MPC-622

February 18, 2020

# Project Title

Utilizing Traffic Signal Pedestrian Push-Button Data for Planning and Safety Analysis

# University

Utah State University

# Principal Investigators

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# Research Needs

Multimodal transportation planning, traffic safety analyses, and health impact assessments require information on how many people walk in various locations throughout the day. Pedestrian volumes can be used as outputs when developing pedestrian travel demand forecasting models and as measures of walking exposure when conducting pedestrian safety and health analyses. Unfortunately, traditional data collection methods for levels of pedestrian activity are insufficient for these purposes (FHWA, 2016; Ryus et al., 2014). Manual counts on intersection or street segments are time consuming and often infeasible to conduct over long periods of time. Instruments such as infrared counters can record continuous data on non-motorized trail users, but they are costly to deploy across multiple locations. Video-based pedestrian data collection methods via computer image processing are promising, but video cameras are also costly to install everywhere in a network.

Luckily, a novel “big data” source of pedestrian information that is relatively ubiquitous in both time and space (available 24/7 at many locations) is now available: pedestrian push-button actuations recorded in high-definition data logs from traffic signal controllers at signalized intersections. Thanks to recent advances (Smaglik et al., 2007), archived and near real-time pedestrian push-button data can be accessed through the Automated Traffic Signal Performance Measures (ATSPM) system (Day et al., 2016). A previous research project compared pedestrian push-button data from nearly 100 signalized intersections in Utah with thousands of observed pedestrian crossing events and developed factoring methods to accurately estimate pedestrian volumes at signalized intersections (Singleton, ongoing).

While useful and an improvement upon existing methods of pedestrian data collection and monitoring, these signal-based pedestrian volume estimates and factors have a key limitation for use in planning, safety, and health analyses: they (currently) cannot be directly applied to unsignalized intersections. However, they do allow for the development of “direct demand” pedestrian travel demand models that directly estimate site-specific pedestrian volumes as a function of local land uses and transportation system characteristics. Direct demand models can be used to estimate pedestrian volumes at various intersections today as well as predict pedestrian volumes in the future given changes to local built environments (Hankey et al., 2012; Kuzmyak et al., 2014; Schneider et al., 2009). The ubiquity of pedestrian signal data can overcome a major challenge of existing direct demand methods: that they require a large quantity of pedestrian data in order to be applicable to many different locations beyond those (typically few places) where they were estimated. The first part of this project addresses this need by developing large-scale direct demand models for estimating intersection-level pedestrian volumes.

Pedestrian traffic signal data can also overcome a major obstacle to improved pedestrian safety predictive methods: the lack of pedestrian volume exposure data. Pedestrian safety is critical current issue, given a troubling national and local trend of increasing numbers and shares of pedestrian injuries and fatalities. For example, there were nearly 6,000 pedestrian deaths in traffic crashes in the US in 2016, representing 16% of all traffic fatalities, an increase from 4,700 and 11% in 2007 (NHTSA, 2018). Safety predictive methods—safety performance functions (SPFs) and crash modification factors (CMFs)—require the use of exposure data for estimation and application. While motor vehicle volumes are often available, pedestrian volumes rarely are, thus limiting the development, use, and accuracy of pedestrian safety predictive methods. Developing such models—especially in conjunction with a systemic approach to safety management (Gross et al., 2016)—can help to better understand (geometric, traffic, operational, and other) risk factors associated with pedestrian safety and also to assist in the prioritization and selection of countermeasures to improve pedestrian safety. Ubiquitous pedestrian signal data can help SPFs and CMFs include more robust data on pedestrian exposure (Greene-Roesel et al., 2007), which is typically the biggest barrier in pedestrian safety analysis. The second part of this project addresses this need by incorporating signal-based measures of pedestrian exposure into pedestrian safety predictive methods.

# Research Objectives

* Develop methods and models predicting pedestrian volumes at intersections, based on traffic signal pedestrian push-button data and built environment characteristics.
* Develop improved pedestrian safety predictive models at intersections, using pedestrian push-button measures of exposure, crash data, and transportation characteristics.

The first objective is to develop direct demand models for estimating intersection-level pedestrian volumes, utilizing pedestrian signal data (as the output) and local land use, built environment, and transportation system characteristics (as the inputs). These methods will be able to estimate pedestrian volumes at non-signalized intersections (not just signalized intersections), and can be applied to predict changes in pedestrian volumes as a result of potential future adjustments to the local built environment.

The second objective is to improve upon existing pedestrian crash prediction models at intersections, utilizing pedestrian signal data (as a measure of exposure), pedestrian crashes (as the output), and other transportation characteristics (as covariates). These methods will expand our knowledge of pedestrian safety trends and can be applied to identify high-risk locations for potential safety treatments.

# Research Methods

This project will mostly utilize existing secondary data—about traffic signals, crashes, the built environment, and transportation system characteristics. Some data collection of observed pedestrian counts may be conducted if necessary, utilizing video recordings. Development of the direct demand pedestrian volume models and the pedestrian crash prediction models will use statistical and data analytic methods, which may include linear regression, multilevel regression, Poisson regression, negative binomial regression, and/or other methods. Data assembly, modeling, and visualization may be conducted using R and/or other computer software.

# Expected Outcomes

This research will enrich the transportation planning process and contribute towards improved planning outcomes, particularly for active transportation and pedestrian planning. Many planning tasks require (or would benefit from) estimates of walking activity for various locations in the multimodal transportation network: prioritizing off-street infrastructure or sidewalk infill projects, planning for Safe Routes to School, considering crossing treatments, etc. By developing direct-demand models that make use of pedestrian signal data, this project creates validated methods for estimating pedestrian volumes at signalized and unsignalized intersections that are particularly useful for state and local agencies’ transportation planning efforts.

