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Crowd Detection and Overcrowding Alert System

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Abstract: A crowd detection and overcrowding alert system is proposed to monitor public spaces and prevent unsafe crowd conditions. The system applies computer vision and deep learning techniques to analyze live video feeds from surveillance cameras, detecting the number of people present, tracking movement patterns, and estimating crowd density in specific zones. When density exceeds a predefined safety threshold, the system automatically generates alerts for authorities, enabling timely intervention and helping to prevent accidents, stampedes, and congestion in locations such as malls, transportation hubs, campuses, and public events. The proposed solution is designed to integrate with existing CCTV infrastructure as well as IoT devices and mobile notification services for faster response, and to provide continuous monitoring and visual insight through a live dashboard so that authorities can easily identify high-risk zones. By reducing dependence on manual supervision, the system is intended to increase surveillance efficiency, support scalable deployment in both small and large environments, and lay the groundwork for future extensions such as behavior analysis and anomaly detection, contributing to public safety and smart-city crowd management.

Keywords: Crowd Detection; Overcrowding Alert; Computer Vision; Deep Learning; Object Detection; YOLOv8; Crowd Density Estimation; Public Safety; Smart City Surveillance.

I. INTRODUCTION

Public places such as railway stations, shopping malls, stadiums, airports, festivals, and religious gatherings routinely experience heavy crowd movement, which can lead to congestion, accidents, and serious safety risks. Traditional crowd monitoring depends on manual observation of CCTV footage, an approach that is time-consuming, error-prone, and difficult to scale across large surveillance networks.

Advances in computer vision and deep learning now make it possible to analyze video streams automatically and provide instant information about crowd density. This work proposes a Crowd Detection and Overcrowding Alert System that identifies and counts people from live or recorded video using image processing and deep learning models such as YOLO, continuously compares the estimated crowd level against a predefined safety threshold, and generates an alert to authorities the moment that threshold is exceeded.

Rapid urbanization and the growing frequency of large public gatherings have made crowd management a critical challenge for authorities and event organizers. Human operators monitoring dozens or hundreds of camera feeds are subject to fatigue, delayed response, and subjective judgement, so that dangerous conditions such as stampedes or crowd crushes can go unnoticed until they become severe.

Object detection algorithms such as YOLO (You Only Look Once) address this gap by processing an entire video frame in a single pass, predicting bounding boxes and class probabilities for every detected person with high speed and accuracy, even under partial occlusion and overlapping individuals.

Existing systems, however, largely focus on crowd counting or post-event analysis rather than real-time hazard prevention, and many lack an automatic alerting mechanism capable of notifying authorities the instant an unsafe condition is detected. This motivates the present work: an intelligent system that analyzes live video feeds, estimates crowd density in real time, and issues timely alerts, so as to support proactive crowd management, reduce dependence on manual supervision, and enhance public safety in transportation hubs, educational institutions, and public events.

The objectives of the proposed system are to detect people in real time from video input; to continuously analyze crowd density by processing successive video frames; to identify overcrowded zones against predefined threshold values; to trigger an automatic alert whenever crowd density exceeds a safe limit; to present a live monitoring dashboard showing people count, alerts, and crowd status; to minimize reliance on manual CCTV monitoring; and to incorporate person detection, object tracking, and motion analysis so that crowd movement, direction, and abnormal behavior such as sudden rushing or pushing can also be recognized.

II. LITERATURE SURVEY

A review of recent research was carried out to identify effective techniques for real-time crowd detection and overcrowding alerting. Mabrouk et al. [1] proposed a hybrid ensemble framework that combines YOLOv7 detection with dense optical-flow motion features and classical classifiers such as Random Forest and Gradient Boosting, improving interpretability and performing well even on small datasets, although the optical-flow stage adds computational overhead. Gündüz and Işık [2] compared several YOLO versions (v3–v7) for real-time crowd detection, showing that newer variants achieve higher accuracy and frame rate, but with reduced reliability under severe occlusion and dense overlapping crowds. Rezaee et al. [3] surveyed crowd-anomaly-detection approaches, grouping them into tracking-based, handcrafted-feature, deep-learning, and hybrid methods, and concluded that CNN/LSTM-based models outperform traditional techniques, though the survey does not itself propose a new model.

