decode capabilities improved over time. Motor-decode performance was also increased with a novel training paradigm involving extended hold-times at the end point of each DOF. The relative performance of the two motor-decode algorithms varied according to the performance metric: the CNN had fewer unintended movements ($p < 0.05$), whereas the mKF provided significantly better control over intended movements ($p < 0.05$). Altogether, this work highlights progress in motor-decode algorithms and provides novel insights from a unique case-study. Future investigations using selective USEA stimulation to generate well-controlled afferent activity may help elucidate the underlying mechanisms of CRPS. Ultimately, the ability to restore non-painful sensorimotor function demonstrates that neuromyoelectric prostheses can also benefit CRPS individuals after hand amputation.

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Poster

312. Brain-Machine Interface: Reaching Movements

Location: SDCC Halls B-H

Time: Monday, November 5, 2018, 8:00 AM - 12:00 PM

Program #/Poster #: 312.02/PP6

Topic: E.05. Brain-Machine Interface

Support: NSF Grant DGE 1106400
SRC STARnet
SRC JUMP

Title: A robust emg-based hand gesture classifier controlling a 3d-printed bionic arm actuator

Authors: ***A. MOIN**[1], A. ZHOU[1], A. RAHIMI[2], S. BENATTI[3], A. MENON[1], S. TAMAKLOE[1], J. TING[1], N. YAMAMOTO[1], Y. KHAN[1], F. BURGHARDT[1], L. BENINI[2,3], A. C. ARIAS[1], A. ARAUJO[4], J. M. RABAEY[1]
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Abstract: Modern actuated prostheses for upper-limb loss patients provide many degrees of freedom (DOF) and mimic natural limbs well, but robust, multi-DOF control of such devices has not yet been achieved. Electromyography (EMG) signals based on patients' intact muscle activity may be used as control signals, but most available algorithms employ very simple encoding and mapping of EMG features to actuation of few DOFs. Modern machine learning methods can be used to classify gestures and movements from EMG features, but their accuracy is degraded by variance in signal properties due to changing electrode placement, arm position, and other contextual variations.

We present an end-to-end system for classifying finger/wrist movements and gestures using EMG recordings from a flexible, printed, high-density electrode array. Raw signals are digitized right at the electrode array and wirelessly transmitted to a base-station. They are then encoded and classified using a brain-inspired hyper-dimensional computing algorithm operating on 10,000-element random vectors. Because of the high-dimensionality of the vectors, classification performance is very robust to noise and context changes. Hyper-dimensional computing also offers fast, incremental learning, allowing for a minimal initial training dataset and quick model updates for learning new contexts. We achieve ~95% accuracy in classifying 25 common finger/wrist movements and gestures, with little accuracy degradation between different arm positions and wear sessions.
The classified gestures are wirelessly sent as a set of commands to be actuated on a 3D-printed prosthetic arm. The arm is based on HACKberry open-source bionic hand design with some modifications in order to accommodate more DOFs. Two servomotors for wrist (elevation and azimuth), one for thumb, one for index, and one for the rest of the fingers are used to mimic flexion, extension, and combination movements on the prosthesis.

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Poster

312. Brain-Machine Interface: Reaching Movements

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Title: Development of a portable take-home system for control of advanced prostheses

Authors: *M. BRINTON[1], E. L. BARCIKOWSKI[5], T. S. DAVIS[2], M. D. PASKETT[1], J. G. NIEVEEN[3], D. T. KLUGER[1], J. A. GEORGE[1], C. C. DUNCAN[4], D. J. WARREN[1], G. A. CLARK[1]
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Abstract: This work documents the first portable neuromyoelectric prosthetic interface capable of providing intuitive, dexterous, high degree-of-freedom, motor control to amputees, with potential expansion to include neural stimulation for sensory feedback. A mobile processing unit