IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2026

DOI: 10.17148/IARJSET.2026.13561

AI - Based Real Time Crowd Monitoring and Risk Detection System

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Abstract: For the proposed study, it is anticipated that a software product based on Artificial Intelligence will be developed to enable risk detection and analysis to confirm that there are no security threats in crowded public spaces like malls, temples, and train stations. Crowd management can be quite tricky in such spacesHence, it becomes necessary to monitor them constantly. However, the use of traditional surveillance systems like cameras becomes problematic because it requires one to continuously monitor the video footage for any potential threat.

It becomes possible to resolve this issue by leveraging computer vision, integrated with deep learning capabilities, that enables the system to monitor the video stream recorded through the camera. Furthermore, the system will be capable of detecting individuals and analyzing their behavior patterns to verify if they can be deemed dangerous, including the risk of fire and other similar hazards such a detection capability can prevent accidents, such as stampedes.

Keywords: Artificial Intelligence (AI), Computer Vision, Crowd Monitoring, Risk Detection, RealTime Surveillance, YOLO.

I. INTRODUCTION

Crowd surveillance in public places has emerged as a major issue due to increasing numbers of visitors at these sites. In locations such as shopping malls, temples, and railway stations, people may gather in large numbers, leading to hazardous scenarios such as panics or stampedes. At present, the existing CCTV camera systems merely capture videos and rely on persistent human supervision, making it challenging to spot any anomalies in real-time. In order to address this challenge, this project proposes an AI-based solution for crowd surveillance. Using computer vision and machine learning techniques, the proposed system will be capable of analyzing the video captured by the surveillance camera and recognizing crowd behavior, thereby detecting any potential threats.

II. METHEDOLOGY

For this method, surveillance cameras that record live videos in highly congested regions will be used. Such videos will be utilized as input data into the system. At this stage, preprocessing is done on the video footage. This step involves eliminating noises from the video and making it clearer for the purposes of obtaining more accurate results.

Further in the process, machine learning will be applied to determine the number of people in the video. The system will monitor the people in the crowd and determine whether there are any irregularities, such as changes in the number of individuals. Additionally, it will look out for any dangers in the environment, including fire and smoke.

Finally, after the processing stage, the system will assess the risks associated with the detected events.

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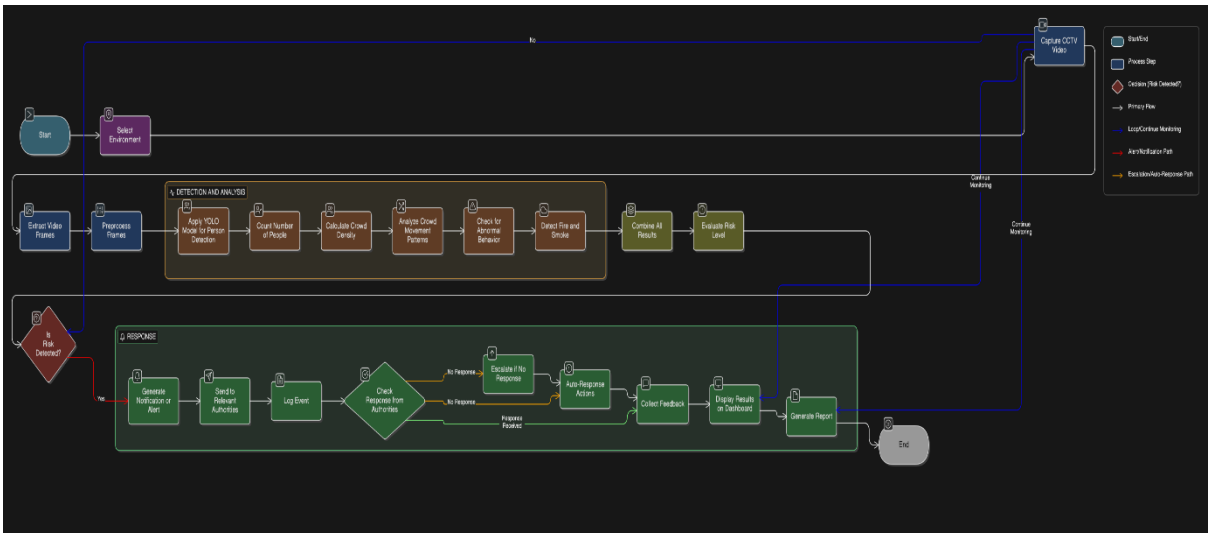

Figure 1:Architectural diagram of the project.

