Connected Simulation for Work Zone Safety Applications

Project 2137
July 2022

Vahid Balali

Introduction

To improve work zone safety, significant research efforts and safety management practices have been developed in the last decades. However, unacceptable injury rates continue to be a common phenomenon across the Department of Transportations (DOTs). With the predicted increase in the number of work zones to address the nation's aging infrastructure needs, work zone safety in the following years is important.

Because improvements in work zone safety have not been experienced in recent years, novel research must be conducted that can yield breakthrough results and safety innovations. Towards this goal, this research project aimed to (1) unveils high risk behavioral and environmental precursors that lead to accidents and injuries in work zones, (2) identify effective interventions to reduce high-risk behavioral patterns in work zones, and (3) use proven training methods to train drivers, highway workers, and equipment operators on safe work zones practices for injury prevention.

Study Methods

To efficiently and safely conduct this study, a connected virtual environment where multiple operators experience a unified virtual experience was developed and tested. Specifically, relevant operators including drivers, highway workers, and equipment operators operate separate simulators but were connected through a unified virtual experience. The connected environment was able to capture the interaction amongst the operators to model a more realistic active work zone and simulate standardized scenarios to capture behavioral patterns.

The research effort was conducted in three sequential phases. The first phase focused on conducting an indepth analysis of previous work zone injury reports identifying common causes of work zone crashes and injuries. Factors of interest include human errors, work zone design characteristics, environmental conditions, road alignment, vehicle types, lighting conditions, crash location, types of traffic channelizers, inattention, distraction, speed, risk-taking behavior, and others. The findings were supplemented with a thorough review of previous research and insights from an expert panel of Department of Transportation (DOT) professionals. The second phase focused on setting up the connected virtual environment to model the causal factors identified.

Findings

The contributions of the research yield both theoretical and practical advancements in several ways. First, the study unveiled the most common behavioral and environmental factors that lead to work zone crashes, accidents, and injuries. Second, the study developed the first connected virtual environment for work zone safety applications. The virtual environment provides a testbed to test the impact of behavioral patterns and environmental factors for future research efforts. In addition, unlike traditional driver simulators, the virtual environment is capable of simulating the interactions between the various operators including drivers, highway workers, and equipment operators; and examining phenomena unexplored in previous research. Third, the connected environment provides a platform to evaluate the efficacy of potential interventions to prevent work zone crashes and injuries. Finally, the connected virtual environment is capable of providing customized training experiences for individual operators based on their performance. This research contributes to reducing the disproportionate number of work zone crashes and injuries while improving work zone safety.

Policy Recommendations

This research helps transportation agencies make effective decisions in work zones setting and project delivery. Although many variables could affect the work zone traffic flow, the study results depict that the suggested model outperforms the common source of traffic prediction models.

One limitation of this study is the lack of detailed information about the work zone setup, such as the lane closure dynamics and project implementation timeline. Another limitation is the lack of traffic sensors on rural, low-volume roads. Although many sensors are installed on primary freeways, very few sensors are available on low-volume roads. Future research could focus on adding probe vehicle data to improve the model accuracy further.

About the Author

PI Vahid Balali, Ph.D., is an Assistant Professor in the Department of Civil Engineering and Construction Engineering Management at California State University Long Beach. Dr. Balali's research focuses on visual data sensing and analytics, virtual design and construction for civil infrastructure and interoperable system integration, and smart cities in transportation for sustainable decision-making.

To Learn More

For more details about the study, download the full report at **transweb.sjsu.edu/research/2137**

MTI MINETA TRANSPORTATION INSTITUTE

MTI is a University Transportation Center sponsored by the U.S. Department of Transportation's Office of the Assistant Secretary for Research and Technology and by Caltrans. The Institute is located within San José State University's Lucas Graduate School of Business.