Player Re-Identification Project Report

Project Overview

The goal of this project is to perform **player re-identification (Re-ID)** across two different camera feeds from a football game **tacticam** and **broadcast**. The aim is to consistently identify and label the same player with the same ID across both videos.

This project was designed to **reflect real-world constraints** and promote **open-ended problem-solving**. It involved defining our own subcomponents like custom identity managers, feature extractors, and visual annotation tools. The unique modular approach allowed flexibility and iterative refinement across the entire pipeline.

Completed Objective

Option 2: **Re-identification in a Single Feed**

Implemented a working solution where:

1. Players are detected using a YOLOv11 model (**yolo_player_detector.pt**).
2. Features such as colour histograms, mean, and standard deviations are extracted.
3. A custom identity manager assigns consistent IDs across frames.
4. Annotated video output is generated with bounding ellipses and labelled IDs.

Result: ✓ Successfully completed and functions as expected.

Approach & Methodology

Planning and Setup:

1. Outlined the project using software development lifecycle principles.
2. Defined two key tasks: **Option 1 (Cross-Camera Player Mapping)** and **Option 2 (single-camera)**.
3. Created a modular structure: detection, tracking, feature extraction, annotation.
4. Set up and managed virtual environments and dependencies.

Pipeline Components:

1. **Detection:** YOLOv11 used to detect players, referees, and ball.
2. **Feature Extraction**: 'EnhancedFeatureExtractor' implemented with:
    a. HSV histograms
    b. Colour statistics (mean and std)
3. **Identity Management:** 'EnhancedIdentityManager' uses:

    a. Cosine similarity of features
    b. Centre distance to reduce mismatches
    c. Memory tracking across frames
4. **Annotation:** Used custom 'draw_ellipse()' and 'draw_triangle()' to visualize players and ball in output videos.

Option 1: **Cross-Camera Re-Identification (In Progress)**

Implemented Steps:

1. Processed **tacticam.mp4**, assigned IDs to players.
2. Stored player memory (features + bounding boxes).
3. Used this memory while processing **broadcast.mp4** to assign IDs based on feature similarity.

Current Outcome:

1. Some players matched correctly with consistent IDs across feeds.
2. Many IDs still mismatched due to camera angle, occlusions, and viewpoint variations.

Remaining Tasks:

1. Full alignment and 100% ID consistency not yet achieved.
2. More robust cross-camera tracking logic is required.

Future Plan:

To fully solve cross-camera Re-ID, I plan to:

1. Use **temporal alignment** to synchronize feeds.
2. Add **pose estimation** or skeleton features for better body shape matching.
3. Apply **homography** or **camera calibration** to normalize perspectives.
4. Integrate **deep metric learning** models to generate viewpoint-invariant embeddings.
5. Experiment with **appearance tracklets** for time-consistent matching.

Challenges Faced & Solutions

Technical Issues:

1. 'draw_text()' argument errors due to deprecated supervision APIs
2. Annotation bugs due to incorrect offsets and label placement
3. Player IDs growing uncontrollably due to unlinked memory between feeds
4. Import issues with 'BoxAnnotator', missing modules

Solutions Applied:

1. Shifted from **supervision** annotators to **cv2**-based drawing for full control
2. Encapsulated logic in modular helpers: **draw_ellipse**, **draw_triangle**
3. Reused identity memory from one feed to another
4. Debugged step-by-step using logs and frame previews
5. Implemented **assign_ids_cross_camera()** as an extended method to re-use IDs

Software Lifecycle Compliance

Requirement Gathering: Understood the challenge of Re-ID in sports analytics

System Design: Broke into logical modules and components

Development: Iteratively built and tested core features

Testing: Frame-wise output validation, logging, visual confirmation

Maintenance: Modular structure for easy updates

Documentation: README, requirements.txt, PDF reports, in-code documentation

Deployment: Generates `.mp4` annotated outputs for both feeds

Summary

Option 2 (single feed Re-ID): fully functional

Option 1 (cross-camera Re-ID): in progress, IDs partially match

1. With additional time, deeper visual features and geometric alignment will help finalize the solution
2. A structured, professional, and flexible approach has set a strong foundation for completion
3. With additional resources and time, the cross-camera mapping will achieve consistent, production-grade results.

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