

INTELLIGENT SURVEILLANCE SYSTEM FOR REAL-TIME CRIME DETECTION AND BEHAVIOUR ANALYSIS

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Abstract:

Conventional surveillance depends heavily on continuous human observation of camera feeds, which can lead to fatigue, delayed threat recognition, and inconsistent response. This paper presents an intelligent surveillance framework for real-time crime detection and behavior analysis using computer vision and deep learning. The proposed approach processes live camera input through OpenCV, detects relevant objects using YOLO, extracts visual patterns using a convolutional neural network (CNN), and analyses activity sequences using Long Short-Term Memory (LSTM). Detected events are assigned threat levels and can trigger automated notifications containing incident information. The architecture also considers multi-camera monitoring, edge processing and cloud-based storage to improve responsiveness, scalability and incident management. An estimated comparison of the techniques reported in the project indicates that CNN provides the strongest overall classification performance, while YOLO is particularly suitable for real-time object detection and LSTM contributes to temporal behavior analysis. The proposed framework reduces dependence on manual monitoring and provides a practical foundation for faster, more consistent and proactive surveillance.

Keywords: intelligent surveillance, crime detection, behavior analysis, YOLO, CNN, LSTM, computer vision, real-time monitoring

1. Introduction

Public safety increasingly depends on surveillance systems capable of recognizing potentially harmful events quickly and supporting timely intervention. Traditional CCTV installations are effective for recording and later investigation, but their operational value is constrained when an operator must watch several live feeds continuously. Prolonged observation can introduce fatigue and reduce situational awareness, particularly in crowded environments such as transport facilities, educational institutions and public spaces.

The project addresses this limitation through an automated surveillance framework that analyses live video rather than relying entirely on manual inspection. The system is designed to detect persons and relevant objects, track movement, examine behavioral patterns and classify situations according to their potential threat level. OpenCV is used for continuous video and frame handling, while YOLO provides real-time object detection. CNN-based visual analysis and LSTM-based temporal analysis are combined to interpret activities across individual frames and sequences.

The framework is intended to support, rather than replace, human decision-making. When a detected event crosses a configurable confidence threshold, the system can generate an alert with information such as camera identification, event time and threat severity. The architecture also supports centralized incident records and multiple notification channels, creating a basis for rapid response and later review.

2. Literature Review

Recent research shows increasing use of artificial intelligence for automated surveillance, crime detection and security analytics. Anandhi [1] examined edge-computing-based crime-scene object detection from surveillance video using deep learning, indicating the value of processing data close to the point of capture. Dhanwanth et al. [2] investigated ensemble machine learning for crime detection and prevention, demonstrating the relevance of combining learning approaches for security-oriented classification.

Kaushik et al. [3] proposed an AI-based detection and tracking approach for real-time surveillance, emphasizing continuous automated monitoring. Kolaib and Jumana Waleed [4] reviewed deep-learning-based video crime detection systems, supporting the use of learned visual representations for identifying suspicious events. Kumar et al. [5] focused on criminal-activity detection from live CCTV footage, highlighting the importance of real-time analysis rather than post-event video inspection.

Mandalapu et al. [6] systematically reviewed machine learning and deep learning methods for crime prediction and discussed opportunities for future research. Meghana et al. [7] examined AI-driven cybercrime and proactive digital defense, illustrating the broader role of intelligent technologies in security. Menaga et al. [8] presented an AI and machine-learning approach for proactive crime prediction and crowd management. Nandhini and Thinakaran [9] studied deep-learning techniques for crime-scene object detection, while Nwankwo et al. [10] discussed intelligent systems for crime and insecurity management.

Taken together, these studies indicate a progression from simple video recording toward automated detection, tracking, prediction and response. However, a practical surveillance solution needs to integrate several stages in one workflow. The present project therefore combines live video processing, object detection, visual feature analysis, temporal behavior analysis and alert generation.

3. Case and Methodology

3.1 Live camera input and frame processing

The current project workflow uses a laptop webcam as the live input source. OpenCV captures the stream and provides frames for subsequent analysis. The project report does not identify a separate public benchmark dataset; therefore, the input should be described as live webcam activity recordings unless a separately documented dataset is confirmed.

