


Object tracking and automated video annotation

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Who?

- The orange ball
- Players
 - A – transferred from Juventus Torino for 5 meal tickets
 - B – goal getter from Ajax Amsterdam
 - C – gained for 1mil \$ and 10 meal tickets
- Development Team
 - Agnes – Head of Female Research Department
 - Cami – Public Relations Key Advisor
 - Anca – Chief Web and Presentation Designer
 - Tamas – Chief Technology Officer
 - Sandor – Lead System Designer


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What?

- Input: video sequence of for example of part of a ball game match
- Aim: to detect elements and key events
- Output:
 - ball detection
 - video annotation
 - a computed game model
 - statistics of match

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How?

```


graph TD
    A[Video Sequence] --> B[PREPROCESSING]
    B --> C[BALL TRACKING]
    C --> D[TRAJECTORY EVALUATION]
    D --> E[KEY EVENTS EXTRACTION]
    E --> F[VIDEO ANNOTATION]
    E --> G[GAME MODEL]
    G --> F
  
```

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Ball tracking

- Ball detection: Hough transformation for circles - Joakim Lindblad

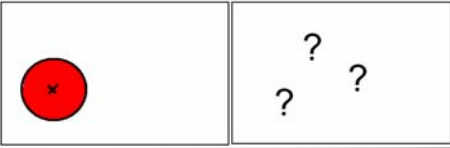
$$(x - a)^2 + (y - b)^2 = r^2$$


P.V.C. Hough, Machine Analysis of Bubble Chamber Pictures, International Conference on High Energy Accelerators and Instrumentation, CERN, 1959.
- Tracking: Template matching
 - Measure of similarity between image and template
 - Normalized cross correlation - Dmitriy Csetverikov
$$NCC(x, y) = \frac{1}{N_1} \sum [f(x + x', y + y') - \bar{f}(x, y)] \cdot [w(x', y') - \bar{w}]$$
- Color test to eliminate false detection – use of more reference colors

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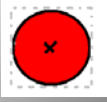
Template matching

What to do if we find the ball, but on the next frame we loose it?



Our solution:

- create a ball template
- search for similarities on the next frame



Ball template

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Tracking by color

- quickest and easiest method



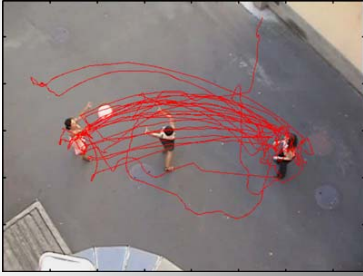
- its simplicity can cause the tracking to fail



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Trajectory evaluation

- Evolution of ball position in time
- Pixel coordinates of the ball during the game


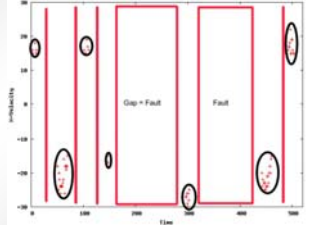


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Use of velocity for extracting the movement events

Annotating the ball:


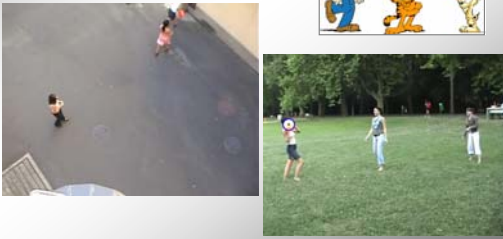
- in standby
- in game process

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Base level key events extraction

- Ball is thrown from one player to the other
- The players carry the ball
- Players change place (according to the game's rules)

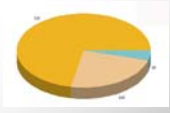




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High level key events extraction

- Statistics of standing as cat (macska)

	A	B	C
Game 1	1	2	2
Game 2	0	2	1

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Animation based on extracted information

```

graph TD
    A[ANALYSIS PROGRAM] --> B([key events])
    B --> C[Visualization program]
    B --> D[Text file]
    D --> E[0 for left  
1 for center  
2 for right]
  
```

Text file		
12	0	18
27	2	35
40	0	56
70	1	80

0 for left
1 for center
2 for right

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Animation based on extracted information

game logic

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Future possibilities

- Extension - Physically correct motion model
- Tracking accuracy for automatic annotation of tennis matches

- Football game supervision

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Thank you!!!

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