Evaluation of spine loading across common positions using OpenSim

**Description:**

This project will use OpenSim to model and compare how different static postures affect the loading of the spine, and more specifically the lumbar area. These postures will be centered around those encountered in daily activities, physical therapy, and stretching. This project is primarily motivated by a group member’s vertebral fracture of the L3 and L5 vertebrae one year ago. This event inspired an interest in evaluating which positions exert the least stress on the lumbar region of the spine to reduce pain. Using an OpenSim full body model with a detailed spine, we will simulate postures such as upright standing, laying flat on the floor, forward flexion, and potentially others. These simulations will help quantify both joint reaction forces and muscle activation patters in the lower back.

**Research Papers:**

[1] E. Beaucage-Gauvreau *et al.*, “Validation of an OpenSim full-body model with detailed lumbar spine for estimating lower lumbar spine loads during symmetric and asymmetric lifting tasks,” *Computer Methods in Biomechanics and Biomedical Engineering*, vol. 22, no. 5, pp. 451–464, Feb. 2019, doi: https://doi.org/10.1080/10255842.2018.1564819.

[2] E. Beaucage-Gauvreau *et al.*, “Validation of an OpenSim full-body model with detailed lumbar spine for estimating lower lumbar spine loads during symmetric and asymmetric lifting tasks,” *Computer Methods in Biomechanics and Biomedical Engineering*, vol. 22, no. 5, pp. 451–464, Feb. 2019, doi: https://doi.org/10.1080/10255842.2018.1564819.

‌[3] I. Y. Cho, S. Y. Park, J. H. Park, T. K. Kim, T. W. Jung, and H. M. Lee, “The Effect of Standing and Different Sitting Positions on Lumbar Lordosis: Radiographic Study of 30 Healthy Volunteers,” *Asian Spine Journal*, vol. 9, no. 5, p. 762, 2015, doi: <https://doi.org/10.4184/asj.2015.9.5.762>.

**Resources:**

**OpenSim documentation and tutorials:** The official opensim user guide, and some moco tutorials will provide tools for implementing specific static postures, as well as other things.

**Spine-Specific Musculoskeletal Models from SimTK**: We will utilize full-body OpenSim models that include detailed representations of the spine. The models are available on SimTK.org and have been validated in previous studies.

**Python:** Can be used for any posture scripting, post-processing of output, or potential visualization of spine loading across postures.

**Course materials:** Kinematics, Dynamics and optimization.