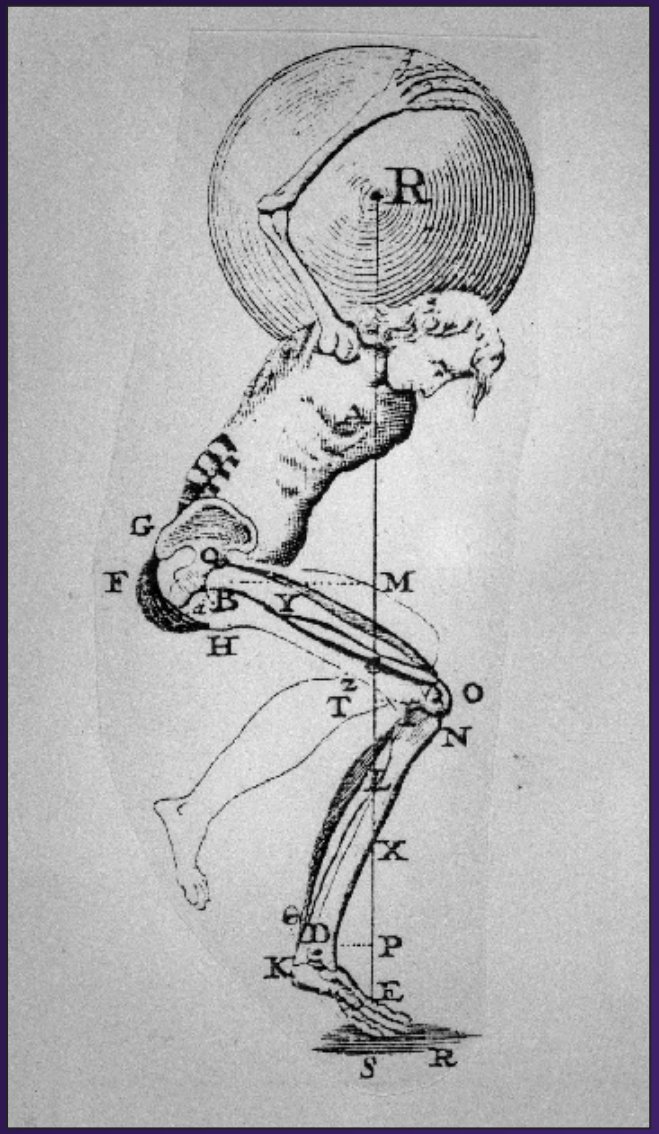


Musculoskeletal Biomechanics

BIOEN 520 | ME 527

Session 4A

Kinematics and Kinetics

Review: Session 3B

- Motion capture systems
  - Retro-reflective vs. active vs. electromagnetic
- Force plates
  - Strain gage vs. piezoelectric
- Pressure plates
  - Capacitive vs. force sensing resistors
- Cadaveric gait simulation

Session 4 Overview...

- Review/complete session 3B
  - Markerless motion analysis
  - Cadaveric Gait Simulation
    - Kinematics and kinetics of the RGS
- Kinematic highlights
- Kinematics and kinetics of gait analysis
- Homework 1
- Mini-Lab 2: Grant writing
- Final project

