| Request for Research Funding for FY 2022-2023 | | | |
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| **SPR Subpart B Project: TEO-23-08** | | | |
| **Requesting Office** | State Traffic Engineering and Operations | **Priority** | 8 of 23 |
| **Proposed Title** | Evaluation of Innovative Pedestrian Detection and Warning Systems to Increase Safety | | |

**Justification**

Pedestrian safety has been a major focus area of FDOT for the last decade. Several countermeasures have been identified to improve safety, including high visibility crosswalks, educational campaigns to educate pedestrians about correct crossing behavior, leading pedestrian intervals (LPIs), and pedestrian-friendly (walkable) road re-designs.

Previous research (“Pedestrian and Bicycle Program Evaluation and Data Collection,” 2018) has shown that a significant issue is the number of pedestrians who do not use the push buttons to activate the pedestrian phase at signalized intersections or midblock crosswalks with RRFBs or HAWK signals. This means that a major infrastructure safety feature available to pedestrians can be left unused if they fail to push the button. Resent observations at corridors in Orlando and Miami (“Corridor-Focused Grassroots Safety Education,” Lin et al. 2021) showed that during 2020–21, even fewer people pushed the button, perhaps due to fear of COVID-19. This means that different solutions are needed to activate pedestrian phases at signalized intersections or midblock crosswalks with RRFBs or HAWK signals.

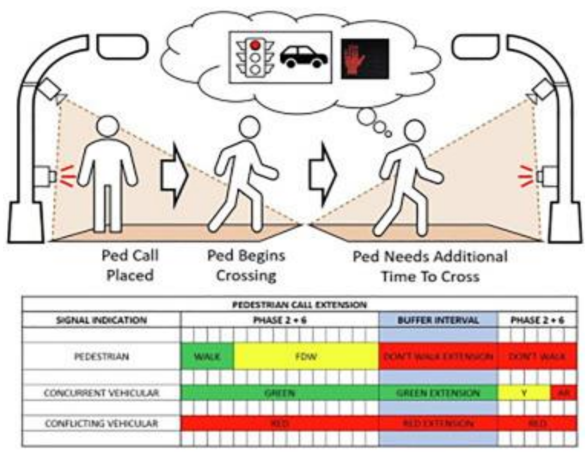


*Figure 1. Pedestrian Call Extension (Hughes et al. 2001)*

Automated Pedestrian Detectors (APD) were researched at the federal level (Hughes et al., 2001) and continue to have relevance (Markowitz and Montufar, 2012). Using APD systems to add a pedestrian call extension (Figure 1) or cancel a pedestrian call (Figure 2) also have been researched. However, APDs have not been used, perhaps due to their sensitivity or accuracy issues and price. Recent research (Lin et al. 2019, Larson et al. 2020) showed that modern pedestrian detection devices can help solve the push button issue; in addition to automated pedestrian detection, there are ways to place a call as long as a pedestrian is in the presence zone and remove it when a pedestrian leaves the zone. This can aid in reducing delay when pedestrians cross the road after pushing the button (and placing a call) by removing the call from the next phase in the traffic controller.

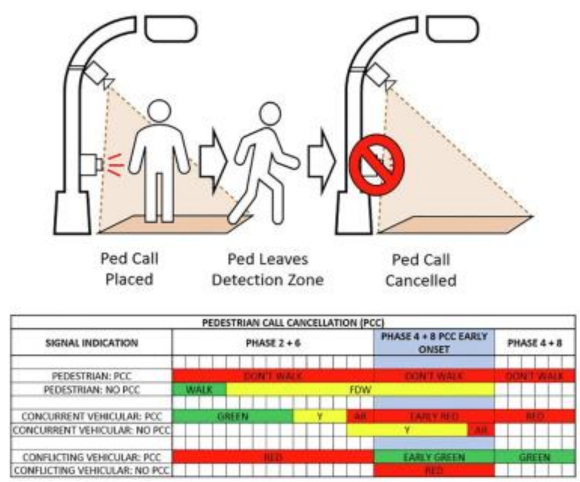


*Figure 2. Pedestrian Call Cancellation (Hughes et al. 2001)*

In more recent studies (Liao and Davis, 2020), a pedestrian detection system was integrated with a smartphone application to provide a way for visually-impaired pedestrians to place a call from their smartphones. New advancements in traffic technologies are making more products available that allow for connected vehicle integration and provide a Signal Phasing and Timing (SPaT) message to improve safety for all road users and the capability of using

