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Wissenschaftliches Werner Kaiser-Sommersymposium

AG Med Phys

Semi-automated Segmentation Pipeline for Analysis of Knee Joint Kinematics

A comparision with manual based segmentation

Jena | 12.09.2024 | Aayush Nepal

Motivation

- Knee osteoarthritis (OA) affects 10% men and 13% of women aged 60 and older (Zhang et al., 2010)
- Altered tibiofemoral kinematics in OA patients can potentially accelerate disease progression (Farrokhi et al., 2014)
- Even in ACL-deficient knees without instability symptoms, knee kinematics are altered (Yang et al., 2018)
- Understanding tibiofemoral kinematics is key to assessing knee joint function

Tibiofemoral kinematics

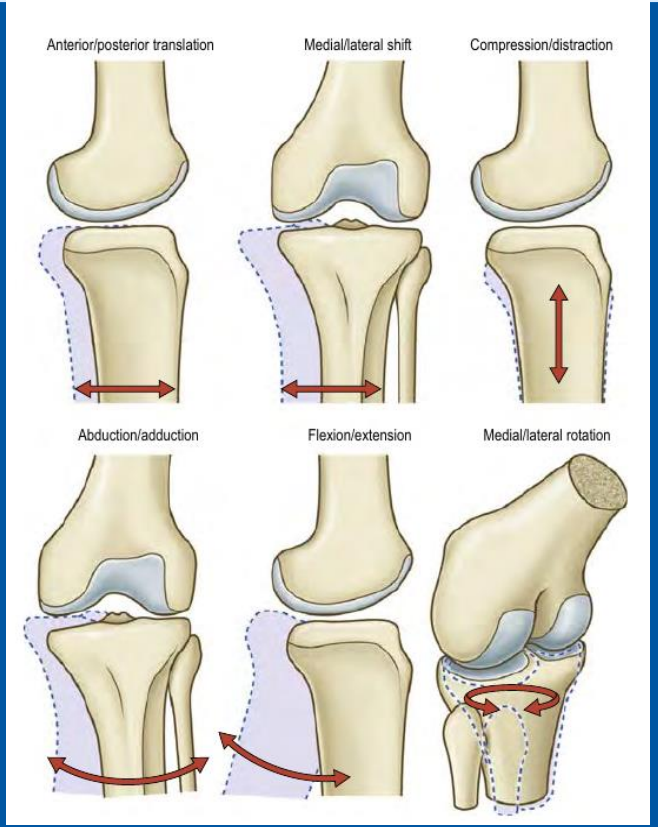
Six Degrees of freedom

<u>3 Rotations</u>

- Flexion-Extension: ~160°
- Medial-Lateral: 25-30°
- Abduction-Adduction: ~5°

<u>3 Translations</u>

- Anterior-Posterior: 5-10 mm
- Meidal-Lateral: 1-2 mm
- Compression-Distraction: 2-5 mm



(Credit: Gray's Anatomy 42nd ed.)

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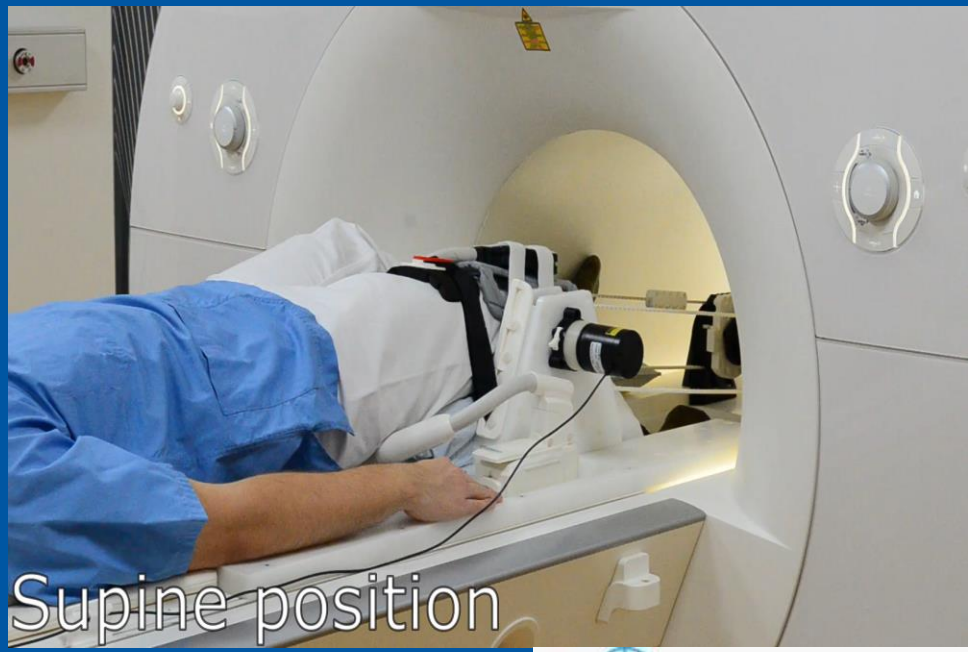
Knee flexion-extension device



