Rugby Field Registration
with Hough Line Detection

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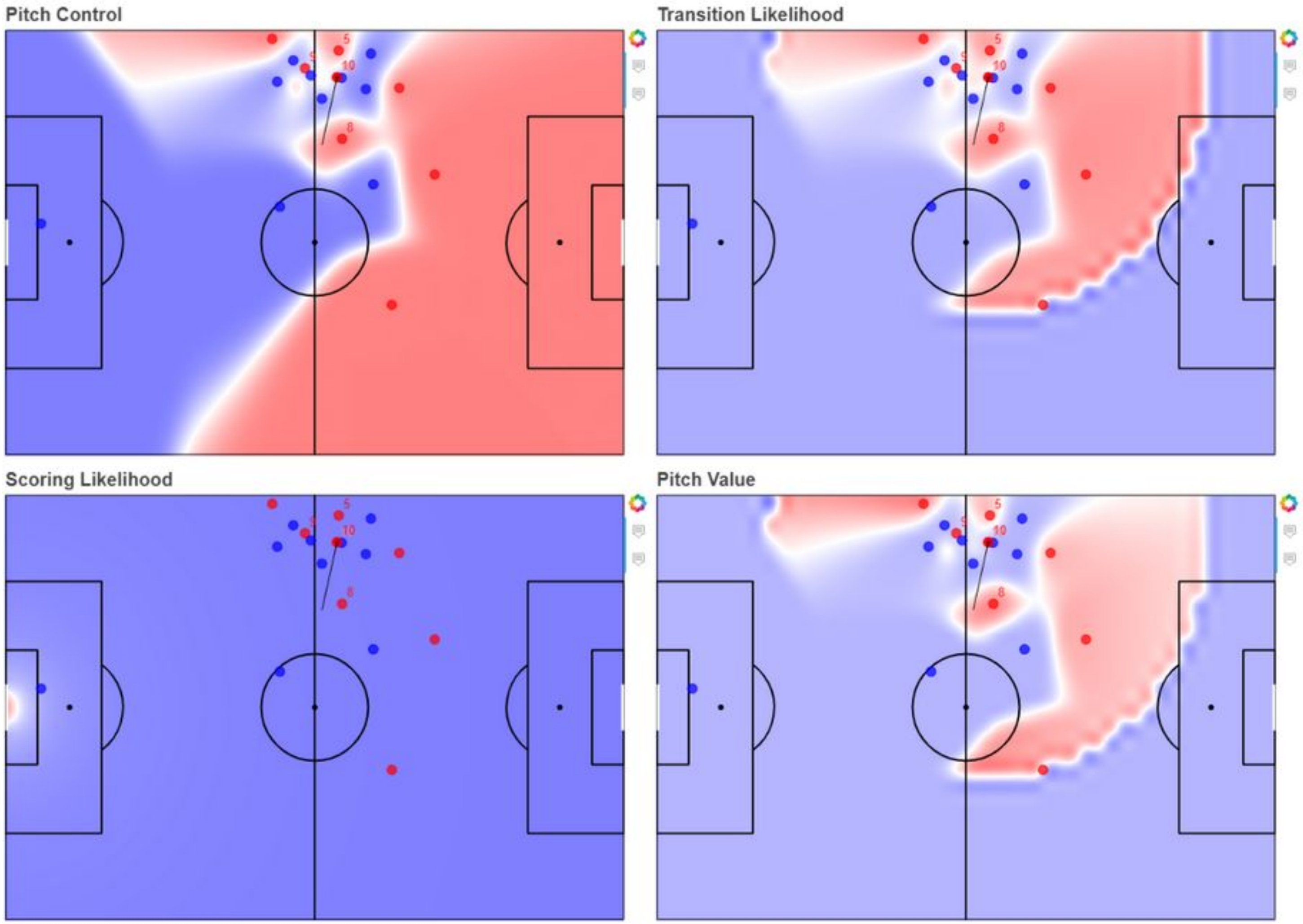
State of Data analytics in Rugby

- Reliance on GPS and MEMS player-action tracking
- No access to opposition team metrics
- Tactical elements are typically studied by manual video analysis
- Computer-vision is rarely, if ever utilized.

Computer Vision applications in football

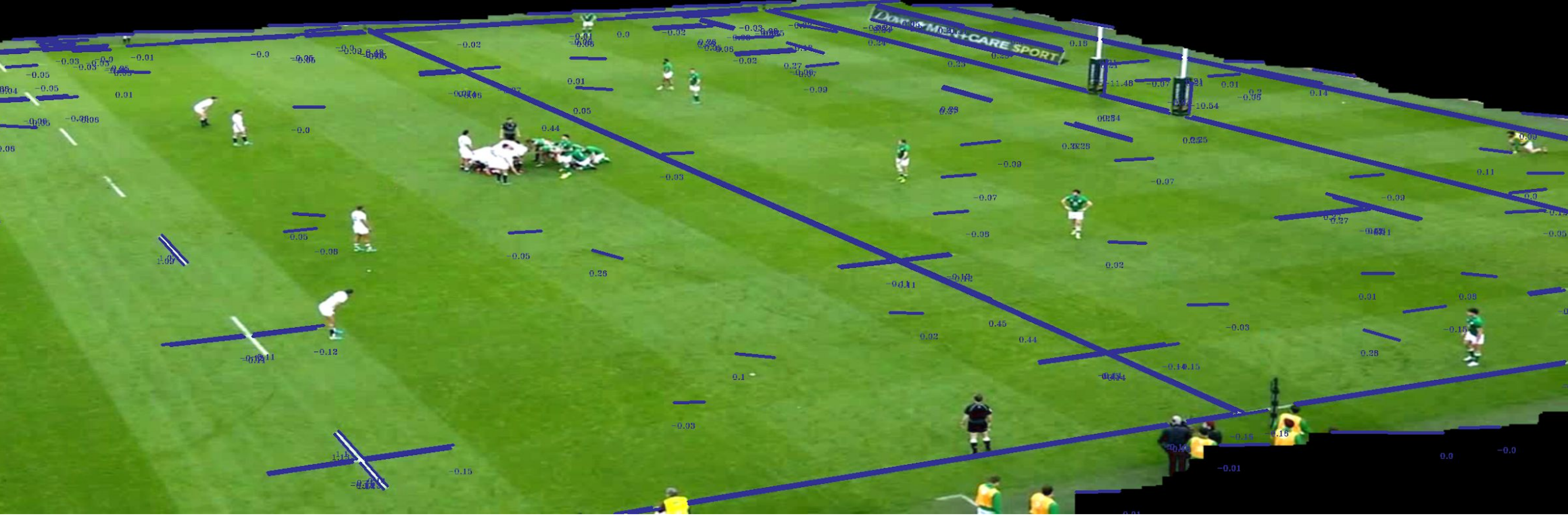
- Pass maps
- Player action tracking
- Possession value models, such as possession maps, XG maps.



