

FOOTBALL DETECTION AND TRACKING PROJECT

Under supervision: Eng.Ahmed Ayman

Problem Statement

Manual tracking in football analytics presents significant challenges, demanding extensive time and resources. The process is prone to human error, especially when dealing with fast-paced action, varying camera angles, and occlusions. Accurately detecting and tracking small objects like the football across diverse video conditions (lighting, weather, resolution) is particularly difficult. Therefore, an **automated**, **accurate**, and **robust** object detection and tracking system is crucial to enhance football analytics and provide valuable insights.

Solution

Our solution is an end-to-end computer vision system designed for real-time football detection and tracking. Key components include:

- **YOLO-based Models:** We leverage state-of-the-art YOLO models, including YOLOv8m, YOLOv11l, and a specialized model fine-tuned for precise ball detection.
- **Optimization Techniques:** We employ various optimization techniques to enhance model performance, speed, and accuracy. Techniques may include transfer learning, data augmentation, and model pruning.
- **Streamlit Web App:** The system is deployed as a Streamlit web application, providing a user-friendly interface for real-time video analysis and visualization of tracking results. This allows for interactive exploration of game footage and immediate access to analytics.

Final Performance Summary (Epoch 30)

Metric	Value	Description
Mean Average Precision (mAP50-95)	0.5333	This is the main metric for the quality of object detection across a wide range of Intersection over Union (IoU) thresholds.
Mean Average Precision (mAP50)	0.8209	Measures the quality of detection at the standard IoU threshold (0.5). Indicates good overall performance in object localization.
Precision	0.9062	Indicates that 90.62% of the detections made by the model were correct.
Recall	0.7515	Indicates that the model successfully identified 75.15% of all existing target objects.

Future Work

The following enhancements are planned for future development:

- **Model Accuracy Improvement:**

Enhance the detection model's accuracy by expanding and diversifying the training dataset. Improved detection precision will directly enhance the tracking stability, reducing player ID switching and misidentification issues during matches.

- **Multi-Camera Integration:**

Integrate data from multiple cameras to provide a comprehensive view of the field and improve overall tracking accuracy and coverage.

- **3D Tracking:**

Implement 3D tracking algorithms to capture depth information and enable more advanced spatial and positional analysis.

- **Event Detection:**

Develop algorithms to automatically detect and classify key game events, such as passes, shots, tackles, and fouls, in real time.

- **Analytics Dashboards:**

Create interactive dashboards to visualize key performance indicators (KPIs) and provide actionable insights for coaches and analysts.

- **Model Generalization:**

Extend the system's capabilities to other sports by adapting models and algorithms to new datasets and domain-specific challenges.

Created by: Osama Ashraf Eid