

COMPARISON BETWEEN INVERSE AND DIRECT APROACHS TO CALCULATE LOWER LIMB KINEMATICS AND KINETICS

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INTRODUCTION

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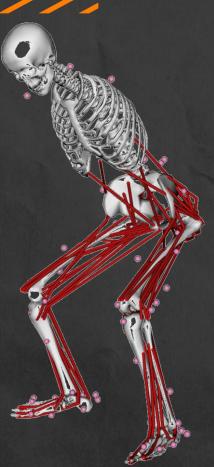


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Movements with high ROM, ensuring the dependability of the kinematic and kinetic data generated by simulation and motion capture software is crucial to ensuring the reliability and accuracy of the resulting output data.

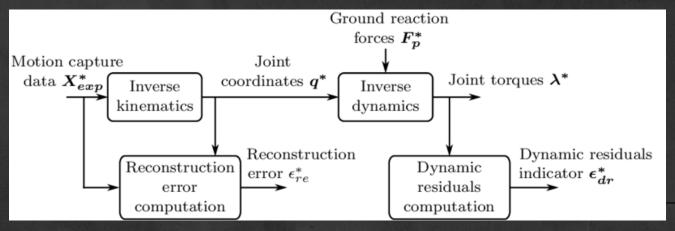




Direct kinematics: Joint kinematic parameters are calculated as Euler angles directly from 3D markers positions;

Inverse kinematics: Used in the most sophisticated musculoskeletal (MSK) models (e.g. OpenSim or Any-Body), also known as global optimization, to calculate joint

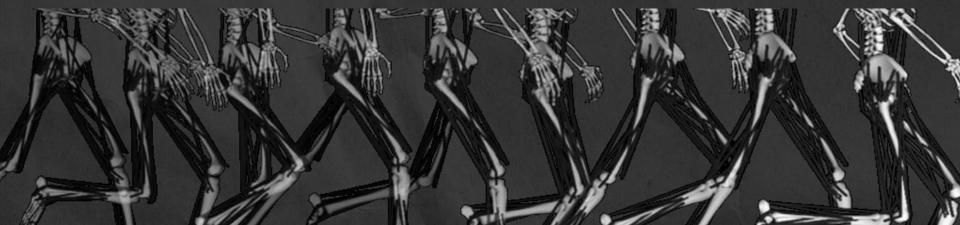
angles.





PURPOSE

To compare the inverse and direct approaches to quantify knee and hip angles and moments during a task with a high range of motion.

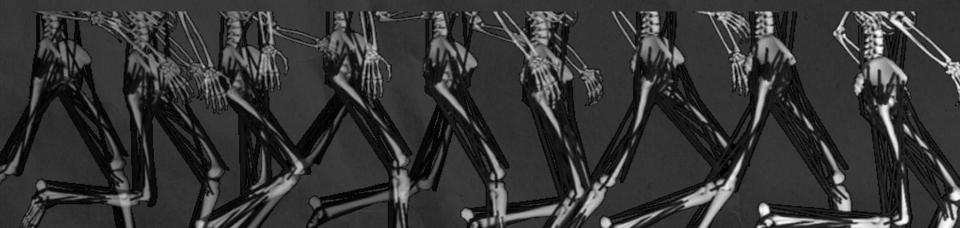




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METHODS

The local Human Research Ethics Committee granted ethical approval, and all participants signed a consent form before data collection (University of Ottawa)







Ten male without previous lower limb injuries





SUBJECTS

Ten male without previous lower limb injuries



TASK

Five deep squat trials at selfselected pace in a controlled position









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MOTION CAPTURE SYSTEM

45 full-body marker trajectories (200Hz) and two force plates (1000Hz)





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PROCESSING

Labelled and filtered (zero-lag, 6Hz fourth-order Butterworth) using Nexus 2.6.1 (Vicon)



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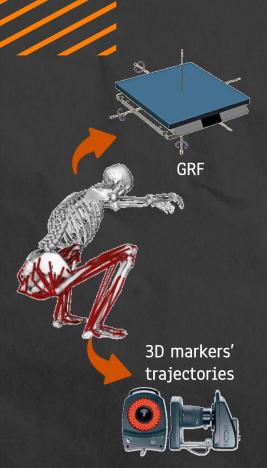


INVERSE APROACH

Inverse method was processed in OpenSim











3D trajectories

Detection of events and preprocessing of trajectories in Vicon Nexus Software

.mot / .trc files



GRF









Direct kinematics



Detection of events and preprocessing of trajectories in Vicon **Nexus Software**

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JOINT **MOMENTS**

3D markers' trajectories

GRF





Inverse kinematics



task

Computer Methods in Biomechanics and Biomedical Engineering

ISSN: 1025-5842 (Print) 1476-8259 (Online) Journal homepage: https://www.tandfonline.com/loi/gcmb20

A musculoskeletal model customized for squatting

Danilo S. Catelli, Mariska Wesseling, Ilse Jonkers & Mario Lamontagne

Taylor & Francis
Taylor & Francis Wrappings surfaces allowing higher hip and knee flexions