Pitch value map models from thelastmananalytics.

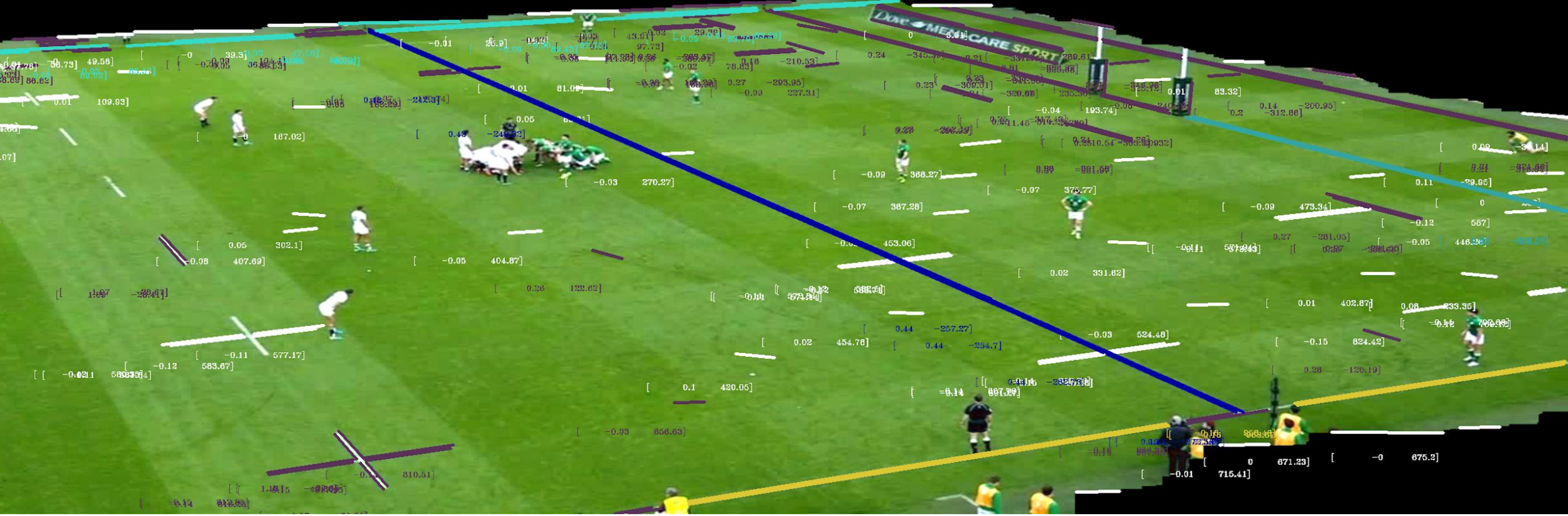
Field Registration Methodology

- Line Detection
- Line Classification
- Line Merging
- Homography Transformation



Line Detection

- This is achieved by finding collinear edges in an image. Pyfld uses Canny edge detection.
- If enough collinear canny edges above a given threshold are found, a Hough line detection has occurred.



Line Classification

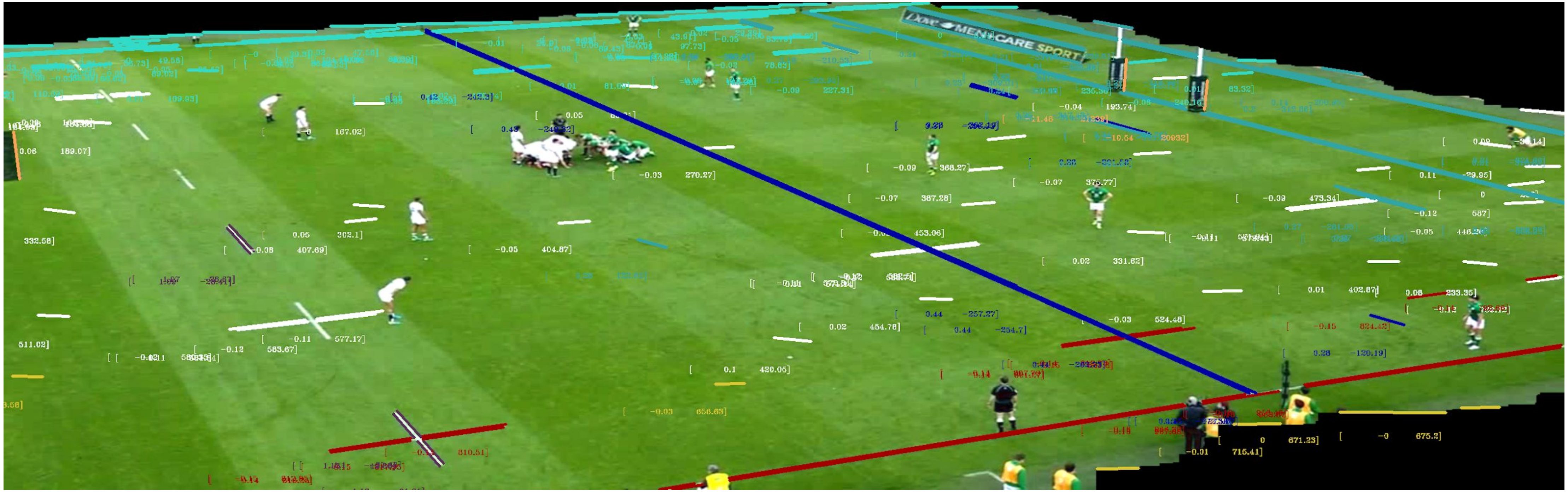
- Lines are classified based on their polynomial equations, length and positions in-frame.

```
  def classifyLines(self, lines, image):
    self.image=image
    self.shi=np.shape(image)
    self.linesID = np.empty(shape=(0,4))
    for ln in lines:
      ln = [ln, "",
       self.lco.asPolynom([ln]),
       self.lco.dist(ln=ln)
      ]
      lnType=str(self.classifyLine(ln))
      ln[1] = lnType
      self.linesID = np.append(self.linesID, [ln], axis=0
)
      self.linesID=np.array(self.linesID)
    return self.reclassifyLines()
```

```
  def reclassifyLines(self):
    # SORT CROSS-PITCH LINES
    self.ltsum=self.lineTypeLengthSum
    self.removeShortLines('22L’)
    self.removeShortLines('22R')
    self.linesID=self.tryLn22OrSideLn()
    self.linesID=self.twenty2orTryLine()
    for crossLine in ['tryLineL', 'tryLineR', 'halfway']:
      self.removeShortLines(crossLine)
    self.linesID=self.tryLineOrEndLine()
    self.removeShortLines('tryLineL')
    self.removeShortLines('tryLineR')
    self.linesID=self.tryLn22OrSideLn()
    self.checkPerspective()
    self.removeGoalPosts()
    # REFINE SIDE LINES
    self.purgeFSLs()
    self.purgeNSLs()
    self.removeShortLines('nearSideLine')
    self.removeShortLines('farSideLine')
    self.removeFlatFSLs()
    self.lengthPrioritizeLines(['nearSideLine’,
          'farSideLine', 'tryLineL’,
          'tryLineR', '22L', '22R'])
    self.removeBadCrossPitchLineSlopes()
    return self.linesID
```

Line Classification

Initial Line Classification Stage

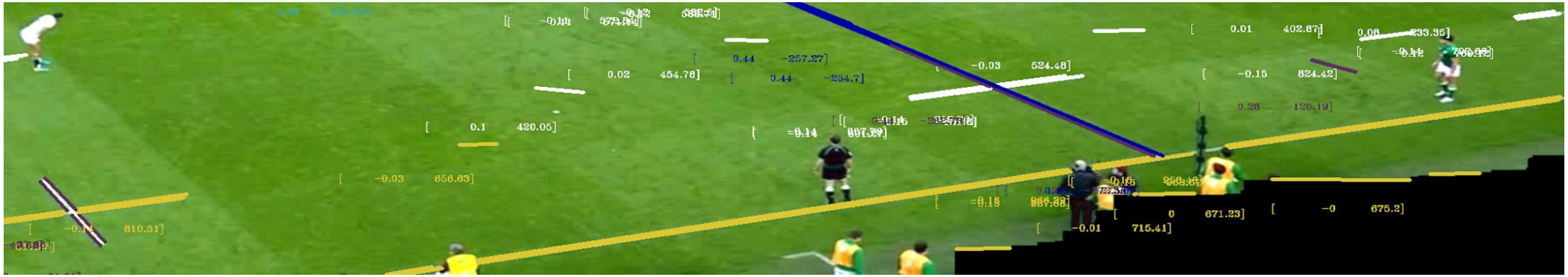


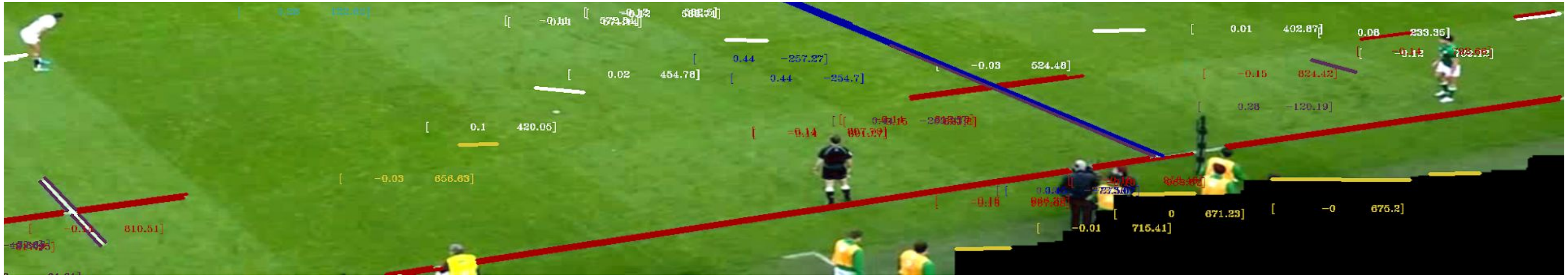
Common misclassifications include:

- Near-side line are misclassified as cross-pitch-lines.
- Try-lines and 5m lines are misclassified as 22m lines.
- End-lines, 5m-lines and advertising-markings are misclassified as try-lines.
- Vertical lines (including goal-posts) are misclassified as the halfway-line.

twenty2orSideLine()

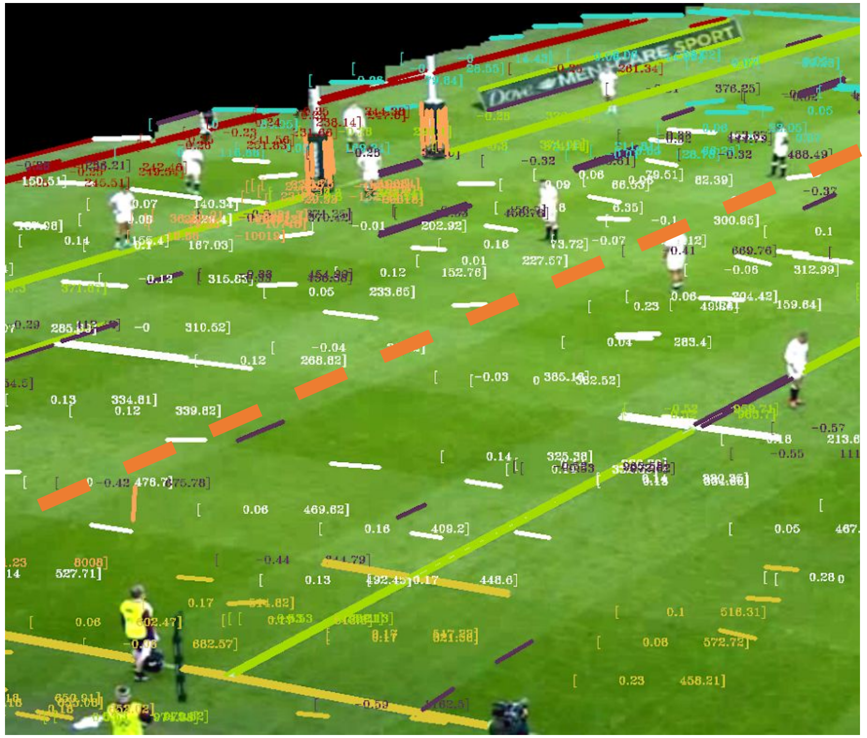
- The perspective of the image is checked based on the accumulated lengths of each cross-pitch line group.
- Using this perspective, cross-pitch-lines are reclassified based on their positions in-frame

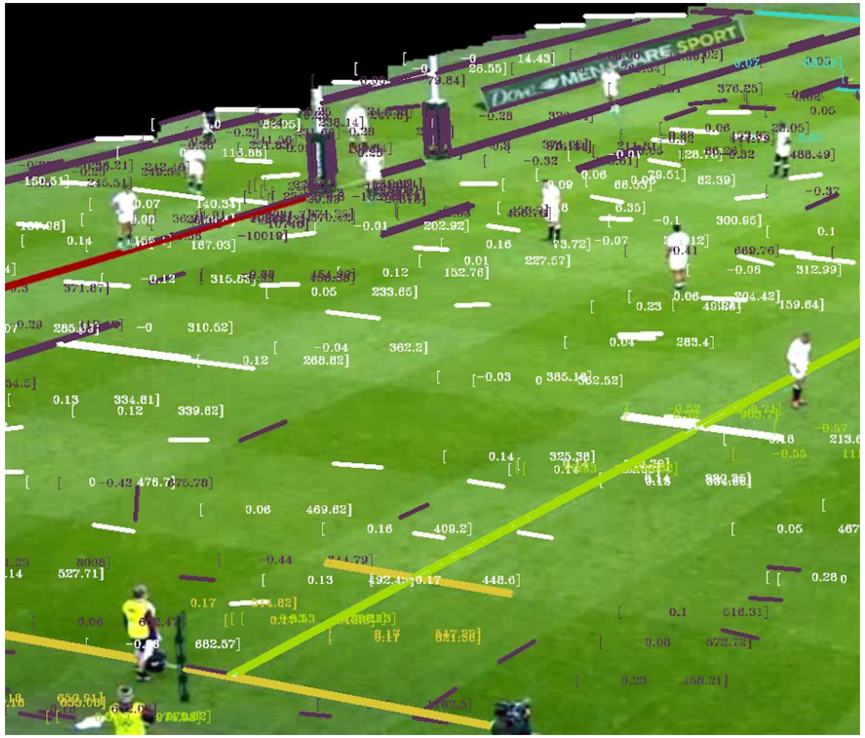




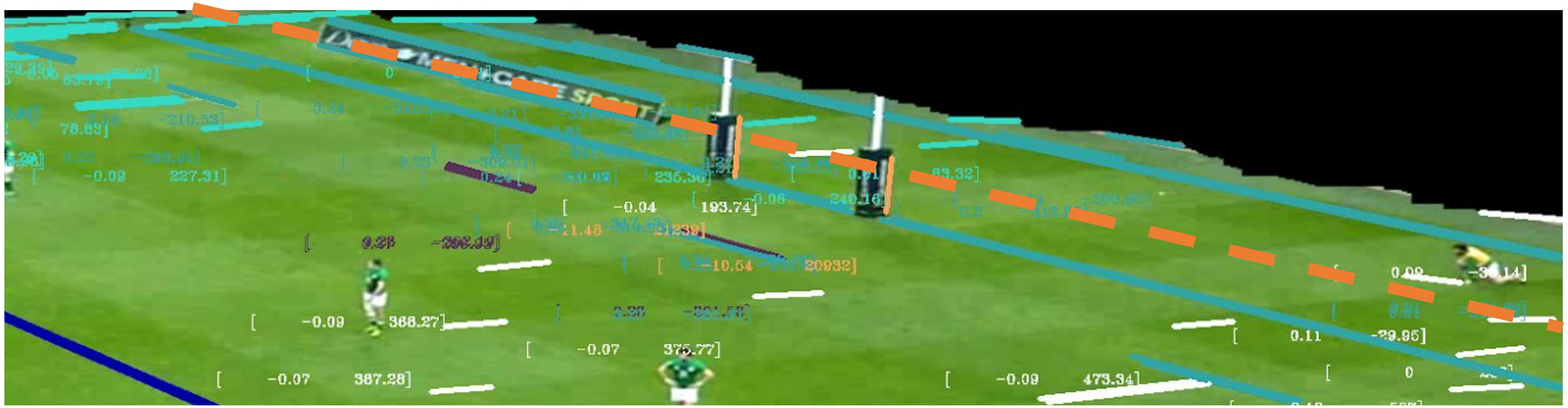
twenty2orTryLine()

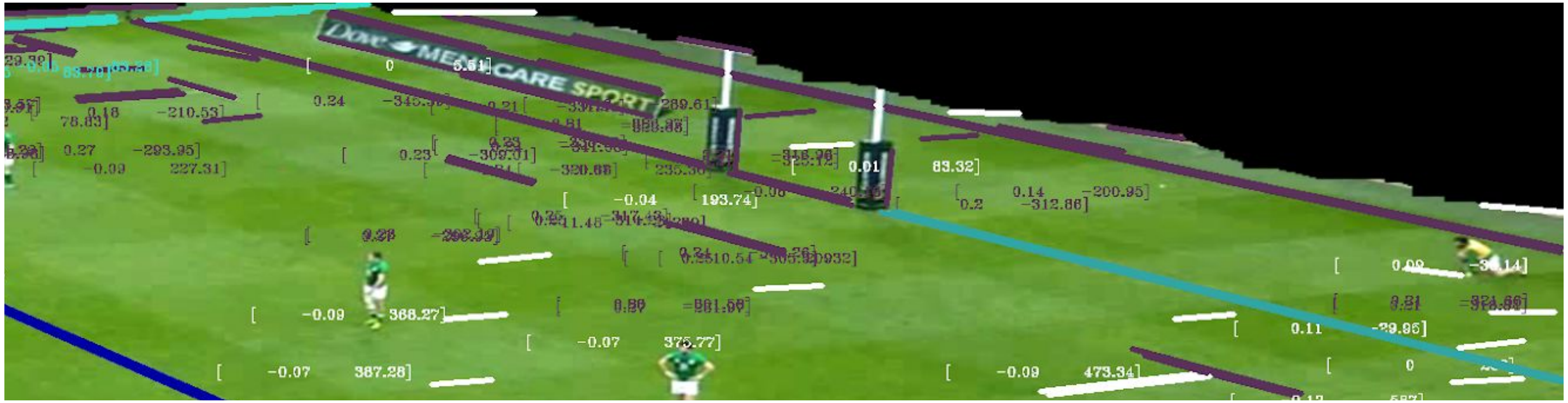
- For the pitch’s LHS, lines to the right of the median y-intercept are removed in a loop, until the try-line group meets a minimum y-intercept range



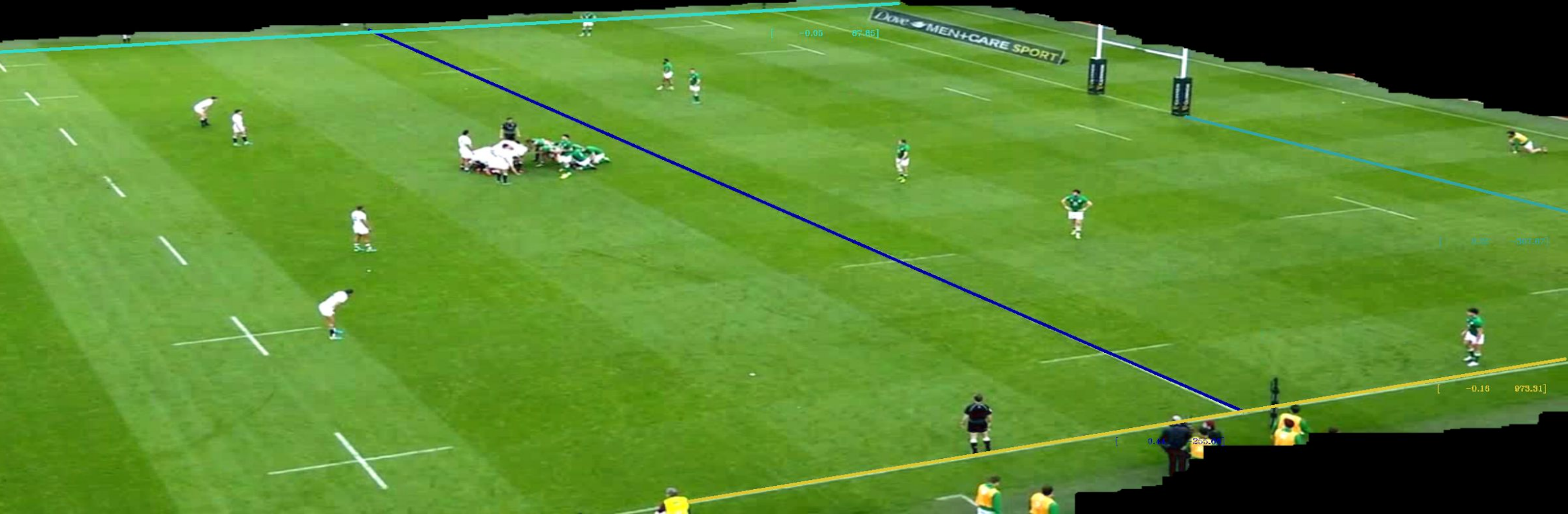


tryLineorEndLine()





- For the pitch's RHS, lines to the right of the median y-intercept are removed in a loop, until the try-line group meets a minimum y-intercept range

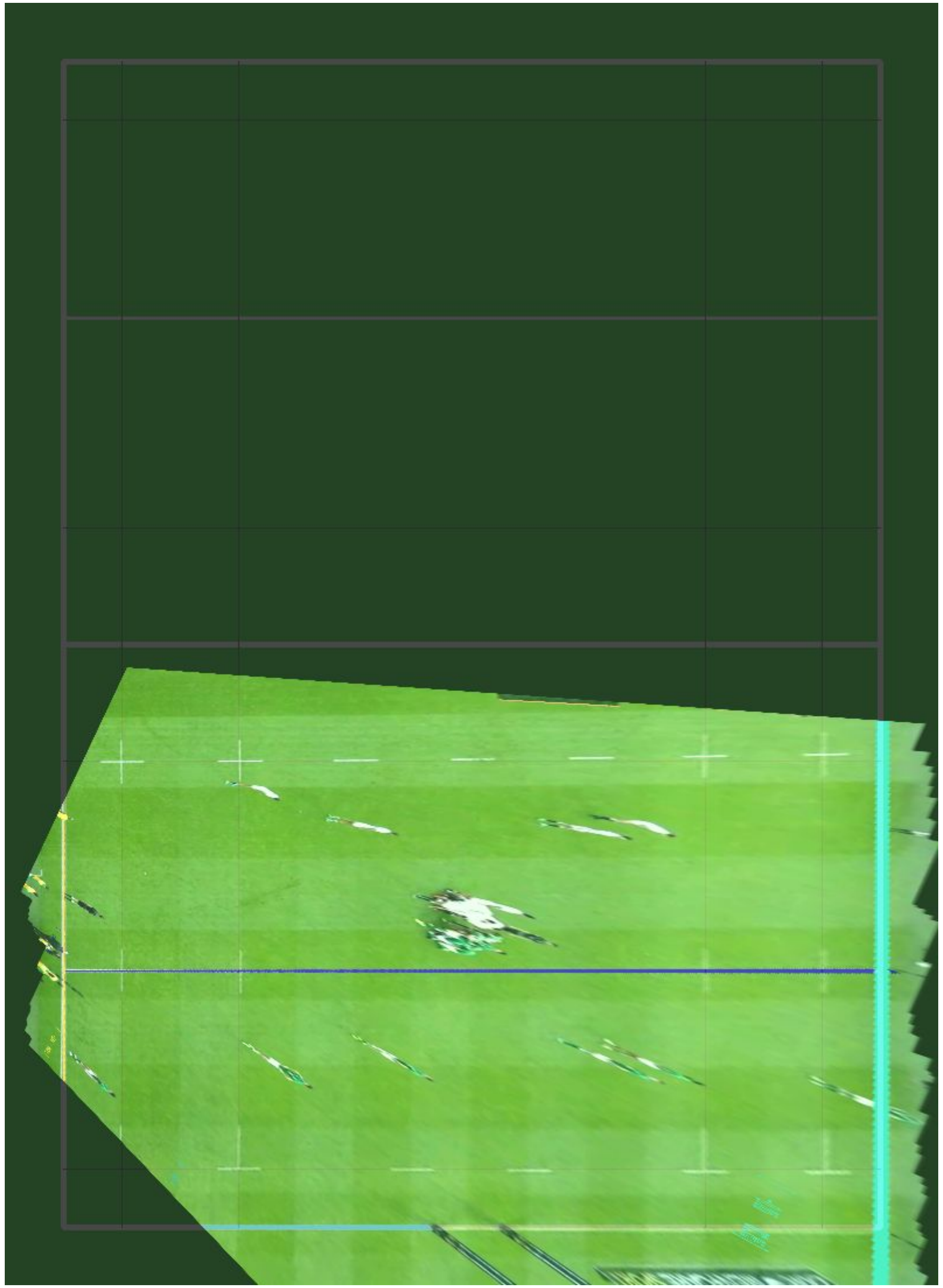


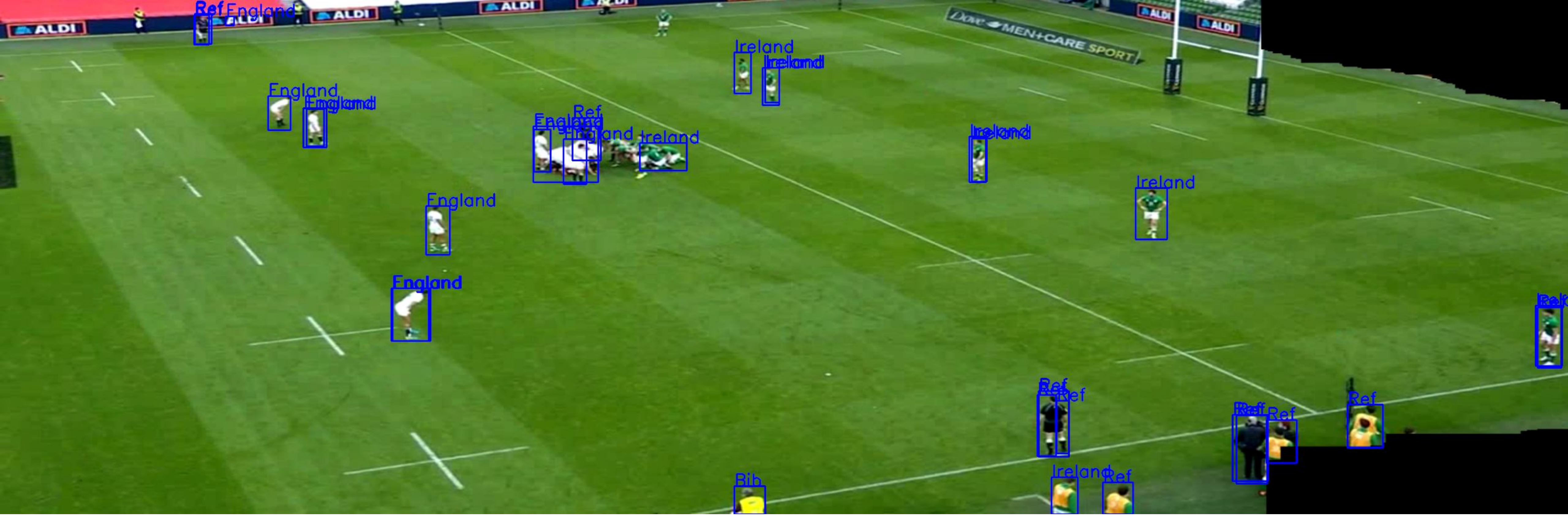
Line Merging

- Prior to merging, outliers are removed from each group.
- Each line class is reduced to their mean polynomial values.

