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Estimation of Joint Torque and Impedance by Means of Surface EMG

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Abstract

The central nervous system dynamically controls individual muscle tensions to affect movement and to interact with the environment. While it is not currently possible to non-invasively monitor these individual muscles tensions, their net effect is to modulate both torque and mechanical impedance about joints. Historically, surface EMG has been used to estimate joint torque. But, joint impedance is equally as important to understand, particularly in regard to how the musculoskeletal system interacts with the physical environment about it. Thus, we have begun an effort to use surface EMG to simultaneously estimate joint torque and impedance about the elbow. We begin by simultaneously monitoring multiple-channel EMG from the elbow flexors and extensors. From these "raw" EMG signals, optimized flexion and extension EMG amplitude estimates are formed. Then, system identification techniques are used to optimally estimate torque, and separately impedance, from the EMG amplitude estimates. Currently, we can optimally estimate elbow joint torque during force-varying, constant-posture contractions; and we are pursuing estimation of elbow joint impedance during quasi-static, constant-posture contractions. This presentation will review our optimal EMG amplitude estimation techniques as well as our on-going EMG-torque and EMG-impedance modeling techniques. These methods provide tools for examining and understanding the motor control properties of the human body.

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