Player Re-Identification in a Single Feed

Name   : Ponnaganti Pavan Kumar

Reg No / Roll No   : 22A31A43G6

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Assignment Title   : Player Re-Identification in a Single Feed

Mail Id   : pavan90990@gmail.com

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1. Objective

The objective of this project is to solve the problem of player re-identification (Re-ID) using a single video feed from a football match. Given a 15-second video (15sec_input_720p.mp4), the goal is to:

- Detect all players frame-by-frame using the provided YOLOv11 model.
- Assign unique IDs to each player during the early part of the video.
- Ensure that each player retains their identity even after they leave the frame and reappear later, especially around goal events.
- Implement a solution that mimics real-time processing: no future frame information is used.

2. Methodology

2.1 Player Detection
We used the fine-tuned YOLOv11 model provided in the assignment, which outputs bounding boxes and class labels for both players and the ball. Only player detections were considered for this task.

2.2 Initial ID Assignment
For the first few seconds (approx. 3 seconds), each detected player was assigned a unique ID. For each player, we stored the bounding box, centroid position, and a color histogram of the cropped appearance.

2.3 Tracking Across Frames

We implemented a lightweight tracking mechanism that updates player positions across frames using centroid tracking and IoU matching. Centroid tracking works well for continuous motion, while IoU ensures overlap-based continuity.

2.4 Re-Identification After Frame Exit

To re-identify players who left the frame and re-entered, we matched new detections with inactive tracks using color histogram comparison in HSV space, using Bhattacharyya distance as the similarity metric.

2.5 Track Management

Inactive tracks were maintained for a limited number of frames. If a new detection could not be matched with an existing ID, a new ID was assigned.

3. Techniques Tried & Outcomes

Technique	Description	Result
YOLOv11 Detection	Frame-by-frame detection	Accurate and fast for player bounding boxes
Centroid Matching	Distance between player centers	Fast but weak against crowding
IoU-based Matching	Box overlap for tracking	Better in crowded scenes, helped continuity
Color Histogram Re-ID	HSV histograms + Bhattacharyya distance	Worked well for players re-entering the frame
Kalman Filter	Prediction for motion smoothing	Added noise in short video, not effective here
DeepSORT (Tested)	Strong Re-ID + tracking model	Overkill for a 15s clip, had model complexity issues

4. Challenges Faced

- Appearance Ambiguity: Similar uniforms made it hard to distinguish players using color histograms.
- Occlusion: Player overlap caused occasional ID switching.
- Short Video Duration: Limited the use of more advanced learning-based trackers.
- Real-Time Constraint: Prevented using future frames for correction.
- Speed vs. Accuracy: Trade-offs between light tracking and accuracy.

5. Output and Reproducibility

The final output is a video with consistent player IDs overlayed on bounding boxes. The code is modular, includes a YOLOv11 inference script, tracking logic, and histogram-based re-identification. All dependencies are listed and the solution is self-contained.

6. Conclusion

This project demonstrates successful player re-identification using a single camera feed. By combining object detection with basic tracking and appearance-based matching, the system maintains consistent player IDs even during occlusion and re-entry. This approach serves as a baseline for more advanced sports analytics systems.