

Enhanced Datasets and AI Models for Monitoring of Grade Crossings

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

Exhibit D

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): Gasser Ali (PI, UTRGV) and Constantine Tarawneh (Co-PI, UTRGV)

Project Partners: Jia Chen (Collaborator, University of California Riverside (UCR)) and Vagelis Papalexakis (Collaborator, UCR)

Research Project Funding: \$51,318 (Federal), \$25,603 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2024 to 08/31/2025

Project Description: The safety of grade crossings is a major concern of transportation agencies and researchers due to the number of accidents every year. The Federal Transit Administration (FTA) reported 592 grade crossing collisions in 2022, resulting in 19 fatalities and 133 injuries. Many innovative technologies have been proposed to automate the monitoring of crossings. The goal of this project is to investigate the use of Artificial Intelligence (AI) and Deep Learning (DL) to monitor grade crossings and detect various hazardous conditions such as vehicles, pedestrians, cyclists, animals, warning lights, and others. In prior work, the research team developed a Convolutional Neural Network (CNN) model and trained it using a dataset of 1,364 images that was collected and manually labeled by the authors, reaching a validation accuracy of 98.90% to detect vehicles at grade crossings. However, there are limitations to the model stemming from the need to improve the size and balance of the data. The work in this proposal aims to address limitations in the current model and to make new advances by (1) increasing the number of photos in the dataset using real video streams; (2) using captures from a train simulator videogame environment; (3) addressing the issue of imbalanced dataset for training and validation; and (4) hyper-optimizing the model for accuracy and real-time performance. This project relates directly to the strategic research goal of UTCRS of reducing fatalities and injuries at highway-rail grade crossings (HRGCs); and relates to the railway operation systems research area of autonomous systems for grade crossing safety. The outcomes of this research will advance knowledge in automated monitoring of hazards at grade crossings, and result in a model that can be implemented in cameras for automated hazard monitoring at grade crossings.

US DOT Priorities: The proposed work in this project is aligned with five of the six USDOT strategic goals: **(a) Safety:** The project is directly related to improving safety at crossings using AI. **(b) Economic Strength:** Improving safety at crossings will lead to better operations of rail and road networks and fewer disruptions which would ultimately support economic strength. **(c) Equity:** UTRGV is 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 graduate student and indirectly support several other undergraduate students. **(d) Sustainability:** Improving the safety of crossings will lead to improved operations of railways and roads which reduces overall energy needs. It will also reduce the risk of rail accidents that may involve environmentally harmful materials. **(e) Transformation:** The project will directly investigate the innovative use of AI for improving crossing safety. Models and data generated from this project will further support other AI-focused projects in the UTCRS.

Outputs: The expected products include:

1. Developed CNN model to detect hazards at railroad crossings.
2. A dataset of labeled images of railroad crossing hazards for further research with UTCRS partner institutions and grade crossing research subgroup.
3. One or more conference or journal publications.

Outcomes/Impacts: The primary impact of the research is providing a framework for using AI to monitor crossings and improve their safety. The research will have impacts beyond this specific goal. **Industry Impact:** The results would lead to recommendations to improve safety at crossings, and practical technologies to autonomously monitor crossings. **Educational Impact:** The UTCRS portions of the project will be carried out by two students working under the supervision of the PIs, and the project will indirectly support the development of many other students. UTRGV is a minority-serving institution. As such, the students will be from underrepresented groups and will receive invaluable training in research methodologies and developing AI models.

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