Intelligent Aerial Drones for Traversability Assessment of Railroad Tracks

Exhibit D

Research Project Requirement Template

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

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

Research Priority: Promoting Safety

Principal Investigator(s): Dr. Nikolaos Vitzilaios (PI, UofSC), Dr. Dimitris Rizos (Co-PI, UofSC),

Project Partners: N/A

Research Project Funding: $59,153 (Federal), $30,684 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2023 to 08/31/2024

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. 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 blocking the rail 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 developed 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 to provide 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. For this portion of the project (Phase 1), the expected results and products include:

a. A set of AI\ML algorithms able to identify track patterns in video images.
b. Demonstration of tracking a rail line on drone footage.
c. Demonstration of identifying obstacles on a rail line.
d. Footage from manual drone flights.
e. A list of the features that will need to be developed for the integration of the drone navigation systems, towards a fully autonomous operation.

Outcomes/Impacts: This project contributes to the development of modern drone-based inspection systems that will have the following key impacts in the railroad sector and beyond:

a. Improved Safety: By autonomously identifying obstacles on railroad tracks, drones can contribute to improving safety for trains, passengers, and railway workers. Obstacles such as fallen trees, debris, or unauthorized objects can pose serious risks if not detected promptly. Autonomous drones can provide real-time monitoring and alert railway operators about potential obstacles, enabling timely action to remove or mitigate the hazards.
b. Enhanced Efficiency: Autonomous drones equipped with obstacle detection capabilities can efficiently scan long stretches of railroad tracks and identify obstacles much faster than manual inspections. This increased efficiency enables quicker response times that minimize disruptions to train services.
c. Timely Maintenance and Repair: By detecting obstacles on railroad tracks, autonomous drones can aid in identifying areas that require maintenance or repair. Timely maintenance reduces the risk of accidents, ensures smooth train operations, and minimizes costly repairs that may arise from prolonged neglect.
d. Cost Savings: By automating the detection process, drones can perform regular inspections at scheduled intervals without requiring extensive human labor. This efficiency reduces the need for manual inspections and associated expenses, leading to potential cost savings in maintenance and workforce deployment.
e. Enhanced Asset Management: Autonomous drones can provide valuable data and insights that contribute to better asset management for rail infrastructure. By continuously monitoring and detecting obstacles, drones generate a wealth of data that can be analyzed to identify patterns, track trends, and optimize maintenance schedules. This data-driven approach enables more informed decision-making and improves resource allocation.
f. Technological Advancements: The development of autonomous drones for obstacle identification on railroad tracks fosters the advancement of obstacle detection algorithms, sensor technologies, and autonomous navigation systems. The knowledge gained from this use case can be transferred to other industries and applications, leading to broader innovations in robotics, automation, and transportation.

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