Soccer Player Re-Identification in a single feed

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1. Approach and Methodology

To address player re-identification in soccer footage, I adopted a multi-model fusion strategy. Unlike conventional bounding boxes, I used **ellipse annotations** for players/referees/goalkeepers to create a video-game feel that's more appealing to viewers. The pipeline integrates:

- **YOLOv11** (Ultralytics) for initial detection of players, goalkeepers, and the ball.
- **DeepSORT** for short-term tracking, associating detections across frames.
- **TorchReID (OSNet-AIN)** for robust re-identification using appearance embeddings.

Methodology:

1. **Detection**: YOLOv11 processes frames at 0.3 confidence, filtering ball/player classes.
2. **Tracking**: DeepSORT maintains ID consistency using motion cues.
3. **Re-ID**: TorchReID pulls out appearance features (512-dim embeddings) from player crops.
4. **Fusion**: Detections without valid embeddings (i.e. detections without clear visuals, blurry or too small) are ignored.

This hybrid approach track players even if they go out of frame and reappear or are blocked, they still maintain the same identity.

2. Techniques Tried and Outcomes

Technique	Outcome	Reason for Limitation
EasyOCR	Poor performance	Jersey numbers often hidden or unclear.
Fine-tuned YOLOv11	Failed re-ID	Detectors lack discriminative re-ID features that's necessary for the project.
DeepSORT alone	Low accuracy (~50% ID consistency)	Similar-looking kits confused the tracker.
Re-ID Packages: FastReID and TorchReID	Selected TorchReID	OSNet offers best speed/accuracy trade-off for real-time use.

Final Solution:

Combined YOLOv11 (detection), DeepSORT (tracking), and TorchReID (OSNet-AIN embeddings). After tuning:

- **Max Cosine Distance**: 0.4 (stricter matching).
- **NN Budget**: 210 (stores more past appearances).
- **Max Age**: 140 frames (lets IDs continue longer when players are hidden).
  Result: Better tracking, even with heavy movement or players temporarily out of view.

3. Challenges Encountered

- **ID Swaps**: Players switch IDs when too close (e.g., during tackles, penalty box scrambles).
- **Posture Changes**: Goalkeeper diving causes "new player" false positives (appearance shift).
- **Real-time Trade-offs**: Higher NN budget improves accuracy but increases latency.

4. Future Improvements

Even though the system works well now, here are further upgrades:

1. **Domain-Specific Re-ID Model**:
   - Train OSNet on soccer player datasets (e.g., SoccerNet) to distinguish kits/body shapes.
   - Add training images with different poses (e.g., diving, running, tackles).
2. **Add Pose Tracking:**
   - Use pose models (like YOLO-Pose) to track player body parts, helping reduce mistakes when players bump into each other.
3. **Smooth Player Movement:**
   - Use filters (like Kalman filters) to reduce sudden ID changes when players move fast.
4. **Hardware Tuning:**
   - Convert models to run faster and lighter (e.g., FP16 or INT8) for devices like NVIDIA Jetson.

Deployment Roadmap: