Methods in Biomechanics - Kinemetry

Opto-electronic motion analysis systems

Active and passive markers

Passive: Retroreflective material (3M Scotch®); reflect light into the direction, where it originates from; Problem with hidden markers

Active: Time multiplexed LEDs -> not simultaneous

Methods in Biomechanics - Kinemetry

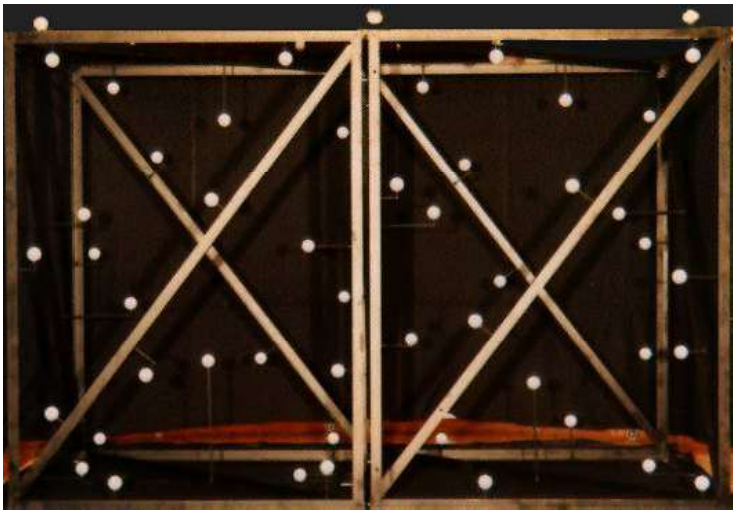
Opto-electronic motion analysis systems

Calibration

Recording of a calibration object

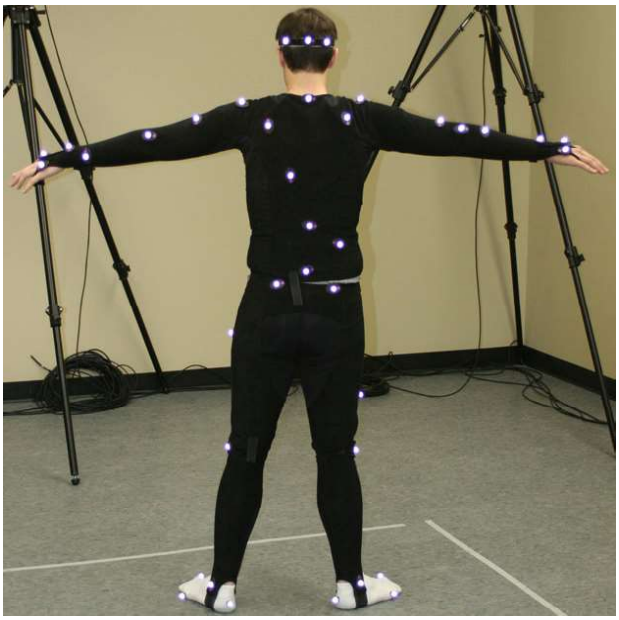
E.g.: Direct linear transformation (DLT) technique
After calibration: Do not change camera settings

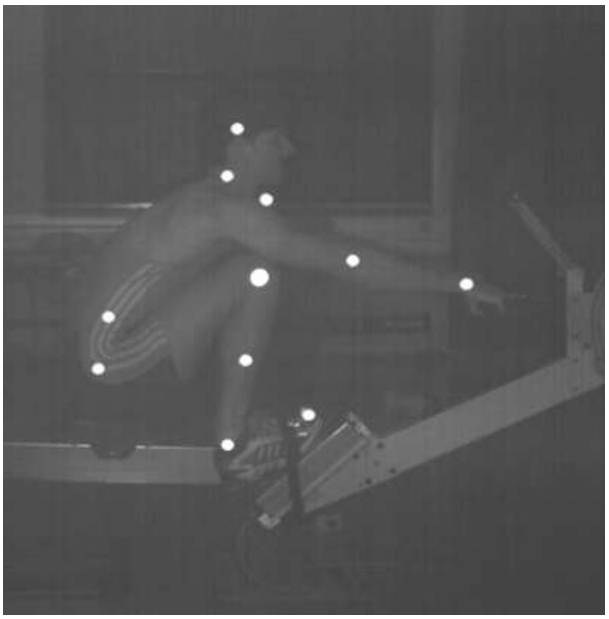
Calibration frame



Calibration – “magic wand“

Subject with markers





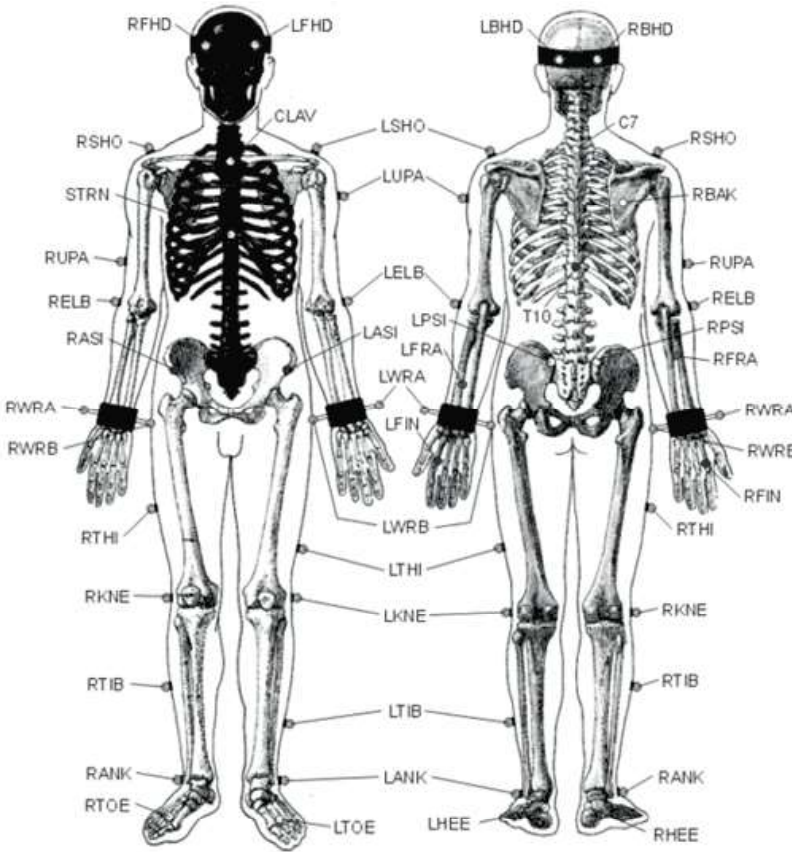
3D analysis of maximum forehand strokes under fatiguing conditions

Marker points on body segments – „Marker Sets“

Based on standardized protocols for positioning markers

Examples: Plug-in-Gait, Helen-Hayes

Plug-in-Gait Marker Placement



Start

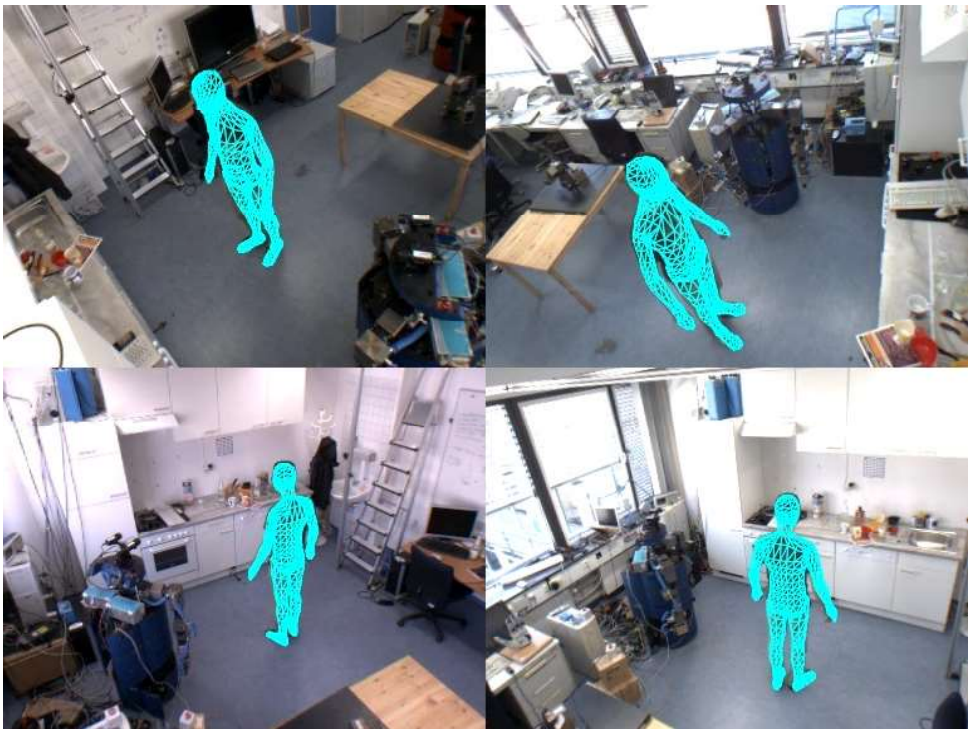
Methods in Biomechanics - Kinemetry

Opto-electronic motion analysis systems

Video-based off-line systems

- Are based on digital video
- Principles of marker recognition and tracking as in real-time systems
- Better options for operator to intervene

Markerless Systems



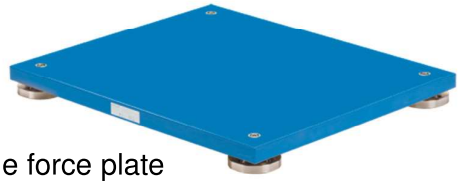
Methods in Biomechanics - Dynamometry

Force plates

Typical Measuring Chains

			
Force plate with charge amplifier Type 9281EA	Connection cable Type 1759A...	DAQ system (USB 2.0) Type 5691A1	Laptop (provided by user) with BioWare software

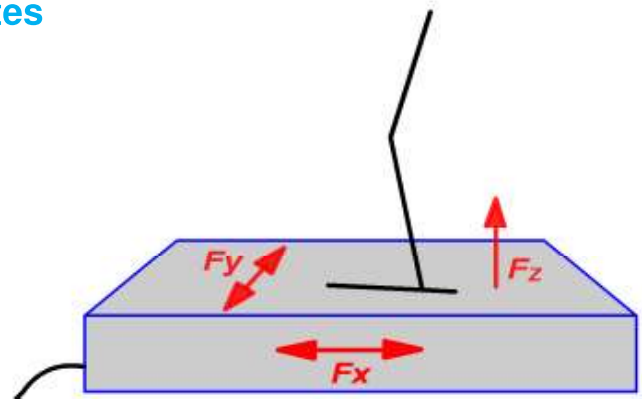
Fig. 10: Configuration of a typical measuring chain with Kistler DAQ system BioWare®



