



AI-Powered Tools for Safe Evacuation of Individuals During Emergencies

CTIPS-030 – UTC Project Information

Recipient/Grant Number:	North Dakota State University, Utah State University Grant No. 69A3552348308
Center Name:	Center for Transformative Infrastructure Preservation and Sustainability
Research Priority:	Preserving the Existing Transportation System
Principal Investigator(s):	Patrick A. Singleton, Ph.D.
Project Partners:	USDOT, Office of the Assistant Secretary for Research and Technology – \$89,136.39 Utah LTAP – \$89,137.00
Total Project Cost:	\$178,273.39
Project Start and End Date:	9/15/2024 to 9/14/2026

Project Description

Emergency evacuation via transportation systems and infrastructure is a critical component of public safety, particularly in scenarios involving fires, transportation incidents, wildfires, and tsunamis. Studies have demonstrated the potential of artificial intelligence (AI) and machine learning to enhance evacuation efficiency. The first research need is to investigate and create personalized evacuation plans that consider various factors such as mobility limitations, communication needs, and access to resources. The second research need is to explore methods for integrating real-time data from IoT (internet of things) devices into AI-powered evacuation tools. First, we will assemble comprehensive datasets from multiple sources, focusing on evacuation scenarios involving fires, transportation incidents, wildfires, and tsunamis. Second, we will employ a range of advanced analytical methods to synthesize and analyze the collected data, ensuring the development of effective AI-powered evacuation tools. This research is expected to yield significant advancements in the modeling, practices, and procedures for emergency evacuations, particularly for vulnerable populations.

USDOT Priorities

The proposed project aligns closely with several CTIPS and USDOT strategic goals. Primarily, it addresses the CTIPS statutory research priority area of preserving the existing transportation system by developing advanced AI-powered tools that enhance emergency evacuation procedures, thereby maintaining the safety and functionality of transportation infrastructure during critical incidents. This

contributes to the USDOT's primary strategic goal of Economic Strength and Global Competitiveness by ensuring that transportation systems remain reliable and efficient, even in emergencies, thus supporting economic stability and resilience. The project also aligns with the CTIPS secondary strategic goal of Equity and Transformation by focusing on the needs of vulnerable populations, ensuring that emergency responses are inclusive and equitable. Furthermore, the research supports USDOT's strategic goals of Safety, by improving evacuation efficiency and reducing risks during emergencies; Climate and Sustainability, by optimizing evacuation routes to minimize environmental impacts; and Transformation, by integrating cutting-edge AI and IoT technologies into emergency management practices. By advancing these strategic goals, the project will contribute to the overall excellence and modernization of the transportation system, ensuring it is robust, inclusive, and prepared for future challenges.

Outputs

The findings of this research project will be disseminated to other researchers, professionals, and practitioners in several ways. We will share results with the research and professional community through presentations at local, national, and international conferences such as meetings of the Utah Department of Transportation, the Institute of Transportation Engineers, and the Transportation Research Board. In addition to the project report, we plan to prepare two manuscripts and submit them for publication in transportation and emergency management journals. The final report will be sent to transportation staff at state and local transportation and emergency management agencies and posted online. We will also provide a CTIPS webinar based on our project's results. Data management and analysis scripts will be shared with the research community on PI Singleton's (<https://github.com/singletonpa>) or PhD student Rafe's (<https://github.com/pozapas/>) GitHub pages. Furthermore, the fine-tuned large language model (LLM) for crowd evacuation will be published on Hugging Face, making it accessible to other researchers and practitioners for further development and application.

Outcomes/Impacts

This research is expected to yield significant advancements in the modeling, practices, and procedures for emergency evacuations, particularly for vulnerable populations. We anticipate creating a robust framework that improves evacuation efficiency and safety by developing personalized AI-driven evacuation plans and allowing for the integration of real-time data from IoT devices and other sources. These innovations will be beneficial for practitioners, providing actionable insights and optimized evacuation strategies tailored to diverse scenarios, including fires, transportation incidents, wildfires, and tsunamis. The project's outcomes will also have implications for future research, offering a foundation for further exploration into AI and IoT applications in emergency management. Tangible products resulting from this project will include prototype software for personalized evacuation planning, real-time data integration frameworks, user-friendly interfaces for emergency responders, and detailed guidebooks and instructional manuals for implementing these AI-powered tools in real-world scenarios. Additionally, the project will generate open-source data processing and analysis scripts, enhancing the research community's ability to build upon our findings and methodologies.

Final Report

Upon completion, the final report link will be added to the [project page on the CTIPS website](#).