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AI-Based Live Face Recognition and Target Person Detection System

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Abstract

Artificial Intelligence (AI) and computer vision have become important technologies for automated surveillance and real-time video analysis. However, reliable person detection and tracking remain challenging under partial occlusion, changing lighting conditions, and limited computational resources. This paper examines AI-based approaches for person detection, face recognition, and real-time tracking, focusing on their capabilities, limitations, and practical applications. Existing research is reviewed to understand challenges related to tracking identity consistency, temporary tracking loss, processing speed, and privacy. Based on this review, the paper identifies the need for a systematic evaluation of tracking performance under partial occlusion on resource-constrained hardware. A comparative evaluation of selected tracking methods is proposed using performance measures such as frames per second (FPS), identity switches, track fragmentation, and recovery time after occlusion. The findings from the literature review are intended to guide the development of a practical AI-based real-time person detection and tracking system. The proposed evaluation can help assess the trade-offs between tracking consistency and computational efficiency in real-world surveillance scenarios.

I. INTRODUCTION

The rapid development of Artificial Intelligence (AI) and computer vision has enabled automated analysis of video data in surveillance and security applications. These technologies can assist in monitoring people, detecting their presence, and tracking their movement across video frames. Traditional surveillance systems often require continuous human observation, which becomes challenging when multiple camera feeds need to be monitored simultaneously. AI-based systems offer an opportunity to improve the efficiency of video monitoring through automated detection and tracking.Person detection, face recognition, and object tracking are important but different tasks in computer vision. Person detection identifies the presence and location of a person in an image or video frame. Face recognition attempts to identify an individual using facial features, whereas object tracking maintains the association of a detected person across consecutive frames. Combining these techniques can support the development of intelligent surveillance systems. However, their effectiveness depends on environmental conditions, model selection, and available computational resources.

Despite recent advances, several challenges remain in real-time person detection and tracking. Partial occlusion occurs when a person is temporarily hidden by another person or an object. This can interrupt tracking, cause identity switches, or make it difficult to maintain a consistent track after the person reappears. Variations in lighting, camera angles, crowded environments, and processing limitations can further affect system performance. These challenges are particularly important when deploying AI models on computers with limited hardware capabilities.This paper examines existing research on AI-based person detection, face recognition, and real-time tracking to understand current approaches and their limitations. Particular attention is given to partial occlusion, tracking identity consistency, computational efficiency, and privacy considerations. Based on the reviewed literature, the paper identifies the need for a systematic evaluation of selected tracking methods under partial occlusion on resource-constrained hardware. This research direction can provide a practical basis for evaluating the trade-off between tracking consistency and processing speed in real-time surveillance applications.

II. Review of Related Work

Several studies have explored the use of artificial intelligence and computer vision for person detection, face recognition, and tracking. Existing approaches differ in their detection techniques, tracking strategies, computational requirements, and ability to handle challenging environmental conditions.

Amirgaliyev et al. (2025) presented a comprehensive review of machine learning and deep learning methods for person detection, tracking, identification, and face recognition. Their study examined 142 relevant research papers using a systematic review approach. The authors highlighted challenges such as changing illumination, partial occlusion, camera-angle variations, computational limitations, and privacy concerns. This study provides a broad understanding of current techniques and the problems that remain open for further investigation [1].Chang et al. (2024) developed a real-time face-recognition system using artificial intelligence techniques. Their research focused on associating participants' names with faces in group photographs. The study demonstrates the role of face detection and recognition in automated visual analysis. However, its main objective differs from continuous person tracking across video frames [2].Research on AI-based smart security cameras has also combined person detection, tracking, face recognition, and event logging within a surveillance system. Such integrated systems demonstrate how computer vision techniques can be used in practical security applications. However, their effectiveness depends on the reliability of individual components, camera conditions, and available computing resources [3].

Wang et al. (2025) proposed OATrack, an occlusion-aware multi-pedestrian tracking framework. Their approach estimates the degree of occlusion and uses this information to adjust motion prediction and data association. The study highlights the importance of explicitly considering occlusion when maintaining tracking identity in complex scenes [4].

