Automated Soccer Data Collection from Videos

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Where is the foul?

- How to track soccer players and ball from live broadcast footage?

Simplifications

- Ignore changing scenes (single scene)
- Look at single camera with panning, zoom and tilt.
- No replay scenes
- Ignore lens distortion
- Consider only penalty area

Main approaches

- Divide problem:
  - Camera localization
    - Where is the camera pointing in world space?
  - Player tracking
    - Where are the players on screen?

Localization

$$\mathbf{p_i} = \mathbf{H}\mathbf{p}'_{\mathbf{i}} = \begin{pmatrix} f & 0 & o_x \\ 0 & f & o_y \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} r_{00} & r_{01} & r_{02} & t_x \\ r_{10} & r_{11} & r_{12} & t_y \\ r_{20} & r_{21} & r_{22} & t_z \end{pmatrix} \begin{pmatrix} x' \\ y' \\ z' = 0 \\ 1 \end{pmatrix}$$

camera projection | camera rotation and placement | world coordinate

ground is at z=0

- Transformation of world coordinates to image coordinates
- Soccer field is on ground therefore z’ = 0
- Transformation implicitly captures tilt, zoom and panning
- Goal: determine transformation matrices

Method

- There are 8 free parameters in total
- We therefore need 4 point correspondences from image space to world space
- Correspondences made from key points in the image and the world space
- Penalty box lines easier to detect than center circle

Implementation

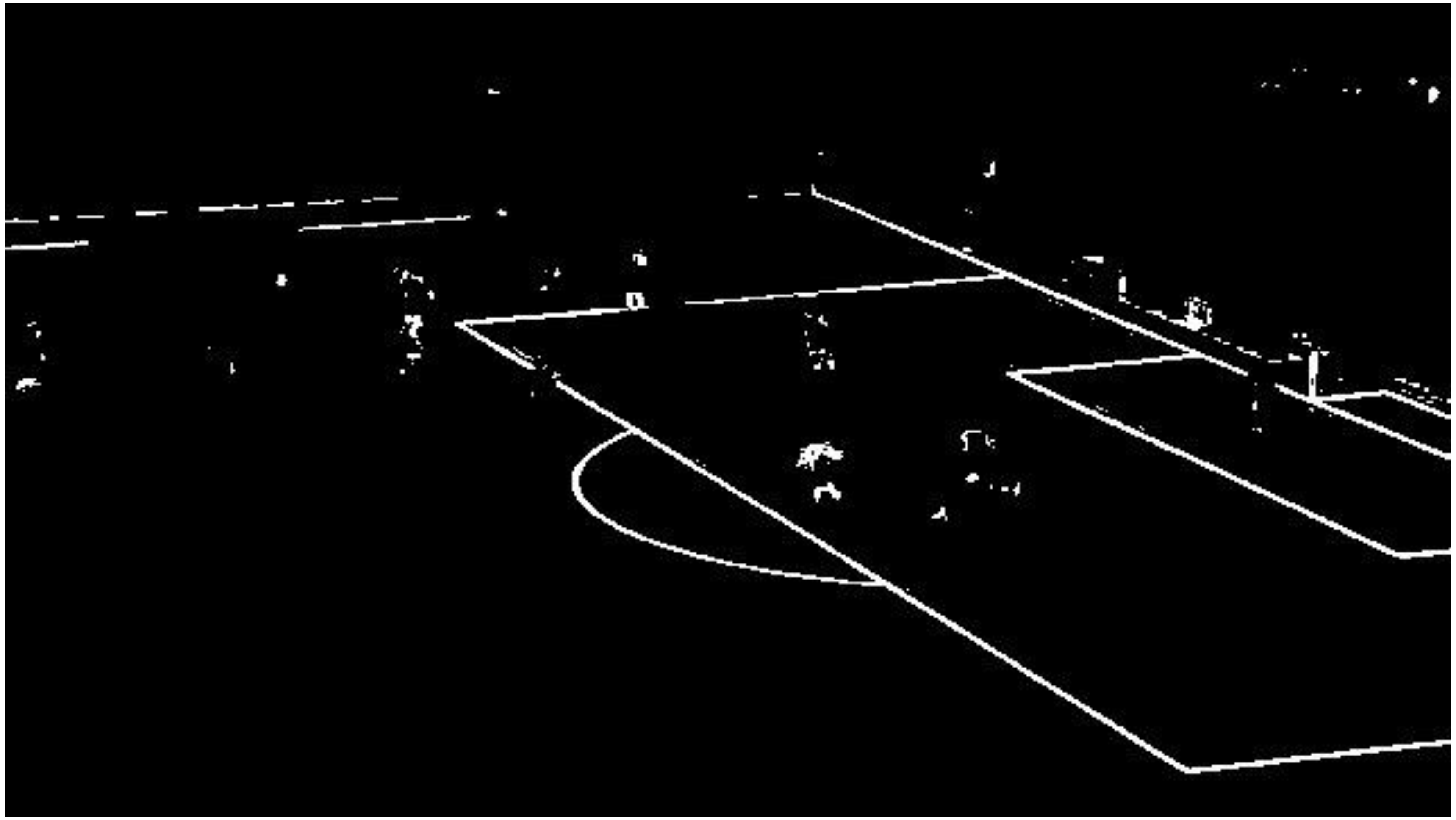
- Step 1: isolate field and lines (colour thresholding, morphology)

