Characterization and Modeling of Ankle Impedance During the Stance Phase of Walking

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Research question

- What factors influence the stiffness of the human ankle during the stance phase of walking?
- Can these factors be used to predict said stiffness?

Background

- What is impedance?
- Factors affecting stiffness during quiet standing
- Previous studies showing how impedance changed during the stance phase of walking

Methods

- Robotic platform that can measure forces and cause perturbations of the human ankle
- Fit data from procedure to impedance model over a 100ms window
- 10 trials with 20 perturbations each Perturbations at four different points in the stance phase. One “no-perturbation” case.
- Collect EMG, CoP, and weight data

$$\tau = J \cdot \delta\ddot{\theta} + b \cdot \delta\dot{\theta} + k \cdot \delta\theta$$

Eq. 1: Differential Torque-Angle Relationship

Preliminary Results

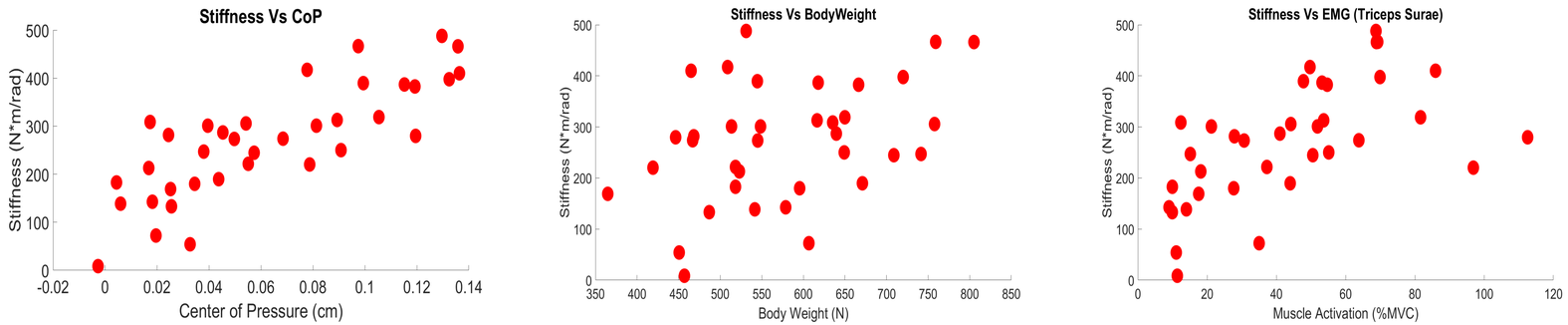

Figure 2: (Left to Right): Stiffness vs CoP, Weight, and EMG during stance phase

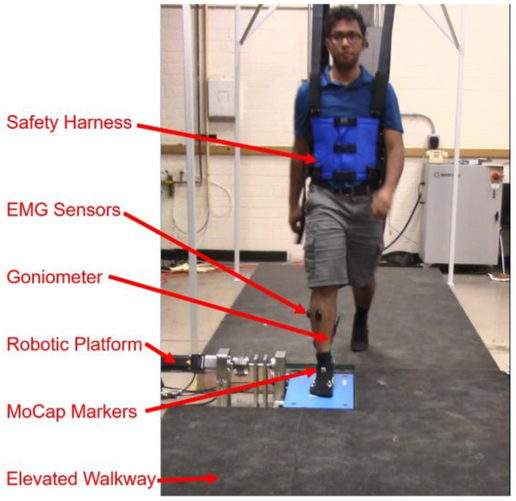

Figure 1: Subject walking across robotic platform

$$K = \alpha \cdot CoP + \beta \cdot EMG + \gamma \cdot BW$$

Eq. 2: Stiffness Relationship to Biomechanical Factors

Future Work

- Collect more data from subjects
- Create regression models to attempt prediction of stiffness value during the stance phase of walking
- Compare against stiffness and relationship to factors for quiet standing

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