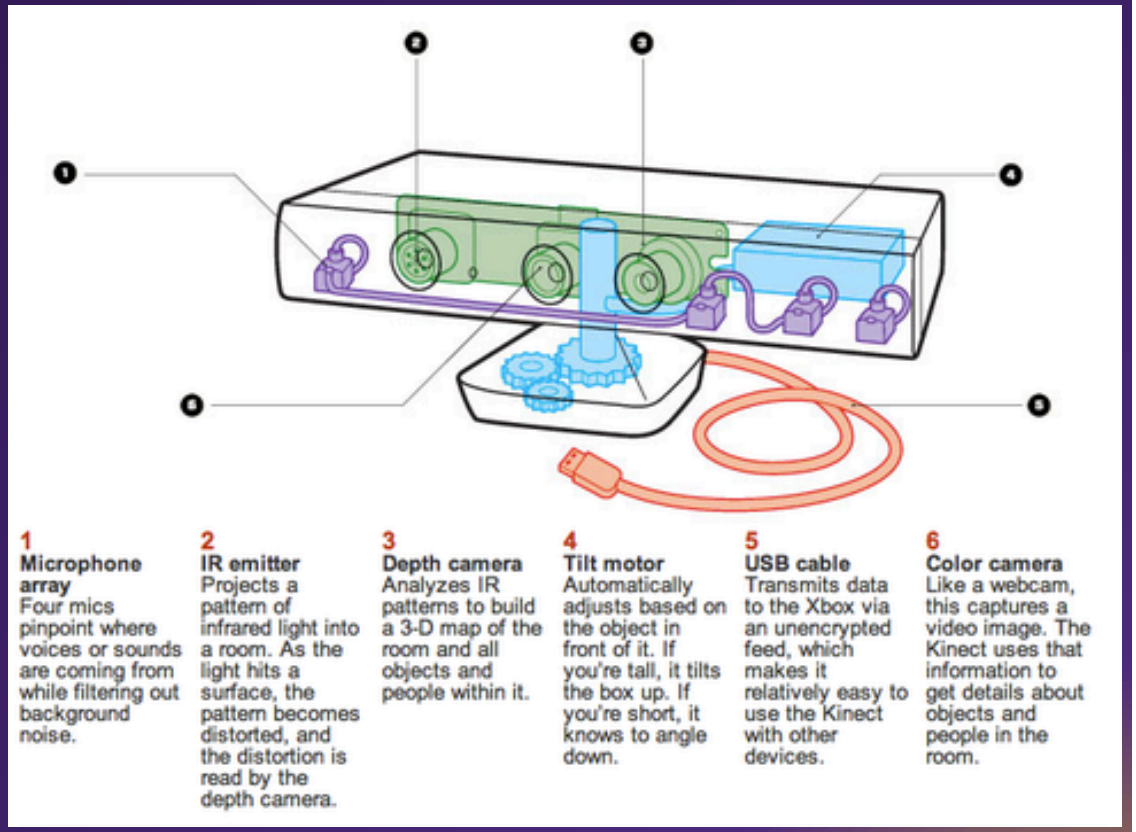
Motion Capture

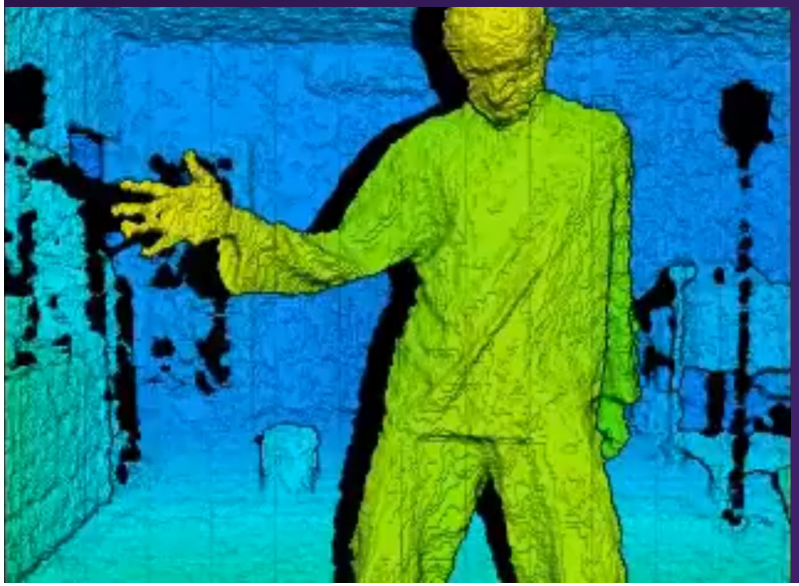
- Markerless
  - Organic Motion
    - Developer of world's only professional markerless motion capture software and systems.
    - Biostage – 14 to 24 cameras

www.organicmotion.com

Motion Capture

- Markerless
  - Kinect
    - Microphone array
    - IR emitter
    - Depth camera
    - Color camera





https://www.quora.com/How-does-Microsofts-Kinect-work-from-a-technology-standpoint

http://www.businessinsider.com/why-microsoft-xbox-kinect-didnt-take-off-2015-9

Motion Capture

- Markerless
  - Strengths
    - Easier to collect - no special suits, markers or equipment are required – just cameras
    - Less expensive systems
    - Real time
  - Weaknesses
    - Less accurate (1-2 cm??)

