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

\[ \tau = J \cdot \ddot{\theta} + b \cdot \dot{\theta} + k \cdot \theta \]
Eq. 1: Differential Torque-Angle Relationship

Preliminary Results

Figure 1: Subject walking across robotic platform

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

Future Work
• Collect more data from subjects
• Ensure data collected is consistent with previous work
• Statistical analysis comparing biomechanical walking to changes in stiffness
• 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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