



# Real Time Crowd Density Monitoring And Safety Alert System Using Yolo V8

Analysing and monitoring crowd Density

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**Abstract:** In this paper, we present a software designed Real-Time Crowd Density Monitoring and Safety Alert System Deep Learning Intelligent Crowd Analysis Using YOLOv8 Model to detect and count people from several inputs: photos, videos, live camera feeds, and event uploads. For photos and videos, past behaviour is analysed; the live feed demonstrates the current living state of people, and event uploads predict danger in the near future. The scoot method will determine Safe, Caution, and Danger. If danger is detected, it will alert through email or SMS. Lastly, the system will create a dashboard through Flask showing the live video, real-time count of people, and color-coded safety alert scale. Since the model does not operate using sensors, the project team designed for low-cost, scalable, and deployable in public economic spaces like stations, malls, and campuses, as well as for events.

**Index Terms** - YOLOv8, Deep Learning, Crowd Density Monitoring, Flask, Real-Time Detection, Safety Alert System.

## I. INTRODUCTION

Crowd density management plays a significant role in public safety, especially at congested venues such as railway stations, malls, campuses, and events. If left uncontrolled, crowd buildups can often lead to panic and stampedes, which can come with significant injuries and large-scale disruption. Traditionally, systems for crowd management, utilize heavy IoT sensor deployments which are often complemented or followed by manual observation. Traditional approaches do not lend themselves well to scaling, flexibility, and/or accurate real time observability within the dynamic public environment.

In this paper, we present a software-only, AI-powered crowd monitoring system that utilizes deep learning to manage real-time crowd density and crowd risk. The system leverages a state-of-the-art object detection model (YOLOv8), to detect and maintain a count of persons per video frame, in near real-time, with accuracy. The system utilizes for detection the presence/absence of persons in individual video frames and classifies the scene to either Safe, Caution, or Danger, based on pre-defined threshold values. In addition, the system provides alert notification based on the color-coded risk assessment and triggers a report for alert action to be taken by the authority.

The proposed dashboard is based on original Flask software which contains interactive options to upload images and videos for crowd monitoring, live streaming visualization of video monitoring at present, and a field for event letters used for predictive (future) crowd management and risk forecasting - prior to the actual event. Meanwhile the proposal maintains a count of all persons observed, and utilizes SQLite to maintain a structured database for efficient management of detection logs, event metadata, and alert records.

Software-only setup means that there is no need to use any IoT device or any special hardware to set up the system, thus keeping it affordable and simple to deploy. The modular and scalable architecture of the software ensures that it can be adapted to different kinds of public infrastructure to provide a smarter, preventive, and technology-driven solution to modern crowd safety management.

## II. LITERATURE SURVEY

Presently, the techniques used to track the crowd are highly dependent on IoT devices, infrared devices, and/or manual monitoring. These techniques are very costly, difficult to scale, and highly susceptible to environmental factors. However, with the advent of the latest developments in deep learning techniques, the cameras can be used to track the crowd in real-time without the need for additional devices. Earlier, the techniques used cameras and computer vision techniques, including OpenCV and CNN, to track the crowd, increasing the precision of the results, though the techniques were difficult to scale and integrate. Recently, the techniques used to detect objects in real-time have been improved, especially the YOLO techniques proposed by Redmon and colleagues, increasing the precision and efficiency of the results in real-time, especially in safety applications. Patel and Sharma proposed a system that uses the internet to monitor the security cameras, including the alert system, though the techniques used in the system are difficult to scale and integrate, including the use of IoT devices. The system proposed in the paper uses YOLOv8, Flask, and OpenCV to develop a system that can be used to monitor the crowd in real-time, including images and videos, without the need for additional devices.

