Bring it to Pitch: Combining Video and Movement Data to Enhance Team Sport Analysis

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Nov.28th 2017

A Single Frame from a Soccer Match Video

Sample Visualization

In this presentation…

- How designers think from the domain perspective?
- How to visualize from several frames in videos?
- Some techniques applied to this visualization.
- What to do to make the system more applicable?

Soccer Game Analysis

- **Domain Task**

  -Integrate appropriate analytical visualizations within the video context

- **Hardware Limit**

  -One main camera positioned on side of the pitch for tactical view

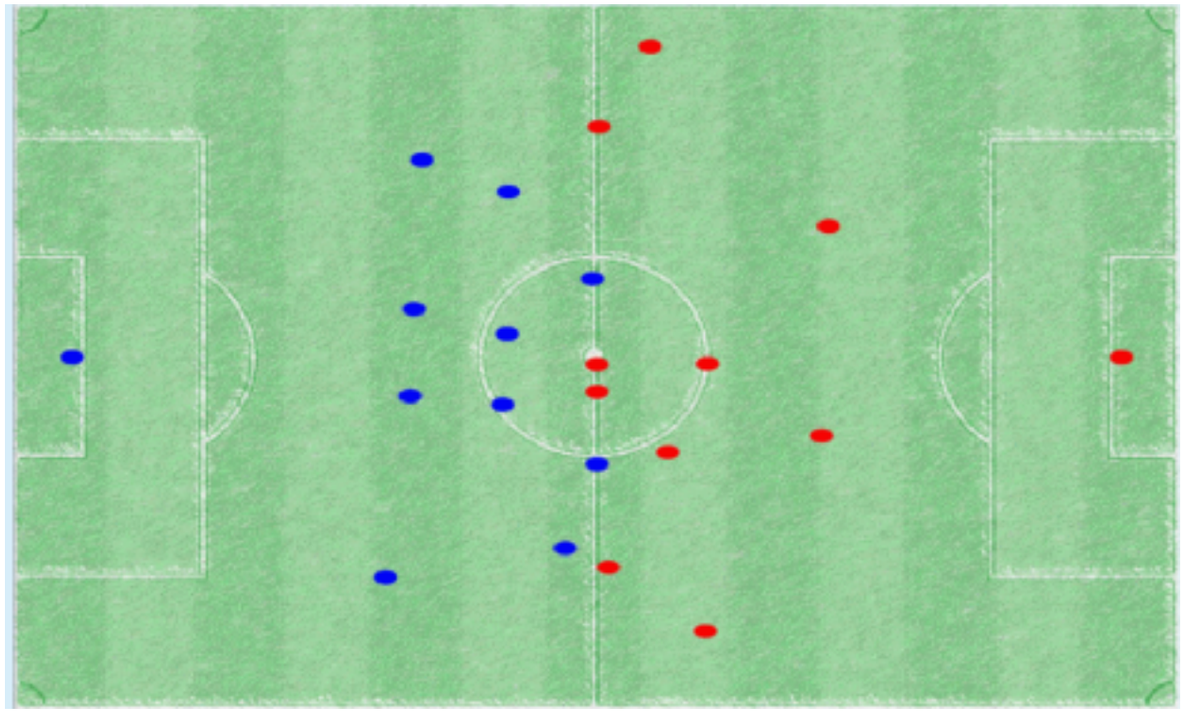
- **Key Requirement**

  -Extact data from standard video recording

  -Allow the user to overlay visualizations on the video material

Soccer is a team match…

- **Tactical analysis:** Bring it to a normalized pitch
- Abstract the 22 players to the points
- Each player controls certain region
- Events happened on every player can contribute to the result of the match



Player Detection

- **Challenge 1:** To allow zooming, the focal length can be different in different frames. And players on the opposite side appear smaller.

