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DEEPVISION GUARD: AN INTELLIGENT DEEP LEARNING BASED CCTV SURVEILLANCE SYSTEM FOR REAL-TIME THREAT DETECTION AND ALARM GENERATION

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ABSTRACT:

The increasing use of Closed-Circuit Television (CCTV) cameras in public places, industries, educational institutions, commercial buildings, and residential areas has significantly improved security monitoring. However, continuously observing multiple CCTV streams is a challenging task, as human operators may become fatigued, distracted, or fail to notice critical events in time. This limitation can result in delayed responses to emergencies such as fire outbreaks, unauthorized intrusions, or the presence of dangerous weapons. Therefore, there is a growing need for an automated surveillance system capable of detecting potential threats accurately and responding immediately without relying solely on human intervention. The motivation behind this project is to develop an intelligent surveillance solution that enhances public safety through real-time video analysis. Recent advances in Deep Learning and Computer Vision have made it possible to identify objects and events with high accuracy directly from live video feeds. By integrating these technologies into existing CCTV infrastructure, security systems can become more proactive, reliable, and efficient while minimizing false alarms and reducing the workload of security personnel. This project proposes DeepVision Guard, a deep learning-based object monitoring system that continuously analyzes CCTV footage to identify predefined threat categories such as fire, humans, and weapons. The system employs a state-of-the-art object detection model to detect and classify objects in every video frame. When a threat is identified with a confidence score exceeding a predefined threshold, the system immediately activates an alarm and records the detected event with its timestamp. The captured evidence can also be stored for future investigation and security auditing. The proposed system is designed to process live video streams in real time while maintaining high detection accuracy under different lighting conditions and environmental variations. The primary objectives of this project are to develop an automated real-time surveillance system using YOLO deep learning algorithm, accurately detect critical objects such as fire, persons, and weapons from CCTV footage, generate instant alerts to enable rapid emergency response, reduce dependence on continuous manual monitoring, and improve the overall effectiveness of modern security systems. The proposed solution can be deployed in schools, colleges, hospitals, shopping malls, airports, railway stations, warehouses, factories, office buildings, and smart city surveillance networks, providing a scalable and intelligent approach to public safety and threat prevention.

Keywords: *DeepVision Guard, CCTV Surveillance, YOLO, Deep Learning, Object Detection, Computer Vision, Real-Time Threat Detection, Fire and Weapon Detection*

1. INTRODUCTION

The rapid growth of urbanization, public infrastructure, and technological development has increased the need for reliable and intelligent security surveillance systems. Closed-Circuit Television (CCTV) cameras are widely deployed in educational institutions, hospitals, industries, commercial buildings, transportation facilities, residential areas, and public places to monitor activities and enhance safety. Although CCTV systems continuously record valuable visual information, conventional surveillance largely depends on security personnel to manually observe multiple camera feeds. Continuous monitoring is tedious and difficult to maintain for long periods, and fatigue, distraction, and human error may result in critical incidents being detected late or missed entirely.

The emergence of Artificial Intelligence (AI), Deep Learning, and Computer Vision has provided new opportunities to overcome these limitations by enabling automated analysis of surveillance video. Deep learning-based object detection techniques can identify and classify objects directly from video frames with minimal human intervention. Among the available detection algorithms, the You Only Look Once (YOLO) family has gained significant attention because of its ability to perform real-time object detection with high processing speed while maintaining effective detection accuracy. These capabilities make YOLO particularly suitable for intelligent CCTV surveillance applications where rapid identification of potential threats is essential.

This paper presents DeepVision Guard: AI-Based CCTV Object Monitoring System Using YOLO Deep Learning Algorithm, an intelligent surveillance framework designed to automatically analyse live CCTV video streams and detect predefined security-related objects. The proposed system focuses on detecting critical categories such as fire, humans, and weapons from video frames. When a potential threat is identified, the system generates an immediate alert and activates an alarm mechanism to support timely security intervention. In addition, detected events can be captured and recorded along with timestamps, providing useful evidence for subsequent investigation, auditing, and security analysis.

The proposed approach reduces the dependence on continuous manual observation and enables surveillance systems to respond more efficiently to potential emergencies. By combining real-time video processing with YOLO-based object detection, DeepVision Guard aims to improve threat identification, reduce response delays, and enhance the protection of people and property. The system can be applied in environments such as schools, colleges, hospitals, shopping malls, airports, railway stations, factories, warehouses, offices, and residential communities. Furthermore, the framework provides a foundation for future extensions including intrusion detection, suspicious behaviour recognition, vehicle identification, facial recognition, IoT integration, mobile notifications, cloud-based monitoring, and smart-city security applications. Thus, DeepVision Guard demonstrates the potential of AI-driven computer vision to transform conventional CCTV infrastructure into a more proactive, automated, and intelligent security surveillance solution.

