

Request for Research Funding for FY 2023-2024

Project Number (Research Center Use Only): FRO-24-02			
Requesting Office	FDOT FRO	Priority	2 of 3 (projects may not have the same ranking – no ties)
Proposed Title	Development of Advance Train Arrival Warning System for Highway-Rail Grade Crossings Leveraging Connected Vehicle Technology		

Describe the current situation, why the research is needed, and how the research affects your office’s mission critical focus areas

Background and Motivation for Proposed Research

Crashes occurring at highway-rail grade crossings (HGGCs) have been a point of challenge for the rail industry. Although the number of GRGC crashes is much less than that of other common roadway crashes, the HRGC crashes always receive significant attention from the public and media. According to FRA statistics, 2,145 HRGC collisions occurred in 2021. There were 234 crossing fatalities and 669 crossing injuries in 2021 across the U.S. Florida ranked 6th with a total of 94 HRGC collisions in 2021. In terms of fatalities, Florida ranked 2nd with 22 deaths in 2021.

Most crashes occur at HRGCs with active devices such as warning beacons or/and gates near downstream signalized intersections. Previous research has shown that the warning time (activating flashing beacons and gates) for motorists is around 25 seconds before a train arrives. Even though countermeasures exist that warn motorists, pedestrians, and bicyclists not to enter the crossing area when a train is arriving, crashes continue to occur. Some crashes at HRGCs happen because road users intentionally violate the laws to cross railroad tracks but fail when a train arrives. The other crashes occur because vehicles are stuck on railroad tracks due to traffic backup from the downstream signalized intersections or due to incorrect turns onto railroad tracks, and drivers do not have enough time to cross the tracks or escape from their vehicles in time before train arrivals. Some signalized intersection near HRGCs utilize traffic signal preemptions to clear the vehicular traffic at railroad crossings, but the issue remains for other signalized intersections and for congested intersections that need more time to clear the traffic at HRGCs.

Justification



(Photo: Sun Rail)



A CSX freight train slowly passes a car on a second set of tracks at Southeast 80th Street south of Ocala Wednesday morning, Ocala Star-Banner

(Photo: Ocala StarBanner)

Need for Proposed Research

This project proposes to utilize connected vehicle (CV) technology with Cellular-Vehicle-to-Everything (C-V2X) applications to provide an advance warning via flashing beacons or LED signs at HRGCs to passing motorists or drivers whose vehicles are stuck on railroad tracks, and therefore give ample time for them to clear the crossing or escape from their vehicles before a train arrives. The proposed project will utilize CV technology to communicate the arrival of the train at adequate distance (and time) from the crossing via roadside units (RSU) to the grade crossing controller. This way, the advance warning via flashing beacons or LED signs can be provided before the gates are activated so that additional time is given to the motorists to clear the crossing. The current 25 seconds could be too short for those whose vehicles are stuck on railroad tracks due to queue back from nearby signalized intersections or incorrect turns onto railroad tracks. The CV technology is simple and cost effective and can provide an