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<tr><td></td><td>smartphones or automated detection via optical or thermal sensors to place, extend, or cancel a pedestrian call when needed.<br><br>Objectives and associated tasks of the proposed project are as follows:<br><br>1. Perform a comprehensive literature review regarding the latest advancements in Dynamic Passive Pedestrian Detection (DPPD) or Automated Pedestrian Detectors (APD) and feedback or warning applications currently available on the market and identify vendors with available products.<br>2. Develop a data collection, implementation, and evaluation plan for the effectiveness of such systems to reduce pedestrians crossing without a pedestrian call.<br>3. Identify sites in FDOT Districts 6 or 7 for pilot deployment and evaluation and install systems at signalized intersections and midblock crosswalks with RRFBs or HAWK signals.<br>4. Conduct a feasibility study including working with at least one traffic controller vendor to implement placing, extending, or canceling a pedestrian call and integration with a smartphone application.<br>5. Conduct a before-after study of the behavior of pedestrians at sites where systems are deployed.<br>6. Perform in-depth data analyses to evaluate the effectiveness and benefits on the use of DPPD or APD and warning devices in Florida.<br>7. Develop implementation guidelines on when, where, and how to deploy these systems and document analysis results and research findings from the evaluation and provide recommendations.</td></tr>
<tr><td>Impact</td><td>Pedestrians needing to cross a street at an intersection usually must push a button to place a pedestrian call to the traffic controller, then wait for the “Walk” signal. Often, however, they may cross as soon as there is a gap in traffic, especially when the cycle time is long. This creates a safety issue that has been observed and documented when pedestrians cross during the “Do Not Walk” signal. In addition, pedestrians can be caught on the crosswalk when the pedestrian countdown ends, leaving them vulnerable to oncoming vehicles with inattentive drivers. The COVID-19 pandemic also created an additional hurdle of people not wanting to touch the button. On the other hand, drivers get frustrated when there is a pedestrian phase on a crossroad (so they do not have a green signal) but no pedestrians are present. This increases delays and frustration, leading to careless driving and unsatisfied road users. The results and findings of this research will shape additional policies in using new traffic technologies to increase traffic safety.<br><br>The consequences of <u>not</u> doing this research include the following:<br><br>• FDOT will not obtain a detailed literature review on the availability and implementation of APD or DPPD systems.<br>• FDOT will not be able to research the implementation of such systems, including the use of smartphones to place a call or the behavior of pedestrians using these systems.<br>• FDOT will not be able to provide safer alternatives for the non-use of current push buttons at signalized intersections and midblock crosswalks with RRFBs or HAWK signals.<br>• FDOT will not be able to reduce traffic delay by reducing pedestrian calls with phantom pedestrians.<br>• FDOT will not obtain guidelines for successful implementation of APD and DPPD systems.<br>• FDOT will not receive a comprehensive research report documenting the effectiveness of these systems’ pilot implementation, analysis results, research findings, conclusions, recommendations, and implementation guidelines for successful deployment to reduce pedestrian crashes at crosswalks with a pedestrian signal.</td></tr>
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<tr><td>Affected Offices</td><td colspan="3">State Traffic Engineering & Operations, District Traffic Operations</td></tr>
<tr><td>Existing Work</td><td colspan="3">The existing literature provides insights on previous research on the topic of APDs and DPPDs:<ul>
<li>“Evaluation of Automated Pedestrian Detection at Signalized Intersections” (Ronald Hughes, Herman Huang, Charles Zegeer, Michael Cynecki, Highway Safety Research Center, UNC, FHWA-RD-00-097, 2001) – Research on whether APDs used in conjunction with standard pedestrian push buttons would result in fewer overall pedestrian-vehicle conflicts and fewer inappropriate crossings. Results indicated significant reductions in vehicle-pedestrian conflicts and in the number of pedestrians beginning to cross during a “Don’t Walk” signal.</li>
