



HIGHLIGHTER

INCORPORATION OF SPEED/TRAVEL-TIME DATA SETS IN TRAFFIC PERFORMANCE ANALYSIS

March 2020

PROJECT TITLE

Incorporation of
Speed/Travel-Time Data Sets
in Traffic Performance
Analysis

FINAL REPORT

SPTC15.2-08-F
Southern Plains
Transportation Center,
ODOT MATCHING FUNDS,
SP&R 2160

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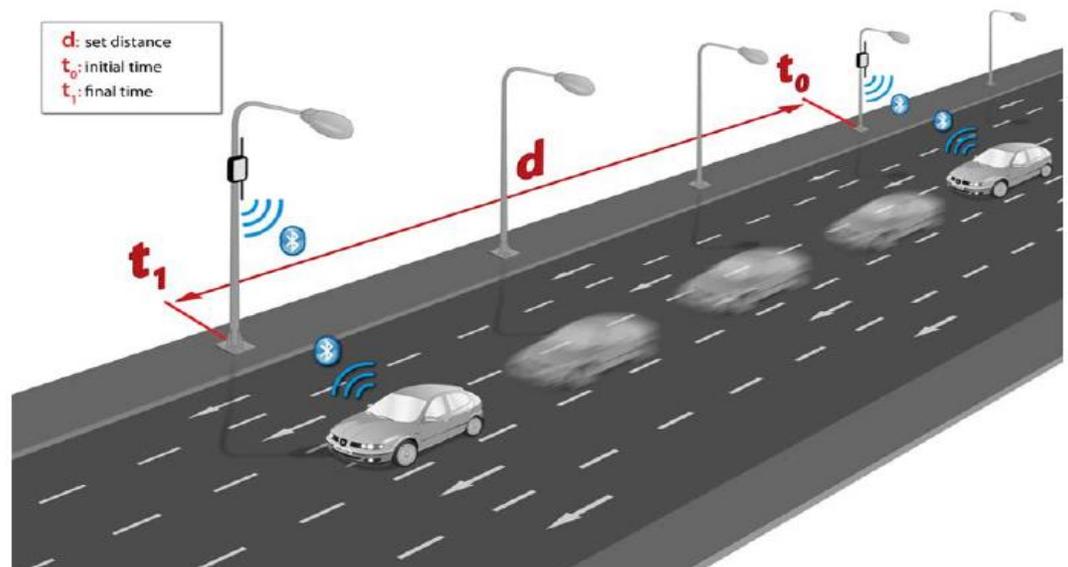
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OVERVIEW Travel time (TT) is a basic measure of traffic operation quality and level of service. This metric is considered a component of travel speed, thus an extremely valuable piece of information for travelers, shippers, and Traffic Management Center (TMC) personnel. TMC in particular use TT for traffic prediction and analyses, as its accuracy and reliability aids in reducing congestion, improving safety, and enhancing traffic flow (e.g., commuters avoiding congested roads; transportation agencies improving traffic management). Measuring TT requires speed estimation, often including vehicle identification. Transportation agencies have leveraged different technologies for estimating TT (e.g., Bluetooth Wi-Fi identification detection, toll tag/automatic license plate reader, in-pavement magnetic detector, machine vision, radar equipment, inductive loop, crowdsourcing, and cell phone signal monitoring). Each technology is characterized by advantages and disadvantages (e.g., accuracy, coverage, cost, portability, and other factors) for TMC to consider when designing a program for evaluating and/or improving TT reliability.