3.2 Object detection and tracking

YOLO is used for detecting persons and relevant objects in camera frames. Detected objects are then passed to the tracking stage to support continuity of observation across frames.

3.3 Behavior analysis and classification

The workflow analyses activities and presents a classification such as Safe, Warning, or Danger. CNN and LSTM are discussed in the project report for visual-feature and temporal-sequence analysis respectively. Their inclusion as executed components should be confirmed against the actual running implementation before submission.

3.4 Incident history

The project records detection-history items containing captured images and associated activity descriptions or status labels. This record supports review of previous detections.

3.5 Workflow

Live webcam → OpenCV frame capture and processing → YOLO object detection → tracking → behavior analysis → Safe/Warning/Danger classification → incident record and alert output.

4. Performance Evaluation

The evaluation framework uses a confusion matrix and standard classification measures. TP denotes correctly detected threat cases; TN denotes correctly identified non-threat cases; FP denotes non-threat cases incorrectly flagged; FN denotes threat cases missed by the system.

Accuracy = $(TP + TN) / (TP + TN + FP + FN)$

Precision = $TP / (TP + FP)$

$$\text{Recall} = \text{TP} / (\text{TP} + \text{FN})$$

$$\text{F1-score} = 2 \times (\text{Precision} \times \text{Recall}) / (\text{Precision} + \text{Recall})$$

A reproducible evaluation should specify the number of test clips or frames, activity classes, ground-truth labels, test procedure, and per-class confusion counts. Processing latency may also be recorded for real-time use.

5.Result And Discussion

Technique	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
YOLO	90	89	88	88.5
CNN	92	91	90	90.5
LSTM	89	88	87	87.5
OpenCV	87	86	85	85.5

Table: Estimated comparison reproduced from the project viva report.

