Athlete Motion Analysis summary

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Version 1.1

Artificial Intelligence & Information Analysis Lab

Athlete Motion Analysis

- Introduction
- Motion Caption
- Body pose
- Rigid object motion
- Articulated object motion
- Motion Analysis in Sports

Introduction

- Player motion tracking contains data collection techniques from live observation to post-event video analysis in which the player movement patterns are recorded and categorized.

- Athletes tend to make fast and agile moves, with many unpredictable changes in direction and frequent collisions with other athletes.

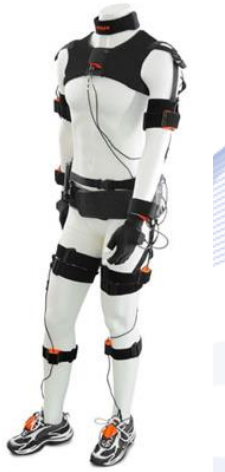
Introduction

- All these characteristics of players movements violate the assumptions of smooth movement that are typically based computer tracking algorithms.

- It is challenging to obtain appropriate video sequences that are able to accurately identify and label people's pose and action through time, in a crowded environment which has a lot of interacting people.

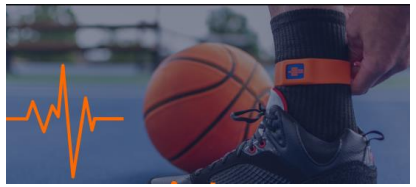
Motion Caption

- Motion Caption: 3d position trackers or sensing suits
- Measuring the performance of the trackers:
- Trackers accuracy = |real position-tracked position|
- Jitter: sensor noise
- Drift: ongoing increase on trackers error
- Latency: (number of tracker's measurements)/sec