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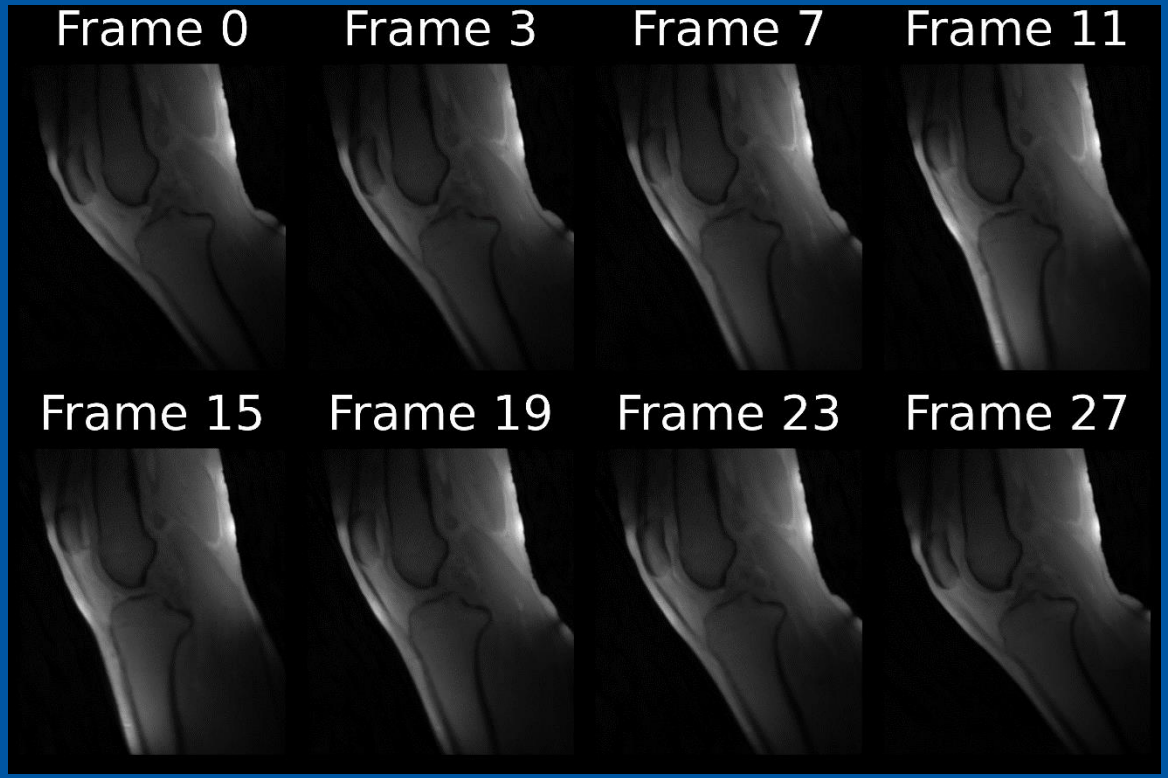
