Research Project Name: A Diffusion Model for Generating Safety-Critical Rural Driving Video Data
Recipient/Grant (Contract) Number: Florida A&M University; Stony Brook University
Center Name: Rural Safe Efficient Advanced Transportation (R-SEAT) Center
Research Priority: Improving Mobility of People and Goods
Principal Investigator(s): Ruwen Qin
Project Partners: -
Research Project Funding: $97,569 (Federal request); $50,000 (Non-Federal cost share)
Project Start and End Date: 6/1/2024 to 12/31/2025
Project Description: In the United States, about 20% of the population lives in rural areas that collectively cover 97% of the land. Because of the low population density, automobiles, including cars, SUVs, pickup trucks, and rental vehicles, remain the dominant mode of transportation in these areas. The traffic fatality rate, measured as deaths per 100 million vehicle miles traveled (VMT), is approximately 50% higher than in urban areas. Moreover, rural communities have a higher proportion of individuals who face challenges in driving, such as older adults and people with functional disabilities. Automated driving technologies offer a promising solution to enhance safety, mobility, and access to opportunities and resources for rural residents, particularly benefiting those who rely heavily on vehicles but cannot drive safely. Although automated driving technologies have achieved significant advancements and market penetration, they remain biased toward urban environments, partly due to insufficient training and testing data from rural areas. This project aims to address this data disparity by exploring the use of generative artificial intelligence (AI) for cost-effective video data generation, particularly in rural driving contexts. Specifically, this project will explore the capabilities of diffusion-based generative models to address the challenges of generating realistic rural driving videos. The project will focus on two key directions. The first is to model motion priors through temporal-aware latent conditioning and motion-aware encoding to enhance the quality and consistency of the generated video data. The second is to develop a computationally efficient framework for multimodal video generation. The proposed diffusion model will be implemented and demonstrated through applications such as crash anticipation. A comprehensive evaluation framework will also be established to assess both the realism of generated rural driving videos and their effectiveness in improving downstream model performance. By contributing a motion-aware diffusion model for driving video generation, this project will extend automated driving research to broader and more diverse scenarios, enhancing the safety, reliability, and resilience of intelligent driving systems under widely distributed rural conditions.
US DOT Priorities: This project aligns with the USDOT's strategic areas of Safety and Transformation
Outputs: A new deep learning model for driving video generation, enabling self-driving technologies to adapt effectively for rural conditions.

Outcomes/Impacts: The new model generates synthetic data to help extend self-driving technologies to widely distributed rural areas, ensuring that advanced driver assistance systems (ADASs) and automated driving systems (ADSs) equally beneficial and safe for rural residents.
Final Research Report: N/A