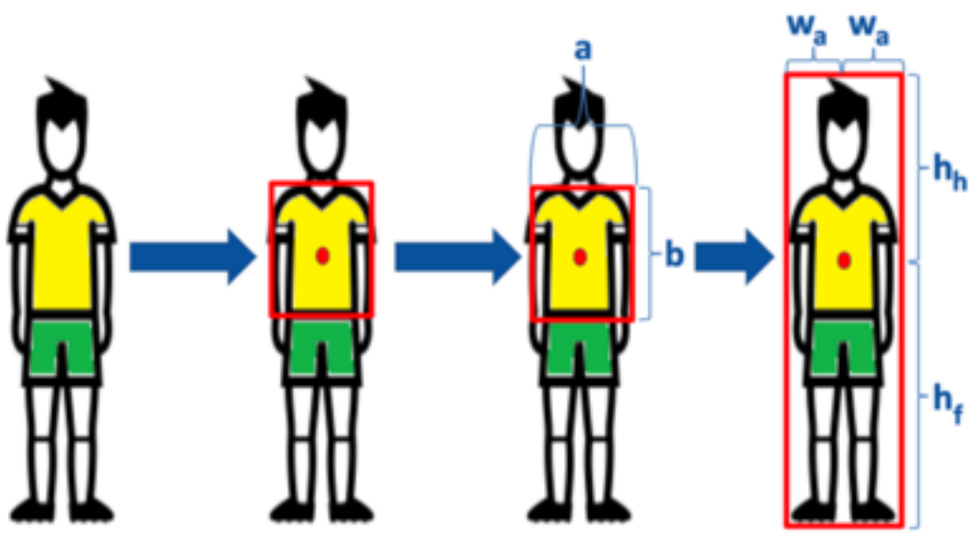
- **Challenge 2:** Body pose, proportions and imaging conditions.

- **Low-level appearance models.** Perform the player contour analysis through color histograms.

- Require only minimal characteristics about the search object, making it adaptive to more videos.

Player Detection

- Create color histograms
- Inspect each pixel in the image
- Calulate the centroid of each detected area
- Abstract to boxes using empirical factors