Implementation

- Step 2: Apply mask over original image

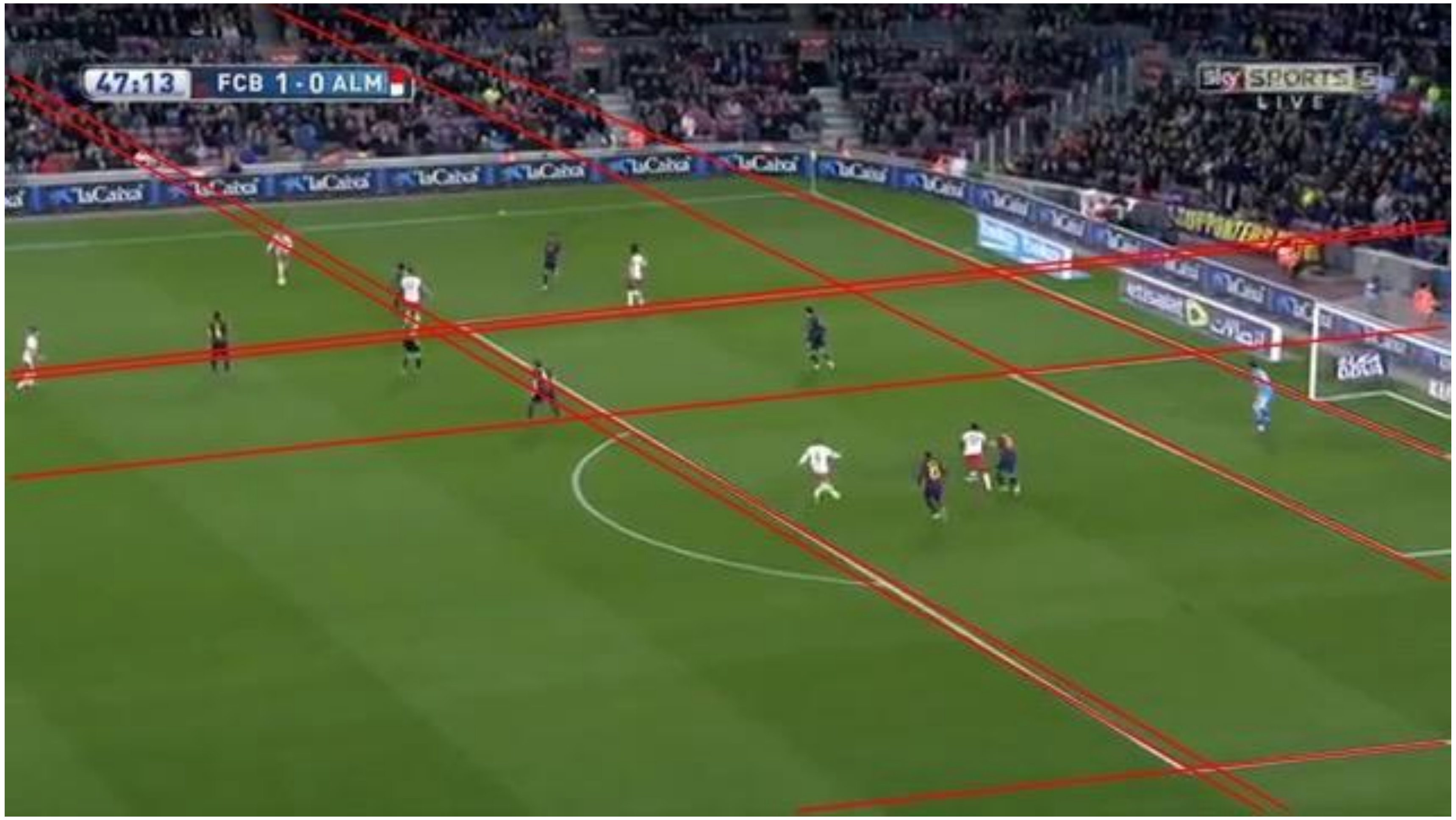
Implementation

- Step 3: Convert image to binary

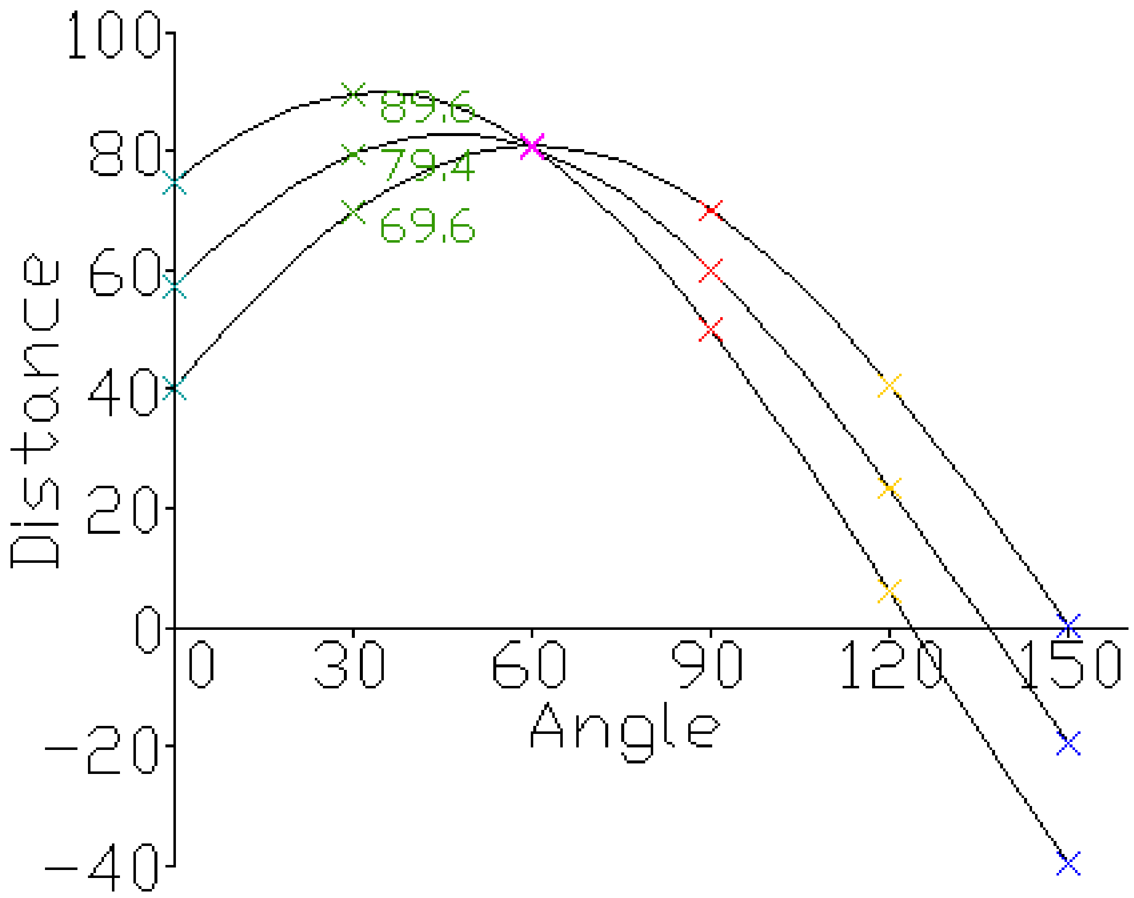


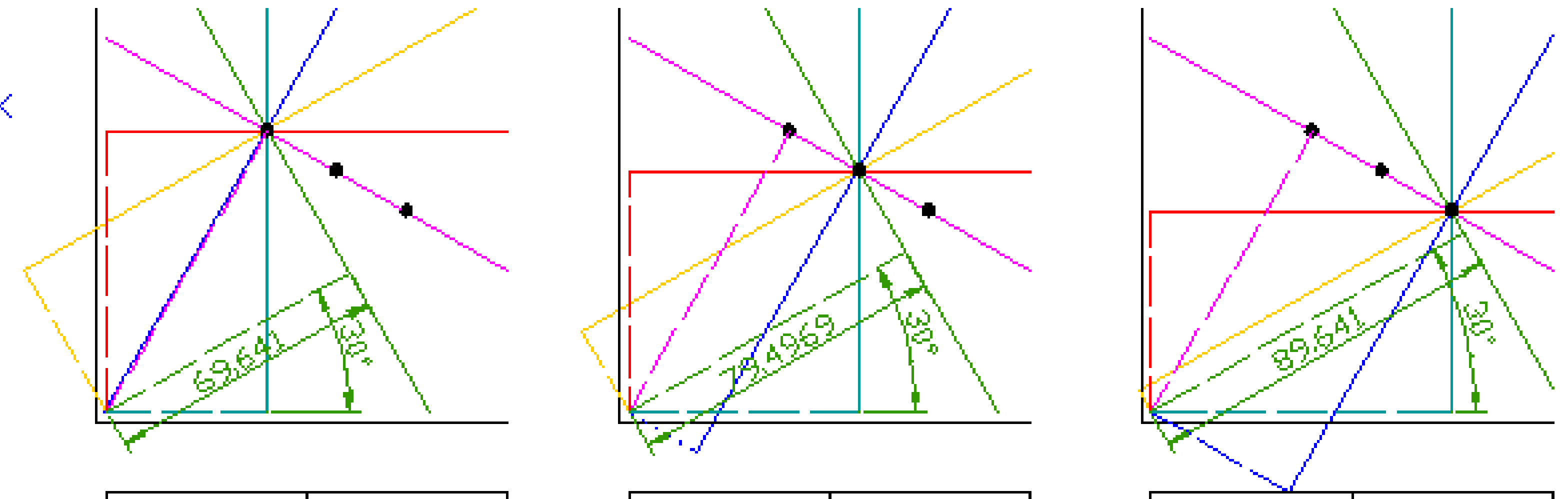
Implementation

- Step 4: Detect straight lines (Hough transformation)



Hough Transform





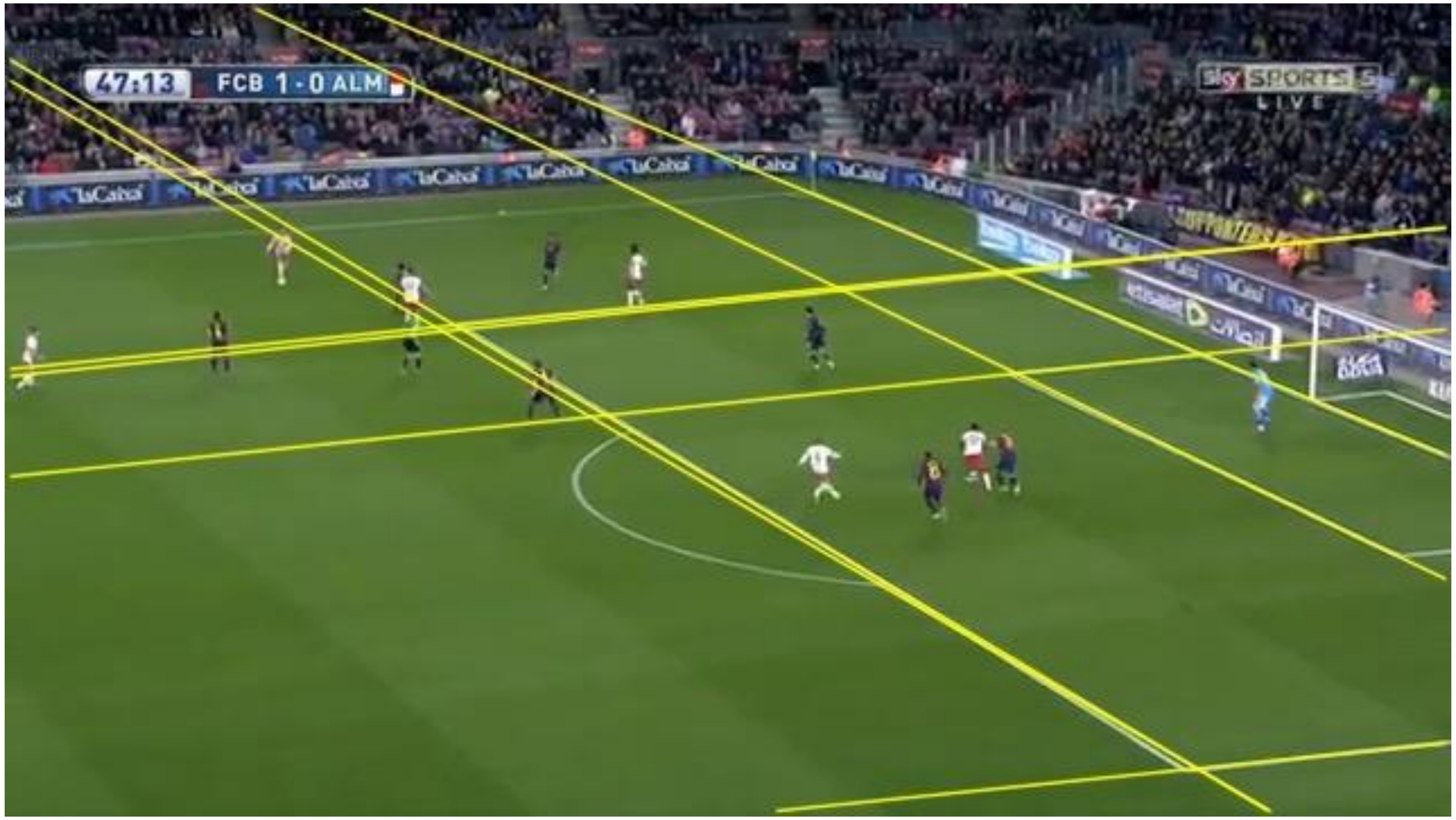
Angle	Dist.
0	40
30	69.6
60	81.2
90	70
120	40.6
150	0.4