Homography Transformation

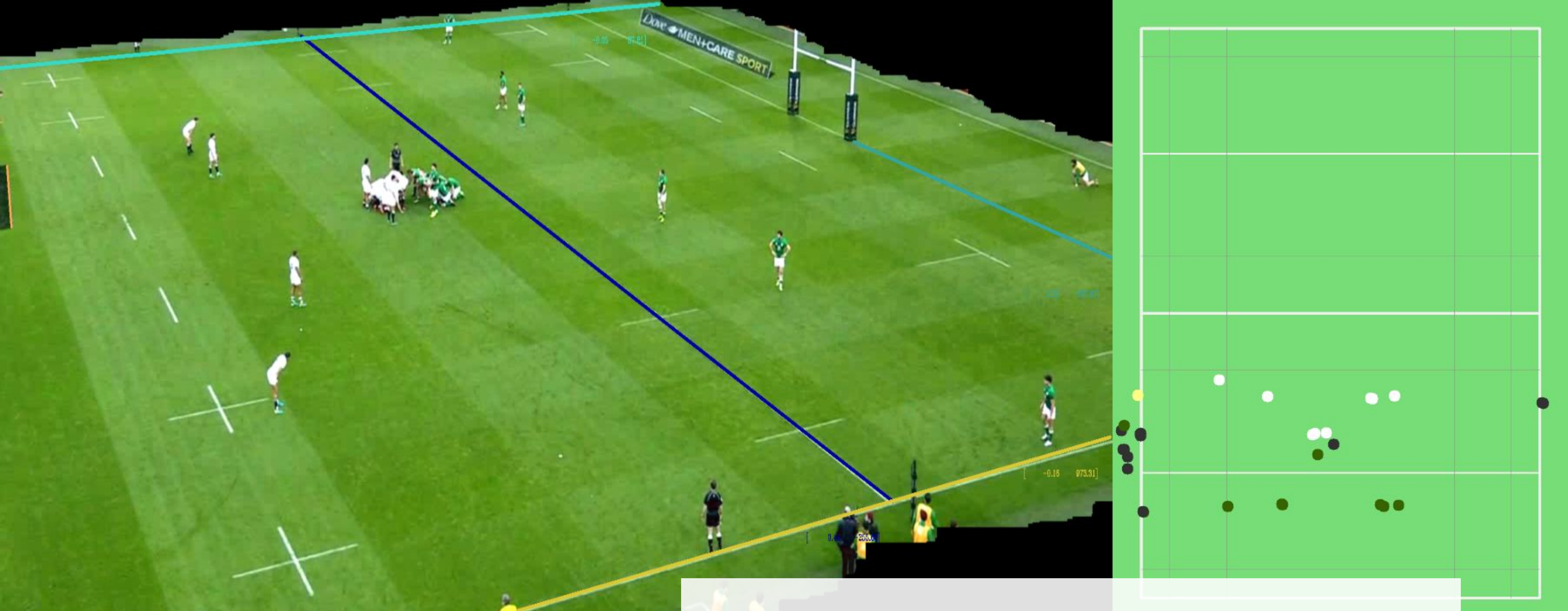
- The image's perspective is morphed by applying cv2.warpPerspective() to the intersections of the two longest cross-pitch-line segments and the side-lines.





