

Proposal for Interdisciplinary-Collaborative Seed Grants

Project title: Enhancing Hazard Recognition and Managing Mental Workload: Assessing Soundscape Impact with Virtual Reality (VR)

PI: Charlie Zhang, Associate Professor, Department of Civil, Architectural Engineering and Construction Management

Co-PI: (1) Chen Xu, Associate Professor, School of Computing, (2) Jian Gong, Research Scientist, School of Computing

The total amount requested: \$25,000

Description of the research problem:

The construction industry, notorious for its hazardous work environments, demands continuous improvements to mitigate workplace accidents and fatalities. In response, research endeavors have increasingly turned to virtual reality (VR) as a tool to replicate onsite conditions, enabling workers to acclimate to real-world construction scenarios and prevent mishaps. However, a critical aspect often overlooked in these studies is the role of the soundscape within these simulated environments. The soundscape refers to the auditory environment within a construction site. It encompasses various sounds, such as machinery noise, tool operation, communication among workers, and ambient sounds. Despite its potential impact, the soundscape remains inadequately explored in existing research. Understanding how it influences workers' safety and well-being is crucial for enhancing workplace practices.

Current limitations:

1. Existing VR training programs for construction safety often lack the inclusion of a realistic soundscape, potentially limiting their effectiveness in preparing workers for real-world scenarios.
2. Research on the influence of soundscapes on hazard recognition and mental workload in construction environments remains limited.

Knowledge gap:

A comprehensive understanding of how soundscapes impact workers' ability to identify hazards and manage their cognitive load is crucial for developing more effective VR training programs and improving safety outcomes in the construction industry.

Research Questions:

1. How does the soundscape influence workers' hazard recognition rate?

We will examine whether specific sounds enhance or hinder workers' ability to recognize potential hazards. For instance, does the sound of heavy machinery mask warning signals, affecting their situational awareness?

2. What impact does the soundscape have on workers' mental workload?

We will explore how the auditory environment affects cognitive load. Are certain sounds distracting, leading to increased stress and reduced concentration? Conversely, can a well-designed soundscape improve focus and overall mental well-being?

Significance and Benefits of the Study:

1. Enhancing Workplace Safety

Understanding how soundscapes influence workers' hazard recognition rates is pivotal. Accurate hazard identification is the cornerstone of workplace safety. Optimizing Alertness and Awareness: Armed with improved knowledge, we can design sound environments that enhance workers' alertness and situational awareness. This optimization can directly contribute to reducing accidents and enhancing overall workplace safety.

2. Advancing Occupational Health Psychology

Our study explores how different elements of the soundscape affect workers' mental workload. By identifying stressors and cognitive challenges, we can tailor interventions to minimize stress and fatigue. Mitigating stress not only benefits individual health but also positively impacts productivity and job satisfaction. A mentally well-supported workforce is more efficient and engaged.

Why choose us:

1. State-of-the-Art Sound Lab: The development of the sound lab within the School of Computing is a significant asset. Leveraging this facility allows us to create controlled soundscapes, manipulate auditory conditions, and conduct experiments without the need for external instruments.
2. Expert in the field: Charlie Zhang's understanding of construction processes will guide data collection. Observe workers' reactions to different sounds, hazard recognition rates, and mental workload. Chen Xu, the sound lab creator, ensures that the lab's capabilities align with research objectives. His expertise in designing and maintaining the lab infrastructure will be instrumental. Jian Gong's expertise will be crucial in creating realistic and immersive auditory environments within the VR simulations.

Short-term objectives (1 yr.):

Utilize and enhance the sound lab, design an experiment, collect initial data, Draft and submit a paper, and draft a proposal to the NSF.

List of potential future partners:

Dr. Francois Jacobs and the Associate General Contractors of Wyoming (AGC) for Enhanced Construction Workforce Development. This collaboration bridges academia and industry, fostering innovation and improving construction workforce practices worldwide.

List of funding sources and programs:

National Institute for Occupational Safety and Health (NIOSH)

National Science Foundation (NSF)

Department of Labor (DOL)

Construction Industry Institute (CII)

Department of Workforce Development

Budget Justification

Total Budget: \$25,000

Staff Salary	
1. Jian Gong, 2. Jian Gong Fringe 50.9%	\$2,500 \$1,273
Student Support	
1. Soc Master's Student Stipend (including fringe) 2. CAECM Master's student 1 semester support ((including tuition, stipend, fee, and fringe)	\$4,000 \$11,585
Equipment	
3. 3 Portal Recording Devices. \$1,214 each. 4. FLEX 2 Saline - 32 Channel Wireless EEG Head Cap System	\$3,643 \$1,999
Total:	\$25,000