Project Title: A Prototype Decision Support System for Optimally Routing Border Crossing Traffic Based on Predicted Border Crossing Times

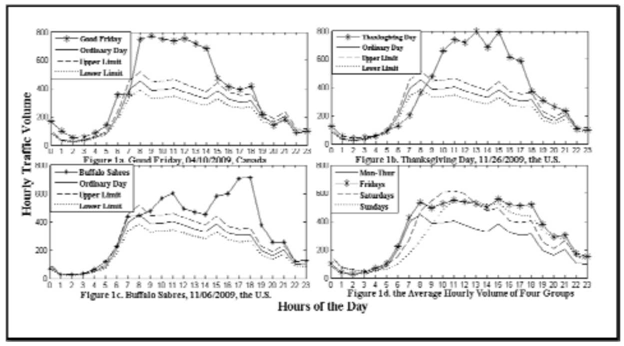
Principal Investigators: Adel W. Sadek & Qian Wang

The economic vitality of the "Golden Horseshoe", a densely populated and industrialized region which encompasses Southern Ontario, Canada and parts of New York State including the Buffalo-Niagara Region, is heavily dependent upon the ability to move goods freely and efficiently across the Canadian-US border. In recent years, and as a result of the continued increase in travel demand across the border coupled with the need for tighter security and inspection procedures after September 11, border crossing delay has become a critical problem with tremendous economic and social costs.

This study had two primary objectives. The first objective was to develop a novel forecasting method for the on-line, short-term prediction of hourly traffic volumes at the Niagara Frontier border crossings. The second objective was to develop queueing models which would use the predicted traffic volume to estimate the future border delay. As a case study, we consider the Peace Bridge border crossing, which is one of the busiest Niagara Frontier border crossings, serving over 4.76 million cars annually.

To accomplish the objectives of the study, hourly traffic volume and classification counts for the Peace Bridge from the years 2009 and 2010 were compiled. The data was first pre-processed using the Frequent Pattern Tree (FP-TREE) algorithm to identify outliers, if any. Results from applying the FP-TREE algorithm on the Peace Bridge volume data showed a very high quality dataset with very few outliers.

Next, the dataset was analyzed to identify appropriate categories for model building. Six groups were defined: (1) weekdays excluding Fridays; (2) Fridays; (3) Saturdays; Sundays; (5) game days; and (6) holidays. Separate prediction models were then developed for each group.



Two different modeling paradigms were investigated: (1) a time-series approach based on the Seasonal Autoregressive Integrated Moving Average (SARIMA) model; and (2) an Artificial Intelligence (AI)-based approach based on Support Vector Regression (SVR). The study further investigated a multi-model combined forecasting method which combines both SARIMA and SVR to improve prediction performance. Different methods of combining the forecast were investigated including: (1) a simple or fixed weight method; and (2) a fuzzy adaptive variable weight method based on the Fresh Degree Function. The accuracy of the prediction models were then evaluated by comparing predictions against field observations. The evaluation showed high accuracy of the developed models, especially for the combined fuzzy adaptive weight combined multi-model forecast method.

Finally, the study developed queueing models for predicting the average vehicle delay at the border. The formulation was based on solving an inverse M/M/c queueing model, resulting in an estimate of the average time a vehicle would spend in the queue and in the system.

Sponsors: Region II University Transportation Research Center

Completion Date: August 2011

University: University at Buffalo, the State University of New York