Muscle Activity and Energetic Adaptation to Step Frequency

Nevarez-Sanchez, Wendy (School: South Atlanta High School)

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. We believe muscular activation could reduce this time. Muscle Activity is said to reach steady-state instantaneously. To quantify steady-state muscle activity value and timing, we used Electromyography (EMG) electrodes. We hypothesized steady-state EMG occurs 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, we 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 1.25 m/s, while metabolic cost and EMG were recorded. The preferred step frequency of the participant was tested along with 7 step frequencies between 45-75 steps/min. We found that EMG and metabolic cost reach minimal steady-state at relatively the same step frequency of 62 steps/min. EMG reaches steady-state in 30-50 seconds. This is faster than metabolic cost, according to current literature. Both of our hypotheses were supported. We conclude EMG could be a suitable replacement for metabolic cost for HiLO and more importantly, assist with future optimization of parameters for controls of exoskeletons.

Awards Won: