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REAL TIME SUSPECT DETECTION AND TRACKING USING AI BASED SURVELIIENCE SYSTEM

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Abstract: This project presents an AI-based intelligent system that integrates Natural Language Processing (NLP) and Computer Vision techniques to automate resume analysis and real-time surveillance monitoring. The system utilizes advanced machine learning and deep learning models such as Named Entity Recognition (NER), semantic similarity algorithms, Convolutional Neural Networks (CNN), and YOLO-based object detection to process both textual and visual data efficiently. It analyzes resumes to match job descriptions, identify skill gaps, and provide optimization recommendations, while in surveillance it focuses on detecting and identifying suspicious persons based on given image data and tracking them across video frames. The system compares live video input with pre-stored images to recognize individuals and assign unique tracking identities for continuous monitoring. By combining text analysis with image-based person recognition, the system improves accuracy, reduces manual effort, and enables faster decisionmaking. Overall, the proposed system provides an efficient, scalable, and real-time solution for recruitment optimization and intelligent surveillance applications.

Keywords: Artificial Intelligence (AI), Natural Language Processing (NLP), Computer Vision (CV), Deep Learning (DL), Resume Analysis, Semantic Similarity, Named Entity Recognition (NER), Convolutional Neural Networks (CNN), YOLO (You Only Look Once).

I. INTRODUCTION

In recent years, the rapid growth of urban areas, public infrastructure, and smart city initiatives has significantly increased the demand for advanced surveillance systems. Public places such as railway stations, airports, shopping malls, streets, and educational institutions generate massive amounts of CCTV footage every day. Monitoring this large volume of video data manually is both time-consuming and inefficient. Human operators may miss critical events due to fatigue, distraction, or limited attention span, which can delay response time during emergencies. Traditional surveillance systems primarily rely on manual observation or basic image processing techniques. These systems are limited in their ability to analyze complex human behavior, detect suspicious activities accurately, or track individuals continuously across multiple frames. As a result, there is a need for intelligent systems that can automatically analyze video streams in real time and assist security authorities in crime prevention and monitoring. Advancements in Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) have enabled automated video analysis with high accuracy and efficiency. In particular, Convolutional Neural Networks (CNNs) have shown remarkable performance in image classification, object detection, and activity recognition tasks. By extracting meaningful spatial and motion features from video frames, deep learning models can identify suspicious patterns and distinguish them from normal activities.The proposed project, Real-Time Suspect Detection and Tracking Using AI-Based Surveillance System, aims to develop an intelligent framework that detects suspicious persons and related objects from live CCTV footage. The system not only identifies individuals based on their behavior but also assigns unique IDs to track them continuously across consecutive frames. This ensures that monitoring is consistent and context-aware rather than limited to isolated frame analysis. Furthermore, the system links suspicious objects to the corresponding individual and generates alerts when abnormal behavior persists. By integrating detection, classification, and tracking into a unified framework, the proposed solution enhances surveillance efficiency, reduces human effort, and supports faster decision making. Ultimately, this project contributes to improving public safety through accurate, real-time monitoring in crowded and complex environments.

II. RELATED WORK

Research on automated resume processing and candidate matching has evolved through three broad phases: rule-based parsing, classical machine learning, and deep learning approaches. Each phase introduced new capabilities while exposing new limitations that motivated subsequent advances.

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A. Deep Learning-Based Object Detection for Surveillance

Recent advancements in deep learning have significantly improved the performance of object detection systems in surveillance applications. Models such as YOLO (You Only Look Once) have been widely adopted for real-time person detection due to their high speed and accuracy. These models process entire images in a single pass, enabling efficient detection of multiple objects within video frames. However, while YOLO provides robust detection capabilities, it does not inherently support identity recognition or long-term tracking of specific individuals across frames, which limits its standalone use in targeted surveillance systems.

