Intelligent Aerial Drones for Traversability Assessment of Railroad Tracks: Year 2

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): Nikolaos Vitzilaios (PI, University of South Carolina (USC)), Dimitris Rizos (Co-PI, USC), and Yu Qian (Co-PI, USC)

Project Partners: N/A

Research Project Funding: $43,759 (Federal), $21,209 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2024 to 05/31/2025

Project Description: Efficient railroad infrastructure monitoring and assessment is a critical issue for safe and sustainable operations. Apart from scheduled inspection and routine maintenance, there is a need for rapid assessment of the rail network after major events. For example, a storm can affect the traversability of a line (downed trees, rocks or flooding can block the line). Since it is impossible to continuously monitor the whole network before and after a major event, there is always the risk of an accident for a train crossing a blocked line, if the obstacle\damage ahead is realized too late. Current practice for the rail industry is to shut down traffic until the line has been inspected and any potential obstacles have been removed. This is, however, a process that may take a significant amount of time and imposes significant costs on top of the financial losses created by the track downtime.

In this project, we aim to develop intelligent aerial drones capable of identifying and following railway lines, while assessing the traversability and providing an early warning whenever needed. The drone system can be carried and deployed by the locomotive, with the mission to fly ahead of the train within the railway right of way for a distance that is safe to provide this early warning (2-3 miles).

The main characteristics of this system are: i) Visual based identification and autonomous following of the line; the system will be able to work even in GPS-degraded environments (tunnels, dense forests); ii) Collision avoidance capability where the drone senses and avoids obstacles; iii) Track centering capability where the drone follows the same line regardless of the number of tracks in the field of view; and iv) Identification and mapping of any obstacles identified blocking the line.

US DOT Priorities: This project aligns with the following USDOT strategic goals, as established in the USDOT Strategic Plan for FY2022-FY2026: **(a) Safety:** The drone-based traversability assessment system will make the transportation system safer for all people. The rapid assessment of track, especially after major events, will increase safety of operations and reduce serious accidents and fatalities that may be caused by obstacles on the track or damage induced by significant weather events. **(b) Economic Strength and Global Competitiveness:** This project aims to build a modern transportation system with economic strength and resilience in major events. A rapid assessment technology for targeted inspection of track will help minimize disruption and downtime of operations after a major event. This disruption may have significant economic effects considering the vast amount of rail network in the country and the financial loss accumulating over time if operations are not resumed due to delays in the inspection process. **(c) Transformation:** This project makes use of drone technology, building a system that addresses present challenges but also modernizes operations and builds the transportation system of the future. **(d) Organizational Excellence:** This project aims in providing the tools for an innovative inspection system that will improve the inspection process and strengthen rail organizational excellence.

Outputs: The overarching goal of this project is to develop an autonomous drone-based system able to track and follow railroad lines, identifying obstacles that affect the traversability. On this project (Phase/Year 2), the expected results and products include:

1. A set of AI\ML algorithms able to identify obstacles on railroad tracks.
2. Algorithms for autonomous navigation and collision avoidance for drone systems flying over railroad tracks.
3. A prototype drone system with online processing capabilities.
4. Demonstration of the drone system tracking\following a railroad line while identifying obstacles on the track.
5. One or more conference or journal publications.

Outcomes/Impacts: This project contributes to the development of modern drone-based inspection systems with these key impacts in the railroad sector: Improved Safety, Enhanced Efficiency, Timely Maintenance-Repair, Cost Savings, Enhanced Asset Management, Technological Advancements.

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