Portable force plate

Methods in Biomechanics - Dynamometry

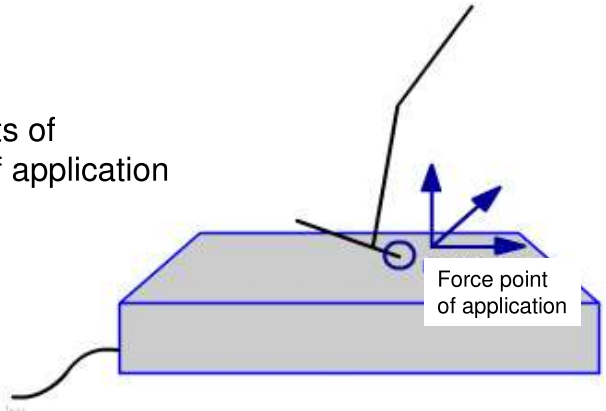
Force plates



Charge amplifier

Forces in 3 dimensions

2 components of
force point of application

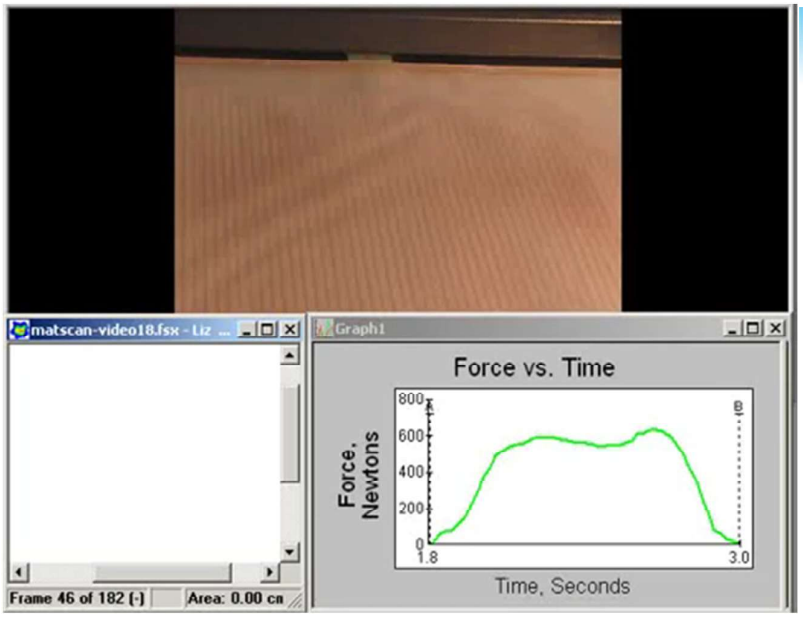


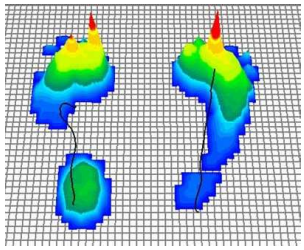
Charge amplifier

Force plate

Methods in Biomechanics - Dynamometry

Pressure distribution



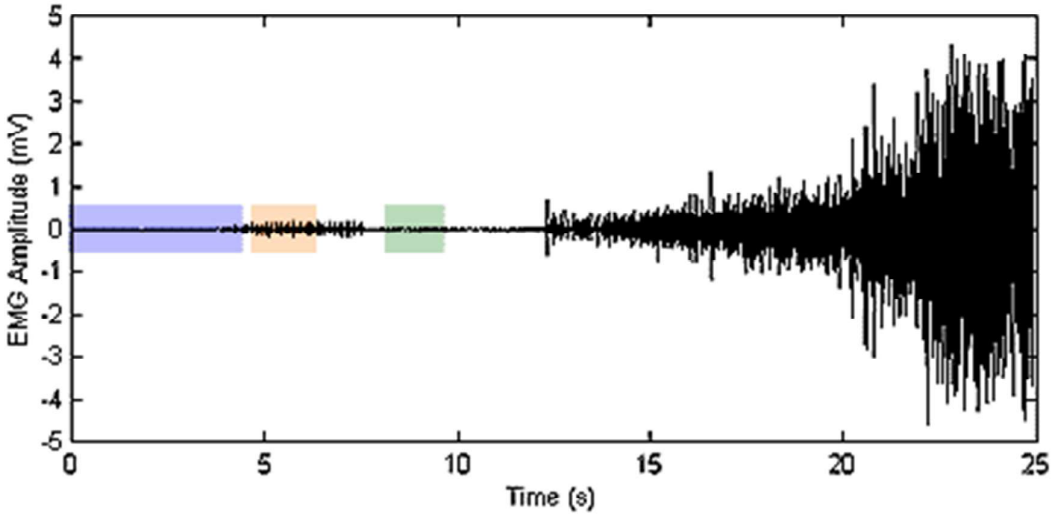


Methods in Biomechanics - Electromyography

Methods for estimating muscle activity

Delsys

Methods in Biomechanics - Electromyography



Contraction of a muscle (0 to 100% MVC)

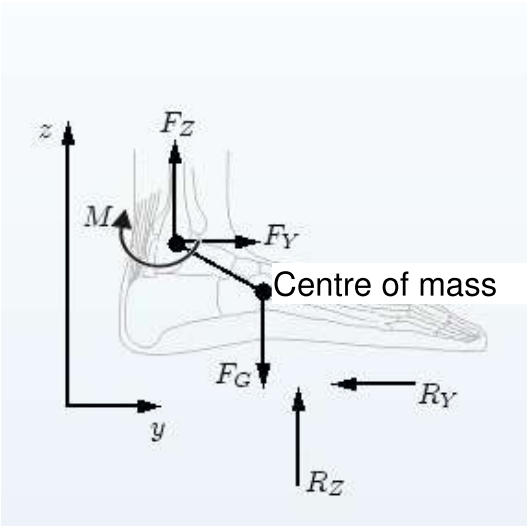
(www.delsys.com)

Methods in Biomechanics - Electromyography

- Temporal activation pattern (start and end of activity) of a muscle,
- Contribution / non-contribution of a specific muscle to a motion,
- Timely coordination of muscles (intermuscular coordination; timing or sequencing),
- Antagonistic / synergistic muscle activities.

