Player Tracking using YOLOv11 + DeepSORT

1. Introduction :

This project is focused on multi-person tracking in soccer videos using YOLOv11 for object detection and DeepSORT for maintaining consistent identity tracking. The key goal is to ensure each player retains a unique and stable ID across frames, even when they exit or re-enter the frame

2. Approach and Methodology:

The pipeline consists of:
-YOLOv11 (Ultralytics) for real-time detection of 'person' or 'player' class.
- DeepSORT tracker (with MobileNet embedding) for assigning consistent track IDs.
- A Non-Maximum Suppression (NMS) method using OpenCV to eliminate overlapping detections and avoid assigning multiple IDs to the same player.

Each detection is first filtered based on confidence score and class label. Detected boxes are processed through NMS to remove overlapping ones. This helps ensure that only the most confident detection for each player is passed to the DeepSORT tracker, which maintains consistent IDs based on both position and appearance features.

3. Why Norfair was Not Used:

Initially, the Norfair tracker and its detection pipeline were explored for multi-person tracking. However, a major issue was observed: the assigned IDs were not stable across frames. Even for the same player, the ID would fluctuate frequently when the player moved fast or changed direction.
This instability made it unsuitable for use in match analysis and player statistics generation, which require persistent identity tracking.

4. Removing Overlapping Boxes:

Overlapping detections of the same player led to DeepSORT assigning multiple track IDs for one person. To resolve this, OpenCV's Non-Maximum Suppression (`cv2.dnn.NMSBoxes`) was used before passing detections to the tracker.
This function compares detection boxes using their Intersection-over-Union (IoU) and retains only the most confident detection among those that significantly overlap (IoU > 0.6). This method was crucial in reducing ID duplication.

5. Challenges Encountered:

- **Using Norfair**: As mentioned, fluctuating IDs caused major issues in consistent tracking.
- **Without Overlap Filtering**: When overlapping player detections were not filtered, a single player could receive multiple IDs in the same frame.
- **Occlusion**: Even with DeepSORT and NMS, when one player stands behind another, the tracker's ID can switch or reassign, causing fluctuations.

6. Remaining Issues and Future Solutions:

Even after integrating DeepSORT and applying NMS, ID fluctuation remains a challenge during occlusions or when players come close together. This happens because the appearance embeddings from MobileNet become similar and positional uncertainty increases.

Potential solutions include:

- Integrating Re-ID (re-identification) models trained specifically on sports datasets.
- Increasing tracker memory (e.g., `max_age`) and tuning `nms_max_overlap`.
- Exploring transformer-based multi-object trackers that understand scene context.
- Using multi-camera views to improve identification when one view fails.

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