Public Abstract

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Title:ARTIFICIAL INTELLIGENCE TECHNIQUES FOR MODELING DYNAMIC TRAFFIC BEHAVIOR AT BOTTLENECKS

Due to the increasing passenger and freight demands on urban transportation networks, urban traffic will become more congested at bottlenecks including natural lane reduction and work zone closure, and transportation management centers (TMCs) will be tasked with resolving such challenges in the coming decades. Traffic congestions cause travel time delays, accidents, and air pollution, and they indirectly cause wasted energy as well as economic losses. In the last decade, bottleneck traffic congestion has received increasing attention around the world. For example, work zones with lane drops significantly impact roadway capacity and traffic patterns. According to USDOE (2002), work zones account for approximately 24% of the non-recurring delay. To alleviate bottleneck congestion, there are two strategies: (1) Use microscopic traffic simulation to determine the optimum traffic control alternatives, However, experiences showed that current simulation models yield unsatisfied performance under saturated and oversaturated traffic conditions at bottlenecks. Thus, accurate lane changing models for simulating congested traffic at bottlenecks are needed. (2) Plan and proactively manage traffic operations at work zone bottlenecks. In order to achieve that, accurate traffic flow forecast models are necessary.

This dissertation applies artificial intelligence (AI) techniques to enhance the models of travel demand and traffic behavior at bottlenecks including natural lane reduction and work zone closure. AI models for accurately forecasting travel demand at work zone bottlenecks in urban areas were developed. Driving behavior models of lane changing at natural lane drops at freeway interchanges were proposed. Real-world datasets were used to develop and test the AI models.

The lane-changing models took into account factors such as gap acceptance in the target lane, vehicle speeds in the target lane, and distance to the end of the merge lane. The models were built using traffic data collected by the Federal Highway Administration (FHWA) on a segment of southbound US Highway 101 in Los Angeles, California. To assess the quality of the models, they were tested on traffic data on Interstate 80 in San Francisco, California. The empirical results demonstrated superior performance of AI models over the conventional binary logit model, thus they can more realistically reflect driver's lane changing behavior at bottlenecks. All the lane changing models presented in this dissertation were developed using traffic data collected under approaching congestion condition and congested condition. Thus, they can enhance the performance of microscopic simulation models at bottlenecks under congested traffic condition.

Traffic forecast models are classified into two types based on the forecast horizon: daily, and short-term. None of numerous existing traffic flow forecasting models focus on work zone bottlenecks. Work zone bottlenecks create conditions that are different from both normal operating conditions and incident conditions. Four models were developed for forecasting traffic flow for planned work zone events. Both daily and short-term traffic flow forecasting applications were investigated. Daily forecast involves forecasting 24 hours in advance using historical traffic data, and short-term forecasts involves forecasting 1 hour, 45 minutes, 30 minutes, and 15 minutes in advance using real-time temporal and spatial traffic data. Models were evaluated using data from work zone events on two types of roadways - a freeway, I-270, and

a signalized arterial, MO-141, in St. Louis, Missouri. The results showed that the random forest model yielded the most accurate daily and short-term work zone traffic flow forecasts. For freeway data, the most influential variables were the latest interval's look-back traffic flows at the upstream, downstream and current locations. For arterial data, the most influential variables were the traffic flows from the three look-back intervals at the current location only.