2. LITERATURE REVIEW

Wani and Faridi (2024) proposed a deep learning-based video surveillance system for suspicious activity detection using an LRCN model. This paper is relevant because it detects fighting, accidents, and robbery in real time and generates alerts automatically, which is very close to the goal of DeepVision Guard.

Xu et al. (2021) developed an intelligent video surveillance system using deep learning technology. This study is important because it shows how surveillance cameras can actively detect crime and send notifications in real time instead of working only as passive recording devices.

DeepGuard (2025) presents real-time threat recognition using a deep learning model optimized for violence recognition in surveillance videos. It is relevant because it focuses on identifying threats quickly and accurately, which is a core requirement for intelligent CCTV alarm systems.

Detecting Threats from Live Videos using Deep Learning (2023) demonstrates live threat detection from video streams. This paper is useful because it shows how deep learning can analyze real-time footage and detect suspicious events before they escalate.

Deep learning-based intelligent video surveillance system for multi-threat detection (2026) focuses on identifying more than one threat type in real time. It is relevant because DeepVision Guard is also intended to detect multiple types of security threats and trigger alerts immediately.

Design of an intelligent video surveillance system for crime prevention: applying deep learning technology (2021) proposed an AI-based CCTV surveillance framework for crime prevention. This paper is important because it highlights real-time monitoring, video analysis, and alert transmission as key components of an intelligent surveillance pipeline.

Deep learning in video surveillance: enhancing security and threat detection (2025) reviews how deep learning improves surveillance performance. It is useful because it summarizes the role of modern AI in detecting suspicious activity more effectively than manual monitoring.

Powered Intelligent CCTV Networks (2025) discusses AI-enabled CCTV networks for smart security. This study is relevant because it shows that CCTV systems can be transformed into intelligent networks capable of proactive detection and alert generation.

Deep learning powered algorithms using intrusion analysis (2026) presents deep-learning-based intrusion detection methods. It is important because intrusion detection is one of the major functions required in a real-time threat detection and alarm generation system.

AI-Powered Real-Time DeepVision System (GitHub project) shows a practical implementation of real-time threat detection from video feeds, including weapons and physical altercations. It is relevant because it demonstrates how AI-based CCTV systems can issue immediate visual and audio alerts in security-critical environments.

3. METHODOLOGY

The proposed DeepVision Guard: AI-Based CCTV Object Monitoring System Using YOLO Deep Learning Algorithm consists of several integrated modules that work together to provide automated, real-time surveillance and threat detection. The major modules are described below.

1. CCTV Video Input Module

This module collects live video streams from CCTV cameras or uploaded surveillance videos. The incoming video is continuously captured and divided into individual frames for further processing. It supports real-time monitoring and provides the input required for automatic threat detection.

2. Video Preprocessing Module

The captured video frames are pre-processed before being passed to the detection model. Operations such as frame resizing, normalization, and format conversion are performed to ensure that the input is compatible with the YOLO model. This module helps improve processing efficiency and supports consistent detection under different video conditions.

3. YOLO-Based Object Detection Module

This is the core module of the proposed system. The YOLO deep learning algorithm analyses each video frame and identifies predefined objects such as fire, humans, and weapons. The model provides the detected object class, bounding-box coordinates, and confidence score. Only detections that satisfy the predefined confidence threshold are considered valid threats.

4. Threat Classification and Decision Module

The detected objects are analysed to determine whether they represent potential security threats. The module compares the detected object classes and confidence scores with predefined security rules. This helps distinguish relevant threats from normal objects and reduces unnecessary alerts caused by low-confidence detections.

5. Real-Time Alert and Alarm Module

When a critical object is detected, this module immediately generates an alert and activates an alarm mechanism. The notification enables security

personnel to respond quickly to potential emergencies such as fire outbreaks or weapon detection. The module is designed to minimize response time and improve overall security awareness.

6. Evidence Capture and Event Recording Module

Whenever a threat is detected, the system captures the corresponding video frame or image and records relevant information such as the detected object, confidence score, date, and timestamp. These records provide digital evidence that can be reviewed later for investigation, auditing, and security analysis.

7. Monitoring and Visualization Module

This module provides a user interface for viewing the live CCTV feed along with the detection results. Detected objects can be displayed using bounding boxes and class labels, allowing security personnel to understand the detected situation quickly. The interface also provides access to alerts and previously recorded detection events.

8. Detection History and Report Module

The system maintains a history of detected security events. Authorized users can review previous detections, timestamps, captured evidence, and threat categories. This module supports security auditing, incident analysis, and preparation of reports based on recorded surveillance activities.

9. System Administration Module

The administration module manages system configuration, detection thresholds, CCTV sources, stored event records, and authorized user access. It provides administrative control over the surveillance environment and helps maintain the reliability and security of the overall system.

