Muscle Activity and Energetic Adaptation to Step Frequency

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Exoskeletons are wearable devices that assist the user with a task. Optimal control for exoskeletons is unknown. Human-in-the-Loop Optimization (HiLO), an automated process that uses biological signals to tune controllers. The most used biological signal used for HiLO is steady-state metabolic cost, the average value when variation is minimal. Steady-state metabolic cost can be estimated in 2 minutes. It is believed that muscular activation could reduce this time. Muscle activity is said to reach steady-state instantaneously. To quantify steady-state muscle activity value and timing, I used Electromyography (EMG) electrodes. I hypothesized that steady-state EMG will occur earlier than metabolic cost and is minimized at the same step frequency. If walking speed remains constant, a person's preferred step frequency minimizes metabolic cost. By varying step frequency, I could compare when metabolic cost and EMG reach steady-state and if EMG is minimized at the preferred step frequency. The subject walked on a treadmill at a set speed of 1.3 m/s, while metabolic cost and EMG was recorded. The preferred step frequency of the participant was tested along with 0, +/- 10, +/- 20, +/- 30% from their preferred. I found that EMG and metabolic cost reach minimal steady-state at relatively the same step frequency. EMG reached steady-state in 30-50 seconds. This is faster than metabolic cost, according to current literature. Both hypotheses were supported. It is concluded that EMG could be a suitable replacement for metabolic cost for HiLO and more importantly, assist with future optimization of parameters for controls of exoskeletons.

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