech campus was developed.
- Video based field travel time data were compared with the VISSIM model to determine how well the data-driven simulation was able to reflect field travel times and microscopic traffic simulation model was able to be driven in real-time by real-world data streams.



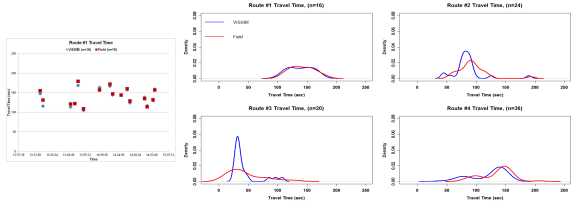






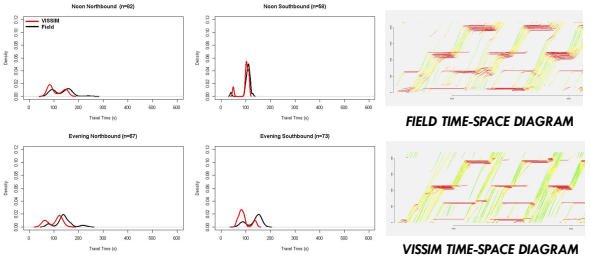
#3 FIELD TEST WITH TEMPORARY AND PERMANENT DETECTORS

- Both permanent (Video Detection System (VDS)) and temporary detectors, capable of streaming individual vehicle records, were employed. In addition, six camcorders and four probe vehicles with GPS were used to collect additional traffic information for post processing.
- Based on paired travel time comparisons for an individual vehicle's travel time, the simulation reasonably reflected the real world.



#4 NGSIM's PEACHTREE CORRIDOR STUDY

- This experiment utilized a near ideal data set (tenth of a second resolution of vehicle positions on the corridor, route data for every vehicle, individual vehicle turning movement data, and signal status at a tenth of a second resolution) to determine the performance of the real time simulation under ideal conditions.
- This experiment used previously collected field data as input to the real time simulation, streamed in wall clock time. The data were collected as part of the FHWA Next Generation Simulation (NGSIM) program.
- Under ideal data collection conditions, a real time simulation is capable of providing a reasonable reflection of the real world.

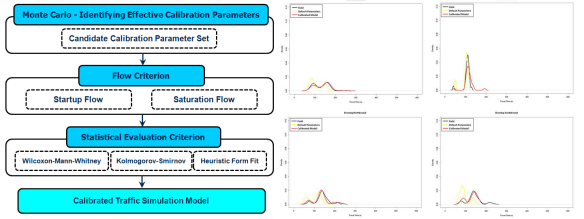


FIELD TIME-SPACE DIAGRAM

VISSIM TIME-SPACE DIAGRAM

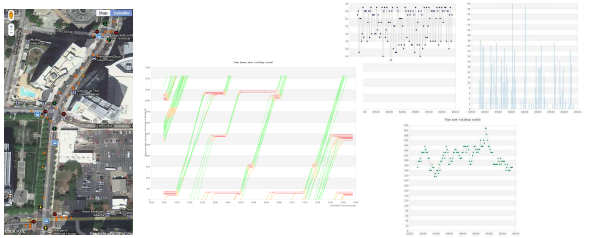
#5 ADVANCED MODEL CALIBRATION PROCEDURE

- The calibration process involves the selection of values for adjustable modeling parameters that allow a particular model to most accurately reflect the specific network conditions under consideration.
- Two calibration criteria were developed; 1) evaluation of startup and saturation flow and 2) statistical evaluation of travel time distributions. The parameter sets that satisfy both these criteria are considered as adequately calibrated.



#6 VISUALIZATION OF ARTERIAL PERFORMANCE

- A web-based tool was developed which the consumers may visit to evaluate the current performance of the arterial under study. The visualization provides the representation of individual vehicles and the depiction of changes in traffic conditions as a function of time and space, and the historical presentation of key arterial performance measures.



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