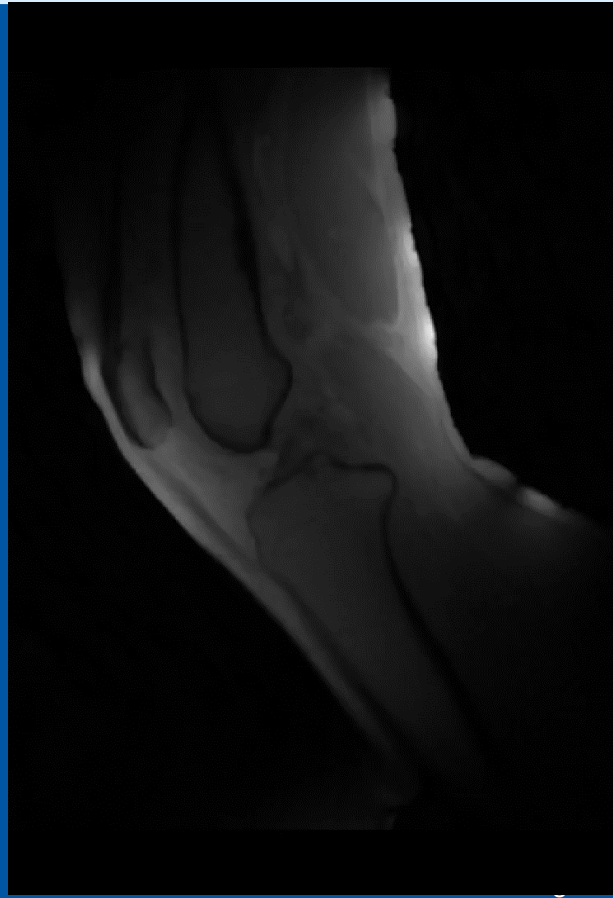
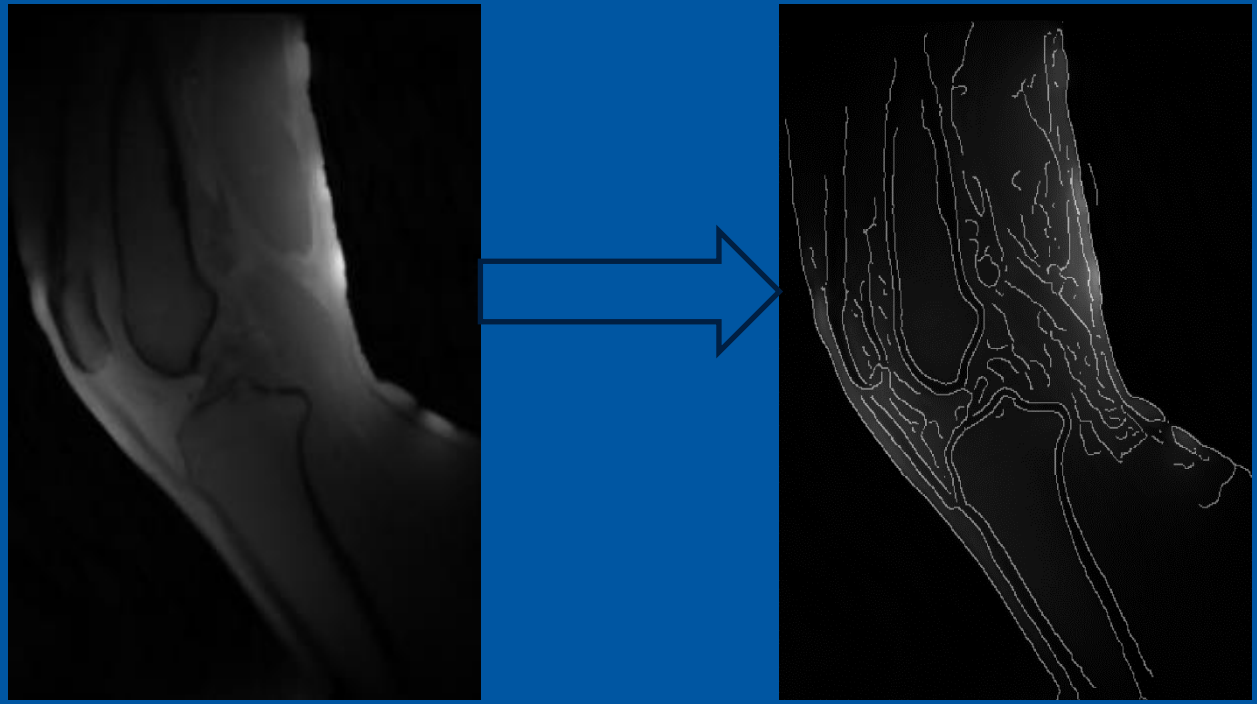
Reconstructed frames

