ABSTRACT

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Work zones present challenges to safety and mobility that require agencies to balance limited resources with vital traffic management activities. It is important to obtain operational feedback for successful active traffic management in work zones. Extensive literature exists regarding the impact of congestion and recommendations for work zone design to provide safe and efficient traffic operations. However, it is often infeasible or unsafe to inspect every work zone within an agency's jurisdiction. This dissertation outlines the use of connected vehicle data, crash data, and geometric data from mobile light detection and ranging (LiDAR) technology for active traffic management in work zones.

Back-of-queue crashes on high-speed roads are often severe and present an early opportunity for leveraging connected vehicle data to mitigate queueing. The connected vehicle data presented in this dissertation provides compelling evidence that there are significant opportunities to reduce back-of-queue crashes by warning drivers of unexpected congestion ahead. In 2014 and 2015, approximately 1% of the total mile-hours of Indiana interstates were operating below 45 MPH and were considered congested. Congested conditions were observable in the connected vehicle data prior to 18.5% of all interstate crashes. The congested crash rate was found to be 20.6-24.0 times greater than the uncongested crash rate.

A real-time queue alert system was developed to detect queues and notify INDOT personnel via email. When average speeds drop below 45 MPH, queue monitoring algorithms are triggered, and an alert is sent to selected individuals. Still camera images, work schedules, and crash reports were used to ground-truth the alert system. The notification model could be easily extended to in-car notification.

A weekly work zone report was developed for use by the Indiana Department of Transportation (INDOT) for the purpose of assessing and improving both mobility and safety in work zones. The report includes a number of graphs, figures, and statistics to present a comprehensive picture of performance. This weekly report provided a mechanism for INDOT staff to maintain situational awareness of which work zones were most challenging for queues and during what periods those were likely to occur. These weekly reports provided the foundation for objective dialog with contractors and project managers to identify mechanisms to minimize queueing and allocate public safety resources.

Lastly, this dissertation discusses the integration of LiDAR -generated geometric data with connected vehicle speed data to evaluate the impact of work zone geometry on traffic operations. A LiDAR-mounted vehicle was deployed to a variety of work zones where recurring bottlenecks were identified to collect geometric data. The advantages and disadvantages of the technology are discussed. A number of case studies demonstrate versatility of the technology in transportation applications.