

An Artificial Intelligence Mechanism to Monitor and Manage Crowd

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Abstract: *In this paper we propose a real time crowd counting and detecting method using OpenCV. With reference to the previous methods such as edge recognition, morphological filter, SVM order which are not real time applications, our method trains the system using video streaming and provides result in real time. The application of artificial intelligence (AI) has shown promise in addressing these issues. This paper presents a real-time artificial intelligence mechanism to monitor and control crowd behaviour. Detecting and counting crowd using image processing and YOLO v8 involves several steps, including image acquisition, preprocessing, object detection, and post-processing. Once the crowds are detected and counted, the results can be discussed in terms of accuracy, efficiency, and potential applications. The suggested mechanism combines deep learning, machine learning, and computer vision methods to detect and track individuals, analysed crowd motion, predict potential risk and provide increased accuracy and efficiency.*

Keywords: Artificial Intelligence, Computer Vision, Object Detection, Real Time Monitoring, Crowd Monitoring System

I. INTRODUCTION

Rise of the Urban Crowd: In today's more urbanized world, crowd management has become an essential skill. Cities are centres of social interaction, cultural exchange, and economic activity that draw millions of people to congregate in public areas for a variety of reasons. For law enforcement and event planners, this influx poses a special challenge: guaranteeing the comfort, safety, and security of sizable crowds while allowing for their movement and averting disturbances. Traditional methods of crowd control often fall short in addressing the complexities of modern-day gatherings, necessitating innovative solutions that leverage cutting-edge technologies. Among these, image processing, coupled with state-of-the-art object detection algorithms like YOLO (You Only Look Once) v8, presents a promising avenue for revolutionizing crowd management strategies. The amalgamation of image processing techniques with YOLO v8 brings forth a powerful framework capable of real-time analysis and identification of individuals within dense crowds. YOLO v8, renowned for its speed and accuracy in object detection, enables swift recognition of various entities, including people, amidst cluttered scenes, thus furnishing invaluable insights into crowd dynamics. By harnessing the capabilities of YOLO v8 alongside image processing methodologies, crowd management stakeholders can attain a multifaceted understanding of crowd behaviour, facilitating proactive measures for ensuring public safety and optimizing crowd flow.

II. TECHNIQUES

1. Object Detection using YOLOv8

A deep learning-based real-time object detection technique is used.

The YOLO (You Only Look Once) algorithm detects multiple objects in a single frame.

It identifies humans using bounding box regression and classification.



Why used:

High speed and accuracy
Suitable for real-time surveillance systems

2. Convolutional Neural Networks (CNN)

YOLOv8 is based on CNN architecture.
CNN extracts spatial features such as shapes and patterns from images.

Role in project:

Helps in detecting human presence even in complex backgrounds Improves detection accuracy in CCTV footage

3. Real-Time Video Processing using OpenCV

Frames are captured and processed continuously from video streams.
Each frame is analyzed for human detection.

Techniques used:

Frame extraction
Image resizing
Frame-by-frame analysis

4. Threshold-Based Crowd Detection

A predefined threshold (e.g., more than 2 people) is used.
If detected count exceeds the threshold, the system triggers an alert.

Purpose:

Simple and efficient decision-making mechanism
Enables automated monitoring

5. Event-Driven Alert System

Alerts are generated when a specific condition is met. Includes:

- o Visual warning display
- o Audio alert (beep sound)
- o Automatic screenshot capture

6. Frame Optimization Techniques

Used to improve performance and reduce lag:

- o Frame skipping
- o Resolution reduction

Benefit:

Faster processing
Near real-time system response

7. Data Logging Technique

Crowd count data is stored in a CSV file.
Enables analysis of crowd trends over time.