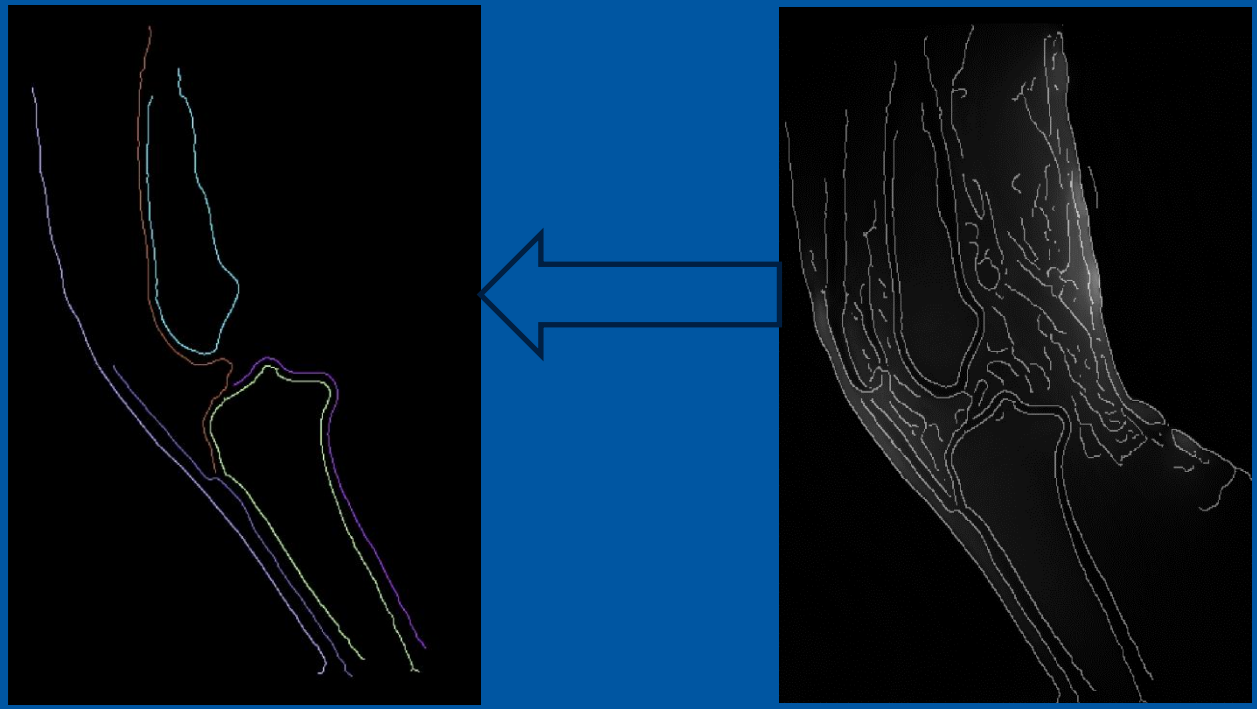




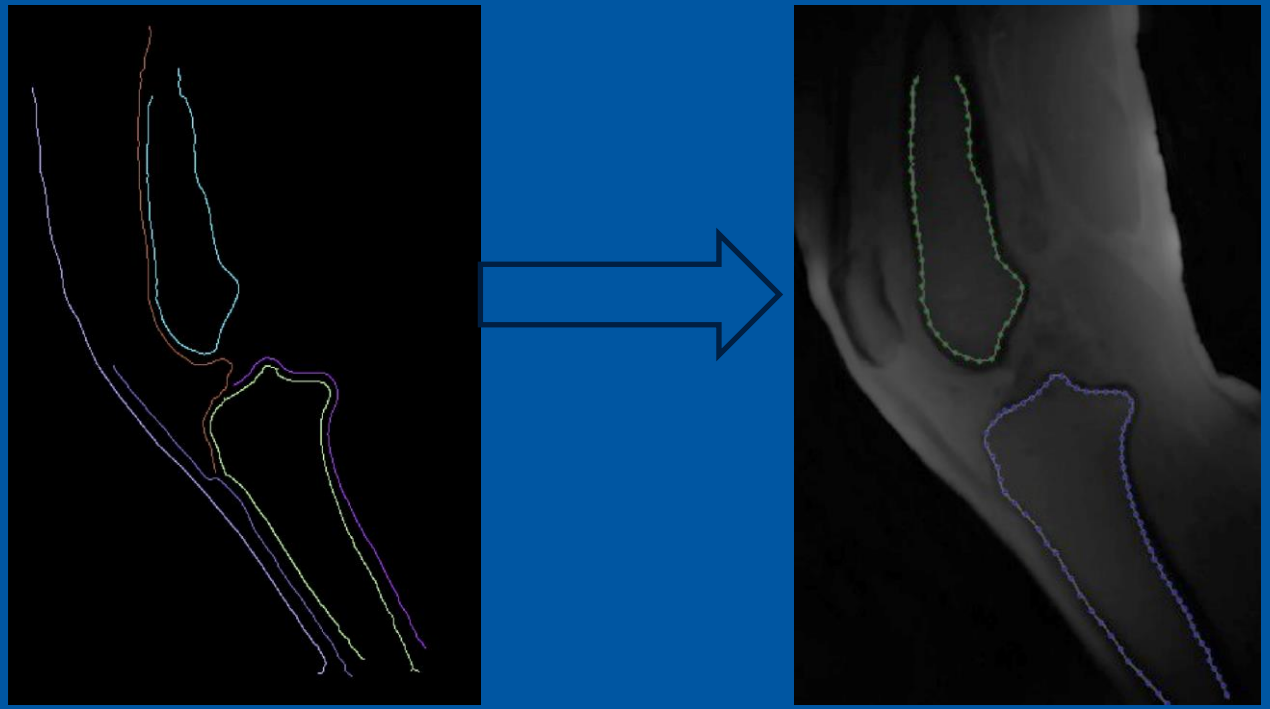
Methods: Edge Detection



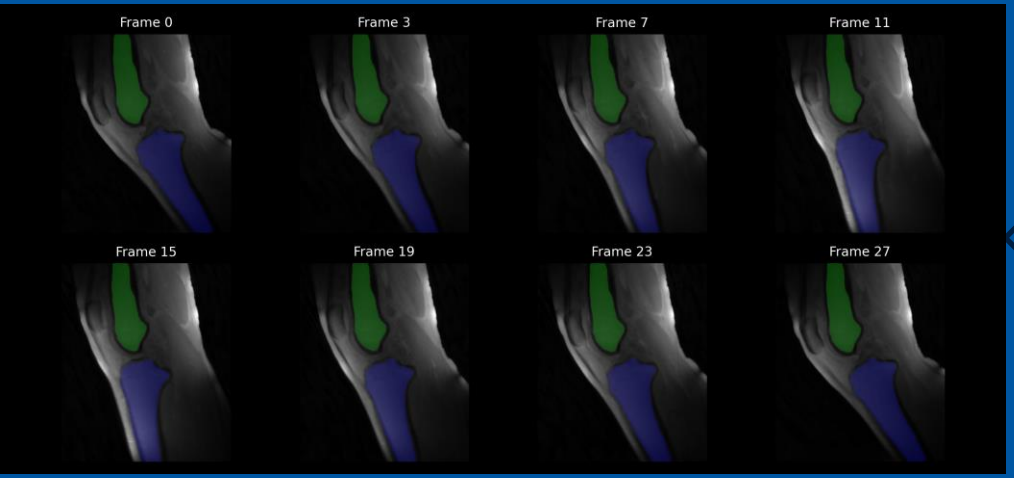
Methods: Connected Component Labelling



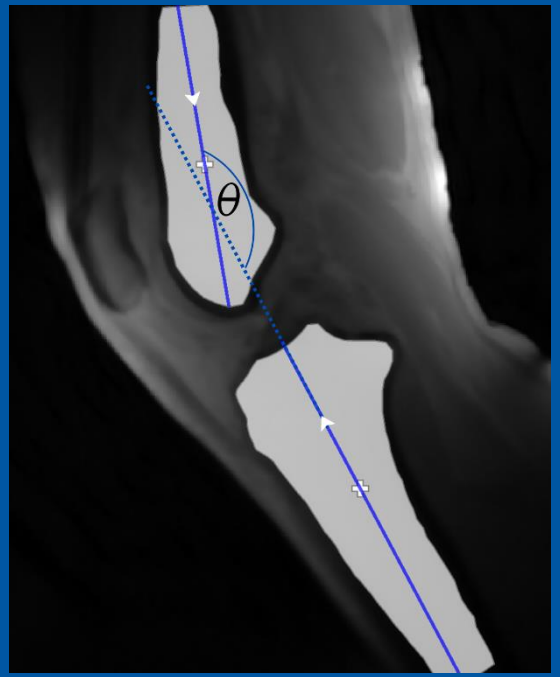
Methods: Downsample and sorting



