Interface design and neurophysiological intervention for fatigue reduction during adaptive human-robot interaction

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This PhD project will use a combination of neurophysiology techniques to assess and reduce muscle fatigue. Muscle fatigue can be defined as a reduction in the force or power generated during the performance of a physical task. Fatigue typically develops gradually during a task, is temporary in duration and leads to a feeling of tiredness due to the lack of strength. We have previously used two measurement techniques, a non-invasive measurement of brain activity called electroencephalography (EEG) and muscle activity measurement called electromyography (EMG), to assess core and peripheral fatigue. Our results have revealed for example, the muscles involved in different forms of fatigue.

Furthermore, previous studies have shown that transcranial direct current stimulation (tDCs) has been used and shown to reduce fatigue in both patients (for example with multiple sclerosis) and able-bodied individuals, during tasks requiring high cognitive workload. We propose that robot load balancing can be used to elicit a similar reduction in fatigue and match the effect of tDCS. In addition, we would also plan to investigate whether a combined approach of robotic assistant with tDCS is better than each intervention alone.

The PhD project will test the following questions:

1. Can better interface design help to reduce cognitive workload? In particular, incorporating feedback from qEEG (quantitative EEG) to adapt display complexity. What effect does tDCS have in this situation?
2. Can better robot human interaction help to reduce physical fatigue? Can the addition of tDCS reduce this further?
3. Would using tDCS alongside both adaptive display and robotic assistance reduce core and peripheral fatigue further?

At the end of the PhD, we will have a contrast between the three questions and a combined effect assessment showing if there is a clinical case for combining tDCS with adaptive human-robotic interaction and adaptive vision. Each hypothesis can be assessed in one year, with the first and second benefitting from the previous work from the lab.

Requirements: Applicants should have a very strong first degree or (preferably) a Master’s degree in Cybernetics, Computer Science, Biomechanics or other relevant area, and are expected to have strong interdisciplinary interests (e.g. in robotics, rehabilitation, neuroscience). They are also expected to have very good programming skills and interest in robotics.