

Grade Crossing Monitoring Using Deep Learning

Deliverables and Reporting Requirements for UTC Grants Awarded in 2023 (June 2023)

Exhibit D

Research Project Requirement Template

Recipient/Grant (Contract) Number: University of Texas Rio Grande Valley (UTRGV)/Grant No. 69A3552348340

Center Name: University Transportation Center for Railway Safety (UTCRS)

Research Priority: Promoting Safety

Principal Investigator(s): Dr. Gasser Ali (PI) and Dr. Constantine Tarawneh (Co-PI)

Project Partners: University of Nebraska Lincoln (UNL), University of California-Riverside (UCR), University of South Carolina (UofSC)

Research Project Funding: \$43,685 (Federal), \$21,763 (Non-Federal Cost Share)

Project Start and End Date: 09/01/2023 to 08/31/2024

Project Description: Railway crossings are critical elements of railway safety due to the heightened risk of train collisions. The USDOT's National Highway Traffic Safety Administration (NHTSA) reported more than 1,600 collisions between vehicles and trains in 2021, and 500 collisions at transit rail crossings in 2020. Transportation agencies and researchers are continuously working to enhance safety at railway crossings with better operating procedures and equipment to avoid accidents. Many innovative methods have been proposed to detect hazards at crossings and rail tracks using technologies such as sensors, computer vision, depth cameras, and many others. However, there is still a need to develop a holistic approach that is robust and generalizable to the many conditions and hazards related to grade crossing accidents. This project aims to investigate Artificial Intelligence (AI) and Deep Learning (DL) models to monitor grade crossings and detect various hazardous conditions such as vehicles, pedestrians, cyclists, animals, warning lights, arm positions, and others. There is a need for generalizable AI models that can be applied at different grade crossings and monitor the various conditions associated with accidents and near-miss events. To achieve that, the proposed methodology consists of (1) collecting visual data of railway crossings; (2) labeling the data for training; and (3) developing a computer vision model using deep learning that can detect hazardous conditions at railway crossings. Ultimately, the outcomes of this research support improving safety at crossings, modernizing unsafe crossings, optimizing traffic in crossings, and data sharing for research with UTCRS partners.

US DOT Priorities: The proposed work in this project is aligned with four of the six USDOT strategic goals: **(a) Safety:** The project directly investigates a potential safety concern that has been identified by the National Transportation Safety Board (NTSB). **(b) Equity:** This project is especially applicable to urban neighborhoods where there is high pedestrian activity close to tracks. It will be carried out at UTRGV, a minority serving institution with an established record of training students from underrepresented groups and placing them in professional positions in the transportation industry. This project will directly employ one student, and indirectly support the employment of others. **(c) Sustainability:** The deep learning approach used here relies on low-cost sensors (video cameras) that are already widely deployed. Extensive new infrastructure is not required. **(d) Transformation:** The project will enable and facilitate future research by producing a large collection of sorted and annotated videos of grade crossing scenarios.

Outputs: The expected results and products include:

- a. Code for training and deploying deep neural networks to detect hazards at railroad crossings.
- b. Dataset of labeled images of railroad crossing hazards for further research with UTCRS participants and grade crossing research subgroup.
- c. Final report of all the above results and products.
- d. One or more conference or journal publications co-authored with students.

Outcomes/Impacts: The proposed research project has potential for addressing societal challenges by advancing scientific knowledge and fostering tangible educational improvements in safety of the U.S. rail network. **Research Activities:** The results of this project will be used to develop deep learning models to predict potential hazards at grade crossings. This will eventually help to improve and reduce the risk of accidents. **Educational Activities:** This project will help to train a diverse and skilled workforce with direct experience in rail applications of the latest generation technology.

Final Research Report: Upon completion of the project, a URL link to the final report will be provided.