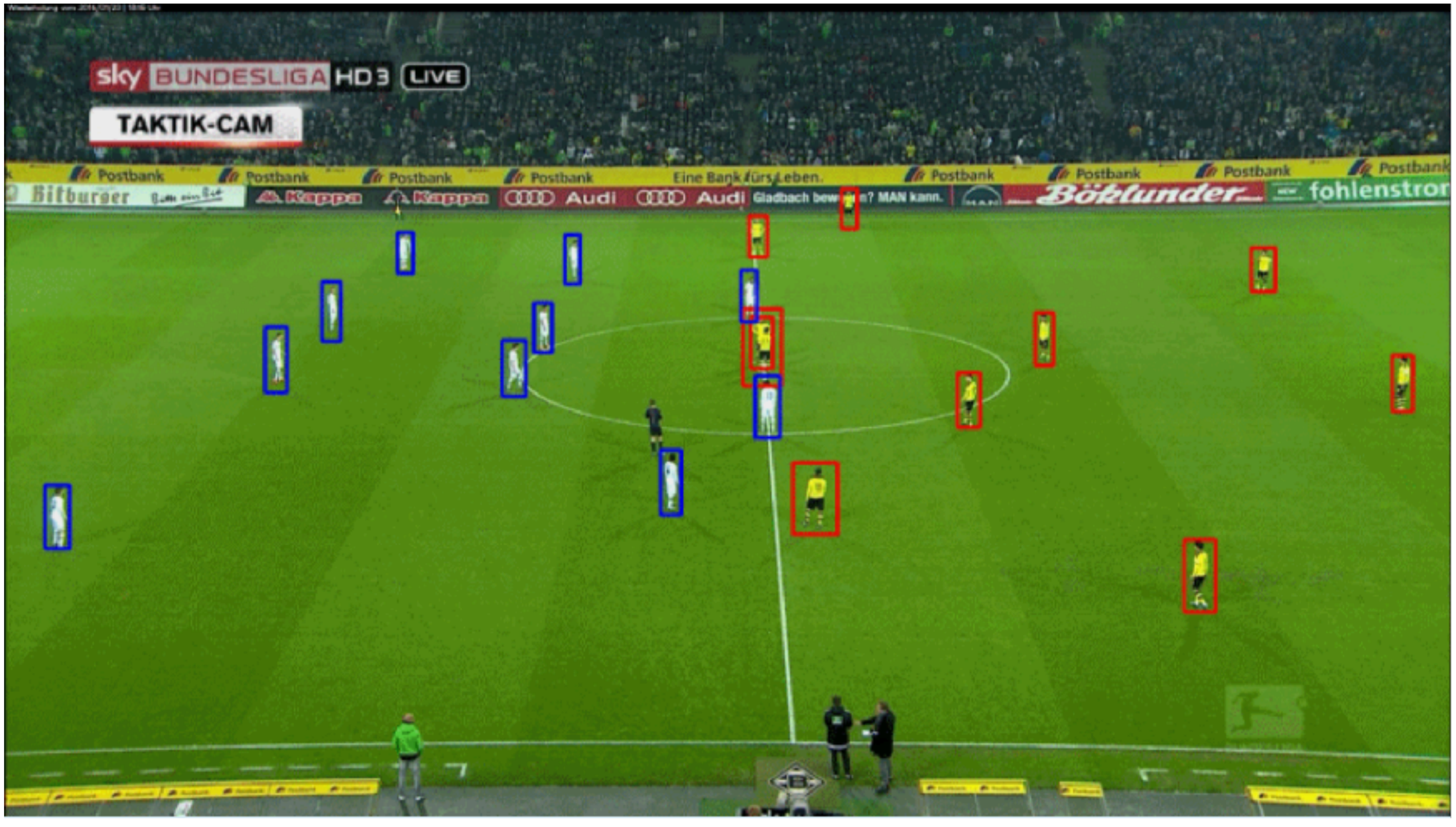


$$h_h = \frac{b}{2} + \frac{b}{2} \cdot s_h$$

$$h_f = \frac{b}{2} + \frac{b}{2} \cdot s_f$$