Mehrabi et al. [4] introduced a cloud-based framework using EfficientNetV2B0 together with the RAFT optical-flow model to detect pushing behavior at crowded event entrances, offloading computation to GPU-equipped cloud servers at the cost of network latency. Kim et al. [5] developed a CNN-based density-map approach that classifies crowd density into five levels and was validated on real disaster footage from the Itaewon incident, though its fixed, camera-specific thresholds require manual calibration. Sharif et al. [6] reviewed deeplearning paradigms for anomaly detection—autoencoders, GANs, CNNs, and transformer-based architectures—identifying Frame-level Area Under Curve as a preferred evaluation metric and highlighting transformer and visionlanguage models as emerging directions.

Yasen et al. [7] proposed MSCANet, a point-supervised, multi-scale feature-fusion network with convolutional attention that reduces annotation cost while remaining robust to occlusion and cluttered backgrounds, though its architectural complexity limits edge deployment. Vasavi et al. [8] combined YOLOv8-pose with MediaPipe and motion tracking to detect overcrowding together with abnormal activities such as running, crawling, and kicking, and used automated email alerts, but relied on fixed pixel-based thresholds that generalize poorly across cameras. Jayachitra et al. [9] presented a threelayer YOLOv11–Optical-Flow–LSTM architecture for combined crowd and weapon/violence detection with multichannel SMS and email alerting, reporting high accuracy under controlled conditions but limited transparency on real-world generalization. Finally, Kumar et al. [10] described SAMRAKSH, a multi-module system integrating YOLOv11 crowd counting, ByteTrack-based blockade detection, Deep Face-based missing-person recognition, and weapon detection for the Kumbh Mela, illustrating the value of a unified framework while also reporting a comparatively modest crowddetection mAP and unresolved privacy considerations around biometric data collection.

Across these studies, most systems emphasize crowd counting, density estimation, or offline analysis rather than integrated, real-time, threshold-based alerting, and few combine detection, tracking, and automated notification into a single, cost-effective platform built on existing CCTV infrastructure. This gap motivates the system proposed in this paper.

III. PROPOSED METHODOLOGY

The proposed system is organized as a pipeline of five stages: video acquisition, preprocessing, person detection, density estimation with threshold-based decision-making, and alert generation, so that recorded CCTV footage can be turned into an actionable overcrowding warning with minimal human involvement.

A. Video Acquisition and Preprocessing

Recorded video streams from existing CCTV cameras are read frame by frame using standard computer-vision libraries. Each frame is preprocessed through resizing, noise reduction, and image enhancement to improve downstream detection quality, and the relevant region of interest for a given camera view is identified before further analysis.

B. Person Detection using YOLOv8

Each preprocessed frame is passed through a YOLOv8 object-detection model, which analyzes the entire frame in a single pass, dividing it into a grid and predicting bounding boxes with class probabilities for every person present. YOLOv8 is selected for its balance of detection accuracy and inference speed, and its ability to localize individuals even when they are closely spaced or partially occluded, which is essential for dense crowd scenes.

C. Crowd Density Estimation

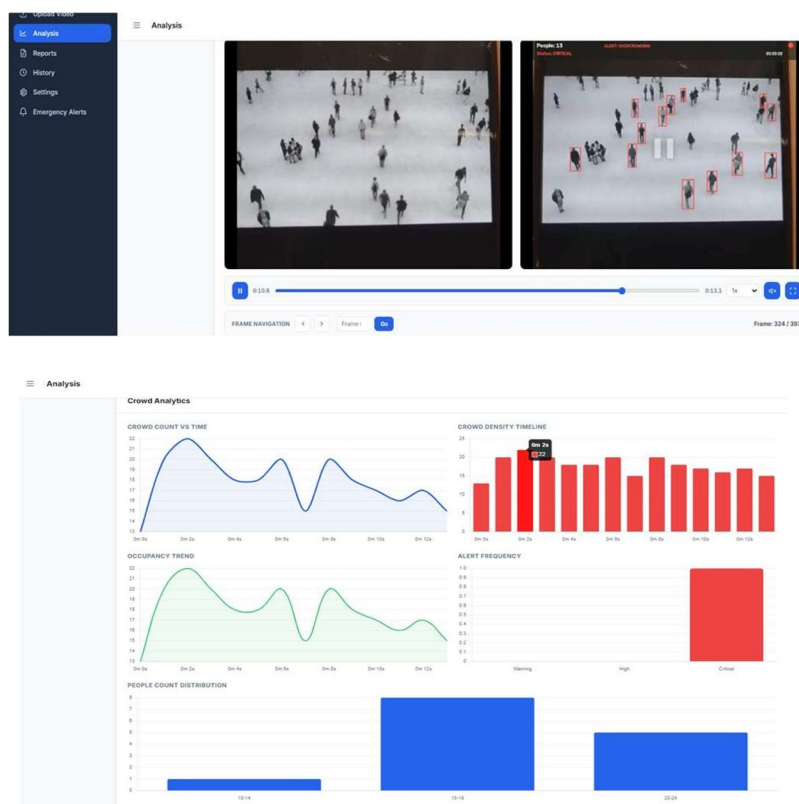
The bounding boxes produced by the detector are counted within the defined region of interest to obtain the current people count. This count is tracked across consecutive frames, together with basic object tracking, to understand movement direction and crowd flow, which supports later extension toward motion analysis and behavior recognition such as detecting sudden rushing or pushing.

D. Threshold Comparison and Alert Generation

The estimated crowd count is continuously compared against a predefined, zone-specific safety threshold. When the count exceeds this threshold, the system automatically raises an overcrowding alert, which can be delivered to authorities through a live monitoring dashboard and can be extended to mobile notifications or IoT-connected devices for faster response, reducing dependence on continuous manual supervision of camera feeds.

E. Monitoring Dashboard

A dashboard presents the live people count, current crowd status, and generated alerts for each monitored zone, giving authorities continuous visual insight into high-risk areas. Because the pipeline operates on standard CCTV input, the design is intended to be deployable, cost-effective, and scalable to both small and large environments, with future scope for predictive analytics and richer behavior-anomaly detection.



IV. CONCLUSION

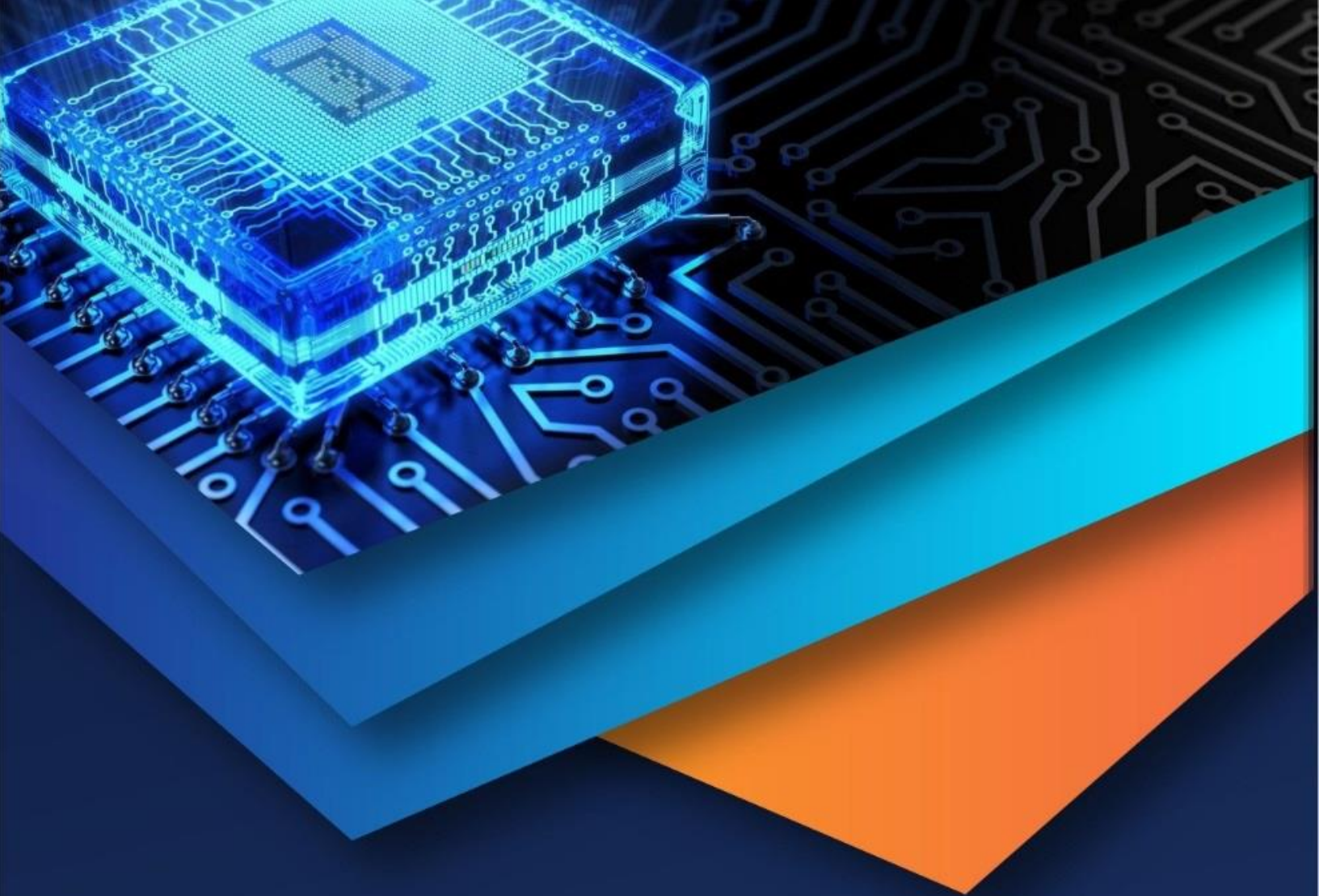
This paper has presented the design of a Crowd Detection and Overcrowding Alert System that combines computer vision and deep learning to detect people, estimate crowd density, and issue automatic alerts when a predefined safety threshold is exceeded. By building on existing CCTV infrastructure and a YOLOv8-based detection pipeline, the proposed approach aims to reduce reliance on manual surveillance, support faster response through dashboard and notification integration, and provide a scalable foundation for future enhancements such as behavior analysis, anomaly detection, and predictive crowdfow modeling in smart-city environments.

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REFERENCES

- [1] D. Mabrouk, M. A. Abdel-Fattah, and A. Taha, "Robust crowd anomaly detection via hybrid ensemble learning for real-world surveillance," *Scientific Reports*, vol. 15, Nov. 2023. DOI: 10.1038/s41598-025-27408-9
- [2] M. S. Gündüz and G. Işık, "A new YOLO-based method for real-time crowd detection from video and performance analysis of YOLO models," *Journal of Real-Time Image Processing*, vol. 20, no. 1, p. 5, Jan. 2023. DOI: 10.1007/s11554-023-01276-w
- [3] K. Rezaee, S. M. Rezakhani, M. R. Khosravi, and V. G. Sangeetha, "A survey on deep learning-based real-time crowd anomaly detection for secure distributed video surveillance," *Personal and Ubiquitous Computing*, vol. 28, pp. 135–151, 2024. DOI: 10.1007/s00779-021-01586
- [4] M. Mehrabi et al., "A cloud-based deep learning framework for early detection of pushing at crowded event entrances," *arXiv preprint*, arXiv:2302.08237, Feb. 2025.
- [5] J. Kim et al., "A real-time crowd density level detection system," in *Communications in Computer and Information Science*, vol. 1978, Springer, Cham, Dec. 2025, pp. 145–157. DOI: 10.1007/978-3-031-49529-8_12
- [6] M. H. Sharif, L. Jiao, and C. W. Omlin, "Deep crowd anomaly detection: state-of-the-art, challenges, and future research directions," *Artificial Intelligence Review*, vol. 58, Feb. 2025. DOI: 10.1007/s10462-024-11092-8
- [7] K. Yasen, J. Zhou, N. Zhou, K. Qin, Z. Wang, and Y. Li, "Crowd gathering detection method based on multi-scale feature fusion and convolutional attention," *Sensors*, vol. 25, no. 21, p. 6550, Oct. 2025. DOI: 10.3390/s25216550
- [8] S. Vasavi, C. Neeraja, and A. Kruthika, "Crowd Density Analysis for Public Safety Using YOLOv8," in *2025 12th International Conference on Reliability, Infocom Technologies and Optimization (ICRITO)*, Noida NCR, India, 2025, pp. 1–5. DOI: 10.1109/ICRITO66076.2025.11241798.
- [9] R. Jayachitra, R. Ragul, and C. R. Krishna, "Next-Generation Public Safety System for Real-Time Crowd and Weapon Detection using YOLOv11 with Automated Alerts," in *2025 3rd International Conference on Advancement in Computation & Computer Technologies (InCACCT)*, Gharuan, India, 2025, pp. 767–772. DOI: 10.1109/InCACCT65424.2025.1101140.
- [10] A. Kumar, A. Shukla, P. Garg, S. Sahu, and P. Shukla, "Leveraging Machine Learning for Real-Time Crowd Control and Safety at Kumbh Mela," in *2025 3rd International Conference on Communication, Security, and Artificial Intelligence (ICCSAI)*, Greater Noida, India, 2025, pp. 1416–1422. DOI: 10.1109/ICCSAI64074.2025.11064144.



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