Kansas Department of Transportation

TECHNICAL SUMMARY

Feasibility of Bluetooth Data as a Surrogate Measure of Vehicle Operations

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Introduction

The widespread use of portable electronic devices among consumers has allowed new opportunities for traffic data collection. Many of these devices contain short-range Bluetooth radios in addition to other electronic equipment. The included Bluetooth radio on each device is intended to provide a low-power communications protocol to connect devices such as cell phones, headphones, music players, and more to each other. The presence of a unique identification number when activated can be discovered electronically which unintentionally creates anonymous probes in the traffic stream.

Project Objective

The objective of this research study was to evaluate the feasibility of using Bluetooth data as a surrogate analysis measure of traffic and was conducted in several stages. The initial stage was to evaluate a number of hardware related variables including:

- in-vehicle Bluetooth source placement;
- traveling speeds of vehicles with Bluetooth sources;
- variations in detectability among several Bluetooth sources;
- horizontal and vertical roadside Bluetooth antenna placement options; and
- Bluetooth antenna selection.

Project Description

Understanding the technology and potential uses for traffic data collection began by testing Bluetooth roadside data logger hardware configurations including the Bluetooth antenna selection and roadside placement options. Detection areas for five antenna options were mapped, and their detection reliabilities were investigated. Other tests were conducted to assess the impacts of roadside antenna placement, vehicular speeds and in-vehicle source placement. The feasibility of using data from Bluetooth enabled devices in vehicles as a surrogate for traditional traffic engineering data were investigated for several types of traffic studies. These studies included urban corridor travel time monitoring, freeway travel time monitoring, origin-destination studies, estimating turning movements at roundabouts, and truck tracking across the state of Kansas. Each of these studies demonstrated how the same technology could be applied to different study objectives.

Project Results

The hardware evaluations showed that a dipole antenna placed 6 to 12 feet from the edge

of the roadway with at least 3 feet of elevation performed the best. The antenna power of the dipole could be changed to increase or reduce the coverage area as needed. In the five study applications, four showed that the Bluetooth data were statistically comparable to data collected following traditional methodologies. The lone strategy that was found to be not comparable was when using Bluetooth data collection techniques at roundabouts. It is likely that some confounding issues arose at the selected locations (such as differences in trip type/purpose between short-range urban trips on city streets versus long-range intercity trips), and more study is needed to fully understand the differences between urban roundabouts and rural roundabouts

The data collected created an automated process for identifying and re-identifying vehicles along a corridor. This opened up new potential analyses of the data including being able to separate frequent (repeat) travelers from occasional travelers along a corridor.

While this technology was found to have enormous potential to collect vehicle operational data, it was not found to be completely stand-alone. An identified weakness of the technology was that it was found to sample around 5 percent of the available traffic. The implication of this was that Bluetooth data were not always available for analysis at very low volume locations which can occur in some rural Kansas locations. This could be a particular issue when the data need to be separated into smaller hourly groups or if a long data collection period is not possible. Furthermore, because of this unintentional use of Bluetooth technology, there was not any way to guarantee data to be available at the time periods needed. Also, in order to extrapolate volumetric data from the Bluetooth data, a secondary source was needed to assess a Bluetooth penetration rate.

Along with the need for calibration data to pair with the Bluetooth data, a key assumption was that each Bluetooth source detected represented a separate independent vehicle. While this assumption could be violated with multiple discoverable Bluetooth devices in a single vehicle (e.g. a transit bus) this was not found to be an issue. The results of the study indicate that collecting vehicle operational data through the detection of a Bluetooth device in a vehicle to be adequate, given when the circumstances are correct.

Project Information

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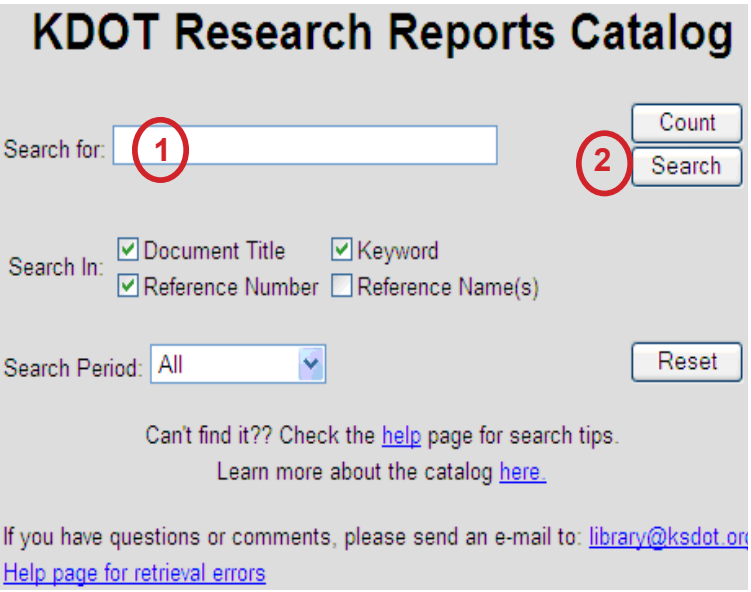

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