

Research Project Name: Advanced 3-D Technologies for Enhancing Traffic Operations and Safety on Rural Roadways
Recipient/Grant (Contract) Number: 69A3552348321
Center Name: Rural Safe Efficient Advanced Transportation (R-SEAT) Center
Research Priority: Improving Mobility of People and Goods/Promoting Safety & Preserving the Existing Transportation System
Principal Investigator(s): Eren Erman Ozguven, Ren Moses
Project Partners: TBD
Research Project Funding: \$91,500 (Federal request); \$46,267 (Non-Federal cost share)
Project Start and End Date: 02/02/2026 to 02/01/2027
Project Description: Over the past decade, USDOT and state DOTs have invested heavily in advancing roadway safety and operations through data-driven research, traditional GIS methods, and artificial intelligence-based methods. These efforts have led to meaningful insights into identifying crash hotspots zones and infrastructure vulnerabilities, improving existing data sets and capabilities, and developing policy recommendations, particularly in rural and hazard-prone areas. However, as the landscape of geospatial technology evolves, so too must our approaches. Tried and proven 3-D technologies — from UAV-based photogrammetry and LiDAR to neural rendering models like Neural Radiance Fields (NeRFs) and 3-D Gaussian splatting — now offer an unprecedented opportunity to elevate the practice and research from flat and map-based assessments to immersive and data-rich spatial intelligence systems. With the integration of these tools, DOTs can reconstruct, analyze, and simulate rural transportation networks in full three-dimensional fidelity, opening the door to proactive, predictive, and deeply contextualized safety interventions. As such, building on the existing foundation, this proposal aims to formally inaugurate 3-D geospatial technologies into the traffic safety framework — setting a new benchmark for traffic operations and safety with a specific focus on spatial analysis, disaster preparedness, and real-world impact. To operationalize the proposed vision, this research is structured around a set of interrelated objectives that collectively transform how traffic operations and safety could be measured, modelled, and managed — particularly in rural and hazard-prone areas. These objectives are: 1) perform 3-D roadway geometry analysis and visibility assessment based on the application of artificial intelligence techniques on 3-D data, 2) simulate real-world driving scenarios using 3-d rendering, and 3) evaluate the impact of flora cover on roadway safety and augment the framework with additional geospatial data sets as needed. Each objective builds upon the next, beginning with data acquisition and moving through semantic analysis, scenario simulation, and long-term infrastructure monitoring.
US DOT Priorities*:
Outputs: The following outputs are expected: <ul style="list-style-type: none"> Dense point cloud and mesh models for selected roadway segments that present the greatest safety concerns (e.g., rural intersections, sharp curves, school bus stops, and work zones). These datasets, delivered in standard open formats (LAS/LAZ, OBJ, or E57), will complement USGS 3DEP outputs by filling spatial and temporal gaps in accident-prone or rapidly changing areas.

- A web-based 3-D map demonstrating driver line-of-sight in accident-prone rural areas.
- Scenario-based analysis at critical locations such as school bus stops, work zones, and curves.
- Photorealistic rural roadway simulations (built with Neural Radiance Fields and Gaussian Splatting).
- Integration with driving simulators to support CMV driver training and awareness.
- A WebGIS application highlighting hazardous trees and branches identified for selective pruning.
- Provides agencies with actionable insights for targeted roadway management, balancing safety with resilience.

Outcomes/Impacts: The proposed project is expected to have a positive impact for different cities and communities and their transportation data inventory and plans. Incorporating local transportation agencies, both urban and rural, the PIs will engage public and private input gathering for this project. The PIs plan to broadly disseminate the findings from this project to researchers, and practitioners at national, state-wide, and local conferences and gatherings (e.g., TRB annual meeting). The PIs will also present the project results at any other public meetings, workshops, and seminars, as needed, as part of the REAT outreach and technology transfer activities. The outcomes of the project will also be published in reputable journals.

This project will provide new knowledge and database for decision support and assistance to traffic operations focusing on the safety, accessibility, resilience, with a specific focus on rural populations, and extreme events such as hurricanes. The research team will strive to ensure practicality and implementability of all recommended strategies and solutions by focusing on real-world scenarios. The research team will interact with state and local transportation and emergency management agencies to help ensure implementability of the proposed work. The audience for this research will be federal and state agencies, municipality, county and city agencies, private transportation companies, and other related entities, as well as academics.

Final Research Report: N/A

** Section left blank until USDOT's new priorities and RD&T strategic goals are available in Spring 2026.*