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AI-based Smart Surveillance for Behavioral Risk Face and Weapon Detection

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Abstract

Modern surveillance systems play a crucial role in maintaining security in public places such as airports, railway stations, banks, and shopping malls. Traditional cctv surveillance mainly depends on continuous human monitoring, which is time-consuming and often inefficient when multiple cameras are involved. In many situations, security personnel may miss important events due to fatigue or human error, which can delay the response to potential threats. Therefore, there is an increasing need for intelligent surveillance systems that can automatically analyse video streams and detect suspicious activities in real time. This paper proposes an ai-based smart surveillance system for behavioural risk, face and weapon detection that uses computer vision and deep learning techniques to enhance public safety. The proposed system captures live video frames from a surveillance camera and processes them using advanced detection models. A face detection module is used to identify human faces in the video stream, and a face recognition mechanism can be applied to compare detected faces with stored records. At the same time, a weapon detection module based on the yolov8 object detection model analyses the frames to identify dangerous objects such as guns and knives. When a weapon is detected, the system automatically highlights the object using bounding boxes and generates alerts to notify security personnel. In this context, the proposed project introduces an ai-based smart surveillance system for behavioral risk, face and weapon detection. The system captures live video frames and processes them using computer vision techniques to detect human faces and identify weapons such as guns and knives. When a potential threat is detected, the system generates alerts and records the detection information for monitoring and investigation purposes

Keywords- *artificial intelligence, smart surveillance system, computer vision, face detection, face recognition, weapon detection, yolov8, real-time monitoring, security surveillance, deep learning.*

1. Introduction

With the rapid growth of urbanization and population, ensuring security in public places such as airports, railway stations, banks, and shopping malls has become very important. Traditional surveillance systems mainly rely on cctv cameras that are continuously monitored by human operators. However, manual monitoring of multiple video feeds is time-consuming and often leads to human errors, fatigue, and delayed responses to potential threats. In many situations, security personnel may miss suspicious activities or dangerous objects because it is difficult to observe several camera streams at the same time. As a result, traditional surveillance systems may fail to detect threats quickly. Therefore, there is a growing need for intelligent surveillance systems that can automatically analyse video streams and detect security risks in real time. Recent advancements in artificial intelligence (ai), deep learning, and computer vision have enabled the development of smart surveillance systems. These technologies allow computers to analyse images and videos, detect objects, and recognize faces automatically. Deep learning models such as yolo-based object detection algorithms provide fast and accurate detection of objects in real time. In this context, the proposed project introduces an ai-based smart surveillance system for behavioural risk, face and weapon detection. The system captures live video frames and processes them using computer vision techniques to detect human faces and identify

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weapons such as guns and knives. When a potential threat is detected, the system generates alerts and records the detection information for monitoring and investigation purposes.

2. Methodology

2.1.Camera input

The proposed system begins with capturing live video from a surveillance camera. The camera continuously records the surrounding environment and sends video frames to the processing system. This allows the surveillance system to monitor activities in real time and analyze the captured frames for security threats

2.2.Image acquisition

The image acquisition module collects video frames from the camera using the opencv library. Each frame is captured at a specific frame rate and stored temporarily in memory. The captured frames act as input data for further image processing and detection tasks in the surveillance system.

2.3.Image preprocessing

In this stage, the captured frames are preprocessed to improve image quality and prepare them for detection algorithms. Operations such as resizing, normalization, and color conversion are applied to the frames. These preprocessing steps help the detection models analyze the image data more efficiently and accurately.

2.4.Face detection and recognition

The system uses computer vision techniques to detect human faces in the captured frames. A face detection algorithm scans the frame and identifies facial regions using bounding boxes. After detecting faces, the system can compare them with stored face images to recognize known individuals.

2.5.Weapon detection

The weapon detection module is responsible for identifying dangerous objects such as guns and knives. The system uses the yolov8 deep learning model to analyze each video frame and detect objects. If a weapon is detected with a high confidence score, the system highlights the object using bounding boxes and labels.

2.6.Alert generation

When the system detects a potential threat such as a weapon, it automatically generates an alert. The alert contains information such as the detected object type, confidence score, and detection time. These alerts help security personnel respond quickly to suspicious activities.

2.7.Database storage and monitoring

All detection results, timestamps, and screenshots are stored in a database for future reference. The system also provides a web-based monitoring dashboard where users can view live camera feeds, detection alerts, and historical surveillance records.