Maximum flexion:

Hip: 138°

Knee: 145°

Catelli et al. 2019







Inverse kinematics



task

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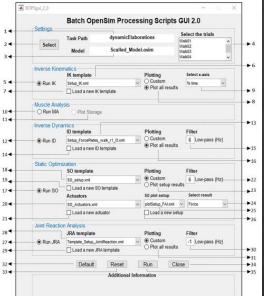
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BOPS: a Matlab toolbox to batch musculoskeletal data processing for OpenSim

Bruno L. S. Bedo , Alice Mantoan , Danilo S. Catelli , Willian Cruaud , Monica Reggiani & Mario Lamontagne







Inverse kinematics



Taylor & Franci





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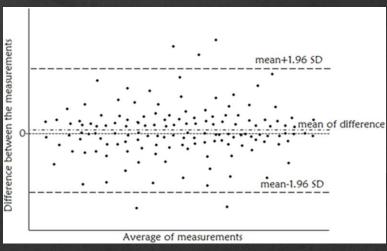
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The degree of agreement between the two methods was assessed with Bland and Altman.

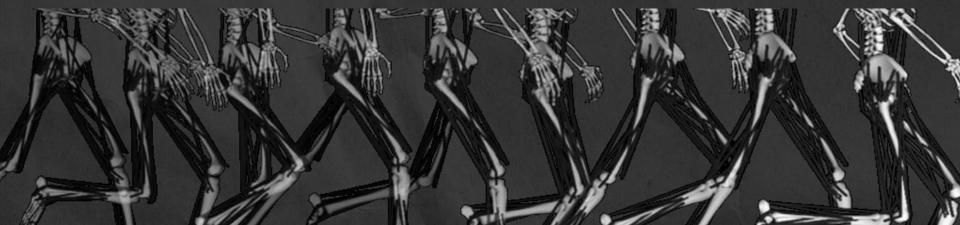
which is a statistical technique that plots means versus differences of measurements: if the means dispersion is within the 95% confidence limits, the measurements are in agreement





RESULTS

Bland-Altman plots applied to the peak joint angles or moments showed only partial agreement between the methods

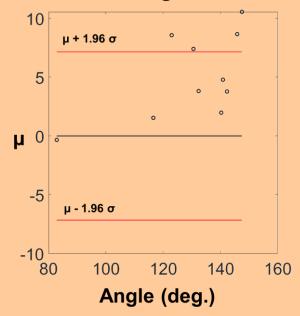


Tendency to measure higher knee flexion angles in Nexus than in OpenSim (133±21° and 128±18°, respectively)



RESULTS

Knee – Sagittal Plane

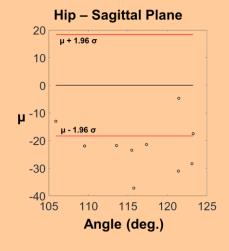


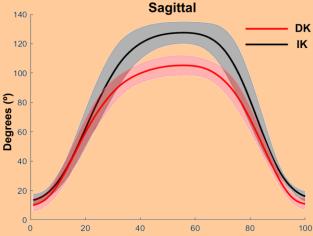
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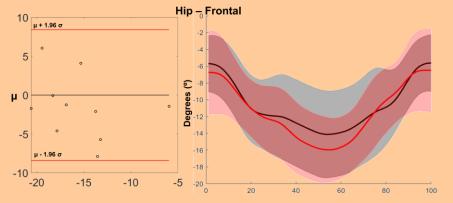


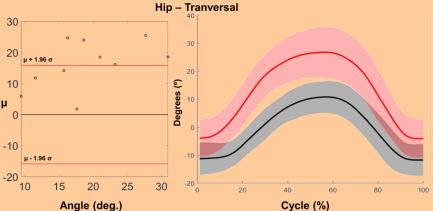
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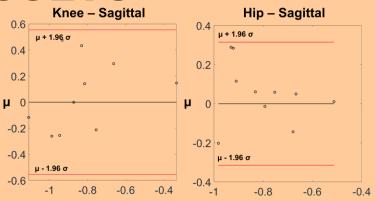
kinetics

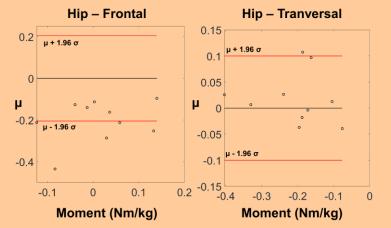
Kinetic peak analyses showed good agreement between the methods in the sagittal plane for the knee and hip

There is a tendency for higher hip abduction in the OpenSim method (Nexus: -0.09±.11, OpenSim: 0.12±0.08)



RESULTS







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CONCLUSION

Bland-Altman plots applied to the peak joint angles showed poor agreement regarding sagittal and transverse planes.

At the same time, the tests used for the typical peak moments showed good understanding, with its worst deal being on hip frontal moments.







THANKS!



Do you have any questions or ideas?

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