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AI-Driven Visual Intelligence and Safety Analytics for Industrial Operations

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ABSTRACT

Modern industrial operations generate high volumes of heterogeneous visual and sensor data from inspection systems, surveillance infrastructure, and autonomous platforms. However, most safety monitoring architectures remain fragmented, relying on manual interpretation, rule-based alarms, and delayed post-event analysis. This creates a critical gap between data availability and actionable safety intelligence in high-risk environments.

This work introduces an AI-driven visual intelligence and safety analytics framework designed to transform continuous industrial data streams into structured hazard intelligence. The system is built on computer vision–based perception models integrated with real-time analytics pipelines to detect, classify, and prioritize operational risks across dynamic industrial settings.

At the core of the architecture is a deep learning–based visual analytics engine that performs multi-dimensional feature extraction from live video and imaging streams. The system identifies safety-critical events such as spatial violations, equipment abnormality signatures, process deviations, and human–machine interaction risks. These detections are not treated as isolated events but are aggregated into temporal risk profiles using sequence modeling and anomaly scoring techniques.

The analytics layer incorporates event correlation and contextual inference mechanisms that combine spatial localization, object-state transitions, and environmental conditions to improve detection reliability in complex industrial scenarios. This enables reduction of false positives and supports higher-order reasoning for hazard prioritization.

A key component of the framework is edge-deployed AI inference, enabling low-latency processing directly at the data source. This minimizes dependency on centralized infrastructure and supports continuous monitoring in bandwidth-constrained or safety-critical environments. The system architecture is designed for scalability across distributed industrial assets, allowing unified safety intelligence across multiple sites.

The proposed approach shifts industrial safety monitoring from reactive event detection to continuous safety intelligence generation. By structuring raw visual data into analysable risk signals, the framework enables predictive safety assessment, operational pattern recognition, and early hazard escalation.

This AI analytics-driven model demonstrates how computer vision systems, when integrated with industrial safety logic, can evolve from passive monitoring tools into active safety intelligence systems capable of supporting major hazard management in complex industrial ecosystems.

KEYWORDS

Industrial Safety, Computer Vision, Safety Analytics, Hazard Detection, Edge Computing, Risk Intelligence

BIOGRAPHY (Presenting Author)

Kalaikovan Antony is the Co-Founder and Chief Technology Officer of MiBOT Ventures, with over 26 years of experience in the IT sector across India and Malaysia. He has led large-scale digital transformation and modernization programs in industrial and enterprise systems, including projects for Serba Dinamik Group, BASF Petronas Chemicals, XYBase Software, and Sydney Airport International. Beginning his career as a programmer, he progressed into leadership roles in artificial intelligence, robotics, and autonomous systems. He leads the development of AI-powered robotic solutions for industrial safety, operational efficiency, and risk reduction.

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