2.8.Outcome

the proposed methodology enables an intelligent surveillance Figure 1.

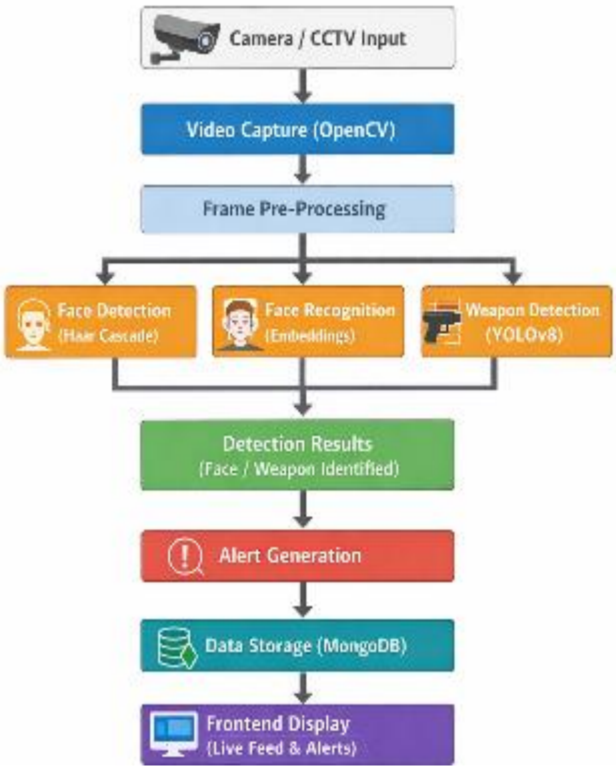

Figure 1 System Methodology

System capable of automatically detecting faces and dangerous weapons in real time. By integrating computer vision, deep learning, and automated alerts, the system improves security monitoring and reduces the need for continuous manual observation.

3. System architecture

The proposed ai-based smart surveillance system for

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behavioural risk, face and weapon detection follows a modular architecture that enables efficient video monitoring, real-time threat detection, and scalable system deployment. The system integrates computer vision algorithms, deep learning models, and web technologies to analyse live video streams and detect potential security threats automatically.

- Frontend (presentation layer): the frontend is developed using react.js and typescript to provide an interactive and user-friendly monitoring dashboard. It allows users to view live camera feeds, receive detection alerts, register faces, and monitor detection history in real time.
- Backend (application layer): the backend is implemented using fast api, which handles api requests, processes video frames, and communicates with ai detection modules. This layer manages data processing, alert generation, and communication between the frontend interface and the detection models.
- Ai detection modules (model layer): the system integrates multiple ai models for surveillance analysis. Face detection and recognition are implemented using opencv and haar cascade algorithms, while yolov8 is used for detecting weapons such as guns and knives in video frames. These models analyse images and generate detection results in real time.

Table 1 Key Modules and Its Functionality

Module	Functionality
Camera input module	Captures live video frames from surveillance cameras
Image processing module	Processes video frames for detection tasks
Face detection module	Detects and identifies human faces
Weapon detection module	Detects dangerous objects such as guns and knives
Alert generation module	Generates alerts when threats are detected

Table 1 presents the major modules of the proposed surveillance system and their functionalities. Each module performs a specific role in the surveillance workflow, ensuring efficient processing and system reliability. The integration of opencv, yolov8, fast api, react, and mongodb enables seamless communication between system components and supports real-time monitoring. Figure 1. System architecture of ai-based smart surveillance system Figure 1 illustrates the overall architecture of the proposed system. It shows how video frames captured from the camera are processed through the image processing pipeline and analysed by ai detection modules. The results are then stored in the database and displayed on the monitoring dashboard, allowing users to observe real-time surveillance results and receive security alerts.

4. Results and discussion

4.1. Results

The ai-based smart surveillance system for behavioural risk, face and weapon detection was successfully implemented using a react and typescript frontend, fast api backend, and yolov8 deep learning model for object detection. The system was tested using live camera input to evaluate its ability to detect faces and identify dangerous weapons in real time. The results show that the system is capable of performing real-time surveillance monitoring, face detection, face registration, and weapon detection effectively. The system processes video frames from the camera, analyses them using ai models, and displays detection results through a web-based monitoring dashboard. Figure 2.