	<p>excellent solution to a problem that needs a more robust solution than what is currently in use. This proposed project can significantly increase the safety of HRGCs and reduce the chances of crashes at HRGCs in Florida. The advance train arrival warning system developed from this research can also benefit transportation agencies outside Florida.</p> <p><i>How the Research Affects Your Office's Mission Critical Focus Areas</i></p> <p>The mission of the FDOT Freight and Rail Office aims for success through teamwork and efficiency by means of removing institutional, infrastructure, and funding bottlenecks to build a well-connected, reliable, and safe freight and rail network. A critical focus area is to remove bottlenecks and create a safe network. Increased safety and reduced delays are critical to a safe network including trains and vehicles. The proposed project will research, identify, implement, and evaluate a new method to provide advance warning for oncoming trains to stranded vehicles waiting on the tracks. This proposed research is urgently needed to fully support FDOT's mission and its critical focus areas and to assist in achieving its priority on researching emerging technologies and forging partnerships in a quickly evolving industry, supporting innovation in Florida.</p> <p><i>Objectives of Proposed Research</i></p> <p>The major objectives of the proposed research include the following:</p> <ul style="list-style-type: none"> • Identify and document any state-of-the-art implementations of advance warnings for rail applications. • Research and/or develop connected vehicle (CV) applications for advance warning for oncoming trains. • Partner with one railroad operator to investigate the application of advance warning on trains. • Conduct pilot deployment at one location selected by FDOT. • Collect data on the implementation of advance warning utilizing CV technologies. • Provide detailed analysis, research findings, and recommendations on the technology as well as possible improvements for future implementations.
<p>Impact</p>	<p>How shall the results impact practice? Consequences of not doing the research?</p> <p>The results of this research will help FDOT identify the practicality of using CV technologies or similar technologies for providing advance warnings for railroad grade crossings, to help save lives and mitigate crashes between vehicles and trains. The proposed research will inform FDOT FRO of the effectiveness of such systems, their efficacy, success, and lessons learned from deployment, as well as improvements needed.</p> <p>The consequence of not doing this research would be to continue to have crashes occur at HRGCs when vehicles remain in the crossing while a train arrives. FDOT will not be able to apply useful and proven technologies in solving this issue and will not have the latest state of the art on this topic. The number of HRGC related crashes, fatalities and severe injuries will likely not be reduced.</p>
<p>Affected Offices</p>	<p>Identify any office that will need to be involved in the scoping or conduct of the research, will be affected by implementation of the results, or will need to participate in the implementation process—including OTIT, if enterprise data/network software application will be a deliverable, and district staff, as appropriate, e.g., through statewide meetings.</p> <p>FDOT Freight and Rail Office</p>
<p>Existing Work</p>	<p>A variety of studies regarding warning signs at HRGCs have been conducted including a few that investigated pre-emption for traffic signals close to the crossing. However, limited studies regarding the effectiveness of advance warning have been found, which leaves a gap in the research, especially with the advent of new technologies such as CV technologies for vehicle communication. Given the urgent need of increased crossing safety, research is needed to thoroughly research this topic, and provide effective countermeasures and techniques for FDOT to address HRGC crashes. Studies that are related to the topic are:</p> <ol style="list-style-type: none"> 1. Liu, Ran; Yan, Xuedong; Ma, Siwei; Xue, Qingwan. Eye movement as a function to explore the effects of improved signs design and audio warning on drivers' behavior at STOP-sign-controlled grade crossings. Accident Analysis & Prevention, Volume 172, Issue 0, 2022, 106693, https://trid.trb.org/view/1952064 2. Hellman, Adrian D; Lamplugh, Aaron. Evaluation of LED Sign Technology at a Passive Highway-Rail Grade Crossing. Volpe National Transportation Systems Center; Federal Railroad Administration; Federal Railroad Administration, 2016, 64p, https://trid.trb.org/view/1404757 3. Lin, Pei-Sung; Fabregas, Aldo; Kourtellis, Achilleas; Lall, Sherrell; Bato, Michael. Improved Traffic Control Measures to Prevent Incorrect Turns at Highway-Rail Grade Crossings. National Center for Transit Research; Florida Department of Transportation; Research and Innovative Technology Administration, 2013, 88p, https://trid.trb.org/view/1281005

