⚽ Player Re-Identification in Sports Footage

This project implements a real-time football analytics pipeline using deep learning and computer vision. It integrates **YOLOv8** for object detection, **SORT** for tracking, **CLIP** for team classification and re-identification, and provides basic analytics such as **speed, distance**, and **ball possession stats**.

📁 Repository Contents

```
.
├── models/
│   └── yolo_players.pt         # YOLO model trained for players & ball
├── sort/
│   └── sort.py                 # SORT tracker
├── videos/
│   └── 15sec_input_720p.mp4    # Match video input
├── results/
│   └── final_stats_overlay.mp4# Output video with analytics
├── vlm_action_tracking.py      # Main pipeline script
└── Player Re.docx              # This report
```

⚙ Setup Instructions

🔧 Requirements

- Python 3.8+
- GPU Recommended for CLIP & real-time performance

📦 Install Dependencies

```
pip install torch torchvision opencv-python numpy pillow scikit-learn
pip install git+https://github.com/openai/CLIP.git
pip install ultralytics
```

Ensure the YOLOv8 model is placed at:

```
models/yolo_players.pt
```

▶ Run the Project

```
python vlm_action_tracking.py
```

This processes the video and displays:

- Player tracking with persistent IDs
- Team classification via jersey color
- Speed & distance traveled
- Ball tracking with possession stats

📽 Project Objective

Detect, track, and analyze players and the ball from football footage using:

- **Re-identification** (ID persistence even after occlusion)
- **Team classification** (jersey-based using CLIP)
- **Player analytics** (speed, distance)
- **Ball control percentages**

🔍 What I Did

1. Player & Ball Detection

- YOLOv8 model trained on player and ball classes
- Filters detections by confidence and class

2. Tracking & Re-Identification

- Uses **SORT** for short-term tracking
- Adds **CLIP-based re-identification** to retain consistent player IDs
- Jersey crop passed to CLIP for embedding & cosine similarity check

3. Team Classification

- Jersey region extracted (top 50% of bbox)
- CLIP compares crop to prompts like:
    - "a football player wearing a red Manchester United jersey"
    - "a football player wearing a blue Manchester City jersey"
- Softmax + argmax to assign class (Team Red, Team Blue, Referee)

4. Player Analytics

- Speed calculated using pixel distance per frame (converted to km/h)
- Distance summed over time
- Ball possession calculated based on proximity to player centers

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✅ What Worked & What Didn't

Method	Description	Result
YOLOv8	Player/ball detection	✅ Robust & accurate
SORT	Short-term tracking	✅ Works well for most cases
CLIP + Re-ID	Jersey embedding re-identification	✅ IDs persist after occlusion
CLIP + Prompt	Natural language-based team classification	✅ Consistent & flexible
Speed Metric	Distance per frame (0.05m per pixel approx)	✅ Informative but needs real calibration
Ball Control	Proximity-based possession estimate	✅ Good visual indicator

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⚠ Problems Faced

- CLIP slow on CPU → switched to GPU
- ID switch with long occlusion in SORT → fixed with embedding comparison
- Jerseys not always visible → classification less reliable
- No pixel-to-meter calibration → speed/distance estimates are relative
- Ball tracking misses mid-air shots (if not detected as "ball")

🔧 Future Improvements

- 🔁 Add robust action recognition (e.g. with R3D, SlowFast)
- 👕 Add OCR for jersey number or face recognition for player identity
- □ Integrate play pattern recognition (passes, tackles, goals)
- 📊 Better speed calibration using field dimensions or homography
- ✏ Add commentary or play-by-play generation

👤 My Experience

This project helped me combine vision-language models like CLIP with traditional computer vision. I learned how to:

- Use **CLIP for classification** tasks beyond zero-shot
- Implement tracking + re-ID pipelines
- Apply speed and movement metrics in sports
- Handle edge cases like missing jerseys or occlusions

📞 Contact

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