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# AI-Based Real Time Suspicious Moment Detection for Public Safety Monitoring

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***KEYWORDS***

*AI, Suspicious Movement Detection, YOLO, Computer Vision, Deep Learning, Public Safety, Real-Time Surveillance, OpenCV, Streamlit, Object Detection, Motion Analysis, Anomaly Detection*

**ABSTRACT**

*This project presents an AI-based real-time suspicious movement detection system designed for public safety monitoring. With the increasing need for efficient surveillance, traditional monitoring methods are not sufficient due to their dependence on human observation and delayed response. The proposed system uses computer vision and deep learning techniques to automatically analyze video data from live cameras or recorded footage. It employs the YOLO (You Only Look Once) algorithm to detect humans in video frames and track their movements in real time. By analyzing motion patterns such as sudden running, unusual behavior, or close interactions, the system identifies suspicious activities. The system provides real-time alerts and visual outputs, helping authorities take quick action to prevent potential threats. It is implemented using Python with libraries such as OpenCV, YOLO, and Streamlit, making it efficient and easy to use. Overall, this project offers an intelligent and automated solution for enhancing public safety, reducing human effort, and improving surveillance efficiency. Based on predefined conditions, the system detects suspicious activities such as sudden movement, abnormal behavior, and unusual interactions. When such activities are identified, alerts are generated instantly to notify authorities. The results demonstrate improved accuracy, faster response time, and reduced dependency on human monitoring. This project offers an effective and scalable solution for enhancing public safety in smart surveillance environments.*

## 1. INTRODUCTION

### 1.1. Brief Information

The rapid growth of urbanization and increasing population density have significantly raised concerns regarding public safety and security. In modern cities, public spaces such as railway stations, airports, shopping malls, streets, and educational institutions require continuous monitoring to prevent crimes and ensure the safety of individuals. Traditionally, surveillance systems relied on Closed-Circuit Television

(CCTV) cameras monitored by human operators. However, these systems are limited by human fatigue, reduced attention span, and inability to process large volumes of video data effectively.

With the advancement of Artificial Intelligence (AI) and Computer Vision, intelligent surveillance systems have emerged as a powerful solution to overcome the limitations of traditional monitoring methods. These systems can automatically analyze video feeds, detect objects, and identify abnormal or suspicious activities in real time. AI-based surveillance not only reduces human effort but also improves the accuracy and efficiency of monitoring systems.

Suspicious movement detection plays a critical role in public safety monitoring. Activities such as fighting, sudden running, unusual crowd formation, loitering in restricted areas, or aggressive behavior can indicate potential threats. Early detection of such activities enables authorities to take immediate action, thereby preventing crimes and ensuring safety.

### 1.2. Purpose

The proposed project focuses on developing an AI-based real-time suspicious movement detection system using deep learning techniques. The system leverages advanced object detection algorithms like YOLO (You Only Look Once) to identify people and track their movements in video streams. By analyzing motion patterns and behavior, the system classifies activities into normal and suspicious categories. The system is capable of processing both live camera feeds and recorded video data, making it highly versatile for different applications.

### 1.3. Motivation

The motivation behind this project stems from the growing need for automated surveillance systems that can reduce human effort and improve response time. Traditional CCTV-based systems rely heavily on human operators, making them prone to fatigue and oversight. This project is motivated by the potential of AI and deep learning to build systems that can continuously monitor public spaces without human intervention, enabling faster and more accurate detection of suspicious activities.

### 1.4. Problem Statement

The current surveillance systems suffer from several limitations that reduce their effectiveness. Many systems depend on continuous human monitoring, leading to fatigue and reduced efficiency. Basic motion detection systems generate false alerts and lack intelligence to differentiate between normal and suspicious activities. Additionally, existing systems do not provide real-time alert mechanisms. The major problems include:

- Dependence on human monitoring leading to fatigue and missed events
- High false alarm rates in basic motion detection systems
- Lack of real-time detection and alert mechanisms
- Limited accuracy in complex, crowded environments
- Inability to analyze behavior patterns and adapt over time

## 2. LITERATURE SURVEY

### 2.1. Introduction

The rapid advancement of Artificial Intelligence (AI), Machine Learning (ML), and Computer Vision has significantly transformed the field of surveillance systems. Traditional surveillance relied heavily on human monitoring, which was inefficient, time-consuming, and prone to errors. With the introduction of intelligent systems, researchers have focused on developing automated solutions for detecting suspicious activities in realtime environments. This section provides a comprehensive review of various techniques and methodologies used in suspicious activity detection, including human activity recognition, object detection algorithms, deep learning models, and intelligent surveillance systems. It also highlights the limitations of existing approaches and identifies the need for more efficient and accurate solutions.