B. Face Recognition for Person Identification

Face recognition systems have become a crucial component in identifying individuals within surveillance environments. Techniques based on Convolutional Neural Networks (CNN) are capable of extracting unique facial features and generating embeddings for accurate comparison. Systems using pre-trained models such as FaceNet or similar architectures achieve high accuracy in controlled conditions. However, their performance can degrade in real-world scenarios due to challenges such as low resolution, occlusion, varying lighting conditions, and pose variations. Additionally, face recognition alone does not provide continuous tracking functionality once the person moves across frames

C. Multi-Object Tracking Techniques

Multi-object tracking (MOT) algorithms are designed to maintain the identity of detected individuals across video frames. Methods such as centroid tracking, Kalman filters, and deep learning-based trackers (e.g., Deep SORT) are commonly used to assign unique IDs and track movement over time. These techniques help maintain temporal consistency and enable real-time monitoring of individuals. However, most traditional tracking systems rely only on motion and spatial features, which can lead to identity switches when multiple similar-looking individuals are present. Integrating tracking with face recognition and detection models can significantly improve accuracy and reliability

III. PROPOSED SYSTEM ARCHITECTURE

The proposed system is designed as a modular pipeline that integrates deep learning and computer vision techniques to detect, identify, and track a suspicious person based on a given reference image. The architecture consists of five major components, each responsible for a specific stage of processing

A. Input Acquisition Module

This module is responsible for collecting input data required for the system. It includes:

- Live video feed from cameras or stored video input
- Predefined reference images of the suspicious person

The video stream is continuously captured and converted into frames for further processing, while the reference image is preprocessed for feature extraction.

B. Preprocessing Module

In this stage, both video frames and reference images undergo preprocessing to enhance quality and ensure consistency. This includes:

- Resizing and normalization
- Noise reduction
- Face alignment (if required)

Preprocessing improves detection accuracy and prepares the data for efficient feature extraction by deep learning models.

C. Person Detection Module

This module uses deep learning-based object detection techniques such as YOLO to identify human presence in each video frame. It:

- Detects persons in real time
- Draws bounding boxes around detected
- individuals Filters out non-human objects

This step ensures that only relevant regions (persons) are passed to the next stage

D. Face Recognition and Identification Module

In this stage, the system compares detected individuals with the given reference image:

- Extracts facial features using CNN-based models
- Generates feature embeddings
- Matches embeddings with the stored reference image

If a match is found, the system identifies the person as the target individual.

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E. Tracking and Monitoring Module

Once the person is identified, this module ensures continuous tracking:

- Assigns a unique ID to the detected person
- Tracks movement across consecutive
- frames Maintains identity consistency

over time

This enables real-time monitoring of the suspicious person without interruption, even in dynamic environments.

IV. MODULES

Module 1 Input Acquisition	Module 2 Preprocessing	Module 3 Person Detection
Captures live video stream or recorded footage and takes reference image of the target person for identification.	Resizes frames, normalizes images, reduces noise, and performs face alignment for consistent input quality.	Uses YOLO-based object detection to identify and locate persons in each video frame with bounding boxes.
Module 4 **Face Recognition**	**Module 5** **Tracking Module**	**Module 6** **Flask REST API**
Extracts facial features using CNN models and compares them with the reference image to identify the target person.	Assigns unique ID to detected person and tracks movement across frames ensuring continuous monitoring.	Provides endpoints like /detect and /track to process video input and return identification and tracking results in real time.

V. RESULTS AND DISCUSSION

The proposed system for suspicious person detection and tracking was evaluated using real-time video streams and a set of predefined reference images. The system demonstrated effective performance in identifying and continuously tracking the target individual across multiple frames under varying environmental conditions.

The person detection module, based on YOLO, achieved high accuracy in detecting human subjects in real-time, even in moderately crowded scenes. Bounding boxes were consistently generated around detected individuals with minimal delay, ensuring smooth frame processing. The face recognition module successfully matched detected faces with the given reference image by extracting discriminative facial features using CNN-based models. The system was able to correctly identify the target person in most cases where the face was clearly visible.

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TABLE I. PERFORMANCE COMPARISON

As shown in Table I, the proposed system achieves an overall accuracy of **91.8%**, outperforming traditional CCTV monitoring by **31.3 percentage points** and basic CNN-based detection by **10.5 points**. The integration of YOLO-based person detection with face recognition and tracking mechanisms is the primary contributor to this improvement, enabling accurate identification of the target individual even in dynamic environments. The precision of **89.7%** indicates that the system produces highly reliable identification results with minimal false positives.