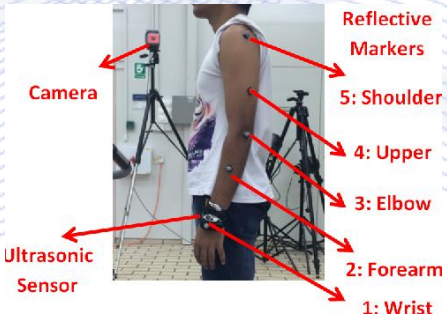
Motion Caption

- Mechanical trackers



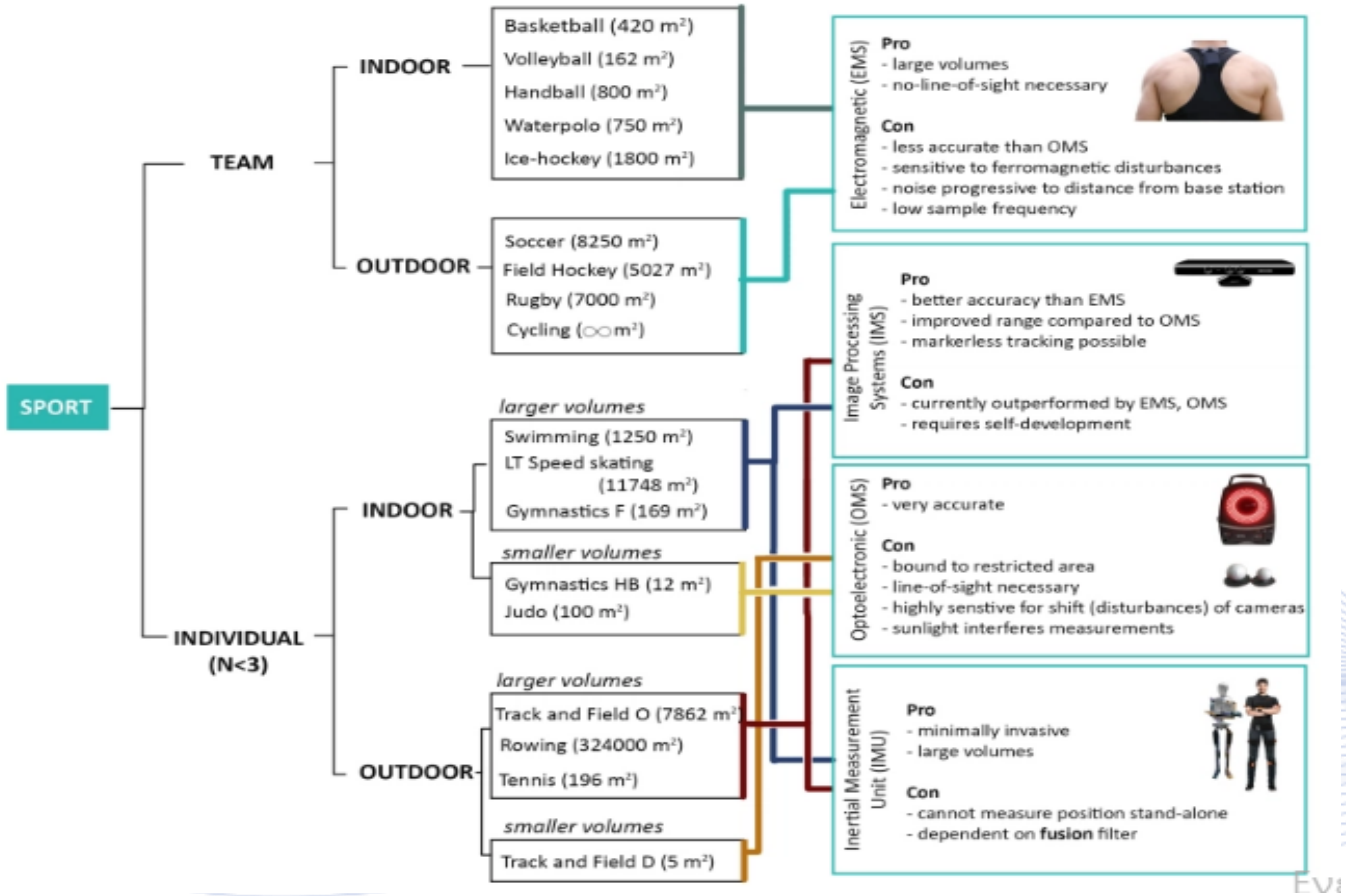
- Inertial trackers

- Electromagnetic devises



- Ultrasonic Trackers

Motion Caption



Wearable Devices

- TraXports collects data of real-time position in order to track players during trainings or games.

- It estimates the distance between stationary stations and athletes wearables, without global positioning system.

(a) TraXports

Wearable Devices

- MBody3 is designed to collect physiological data because its capable of real-time measuring the electrical activity of major muscles groups in each leg.

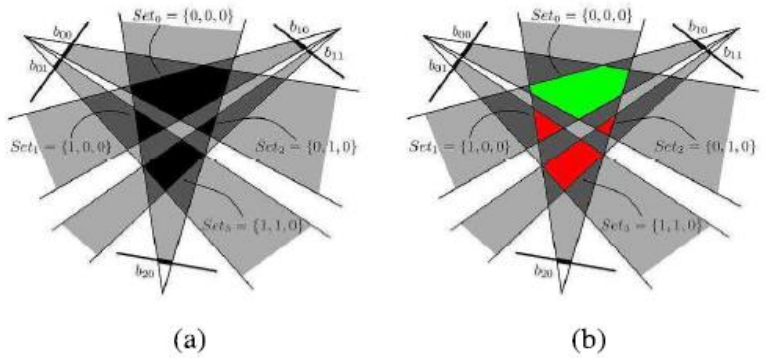
Table 3. Example of Mbody3 CSV file.

MBody3 Example File						
R.Quad	L.Quad	R.Hams	L.Hams	R.Gluteo	L.Gluteo	Time(s)
45	35	21	2	11	3	0.04

