SafeEYE AI: AI-Powered CCTV Surveillance for Real-Time Anomaly Detection with Instant Notifications

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Abstract- In a modern landscape defined by rapid change, ensuring public safety requires a transition from manual oversight to automated real-time monitoring. Traditional surveillance often fails to provide immediate intervention because it relies on human operators who may overlook critical incidents due to fatigue or distraction. SafeEYE AI overcomes these limitations by integrating computer vision and deep learning to analyze CCTV feeds for specific threats like fire, weapons, and fighting. By utilizing advanced anomaly detection and a strategic thresholding concept, the system identifies dangerous patterns and instantly transmits evidence-based alerts via Firebase Cloud Messaging. This framework drastically improves situational awareness and response times, creating a more secure environment through the seamless application of intelligent automation.

Index Terms- Surveillance, Anomaly Detection, Computer Vision, Deep Learning, Real-Time Monitoring, Public Safety

I. INTRODUCTION

In the current global climate, effective surveillance is essential for maintaining public safety, leading to a surge in studies exploring intelligent security systems. While significant research has focused on utilizing deep learning—specifically through convolutional networks, temporal models, and hybrid architectures—many existing solutions are restricted by a narrow range of detectable threats or a lack of real-time processing capabilities. Conventional CCTV monitoring remains heavily dependent on human operators, a method that is inherently flawed due to the risks of fatigue and distraction. SafeEYE AI was conceived to bridge this gap, offering an automated detection framework capable of identifying diverse anomalies instantly, thereby minimizing manual labor and enabling rapid, data-driven interventions.

The primary objective of the SafeEYE AI project is to deploy advanced computer vision and deep learning to identify and respond to critical incidents such as fire, smoke, weapons, and physical altercations as they occur. Beyond simple detection, the project emphasizes the creation of high-reliability modules integrated with cloud messaging systems to ensure that emergency alerts are delivered without delay. By establishing a robust foundation that allows for the future addition of new categories like trespassing or theft, SafeEYE AI aims to transform public monitoring into a smarter, more proactive, and highly responsive infrastructure that enhances overall societal security.

II. PROBLEM STATEMENT

CCTV systems are installed in many places all over the world, but have a major constraint because of the need for continuous human monitoring. In many real-world examples, security in-charge must continuously watch numerous CCTV feeds and remain awake and alert for a longer duration of time, which is not doable at all. Moreover, human observation cannot be relied upon due to fatigue, which often results in delayed responses or missed incidents. The problem stated above is solved by SafeEYE AI, an automated, AI-powered surveillance tool for recognizing various abnormal events such as fights, weapons, smoke and fire outbreaks. This system provides alerts to the responsible authorities so that appropriate action can begin immediately. The integration of Artificial Intelligence enables SafeEYE AI analyze videos

continuously with good accuracy, and this also helps in decreasing dependency on manual supervision. Using this system will eliminate the possibility of a dangerous incident being missed, and improve the effectiveness of the new generation of security systems.

III. LITERATURE SURVEY

TABLE I: Analysis of Existing Research Works

Authors & Year	Concepts	Advantages	Limitations	What features Safe-EYE AI include:
H. Nagar 2023 et al., 2023 [1]	CNN-based real-time anomaly detection from CCTV footage	Practical real-time implementation	Limited anomaly categories, no scalable alert mechanism	Cloud-based alerts and extensible anomaly detection
M. M. Rahman et al., 2021 [2]	Deep neural networks for anomaly detection and classification	High detection accuracy	Computationally expensive, limited deployment focus	Optimised real-time pipeline with automated alerts
Priyanka H. et al., 2025 [3]	Comparative study of video anomaly detection approaches	Broad methodological coverage	Experimental focus, no real-time response	Fully deployed end-to- end surveillance system
C.-W. Chang et al., 2022 [4]	Spatial–temporal modeling using CNN and LSTM	Effective behaviour modelling	High latency, complex architecture	Faster inference with immediate response triggering
V. Singh et al., 2020 [5]	Neural-network-based abnormal activity recognition	Early real-time surveillance approach	Limited datasets and anomaly scope	Modern deep models with multi-anomaly detection
M. M. Ali, 2022 [6]	Smart surveillance using anomaly scoring methods	Efficient in controlled settings	No automatic alerting or response	Integrated emergency notification system

IV. OBJECTIVES

The goals of the system, SafeEYE AI are:

- Real-Time Multimodal Incident Detection: Develop high-performance AI models capable of the instantaneous identification of high-risk events—including fire, smoke, weapons, and physical violence—by analyzing the temporal sequences of CCTV footage. The system is designed to provide continuous, automated scanning to ensure no critical incident goes unnoticed.
- Instantaneous Evidence-Based Notification: Implement an automated alert system that provides immediate notification to relevant authorities upon the detection of an anomaly. These alerts will deliver a comprehensive package of textual evidence, empowering security personnel to evaluate the situation accurately and initiate rapid response protocols.
- Scalable and Integrative Architecture: Engineer a flexible system architecture that facilitates the seamless addition of new detection categories and simplifies integration with existing surveillance infrastructures.
- Emergency Response Optimization: Minimize critical response times by replacing traditional, fatigue-prone human monitoring with an automated alert generation system. The platform enables faster situational assessment and more effective emergency management compared to conventional security models.

V. HIGH-LEVEL SYSTEM OVERVIEW

The top-level architecture of the SafeEYE AI looks like:

- Video Capture: CCTV Cameras receive and record live video streams and transmit them to the preprocessing module.
- Frame Extraction and Preprocessing: The video frames that have been taken by the CCTV Cameras are extracted from the input videos and processed (resized and normalized) to enhance the precision of the model output.
- Spatial Detection Module: It will be applied to produce various objects that have been detected at

each frame and a visual representation (e.g. smoke, fire, weaponry use, physical fight).