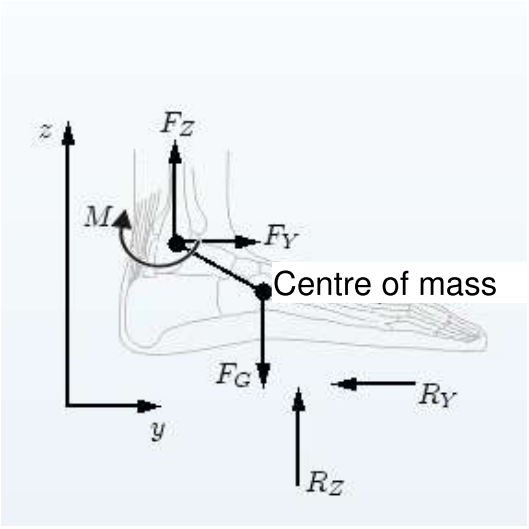
Inverse dynamics

Inverse dynamics



R_Y, R_Z...	Ground reaction force
F_G...	Weight of foot
M...	Net muscle moment

Inverse dynamics



R_Y, R_Z... Ground reaction force

F_G... Weight of foot

M... Net muscle moment

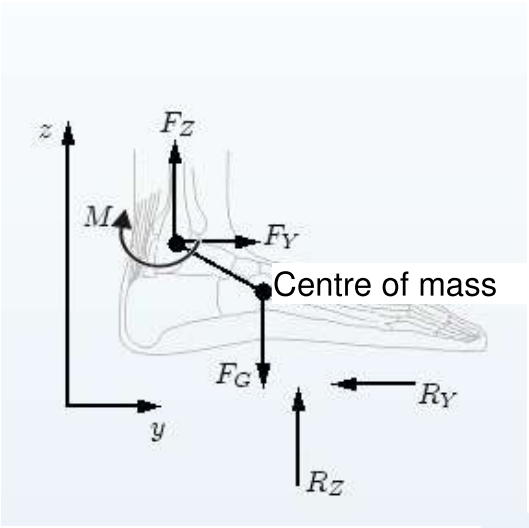
m…mass of foot

a_Y, a_Z…acceleration of center of mass (foot) in y- and z-direction

$$m\,a_Y = F_Y - R_Y \;\Rightarrow\; F_Y = m\,a_Y + R_Y$$

$$m\,a_Z = F_Z - F_G + R_Z \;\Rightarrow\; F_Z = m\,a_Z + F_G - R_Z$$

Inverse dynamics



R_Y, R_Z... Ground reaction force

F_G... Weight of foot

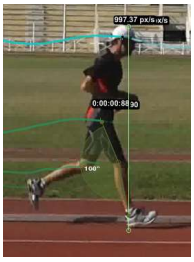
M... Net muscle moment

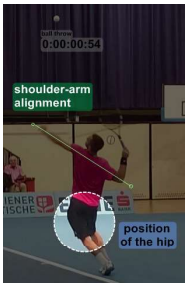
J…Moment of inertia w.r.t. normal axis passing through center of mass

M_i…Moment of Force F_i

$$J\alpha = M_{Fz} + M_{Fy} + M_{Rz} + M_{Ry} + M$$

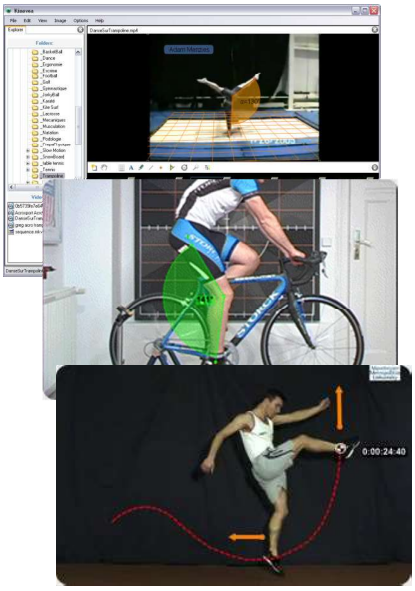
$$M = J\alpha - M_{Fz} - M_{Fy} - M_{Rz} - M_{Ry}$$





Biomechanics & Motion Analysis: Practical Issues

Kinovea – open Source Video Analysis Software



Installation Instructions (Windows only):

1. Use the following link to download **Kinovea 0.9.3** (beta): https://kinovea.org/setup/kinovea.0.9.3/Kinovea-0.9.3-x64.exe
2. Save the file on your local hard drive
3. Run the installer (double-click on that file) and follow the instructions on your screen
4. When asked for installing .NET platform 4.8 agree and wait until the complete installation routine has finished
5. Now you can try to run Kinovea using the link on the Desktop

http://www.kinovea.org