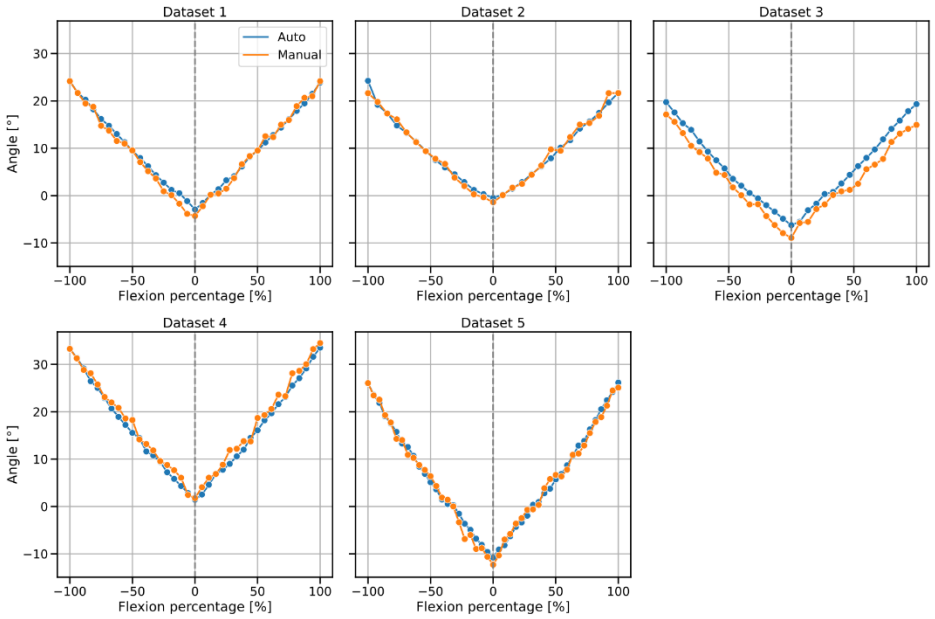
Methods: Applying transformation

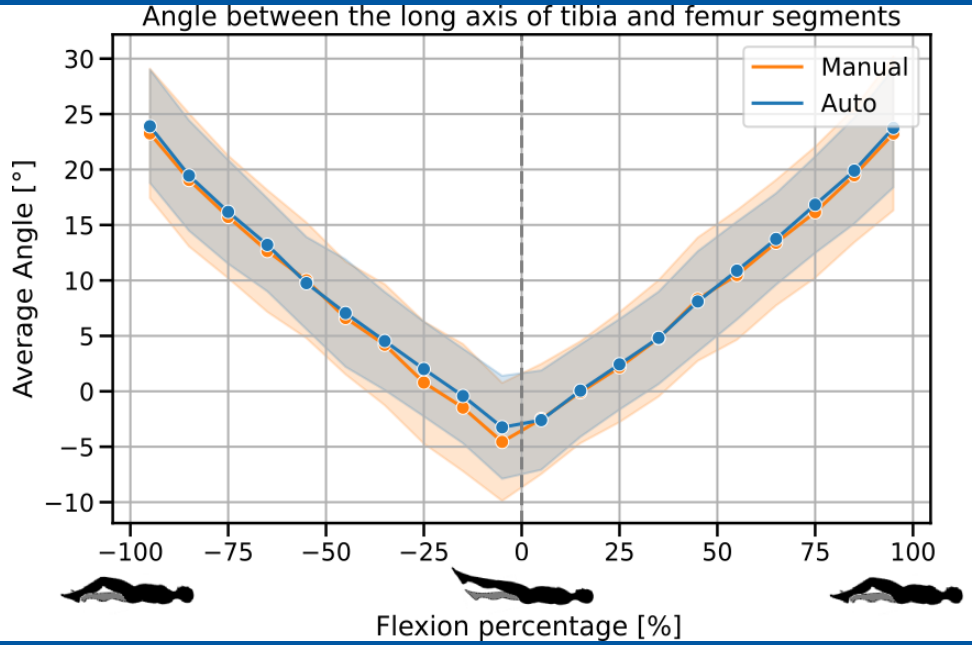


Parameter extraction and tracking

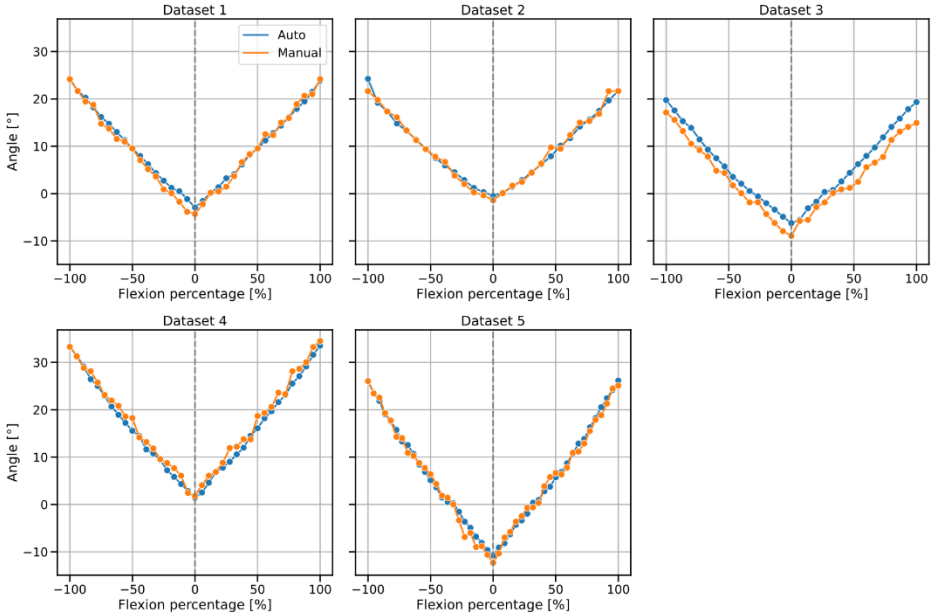


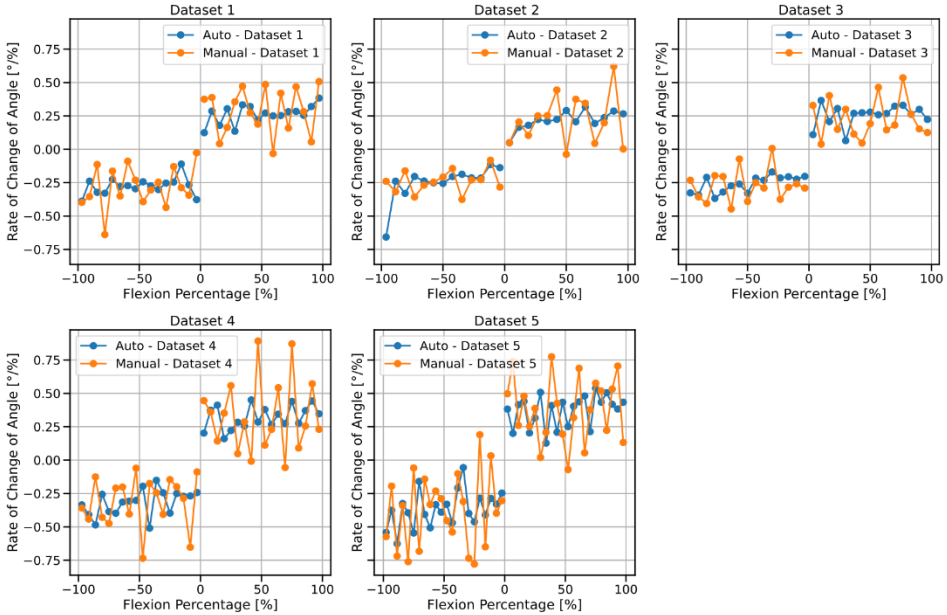
Results


Dataset 1
Dataset 2
Dataset 3
Dataset 4
Dataset 5
Auto
