Improving Construction Workers' Auditory Awareness of Moving Equipment

Intelligent Hearing Protection for Construction Workers Exposed to Hazardous Noise

Tuyen Le, Kehinde Elelu. CPWR Small Study, 2022.

Overview

Struck-by vehicle incidents are a leading cause of fatalities on construction job sites. Previous studies have found that in noisy environments, workers lose the ability to pick out sounds of potential hazards, and this loss of auditory situational awareness can be a critical factor in deadly collisions involving heavy mobile equipment. Although the range of equipment on a job site—including static equipment and hand tools—produces a complicated mix of sounds, advanced computational techniques for auditory signal processing have the potential to improve safety. This study aimed to increase auditory awareness of workers exposed to loud noise with a new hearing protection technology that uses artificial intelligence to both amplify safety-critical sounds and greatly attenuate ambient noise. The researchers proceeded in three phases: (a) collecting audio data of construction equipment, (b) developing a machine learning model for automated detection of collision hazards to be integrated into intelligent hearing protection devices, and (c) conducting field experiments to investigate the system's efficiency and latency.

Key Findings

- An advanced hearing protection prototype that includes a conventional ear muffs connected to an Android mobile device was developed and tested in real-world situations on a job site. The mobile device detects sounds of collision hazards and sends alerts to the worker through the auxiliary jack on the ear muffs.
- The device's detection accuracy remained high in loud-noise situations when the signal-to-noise ratio remains above 10db.
- The machine learning models trained with a Convolutional Neural Network (CNN) yielded reliable collision hazard predictions, with an accuracy of 88% in detecting sounds related to collision hazards when the sounds are not overlapped with the background noises from other stationary equipment.
- Future research needs to examine how to enable the device to capture the location—particularly direction and distance—of the potential hazard. For example, a vehicle moving toward a worker is a risk, but not moving away.
- It will also be important to expand the types of background noises—such as natural sounds (e.g., wind, rain) and transportation (e.g., car engine, horn)—in the device's dataset.

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 Production of this document was supported by cooperative agreement OH 009762 from the National Institute for Occupational Safety and Health (NIOSH). The contents are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH.

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