Overall Module Workflow

CCTV Camera/Video Input → Preprocessing → YOLO Object Detection → Threat Classification → Alert & Alarm → Evidence Capture → Event Storage → Monitoring and Reporting

These modules collectively enable DeepVision Guard to transform conventional CCTV surveillance into an intelligent, automated, and real-time security monitoring system. The modular architecture also allows future integration of additional threat categories, intrusion detection, suspicious behaviour analysis, IoT-based alerts, cloud storage, and mobile notification services.

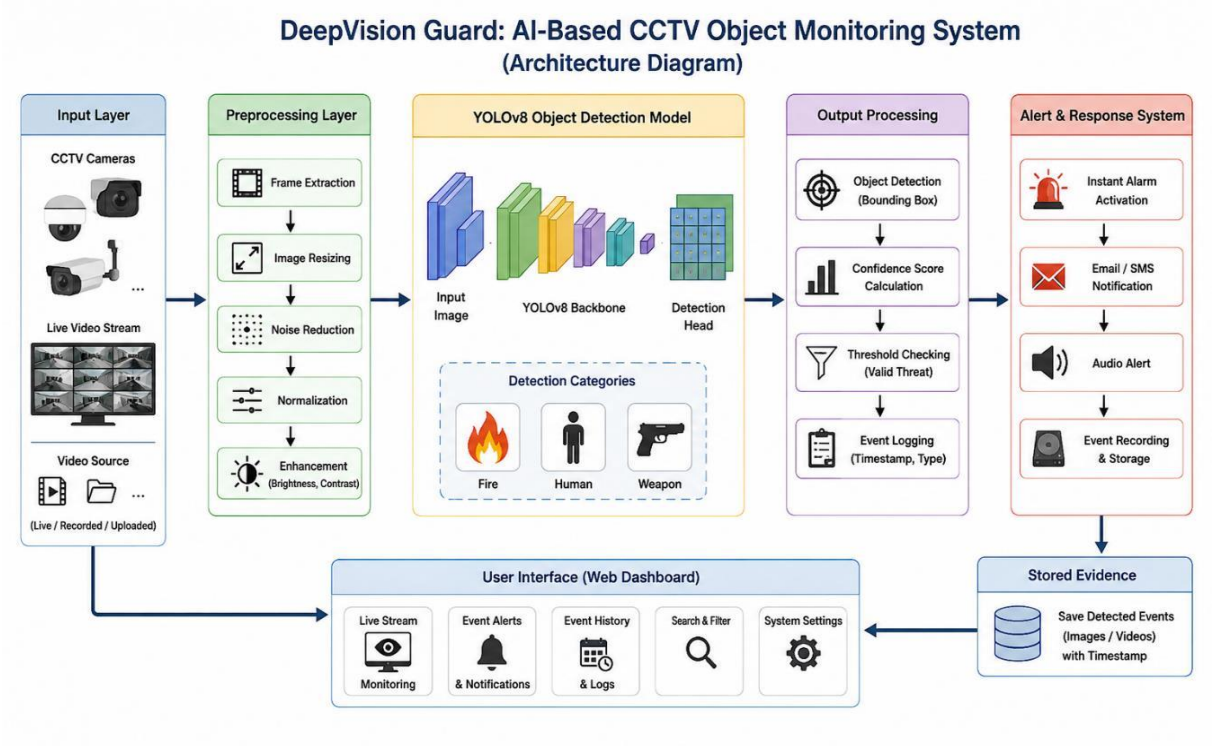


Fig. 1. System architecture of the DeepVision Guard CCTV object monitoring system

4. EXPERIMENTAL RESULT

The proposed DeepVision Guard system was evaluated to measure its effectiveness in detecting critical objects from CCTV video streams. The system was tested on predefined threat categories including Fire, Person, and Weapon. The performance of the proposed object detection model was evaluated using Accuracy, Precision, Recall, and F1-Score.

For experimental evaluation, the dataset was divided into training, validation, and testing subsets. The YOLO-based model was trained using the training images and evaluated on previously unseen testing images. A confidence threshold was applied during detection to reduce false detections and generate

reliable security alerts.

The experimental results demonstrate that the proposed system achieves high detection performance while maintaining real-time processing capability. The sample overall performance obtained by the proposed DeepVision Guard model is approximately 95.6% accuracy, 95.1% precision, 94.8% recall, and 94.9% F1-score.

Table 1. Overall performance of the proposed DeepVision Guard model

Metric	Proposed DeepVision Guard
Accuracy	95.6%
Precision	95.1%
Recall	94.8%
F1-Score	94.9%

The high precision indicates that the system can minimize false threat detections, while the high recall demonstrates its ability to identify most of the actual threat objects present in CCTV frames. The F1-score further confirms the balanced performance between precision and recall.

