A Novel EMG-Driven Approach to Assist as Needed Control of a Powered Knee Orthosis

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Increased patient involvement in rehabilitation therapy is fundamental in improving both the level and rate of a patient's recovery. This observation has fueled the recent trend in developing 'assist as needed' control algorithms for rehabilitation robotics. Currently, most approaches employ ad-hoc methods for parameter adaptation or feed forward compensation of standard position or impedance controllers. While effective, these techniques still rely on defining a desired trajectory for the robot and patient. Consequently, these approaches are not flexible enough to address the intrinsic variability and complexity in completing common tasks like negotiating variable terrain. Additionally, the types of therapies facilitated using trajectory based approaches cannot faithfully represent the daily living tasks for which functional recovery is desired. In this paper, we address these problems by developing a novel, trajectory-independent approach to 'assist as needed' control. This approach uses surface electromyography (sEMG) signals from the flexor and extensor muscles of a joint. These signals are provided as input to an adaptive algorithm used to approximate the desired control law in real-time. This approach avoids the need to model complex muscle and body dynamics and is capable of handling both inter- and intra-patient variability in sEMG signals. The algorithm is implemented on a simulation of knee motions supplemented with a powered orthosis. Results indicate that this approach ensures patient involvement and enhances device/therapy flexibility. The orthosis extends functional capacity and assists the patient when necessary without imposing constraints on the allowable motions.