$$w_a = \frac{a}{2} + \frac{a}{2} \cdot s_a$$

Player Detection



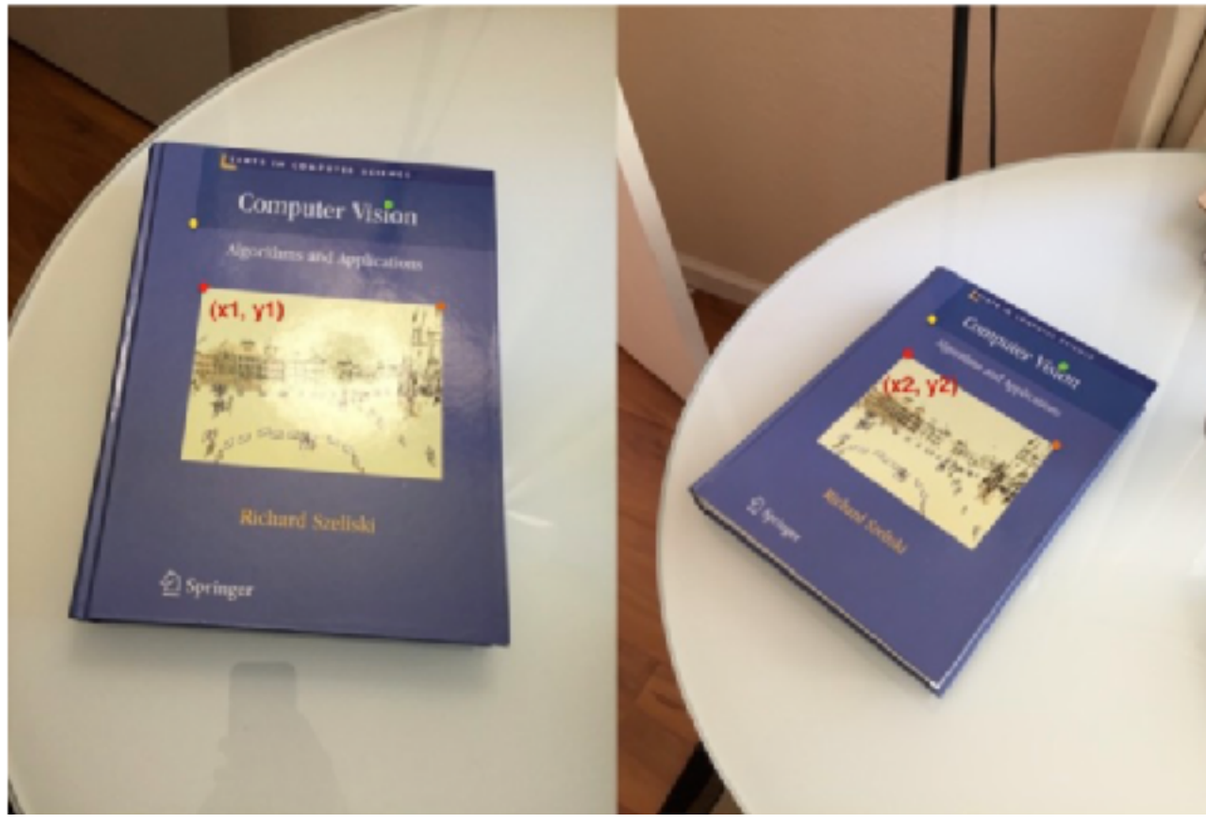