This research will also provide pedestrian safety analysis methods that improve upon existing practices, particularly with respect to the use of measures of pedestrian exposure at signalized intersections. Making use of more detailed local data could generate more useful models that can consider a wider range of potential safety countermeasures and treatments. Additionally, state and local agencies could make use of pedestrian signal data for performance measures tracking pedestrian intersection crashes/fatalities at different levels of walking activity: low, medium, and high pedestrian volume intersections.

This research is anticipated to generate additional products beyond the research report that may be implementable by the Utah Department of Transportation (UDOT) or other agencies. A prototype online tool and graphical interface will visualize estimated pedestrian volumes at intersections, and can facilitate potential future integration with existing internal UDOT traffic signal data management and planning processes, such as the ATSPM system. Additionally, pedestrian SPF and CMFs developed from this project can be adapted by UDOT safety analysts, project managers, designers, and consultants when conducting spot, corridor, or larger-scale (or systemic) safety analyses or when considering safety-driven or other improvements at intersections.

# Relevance to Strategic Goals

Primary: Safety. Utilizing big data on walking from traffic signals as a measure of pedestrian exposure for traffic safety analysis will help develop improved predictive methods for multimodal roadway safety management processes, thus informing investments to reduce transportation-related fatalities and injuries.

Secondary: Livable Communities. Relating traffic signal pedestrian data to built environment characteristics will help develop improved pedestrian travel demand forecasting tools that can be used for planning livable communities that increase transportation choices and access to transportation services for those on foot and accessing transit.

# Educational Benefits

One MS student will be involved in this project as a graduate research assistant. This student will gain general project management, communication, and data management skills, as well as discipline-specific skills such as transportation data analysis, traffic safety analysis, and transportation planning. The MS student will take the lead on many of the research project’s major tasks, including preparing and administering the questionnaire as well as writing and presenting results.

The PI teaches undergraduate/graduate level courses on transportation data and safety analysis as well as transportation planning. Data, analyses, and findings from this project will be used as examples in those courses.

# Technology Transfer

The findings of this research project will be disseminated to other researchers, professionals, and practitioners in several ways. We will share results with the research and professional community through presentations at local, national and/or international conferences such as meetings of Utah Department of Transportation, the Institute of Transportation Engineers, and the Transportation Research Board. In addition to the project report, we plan to prepare two manuscripts and submit them for publication in transportation and traffic safety journals. The final report will be sent to traffic safety staff colleagues at state and local transportation agencies, and the presentations and articles will also be shared on the PI’s personal research website (<https://cee.usu.edu/faculty-sites/patrick-singleton/>).

# Work Plan

1. Assemble and prepare intersection data: pedestrian signal data, pedestrian crash data, local land use and built environment characteristics, and adjacent transportation system characteristics.

Study intersections will be selected based on data availability and representativeness. Pedestrian signal data will come from traffic signal controllers through UDOT’s ATSPM system. Pedestrian crash data will come from UDOT’s crash database. Other data include local land use and built environment characteristics (e.g., residential density, businesses, schools, parks) and geometric, traffic, and operational characteristics of the adjacent multimodal transportation system (e.g., transit service, # legs, # lanes, speed limits, motor vehicle volumes & turning movements). These additional data will come from existing UDOT and Utah databases. Data will be processed so that it is a comparable form. This task will be completed approximately 6 months after the project starts.

1. Calculate estimated pedestrian volumes at intersections, as outputs for direct demand pedestrian models and as exposure measures for safety predictive methods.

These estimates will be calculated by applying the factoring methods developed in the previous UDOT project to archived pedestrian push-button data from traffic signal controllers. Additional data collection of observed pedestrian counts may be conducted if necessary. The estimates will be used when developing models in Tasks 3 and 4. This task will be completed approximately 9 months after the project starts.

1. Estimate direct demand pedestrian volume models at intersections as a function of land use, built environment, and transportation system characteristics.

Models will be appropriate for the data (e.g., negative binomial, multilevel) and will account for spatial autocorrelation; they could include some temporal aspects (e.g., weekday, season) as well. Different specifications may be utilized to examine the sensitivity of model accuracy to varying data inputs (e.g., only predictable built environment measures) and spatial units (e.g., quarter-mile buffers). This task will be completed approximately 15 months after the project starts.

1. Perform crash data modeling to generate SPF and CMFs for pedestrian crashes at intersections.

The models will include push-button/signal-based measures of pedestrian exposure. The analyses will follow best-practice guidelines for crash data modeling and CMF development. It will identify risk factors for pedestrian intersection safety. This task will be completed approximately 18 months after the project starts.

1. Develop a prototype online tool and graphical interface to visualize estimated pedestrian volumes at intersections.

The models developed in Task 3 will be applied to many (signalized and unsignalized) intersections throughout Utah. The tool could include some temporal dynamics to show pedestrian volumes at different days of the week or seasons of the year. For instance, it may be able to generate a “heat map” of walking activity. This task will be completed approximately 21 months after the project starts.

1. Prepare final report(s) and presentation(s) summarizing the project.

This task will be completed approximately 24 months after the project starts.

# Project Cost

Total Project Costs: $ 100,000

MPC Funds Requested: $ 50,000

Matching Funds: $ 50,000

Source of Matching Funds: Utah Department of Transportation, financial support

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