Protecto: PPE Detection System Using YOLOv3 and DeepSORT

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Abstract

This project presents Protecto, an intelligent real-time Personal Protective Equipment (PPE) detection and violation alert system designed for manufacturing environments. Utilizing the power of YOLOv3 for object detection and DeepSORT for object tracking, the system monitors CCTV feeds to ensure worker compliance with safety protocols. Our contribution enhances workplace safety by introducing automated detection, real-time alerts, and efficient use of existing infrastructure. The project further explores threshold-based alert generation and potential future integrations like web-based dashboards and notification systems.

Introduction

Workplace safety in manufacturing industries is highly dependent on consistent use of Personal Protective Equipment (PPE) such as helmets, harnesses, and goggles. Manual supervision, however, often falls short, leading to avoidable accidents. With advancements in computer vision, automated PPE compliance systems offer a scalable and efficient solution.

Our system, Protecto, leverages deep learning models to detect PPE violations in real time using live CCTV feeds. While previous research has focused on general object detection or worker tracking, our approach specifically targets PPE compliance using an integrated pipeline of detection, tracking, and alerting. The goal is to provide a cost-effective, deployable solution that integrates seamlessly with existing infrastructure.

Methodology

- • CCTV Feed Integration: Live video streams from existing CCTV infrastructure are ingested using OpenCV, eliminating the need for additional camera installations.
- • Frame Extraction and Preprocessing: Video frames are extracted in real-time, resized, and normalized to match the input requirements of YOLOv3. Basic enhancements like contrast adjustment are applied for improved clarity.
- • Object Detection using YOLOv3: YOLOv3 identifies workers and classifies whether they are wearing required PPE such as helmets, gloves, or vests.
- • Labeling PPE Compliance: Detected individuals are categorized as either PPE-compliant or non-compliant based on the presence or absence of safety gear.
- • Unique ID Assignment via DeepSORT: DeepSORT assigns persistent IDs to each detected individual, ensuring continuous tracking across frames.

- • Time-Based Violation Monitoring: A time counter is associated with each individual. If the person remains non-compliant for more than a predefined threshold, the system considers it a violation.
- • Violation Logging and Alert Generation: Violations are logged with timestamps, and alerts are triggered—either as console logs, popup notifications, or optional web-based messages.
- • Modular Alert System: A lightweight Flask server can be integrated to send real-time alerts to supervisors via browser dashboard, SMS, or email notifications.
- • Performance Optimization: The pipeline is optimized for performance using multi-threading and GPU acceleration.
- • Scalability and Adaptability: The system is designed to work with various camera angles and environments and can be scaled across multiple factory zones.

Results and Future Work

Initial tests on industrial CCTV footage demonstrate promising results, with high detection accuracy and minimal false positives. The system reliably flags violations and successfully tracks individuals even in moderately cluttered scenes. Performance varies based on lighting conditions and camera angles, highlighting areas for improvement.

Future enhancements include:
• Notification System: Integration with real-time alert channels like SMS, email, or app-based notifications.
• Custom Training: Fine-tuning detection models on industry-specific datasets for improved accuracy.
• Dashboard Development: A web-based interface to visualize PPE compliance trends, logs, and real-time video analytics.
• Edge Deployment: Optimizing the system for edge devices (e.g., Nvidia Jetson) for on-site processing.

References

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