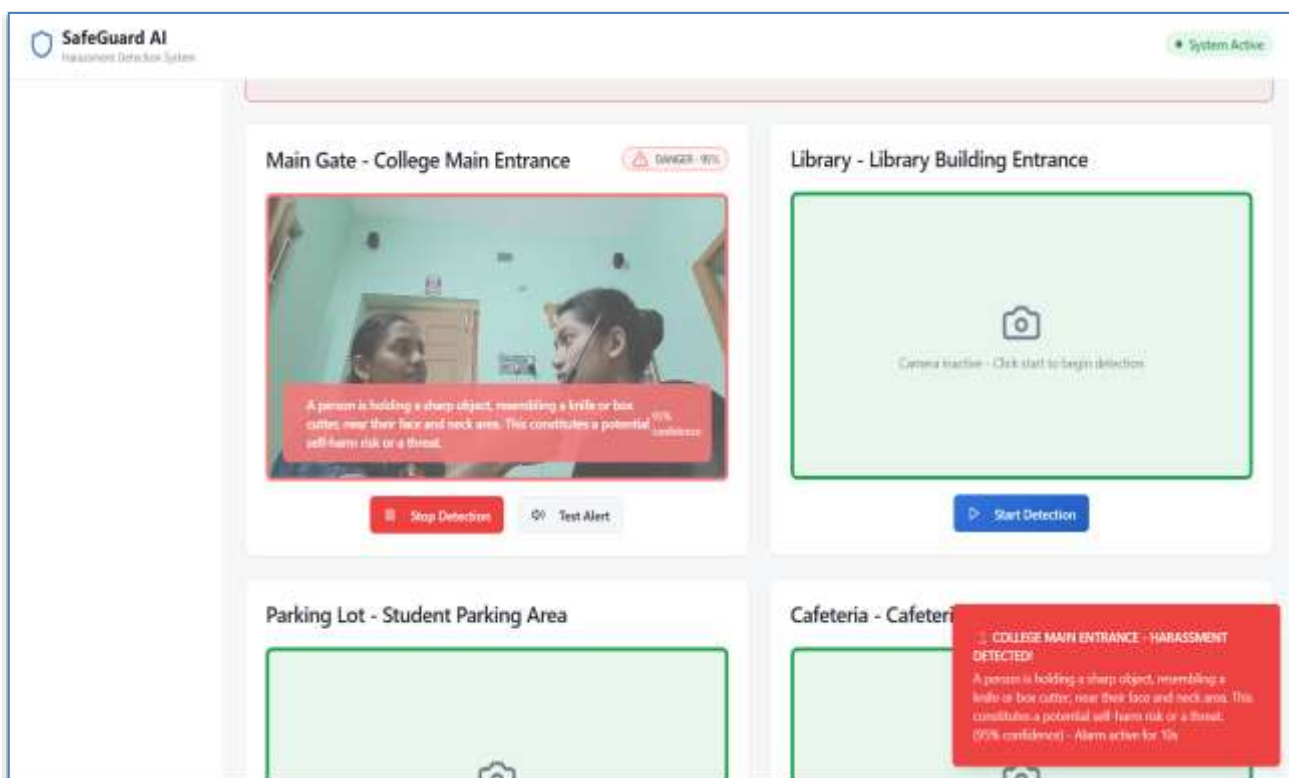
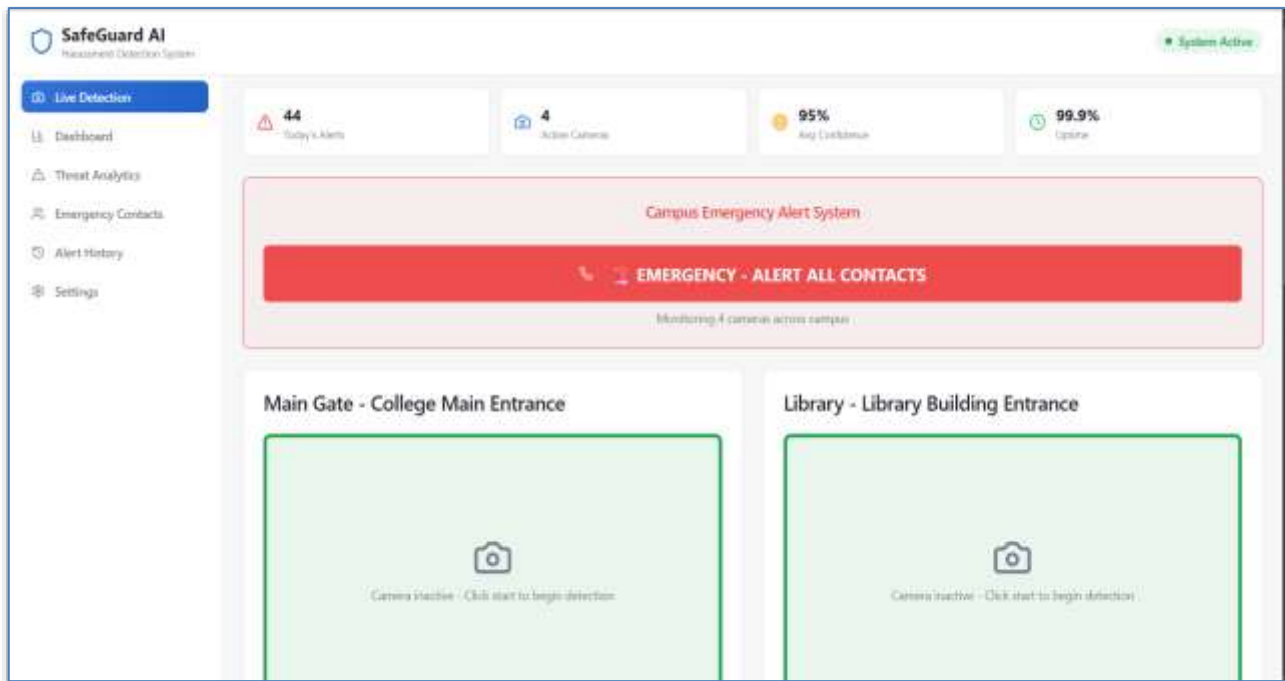
The comparison shows that CNN has the highest estimated accuracy of 92%, followed by YOLO at 90%, LSTM at 89%, and OpenCV at 87%. CNN provides effective visual feature analysis, while YOLO supports real-time object detection. LSTM is useful for analysing behavioural patterns over a sequence of frames, whereas OpenCV primarily supports real-time frame capture and image processing. The combined use of these techniques contributes to the overall real-time surveillance and threat detection capability of the proposed system.

