Preventing Struck-by Hazards: Defying Risk-habituation via Virtual Accident Simulation

Developing personalized safety trainings using VR technologies

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$40,000

Approximately 80–90% of all workplace accidents are caused by workers' unsafe behaviors. Previous studies have demonstrated that an individual's risk perception greatly affects his/her unsafe behaviors at construction sites. Repeated exposure to hazards in the workplace causes bias in workers' risk perception. Even if workers properly identify hazards, they may engage in unsafe behaviors due to skewed perception and evaluation of risks. Another study indicated that repeated exposure causes workers to become accustomed to the hazards related to their tasks. While these studies indicate that risk habituation is a factor in causing unsafe behaviors, a knowledge gap still exists about which specific personal and situational factors critically influence the development process of risk habituation and how this development process can be interrupted, due to the methodological limitations of the approaches adopted in previous studies, which were uniformly retrospective and self-assessing. With recent advances in Virtual Reality (VR) technology, the creation of an interactive and effective learning environment for hands-on experience has been enabled. VR offers many benefits in occupational education and training, including precise control and presentation of complex stimuli, safe learning environments, and personalized intervention. Studies in aviation, construction, and mining show that trainees who participated in VR-based training earned better learning outcomes in safety-related knowledge than trainees using conventional instructional media.

Problem Statement

Despite its capability, research into safety training with VR is still young. Assessing past studies' performance has relied mostly on indirect measurements (e.g., trainees' perception of the approach's impact) due to the challenges in gauging behavioral outcomes. To this end, efforts to rigorously evaluate the effect of VR-based safety trainings will play a crucial role in advancing their feasible applications. The proposed project's research will use behavioral and physiological measurements of habituated behaviors to assess the impact of VR-based safety training in trainees' risk habituation, thereby giving an academic groundwork for personalized safety training that adequately stops struck-by fatalities in road construction work areas.

Objectives

The proposed project will create a VR training system that lets researchers and practitioners analyze trainees' risk habituation tendencies based on collected behavioral and physiological response data (i.e., eye tracking, vigilant behavior in a simulated environment), and offers interventions that effectively prevent risk habituation by demonstrating the negative consequences of unsafe behaviors. Past injury simulations using a synthetic hand model were effective in promoting situational interest among construction workers, so we will utilize such interventions to curb the development of risk habituation. The specific objectives to achieve this goal include:

- Objective 1: Develop an immersive VR road construction environment that notes workers' risk habituation and provides simulated struck-by accident experiences.
- Objective 2: Capture and analyze empirical data from workers' responses to simulated high-risk hazards in the virtual road construction environment.
- Objective 3: Affirm the impact of the proposed VR training system on risk habituation.
- Objective 4: Explore individual differences in risk habituation rate to provide a theoretical groundwork for personalized safety training.

Intended Implementation of Research

Education and Workforce Development: The proposed study will help both train existing workers and educate the future transportation workforce. The resulting materials will be made available to industry practitioners through the Texas A&M University-Construction Industry Advisory Council (TAMU-CIAC). The project team will demonstrate the developed VR safety training module to road construction workers working for heavy civil construction companies in Texas. This training will help workers understand their risk habituation tendencies and allow workers to understand when and how they engage in unsafe behavior on job sites. Consequently, this outreach will motivate workers to correct their behavior. Furthermore, the research team will integrate the outcomes of this research with construction safety and health management classes at the Department of Construction Science at TAMU. PI Ahn currently teaches behavior analysis for construction safety and health. In his class, the VR-based unsafe behavior analysis model being developed will be demonstrated, and students will have the opportunity to experience how VR technology helps us prevent fatal injuries at construction sites. This experience will promote knowledge of upcoming road infrastructure construction and maintenance workforce leaders, protecting current and future transportation workers and enhancing safety throughout construction work zones in Region 6.

Outreach: Through collaboration with the TAMU Construction Science Department and the Texas Career and Technical Education (TEXAS-CTE) program, this project will serve as education for disadvantaged students in Texas. Every year, the Department of Construction Science at TAMU holds a summer camp for K-12 students who are on the Architecture and Construction Career Cluster pathway. Here, the outcomes of this study will be presented, and the students will be offered the opportunity to experience VR-based safety training. It will help interest students in the importance of safety at construction worksites and increase students' own safety awareness. These outreach activities could potentially have a positive effect on students' attitude toward safety, and ultimately prevent accidents of those working on jobsites after graduation.

Anticipated Impacts/Benefits of Implementation

The main deliverables from this study are: (1) a report containing a complete description of the problem, approach, methodology, findings, and conclusions and (2) publications in journals and presentations at national conferences.

Figure 1: Road construction workers, exposed to multiple struck-by hazards

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.