## III. EXISTING METHOD

The existing crowd monitoring systems are still largely based on human intervention and hardware-based sensors such as infrared and ultrasonic sensors. These traditional methods are static, have a limited range of detection, and hence provide a narrow field of view. These methods are not appropriate in large and ever-changing environments such as train stations, stadiums, temples, shopping malls, and university campuses. Expanding the range of detection means more hardware, more wiring, and a lot more expense and complexity. Traditionally, before the advent of deep learning methods and object detection algorithms such as YOLO, many of the crowd monitoring systems used traditional image and video processing techniques and tools such as OpenCV, which offered various traditional image and video processing tools such as HOG-based human detection algorithms. Although the traditional methods could detect human crowds, they performed poorly in dense and overlapping crowds. These methods were also computationally expensive. These methods were reactive, i.e., they could only detect congestion after it has already occurred. These methods are lagging behind the smart and real-time inferences and capabilities of the modern crowd monitoring systems. Traditionally, there was a lack of a unified web interface, which made it difficult to monitor the system as a whole. Unlike the modern crowd monitoring systems, which use a unified web interface and a Flask-based dashboard, traditional hardware-based systems were difficult to manage as a whole. There was a lack of data logging, and there was little room to analyse the data. In comparison to the modern crowd monitoring systems, which are based on real-time object detection and safety, the traditional methods of crowd monitoring are hardware-based, not scalable, and not capable of handling the overall safety of the public.

## IV. PROPOSED METHOD

The proposed solution provides an AI-based YOLO computer vision system for intelligent crowd monitoring and analysis. Instead of using physical devices, the proposed system will utilize the existing CCTV cameras and infrastructure to monitor the crowd in real-time and provide intelligent analysis. YOLO, or "You Only Look Once," is a computer vision system that can detect and recognize objects in real-time, allowing the proposed system to monitor the crowd density in real-time.

The proposed system offers wide and flexible coverage since cameras can monitor larger areas compared to physical devices. The proposed system can monitor multiple areas at the same time and can adapt to the dynamic movement of the crowd. Moreover, since most public places have existing CCTV cameras, the proposed system will utilize existing infrastructure, reducing the need to purchase additional devices.

Scalability is easier and more cost-effective with the proposed system. To add more functionality to the system, additional cameras and cloud-based processing units can be easily added to the system without the need to make any major changes to the existing system. Moreover, the proposed system can be implemented in multiple locations. One of the most important benefits of the proposed system is that it can provide instant automated alerts to the concerned authorities in real-time. When the density of the crowd increases, the system will send automated alerts to the concerned personnel via Telegram and email.

The proposed system is more intelligent compared to the traditional system since it can provide event-based predictive analysis of the crowd density and can take preventive measures before the problem occurs. The

proposed system can parse the event documents and obtain the event date, venue capacity, expected attendees, and timing, allowing the system to provide predictive analysis.

Moreover, the proposed system provides a web-based centralized dashboard that can provide real-time monitoring, crowd density graphs, and event management, allowing the system to provide better and more efficient monitoring and analysis. Overall, the proposed system is intelligent, more scalable, more cost-effective, and more proactive in managing the crowd in real time, making it far superior to the traditional system based on physical devices.

#### 4.1 ADVANTAGES OF THE PROPOSED METHOD

1. Real-Time Crowd Detection
2. Wide Area Coverage
3. Cost-Effective Implementation
4. Easy Scalability & Flexible Deployment
5. Instant Automated Alerts
6. Predictive Crowd Analysis
7. Centralized Web Dashboard
8. Reduced Human Dependency
9. Faster Emergency Response
10. Data Storage and Historical Analysis

