

Kornbluh & Ziemba

SRI International



1. Tell us about you or your group:

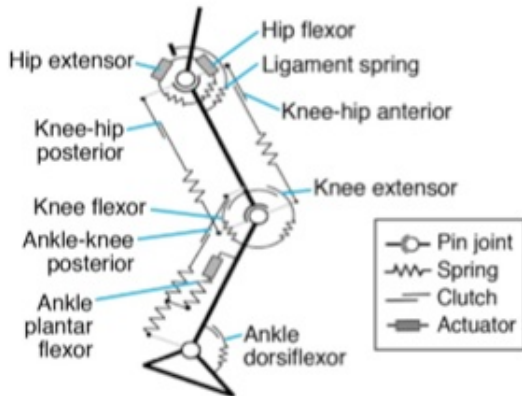
- Aaron Wayne, Robotics Laboratory, Menlo Park, CA
- Adam Ziemba, Poulter Laboratory, Menlo Park, CA
- Roy Kornbluh, Robotics Laboratory, Menlo Park, CA
- (Aaron will attend all sessions. Adam will attend Wednesday and Thursday and Roy will attend as possible)

2. Workshop Goals:

- Model our Exosuit system design
 - Begin with Exotendon (clutched spring) and Exomuscle (force producing element) control around the ankle and extend to include knee and hip as time permits
 - Include inertial effects of distal mass (point mass is OK initially)
 - Include dynamics of Exotendon and Exomuscle components
 - Include dynamics of skin attachment
- Model the sensing and control to allow for parametric studies
 - Begin with torque control around the ankle and extend to include knee joint and hip joint as time permits
- Learn best practices to perform optimization analysis using OpenSim
 - e.g. parametric study on metabolics of control gains and timing on overall metabolic cost
 - Understand the limits of predictive capabilities, particularly with regard to metabolics of load carrying and imposed constraints on human joints

Modeling the Warrior Web Design in OpenSim

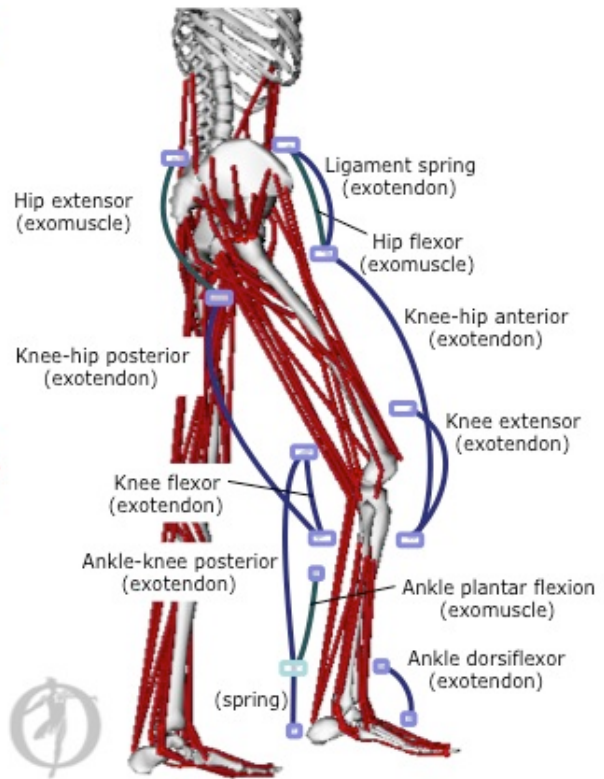
Based on:



Endo-Herr Under-Actuated Model

Clutched springs → exotendons

Actuators → exomuscles



OpenSim Model with Added Components

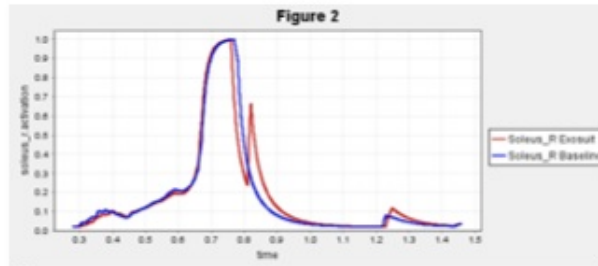
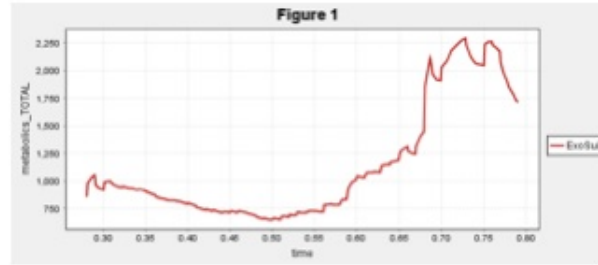
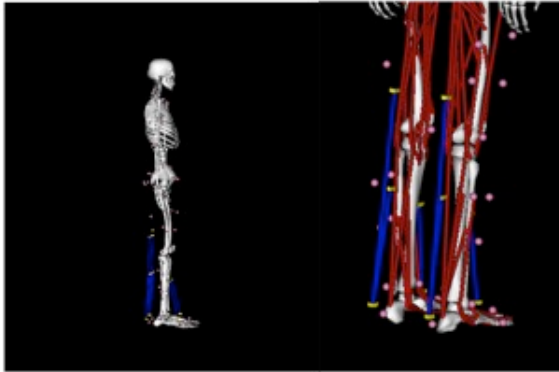
14 exotendons, 6 exomuscles, 2 linear springs, 12 body connection points, 1 free moving body

OpenSim Workshop, August 2013

The following slide shows preliminary data for the exosuit. This data uses our initial guesses to decide when to activate and deactivate each component.

The plan moving forward will be to iteratively optimize the timing of the six components. Once this is accomplished, more elements will be added to the knee and then the hip.

Loaded Walking Model & Kinematics



Baseline: XXX J / gait cycle

Warrior Web Devices Added: XXX J / gait cycle

- * Kinematics assumed unchanged from baseline
- Subject: 60 kg male, 30 kg vest & 8 kg backpack
- * Model assumes rigid body connections (for now)