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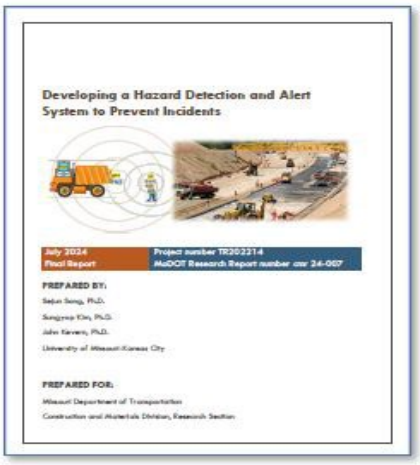
Research Summary

Developing a Hazard Detection and Alert System to Prevent Incidents



The Missouri Department of Transportation (MoDOT) has required contractors to develop a reliable hazard detection and alert system proposal to "connect" heavy fleet vehicles to the workers outside the vehicle.

In this study, the project team aimed to develop a cost-effective, user-friendly, adaptable, accurate, and reliable bi-directional warning system that leveraged advanced Bluetooth-based device-to-device direct communication (beacon) technologies tailored for work zones. This system incorporated a lightweight wearable proximity sensor, a beacon communication handler, and auditory and tactile warning capabilities for work zone personnel. Simultaneously, an in-vehicle portable detection system featuring a beacon communication handler and an application for visualizing hazard prediction maps was provided for vehicle drivers and operators. Additionally, the design incorporated the deployment of Vehicle Proxy Tags (VPTs) on the rear end of vehicles to address limitations related to direct signal advertising and scanning between ground workers and equipment operators. Furthermore, the project included on-site assessments designed to evaluate the practical effectiveness of the hazard detection and alert system.

Ground workers are often fully engaged in their tasks and need help to maintain constant vigilance regarding the movement of vehicles within work zones. Similarly, the drivers of heavy fleet vehicles may find their awareness compromised due to various physical and cognitive impediments. This is particularly concerning when ground workers are situated outside their line of sight, such as within blind spots or obscured by barriers, introducing a heightened potential for incidents. Even when drivers can visually identify ground workers and attempt to alert them through conventional auditory or visual alarms, the efficacy of these warnings can be undermined by factors like ambient noise or inattention. Any miscalculation in these situations can have severe and, at times, fatal consequences.

"An economically viable, user-friendly, versatile, precise, and dependable hazard detection and alert system … The developed system had limitations associated with environmental and natural factors."

Work zones often create traffic conditions and road environments that are predisposed to incidents despite the presence of regulatory measures and various safety protocols. In the United States, work zone-related fatalities have persisted as a significant highway safety concern. Between 1982 and 2020, a total of 29,410

individuals, including both road users and workers, lost their lives within work zones, averaging approximately 774 fatalities per year. While work zone crashes are often categorized as a subcategory of traffic incidents, they exhibit considerable heterogeneity in location, contributing factors, and crash characteristics.

Ground workers are exposed to substantial risks, including the danger of being struck by passing vehicles and heavy machinery entering and exiting the work zones. However, rear-end collisions are the most prevalent incident within the workspace designated for construction activities, where ground workers and equipment are present. National work zone safety statistics reveal that workspace incidents are frequently linked to the backing of mobile equipment. Therefore, a comprehensive understanding of these backing incidents within the workspace and safeguarding workers on foot are pivotal for enhancing work zone safety. This project initiated a comprehensive review of existing commercial alert systems.

It was determined the developed system had limitations associated with environmental and natural factors. The project concludes that BLE beacon technology is unsuitable for developing a safety detection and alert system for work zones.

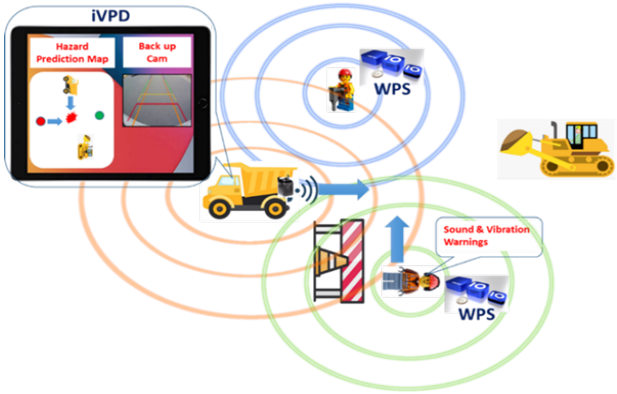


Figure 1: Proposed Proximity Detection and Warning System

Project Information

PROJECT NAME: TR202214—Developing a Hazard Detection and Alert System to Prevent Incidents

PROJECT START/END DATE: March 2022-January 2024

PROJECT COST: $200,000

LEAD CONTRACTOR: University of Missouri – Kansas City

PRINCIPAL INVESTIGATOR: Sejun Song

REPORT NAME: Developing a Hazard Detection and Alert System to Prevent Incidents

REPORT NUMBER: cmr 24-007

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Project Manager

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