Capstone project-2

Football System Analysis

Analyzing football games using computer vision techniques.

This will provide insights into player movement and performance.

-BY RETHECK

Using Ultralytics & YOLO for Player, Referee, and Ball Detection

Ultralytics and YOLO (you only look once), a leading deep learning library and object detection framework, are powerful tools for real-time analysis of football footage. YOLO is known for its speed and accuracy, making it suitable for real-time applications. YOLO divides the input image into a grid and predicts bounding boxes and class probabilities for each grid cell.

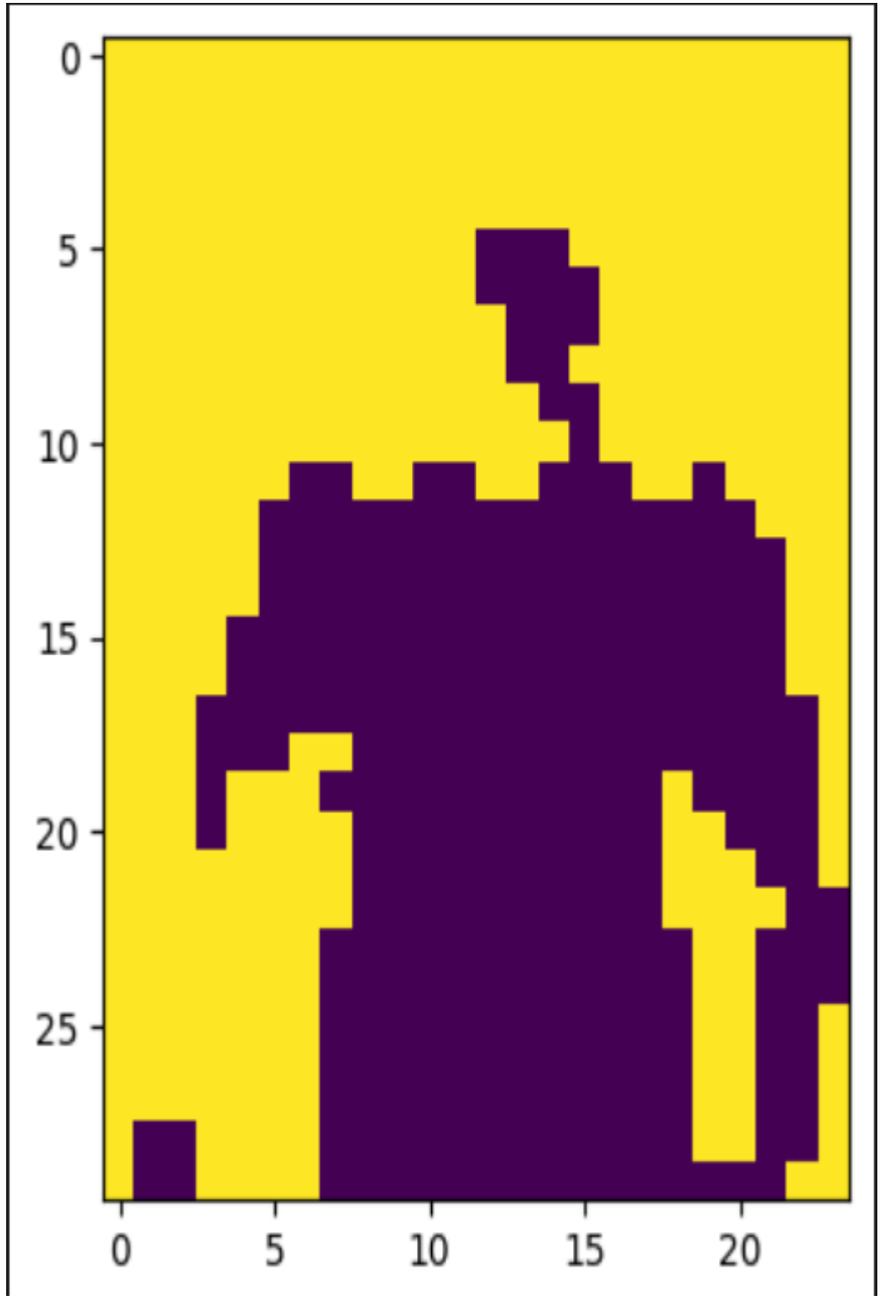
These tools enable precise detection and tracking of players, referees, and the ball, laying the foundation for advanced game analysis.