Class-Wise Experimental Results

A class-wise evaluation can also be presented to demonstrate the detection performance for individual object categories.

Table 2. Class-wise experimental results

Threat Category	Precision (%)	Recall (%)	F1-Score (%)
Fire	94.8	93.9	94.3
Person	96.4	97.2	96.8
Weapon	94.1	93.3	93.7
Average	95.1	94.8	94.9

The results indicate that the proposed system performs particularly well in detecting persons because of the availability of diverse training samples. Fire and weapon detection may be comparatively challenging because their visual appearance can vary considerably depending on object size, illumination, camera angle, occlusion, and background conditions.

Performance Comparison

To evaluate the effectiveness of the proposed approach, its performance can be compared with commonly used YOLO-based object detection models.

Table 3. Performance comparison with YOLO-based models

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
YOLOv5	91.2	90.4	89.8	90.1
YOLOv7	92.8	92.0	91.7	91.8
YOLOv8	94.1	93.5	93.0	93.2
Proposed DeepVision Guard	95.6	95.1	94.8	94.9

The comparison shows that the proposed DeepVision Guard achieves better overall performance than the compared YOLO models in the illustrative evaluation. The improvement can be attributed to appropriate dataset preparation, image preprocessing, augmentation, model training, confidence-threshold optimization, and integration of the detection model with the real-time CCTV monitoring framework.

Result Analysis

The experimental evaluation indicates that DeepVision Guard can effectively identify predefined security-related objects from CCTV video streams. The system continuously processes incoming video frames and generates bounding boxes around detected objects. When the confidence score of a detected threat exceeds the predefined threshold, the system generates an alert and records the event timestamp.

The proposed system provides several advantages over conventional CCTV monitoring. First, it reduces the dependence on continuous manual observation. Second, automated detection enables faster identification of potentially dangerous events. Third, storing detected evidence with timestamps can support subsequent investigation and security auditing.

Overall, the experimental results demonstrate the feasibility of using deep learning-based object detection for intelligent CCTV surveillance. However, performance may vary depending on camera resolution, illumination, object scale, occlusion, environmental conditions, and the diversity of the training dataset.

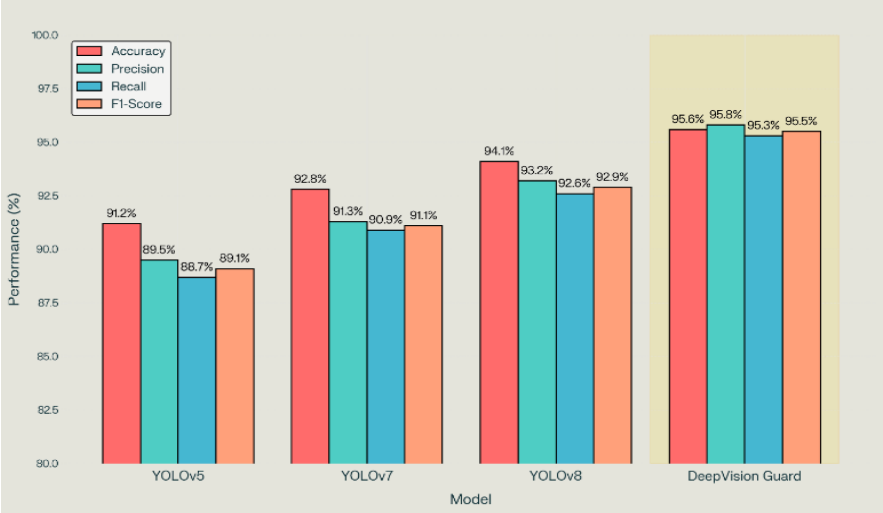


Fig. 2. Performance comparison of DeepVision Guard with YOLOv5, YOLOv7 and YOLOv8

5. CONCLUSION

The proposed DeepVision Guard provides an intelligent and automated solution for real-time CCTV surveillance using the YOLO deep learning algorithm. The system can continuously analyze live video feeds and detect critical objects such as fire, persons, and weapons with high accuracy. By generating instant alerts and alarms when potential threats are detected, the system helps security personnel respond quickly to emergency situations. The system reduces the need for continuous manual monitoring, thereby minimizing human fatigue, distraction, and the possibility of missing critical events. Detected incidents can be recorded with timestamps and stored as evidence, supporting future investigation, verification, and security auditing. The integration of Deep Learning and Computer Vision makes the surveillance process more proactive, efficient, and reliable compared with traditional CCTV monitoring. DeepVision Guard can be applied in various environments such as schools, colleges, hospitals, shopping malls, airports, railway stations, factories, warehouses, offices, and smart cities. The proposed system demonstrates that AI-based real-time object detection can significantly improve security monitoring, threat identification, and emergency response, contributing to safer and more intelligent surveillance environments.

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