Angle	Dist.
0	57.1
30	79.5
60	80.5
90	60
120	23.4
150	−19.5

Angle	Dist.
0	74.6
30	89.6
60	80.6
90	50
120	6.0
150	−39.6

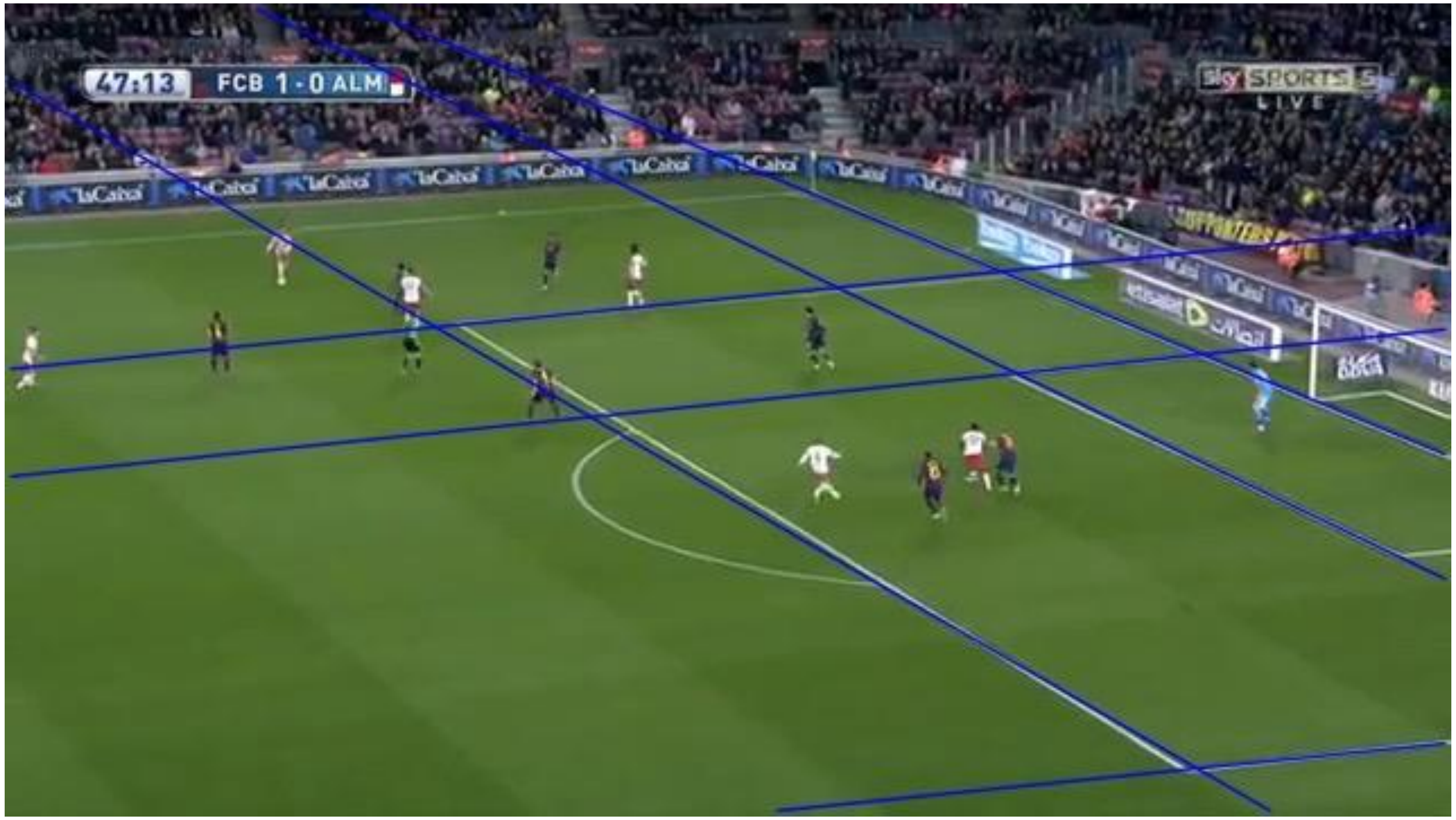
Implementation

- Step 5: Refine lines (least square best fit)



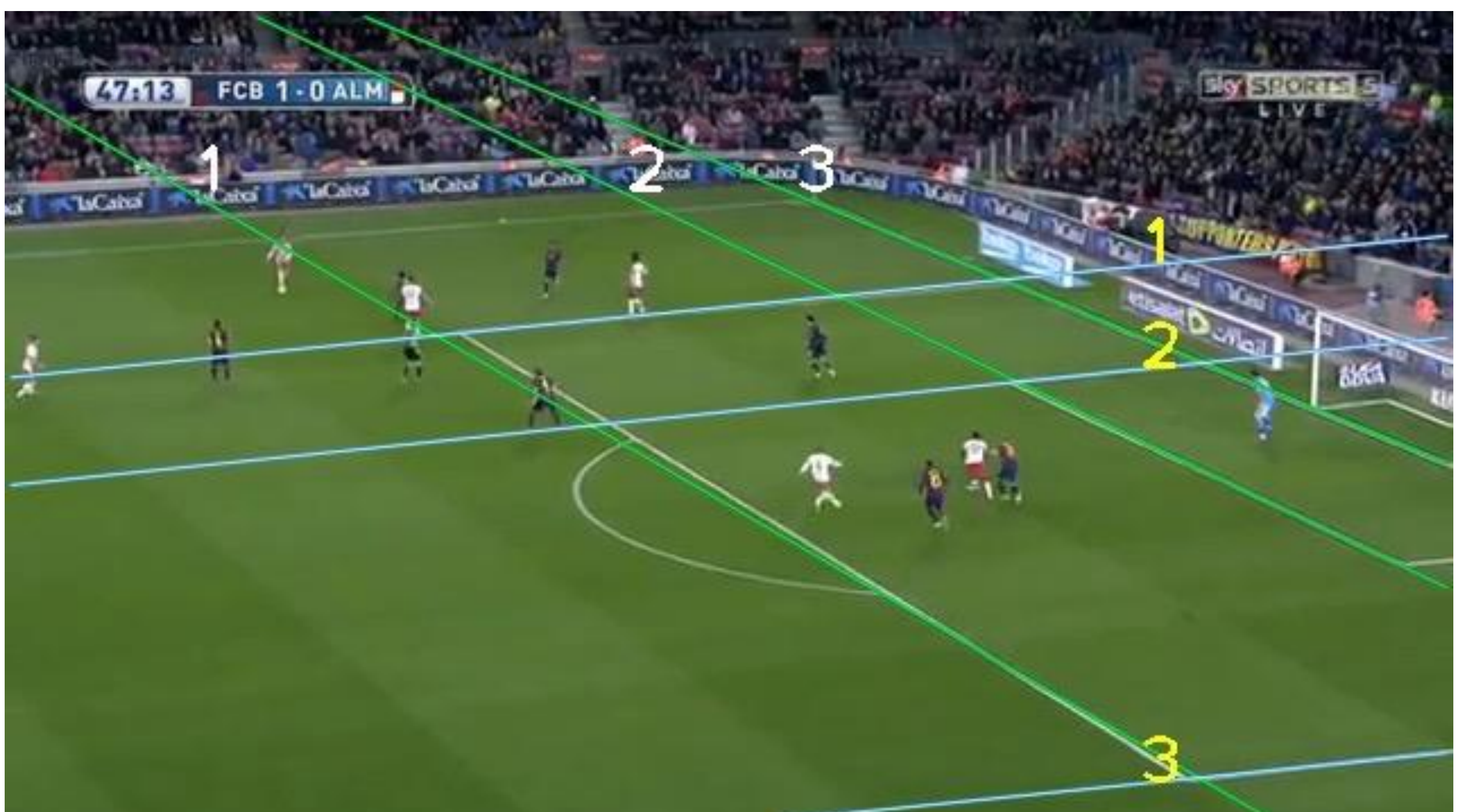
Implementation

- Step 6: Prune excess lines (distance and angle criteria)



Implementation

- Step 7: Classify lines as vertical and horizontal (angle criteria)
- Step 8: Order and label sets of lines (distance criteria)