Cadaveric Gait Simulation

- Development of the robotic gait simulator (RGS)
- Kinematics and kinetics of the RGS
- Summary slide deck
  - Methods for quantifying foot kinematics
  - How the RGS works

Kinematic highlights

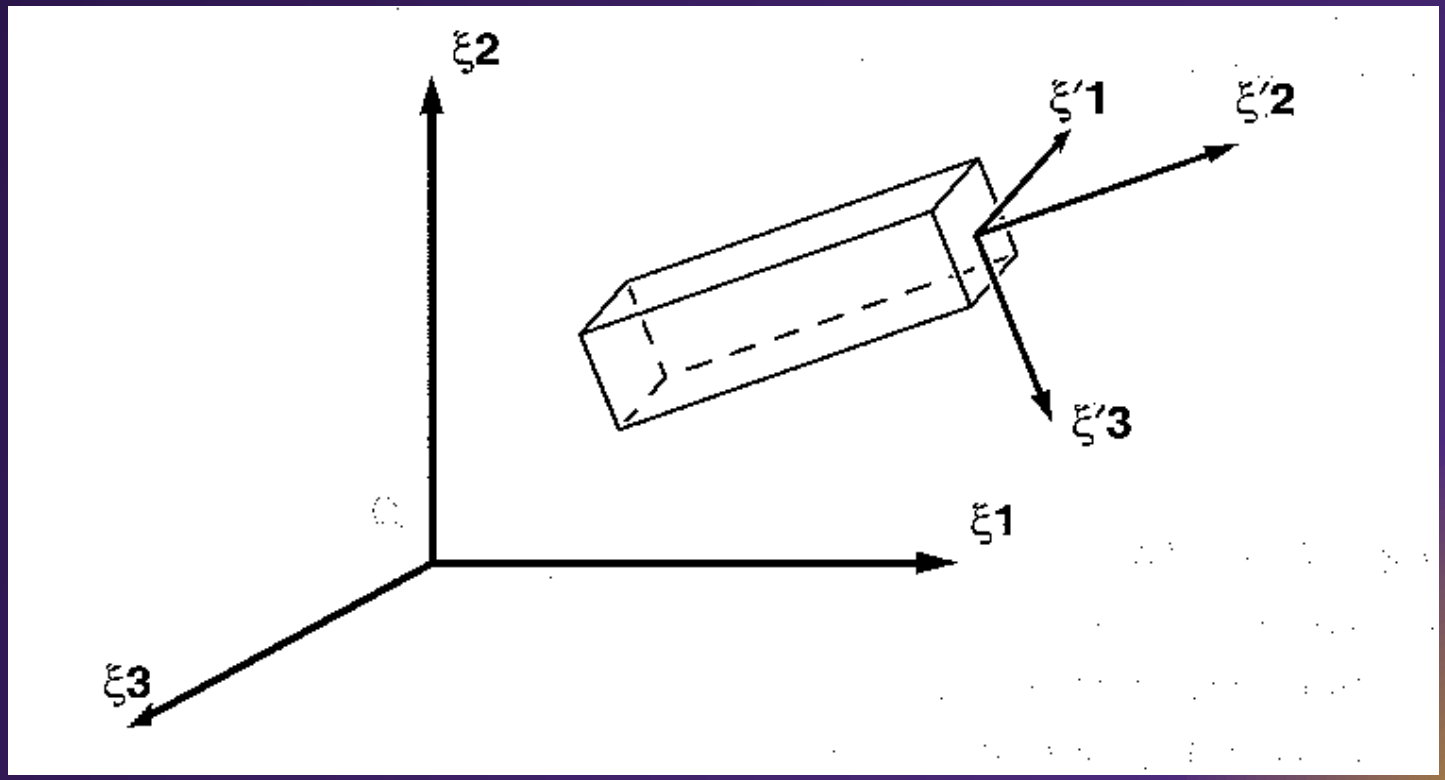
- Position vectors and rotation matrices
  - Craig chapter (on your own)
- Marker-based coordinate systems
  - Nigg and Herzog chapter p2
- Anatomic v. technical coordinate systems
  - Nigg and Herzog chapter p2
- Descriptions of rigid body kinematics
  - Nigg and Herzog chapter p5-6, 8-10

