



Using Ultrasound to Detect Muscle Fatigue

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Functional electrical stimulation (FES) is often used for rehabilitation in movement disorders and in assistive devices such as exoskeletons. However, FES can rapidly cause muscle fatigue, which limits the induced force production. At present there exists no reliable, real time indicator for FES-induced muscle fatigue. We believe that functional muscle physiology associated with muscle fatigue can be inferred from ultrasound imaging. In this study, we utilized tissue Doppler imaging (TDI) to quantify FES-induced twitch responses in the gastrocnemius muscle, at baseline and after inducing fatigue through repeated voluntary isometric contractions. We estimated muscle velocities using M-mode TDI to quantify differences in the twitch response before and after fatigue. Preliminary results indicate that fatigue induces a higher muscle acceleration during twitch, and the muscle contracts for a longer duration. These results could potentially be used as a real-time indicator for muscle fatigue. We are investigating the use of such a system integrated into an external hybrid walking exoskeleton that can switch from FES-induced force generation to external motors for force generation once the muscle fatigues. Further, it may be possible to replace TDI imaging with a wearable single-element continuous wave Doppler instrument for these measurements, reducing computational complexity and power requirements.



The relationship between embodiment and functional performance with assistive devices: a discussion of upper limb prostheses

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In order to understand patient performance with assistive devices, researchers often use biomechanical methods to quantify whether the device helps restore natural movement patterns. There is growing recognition of the need to include additional methods that characterize the user's interaction with the device from a psychological standpoint. In particular, quantifying embodiment (perception of the device as part of the body) in conjunction with biomechanics may lead to a valuable understanding of what factors promote functional success with assistive devices. In this presentation, I will discuss my research on understanding how the design of an upper limb prosthesis can affect both the user's experience of embodiment and their functional outcomes.

**Friday, October 25th @ 1:00 p.m.
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