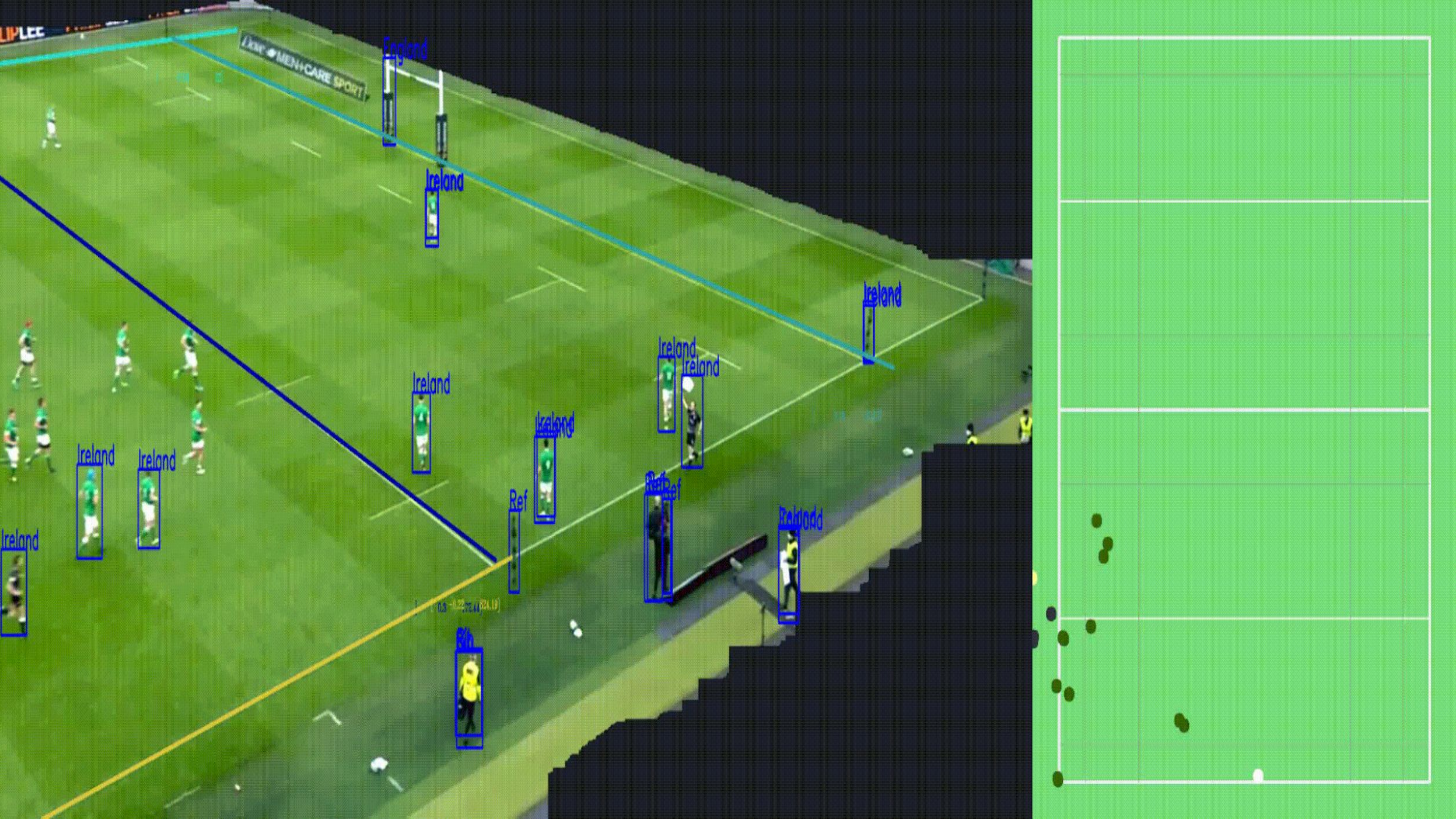
Player Detection

- Ultralytics Yolo-v5 object detector is used to detect players.
- Players are classified by counting the number of pixels matching jersey colors in each object bounding box.
- Player positions are projected by applying the homography transformation matrix to the center-bottom of each object bounding box.
- England players are more successfully detected than Ireland players, due to kit colors



Pitch Projection

- The rugby pitch has been successfully projected to a top-down view
- Detection failures occur due to occlusion (scrum) and players being too distant.
- Player misclassifications occur due to clashing kit colors.


England
Dove MEN+CARE SPORT
Ireland
Ireland
Ireland
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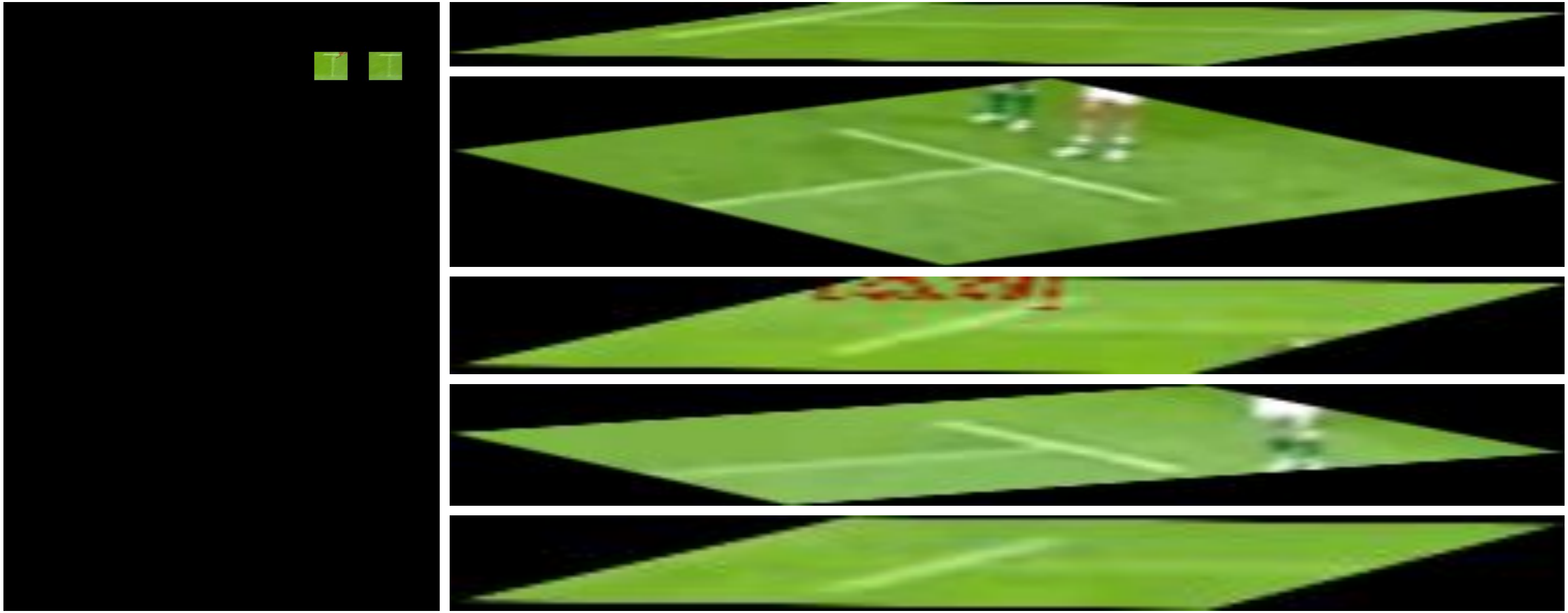
Future Work – feature extraction



Extra Content: End-on-view