III.LITERATURE REVIEW

SL NO	YEAR OF PUBLICATION	TITLE	DESCRIPTION
1	2025[1]	CrowdSentry: An AI-Powered Framework for Real Time Crowd Behavior Analysis and Stampede Risk Prediction	CrowdSentry is a technology that uses artificial intelligence and machine learning algorithms to monitor crowds and predict stampedes, which can also be applied at the railway station, among others. For crowdSentry, deep learning techniques, such as YOLOv8 and DeepSORT to detect and track movements using video imagery, respectively, are used. An assessment is made concerning whether the crowd behavior, measured by crowd density, velocity, and directions, is either within normal limits or abnormal through a grid technique. Heat maps and zoning (dividing spaces into safe zones, congested, or high-risk zones) visualization techniques are provided in this technology. Once the pre-set threshold is crossed, an alert will be generated. Some of the key features of crowdSentry include real-time dashboard, data log, high precision, and low latency.
2	2025[2]	A Novel AI-Based Predictive Crowd Monitoring and Stampede Prevention System	In this research work, the utilization of the proposed improved crowd congestion monitoring and prediction AI system would be recommended to prevent the occurrence of stampedes. The detection of people will be done through YOLOv8 based on the CCTV footage or drones' video feed. Thereafter, the area will be sectioned into 5m x 5m squares in order to calculate the population density. Moreover, the LSTM algorithm will predict the future population density based on the previous population density trend, considering the next two minutes. If the population density becomes unsafe, alerts will be issued to prevent stampedes.
3	2025[3]	Vision Crowd: Automated Crowd Monitoring and	An AI-based approach will be used in this paper that includes automated detection of helmets as

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		Analysis Through AI	well as crowd monitoring. The use of YOLOv3 will enable the system to detect helmets while YOLOv5 will help detect and count people from video footage. This could be done using the DNN function of OpenCV and drawing bounding boxes of those without helmets. No human interference would be needed and this would decrease any kind of error by humans. These kinds of systems would allow for high risk areas where safety guidelines should always be followed, such as during construction activities and similar jobs. There may be some difficulties in implementing such systems in low lit environments and overcrowded places.
4	2025[4]	Anomaly Detection in Crowd Behavior for Public Safety Assurance	The current paper introduces a system that utilizes AI to monitor crowd behavior anomalies with the emphasis on real-time detection of falling individuals for public safety improvement purposes. In particular, the system leverages the potential of YOLOv8 together with the technique of pose estimation for processing live CCTV footage. It implements a two-phase fall detection procedure, which includes verifying that an individual has fallen on multiple frames to minimize false-positive results. Once the system detects a person falling down, alert notifications are immediately delivered via cloud messaging systems such as Firebase or SMS APIs. This non-invasive approach is scalable, does not need any wearables, and provides accurate results (about 91–94%) with minimal delay in crowded conditions.
5	2025[5]	Smart Crowd: AI-Driven Crowd Density Monitoring and Management in Indian Public Hotspots	The Smart Crowd Surveillance is one technology that can be deemed as the future of surveillance systems since they incorporate the use of AI-based algorithms, which help in monitoring individuals within certain locations such as temples, railways, and crowded places in India. The features of the Smart Crowd Surveillance include: - The use of various technological advances for effective performance of the surveillance system. To begin with, there is the application of YOLOv5 algorithm, which helps to detect individuals through the surveillance camera videos. Secondly, there is the application of CSRNet algorithm, which aids in detecting crowds in crowded locations. Lastly, the application of LSTM algorithm helps to predict crowd behavior. - The application of various technologies including Wi-Fi, Bluetooth, and visual sensors to overcome visualization issues. Lastly, there is the incorporation of edge computing technology such as NVIDIA Jetson Xavier NX.
6	2025[6]	Proactive Public Safety in 6G: Leveraging AI and Crowdsourcing for Critical Tasks	A proactive public safety framework for 6G network environment is suggested in this research work, which utilizes AI, crowdsourced data, and edge intelligence for efficient real-time decision making. Multiple data sources will be used including mobile devices, IoT devices, vehicles, social media, and digital twins to detect and

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			manage any incident such as accident and congestion in time. This framework will use transformers for detecting incidents and CVAE-based generative AI model to predict future scenarios. Agentic AI combined with reinforcement learning will be implemented for resource management. Blockchain technology will be incorporated for the security of data, and federated learning will enable distributed training without compromising data privacy. This proactive framework is based on SAGIN network, including terrestrial systems, UAVs. The results from the simulation experiments show that the performance is considerably improved regarding accuracy, load balancing and the resilience to malicious data.
7	2025[7]	ShielDir: AI-Powered Real-Time Threat Detection System to Reduce Crime Response Time	ShielDir is an innovative real-time surveillance system that uses AI algorithms for the purpose of ensuring public safety through detecting weapons and aggression in the CCTV cameras' feed. As opposed to current state-of-the-art solutions, it offers several significant advantages, such as real-time video analytics, scalability due to a microservices architecture based on Docker and Kafka containers, and immediate notifications. The system uses the YOLOv11 algorithm to detect weapons, while the behavior analysis is performed by OPear, which is a VideoMAE-based deep learning model. Detected events in the system are prioritized into threat levels, including low, moderate, and critical ones, and then immediately reported to the relevant authorities via a cross platform mobile and web app.
8	2025[8]	API-Driven AI Framework for Real-Time Beach Safety and Coastal Hazard Prediction	The SeaAegis is a new system for securing the coast based on artificial intelligence, machine learning and application programming interfaces which are capable of forecasting any hazards that may occur on the beach such as dangerous currents and adverse weather conditions. The system uses geolocation tools and routing optimization and allows for predicting any potential hazards on the beach individually and enables individuals to be safe while using the beach. In addition, it uses environmental factors such as wind velocity and waves, creates predictive models through using ensemble and reinforcement learning methods, and calculates the risk score for that particular beach which reflects the degree of its safety. Moreover, individual notifications are issued and the use of multiple languages is possible, in addition to providing relevant information related to location-based services. Achievements in terms of improvements consist of accurate forecasts (92% vs. 75%), rapid updates and high user satisfaction (4.7/5).
9	2024[1]	Enhancing University Safety through AI-Powered Speed Detection	The current research discusses an automatic speeding detection mechanism based on artificial intelligence techniques that enhance the security of university campus through computer vision-based