Video to be analyzed

The same video after using yolo and ultralytics for object detection

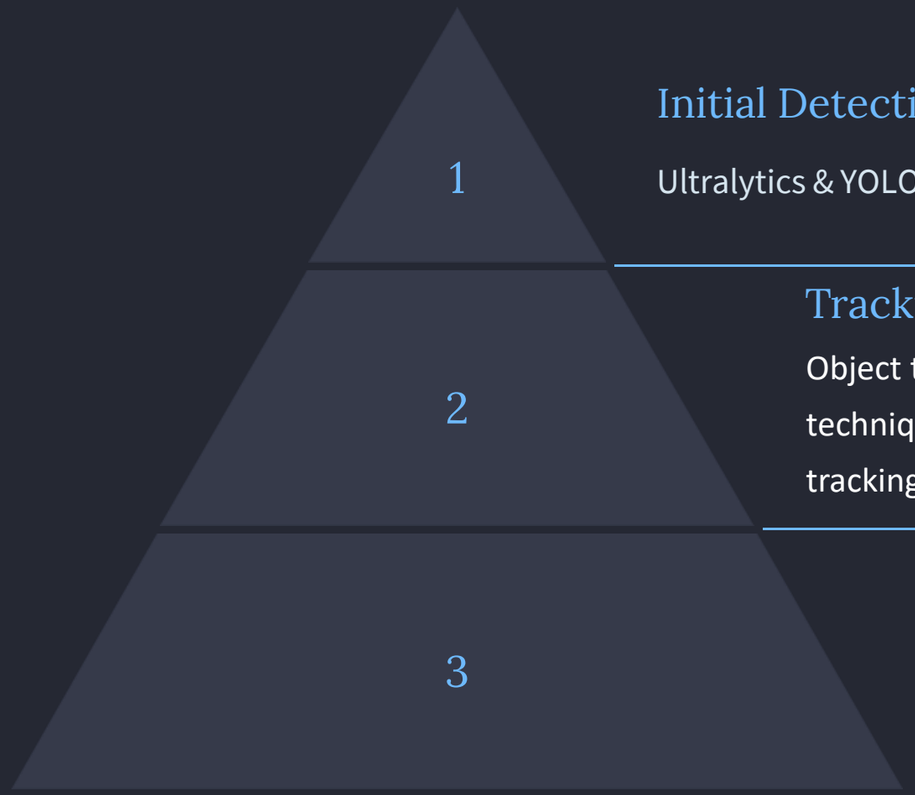
Converting an image taken from the video from BGR to RGB

After performing K-means clustering with 2 clusters for 2 team players



Tracking Objects Across Frames

We use trackers to keep track of players, referees, and the ball as they move throughout the game.



Initial Detection

Ultralytics & YOLO detect players, referees, and the ball in each frame.

Tracking

Object tracking using DeepSORT, it integrates deep learning techniques, particularly deep neural networks, to improve the tracking performance compared to traditional methods.

Confirmation

The tracker's prediction is verified with the newly detected objects, ensuring accuracy.

The trackers use a variety of algorithms to predict the location of these objects in future frames. By using past data to make these predictions, we can create a continuous flow of data, allowing us to analyze object movement and interactions throughout the entire game.

Training Custom Object Detectors

1

Data Collection

Gathering a large, diverse dataset of football footage, ensuring images are high-quality and labeled accurately.

