7th World Congress of Biomechanics
July 6-11, 2014
John B. Hynes Veterans Memorial Convention Center
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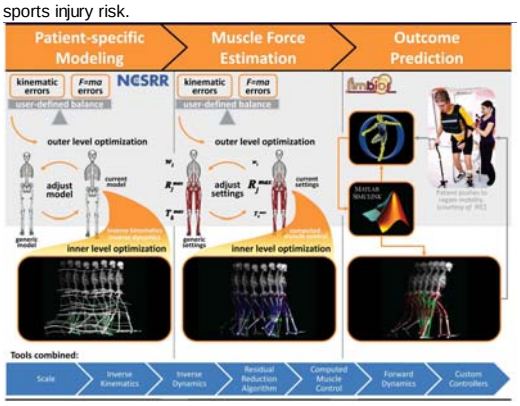
Control/Tracking Number: 14-IS-3530-WCB
Activity: Invited Speaker
Current Date/Time: 7/24/2014 4:33:10 PM

Patient-specific software tools for OpenSim

Author Block: J. A. Reinbolt;
University of Tennessee, Knoxville, TN.

Abstract:
How the brain selects appropriate muscle patterns to achieve a specific movement is an open question and computer simulations are a vital tool for providing answers. Simulations complement experiments by estimating immeasurable variables, probing muscle function, and helping uncover the principles that govern muscle coordination during normal and abnormal movements. Engineering and musculoskeletal software tools laid the foundation for simulations to predict patient outcomes; however, these tools need to advance significantly to realize the full potential of personalized, simulation-based medicine. A gap remains between experimental data and modeling software, since it is challenging and time-consuming to integrate experiments and computations to produce reasonable muscle-actuated, forward dynamic simulations that track recorded movements and other patient-specific data. Current methods cannot predict how treatments will change a subject's movement patterns. Combining control systems with musculoskeletal dynamics tools will help researchers and clinicians understand movement control, simulate treatments, and determine functional outcomes.
Next-generation patient-specific software tools have the potential to revolutionize medical decision making and treatment design by personalizing models to patients, creating intuitive tools for computing muscular control during movements, and developing strategies for goal-oriented functional movement prediction. To model specific patients, we developed tools to personalize a generic musculoskeletal model to match a patient's size and movement data. Our algorithm minimizes differences between the patient and model by adjusting the modeled body segment lengths, joint definitions, and mass properties. To estimate muscle forces, we developed intuitive computed muscle control through a nested optimization to easily produce a muscle-actuated simulation. Kinematic errors and model residuals are minimized by adjusting acceleration tracking weights and residual and reserve actuator maximums. To determine functional outcomes, we developed a platform integrating OpenSim with MATLAB/Simulink combining relevant strengths of each tool. An OpenSim description of a Simulink block allows rapid model-based design and numerical simulation of movement using open-loop or closed-loop control systems.
We use these tools with OpenSim to help answer clinically relevant questions from identifying relationships among posture, stability, and muscle control to designing movements for reducing sports injury risk.



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Presentation Type (Complete): Invited Podium Presentation (no more than 2 total per speaker)
Track (Complete): Special Topics in Biomechanics
Session Details (Complete):
Session Chair : Jennifer Hicks and Ajay Seth
Session Title : OpenSim Showcase: New Modeling Tools and Applications

Availability (Complete):
Status: Complete