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			technology. With the help of applying YOLOv9c technique alongside real-time video processing, the speed detection can be made possible without any specialized hardware components and accurate tracking of vehicles is obtained. The outcomes obtained from experimental evaluations show excellent accuracy in recognizing the speeding vehicles in comparison to the conventional technique based on radars. The proposed methodology successfully minimizes the risk factors caused by speeding cars. As future improvements, IoTs can be included to boost its accuracy and latency.
10	2024[2]	Crowd Coordination System	The current research is dedicated to the analysis of the newly developed crowd coordination software with YOLOv7 used for crowd identification and counting. With the help of this tool, the video frames will be analyzed, the necessary parameters will be calculated and the alarms will be triggered through the Gmail API in case any pre-specified limits are crossed. In such a way, it will become possible to get in touch with the police services immediately to make crowd management more effective. Having evaluated all results received from the analysis, one can say that the tool works very accurately which can be seen as a basis for evaluating the effectiveness of the solution.
11	2024[3]	Crowd Management using AI & ML	The proposed idea discussed in this paper concerns the use of AI and ML technologies to control crowds in Indian urban areas. This technology is based on using computer vision and analytic to monitor individuals' activities in a crowd, detect any anomalies, and enhance security. Such technologies could be very useful in terms of preventing crimes because such technologies will make it possible to analyze the crowd's activities and identify criminals. Moreover, places of work will become much safer with such technologies since there will be no issues with employees' safety. Finally, the use of these technologies would be beneficial for organizers of different events since it allows identifying issues that might arise with the help of monitoring people's activities.
12	2024[4]	Advanced Surveillance System for Public Safety	The present study outlines a sophisticated approach of intelligence supervision that incorporates artificial intelligence supervision tools to ensure the security of cities. The limitations associated with the conventional Cameras approach can be addressed through more effective strategies, such as deploying deep learning algorithms for abnormality detection, crowd behavior analysis, and crowd safety violation monitoring. It entails employing the YOLOv8 algorithm to guarantee precise identification of weaponry, abnormal actions, and violation of people intensity levels. Furthermore, the utilization of object detection approaches, encompassing deep SORT, facial recognition, and internet of things, is necessary for facilitating

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			continuous supervision.
13	2022[1]	Using Computer Vision to enhance Safety in a Post COVID World	The objective of the present paper will be to illustrate how computer vision and deep learning systems may contribute to ensuring safety in the post-pandemic reality. The main focus will be placed on the application of algorithms such as YOLO and Faster R-CNN that will be designed to detect instances when masks should have been worn as well as ensure that there is appropriate social distancing between different people. This system will be based on the analysis of video footage from the camera surveillance cameras used within buildings where gatherings of people take place. The system will not only be capable of detecting safety rule violations, including lack of masks and social distancing, but also tracking individuals' presence using object detection and measuring interpersonal distances.
14	2022[2]	Reducing Viral Transmission through AI-based Crowd Monitoring and Social Distancing Analysis	This proposed methodology aims to develop an AI-driven framework for maximizing public safety by keeping track of crowd behaviors while avoiding any chances of getting infected with the virus. Computer vision algorithms, as well as machine learning models, are applied in order to perform analysis of the Camera feed in real-time mode. Detection of a crowd, body posture analysis, and using face masks are taken into account as the critical factors in evaluating potential threats. On top of that, distance between individuals is calculated to determine whether people tend to stand close together or not. While traditional bounding box methods have already been developed for detecting people, the use of pose estimation can allow one to calculate distances more precisely. Additionally, information about activities performed by crowds, such as walking, standing, or sitting, would also be acquired. Overall risk factor is calculated based on the gathered data.

IV.CONCLUSION

The AI-based real-time crowd monitoring and risk assessment system is an efficient and intelligent way of ensuring safety in crowded public places. Using computer vision and applying deep learning algorithms, this system can analyze live video feeds, monitor and count people, as well as determine crowd density. It can also identify unusual crowd behaviors and risk factors like fire and smoke. This helps in identifying risks at an early stage and enabling appropriate action by concerned authorities. Furthermore, this process makes it unnecessary to conduct surveillance constantly, hence increasing efficiency. While lighting and angles of cameras may affect the performance of this system, it has been found to be both efficient and realistic.

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