

MAE MS or Meng Project Biomechanics – Fall 2016

Biomechanical Modeling in OpenSim of Exercise Activities using Advance Exercise Concept (AEC) Devices

Bone and muscle experience adverse changes during spaceflight and exercise countermeasures have become an essential part of the astronauts' daily life. Thus, the understanding of the effects of exercise activities onto the musculoskeletal system is critical in order to design and prescribe adequate exercise countermeasures, not only for the current ISS missions but also in future exploration missions. This research project, to be conducted in collaboration with the Digital Astronaut Program (DAP) Musculoskeletal group at NASA Glenn Research Center, intends to develop a new computational musculoskeletal framework to quantify joint loads and individual muscles forces during exercise activities using Advance Exercise Concept (AEC) devices. The musculoskeletal framework will be developed in OpenSim, an open-source biomechanics program developed by Stanford University. A large community of researchers, including NASA, is already using OpenSim and it is becoming a worldwide reference in the field. Current models being implemented within the DAP team are not capable of providing reliable individualized muscle forces developed during the exercises. Using different but complementary OpenSim capabilities, we intend to quantify more accurate joint loading and individual muscle activation profiles from previously gathered experimental data, including motion-capture data, ground reaction force data, device-loading data, and EMG data. This musculoskeletal framework will better inform current and future exercise countermeasure developments and in-flight exercise prescriptions.



Figure 1 – – Subject performing a single leg squat on the *Hybrid Ultimate Lifting Kit (HULK)* device (left), and musculoskeletal model during the same exercise (right). The green arrows represent the external forces applied to the model: ground reaction forces (GRF) and bar loads from HULK

Desired qualifications

- Previous OpenSim experience is desirable but not required. OpenSim is open-source software and it can be downloaded from here: <http://opensim.stanford.edu/support/index.html>. The selected student is encouraged to familiarize him/herself with it and go over the tutorials online.
- Ability to work autonomously and in a team.
- Applicants should have good leadership, organizational and communication skills, as well as a proactive attitude towards solving problems.

Application Instructions

- E-mail Dr. Diaz Artilles (ad877@cornell.edu) with the following material:
 - o Updated CV
 - o Unofficial transcript
 - o Short paragraph indicating your motivation
 - o Level of effort (number of credits desired)