Kinematic highlights

- Position vectors and rotation matrices
  - Craig chapter (on your own)
    - Spatial Descriptions and Transformations
  - Position = vector
  - Rotation = matrix
  - Transformations between coordinate systems
  - Appendix on how to determine angles from transformation matrices

Marker-based coordinate systems

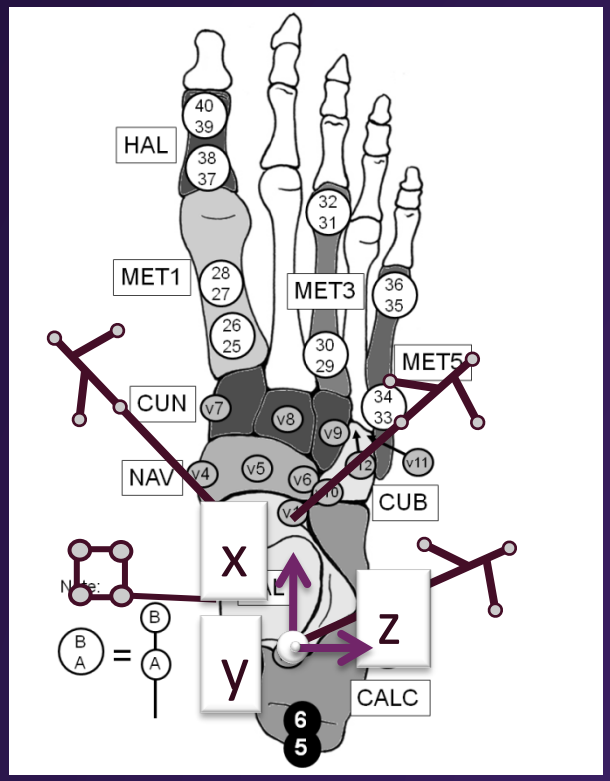
- Nigg and Herzog p2

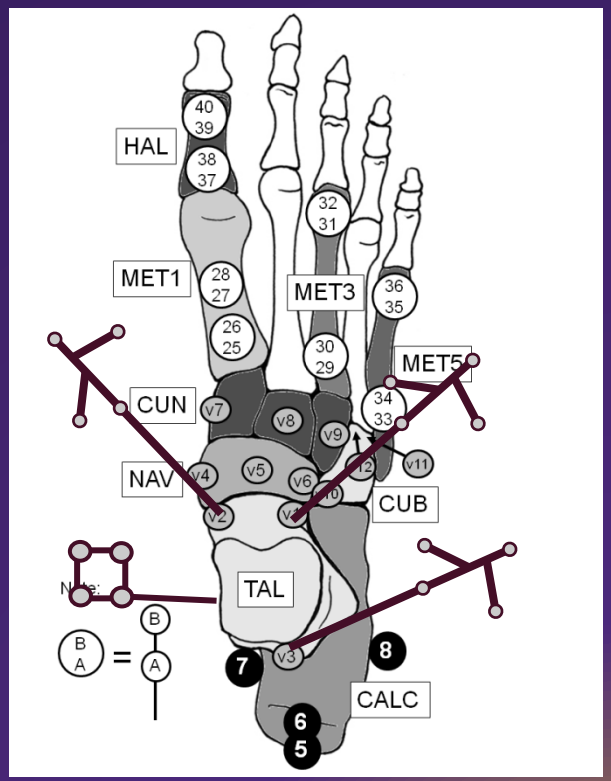


Anatomic v. technical coordinates

- Difference?
- Anatomical – if possible
- Technical
  - Neutral position calibration
    - Medial malleolus marker
  - Digitization
    - Cadaver foot model
  - Nigg and Herzog chapter
    - Joint coordinate systems p2