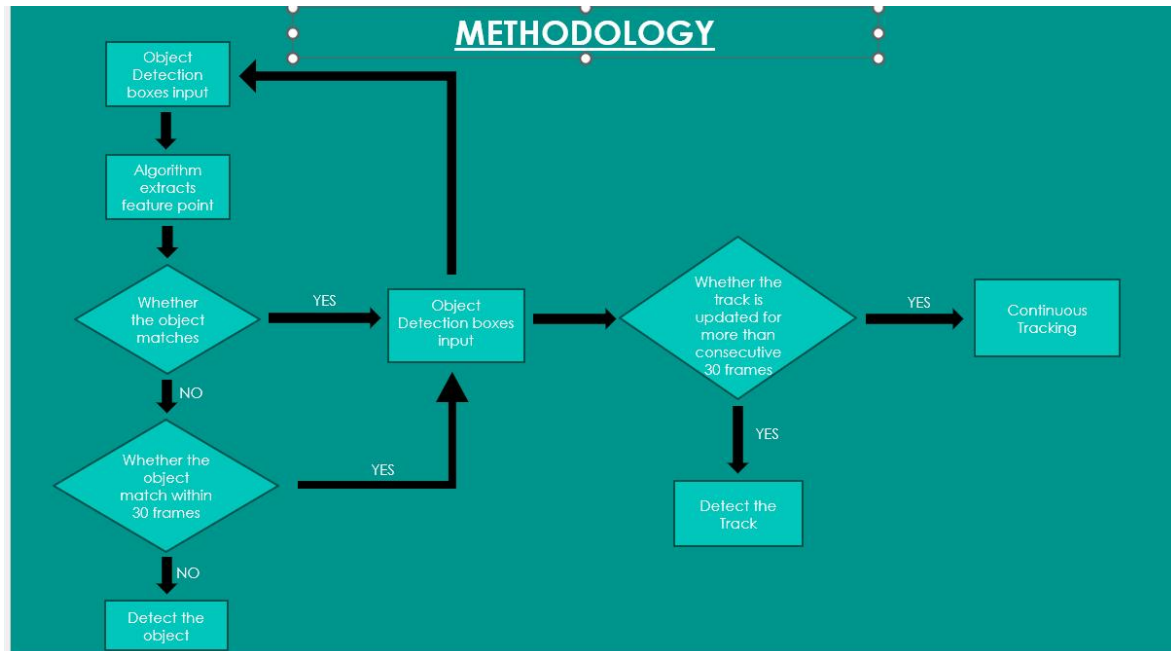


Application:

Useful for surveillance records

Helps in future data analysis

III. METHODOLOGY



- Video Streaming Monitoring : For object detection, we work with a webcam and calculate the Frames per Second (FPS) throughput rate.
- Pre-Processing : Frames are pre-processed by resizing and switching RGBs. Open cv is a library for performing common computer vision and image processing tasks.
- Object Detection is a computer technology that deals with identifying instances of Semantic objects of certain class in image. Yolo V8 are used for this.
- Centroid tracking algo, is used for tracking the objects.

IV. OVERVIEW OF THE SYSTEM

The proposed system is an intelligent AI-based crowd monitoring solution designed to analyze CCTV video streams in real time and detect human presence automatically. The system utilizes advanced computer vision and deep learning techniques to identify and count individuals in surveillance footage, enabling efficient monitoring of crowded environments.

The core of the system is built using YOLOv8, a state-of-the-art object detection algorithm, which is capable of detecting multiple objects within a single frame with high accuracy and speed. The model processes each video frame and identifies human subjects by generating bounding boxes around detected individuals.

Video input is acquired through CCTV cameras or recorded footage and processed using OpenCV, which handles frame extraction, resizing, and real-time display. The system continuously counts the number of detected individuals in each frame and compares it against a predefined threshold limit.

When the number of people exceeds the specified limit, the system triggers an automated alert mechanism. This includes a visual warning message displayed on the screen, an audio alert signal, and automatic screenshot capture for



record-keeping and evidence purposes. Additionally, crowd data is logged into a file for further analysis and monitoring.

To enhance usability, the system can be integrated with a frontend interface through a backend server, allowing real-time monitoring via a web-based dashboard. This architecture ensures scalability and makes the system suitable for deployment in real-world environments such as shopping malls, transportation hubs, and public gathering areas.

Overall, the system provides an efficient, automated, and scalable solution for crowd monitoring, reducing the need for manual supervision and improving response time in critical situations.

V. RESULTS OF EXPERIMENTS

- Successfully detected and counted humans in real-time using YOLOv8.
- Accurate alert generation when crowd limit exceeded.
- Achieved near real-time performance after optimization.
- Worked well under normal lighting conditions.
- Minor limitations observed in low light and crowded scenes.

VI. CRITICAL ANALYSIS

- High accuracy and speed using YOLOv8.
- Effective alert system (warning, beep, screenshot).
- Performance affected in crowded and low-light conditions.
- Dependent on CCTV angle and video quality.
- Requires optimization for real-time processing.
- Limited to threshold-based crowd detection.

VII. SUGGESTIONS FOR FURTHER RESEARCH

- Improve detection using advanced YOLO models and custom datasets.
- Implement multi-object tracking for accurate counting.
- Add behavior and anomaly detection.
- Integrate cloud and edge computing for scalability.
- Develop advanced dashboard with analytics.
- Extend system to multi-camera environments.

VIII. CONCLUSION

- Developed an AI-based real-time crowd monitoring system.
- Achieved accurate human detection using YOLOv8.
- Implemented alert system (warning, beep, screenshot).
- System works efficiently with CCTV footage.
- Can be enhanced further for smart surveillance applications.

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