2

Data Annotation

Label each frame of footage, carefully marking the location and type of each object: players, referees, and the ball.

3

Model Selection

Choosing object detection model(YOLO), considering factors like accuracy, speed, and computational resources.

4

Model Training

Training the YOLO model on my annotated dataset using frameworks like PyTorch or TensorFlow. Monitor training metrics such as loss, mAP (mean Average Precision), and IoU (Intersection over Union).

5

Model Evaluation

Testing the trained model on a separate, unseen dataset to assess its performance and identify areas for improvement.

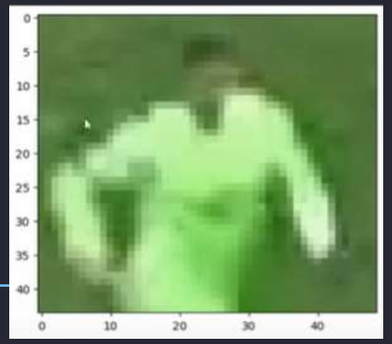
Assigning Players to Teams Using K-Means Pixel Segmentation

We can assign players to teams by analyzing the colors of their jerseys.

1

Identify Player Pixels

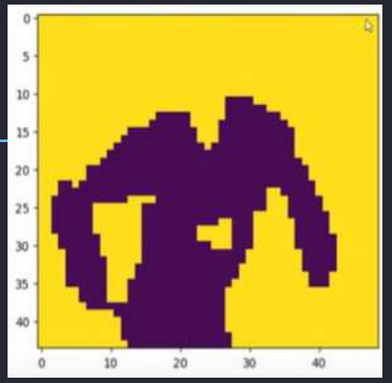
Detect pixels that belong to players, excluding the background and other objects.



2

Cluster Pixel Colors

Apply the K-means algorithm to group similar jersey colors.



3

Assign Teams

Determine the dominant jersey color for each player and assign them to the corresponding team.

This process automatically identifies the teams based on the color segmentation of the jerseys.

Optical Flow to Measure Camera Movement

1

Frame-to-Frame Comparison

Optical flow algorithms analyze consecutive frames of video footage to identify movement. They analyze pixel displacements, comparing the location of features in adjacent frames to calculate the direction and magnitude of the camera's movement.

2

Motion Vectors

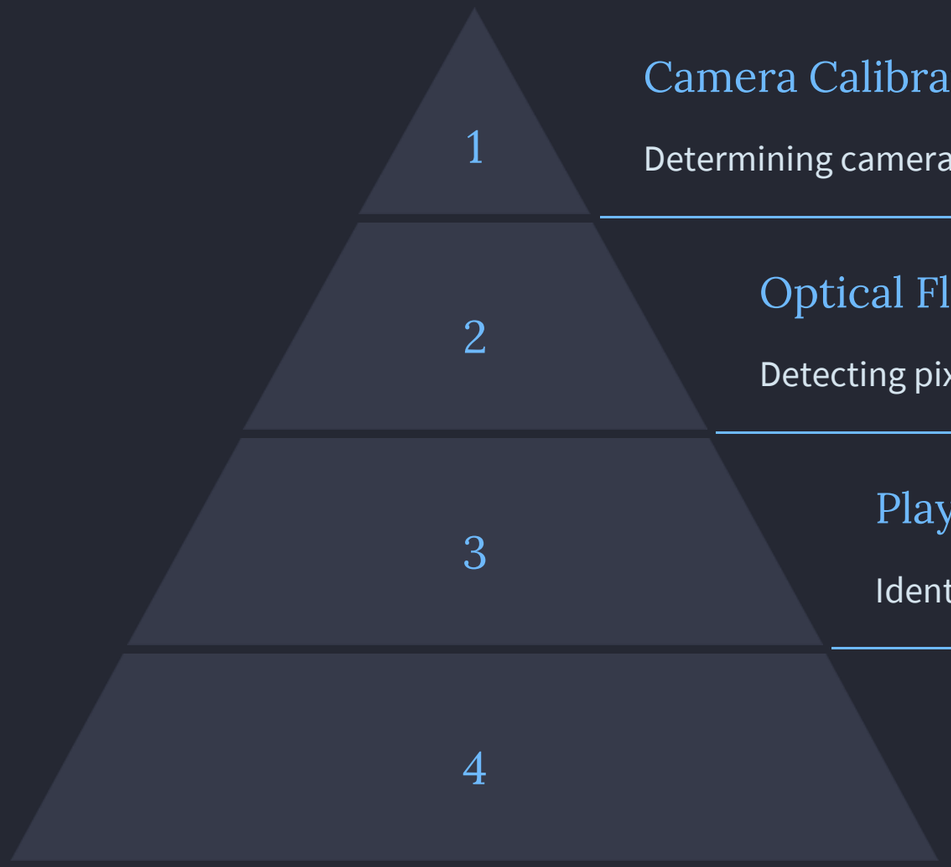
The algorithms generate motion vectors that represent the movement of each pixel. These vectors are used to determine the direction and magnitude of camera movement between frames.