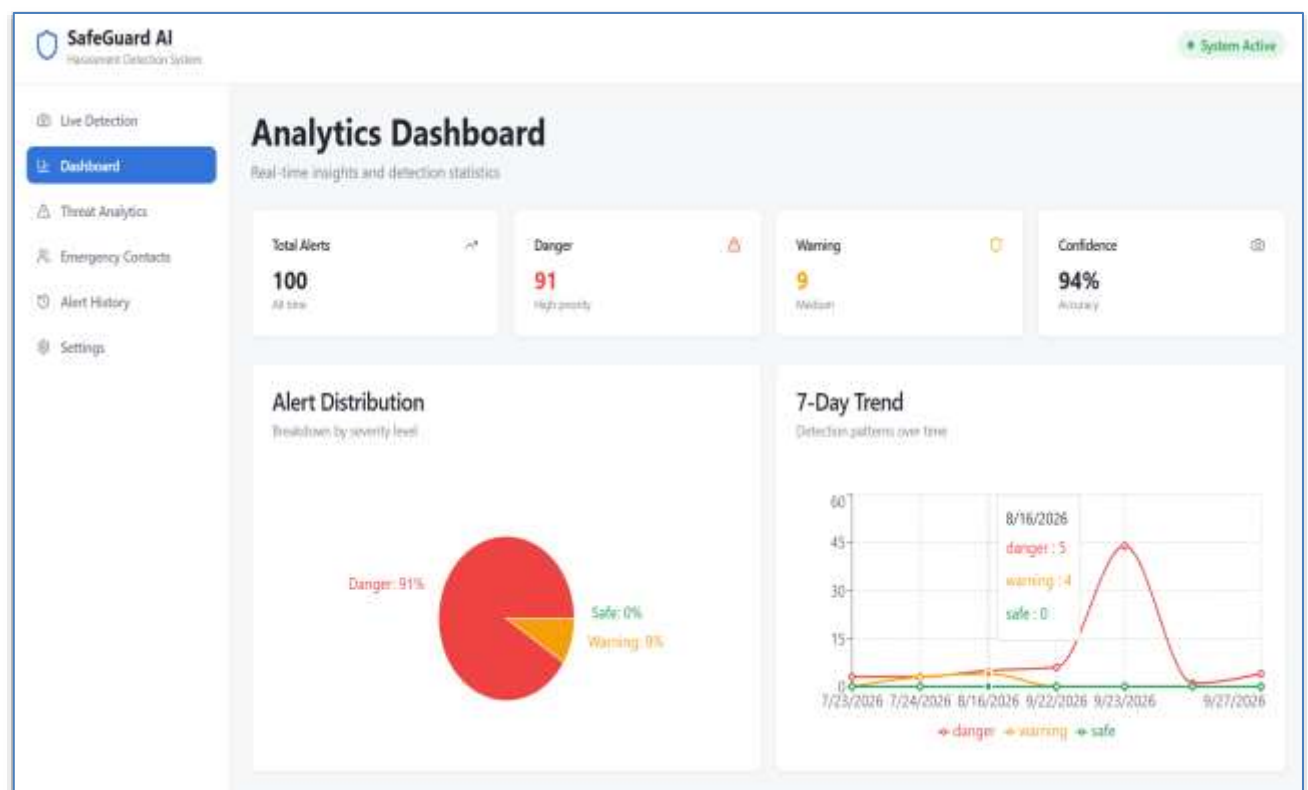
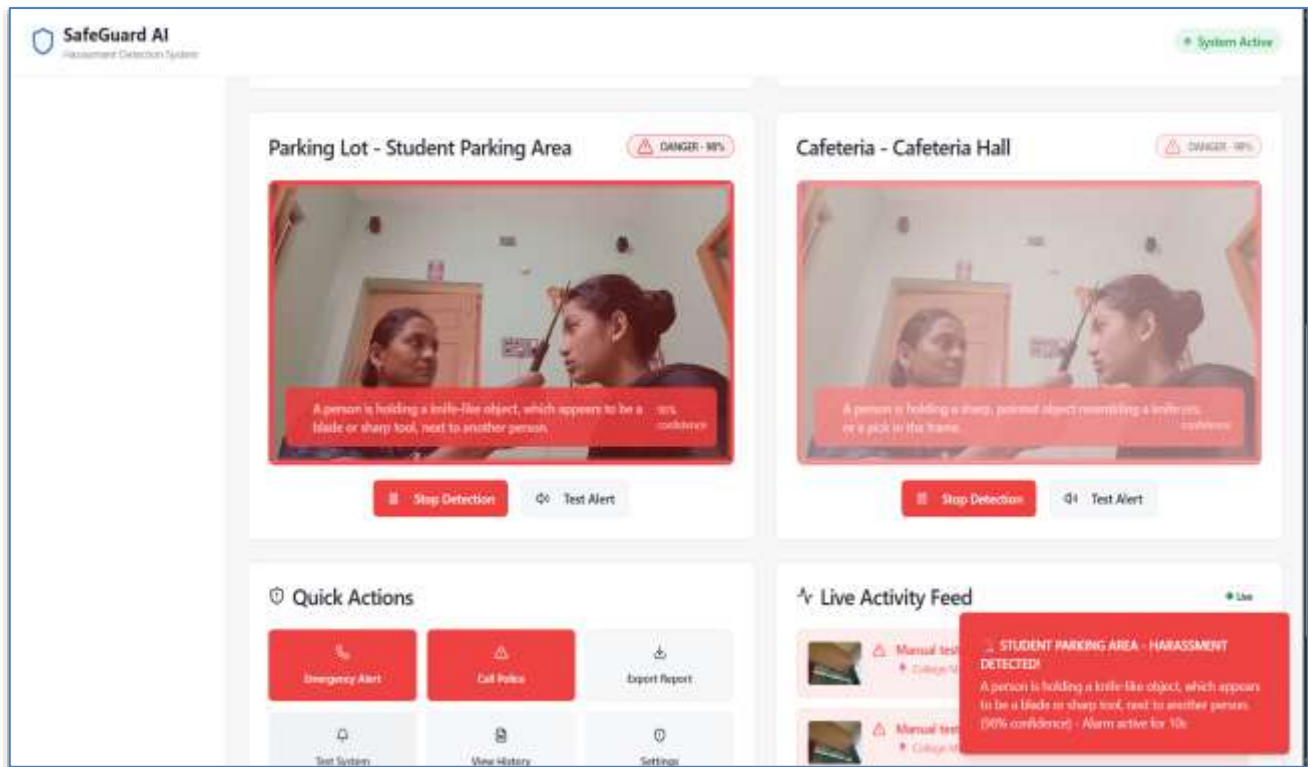
6. Conclusion

