Session 439 - Neuroprosthetics: Human Microelectrode-Based Control

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439.09 / XX2 - Using direction-independent, movement magnitude information from motor cortex to enhance intracortical brain-computer interface performance

November 14, 2016, 1:00 - 5:00 PM	Halls B-H

Presenter at Poster
Mon, Nov. 14, 2016, 1:00 PM - 2:00 PM

Session Type
Poster

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Disclosures

F. Willett: None. **B. Murphy:** None. **W.D. Memberg:** None. **C.H. Blabe:** None. **J. Saab:** None. **B. Jarosiewicz:** None. **C. Pandarinath:** None. **B. Walter:** None. **J. Sweet:** None. **J. Miller:** None. **J.M. Henderson:** None. **K.V. Shenoy:** None. **J.D. Simeral:** None. **L.R. Hochberg:** None. **R.F. Kirsch:** None. **A.B. Ajiboye:** None.

Abstract

Previous work in non-human primates has suggested that neural activity in the motor cortex is correlated with movement speed independently of direction (i.e., the equation $f = a + B \cdot V + c||V||$ describes neural activity more accurately than $f = a + B \cdot V$, where f is the firing rate of a neuron, V is a hand velocity vector, and a, B and c are model coefficients). Here, we interpreted this direction-independent activity to represent the magnitude of a feedback control vector instead of movement speed (so that V now represents a feedback control vector instead of velocity). Using this interpretation, we analyzed neural activity from motor cortex while three participants in the BrainGate2 pilot clinical trial controlled a computer cursor using a brain-computer interface. We found that direction-independent, “control vector magnitude” information was strongly encoded in threshold-crossing rates and high-frequency spectral power. Including $||V||$ in the tuning model increased the average variance explained by 33%, 85%, or 202% depending on the participant. Since $||V||$ is linearly independent from V, neural tuning to $||V||$ is not leveraged by linear velocity decoders. We present a new decoding architecture that can explicitly decode the encoded signal $||V||$ and then combine it with the magnitude information also present in V that is decoded by a standard, linear velocity decoder (Kalman filter). The new “magnitude” decoder substantially increases the signal-to-noise ratio of decoded movement speeds offline relative to a standard Kalman filter (31%, 36%, or 152% average increase depending on the participant). Online performance tests of the magnitude decoder in one participant show that it can increase the user's ability to hold still on top of a target (the cursor stays twice as close to the target center) with no sacrifice in the time taken to reach the target.