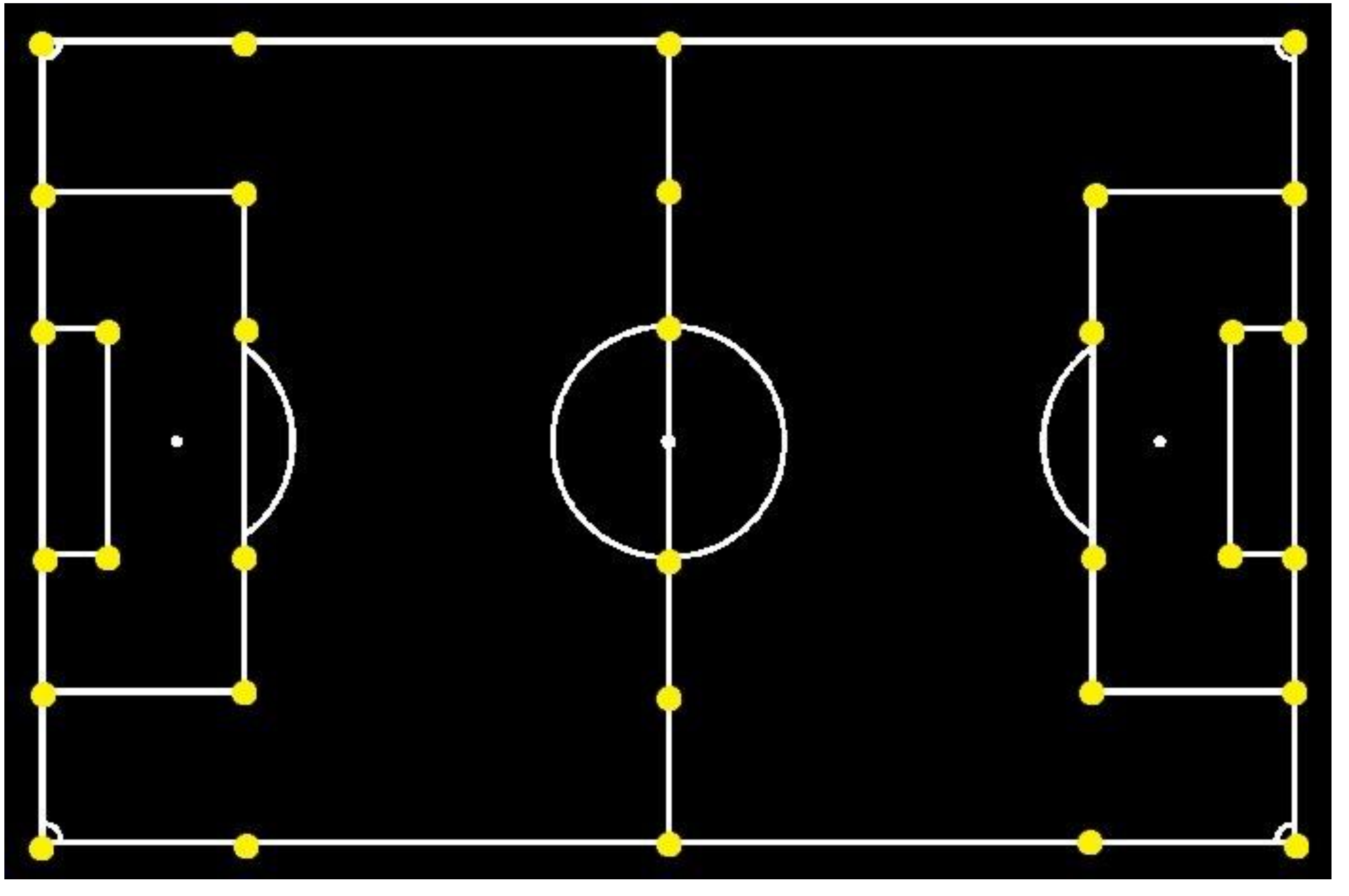


Implementation

- Step 9: Determine intersection points in the line pairs

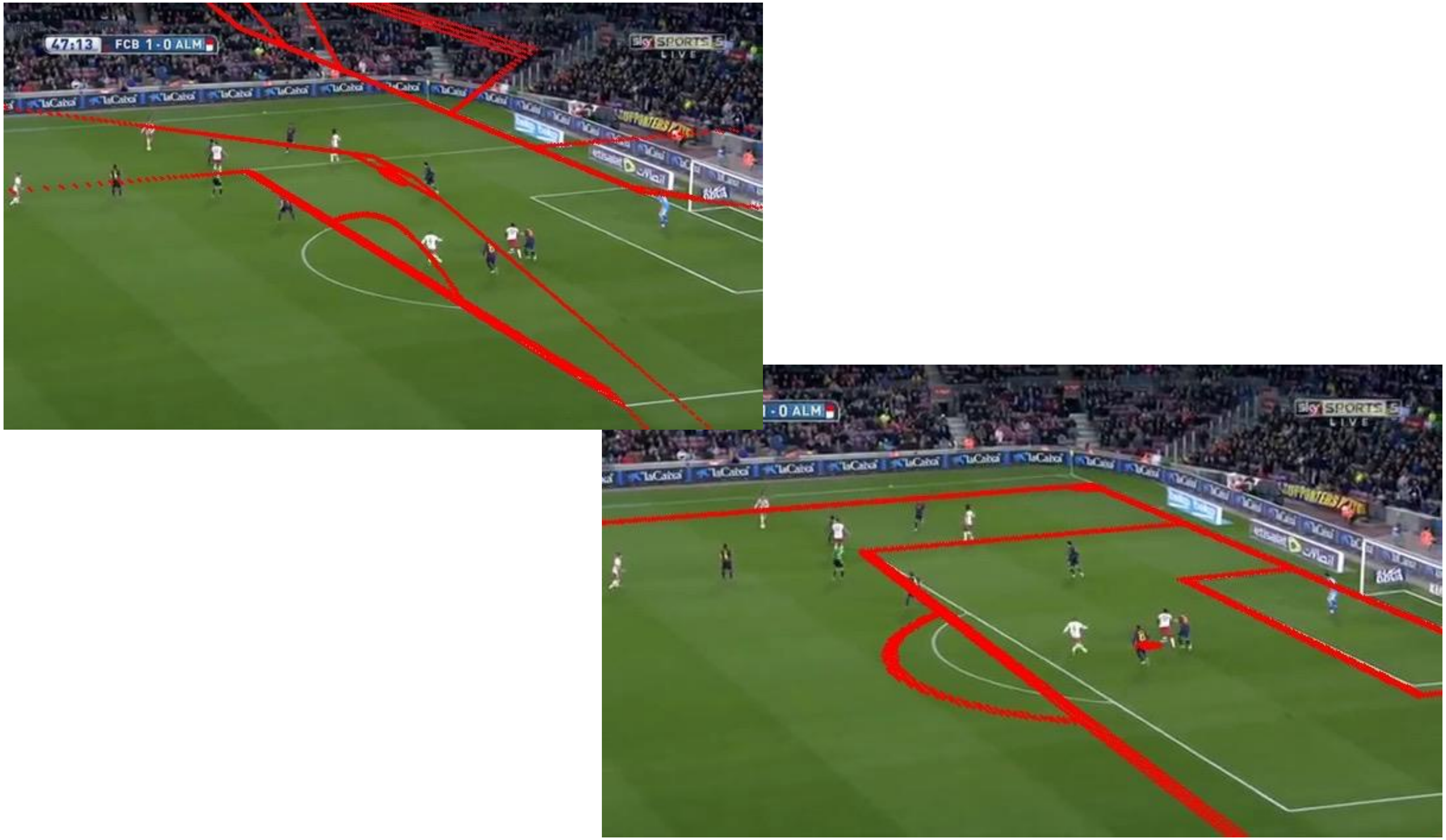
Implementation

- Step 10: Detect intersection points in the world space



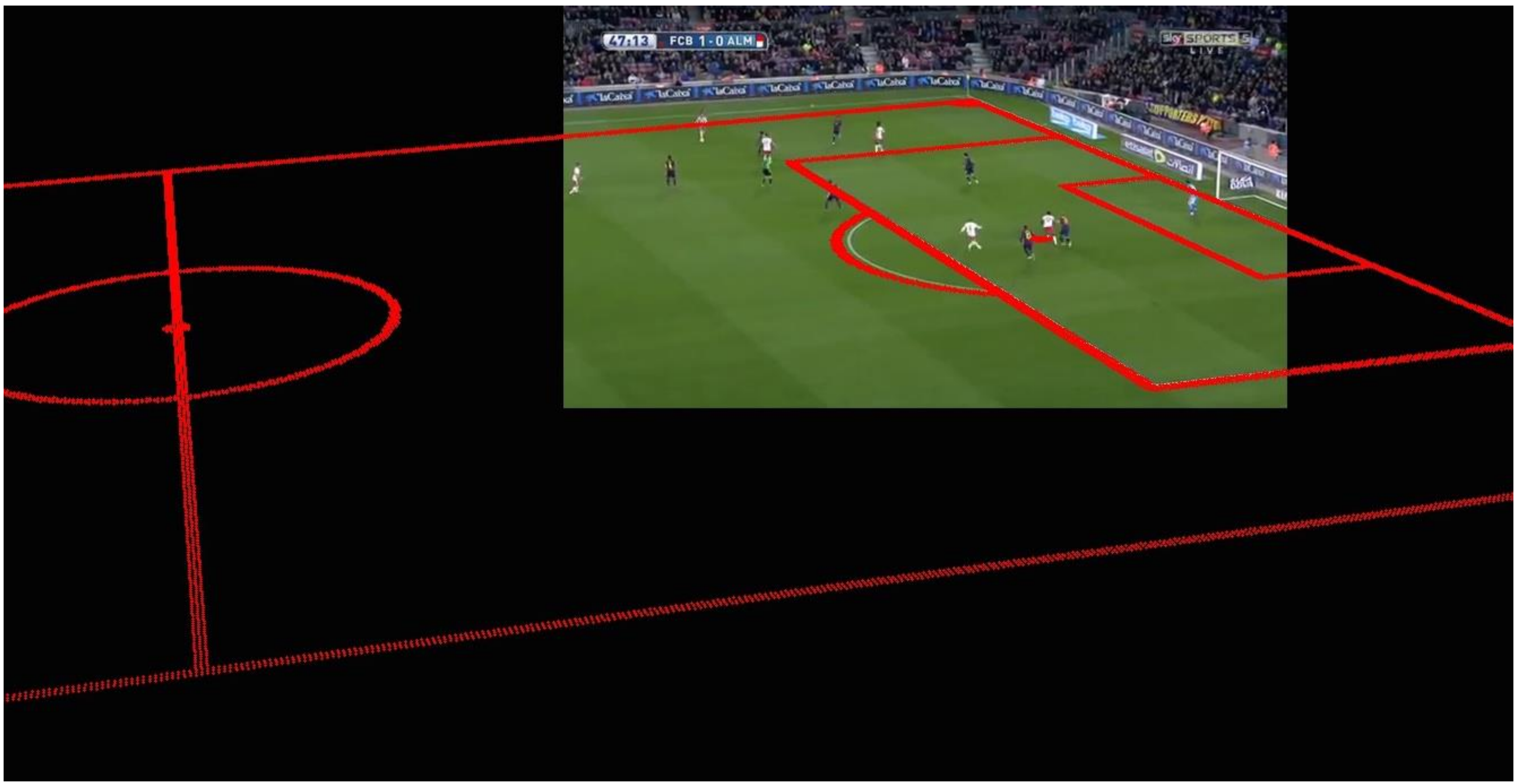
Implementation

- Step 11: Determine transition matrix for each corresponding set (solving linear system)



Implementation

- Step 12: Use best correspondence to map world space onto image space



Football and Player Tracking Approach I

- Eliminate the ground from the image, using a ground detection algorithm

- Algorithmically, the ground is determined to be the area of the image for which green dominates. Consequently, the ground is defined to be:

$$Ground(x,y) = \begin{cases} 0 & \text{if } \; g(x,y) > r(x,y) > b(x,y) \\ 1 & \text{otherwise} \end{cases}$$

