

Football Player Re-Identification in a Single Feed

Introduction

This project focuses on re-identifying football players from a single video feed using real-time detection and tracking. The aim is to assign consistent IDs to players, even when they temporarily leave and re-enter the frame—an essential step for advanced sports analytics.

Methodology

A modular computer vision pipeline was developed with the following components:

- **Player Detection:** YOLOv11, fine-tuned for football, detects players in each frame with high speed and accuracy.
- **Feature Extraction:** 3D RGB histograms (8x8x8 bins) provide lightweight, distinctive visual signatures per player.
- **Track Association:** Cosine similarity compares current and stored features, with a threshold of 0.5 for optimal matching.
- **Short-Term Memory:** A 3-second TTL buffer stores recent identities, enabling seamless re-identification after occlusions.
- **Output Generation:** The system outputs an annotated video and a CSV file detailing frame-wise player identities and positions.

Experiments and Observations

Key techniques and outcomes include:

- **YOLOv11 Performance:** Delivered high-speed detection, outperforming older models post fine-tuning.
- **Color Histogram Effectiveness:** Provided strong separation due to team-specific jersey colors.
- **Cosine Similarity:** Efficient for feature matching with consistent performance across frames.
- **Memory Buffer:** The TTL-based cache ensured ID continuity through short absences.
- **Clean Codebase:** Modular functions like `extract_feature()`, `match_tracks()`, and `match_memory()` improved clarity and reusability.

Challenges

Notable difficulties included:

- **Memory Tuning:** Determining an optimal TTL was critical; 3 seconds proved effective.
- **Setup Issues:** A typo in the requirements file caused initial setup failures.
- **Inference Delay:** Real-time performance was impacted by YOLOv11 processing latency.
- **Error Handling:** Blank image crops occasionally crashed the pipeline; handled using robust checks.

Future Work

Currently at 85% completion, future enhancements include:

- Fix setup scripts and environment issues.
- Integrate CNN-based embeddings (e.g., ResNet, OSNet) for better generalization.
- Enable real-time processing via live feeds.
- Add motion models (e.g., Kalman filter) for smoother tracking.
- Build a live dashboard for tactical analysis.
- Optimize with GPU acceleration and batching.
- Auto-cluster players by jersey color for team-wise tracking.
- Extend analytics with heatmaps and trajectory analysis.

Conclusion

This system provides a reliable framework for football player re-identification using YOLOv11 and appearance-based tracking. It maintains identity across occlusions and is designed for modular expansion. Future developments will push toward a full-fledged real-time analytics platform for multi-camera sports analysis.

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