BCL5

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Decoding Movement Intentions and Error-Related Potentials from Neural Signals for developing Closed-loop Neuroprostheses

Abstract: Following a neurological injury, robotic devices such as powered exoskeletons and functional electrical stimulation (FES) can help paralyzed individuals regain upper-limb movement. However, patients with moderate to severe paralysis often have minimal or no volitional control of their limbs and hence, are unable to operate existing devices during therapy. To overcome this limitation, in this talk we will present decoding of various neural and non-neural signals related to movement, which can be employed to operate an upper limb neuroprosthesis.

Conventional neuroprosthesis such as FES operate in open-loop, by delivering a fixed or pre-defined output that needs to be calibrated for each user. Even after calibrating, static grasping leads to poor regulation of grip force and joint position due to muscle non-linearity and fatigue. To overcome these challenges, traditional closed-loop algorithms have been proposed that modulate the grip force in response to errors produced during generation of movement. However, all the existing strategies rely on the availability of contact or non-contact based sensors which increases the device setup time and cost. Neurophysiological studies involving electroencephalography (EEG) have already identified a neural signature for error awareness, which occurs when there is mismatch between a participant's expected and observed outcomes. Here, we will also present preliminary evidence on how humans perceive error while operating a neuroprosthesis and how the error-related potentials can be decoded from EEG signals.