Anatomic v. technical coordinates





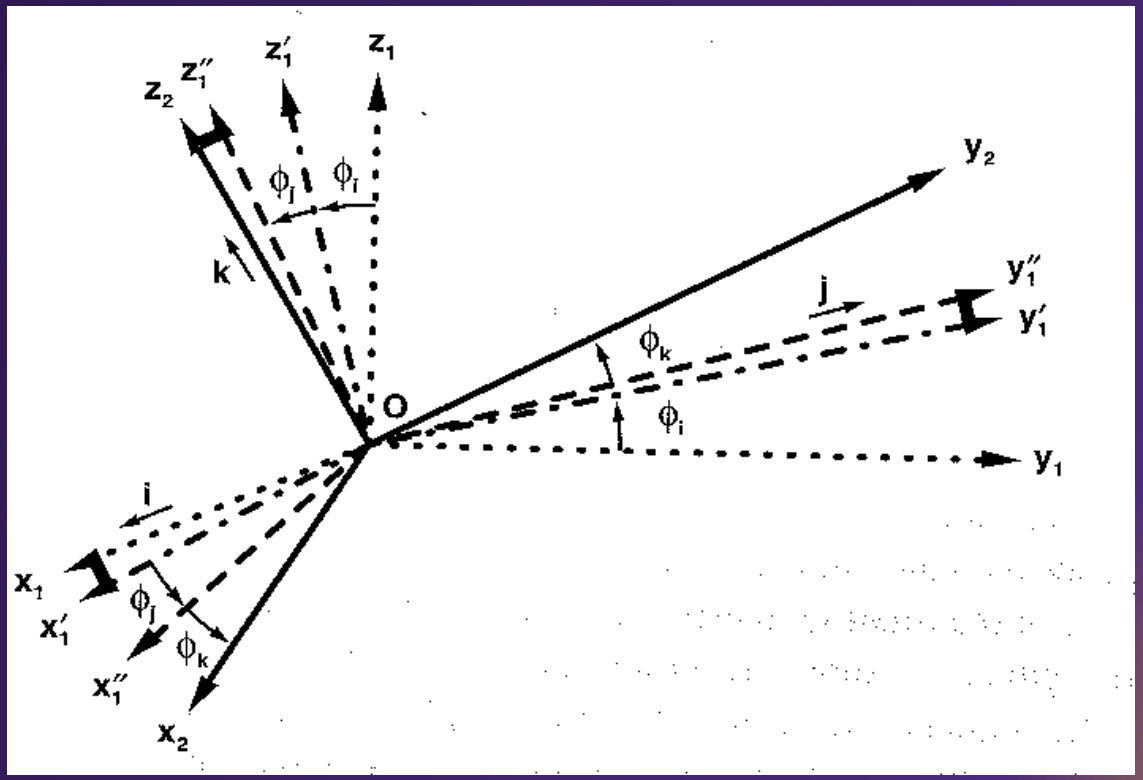
+Z axis: Lateral for right, Medial for left (sagittal plane)

+X axis: Anterior (coronal)

+Y axis: Superior (transverse)