3

Camera Trajectory

The calculated motion vectors can be combined to create a trajectory of the camera's movement. This information can be used to compensate for camera motion and accurately track players' movements on the field.

Measuring Player Movement in Meters



Camera Calibration

Determining camera position and orientation

Optical Flow

Detecting pixel movement between frames

Player Tracking

Identifying player bounding boxes

Distance Calculation

Using known camera parameters and player position

Accurately measuring player movement requires precise camera calibration to understand its position and orientation relative to the field. Optical flow analysis tracks pixel movement between frames to identify player movement. By tracking players across frames, we can calculate the distance they cover based on their position relative to the calibrated camera.

Analyzing Player Movement Patterns

1

Identifying Trends

Analyzing player movement data reveals patterns in their movement behavior, such as average speed, distance covered, and time spent in specific areas of the field.

2

Mapping Heatmaps

Heatmaps visualize player movement frequency, highlighting areas of high activity and identifying strategic areas of the field.

3

Strategic Insights

Analyzing movement patterns provides coaches with insights into player strengths and weaknesses, enabling tactical adjustments and individual player development.

Perspective Transformation Using OpenCV

OPENCV Transforms the scene’s perspective to represent depth, allowing measurement of movement in meters instead of pixels .By applying perspective transformation, we can map the 2D video feed onto a 3D model of the playing field. This allows us to measure player and ball positions in real-world units like meters, rather than just pixels on the screen.

The key steps are:

1. ## Calibrate the Camera

   Determine the camera's intrinsic parameters like focal length, principal point, and lens distortion.

2. ## Establish Field Dimensions

   Use known dimensions of the playing field, like the length of the sidelines, to define the 3D coordinate system.

3. ## Apply Homography

   Calculate the homography matrix that maps 2D image coordinates to 3D world coordinates, allowing us to measure real-world positions.

With this perspective transformation, we can now accurately track player and ball movements in meters, providing coaches and analysts with invaluable data to optimize tactics and player performance.

Speed and Distance Estimator

1

Track Movement

Utilize player and ball tracking data to capture precise movement across the playing field.