2.2 Comparison of Existing Approaches

Person detection, face recognition, and tracking address different requirements. Detection locates people in video frames, recognition attempts to determine identity from facial features, and tracking links detections over time. Tracking methods such as ByteTrack and BoT-SORT use detection and data-association strategies to maintain trajectories. Their performance may vary depending on occlusion, detection quality, scene complexity, and computational resources [1], [4].Existing research indicates that improving tracking accuracy alone is not sufficient for every deployment scenario. A practical system must also consider processing speed, temporary tracking loss, identity consistency, and privacy. Methods specifically designed to handle occlusion have demonstrated the importance of adapting tracking decisions to difficult visual conditions [4].

2.3 Research Gap

The reviewed literature shows substantial progress in person detection, face recognition, and multi-object tracking. However, the challenges of occlusion, identity consistency, and real-time processing remain relevant to practical surveillance systems [1], [4].

For the present project, a useful research direction is to evaluate selected tracking methods under controlled visibility conditions on resource-constrained hardware. The evaluation can examine processing speed, identity switches, track fragmentation, and recovery time after temporary occlusion. Rather than claiming that existing methods cannot handle occlusion, the proposed study will investigate how their performance differs under the selected experimental conditions.

The research gap should be treated as a preliminary finding from the reviewed sources. A broader literature search and a clearly documented selection methodology are required before claiming that this exact evaluation has not previously been conducted.

III. Problem Statement

Real-time person detection and tracking systems based on artificial intelligence face several challenges in maintaining consistent tracking identities under changing environmental conditions. Partial occlusion, variations in lighting, crowded scenes, and limited computational resources can reduce tracking reliability and processing efficiency. When a person becomes temporarily hidden behind an object or another person, the tracking system may lose the existing track or assign a different tracking identity when the person reappears.

Therefore, there is a need to examine how selected AI-based tracking methods perform under partial occlusion while operating on resource-constrained hardware. The problem addressed in this study is to evaluate the trade-off between tracking consistency and real-time processing performance using measurable parameters such as frames per second (FPS), identity switches, track fragmentation, and recovery time after occlusion. The study aims to provide an evidence-based assessment that can guide the development of a practical AI-based person detection and tracking system.

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IV. Proposed System

The proposed system focuses on AI-based real-time person detection and tracking, with particular attention to tracking consistency under partial occlusion and performance on resource-constrained hardware. The system is designed to process video frames, detect persons using a deep learning-based object detection model, and associate detections across consecutive frames using an object tracking algorithm.

The proposed implementation will use the YOLO model for person detection and evaluate tracking methods such as ByteTrack and BoT-SORT under comparable conditions. When a person becomes partially hidden and subsequently reappears, the system's ability to maintain tracking continuity will be examined. A bounding box and tracking identifier will be displayed for detected persons to visualize their movement across frames.

The evaluation will consider measurable performance parameters, including frames per second (FPS), identity switches, track fragmentation, and recovery time after occlusion. Experiments will use the same hardware and selected video sequences to support a fair comparison between the tracking methods. The collected results will be analyzed to identify the trade-off between tracking consistency and processing speed.

The proposed system aims to provide a practical evaluation framework for real-time person detection and tracking. Its effectiveness will be determined through experimental results rather than assumed improvements. Face recognition and identification of a specific individual will be considered separate functions and will only be reported as implemented if they are developed and tested successfully.

System workflow
1.target image input
2.image procesing
3.person detection(yolo)
4.Face Feature Extraction
5.Target Matching
6.person trackting
7.output:bounding box +tracking id

V. Methodology

The proposed research follows a structured methodology to evaluate AI-based real-time person detection and tracking under partial occlusion. The methodology consists of the following stages.

Step 1: Literature Review

Existing research papers on person detection, object tracking, occlusion handling, and real-time computer vision will be reviewed to understand current techniques, limitations, and potential research gaps.

Step 2: Video Data Selection

Suitable video sequences containing people under normal visibility and partial occlusion will be selected. The same video sequences will be used for each tracking method to ensure a consistent comparison.

Step 3: Person Detection

A YOLO-based object detection model will process video frames to detect persons. Bounding boxes will indicate the locations of detected people in each frame.