<li>“Operating Performance of Pole Mounted Curb-Side Automated Pedestrian Detectors at Signalized Intersections” (Jonathan Foord, Jeannette Montufar, ITE 2010 Annual Meeting and Exhibit, Institute of Transportation Engineers, ITE, 2010) – Evaluation of three commercially-available curbside APDs and suitability to place calls for valid pedestrians.</li>
<li>“Developments in Automated Pedestrian Detection” (Frank Markowitz, Jeannette Montufar), Managing Operational Performance ... Exceeding Expectations, 2012 ITE Technical Conference and Exhibit) – Summary of findings of an ITE committee on APD and effectiveness of devices used in the U.S. compared to the UK.</li>
<li>“Integration of a Robust Automated Pedestrian Detection System for Signalized Intersections” (Pei-Sung Lin, Achilleas Kourtellis, Zhenyu Wang, Cong Chen, FDOT Research Report, 2019) – Research on available APD systems for signalized intersections and midblock crosswalks. Evaluation of effectiveness in controlled environment and pilot deployment showed pedestrian detection 94% of the time and automated pedestrian call 90% of the time.</li>
<li>“Evaluation of Dynamic Passive Pedestrian Detection” (Travis Larson, Amy Wyman, David S. Hurwitz, Matt Dorado, Shaun Quayle, Stacy Shetle, Journal of Transportation Research Interdisciplinary Perspectives, Volume 8, 2020) – Research on DPPD systems, including two thermal sensors and one optical sensor in Washington County, Oregon.</li>
<li>“Deploy and Test a Smartphone-Based Accessible Traffic Information System for the Visually Impaired” (Chen-Fu Liao, Brian Davis, Minnesota Department of Transportation, Office of Research and Innovation, 2020) – Research on existing mobility application for the visually-impaired used to aid in navigating and wayfinding with Bluetooth low-energy technology and Signal Phasing and Timing (SPaT) information.</li>
<li>Device – Flir TraffiOne Smart City Sensor – Thermal Imaging Sensor used to detect the presence of pedestrians and bicyclists in adverse weather and low-light conditions; also used for traffic monitoring and dynamic traffic signal control.</li>
<li>Device – SmartSense Touchless Push Button – Push button with infrared technology that allows pedestrians to wave at the push button to activate the pedestrian cycle without touching the button; specifically designed for COVID-19.</li>
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<tr><td>Keywords Used in Existing Work Search</td><td colspan="3">Automated Pedestrian Detection, APD, Pedestrian push button, Dynamic Passive Pedestrian Detection, DPPD, Signalized intersections</td></tr>
<tr><td>Related Contracts (Give contract numbers)</td><td colspan="3">BDV25-977-44, Integration of a Robust Automated Pedestrian Detection System for Signalized Intersections</td></tr>
<tr><td>Funding Request</td><td>$200,000</td><td>Anticipated Duration</td><td>20 months</td></tr>
<tr><td>Project Manager</td><td>Alan El-Urfali, P.E.</td><td>Contracting Method</td><td>Direct contract with USF Center for Urban Transportation Research (CUTR) (Dr. Lin)</td></tr>
<tr><td>Equipment</td><td>Estimated equipment cost (or N/A)</td><td colspan="2">This project will evaluate up to three different systems. These systems can be purchased or procured through service expenditure with a contractor or contractors. The project team members do not expect that the systems can be leased due to their low individual cost. The</td></tr>
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| | $12,000 - $15,000 | project team plans to procure through service expenditure with a contractor or contractors including the installation. The team members will work with vendors and manufacturers to deploy these systems at the lowest possible cost to the project and the Department, realizing that if purchased, these components have to be installed and removed with a service agreement as a separate cost item. |
| **Urgency** | 1 | Florida still ranks 1st in the nation for pedestrian fatalities according to the 2021 *Dangerous by Design* report. Seven of the top 10 large metro areas are in Florida, and some have been for several years in a row. Currently, pedestrian safety is one of the focus areas of FDOT, and this initiative can help in reducing fatality rates and bringing the latest traffic technology to Florida. |
| **Implementability** | 1 | This proposed research will conduct a pilot deployment, evaluate effectiveness, document evaluation results and findings, and provide practical guidelines to successfully implement DPPD systems to reduce pedestrian fatalities at crosswalks across Florida. The cost for these systems has significantly dropped in the last few years, and their accuracy has increased to 94%. Several systems are available on the market, and case studies have been conducted in Florida and Oregon. Implementability is high. |