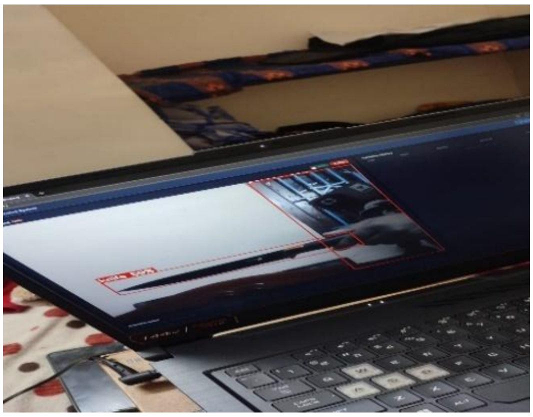

Figure 2 AI Smart Surveillance System – Weapon Detection Output

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This figure shows the weapon detection capability of the proposed system. The yolov8 model analyzes the video frame and identifies a knife with a confidence score. The system highlights the detected object using a bounding box and label. This demonstrates the ability of the system to detect dangerous weapons in real time and assist in identifying potential security threats. Figure 3.

Figure 3 Face Registration Interface

This figure shows the face registration module of the surveillance system. In this interface, users can enter a person's name and upload a face image to register it in the database. The stored face images are used later for recognizing known individuals in the surveillance environment. This module helps the system maintain a database of authorized or known persons.

Figure 3. System Api Interface

This figure represents the api documentation interface of the surveillance system built using fast api. It shows various api endpoints such as starting and stopping the camera, detecting objects, viewing detection history, and registering faces. The api layer enables communication between the frontend dashboard and the backend detection modules.

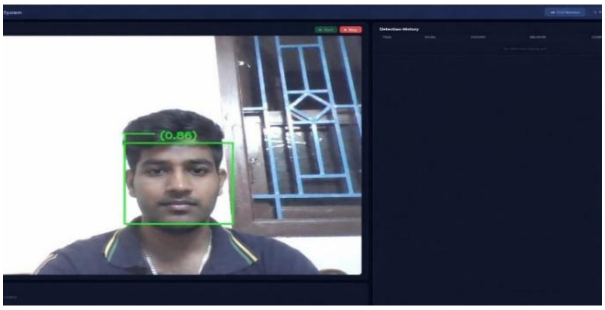

Figure 4 Live Face Detection Monitoring

This figure illustrates the real-time face detection functionality of the surveillance system. The system captures live video from the camera and detects human faces using computer vision algorithms. Detected faces are highlighted with bounding boxes and confidence scores. The detection results are also recorded in the system history for monitoring and analysis. Figure 4.

5. discussion

The results indicate that the proposed ai-based smart surveillance system effectively performs real-time monitoring using computer vision and deep learning techniques. The integration of react, fast api, opencv, and yolov8 enables smooth communication between the frontend dashboard and the ai detection modules. The system interface is simple and user-friendly, allowing security personnel to monitor live camera feeds and detection alerts easily. The face detection and face registration modules allow the system to identify and store known individuals for future recognition. The weapon detection module successfully detects dangerous objects such as knives and guns and highlights them with bounding boxes and confidence scores. The alert generation feature helps security personnel quickly respond to potential threats detected by the system. Overall, the system demonstrates the effectiveness of ai-based surveillance for improving public safety and reducing manual monitoring workload. The modular architecture allows future improvements such as higher detection accuracy, integration with multiple cameras, and advanced behaviour analysis for detecting suspicious activities.

Conclusion

The ai-based smart surveillance system for behavioural risk, face and weapon detection demonstrates the successful application of artificial intelligence and computer vision for automated security monitoring. The system integrates real-time video capture, face detection, face recognition, and weapon detection to identify potential threats in surveillance environments. The implementation using react, fast api, opencv, and yolov8 provides a scalable and efficient platform for intelligent surveillance. The system is capable of detecting faces, identifying dangerous objects, generating alerts, and storing detection records for future analysis. These features significantly improve the efficiency and reliability of surveillance operations. Overall, the proposed system provides an effective solution for enhancing public safety and reducing the limitations of traditional surveillance methods. Future improvements may include multi-camera integration, improved deep learning models for higher detection accuracy, and advanced behavioural analysis for identifying suspicious activities in real time.

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