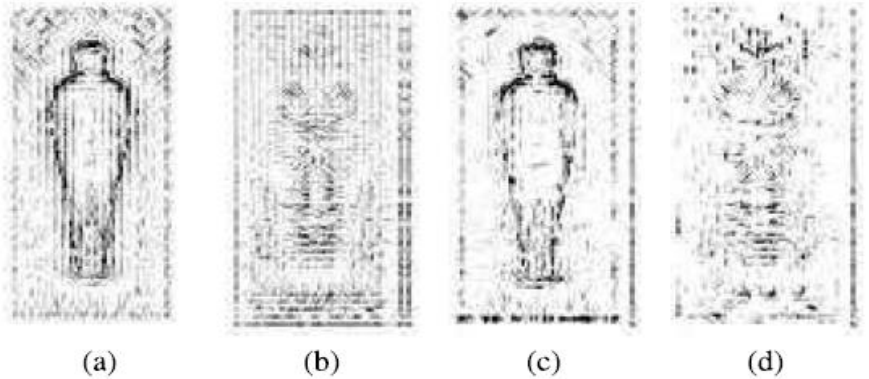
(b) MBody3

Image Based data acquisition

- Shapelets



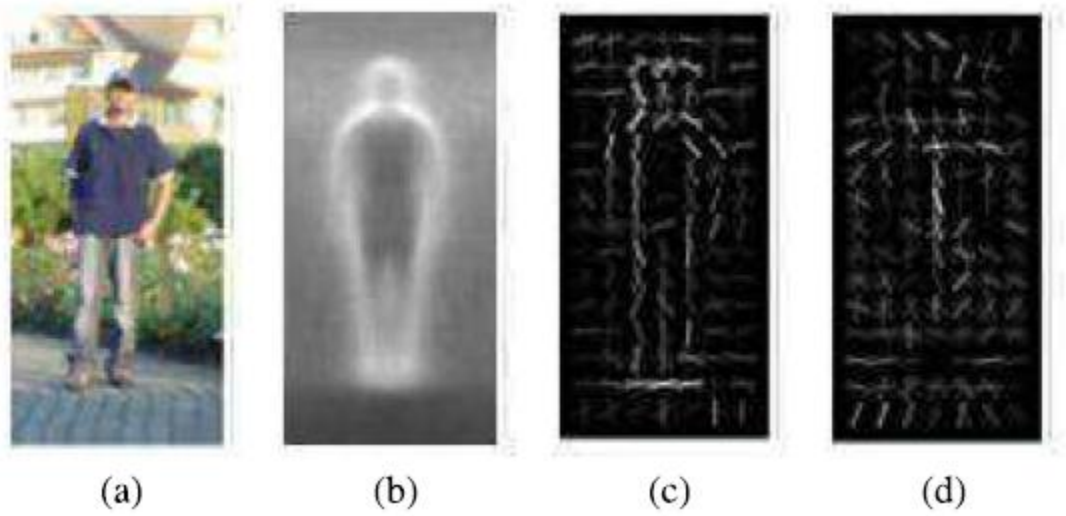
The number of votes is proportional to the size of the area. a) Set of bounding boxes voted by the corresponding retained areas (black color). b) The valid set of bounding boxes (voted by the voxels in the green color area) and the rejected sets (red color)



Shapelets: a) human body model, b) background model, c) shapelets of a test image which show a human body, d) background test image

Feature extraction

- Histogram of Oriented Gradients (HOG)

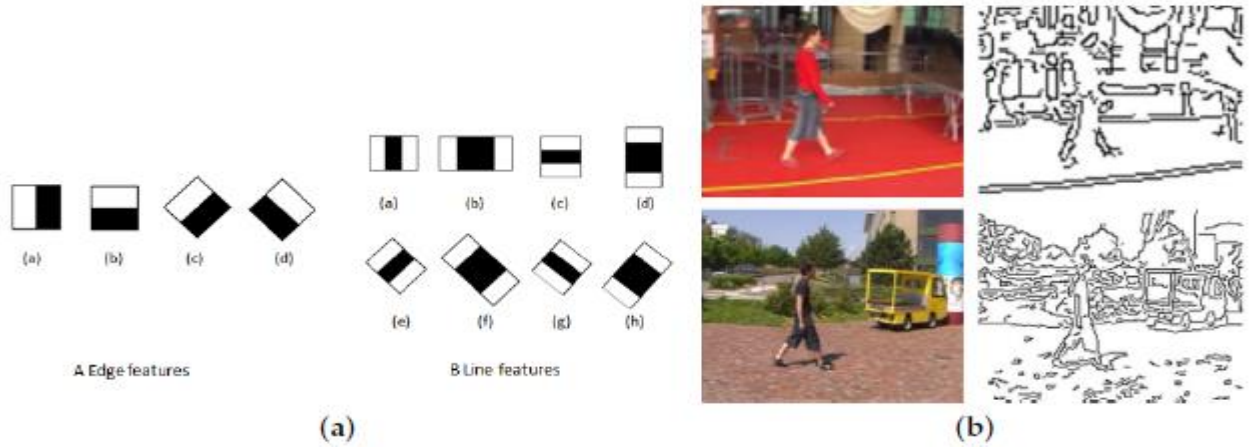


a) Test image, b) the human body model, c) weighted by positive weights HOG, d) weighted by negative weights HOG

Silhouette extraction

Ex. of Silhouette extraction: a) background image , b)original image, c) the extracted silhouette from the original image.

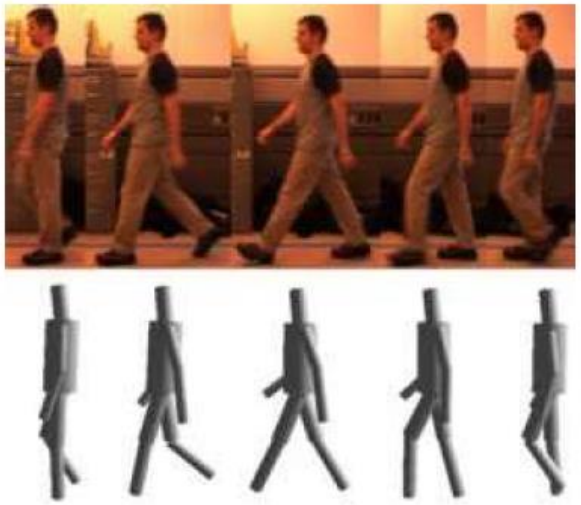
Line and Edge extraction →



Edge Filter and extracted Edge Feature Examples: a) Haar Filters as Edge Filters , b) Edge Features

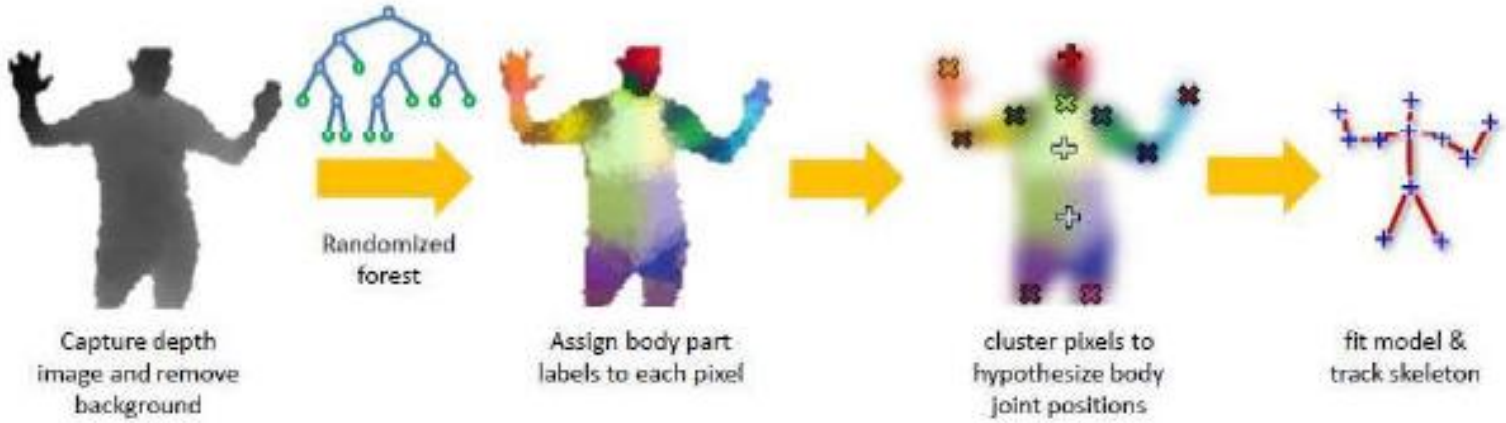
Pose Estimation

- Pose estimation is the determination of an object's coordinate system transformations with reference to the camera coordinate system



Human body pose the http://people.csail.mit.edu/tomas/mainResearch.html

Kinect Body Pose Estimation



Kinect process pose estimation which indentifies 3-d joints of interest.

Rigid Body Motion

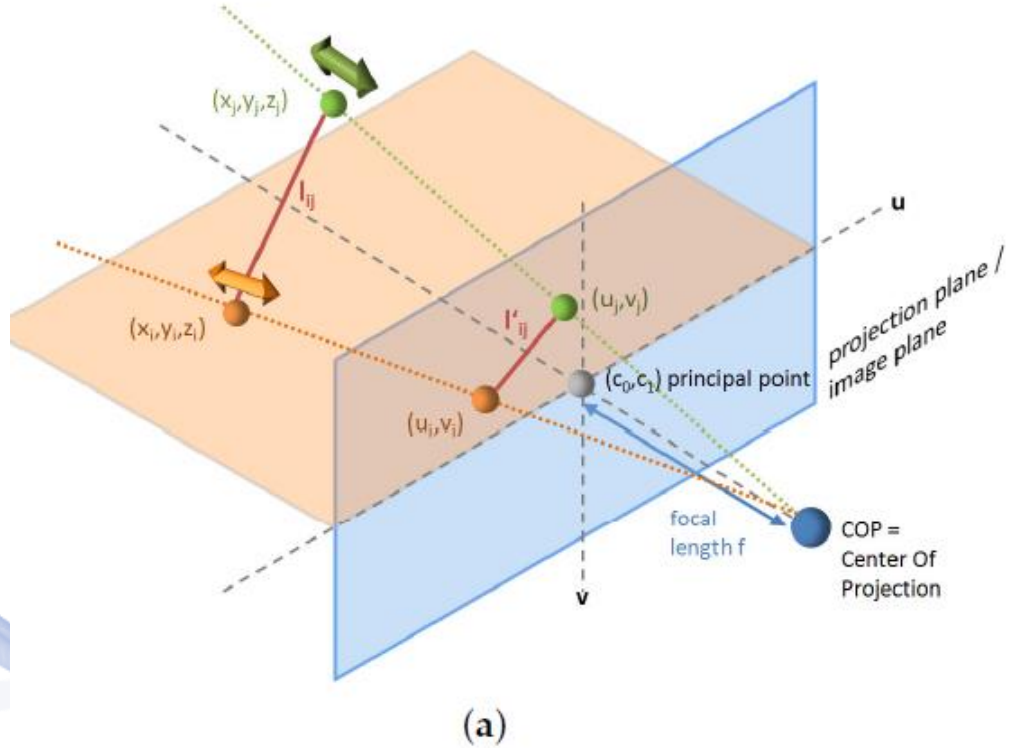
- For a rigid object, 3D motion is decomposed in a 3D rotation and 3d translation component. If $\underline{P}$ is an under examination point, we can be describe its motion as:

