PLAYER DETECTION AND UNIQUE ID TRACKING IN CRICKET FOOTAGE

1. Objective:

The objective of this project was to develop a computer vision pipeline to detect cricket players in video footage and assign unique, persistent IDs to track them across frames, handling challenges like occlusion and camera movement.

2. Model Architecture:

- **Detection Model:** I selected **YOLOv8 (You Only Look Once, version 8)**, specifically the `yolov8n` (nano) variant.
- **Reasoning:** YOLOv8 is a state-of-the-art single-stage object detector known for its high inference speed and accuracy. The 'nano' version provides a balance between performance and computational efficiency, allowing for near real-time processing on standard hardware.

3. Tracking Algorithm:

- **Algorithm:** I implemented **BoT-SORT (Box Tracking + SORT)**, which is integrated into the Ultralytics YOLO framework.
- **Functionality:** This tracker combines the Kalman Filter for motion estimation with Hungarian algorithm matching. It effectively associates detections from the current frame with tracks from previous frames based on spatial proximity and motion prediction.

4. ID Consistency & Challenges:

To ensure IDs remained stable (e.g., "Player 5" stays "Player 5"), the following mechanisms were used:

- **Persistence:** The tracking loop utilizes a `persist=True` flag, ensuring the tracker maintains state memory between frames.

- **Occlusion Handling:** When players cross paths (occlusion), the Kalman Filter predicts where the occluded player *should* be. Once they reappear, the algorithm re-associates the new detection with the existing track ID rather than creating a new one.
- **Camera Motion:** The tracker is robust to minor camera movements by relying on relative bounding box coordinates and high-speed detection updates.

5. Future Improvements:

- **Re-Identification (ReID):** Integrating a visual appearance model (ReID) would improve tracking when a player leaves the frame completely and returns later.
- **Team Classification:** Implementing a secondary classifier to distinguish between teams (e.g., using jersey color histograms) would add semantic value to the data.

6. Advanced Feature: Perspective Transformation (Minimap):

To satisfy the optional requirement of a top-down tactical view, I implemented a Homography transformation pipeline.

- **Methodology:** The system uses a 4-point calibration method. By selecting the four corners of the pitch in the source video (Source Points) and defining a fixed rectangle in the 2D output space (Destination Points), a transformation matrix is calculated using `cv2.getPerspectiveTransform`.
- **Execution:** For every frame, the bottom-center of each player's bounding box (representing their feet) is multiplied by this matrix. This projects their location from the camera's perspective to the flat 2D coordinate system.
- **Result:** This allows for real-time tactical visualization, showing player spacing and movement on a standardized cricket field layout, regardless of the camera's angle.

7. Conclusion:

This project successfully developed and deployed an automated Computer Vision pipeline for tracking cricket players in video footage. By integrating the **YOLOv8** object detection model with state-of-the-art tracking algorithms, the system effectively identifies players and maintains consistent identification across frames, addressing the core challenges of occlusion and dynamic movement.

The implementation went beyond basic tracking by incorporating a **Perspective Transformation (Homography)** module. This advanced feature maps the 3D camera view to a 2D "Bird's Eye" tactical map, providing a professional-grade analytical view of player positioning.

Key achievements of this system include:

- **Robust Detection:** High-accuracy detection of players using YOLOv8n.
- **Consistent Tracking:** Stable ID assignment using tracking logic to handle frame-to-frame continuity.
- **Tactical Visualization:** Successful generation of a top-down minimap for spatial analysis.
- **Scalability:** A modular pipeline architecture capable of processing high-resolution video data.

This project demonstrates the practical application of Deep Learning and Computer Vision in sports analytics, offering a foundational tool that can be extended for real-time coaching insights and automated game analysis.