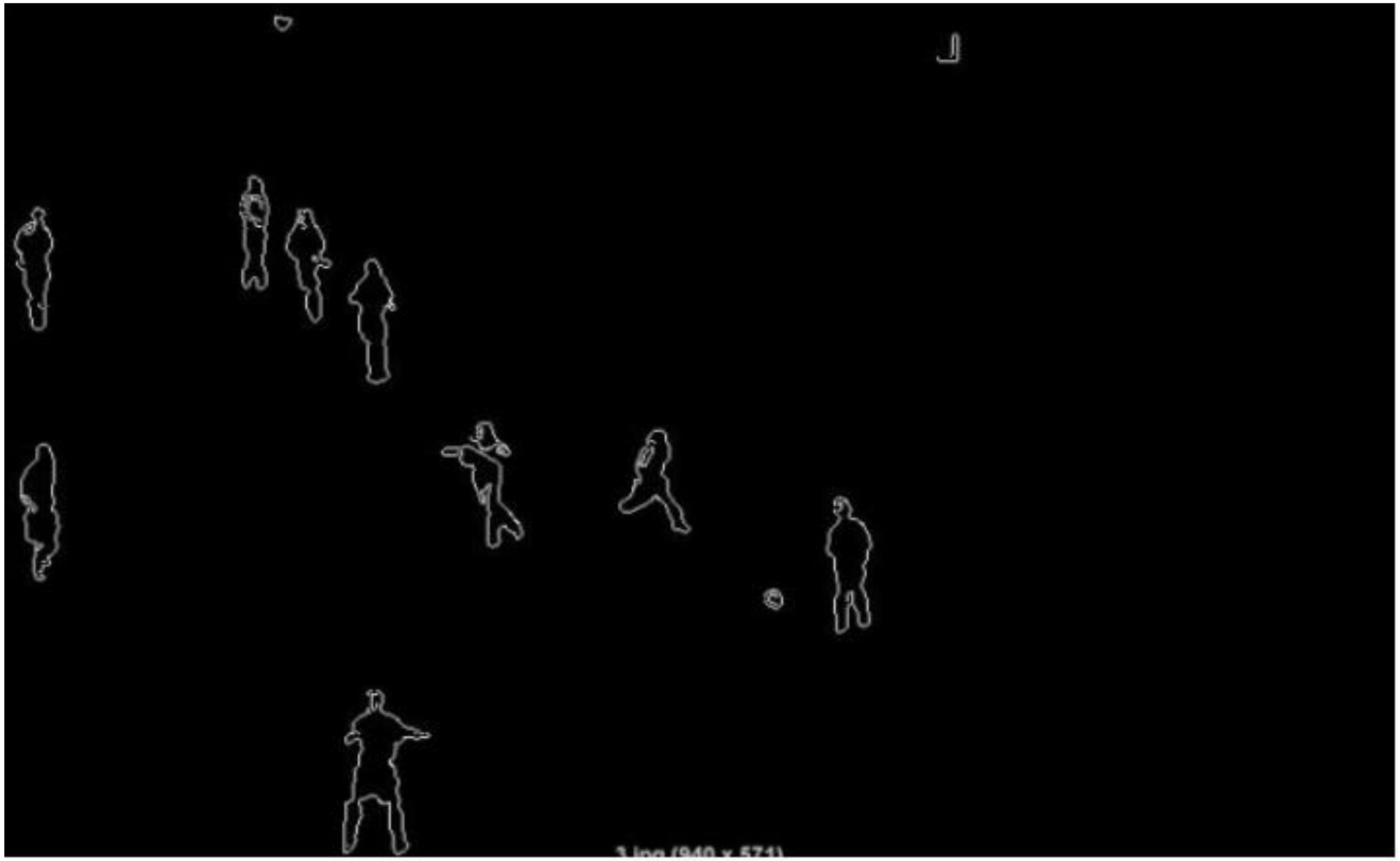
Eliminating the ground

Use Sobel Algorithm

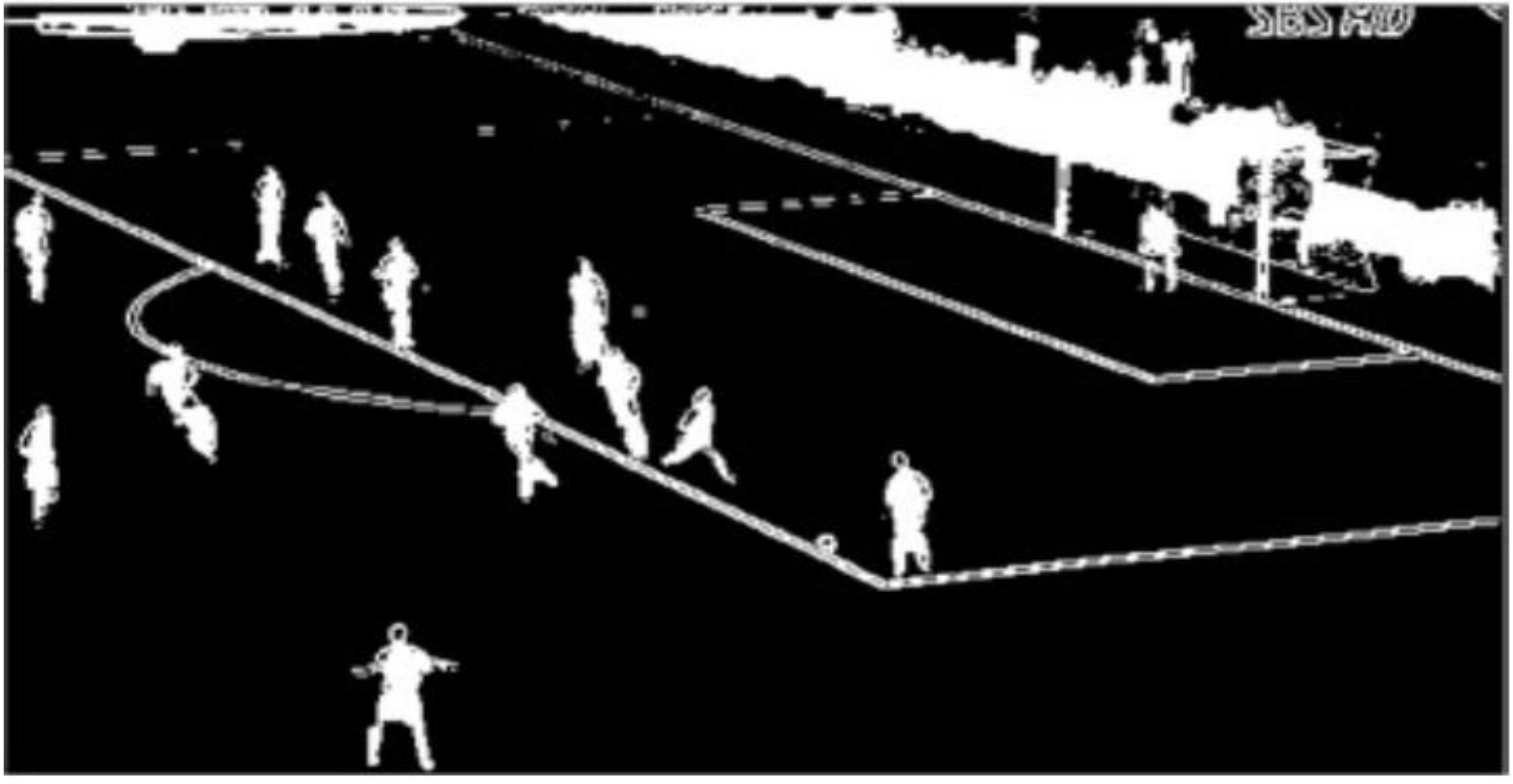
- Use Sobel gradient method to extract the players, the balls and other features:

- The Sobel gradient algorithm detects the color intensity gradients, and the regions for which the value is within a certain range of the maximum intensity derivative are shown, as shown in the following;