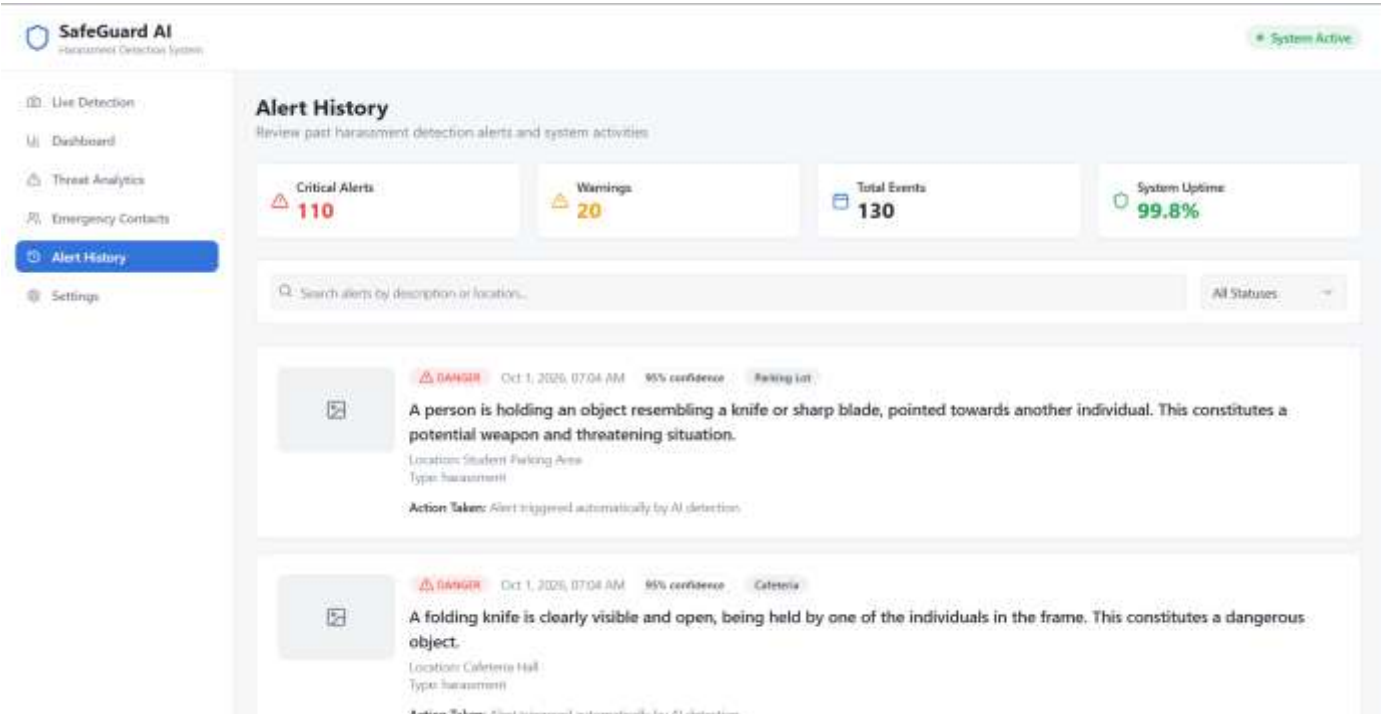
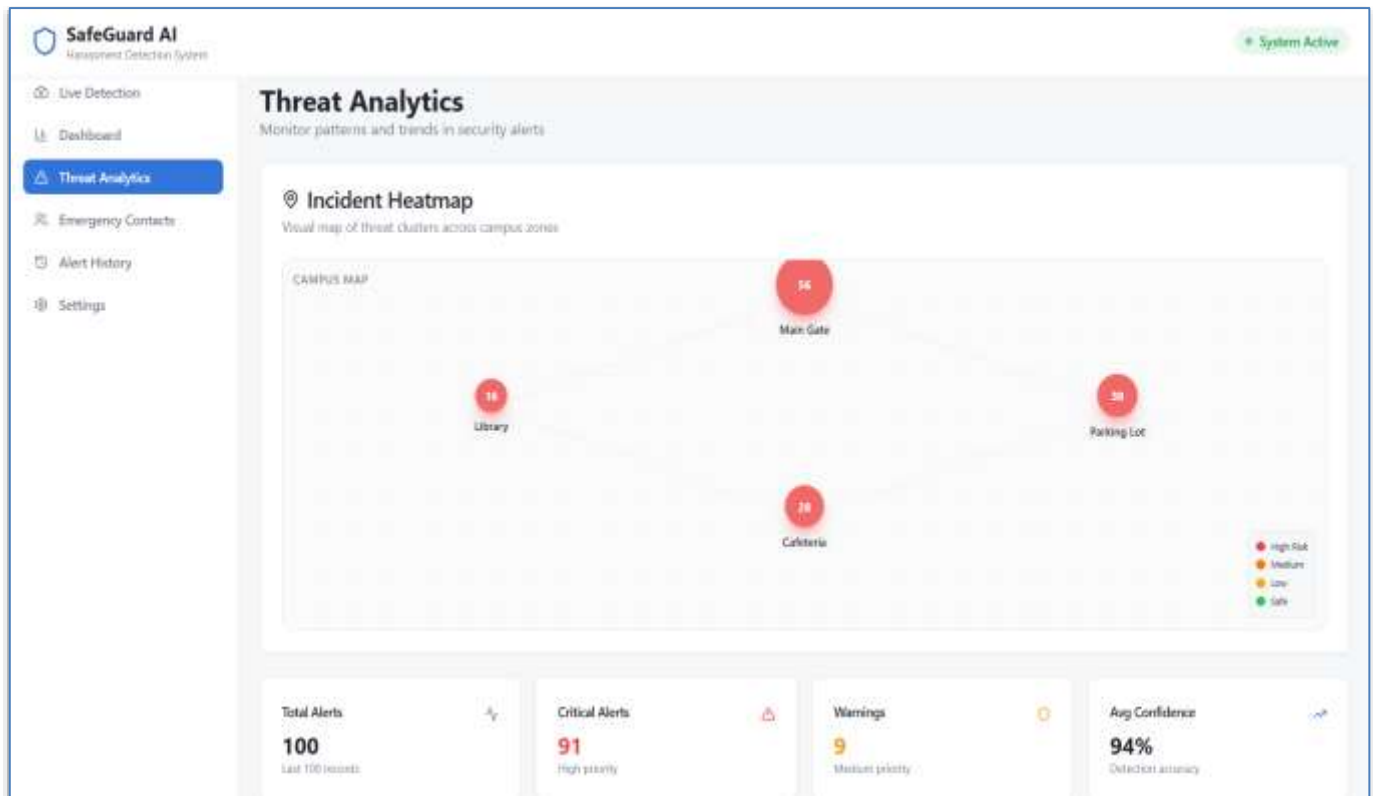
The proposed intelligent surveillance framework provides an automated approach to real-time crime detection and behavior analysis by integrating computer vision, object detection and temporal deep learning. Its main contribution is the combination of OpenCV, YOLO, CNN and LSTM within a single surveillance workflow, allowing the system to move from raw camera frames to threat classification and automated response. This reduces dependence on continuous manual observation and can improve the consistency and speed of surveillance analysis.