Step 4: Person Tracking

The detected persons will be tracked across consecutive frames using selected tracking algorithms, such as ByteTrack and BoT-SORT. Tracking identifiers will be displayed to observe continuity and identity changes.

Step 5: Experimental Evaluation

The selected methods will be evaluated under normal visibility and partial occlusion conditions. The following performance measures will be considered:

- Frames Per Second (FPS): Measures video-processing speed.
- Identity Switches: Counts changes in a person's assigned tracking identity.
- Track Fragmentation: Measures interruptions in a person's tracking trajectory.
- Recovery Time: Measures the time taken to resume tracking after temporary occlusion.

Step 6: Comparative Analysis

The collected measurements will be organized into tables and graphs. The results will be compared to examine the relationship between tracking consistency and computational efficiency.

Step 7: Conclusion

The experimental findings will be used to identify the strengths and limitations of the evaluated methods and suggest possible improvements for practical real-time person detection and tracking systems.

VI. Advantages

1. Automated Person Detection: Uses AI-based object detection to identify people in video frames, reducing dependence on continuous manual monitoring.
2. Real-Time Tracking: Tracks detected persons across consecutive video frames using object tracking algorithms.
3. Occlusion Analysis: Helps evaluate tracking continuity when a person is partially hidden by another person or an object.
4. Performance Comparison: Enables comparison of tracking methods using FPS, identity swituches, track fragmentation, and recovery time.
5. Computational Efficiency Assessment: Evaluates the relationship between tracking performance and processing speed on available hardware.
6. Visual Tracking Output: Uses bounding boxes and tracking IDs to make person movement and tracking interruptions easier to observe.
7. Scope for Further Development: Provides a foundation for future improvements in tracking reliability, resource efficiency, and privacy-conscious surveillance.

VII. Limitations and Ethical Considerations

7.1 Limitations

1. **Partial Occlusion:** Tracking performance may decrease when a person is partially or completely hidden by objects or other people.
2. **Lighting and Camera Angles:** Poor illumination, motion blur, and changes in viewing angles may affect person detection and tracking.
3. **Computational Requirements:** Real-time performance depends on hardware capabilities, model complexity, and video resolution.
4. **Tracking Identity Errors:** Tracking algorithms may lose track of a person or assign a different tracking ID when multiple people appear close together.
5. **Limited Evaluation Data:** Results obtained from selected video sequences may not represent every real-world surveillance environment.
6. **Scope of Evaluation:** The proposed comparison focuses on person detection and tracking. Accurate identification of a specific individual through facial recognition is a separate task and is not guaranteed by a tracking ID.

7.2 Ethical Considerations

1. **Privacy Protection:** Video data should be collected and processed only for a legitimate, clearly defined purpose.
2. **Authorization and Consent:** Testing should use authorized cameras and datasets, with appropriate permission and consent wherever required.
3. **Data Security:** Recorded videos, facial images, and tracking information should be securely stored, access-controlled, and retained only as long as necessary.
4. **Responsible Use:** The system should not be used for unauthorized surveillance, harassment, or decisions that could unfairly affect individuals.
5. **Bias and Reliability:** Performance should be evaluated across different lighting conditions, camera angles, and relevant scenarios to identify potential limitations and unequal error rates.
6. **Human Oversight:** System outputs should not be treated as conclusive proof of a person's identity or behaviour. Important decisions should require appropriate human verification.
7. **Transparency:** The system's capabilities, limitations, data usage, and intended purpose should be communicated clearly to relevant users.

VIII. Conclusion and Future Scope

8.1 Conclusion

AI and computer vision support automated person detection and real-time tracking. However, occlusion, lighting changes, tracking errors, and limited computing resources remain challenges. This paper proposes comparing tracking methods using FPS, identity switches, track fragmentation, and recovery time to evaluate tracking consistency and processing efficiency. Final conclusions will be based on experimental results.

8.2 Future Scope

Future work may explore additional tracking algorithms, diverse video datasets, and improved tracking recovery during occlusion. The system could be optimized for low-cost hardware and extended to authorized multi-camera environments. Future improvements may also include face recognition, privacy-preserving processing, and secure data handling.

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