- Temporal Analysis Module: It will examine the temporal variation between frames (e.g. unexpected crowd movement).
- Anomaly Confirmation and Alerting: In case the confidence of any anomalous event surpasses a definite limit, an alert concerning that anomalous event is emitted to the concerned authorities via dashboard.

Figure 1shows the architecture diagram.

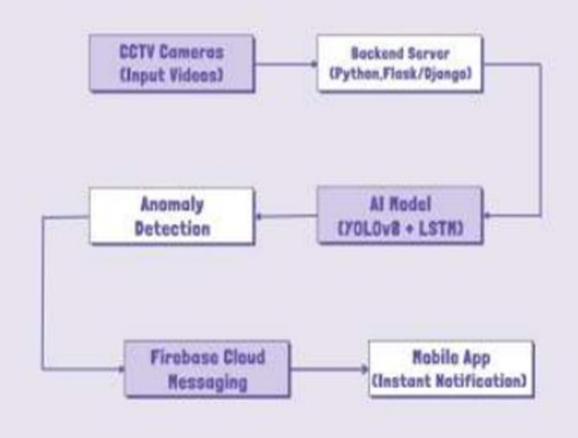

Fig. 1: High-level architecture of the SafeEYE AI system

VI. PROPOSED METHODOLOGY

The proposed methodology for SafeEYE AI centers on a hybrid deep learning framework designed for real-time video analysis. The process begins with Stream Acquisition, where raw CCTV feeds are captured and tagged with temporal metadata. This is followed by Data Pre-processing, involving normalization and resizing to ensure consistent input quality. The core analysis utilizes a dual-path architecture: Spatial Detection (using CNNs) identifies objects like weapons or fire in individual frames, while Temporal Analysis (using LSTMs) evaluates motion sequences to detect behavioral anomalies like fighting. Once a detection exceeds a predefined confidence Threshold, the system triggers an automated Alerting phase, dispatching visual and textual evidence via Firebase Cloud Messaging to a centralized dashboard for immediate intervention.

VII. REPRESENTATIVE OUTPUTS

The output below shows the visualizations of the detected anomalies and notifications being sent. The figure illustrates multiple outputs depicting how detections such as fights, smoke, fire outbreaks and alerts are visually presented to the respective staff or authorities.

Fig. 2: Fire Detection

Fig. 3: Fight Detection

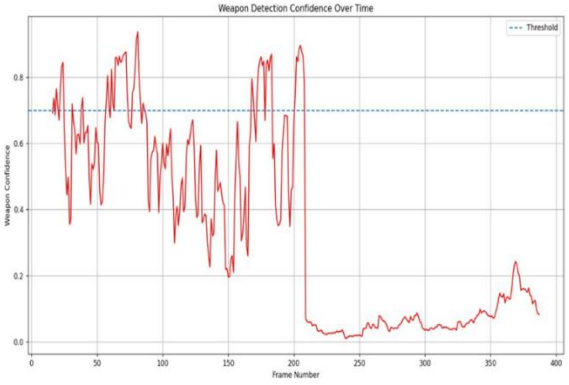

Fig. 4: Confidence Scores of Weapon Detection Module During Testing

Fig. 5: SafeEYE AI Dashboard

VIII. USE CASES AND DEPLOYMENT ENVIRONMENTS

SafeEYE AI can be used in multiple environments, such as:

- Educational Campuses: Schools and universities can secure both indoor and outdoor facilities by monitoring for physical altercations, weapon possession, or fire hazards, ensuring a protected environment for students and faculty.
- Public Spaces: High-traffic areas—such as marketplaces, transit stations, and shopping centers—benefit from real-time oversight to identify violent behavior, concealed weapons, and fire risks within dense crowds.
- Industrial Units: In high-risk settings like factories, warehouses, and production plants, the system provides early detection of smoke, fire, or safety breaches. This proactive approach prevents large-scale infrastructure damage and prioritizes worker welfare.

IX. LIMITATIONS

The limitations of the SafeEYE AI system are:

- Environmental and Hardware Dependencies: The precision of object detection is highly sensitive to ambient lighting conditions and camera resolution. To mitigate these effects and ensure model reliability, extensive pre-processing and data augmentation are required during the development phase.
- False Positive Management: Maintaining a low false-alarm rate remains a challenge, particularly in high-density environments where complex crowd dynamics can trigger erroneous alerts. Continuous refinement of anomaly validation logic is necessary to improve accuracy.
- Privacy and Regulatory Compliance: Deployment in public sectors necessitates strict adherence to regional privacy mandates and surveillance regulations. The system must be configured to balance effective monitoring with the legal rights of individuals.

X. FUTURE SCOPE

In the original SafeEYE AI System, the following enhancements will be undertaken as future improvements:

- A wider range of potential anomaly detection types will be included.
- Develop a direct connection to the Authorities' Security Management Dashboard, and implement an Automatic SMS (Short Message Service) alert functionality.

XI. CONCLUSION

SafeEYE AI is a cutting-edge automated surveillance framework that leverages deep learning to identify life-threatening incidents—such as fire, smoke, weapons, and violence—in real time. By synthesizing object detection with temporal analysis, the platform provides instantaneous notifications that significantly reduce the burden of manual, human-led monitoring. When a critical event is detected, the system immediately alerts the proper authorities with actionable evidence, drastically shortening response windows. With a scalable architecture designed for diverse environments—ranging from educational campuses to high-traffic public hubs—SafeEYE AI offers a robust solution for modern security challenges, ultimately fostering a safer environment through intelligent, data-driven oversight.

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