$$\underline{P'} = \underline{RP} + \mathbf{T}$$

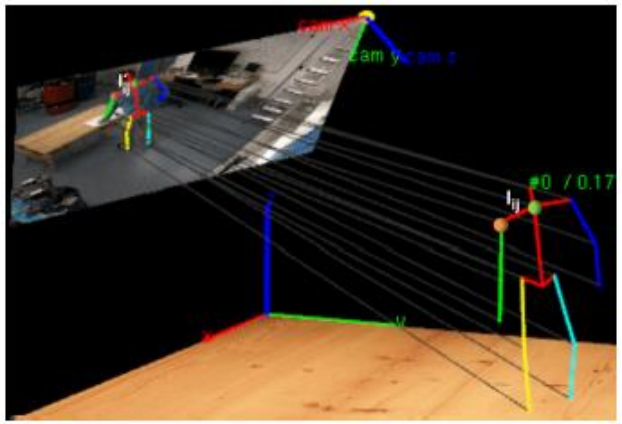
Articulated Body

- Generative Methods
- Discriminative Methods
- Machine Learning Methods

Generative Methods



(a)

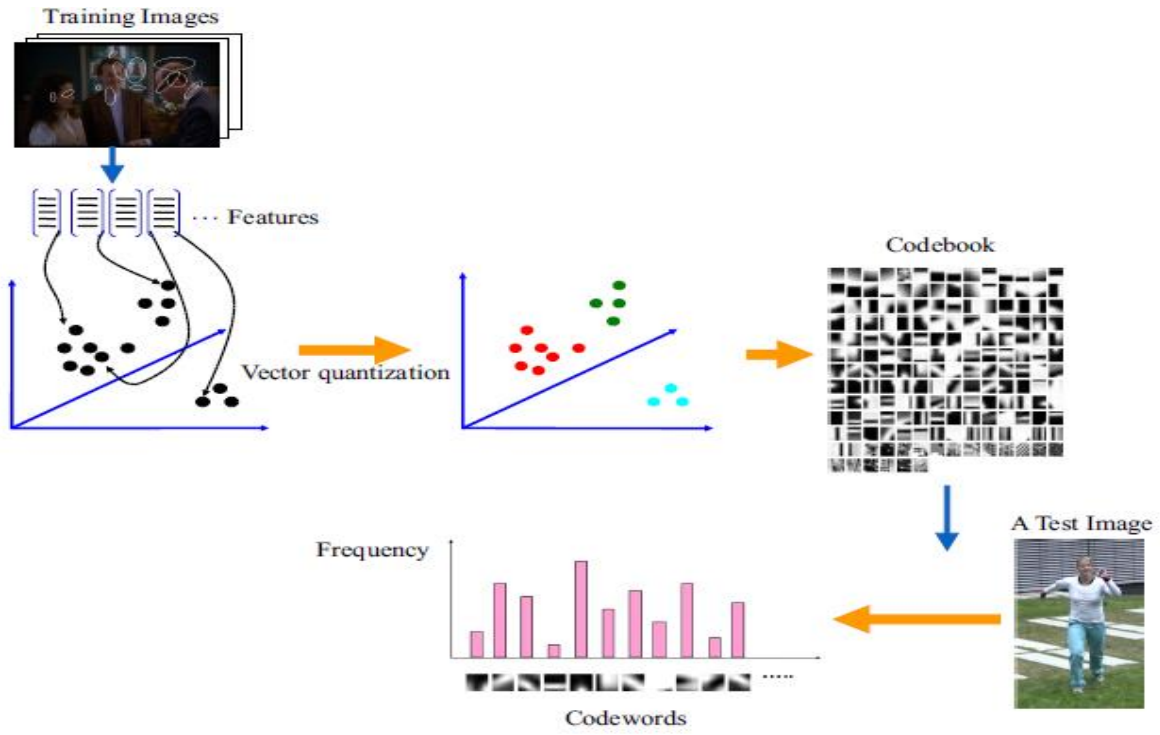


(b)

At most cases a human body model is required, we project the model at the image space (Fig a: Perspective camera models) and adjust it so as the projection is compliant with the image observation (Fig b: example pose and its projection).

Discriminative Methods

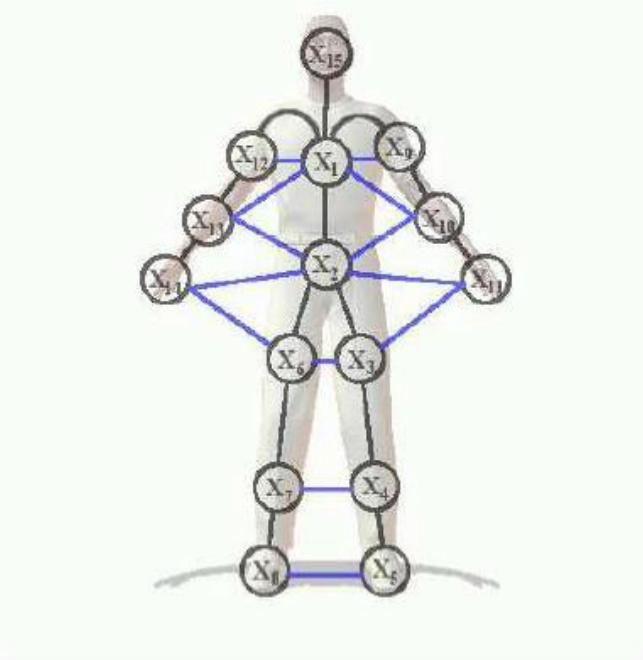
- Bag-of-words based methods:



Bag-of-words feature representation pipeline

Modeling Human body

- Pose estimation human body is usually divided in 10 parts and is described with 15 control points.



Human model from http://www.cs.brown.edu/ ls/research.html

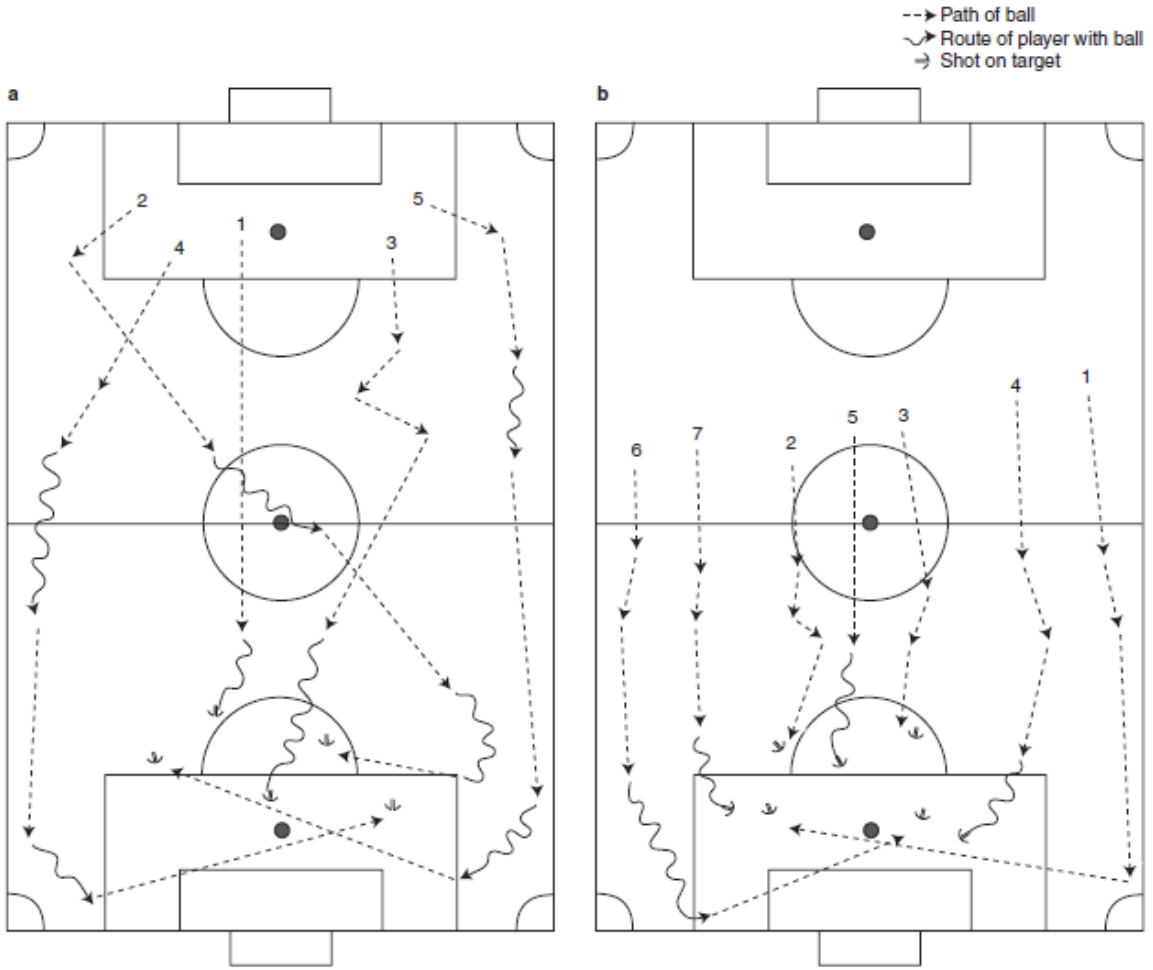
Vision-Based Motion Analysis in Sport

- Manual Vision-Based Tracking Systems: Notational Analysis in Sport

- Notational Analysis: the quantification of individual player movements by an investigator, and the frequency and timing of particular movements.

- Limitations and Reliability of Manual Notational Analysis Techniques: the reliability of the data entry procedure.

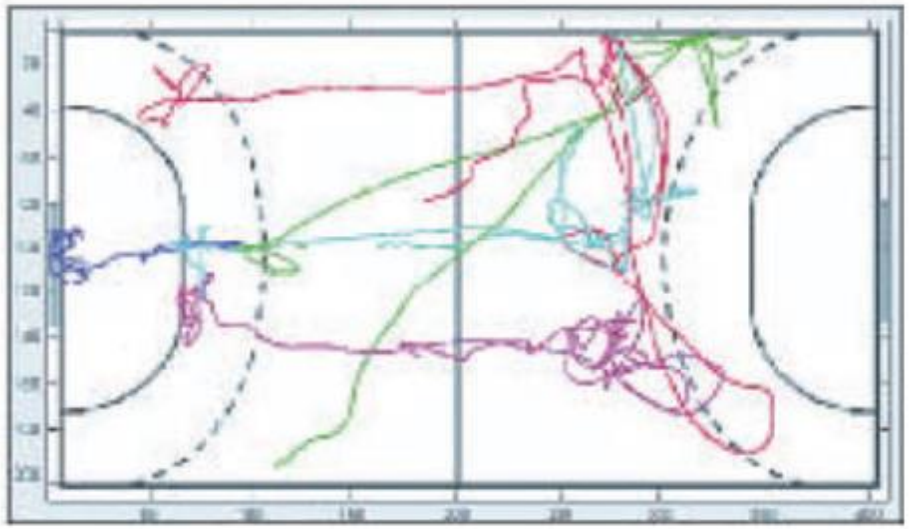
Soccer example



Notational Analysis in Sport

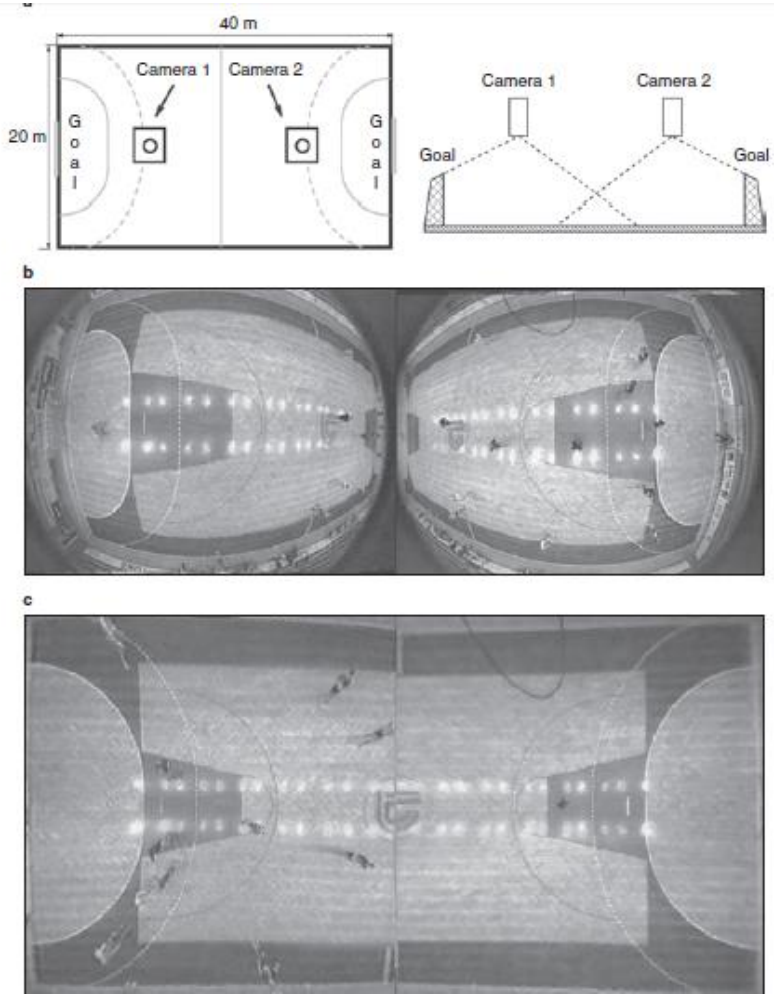
Indoor Sports Tracking Systems

- **Pers and Kovacic** devised a system that tracks multiple players with accuracy, in real time and with intervention of human operator.



Spatio-temporal trajectories of 5 handball players fro the first minutes of a match obtained by motion detection algorithm (Pers and Kovacic)

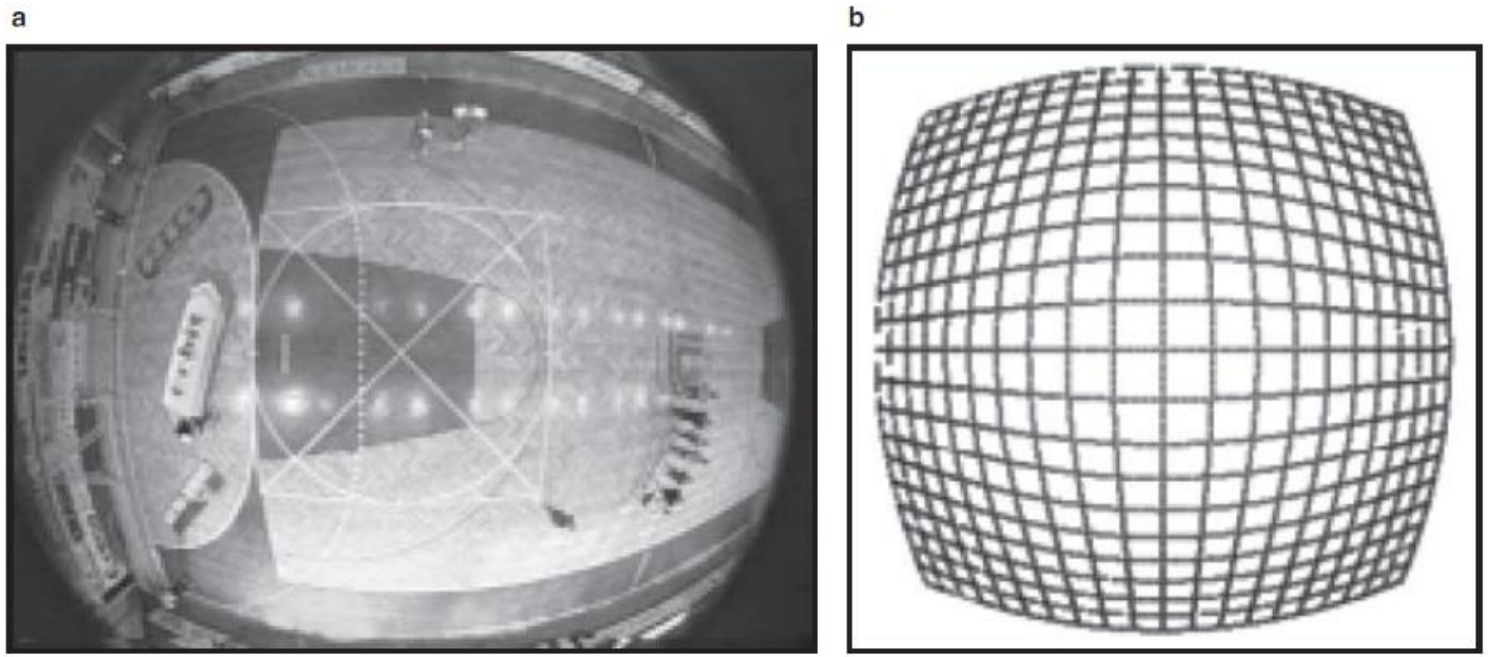
Indoor Sports Tracking Systems



a) placement of the camera, b) obtained image , c) the resulting image after correction

Geometrical camera distortions

- Relates to the effect that radial distortion has on the input images, which is problematic at boundary regions.



The effect of radial distortion: a) acquired image , b) Demonstration of wide –angle lens distortion at court boundaries

Commercially Available Vision-Based Analysis Systems

- Semi-Automatic/Online Systems.

- Basic video analysis systems: Game Breaker, Dartfish, Digital, Soccer, Utilius VS (CCC-Software).

- Systems where players wear special tracking devices: TRAKUS TKS.

Commercially Available Vision-Based Analysis Systems

- SoccerMan: football game-reconstruction system that generates an animated 3-D scene from a video sequence as an input.

- LucentVision: is a product for analyzing and visually presenting tennis games.

- TRAKPERFORMANCE: provides player tracking information rom games in real-time, video-based system.

Commercially Available Vision-Based Analysis Systems

- Online motion analysis systems: Motion Analysis Corporation: captures movement in digital format in real time.

- Pfinder: tracks and interprets human movement, a realtime digital video system.

- Amisco, Prozone: video tracking systems

Limitations of Commercial Tracking Systems

- TRAKPERFORMANCE, SoccerMan, ProZone: the accuracy of the positional information from these systems depends upon the training.

- MAC system: the infra-red light-detecting cameras cannot be used for outdoor sports and has a limited capture volume.

Limitations of Commercial Tracking Systems

- Pfinder system: the assumption that only one person occupies a space prevents multiple object tracking and it is also limited by its reliance on dynamic scenesz.

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Q & A

Thank you very much for your attention!

More material in
http://icarus.csd.auth.gr/cvml-web-lecture-series/

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