Manual
Angle [°]
Flexion percentage [%]


Angle between the long axis of tibia and femur segments
Manual
Auto
Average Angle [°]
Flexion percentage [%]

Results


Dataset 1
Dataset 2
Dataset 3
Dataset 4
Dataset 5
Auto
Manual
Angle [°]
Flexion percentage [%]


Dataset 1
Dataset 2
Dataset 3
Dataset 4
Dataset 5
Auto - Dataset 1
Manual - Dataset 1
Auto - Dataset 2
Manual - Dataset 2
Auto - Dataset 3
Manual - Dataset 3
Auto - Dataset 4
Manual - Dataset 4
Auto - Dataset 5
Manual - Dataset 5
Rate of Change of Angle [°/%]
Flexion Percentage [%]

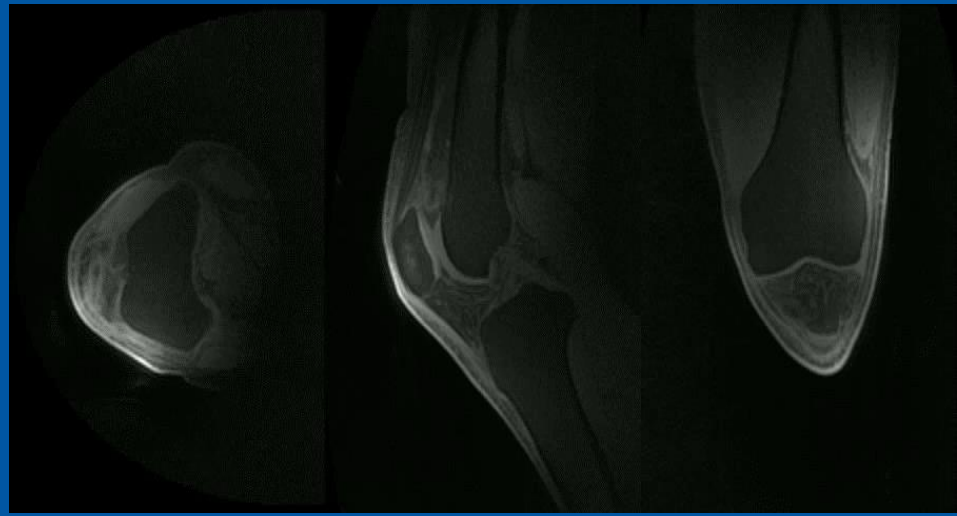
Outcome

Part of a larger longitudinal study

- 20 healthy volunteers (controls)
- 20 post-ACL reconstruction patients
- Baseline and follow-up measurements

Efficient extraction of kinematic parameters for cohort analysis

Potential for 3D application



Thank you for your attention!