Request for Research Funding for FY 2019-2020			
Requesting Office	**Freight and Multimodal**	**Priority**	4 of 4
Proposed Title	Evaluation of Automatic Object Detection Technologies to Improve Safety at Highway-Rail Grade Crossings		
Justification	**Describe the current situation, why the research is needed, and how the research affects your office's mission critical focus areas** In the US, a train hits a person every 115 minutes, often with fatal results (*1*). According to the Federal Railway Administration (FRA) database, in Florida in 2017, 107 highway-rail incidents resulting in 20 fatalities and 55 injuries. A large number of these incidents occurred on gated or ungated highway-rail grade crossings, and victims included motorists, pedestrians, and bicyclists. This issue is more serious along high-speed rail tracks, such as Brightline. Several highway-rail crashes along the Brightline have been reported in the news since 2018. Selected cases include: • September 19, 2018, 7:00 am – Bright line train struck car stopped on railroad tracks in Hallandale Beach • December 26, 2018, 9:00 pm – Bright line train struck car in Fort Lauderdale; two injuries • November 23, 2018 – Bright line train struck and killed person in Hollywood in Broward County • January 1, 2019 – Bright line train traveling south through Fort Lauderdale struck pedestrian Trains always have the right-of-way at highway-rail crossings. Road users must wait for the passing of trains at railroad crossings when the railroad gates are down or/and advance warnings of upcoming trains via sound and flashing light are given to road users. During this warning period before a train reaches the railroad crossing, it is crucial to have an automatic detection system to detect any stalled or moving objects (e.g., vehicles, pedestrians, cyclists, and debris) at the railroad crossing and alert the train drivers of collision risk in advance. Because of this instant alert and notification, a train driver can take needed actions such as applying emergency brakes to slow down or/and applying the horn on the train or at the crossing to warn road users. Additionally, it is also important and needed to have an automatic object detection system to detect a stalled vehicle (e.g. a trapped vehicle due to an incorrect turn) or objects on railroad tracks at or near highway-rail crossings, and send a notification to the associated railroad company and TMC. If a train driver can apply a train horn to warn road users and emergency brakes to slow down the train, it can warn and potentially allow people to get out of a stalled vehicle, move off the tracks, or move away from the crossing. A pedestrian or a bicyclist on the railroad tracks may also have a chance to quickly move away to avoid a crash. Reduced train speed also potentially can lessen damages and injury severity. Therefore, advance warnings from an automatic detection system to train drivers to take proper actions provide the potential to reduce the risk of fatalities and injuries from a collision. This advance warning from an automatic detection system at a highway-rail crossing can also be sent to associated Traffic Management Centers (TMCs) and emergency management agencies for their quick attention and needed response if a train crash does occur. For a stalled vehicle or object on railroad tracks at or near highway-rail crossings, the automatic object detection system can detect and send a notification to the associated railroad company and TMC to remove the vehicle and/or object to avoid a potential crash. Many sensing and detection technologies exist for vehicle/pedestrian/cyclist detection, including but not limited to infrared, microwave, thermal sensors, and computer-based video-analytic applications. These technologies could provide an opportunity for detecting stalled or moving objects (vehicles, pedestrians or bicyclists) at railroad crossing areas during the critical warning period of approaching trains or a period without coming trains, and send advance alerts to train drivers, TMCs, and emergency agencies. Each automatic detection system has its strengths and potential weaknesses in terms of accuracy, reliability, accessibility, cost, installation and maintenance requirements, etc. To ensure benefits to FDOT and railroad companies, it is essential to research, evaluate, and identify effective and accurate automatic detection systems on the market for automated detection of stalled and moving objects at highway-rail grade crossings. A pilot study also is needed to evaluate and compare the performance of selected detection systems to detect stalled and moving objects under various Florida scenarios (weather, lighting, crossing layout, train speed, etc.). Reference: *1. https://www.tdi.texas.gov/pubs/videoresource/fsrailroadcross.pdf*		
Impact	**How shall the results impact practice? Consequences of not doing the research?** Detection technologies have been implemented at many roadway facilities for various purposes, such as pedestrian detection at signalized intersections and wrong-way driving detection on interstates and freeway off-ramps. However, limited knowledge and studies are available for the implementation of detection technologies at highway-rail crossings. This study will assist FDOT in evaluating, identifying, and demonstrating proper technologies/systems on the market for hazard detection at highway-rail crossings regarding accuracy, reliability, cost, and installation and operations for future		