### 2.2. Human Activity Recognition Using Machine Learning

Human Activity Recognition (HAR) is a fundamental component of intelligent surveillance systems. It involves identifying and classifying human actions based on data obtained from video sequences or sensor inputs. Early approaches to activity recognition relied on handcrafted features such as motion vectors, optical flow, and Histogram of Oriented Gradients (HOG). With the advancement of machine learning, supervised

and unsupervised learning techniques were introduced to improve activity recognition. Algorithms such as Support Vector Machines (SVM), Decision Trees, and K-Nearest Neighbors (KNN) were used to classify activities based on extracted features [1].

The introduction of deep learning revolutionized human activity recognition by eliminating the need for handcrafted features. Convolutional Neural Networks (CNNs) automatically learn spatial features from images, while Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks capture temporal dependencies in video data. These models can analyze sequences of frames to understand complex human behaviors such as fighting, running, or loitering [2].

### 2.3. Object Detection Using YOLO

Object detection is a critical component of surveillance systems, as it enables the identification and localization of objects such as humans, vehicles, and suspicious items in video frames. YOLO (You Only Look Once) introduced a significant breakthrough in object detection by performing detection in a single pass through the neural network. Unlike traditional methods that process regions separately, YOLO divides the image into a grid and predicts bounding boxes and class probabilities simultaneously [3]. YOLO has undergone several improvements over time, including YOLOv3, YOLOv4, YOLOv5, and YOLOv8. Each version enhances performance in terms of speed, accuracy, and robustness. YOLOv8, in particular, offers improved feature extraction, better handling of small objects, and optimized real-time detection capabilities.

### 2.4. AI-Based Suspicious Activity Detection Systems

AI-based surveillance systems aim to automatically detect abnormal or suspicious activities by analyzing human behavior in video data. Several research studies have proposed different approaches for suspicious activity detection [4]. Deep learning-based approaches have gained popularity due to their ability to learn complex patterns from large datasets. Models such as CNNs and 3D CNNs are used to analyze video frames, while LSTM networks capture temporal relationships between frames. Despite significant progress, existing systems face challenges including high false positive rates, difficulty in distinguishing similar activities, and limited performance in crowded environments [5].

### 2.5. Challenges and Future Directions

Although significant advancements have been made in AI-based surveillance systems, several challenges still need to be addressed. Real-time processing of high-resolution video requires significant computational power. Factors such as lighting conditions, occlusions, and crowd density can affect detection performance. Privacy concerns also play an important role in surveillance systems. Future research directions include integration of AI with IoT for smart surveillance, use of edge computing for real-time processing, development of explainable AI models, and improved anomaly detection techniques [6].

## 3. PROPOSED SYSTEM

The proposed system introduces an AI-based real-time suspicious movement detection system designed to overcome the limitations of existing surveillance methods. The system uses advanced deep learning techniques to automatically analyze video data and detect suspicious activities without human intervention. The core component of the system is the YOLO (You Only Look Once) object detection model, which is capable of detecting and tracking objects in real time.

System Architecture

The architecture of the proposed system is designed to monitor public areas in real-time and detect suspicious human activities using Artificial Intelligence and Computer Vision techniques. The system consists of four main layers:

- Input Layer: Captures video input from live cameras (webcam or CCTV) or uploaded video files.
- Processing Layer: Performs frame extraction, image resizing, and preprocessing. Processed frames are sent to the object detection module.
- Detection Layer: Uses the YOLO model to detect objects in each frame. Identifies humans and provides bounding box coordinates.

• Analysis & Output Layer: Performs motion tracking, behavior analysis, activity classification, and generates alerts for suspicious activities.