2

Velocity Calculation

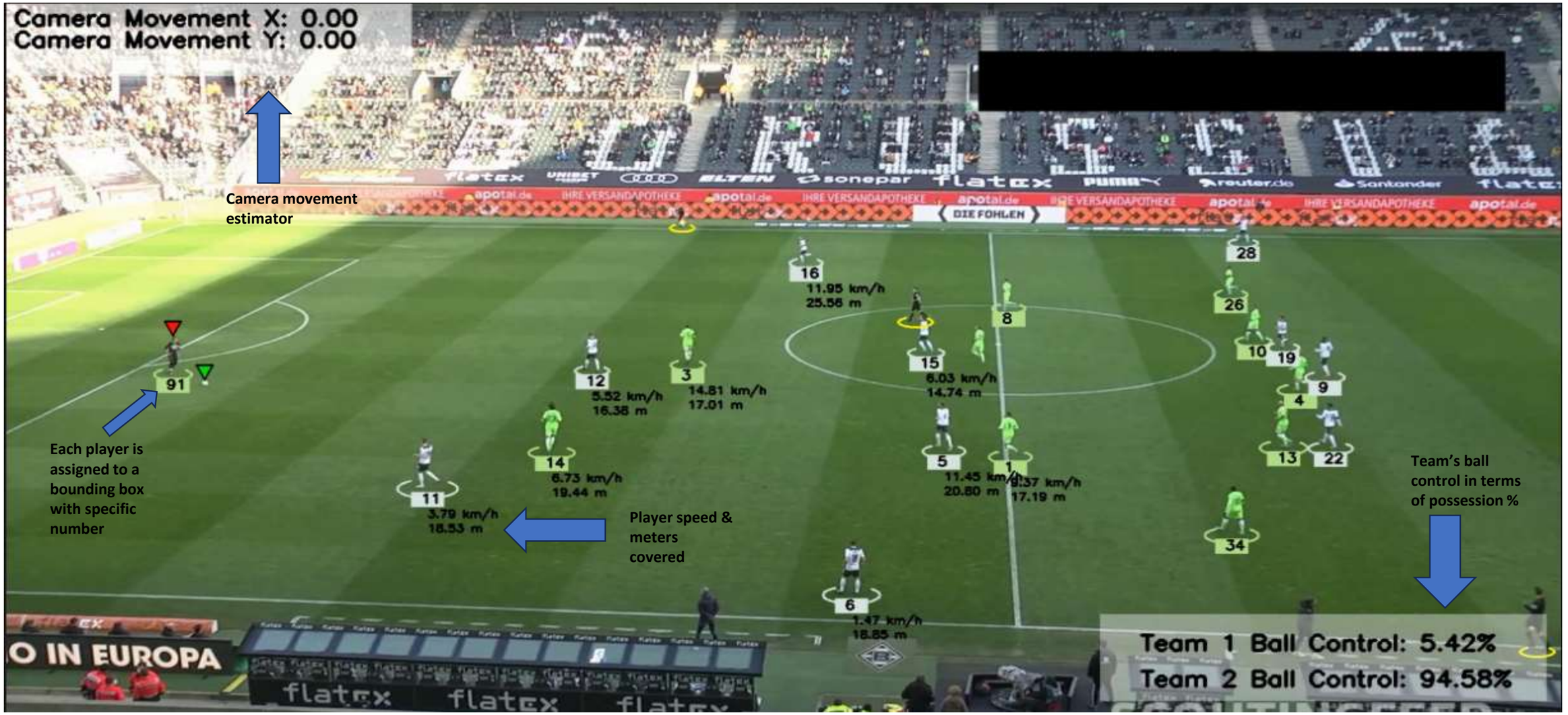
Analyze the speed and acceleration of players and the ball using advanced algorithms.

3

Distance Mapping

Translate the tracking data into real-world distance measurements, providing valuable insights.

Final output video will look like this:



Leveraging Tracking Data for Tactical Insights

1

Team Formation Analysis

Track player positioning to identify strengths and weaknesses in team formations. Analyze the effectiveness of various formations and tactical setups.

2

Player Performance Evaluation

Track player movement, speed, and distance covered. Use this data to evaluate individual player performance and identify areas for improvement.

3

Opponent Analysis

Track opponent player movement and identify their tactical tendencies and weaknesses. Use this data to develop counterstrategies and exploit opponents.

4

Real-Time Tactical Adjustments

Analyze tracking data during games to make real-time tactical adjustments and optimize player positions and strategies.

5

Performance Optimization

Use data to identify optimal training regimens and identify individual player strengths and weaknesses.