	implementation to significantly improve the safety of Florida's highway-rail crossings. The results and findings from this research will provide FDOT and railroad companies with the valuable performance information of automatic detection systems on the market for highway-rail crossing safety. The absence of this proposed research could prevent FDOT and railroad companies from evaluating the automatic detection technologies and systems currently on the market, and implementing accurate and robust detection system in the future to alleviate the hazards, fatalities, and injuries at highway-rail crossings. This proposed research will also support FDOT for reaching leading status among U.S. states on the safety of highway-rail grade crossings.		
Affected Offices	FDOT Freight and Multimodal Office, FDOT Safety Office, FDOT Districts Rail Office, railway companies		
Existing Work	Learning About and Using the Research in Progress (RiP) Database, http://www.trb.org/main/blurbs/176215.aspx. At a minimum, the Transportation Research International Documentation (TRID) and Research in Progress (RIP) online databases should be reviewed by an expert in the research subject matter to ensure research that effort and resources shall not duplicate prior or ongoing work. TRID: https://trid.trb.org/Results RIP: https://rip.trb.org/. • Salmane, H., Khoudour, L., Ruichek, Y. (2015). A video-analysis-based railway-road safety system for detecting hazard situations at level crossings. *IEEE Transactions in Intelligent Transportation Systems*, 16(2), 596-609. • Fakhfakh, N., Khoudour, L., El-Koursi, E. M., Jacot, J., Dufaux, A. (2010). A video-based object detection system for improving safety at level crossings. *Open Transportation Journal*, 5, 2011, 45-49. • Watanabe, I., Akita, K., Okuda, T. (1995). Object detection algorithm in a level crossing area using image processing. Railway Technical Research Institute, Quarterly Reports, 36(1). **Summary:** Only a few studies exist that investigate object/hazard detection at highway-rail grade crossings and are limited to video detection technology and focus on algorithms. No study was identified to focus on an assessment of different object/hazard situation detection technologies and their impacts on highway-rail crossing safety.		
Keywords Used In Existing Work Search	Railway crossing, Object detection, Hazard detection, Highway-rail accident		
Related Contracts	N/A		
Funding Request	**Estimated cost:** $180,000	**Anticipated Duration**	18 months
Project Manager	Catherine Bradley, P.E.	**Contracting Method**	Direct contract with University of South Florida's Center for Urban Transportation Research (CUTR)
Urgency	*Score 1–5 1= highest, most immediate need* Score = 1	In addition to the existing countermeasures implemented, there is an urgency to research on implementation of effective and accurate automatic object detection systems at major highway-rail crossings to provide advance warnings of hazard situations on railroad crossings to train drivers, railroad companies, TMC operators, and emergency agency managers before possible collision occurrence. It is a serious safety concern at Florida at highway-rail crossings, especially for passenger and higher-speed rail (Brightline). Applications of automatic object detection technologies and systems is an effective way to prevent highway-rail crashes, reduce fatalities, and alleviate injury severity as well as ease potential traffic congestion. Understanding automatic detection systems and their performance is critical for successful future implementation of the systems. This proposed research can provide FDOT and railroad companies with important and timely evaluation of automatic object detection technologies and systems on the market at selected highway-rail crossings via pilot implementations.	
Implementability	Score 1–5 1=greatest *likelihood of and proximity to implementing results* Score = 1	The proposed research aims to conduct a pilot study to evaluate selected available automatic object detection technologies/systems on the market for stalled or moving object detection at highway-rail crossings. The proposed research will provide evaluation results and valuable recommendations on selection of the most cost-effective automatic detection technologies/systems for future widespread implementations at key Florida and U.S. highway-rail grade crossings.	
Project Benefits (Succinct, complete explanation) • Support FDOT to review and identify automatic object detection technologies and systems at highway-rail crossings for evaluation. • Conduct pilot implementation to evaluate the performance of selected automatic object detection systems at highway-rail crossings under various Florida scenarios (weather, lighting, crossing layout, train speed, etc.). • Provide evaluation results and recommendations for selecting automatic object detection systems for future implementations.			

• Assist FDOT in preparing guidelines and action plans to implement automated object detection systems at highway-rail crossings. • Improve highway-rail crossing safety to prevent and reduce highway-rail fatalities, injuries and crashes in Florida. • Support FDOT for reach leading status among US states on the safety for highway-rail grade crossings.		
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**
o **Materials Enhancement**		
o **Materials Savings**		
o **Time Savings**	Travel time improvements due to reduced emergency response time to railway crossing collision	*Method:* The research team will construct several scenarios of railroad crossing accidents from the historical database. Based on historical data, traffic conditions, incident detection time, and response time, the research team will conduct traffic simulation to compare and estimate the time saving and traffic congestion reduction from the implementation of automatic object detection system at highway-rail crossings. Any prevention of highway-rail crashes from the implementation of automatic object detection systems can result in significant time saving and congestion reduction.
o **Lives Saved/Injuries Prevented**	Reduction of highway-rail fatalities and injuries	*Method:* The research team will design and conduct practical experiments in a controlled environment to simulate various scenarios at highway-rail crossings. The researchers will produce probability functions based on these experiments to estimate probabilities for motorists to get out of a stalled vehicle, move off the tracks, or move away from the crossing and for a pedestrian or bicyclist on railroad tracks to quickly move away to avoid a crash due to an additional alert from a train horn. Based on probability functions, researchers can estimated the potential number of lives saved and injuries prevented with the implementation of automatic object detection system at key highway-rail crossings.
o **Other (Explain)**	Benefit-cost ratio larger than 1.0	*Method:* Based on time savings, lives saved/injuries prevented, total costs of the automated object detection systems, and implementation of the systems at key highway-rail crossings in Florida, the research team can estimate an overall benefit-cost ratio by dividing the estimated total benefits by the estimated total costs.

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