#### V. FLOWCHART

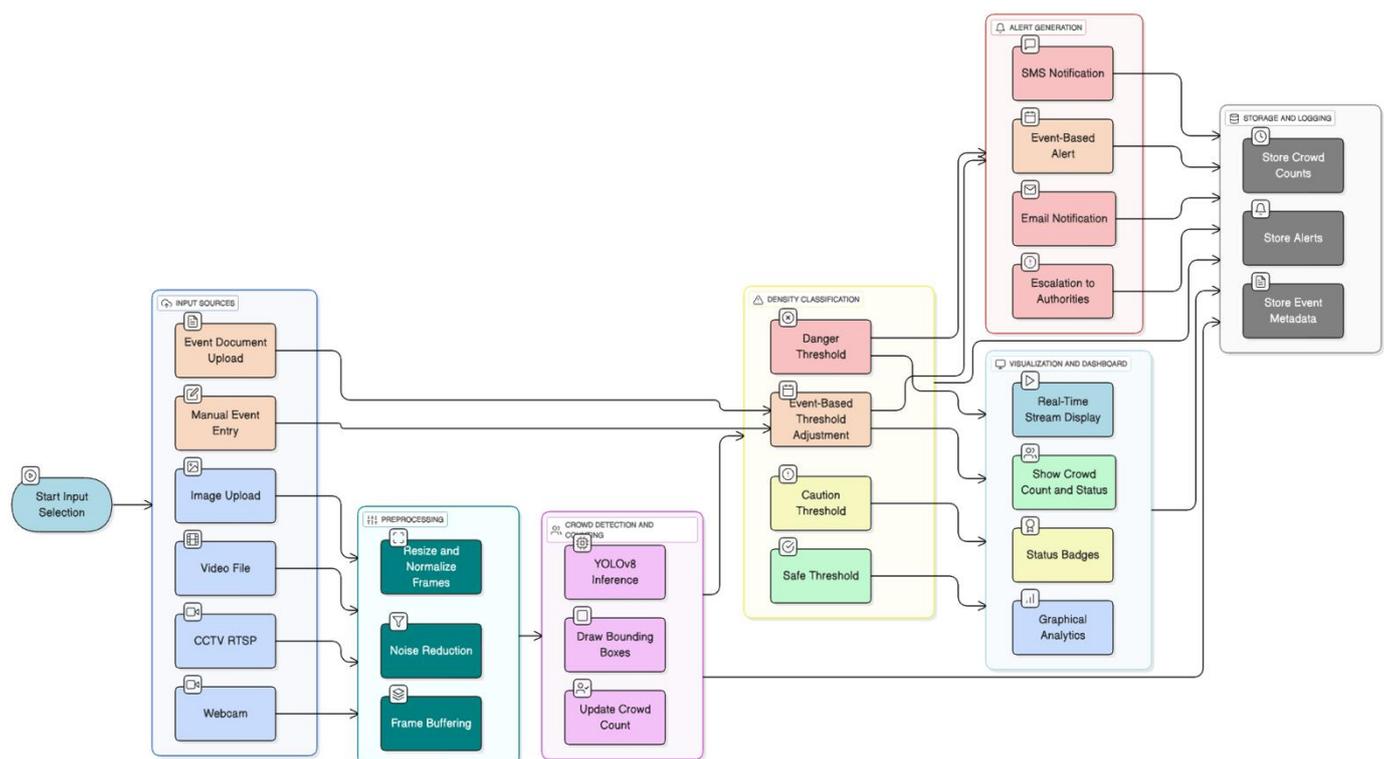


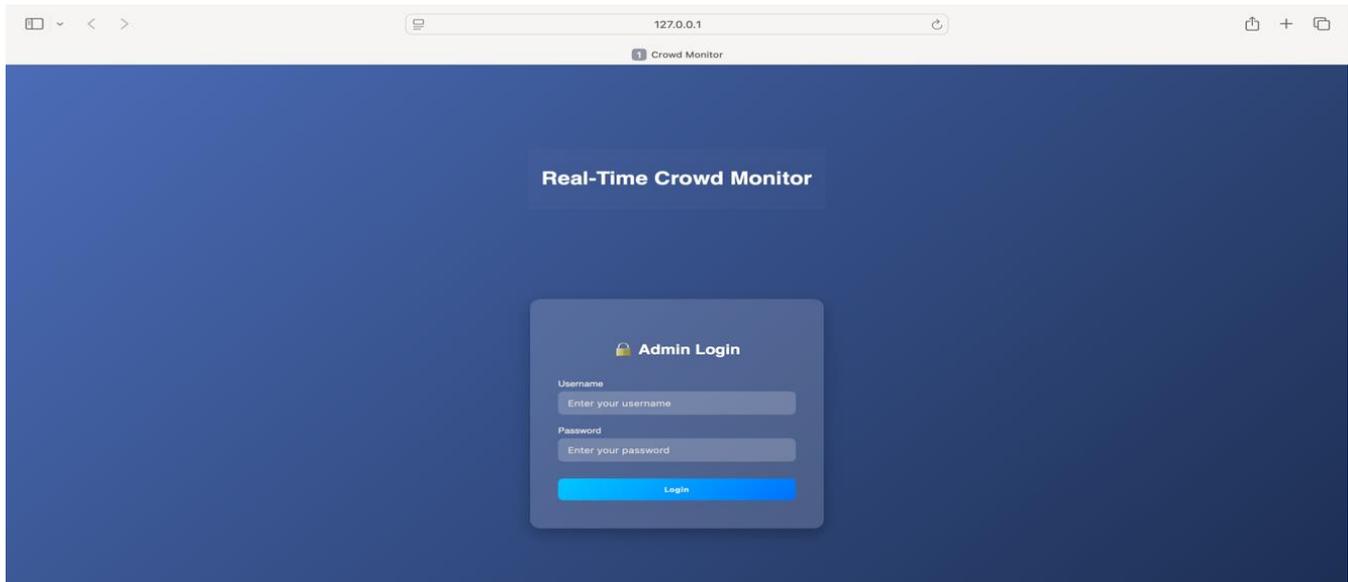
Fig.1

#### VI. WORKING MODEL OF PROJECT

The working model of the AI-Based Real-Time Crowd Density Monitoring and Safety Alert System follows a structured and intelligent flow, starting from user interaction through the web-based dashboard interface. The interface will act as the main control panel, allowing the user to monitor the cameras, manage the alerts, upload event documents, and monitor the crowd density in real-time. The system can be implemented on localhost for testing and development purposes, and the same system can be implemented on the cloud server for public use.

### 6.1 User Authentication

Upon accessing the web application, the user will be redirected to the login and registration page. The system allows role-based authentication, i.e., User and Admin roles. The user credentials will be securely validated at the server level via the backend database. Only authorized users will have access to the main dashboard,



and in the case of incorrect login credentials, the system will display an error message.

Fig.2

### 6.2 Dashboard Access and Role

After a successful login, users are redirected to their respective dashboards based on their respective roles. Admin users have access to the system configuration, threshold settings, event uploads, and monitoring of alerts, while general users have the ability to access the live feeds and updates of the crowd status. This categorization of users aids in the management of the system in a well-organized manner.

