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SUBJECT SPECIFIC HUMAN MOTION DYNAMIC SIMULATION ON THE BASIS OF 3D BONES AND SOFT TISSUE MEASURED MORPHOLOGY

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ABSTRACT

Introduction.

Physically based prediction of joint and muscle force distribution using multibody mechanics and numerical methods of mixed dynamics [1,2] requests accurate adjustment of the model parameters defined in reproducible coordinate system(CS) using strict definition of anatomical landmarks (ALs) [3]. This paper focuses on development of customizable dynamical model of human passive motions, based on accurate 3D bones and soft tissue reconstruction, medical imaging data (CT, MRI) and stereophotogrammetry by digital cameras during subject dissection [4].

Methods and Results

Based on past protocols [5], customizable dynamical models were imported as bone surfaces and soft tissue attachment data of one subject's right leg in MSC ADAMS software. Some results of 3D bones and soft tissues morphology reconstruction are presented in figure 1. Currently the model includes (fig. 2) hip joint, femoro-tibial joint, femoro-patellar joint and ankle joint. Joints are simulated by full impact contacts and constrained by corresponding ligaments. Passive motion simulation were obtained by constraining the model with cylindrical and hinge joints connected to iliac and metatarsus respectively. Impact contact between calcaneus and floor was also implemented.

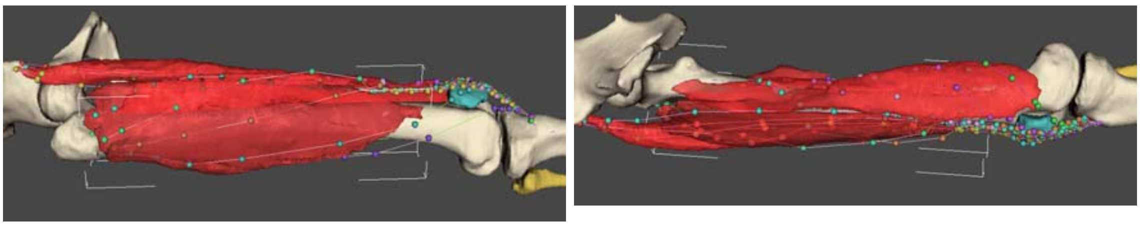

Figure 1. Anterior-lateral (left) and medial (right) view of right thigh bones and muscles reconstructed from CT, MRI and dissection. Fibre path indicated by colour pins.

Wrapping of the quadriceps tendon around the knee joint surface was simulated using several cylinders (fig. 3). Each ligament was simulated as several passive spring-dumper elements to stabilize joints during full range of kneeling motion.

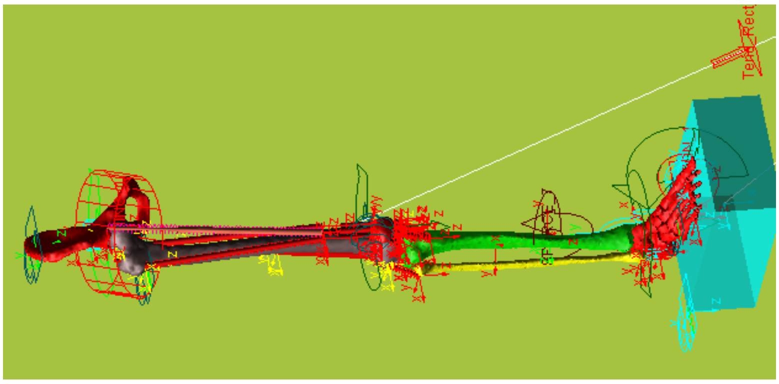

Figure 2. Customizable model of right leg for passive dynamics by ADAMS solver.

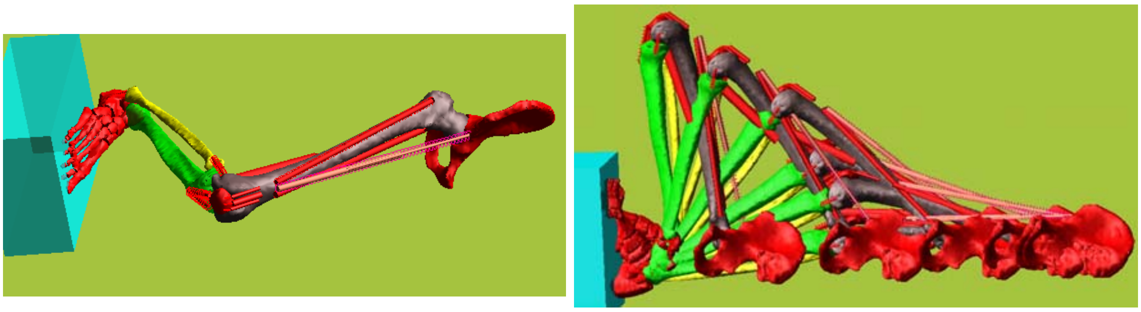

Figure 3. Wrapping of quadriceps tendon (left) and several frames of passive dynamics (right) for deep kneeling motion.

Import of subject-specific data measurement into ADAMS was done by macros. Before importing, all collected data were registered in one common coordinate system. Due to software limitation, resolution of the surfaces was decimated to speed up object contact implementation.

Conclusion

The presented approach allows evaluating of internal force distribution with anatomically correct joint kinematics due to accurate customization of morphological and parametrical values specific for a particular subject.

REFERENCES

[1] V. Sholukha, M. Guenther and R. Blickhan. "Running synthesis with a passive support leg". Biomechanics Seminar, vol. 12, (ISSN 1100-2247), Gothenburg, Sweden, pp. 63-72,(1999).

[2] A.V. Zinkovsky, V.A. Sholuha, A.A. Ivanov. Mathematical Modelling and Computer Simulation of Biomechanical Systems, WSP, Singapore, 1997. 216p.

[3] S. Van Sint Jan. Skeletal landmark definitions. Guidelines for reproducible manual and virtual palpations. Churchill Livingstone - Elsevier, ISBN 978-0443-10315-1, (189 pp), 2007.

[4] V. Sholukha, V. Aranov, F. Moiseev and S. Van Sint Jan. "3D RECONSTRUCTION OF SOFT TISSUE MORPHOLOGY BY DIGITAL CAMERAS", Journal of Biomechanics, Vol 40, Suppl 2, Page S417, (2007)

[5] S. Van Sint Jan, F. Taddei, A. Leardini, O. Snoeck, V. Sholukha. "MULTISCALE DATA COLLECTION METHOD FOR ADVANCED MODELING OF THE HUMAN MUSCULOSKELETAL SYSTEM", Journal of Biomechanics, Volume 40, Supplement 2, Page S562, (2007)

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