Robotics and Autonomous Systems Thesis Defense

Investigations into Human Ankle Impedance

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Abstract

Mechanical impedance is a concept that is used in many robotics applications and can be applied to modeling biomechanical properties of human joints. The latter can then be utilized to provide insight into the inner workings of the human neuromuscular system or be used to provide insight into how to best design controllers for robotic applications that either attempt to mimic capabilities of the human neuromuscular system or physically interact with it. In order to further elucidate patterns and properties of how the human neuromuscular system modulates mechanical impedance at the human ankle joint, multiple studies were conducted. The first study was to assess the ability of linear regression models to predict the stiffness - a component of mechanical impedance - of the human ankle during the stance phase of walking using a collection of independent biomechanical variables. The R-squared value of the best performing model was 0.7. The second study was conducted to simultaneously characterize and compare the bilateral mechanical impedance of the human ankle joint for healthy able-bodied subjects during the stance phase of walking and quiet standing in both the Dorsi-Plantar flexion (DP) and Inversion-Eversion (IE) planes. Subjects showed a high level of subject specific symmetry, however, the non-dominant limb showed a tendency for the stiffness magnitude to be slightly less than the dominant. Lastly, a similar bilateral ankle characterization study was conducted on a set of subjects with multiple-sclerosis, but with the IE plane excluded. Results showed a high level of discrepancy between the subject's dominant and non-dominant limb.

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Zoom Link: https://asu.zoom.us/j/89993709271