### Management

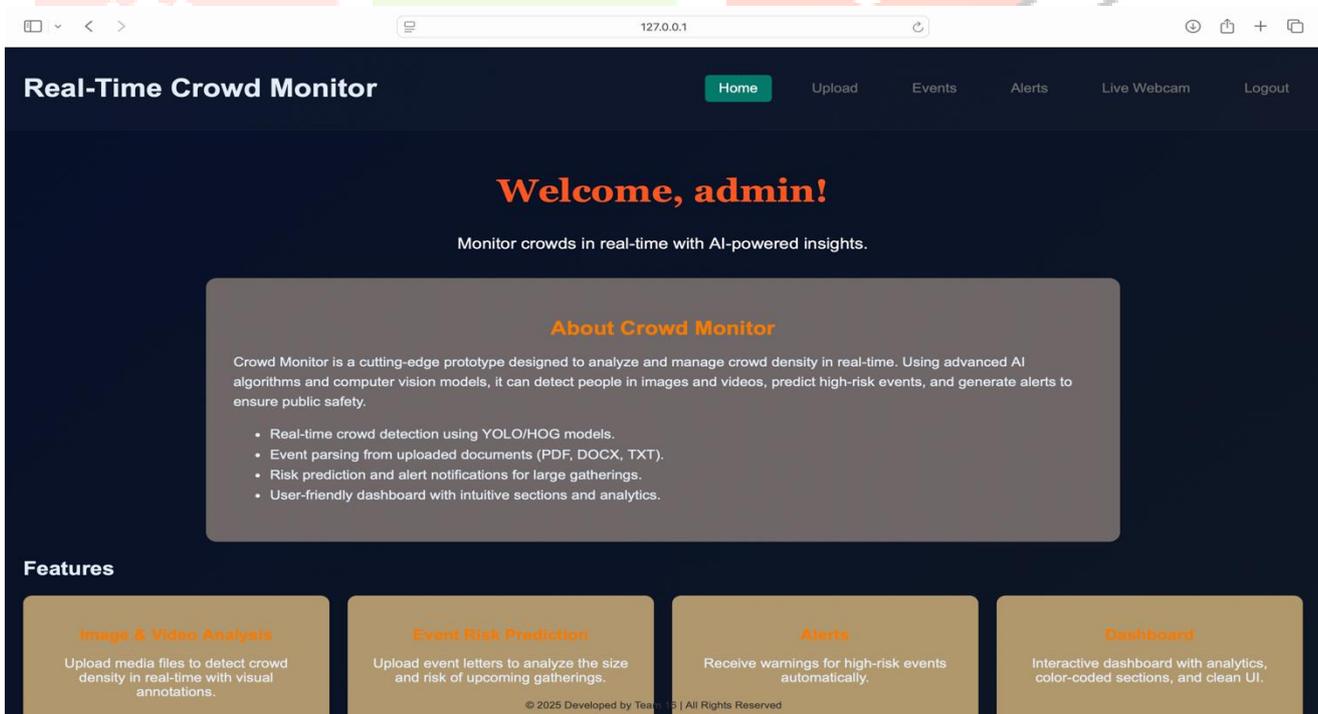


Fig.3

### 6.3 Camera Monitoring Initialization

Once the user is logged in, they can begin the live webcam or CCTV video feed by clicking the “Start Monitoring” button. This will activate the video camera and begin the processing of the video. When the “Stop Monitoring” button is clicked, the video processing is stopped. This module allows for the continuous observation of the crowd while still maintaining the interface of the dashboard.