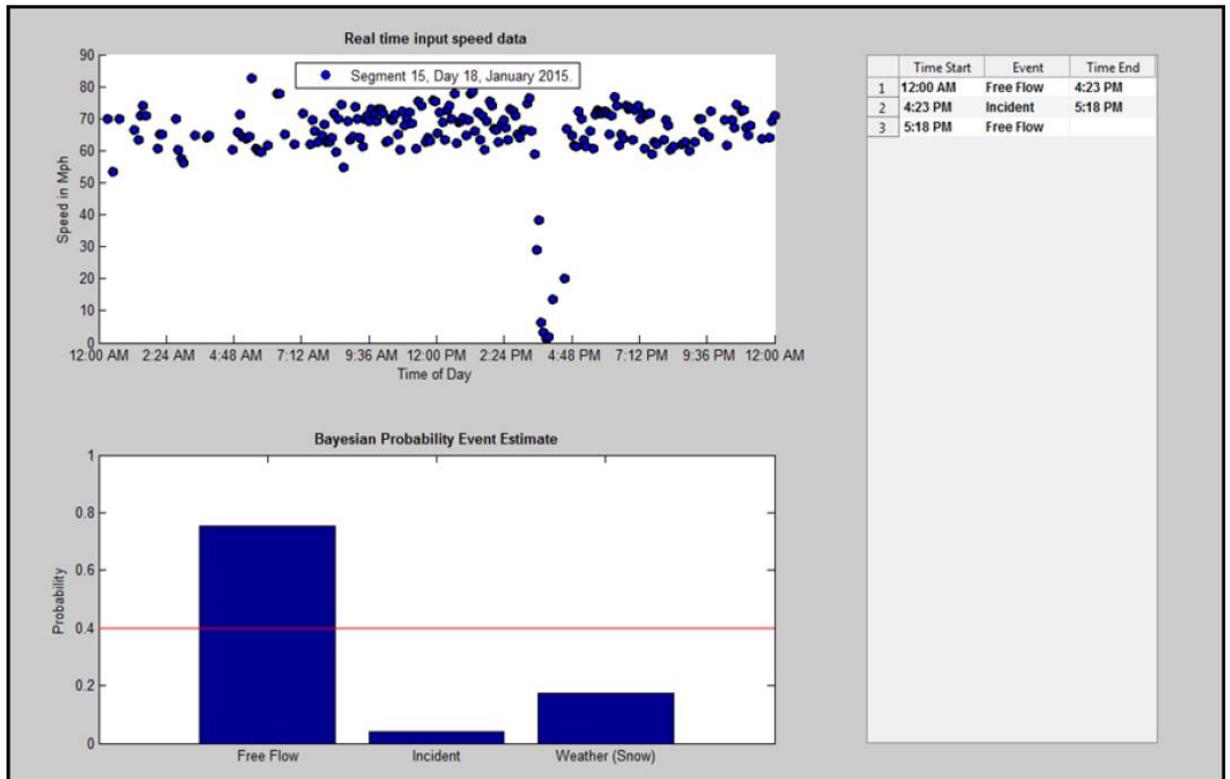
RESULTS This work involved the development, field testing and implementation of an inexpensive Bluetooth traffic monitoring system for reliable and real-time TT measurements. The following figure depicts the overall Bluetooth Traffic Monitoring System that consists of Bluetooth stations for detecting Bluetooth devices associated with vehicles using Ubertooth-one — an open source 2.4 GHz wireless development platform used for Bluetooth sniffing. Each Bluetooth station is connected to a Linux box (i.e., Beaglebone) that reads data collected by Ubertooth-one before transmitting the data to a back-end server, where it is stored and processed in real-time. The Bluetooth system proved instant and accurate TT measurements 99.9% of the time.



Furthermore, algorithms used for collecting traffic information from various ODOT platforms were fully developed, integrated, and evaluated. National Performance Management Research Dataset (NPRMDS) was chosen for developing TT models, and for identifying TT outliers and anomalies. Since incidents on highways increase TT, artificial neural network (ANN) model was designed for incident classification based on many features, such as vehicle count, weather condition and traffic flow. The ANN model reported accuracy of 91%.

Moreover, a Bayesian model for detecting non-recurrent congestions was developed and evaluated. These conditions correspond to a variety of characteristic models, the impact of which is clearly visible and identifiable on the baseline distribution. Thus, distinguishable statistical models can be used to reveal assorted information for each condition. By combining distribution models with Bayesian probability, an approach can be determined for identifying the underlining condition occurring in both offline and real-time speed analysis. The work reported within this study provides a Bayesian engine for congestion identification. The engine utilizes statistical models derived from observed data records per condition, and then estimates a posterior credibility for each hypothesis. The model was developed to identify three situations: incident (e.g., crash and collision), weather (e.g., snow) and free-flow traffic.

The figure shows a screen capture of the Bayesian inference engine GUI final output after a day of monitoring. The example shows the top subplot, which illustrates speed records arriving in real time. The bottom subplot illustrates the probability of the Bayesian engine pertaining to each of the three defined states. The right



subplot illustrates system output. The example shows indication of incident detection between 4:23 and 5:20 p.m. For this implementation, a threshold of 40% confidence was required for decision-making. The threshold is flexible and can be modified as needed.

POTENTIAL BENEFITS The proposed solution can promptly respond to changes in traffic patterns, proving that accurate TT (or "speed data") can be obtained in real-time. The project recorded two significant successful technology transfers: 1) an inexpensive (i.e., \$500 versus \$5,000 for commercial systems) portable Bluetooth monitoring system that when integrated with the current ODOT network will immediately impact ODOT traffic management programs, and 2) a novel design for developing a TTR and monitoring system composed of multi-sensing technology that leverages empirically developed models for providing accurate information about traffic flow and congestion. An accurate Travel Time (TT) information is essential for traffic prediction and analysis. This project facilitates the Oklahoma Department of Transportation in obtaining correct TT measurements that can be used to reduce congestion, improve safety and enhance traffic flow.