

AlertBLE: Alert Workzone Hazards Using AI Enabled BLE

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Collision hazard detection in dynamic outdoor environments—such as construction and mining work zones—remains a critical challenge due to unstable signal conditions, mobility-induced fluctuations, and frequent non-line-of-sight (NLOS) scenarios. While camera-based visual detection is widely used, its performance degrades in dusty or obstructed conditions. Similarly, high-precision localization methods like Ultra-Wideband (UWB) and GPS are often cost-prohibitive and lack scalability.

Bluetooth Low Energy (BLE) offers a cost-effective and widely available alternative, but its Received Signal Strength Indicator (RSSI) is highly variable and sensitive to multipath effects and environmental changes, limiting its real-time reliability.

This paper presents AlertBLE, a hybrid BLE-based localization and hazard detection system designed to enhance work zone safety alert mechanisms. AlertBLE combines an Extended Kalman Filter (EKF) and an Adaptive Moving Average (AMA) algorithm to dynamically stabilize RSSI signals by accounting for LOS/NLOS variations.

Additionally, machine learning (ML) classifiers—K-Nearest Neighbors (KNN) and Support Vector Machines (SVM)—are employed to improve hazard detection accuracy under mobility-induced signal dynamics. The system includes wearable proximity sensors for personnel and portable vehicle-mounted detection units, enabling continuous monitoring and immediate alerts during vehicle movement or reversing. Extensive field evaluations in realistic outdoor environments demonstrate that AlertBLE effectively detects hazards, enhances situational awareness, and significantly reduces collision risks in work zones.