Module-level analysis revealed that the **face recognition component** contributed most significantly to overall system accuracy, as it ensures correct matching between detected individuals and the reference image. The **person detection module** provided consistent results across different scenarios due to the robustness of YOLO in identifying human subjects. The **tracking module** played a crucial role in maintaining identity consistency, with a tracking consistency score of **88%**, ensuring that the target person is continuously monitored across consecutive frames without frequent ID switching.

The system demonstrated strong performance under normal lighting and moderate crowd conditions. However, slight variations in accuracy were observed in cases of occlusion, low-resolution input, and extreme pose changes. Despite these challenges, the combined approach of detection, recognition, and tracking significantly improved overall reliability compared to standalone methods.

User evaluation was conducted with a group of participants who interacted with the system in simulated surveillance scenarios.

Approximately **84%** of users reported that the system effectively identified and tracked the target individual with minimal delay. Users particularly appreciated the real-time bounding box visualization and continuous tracking feature, which enhanced monitoring efficiency. Feedback suggested potential improvements in handling low-light environments and improving recognition performance for partially visible faces.

Overall, the results demonstrate that the proposed system provides a robust and efficient solution for real-time suspicious person detection and tracking, outperforming traditional and single-method approaches in both accuracy and reliability.

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VI. BENEFITS

- Semantic Understanding: Matches synonyms and related concepts unlike keyword-only ATS, reducing false negatives for qualified candidates. [1, 2]
- Free and Accessible: Democratizes resume optimization for all job seekers including students and career changers. [1, 9]
- Personalized Recommendations: Suggestions tailored to the specific resume and job description, not generic advice.
- Multi-Format Support: Handles PDF, DOCX, and plain-text resumes with robust section boundary detection.
- Explainable Results: Match scores accompanied by section-level breakdowns, building candidate trust. [3, 9, 10]• Cost-Effective: Eliminates the need for expensive commercial resume optimization subscriptions.

VII. CHALLENGES AND FUTURE WORK

- **Accurate Person Identification:** Utilizes deep learning–based face recognition to accurately match individuals with the given reference image, reducing false identifications.
- **Real-Time Detection and Tracking:** Enables continuous monitoring of the target person across video frames with minimal delay, ensuring timely response in surveillance scenarios.
- **Automation of Surveillance:** Eliminates the need for constant human monitoring by automatically detecting and tracking the suspicious person.
- **High Tracking Consistency:** Maintains a unique identity for the detected person across frames, reducing ID switching and improving reliability.
- **Scalable System:** Can be deployed across multiple cameras and locations, making it suitable for large-scale surveillance environments such as public areas and institutions.
- **Robust Performance:** Performs effectively under varying conditions such as moderate crowd density and lighting changes due to the integration of detection, recognition, and tracking modules.
- **User-Friendly Integration:** Flask-based API enables easy integration with other systems and provides real-time outputs for monitoring applications.
- **Cost-Effective Solution:** Reduces dependency on expensive commercial surveillance systems while delivering efficient and intelligent monitoring capabilities.

VIII. CONCLUSION

This paper presented an AI-driven surveillance system for image-based suspicious person detection and real-time tracking, addressing the limitations of traditional manual monitoring approaches. By integrating YOLO-based person detection, CNN-based face recognition, and a robust tracking mechanism within a unified framework, the system enables accurate identification and continuous monitoring of a target individual using a predefined reference image. The use of deep learning techniques ensures reliable performance in dynamic environments while maintaining real-time processing capability through an efficient pipeline supported by a Flask-based API.

Experimental evaluation demonstrated an overall accuracy of **91.8%**, precision of **89.7%**, and tracking consistency of **88%**, outperforming conventional surveillance and standalone detection methods. The system showed strong performance under normal conditions, with minor limitations observed in scenarios involving occlusion, low lighting, and extreme pose variations. User evaluation further confirmed the effectiveness of the system in providing reliable identification and continuous tracking with minimal delay.

Future work will focus on enhancing system robustness by improving performance under challenging conditions such as lowresolution inputs and heavy occlusions, as well as extending the system to support multi-camera tracking and advanced reidentification techniques. These improvements will further strengthen the system's applicability in real-world surveillance environments and contribute to the development of more intelligent and scalable security solutions.

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