**Project Benefits (succinct, complete explanation)**

- FDOT will obtain a literature review on the accuracy and use of APD or DPPD systems nationwide.
- FDOT can successfully deploy APD and DPPD systems.
- FDOT will obtain research results and findings on the evaluation of these systems at deployed sites and on the effectiveness of using these systems to reduce pedestrian fatalities at locations with an activated pedestrian signal, RRFB, or HAWK.
- FDOT will obtain a comprehensive report documenting evaluation results and research findings for pilot deployment of these systems.
- FDOT will obtain practical implementation guidelines for successful deployment of these systems on Florida roads.

| **Project Benefits (Select all that apply and explain)** | **Quantifiable Benefits (units, dollars, etc.…if applicable)** | **Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits** |
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| ○ **Materials Enhancement** | | |
| ○ **Materials Savings** | | |
| ○ **Time Savings** | Reduction in delay at signalized intersections<br><br>Total estimated annual cost saving for reduction of vehicle delay at signalized intersections is about **$54M** | The use of APD or DPPD systems is expected to reduce delays by removing a pedestrian call when the pedestrian who placed the call to cross a major street is no longer present when it is served. This project will help evaluate the systems and guide future widespread implementations of the systems to reduce unnecessary delay.<br><br>There are about 8,600 traffic signals in Florida, most of which are in urban and suburban areas (more than 90%). For a typical signalized intersection in an urban or suburban area, a pedestrian signal likely displays without the presence of a pedestrian for more than 20 times per day and 30 seconds of unnecessary delay to 40 vehicles waiting at intersections. The value of this time is estimated to be $19.24 per hour per person based on the *2021 Urban Mobility Report*.<br><br>Implementing APD systems to 40% of these signalized intersections in urban and suburban areas in Florida could result in total estimated annual cost saving for reduction of vehicle delay of about **$54M** (= $19.24*3,200*0.9*0.5*20*40*365*40%/60). Including in the calculation the time saving for commercial vehicles and fuel saving results in a total saving larger than $54M. |

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| ○ **Lives Saved/Injuries Prevented** | Reduction in number of pedestrian crashes, fatalities, and injuries<br><br>**29** lives per year can be saved, and **61** incapacitating injuries, and **255** other injuries per year can be prevented.<br><br>The estimated annual social cost saving is about **$384M**. | Based on the latest Traffic Crash Facts Annual Report (Florida Department of Highway Safety and Motor Vehicles, 2019), there were 9,736 pedestrian crashes, 734 pedestrian fatalities, 1,524 pedestrian incapacitating injuries, and 6,369 pedestrian other injuries on Florida roads in 2019. About 18% occurred at intersections where pedestrian signals were present. Field observations conducted by CUTR in Orange County and Miami in 2018 and 2021 showed that, on average, 64% of pedestrians did not press the pedestrian push button and 38% of pedestrians crossed a signalized intersection on red ("Do Not Walk"); most pedestrian fatalities and injuries (~75%) occurred when intersections were crossed on red.<br><br>It is anticipated that the implementation of pedestrian detection systems including APD systems, pedestrian push button apps, and/or hands-free pedestrian button sensing systems, can increase pedestrian detection by at least 50% to place a pedestrian call, and pedestrian fatalities and injuries due to crossing on red could be reduced by 30% or more. The estimated percentage of reduction in pedestrian fatalities and injuries would be equal to 100%*18%*75%*30%=4%, with estimated lives saved and injuries prevented as follows: pedestrian fatalities—734*4% = **29**; pedestrian incapacitating injuries—1,524*4% = **61**; pedestrian other injuries—6,369*4% = **255**.<br><br>According to FDOT KABCO crash costs (Table 23.5.2, https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/content/roadway/bulletin/rdb14-12.pdf?sfvrsn=dd9f8e48_0), crash costs for a fatal crash are $10.1M, for serious injury are $.0819M, and for moderate crashes are $0.163M. Estimated annual social cost saving of 29 lives, 61 incapacitating injuries, and 255 other injuries is about **$384M** (=29*$10.1M+61*$0.819M+255*$0.163M). |
| ○ **Other (Explain)** | Saving of fuel due to delay reduction at signalized intersections | |