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A SENSITIVE ANALYSIS STUDY TO MEASURE IMPACT OF REAL-TIME TRAFFIC VOLUME DATA IMPUTATIONS ON TRAFFIC PERFORMANCE MEASURES

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ABSTRACT

Smart City initiatives are ongoing around the world to improve the quality of life by leveraging technological advances. In a Smart City, equipped with connected infrastructure, traffic data, such as vehicle detections and intersection signal indications, are expected to be received in (near) real-time. The objective of the real-time simulation platform highlighted in this effort is the creation of a dynamic data-driven simulation that leverages high frequency connected data streams to derive meaningful insights about the current traffic state and real-time corridor environmental measures. A connected infrastructure data-driven simulation model driven in near-real-time with high frequency connected infrastructure traffic volume and signal controller data streams is developed. The model visualizes key traffic and environmental performance measures at near-real time, providing dynamic feedback. This paper provides an overview of the architecture and utilizes sensitivity analysis to explore the impact of volume data imputations on the real-time data-driven simulation produced performance measures.

1 INTRODUCTION

The developed simulation model emulates traffic on 2.3 miles of the North Avenue Smart Corridor, in Atlanta, GA. The simulation model architecture feasibility and robustness were initially explored by driving two intersections with near-real-time data streams and the remaining intersections using preset data. In this initial experiment the overall architecture was found to be capable of inserting the data into the simulation platform, maintaining the faster than real-time processing necessary for such a platform to maintain real-time capabilities, and able to provide meaningful traffic operations and vehicle emission estimates along the corridor (Saroj et al. 2018). Currently, the ability to stream the volume and signal real-time has been expanded to all fifteen signalized intersections. However, investigation of the data streams themselves has revealed the presence of data gaps. Given the challenges of maintaining data streams in harsh field environments, such data loses should be expected. Such data gaps can impact the performance measure results and insights generated from the model. Thus, the model architecture needs to be enhanced to handle such data losses. Development of an imputation methodology should be informed by an understanding of data loss, and errors in data imputation, on generated performance measures.

2 MODEL ARCHITECTURE AND SENSITIVITY ANALYSIS EXPERIMENT

While the application of real-time data-driven traffic simulations to improve traffic performance has been explored previously in several studies (Henclewood et al. 2010 and others), the use of high frequency vehicle data streams along with infrastructure data such as signal phasing from connected corridors to enhance the simulation performance is new. In this effort, the real-time simulation model architecture performs 4 tasks: 1) injection of real-time signal and volume data streams into traffic simulation model, 2) dynamic data-driven traffic simulation, 3) dynamic performance measure visualization, and 4) data request management (Figure 1).

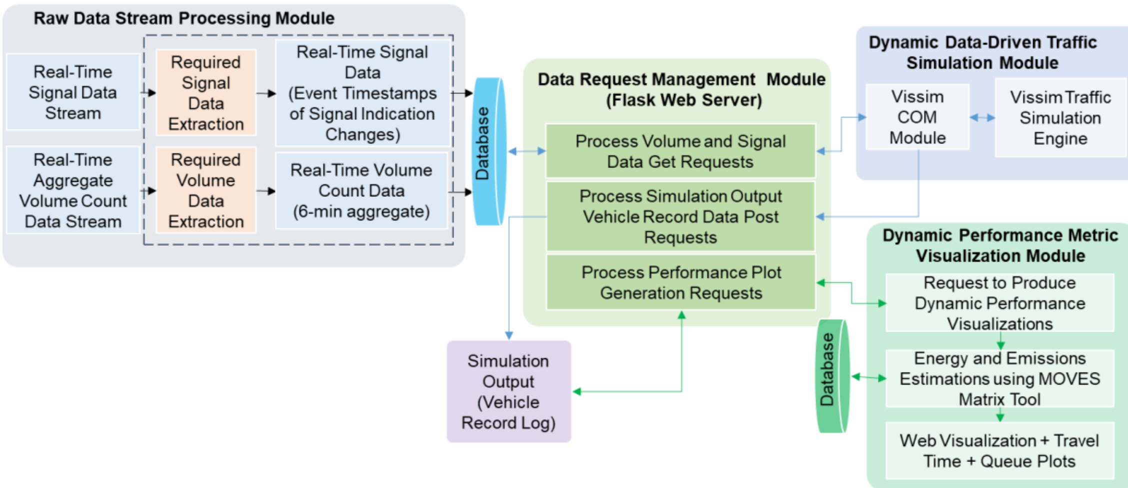

Figure 1: Real-time data-driven traffic simulation model architecture.

Investigation of volume data of 112 days at 147 detectors across the 15 simulated intersections revealed both permanent and intermittent data loss. An experiment was designed to estimate the impact of imputed volume data on the simulated travel time performance measure. For this experiment, a base day with 100% volume and signal data availability is created by estimating the missing data using online and historic data sources. Typical patterns of both permanent and intermittent data loss are then generated using a K-means clustering analysis of the 112 days missing volume data patterns. These missing patterns are then applied to the base day, where an error (20%, 50%, and 80%) is introduced to periods identified as missing data. Five data loss patterns (10 replications each) over the three hour PM peak are considered. Through this effort the experiment is able to explore the impact on the base day of data loss and imputation errors.

3 RESULTS, DISCUSSION, AND CONCLUSION

For the five simulated loss patterns, the 85th percentile vehicle travel time values for selected study routes are considered. The results show: 1) some routes are more sensitive to data loss, 2) generally increasing travel time trend for higher errors, and 3) the individual routes, as well as the overall corridor, has a set of critical approaches on which data loss more significantly effects the model. In addition, while the permanent data losses tended to more significantly impact results it is shown that intermittent losses with 50% and 80% estimation errors have a statistically significant impact as well. The conducted sensitivity analysis experiment revealed a methodology to highlight crucial approaches to which routes are more sensitive thus, needing a more accurate imputations methodology as well as dedicated field resources to limit the occurrence of data loss. Future work entails studying sensitivity of data imputation on environmental performance indices and using historic data to perform volume data imputations for intermittent data gaps.

REFERENCES

Henclewood, D., A. Guin, R. Guensler, M. Hunter, and R. Fujimoto. 2010. "Real-Time Data Driven Arterial Simulation for Performance Measures Estimation". In *Proceedings of the 2010 Winter Simulation Conference*, edited by B. Johansson, S. Jain, J. Montoya-Torres, J. Hugan, and E. Yücesan, 2057–2069. Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc.

Saroj, A., S. Roy, A. Guin, M. Hunter, and R. M. Fujimoto. 2018. "Smart City Real-Time Data-Driven Transportation Simulation". In *Proceedings of the 2018 Winter Simulation Conference*, edited by M. Rabe, A.A. Juan, N. Mustafee, A. Skoogh, S. Jain, and B. Johansson, 857–868. Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc.