

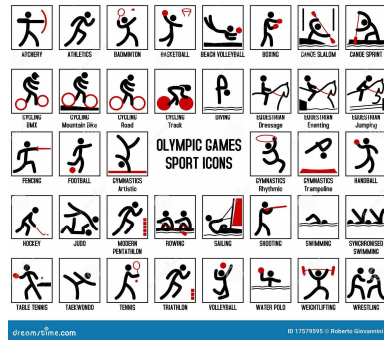
1

Content

- October 4th Measurement devices
- October 8th Kinetics and kinematics, knee osteoarthritis
- October 30th Shoulder
- November 22nd Ankle

2

Complexity of human movement



There should be a specific need!

3

Measures of human movement



www.fancomix.deviantart.com

Spatio-temporal parameters

- Ground contact
- Stride length
- ...

Kinematics

- Joint angle
- Segment angular velocity
- ...

Kinetics

- Joint moment
- Trajectory of the center of mass
- ...

Electromyography

- Contraction amplitude
- Activation period
- ...

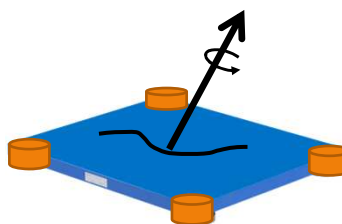
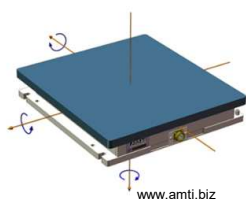
4

Measurement devices

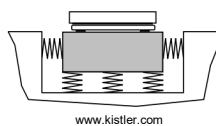


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Force plate



- Measure: 3D force, 3D moment, center of pressure
- High sampling frequency
- Mounting could be an issue



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Force plate

- Embedded in the ground or portable



www.kistler.com



www.amti.biz



7

Force plate

- Embedded in the ground or portable or in built-in treadmill



www.hpscocosmos.com



www.bertec.com



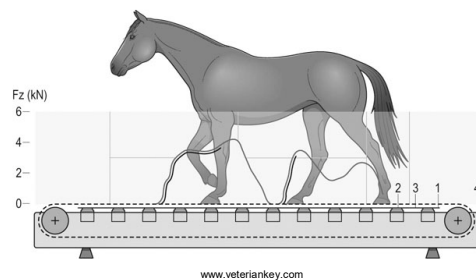
www.amti.biz



8

Force plate

- Embedded in the ground or portable or in built-in treadmill



Martinez-Ramirez et al. Journal of NeuroEngineering and Rehabilitation 2014, 11:20.



9

Plantar pressure mat



- Measure: pressure distribution
- Resolution of $\sim 2-5$ sensels /cm²
- Sampling frequency up to several hundreds of Hz



10

Plantar pressure treadmill

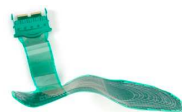


- Measure: pressure distribution



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Plantar pressure insole



www.novel.de

- Measure: pressure distribution
- Resolution of $\sim 2-5$ sensels /cm²
- Sampling frequency up to several hundreds of Hz

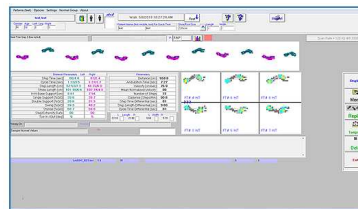
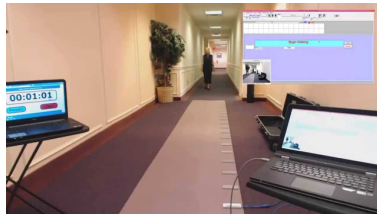


www.motion.de



12

Gait analysis mat



- Measure: contact
- Resolution of $\sim 0.5 - 1$ sensels /cm²
- Sampling frequency up to several hundreds of Hz



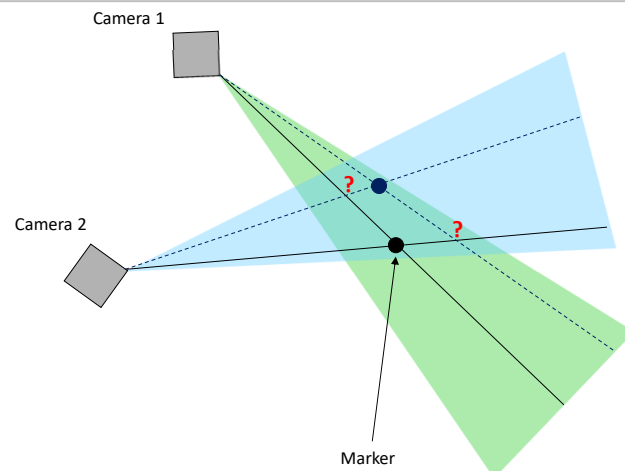
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Passive marker-based motion capture



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Passive marker-based motion capture



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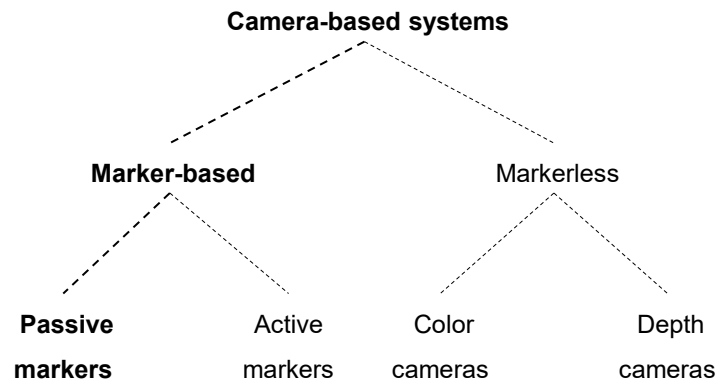
Passive marker-based motion capture

- Measure: marker positions
- Large number of markers possible
- Capture volume of up to 5 x 10 m
- Sampling frequency of 100 Hz and above
- Accuracy ~1 mm
- Drawbacks: calibration, line of sight, tracking & ambient light
- Compatible with ~active~ markers



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Camera-based motion capture



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Active marker-based motion capture



www.metrotest.cz



- Measure: marker positions
- Large number of markers possible
- Sampling frequency dependent to the number of markers (eg., $4600 \text{ Hz} / n$)
- Drawbacks: line of sight & powering of the markers

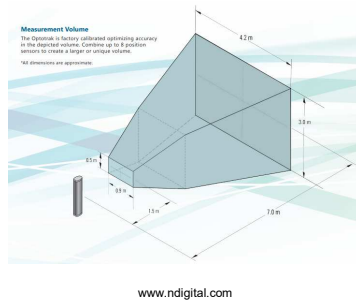


www.ndigital.com

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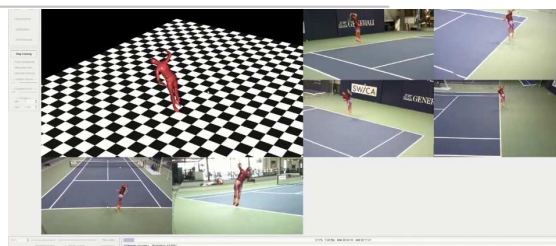
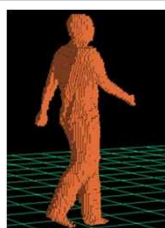
Active marker-based motion capture

- Capture volume



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Markerless motion capture (color camera)



- Measure: joint position & joint angle
- Large capture volume possible
- Sampling frequency of 100 Hz and above
- Less accurate than marker-based
- Drawbacks: calibration, ambient light, background

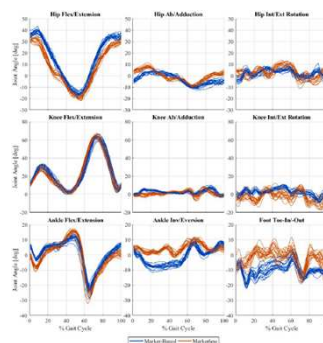


Zang et al. IEEE Transactions on multimedia 2013, 106-119.



20

Markerless motion capture (color camera)



- Measure: joint position & joint angle
 - Large capture volume possible ?
 - Sampling frequency of 100 Hz and above
 - Less accurate than marker-based
 - Drawbacks: calibration, ambient light, background ?
- Dependency on the AI algorithms**



Kanko et al., Journal of Biomechanics 2021, 110665.



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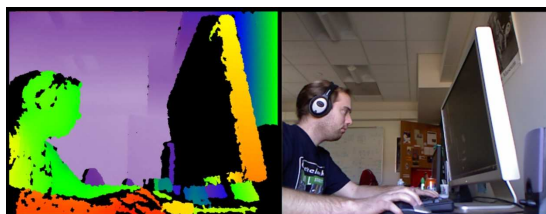
Markerless motion capture (depth camera)



www.Microsoft.com



www.graphics.Stanford.edu



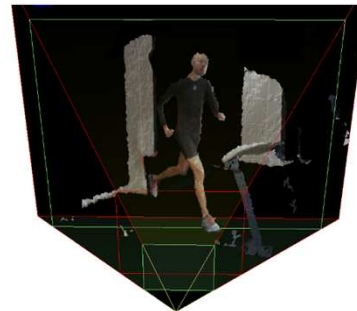
www.graphics.Stanford.edu



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Markerless motion capture (depth camera)

- Measure: joint position & joint angle
- Limited capture volume
- Rather low sampling frequency (<100 Hz)
- Less accurate than marker-based
- Drawbacks: dependent on the built-in AI



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Magnetic-based motion capture



www.polhemus.com

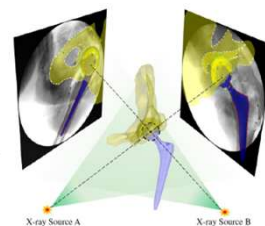
- Measure: marker position and orientation
- Limited number of markers
- Limited capture volume
- Sampling frequency over 100 Hz
- Accuracy ~1 mm & ~ 1°
- Drawbacks: magnetic distortion, cable



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Fluoroscopy

- Measure: bone or implant position
& orientation
- Error < 1mm and <1°
- Invasive
- Low sampling rate & short capture
duration
- Limited capture volume

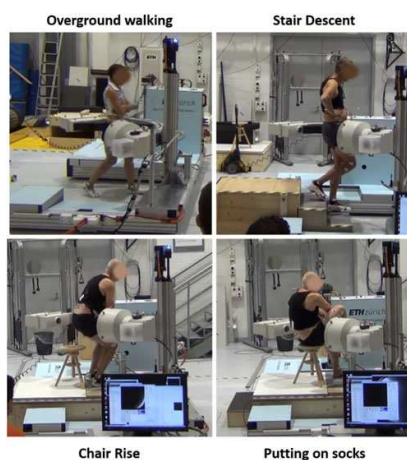


Journal of Biomechanics 46:13:1300



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Fluoroscopy

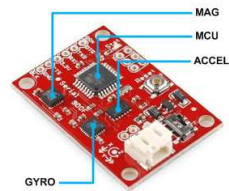


Frontiers Bioengineering Biotechnology, 11:1095845

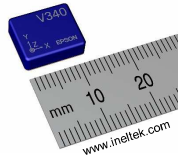


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Inertial measurement unit (IMU) -based motion capture



Zheng et al 2014



www.btsbioengineering.com

- Measure (3D): acceleration, angular velocity and magnetic field
- Can provide orientation



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Inertial measurement unit (IMU) -based motion capture

- Measure (3D): acceleration, angular velocity and magnetic field
- Can provide orientation
- Unlimited number of markers and unlimited capture volume
- Sampling frequency over 100 Hz
- Different approach than stationary devices
- Application-specific algorithms, variable accuracy
- Drawbacks: attachment, anatomical calibration



www.utwente.nl



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Electromyography



www.myon.ch



www.mfimedical.com

- Measure: electric potential
- High sampling frequency
- Skin preparation
- Placement, crosstalk, reference value



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Julien.favre@chuv.ch



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