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Predictive Bomb Blast Threat Detection Using AI and Sensor Fusion for Military Convoy Safety

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Abstract: *Roadside bombs, coordinated blast attacks, and improvised explosive devices (IEDs) pose a constant and changing threat to military ground convoys operating in hostile and asymmetric warfare environments. Convoy protection strategies are still mostly reactive, with little capacity for early threat anticipation and proactive risk mitigation, despite advancements in blast mitigation technologies and armored vehicle design. A paradigm shift toward predictive and intelligent threat detection frameworks is required due to the growing sophistication of adversarial tactics, operational limitations, and environmental complexity. With an emphasis on artificial intelligence (AI), multi-sensor fusion, and cyber-physical system (CPS) architectures, this article provides an extensive review of predictive bomb blast threat detection systems for military convoy safety. The evolution of single-sensor-based detection methods, developments in multi-sensor fusion techniques, and the function of deep learning and machine learning in automated threat analysis are all methodically examined in this review. Predictive blast risk assessment models that combine heterogeneous sensor data with convoy dynamics—such as vehicle speed, formation, spacing, route topology, and terrain characteristics are given special attention.Critical analysis is done on explainability requirements, false alarm mitigation, real time constraints, and operational performance metrics. Important research gaps concerning scalability, robustness, adversarial resilience, and similarly system/level integration is also identified in the paper through the review provided in the paper. There is a detailed discussion on emerging trends in the form of new areas of research in digital twin-based validation, explanation of AI methods, unmanned system integration studies, reinforcement learning methods. Researchers in the arena of designing next generation proactive and intelligent convoy systems will find this paper a Reference.*

Keywords: Artificial intelligence, deep learning, cyber physical systems, military convoy safety, explainable AI, sensor fusion, predictive blast risk assessment, and improved explosive device detection

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