	<ol style="list-style-type: none"> 4. Lin, Pei-Sung; Wang, Zhenyu; Wang, Qing; Guo, Rui. Coordinated Pre-Preemption of Traffic Signals to Enhance Railroad Grade Crossing Safety in Urban Areas and Estimation of Train Impacts to Arterial Travel Time Delay. Final Report, FDOT Project Number BDK85 977-44, 2013. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-bdk85-977-44-sum.pdf 5. Metaxatos, Paul; Sriraj, P S. Pedestrian/Bicyclist Warning Devices and Signs at Highway-Rail and Pathway-Rail Grade Crossings. University of Illinois, Chicago; Illinois Department of Transportation; Federal Highway Administration; Research and Innovative Technology Administration, 2013, 176p, https://trid.trb.org/view/1250622 6. Smiley, Alison; Smahel, Tom. Effect of an Advance Warning Sign on Driver Behavior at a Passive Rail Crossing. Transportation Research Board 91st Annual Meeting, Transportation Research Board, 2012, 18p, https://trid.trb.org/view/1129125 7. Hall, K; Arvanitakis, A; Beer, K; Kenos, A. Railway level crossing infrastructure countermeasures. 24th World Road Congress, World Road Association (PIARC), 2011, 10p, https://trid.trb.org/view/1285899 8. Luoma, Juha; Poutanen, Mikko. How Drivers Understand Safe Behaviour and Perceive Risks at Passive Railway-Road Level Crossings. Open Transportation Journal, Volume 5, 2011, pp 88-91, https://trid.trb.org/view/1146658 9. Traffic Control Devices, Visibility, and Highway–Rail Grade Crossings 2011. Transportation Research Record: Journal of the Transportation Research Board, Issue 2250, 2011, 90p, https://trid.trb.org/view/1126686 10. Ruback, Leonard G; Balke, Kevin N; Engelbrecht, Roelof. Non-Vital Advance Rail Preemption of Signalized Intersections near Highway-Rail Grade Crossings: Technical Report. Texas Transportation Institute; Texas Department of Transportation; Federal Highway Administration, 2007, 122p, https://trid.trb.org/view/836902 11. Gilleran, Brian F. Use of Pre-Signals in Advance of a Highway-Rail Grade Crossing: A Specialized Tool with Specific Applications. ITE Journal, Volume 76, Issue 5, 2006, pp 22-25, https://trid.trb.org/view/783559 		
Keywords Used In Existing Work Search (Cannot leave blank)	Advance warning, rail grade crossing, highway rail grade crossing, HRGC, countermeasures, connected vehicle applications, warning sign, LED sign, Crashes, incorrect turns		
Related Contracts (Give contract numbers)	BDK85-977-44, BDV25-977-11, BDV25-977-54		
Funding Request	\$250,000	Anticipated Duration	18 Months
Project Manager	Eugene Jules	Contracting Method	Direct contract with University of South Florida’s Center for Urban Transportation Research (CUTR)
Equipment	Estimated equipment cost (or N/A)	N/A	
Urgency	Score 1-5 1= highest, most immediate need Score = 1	Florida ranked 6 th on HRGC crashes and 2 nd on HRGC deaths in the nation. It is urgent to take actions.	
Implementability	Score 1-5 1=greatest likelihood of and proximity to implementing results Score = 1	The products from this research, including evaluation of technologies and implementation results will be highly implementable, which can lead to tangible results in significantly reducing crashes at HRGCs.	
Project Benefits (Succinct, complete explanation)			

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
○ Materials Enhancement		
○ Materials Savings		
○ Time Savings		Reduction of rail crossing related crashes, fatalities, and injuries, can reduce significant delays from traffic congestion at and near HRGCs. The reduction of traffic congestion due to reduction of HRGC crashes will vary depending on the locations of HRGCs and their downstream signalized intersections.
○ Lives Saved/Injuries Prevented		<p>Findings and outcomes from this research project could provide FDOT with crucial and needed information and data to implement the most effective and suitable proven countermeasures and techniques on advance warning at rail crossings in Florida to significantly reduce crashes, fatalities, and severe injuries of motorists.</p> <p>According to FRA statistics, Florida has 94 HRGC collisions, 22 deaths and 45 injuries. We believe that the success of implementing advance train arrival warning system throughout Florida can significantly reduce HRGC collisions, deaths, and injuries because drivers and passengers will have sufficient time to prevent being killed or injured. By reduction of 50% of HRGC collisions, deaths, and injuries, we can save 11 lives and 23 injuries. The estimated saving of social costs is about \$129.9M ($=\\$10,100,000 \times 11 + \\$818,535 \times 23$) per year.</p>
○ Other (Explain)		Implementation of state-of-the-art technologies can help Florida and FDOT achieve its goals of using emerging technologies and supporting innovation to increase safety towards a vision zero.

*Comments should explain and support urgency, financial benefit, and implementability scores