But I only see part of the pitch…

Panoramic View

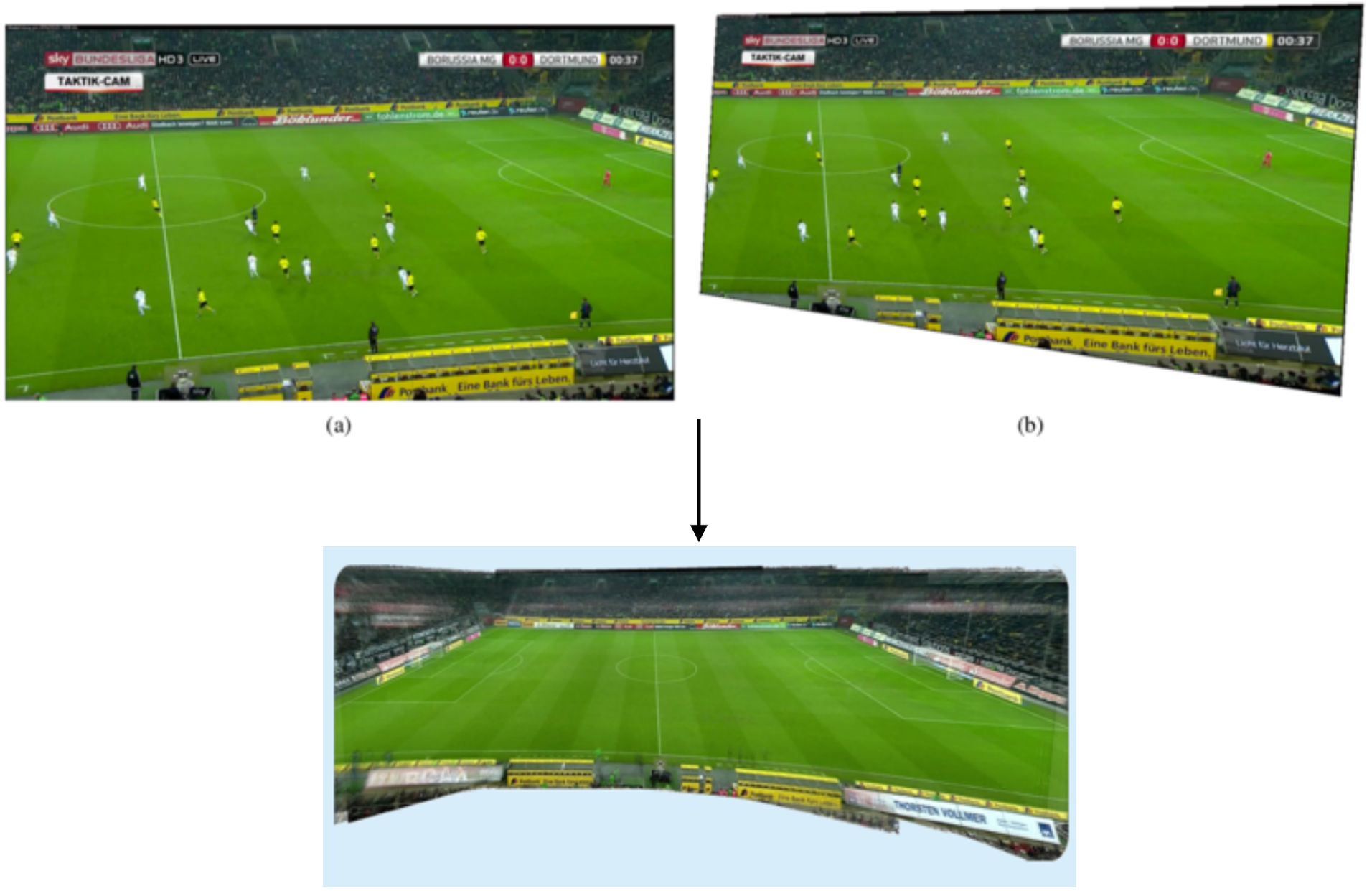
- **Input:** A set of overlapping images

- Align images; Extract and match SIFT (Scale-invariant feature transform) features

- **Homography—**A tranformation matrix acting on projective image coordinates



Panoramic View



A clean background panoramic view

Bring to Normalized Pitch

- **Map panoramic view onto a user-supplied image using reference points**
- **Calculate player position coordinate on the normalized pitch**
- **A detected player position is registered from frames within a certain time span**
- **New player is initialized for all remaining positions**
- **Incorrect detection**
- **Allow user to manually improve the data gathering**

How to analyze the video?

- **Region-based Analysis**

  -interaction spaces and free spaces

  -dominant region

- **Event-based Analysis**

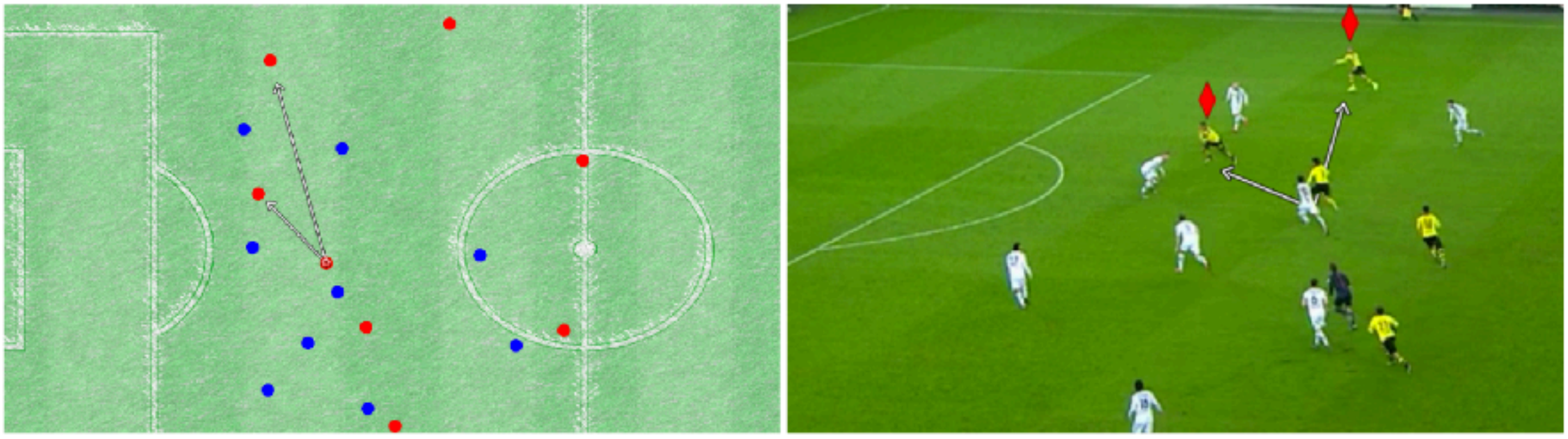
  -shot on goal, cross and pass

  -for the team, the aim is to lower the risk of **pass**

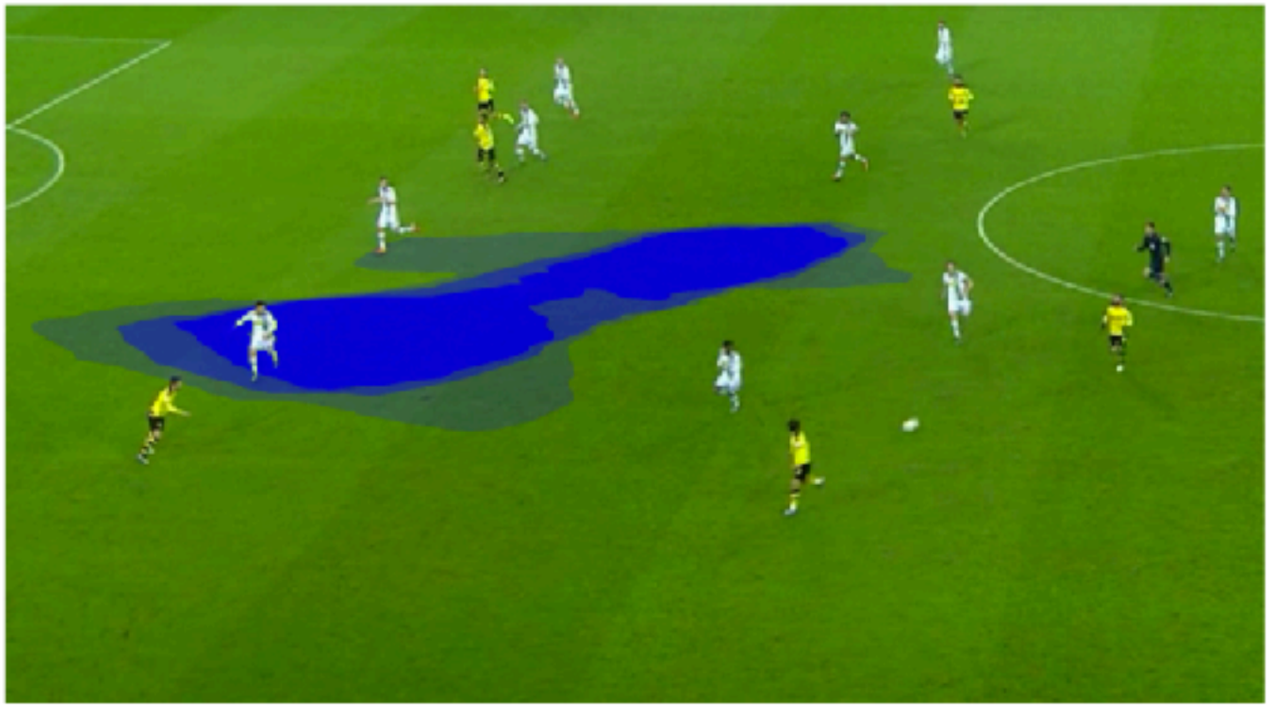
  -passing behavior of each player

How to analyze the video?

- Analyze on the normalized pitch and integrate the result to the video
- Highlighting the players

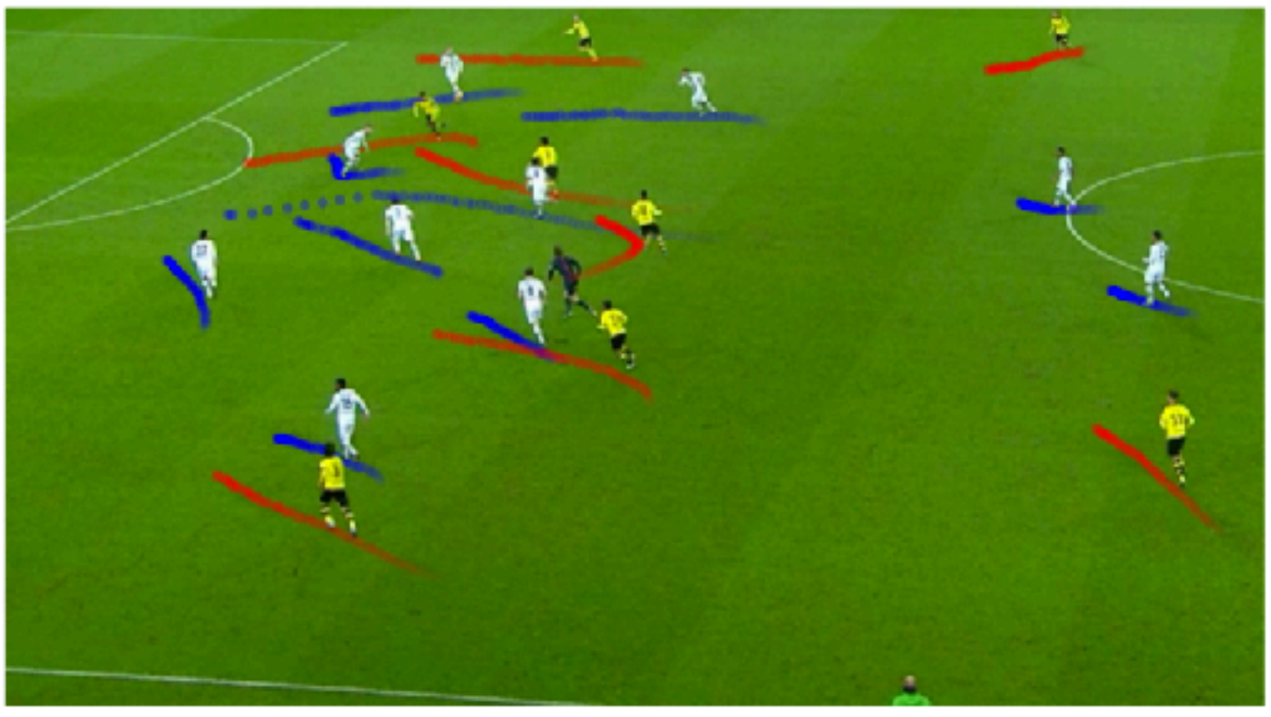


(a) (b)



(a) Dominant Regions

(b) Pass Distances



(c) Player Movement

(d) Player Reactions

Visual Analysis—Complete and Efficient

Assessment

- **Position Difference:** Average < 2m Standard Devistion 0.5m

- **Time to generate a panoramic view:** 40-50 seconds on average, depending on the size of the view.

Insights from Expert

- natural
- advanced in terms of application in practice
- make the invisible visible
- high refresh rate of free spaces
- can dot represent real person?

Challenges from Implication

- Real-time analysis
- Inaccuracy from distortion etc.
- Potential problems: overplotting, contrast effect or distraction caused by non-match information in the video
- How to match the most interesting area?

Summary

What: Data	Video Recording of a Soccer Match
What: Derived	Players's position, trajectory, strategy etc.
Why: Task	Integrate the analysis result with the video
How: Encode	Highlighting,Tracks with colors, Luminance, Saturation
How: Reduce	Filtering

Summary

- Clearly analyze the domain problem.
- Integrate the visualization with original video stream
- Consider the practical engineering requirement
- Making the analysis results objective
- Avoid interference with analysis of domain experts
- That’s what we can learn from this paper

But soccer is a 3D game and full of imagination…

Thanks