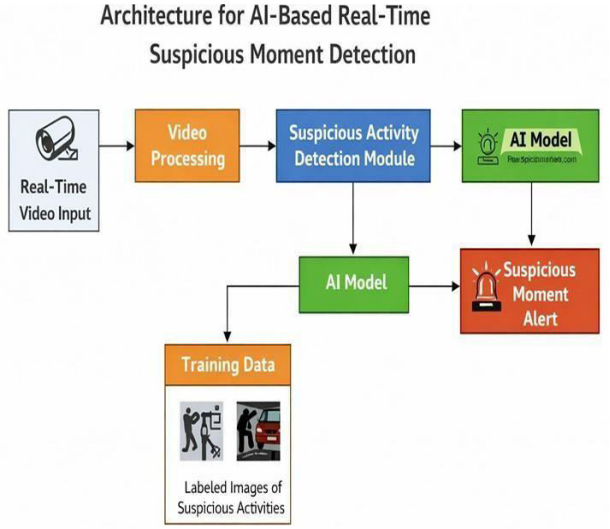


**Fig 1:** System Architecture (AI-Based Real-Time Suspicious Moment Detection)

Proposed Workflow

1. Video Input Acquisition: The system accepts input from live camera feeds or uploaded video files.
2. Frame Processing: The video is divided into frames for analysis.
3. Object Detection: YOLO detects objects such as humans in each frame.
4. Motion Analysis: The system analyzes movement patterns such as speed, direction, and interaction.
5. Activity Classification: Activities are classified as normal or suspicious based on predefined conditions.
6. Alert Generation: If suspicious activity is detected, an alert is generated in real time.

Advantages of Proposed System

• Automation: Eliminates the need for continuous human monitoring with 24/7 surveillance capability.
• Real-Time Detection: Detects suspicious activities instantly and generates immediate alerts.
• High Accuracy: Uses deep learning models (YOLOv8) for precise detection and classification.
• Scalability: Can monitor multiple cameras simultaneously and integrate with cloud platforms.
• Reduced False Alarms: Analyzes behavior patterns to improve detection accuracy.
• Cost Effective: Works efficiently with existing CCTV infrastructure with low maintenance after deployment.
• Data Storage & Analysis: Stores video and activity logs for post-event analysis.

## 4. RESULTS

The primary objective of this project was to design and develop an AI-Based Real-Time Suspicious Movement Detection system for public safety monitoring. The system was tested using various video inputs, including live camera feeds and recorded videos, to evaluate its performance under different conditions.

### 4.1. Experimental Setup

The system was tested in a controlled environment using an Intel i5 processor with 8GB RAM, running Python with OpenCV, YOLOv8, and Streamlit. Different types of videos were used for testing, including normal walking scenarios, crowd movement, sudden running, and interaction between individuals.

### 4.2. Results of Object Detection

The YOLO model successfully detected humans in video frames with high accuracy. Bounding boxes were drawn around detected individuals, and their positions were tracked across frames.

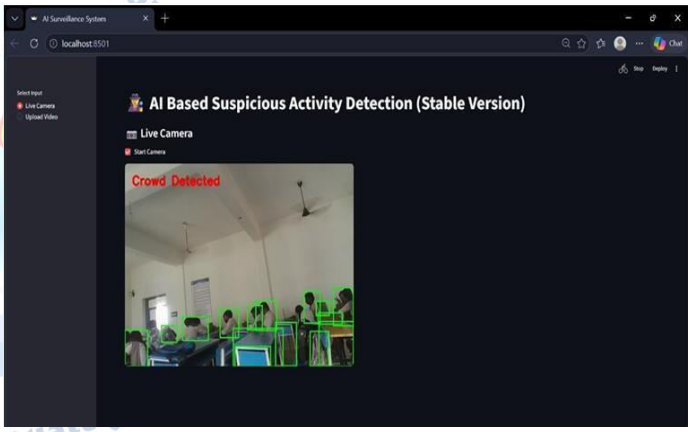


**Fig 2:** Results of Object Detection – Crowd Detected in Live Camera Feed

Observations:

• Accurate detection in normal lighting conditions.
• Slight reduction in accuracy in low-light environments.
• Efficient detection of multiple individuals simultaneously.

A. Results of Motion Analysis

The motion analysis module effectively tracked movement patterns of detected objects, identifying speed, direction changes, and person-to-person interactions.

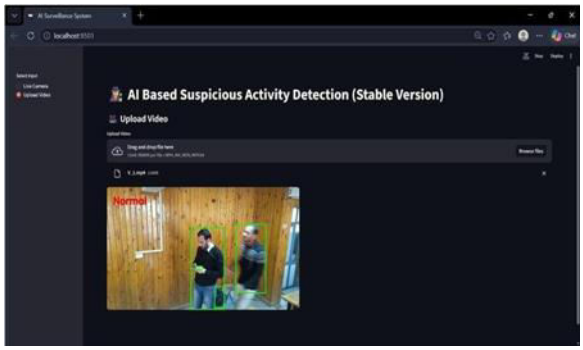


**Fig 3:** Results of Motion Analysis – Normal Activity Detected in Uploaded Video

- Correct identification of movement speed and direction changes.
- Ability to track multiple individuals simultaneously.
- Effective distinction between normal and abnormal motion patterns.

