Research Project Name: Investigating Driving Behavior in Rural Areas During Extreme Weather Conditions through Integrated Driving Simulators and Virtual Reality

Recipient/Grant (Contract) Number: Florida A&M University; Florida State University

Center Name: Rural Safe Efficient Advanced Transportation (R-SEAT) Center

Research Priority: Preserving the Existing Transportation System

Principal Investigator(s): Qianwen Guo, Eren Erman Ozguven, Ren Moses

Project Partners:

Research Project Funding: $73,866 (Federal request); $36,933 (Non-Federal cost share)

Project Start and End Date: June 1, 2024 – May 31, 2025

Project Description:

This project addresses the impact of extreme weather on rural driving safety, focusing on the unique challenges posed by rural roads, such as narrow paths, limited visibility, and poor maintenance. Rural areas often experience severe weather effects, including snow and flooding, which influence driving behavior differently than urban settings. Existing field-based studies on adverse weather and driving behavior face limitations due to the unpredictable nature of weather and driver responses.

To fill this research gap, the project proposes the development of the Immersive Reality Roadscapes Virtual Simulation (IRR-ViS), which will use integrated driving simulators and virtual reality to study driver behavior during extreme weather on rural roads. The research has three objectives:

- Examine how drivers adjust speed and change lanes in rural environments.
- Analyze the factors influencing speed, lane changes, and time-to-collision (TTC).
- Evaluate driver comprehension and responses under adverse weather conditions.

This research is expected to contribute significantly to improving traffic emergency management and optimizing resource allocation during crises, ultimately enhancing rural road and traffic safety in the face of future extreme weather events.

US DOT Priorities: The use of the proposed advanced technologies is critical as outlined in the USDOT RD&T Strategic Plan 2022-2026. The project directly supports the USDOT's goal of reducing roadway fatalities and serious injuries by addressing driver behavior and safety challenges in extreme weather conditions, particularly on rural roads. It contributes to the USDOT's vision of a safer, more efficient transportation system by advancing transformative technologies and responding to the growing challenges posed by climate change.

Outputs: The output of this research includes immersive driving experiments using a simulator to analyze driver behavior in extreme weather. The insights gained will support the development of improved safety measures, driver training programs, and highway design strategies for rural roads during adverse weather conditions, ultimately promoting safer driving experiences.

This research aims to make a significant contribution to traffic safety on rural highways. By analyzing driver behavior in challenging weather scenarios, it will inform the creation of targeted training programs to better prepare drivers. In addition, the findings will guide enhancements to

rural highway infrastructure to reduce accident risks. The research will contribute to a safer and more efficient transportation system by reducing crashes, injuries, and associated costs. Aligned with the USDOT Strategic Plan, the study supports ongoing efforts to improve roadway safety and transportation outcomes nationwide.

Outcomes/Impacts: The research will provide detailed insights into how drivers adjust their behavior—such as speed, lane changes, braking, and steering—on rural roads during adverse weather conditions. It will also examine how Advanced Driver Assistance Systems (ADAS) influence driving decisions in these scenarios. The findings will be used to support the development of strategies aimed at improving rural road safety, reducing crash risks, and enhancing the effectiveness of driver support technologies in challenging driving environments. One paper will be submitted for presentation at 2026 TRB. The other paper is under the journal review.

- Udekwe, D., Guo, Q., Ozguven, E. E., Moses, R., (2025). Driver Behavior in Rural Environments: Insights from Naturalistic Driving Data and Controlled Simulations. Preparation for TRB 2026.
- Udekwe, D., Guo, Q., Ozguven, E. E., Moses, R., (2025). Safety Analysis on Rural Two-Lane Highways: Exploring the Impact of Geometric Design, Vehicle Speed, and Crash Trends. Accident Analysis & Prevention. Under Review.

Final Research Report: N/A