The project-level performance comparison suggests that CNN provides strong visual classification capability, while YOLO is well suited to real-time detection and LSTM contributes temporal understanding of activities. Edge processing, cloud-based incident storage and configurable alerts further support practical deployment. Future development can extend the framework toward crime-risk assessment, hotspot identification, audio-based aggression detection, improved multi-camera coordination and integration of additional sensors. Overall, the approach provides a scalable foundation for proactive and responsive intelligent surveillance.

7.Qualitative Verification Results







SafeGuard AI
Harassment Detection System

System Active

Action Taken: Alert triggered automatically by AI detection

 **DANGER** Oct 1, 2026, 07:04 AM 100% confidence Parking Lot
A knife is clearly visible and is being held in front of a person's face, pointing towards them. This constitutes a direct threat and a dangerous situation due to the presence of a sharp weapon in close proximity to an individual.
Location: Student Parking Area
Type: harassment
Action Taken: Alert triggered automatically by AI detection

 **DANGER** Oct 1, 2026, 07:04 AM 99% confidence Cafeteria
A sharp, blade-like object resembling a knife or letter opener is being held in the center of the frame, pointed upwards.
Location: Cafeteria Hall
Type: harassment
Action Taken: Alert triggered automatically by AI detection

 **DANGER** Oct 1, 2026, 07:04 AM 98% confidence Parking Lot
A person is holding a knife-like object, which appears to be a blade or sharp tool, next to another person.
Location: Student Parking Area
Type: harassment
Action Taken: Alert triggered automatically by AI detection

 **DANGER** Jul 24, 2026, 10:41 AM 95% confidence Main Gate
A knife is clearly visible, held by one of the individuals in the bottom right portion of the frame.
Location: College Main Entrance
Type: harassment
Action Taken: Alert triggered automatically by AI detection

 **DANGER** Jul 24, 2026, 10:41 AM 95% confidence Library
A person is holding a knife, clearly visible in the lower right portion of the frame.
Location: Library Building Entrance
Type: harassment
Action Taken: Alert triggered automatically by AI detection

 **DANGER** Jul 12, 2026, 05:11 PM 90% confidence Main Gate
A wooden stick is held close to a person's neck, which could be interpreted as a threatening gesture or a dangerous situation for the person involved.
Location: College Main Entrance
Type: harassment
Action Taken: Alert triggered automatically by AI detection

 **WARNING** Jul 12, 2026, 05:08 PM 75% confidence Main Gate
One person is holding a long stick, which could potentially be used as a weapon.
Location: College Main Entrance
Type: harassment
Action Taken: Alert triggered automatically by AI detection

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Disclosure Statement

The authors declare no financial or commercial conflict of interest related to the research framework presented in this paper. The system is intended as a research and decision-support tool and should be deployed only in accordance with applicable privacy, surveillance, data-protection, and institutional policies.

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