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Weapon Detection Using Deep Learning: A Systematic Review

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ABSTRACT
Weapon detection is a time-critical vision task spanning public-space CCTV, body-worn cameras, and UAVs. This work presents a systematic review of deep learning approaches across visible-spectrum modalities, covering model families, datasets, evaluation protocols, and deployment constraints. We find that YOLO-family one-stage detectors dominate visible-spectrum applications by offering the best accuracy–latency trade-off for real-time inference, while X-ray research leverages large public benchmarks (e.g., SIXRay, OPIXray, PIDray) and increasingly adopts attention and anchor-free designs to handle clutter, overlap, and deformation. Performance is highly sensitive to scale-aware preprocessing, dataset realism/diversity, and, for video, temporal smoothing/aggregation. Persistent gaps include cross-site generalization, small/occluded weapon detection, rigorous calibration/uncertainty, and responsible deployment (privacy, bias, adversarial robustness). We distill best practices—compact YOLO variants with multi-scale heads and optional tiling; brightness/contrast normalization; synthetic+real data mixing; pose/orientation cues when architecture-compatible—and outline opportunities in foundation-model features, multimodal fusion (RGB–X-ray/IR), self-/active learning for long-tail classes, and standardized benchmarking with consistent mAP/F1/FPS reporting and small-object stratification..

Keywords: Weapon detection, object detection, CCTV, Deep Learning, YOLO, Real-time vision.

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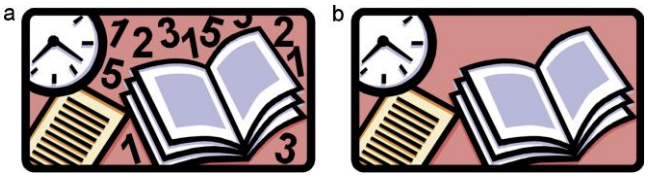

Fig. 1 - (a) first picture; (b) second picture.

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