Satellite Radar Data Analysis for Change Detection of Rural and Urban Railways

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), 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. Dimitris Rizos (PI, UofSC), Dr. Michael Sutton (Co-PI, UofSC)

Project Partners: University of Nebraska-Lincoln (UNL), University of California Riverside (UCR), University of Texas Rio Grande Valley (UTRGV).

Research Project Funding: $54,542 (Federal), $27,729 (Non-Federal Cost Share)

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

Project Description: Changes in vertical and horizontal alignment of railways impact service continuity, efficacy and safety of operations and may lead to cascading failures if they go undetected. Conventional methods (e.g. GPS, surveying, dedicated inspection and measurement vehicles) are expensive, disrupt operations, do not provide network-wide monitoring and, typically do not monitor the rate of change over time and, thus, are not predictive by themselves.

We propose to implement satellite radar image processing techniques for the intelligent monitoring of railway right of way and enable the change detection at critical areas, such as bridge approaches, grade crossings, or other areas with a history of geotechnical failures along the track. A web-based application will be developed for data management and visualization. The proposed approach employs Differential Interferometric Synthetic Aperture Radar (DInSAR), Persistent Scatterer Interferometric Synthetic Aperture Radar (PS-InSAR), and Coherence Change Detection (CCD) methodologies in radar signal processing. The proposed technology applies to (1) network-wide real-time monitoring and detection, (2) on-demand real-time monitoring of high-risk areas, and (3) accident investigation. The proposed work leverages on the findings and experience gained in current studies at UofSC that developed and demonstrated the process in detecting moisture changes in the railway track and slopes and measuring small- and large-scale deformations in millimeter resolution.

US DOT Priorities: This project aligns with four USDOT strategic goals: **(a) Safety:** Deployment of such system as part of railway monitoring improves rail safety since the detection of development of track settlement and movement in a timely manner facilitates the mitigation of the hazard risk. **(b) Economic Strength:** Service disruptions due to compromised track cause serious economic impact and loss of confidence in service reliability. Preventing track caused derailments minimizes the cost of derailments, especially when hazmat is involved. **(c) Sustainability:** The detection of factors that lead to track settlement and failures along the right of way enables predictive action for hazard mitigation, extending the life of track and structures. **(d) Transformation:** The ability to integrate data produced by our technology with information acquired by other track sensing technologies provides both comprehensive understanding and also detailed records of the state of the track over time based on more consistent, accurate, and useful information than that provided by any individual data source.

Outputs: The expected products will include:

a. The procedure for processing satellite radar images for active and/or historic monitoring of track movement over time.
b. The procedure for track change detection.
c. A prototype web-based application for data and results repository, as well as browsing and querying of data and results.
d. One or more conference or journal publications.

Outcomes/Impacts: The products of the proposed work apply to: (1) network-wide real-time monitoring and detection, (2) on-demand real-time monitoring of high-risk areas, and (3) accident investigation to identify possible contributing track condition changes. Deployment of such system as part of railway monitoring improves rail safety since the detection of development of track settlement and movement in a timely manner facilitates the mitigation of the hazard risk. In addition, the ability to integrate data produced by our technology with information acquired by other track sensing technologies provides both comprehensive understanding and detailed records of the state of the track over time based on more consistent, accurate, and useful information than that provided by any individual data source.

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