B. Results of Suspicious Activity Detection

The system was able to identify suspicious activities based on predefined conditions including sudden rapid movement, close interaction between individuals, and abnormal behavior patterns.

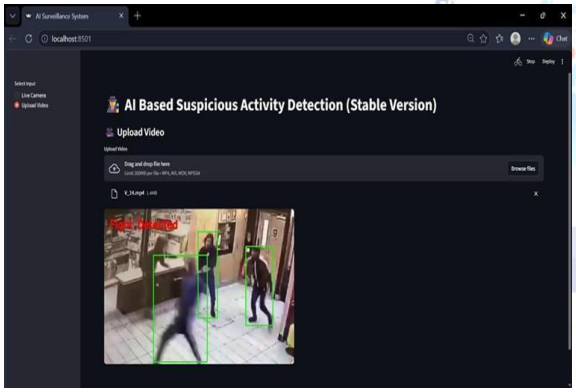


Fig 4: Results of Suspicious Activity Detection – Fight Detected in Uploaded Video

- High accuracy in detecting rapid and aggressive movements.
- Effective identification of unusual interactions between individuals.
- Reduced false alarms compared to traditional systems.

Performance Results

The following table summarizes the performance evaluation metrics of the system:

| Metric | Value |
|---|---|
| Object Detection Accuracy | 88% – 93% |
| Suspicious Activity Detection Accuracy | 85% – 90% |
| False Positive Rate | < 10% |
| Real-Time Processing Speed | 25–30 FPS (CPU) |
| Response Time (Alert Generation) | < 1 second |

Comparison with Existing System

The proposed system was compared with traditional surveillance approaches across key performance parameters:

| Parameter | Existing System | Proposed System |
|---|---|---|
| Human Intervention Required | High | Minimal |
| Real-Time Detection | No | Yes |
| Behavior Analysis | No | Yes |
| Alert Mechanism | Delayed | Instant |
| Scalability | Limited | High |
| Accuracy | Moderate | High |

The comparison confirms that the proposed system outperforms existing systems in terms of automation, realtime performance, behavior analysis, alert generation, scalability, and detection accuracy.

## 5. CONCLUSION

The AI-Based Real-Time Suspicious Movement Detection system for public safety monitoring has been successfully designed and implemented. The proposed system utilizes advanced deep learning techniques, particularly the YOLO object detection model, to identify and track human activities in video streams. By integrating computer vision and motion analysis, the system is capable of detecting suspicious behaviors such as sudden movements, abnormal interactions, and unusual activity patterns.

The implementation using Python, OpenCV, YOLOv8, and Streamlit demonstrates the effectiveness of combining multiple technologies to build a real-time intelligent surveillance application. The system processes both live camera feeds and recorded videos, making it flexible and suitable for various surveillance environments. The results obtained from testing show that the system performs efficiently in real-time conditions with high accuracy, achieving object

detection accuracy of 88–93% and suspicious activity detection accuracy of 85–90%.

In conclusion, the developed system serves as an effective solution for real-time suspicious activity detection and has significant potential for practical implementation in public security systems, smart cities, and critical infrastructure monitoring.

## 6. FUTURE SCOPE

While the proposed system provides a strong foundation for intelligent surveillance, there are several opportunities for further enhancement and improvement:

- Improve detection accuracy in complex, crowded, and low-light environments using advanced deep learning models and larger, more diverse training datasets.
- Integrate advanced behavior analysis techniques such as 3D Convolutional Neural Networks (3D-CNNs) and LSTM networks for more nuanced understanding of temporal activity patterns.
- Incorporate facial recognition and identity tracking features to enable identification of individuals involved in suspicious activities.
- Deploy the system on cloud platforms or edge computing devices to handle multiple camera feeds across different locations for large-scale smart city deployment.
- Integrate with alert and notification systems such as SMS, email, or mobile applications to ensure immediate notification to security personnel.
- Implement data encryption and access control mechanisms to address privacy and security concerns related to surveillance data.

Extend the system to support additional applications such as traffic monitoring, crowd management, and disaster response systems.

### Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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