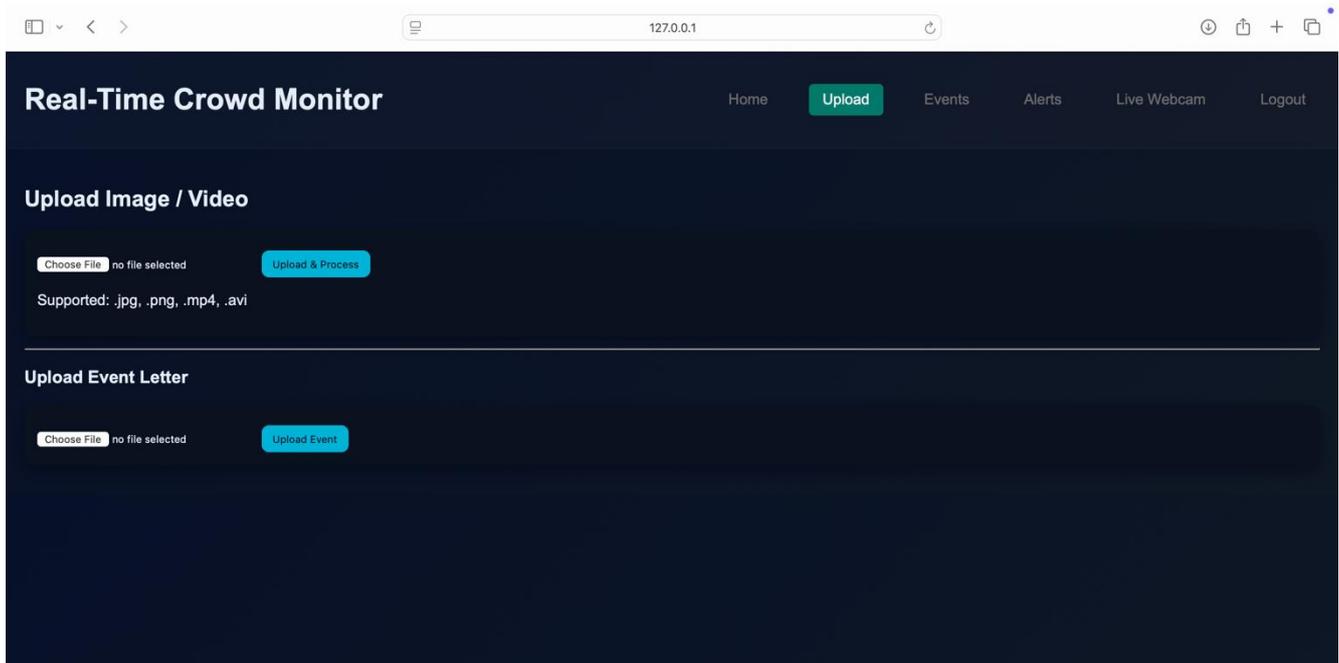


Fig.4

### 6.4 YOLO-Based Crowd Detection and Counting

The system utilizes the YOLOv8 deep learning model for the detection and counting of humans from live webcam feeds, videos, or uploaded video files. Each person detected by the system is highlighted by a bounding box, and the total count of persons is displayed dynamically on the dashboard. This process occurs in real time, allowing for the maintenance of fast processing speeds while at the same time guaranteeing accuracy, especially in moderately dense crowds.