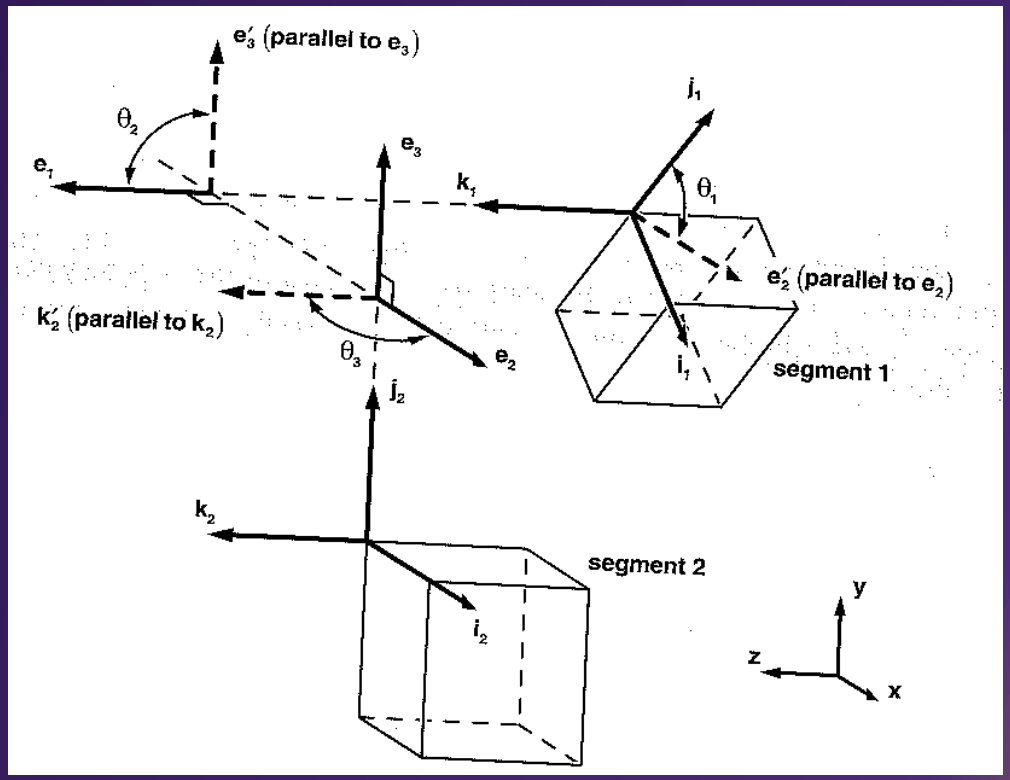
Descriptions of rigid body kinematics

- Cardan/Euler angles
  - 3 independent rotations, sequence dependent
  - Similar to fixed angles



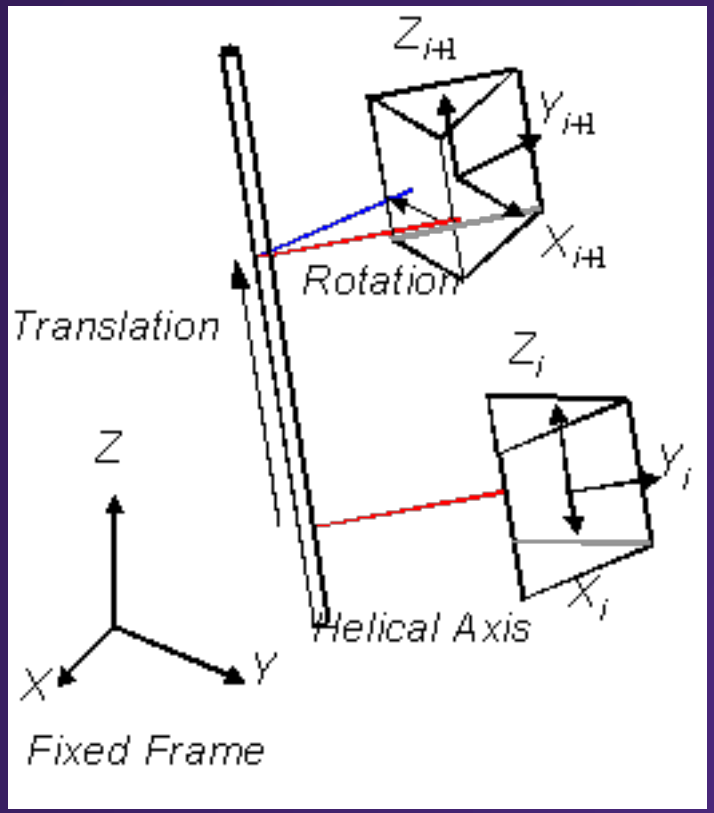
Descriptions of rigid body kinematics

- Joint Coordinate System
  - Axes: flexion/extension; longitudinal; third
  - Grood and Suntay at the knee



Descriptions of rigid body kinematics

- Finite helical axis:
  - axis orientation, translation, rotation



Descriptions of rigid body kinematics

- Helical angles (or axis-angle)