Sobel Algorithm Output



Combine the images



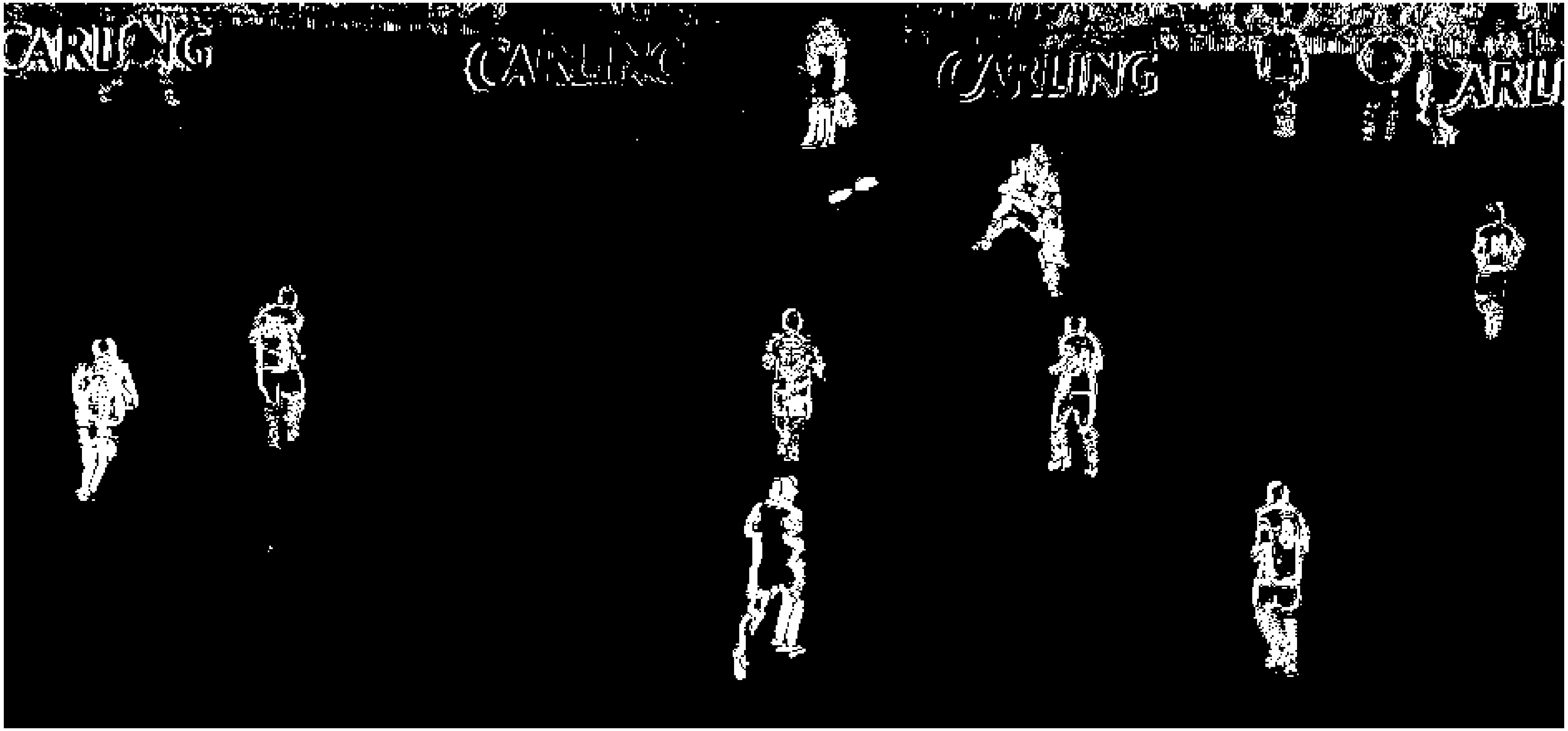
Eliminate Straight Lines

- Eliminate the straight lines present on the field using Repetitive Morphological Closing

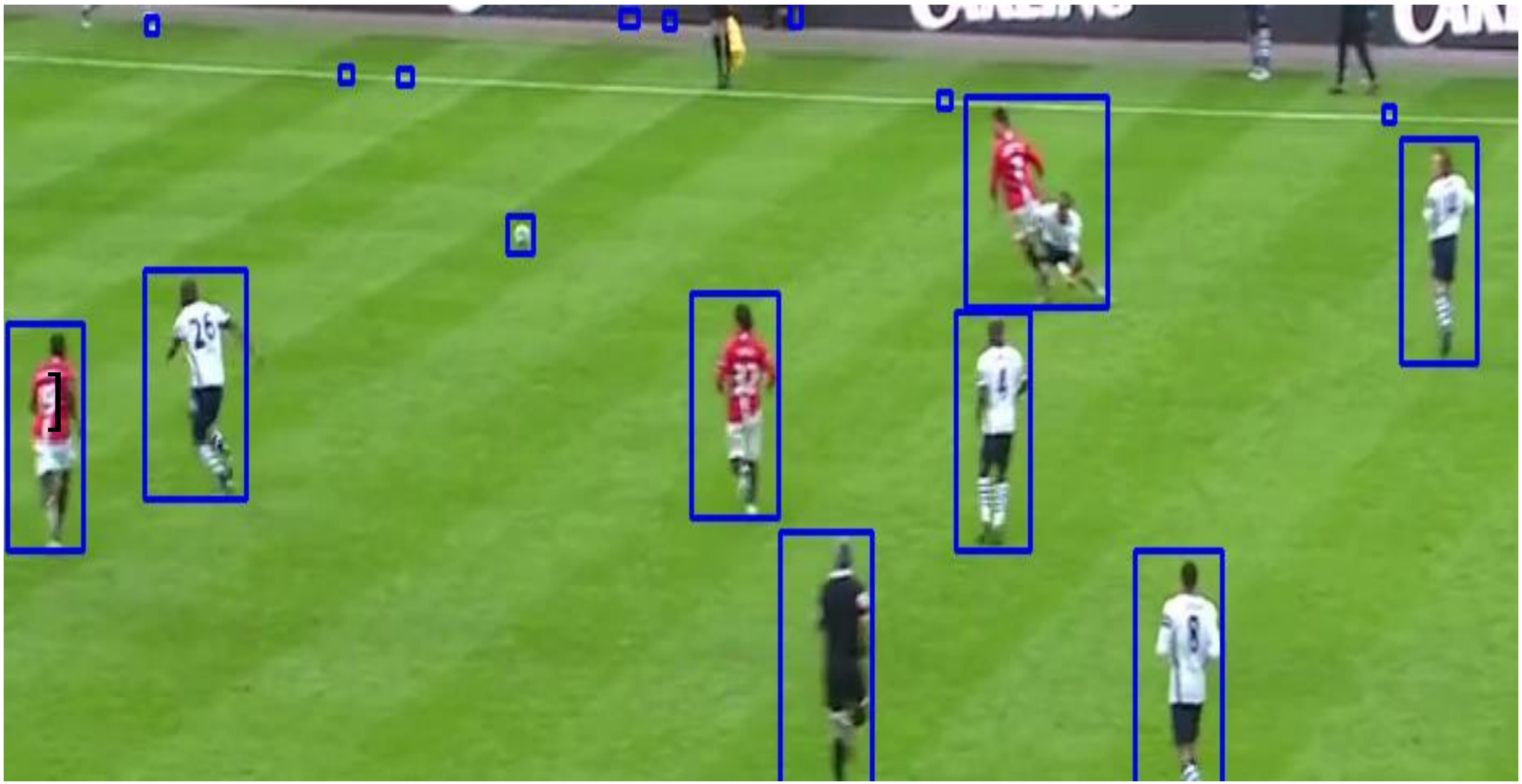
Football and Player Tracking Approach II

- Perform Frame by Frame Query
- Calculate the weighted sum of two images to account for changes in the background
- Compute the difference between the weighted average and every frame queried in the video
- Convert the derived image to gray scale
- Threshold the gray scale image to form a binary image
- Perform morphological closing to remove noise
- Detect Contours of the players and the ball on the pitch
- Apply optical flow to track the path of the players and the ball in each frame

Binary Image



Detected Players and Ball



Further Work

- Repeat procedure on stream of images (optimize various parameters)

- Automatically determine best correspondences by solving optimization problem

- Camera tracking

- Remove noise caused by lines in the pitch

- Explore more tracking algorithms to improve results

References

- Robust Camera Calibration for Sport Videos using Court Models", Dirk Farina , Susanne Krabbe, Peter H.N. de Withb , Wolfgang Effelsberg, Dept. of Computer Science IV, University of Mannheim, Germany LogicaCMG / Eindhoven University of Technology, The Netherlands

- https://ias.cs.tum.edu/_media/spezial/bib/beetz09ijcss.pdf

- Jog, Aditi, and Shirish Halbe. "Multiple Objects Tracking Using CAMShift Algorithm and Implementation of Trip Wire." *International Journal of Image, Graphics and Signal Processing (IJIGSP)* 5.6 (2013): 43.

- Ali, MM Naushad, M. Abdullah-Al-Wadud, and Seok-Lyong Lee. "An Efficient Algorithm for Detection of Soccer Ball and Players." *Proceedings of Conference on Signal and Image Processing (SIP)*. 2012.

THANK YOU!