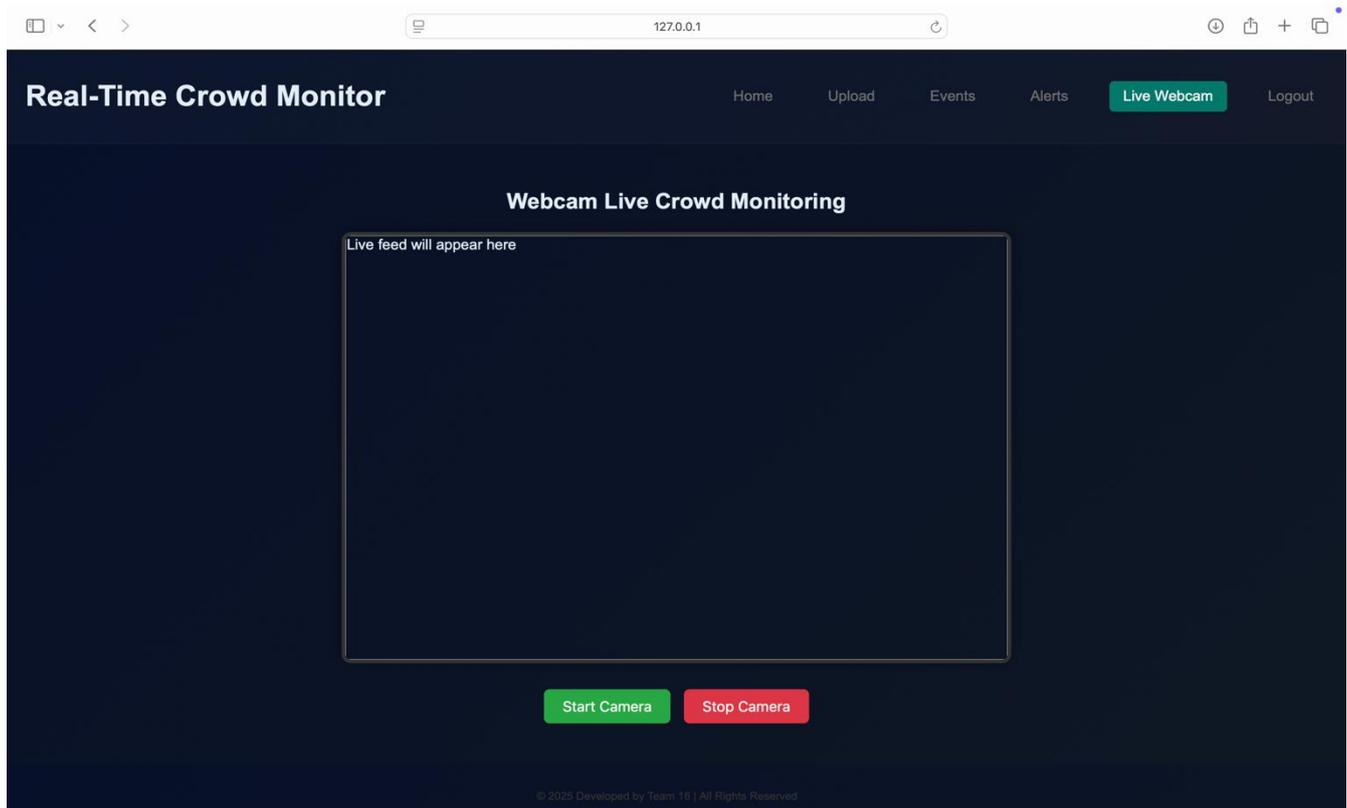


Fig.5

### 6.5 Crowd Density Classification and Alert System

The system will compare the real-time count with the threshold values. Depending on the threshold values, the crowd will be categorized into three different types: Safe, Caution, and Danger. If the count is above the caution or danger threshold, the system will immediately send out an alert message. The message will be sent immediately via email and Telegram integration. The activities will be logged as well.

### 6.6 Event Parsing and Predictive Analysis

The system allows users to upload event-related documents in PDF and text formats. The event parsing module will then extract key information, including the name of the event, the event's location, the event's date, and the expected crowd that will attend the event. This will help in predictive crowd analysis, and the administrators can take preventive measures before the crowd gets congested.

### 6.7 Telegram Integration

The system integrates with the Telegram Bot API to send live crowd density alerts to the concerned authorities or parties in real-time. Once the thresholds are crossed, the system sends automatic notifications with the current count and danger level to the authorities instantly.

### 6.8 Deployment (Localhost / Cloud)

The system may be tested locally using localhost or deployed to the cloud to enable wide-scale monitoring across various sites. Deploying the system to the cloud enhances its scalability and centralizes the control and management of the system, thus making it suitable for a real-world public infrastructure scenario.

### 6.9 Logout and Session Termination

The user can log out of the system in a secure manner, effectively terminating the current session and clearing all temporary data. This will prevent unauthorized access and preserve the privacy and security of the system.

