ABSTRACT

[Title] Ubiquitous Human Sensing Network for Construction Hazard Identification using Wearable EEG

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Hazard identification is one of the most significant components in safety management at construction jobsites to prevent undesired fatalities and injuries of construction workers. The current practice, which relies on a limited number of safety managers' manual and subjective inspections, and existing research efforts analyzing workers' physical and physiological signals have achieved limited success, leaving many hazards unidentified at the jobsites. Motivated by this critical need, this research aims to develop a human sensing network that allows for ubiquitous hazard identification in the construction workplace.

To attain this overarching goal, this research analyzes construction workers' collective EEG signals collected from wearable EEG sensors based on machine learning, virtual reality (VR), and advanced signal processing techniques. Three specific research objectives are: (1) establishing a relationship between EEG signals and the existence of construction hazards, (2) identifying correlations between EEG signals/physiological states (e.g., emotion) and different hazard types, and (3) developing an integrated platform for real-time construction hazard mapping and comparing the results developed based on VR and real-world experimental settings.

Specifically, the first objective establishes the relationship by investigating the feasibility of identifying construction hazards using a binary EEG classifier developed in VR, which can capture EEG signals associated with perceived hazards. In the second objective, correlations are discovered by testing the feasibility of differentiating construction hazard types based on a multi-class classifier constructed in VR. In the first and second objectives, the complex relationships are also analyzed in terms of brain dynamics and EEG signal components. In the third objective, the platform is developed by fusing EEG signals with heterogeneous data (e.g., location), and the discrepancies in VR and real-world environments are quantitatively assessed in terms of hazard identification performance and human behavioral responses.

The primary outcome of this research is that the proposed approach can be applied to actual construction jobsites and used to detect all potential hazards, which was challenging to be achieved based on the current practice and existing research efforts. Also, the human cognitive mechanisms revealed in this research discover new neurocognitive knowledge in construction workers' hazard perception. As a result, this research contributes to enhancing current hazard identification capability and improving construction workers' safety and health.