## VII. RESULT & CONCLUSION

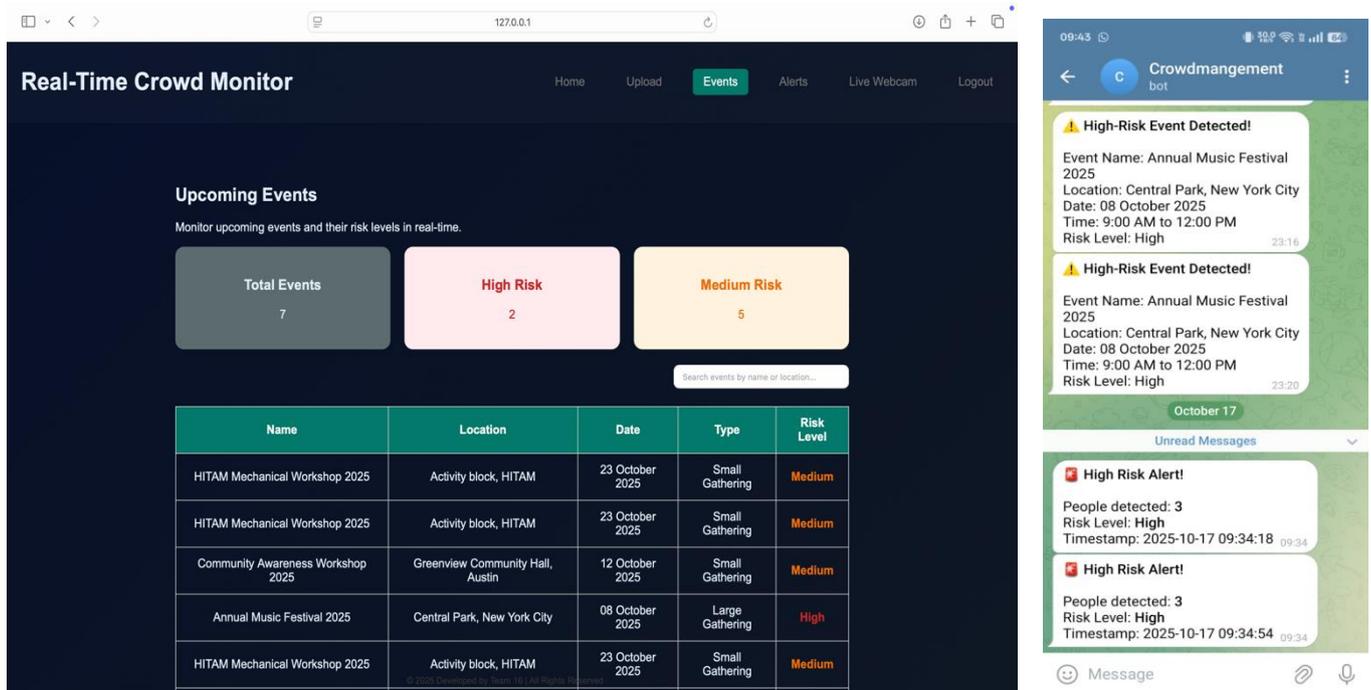


Fig.6

In conclusion, we tested the proposed system for Real-Time Crowd Density Monitoring and Safety Alert Systems using a combination of CCTV footage, webcam feeds, and video recordings to gauge the level of accuracy, speed, and reliability of the system. The proposed system based on the YOLOv8 model was found to be robust and efficient in performing its functions, processing approximately 35-40 FPS on mid-range GPU devices and 10-15 FPS on regular CPUs. The system was found to outperform traditional HOG-based systems like OpenCV, especially in highly packed crowd situations. Moreover, the proposed system provided an efficient categorization of crowd density situations under the 'Safe,' 'Caution,' and 'Danger' heads. The system was also found to send automated emails and SMS messages according to the situations. The feature of uploading an event document was also found to be effective for predictive crowd analysis. The system has low processing requirements and no IoT devices are necessary for deployment. It has good potential for practical deployment in various environments like colleges, shopping malls, religious congregations, and transport hubs.

This research presents a fully software-based crowd density monitoring and safety alert system built using deep learning and computer vision technologies. By integrating the YOLOv8 object detection model with a Flask-based web dashboard, the system enables accurate, real-time crowd monitoring from multiple input sources, including images, videos, live feeds, and event documents. The solution operates independently of IoT devices or specialized hardware, making it cost-effective, scalable, and easy to deploy. Overall, the framework offers an efficient, intelligent, and practical approach to modern crowd safety management, with strong potential for application across various public domains.

## VIII. REFERENCES

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