Print this Page

NEUROSCIENCE 2012

Presentation Abstract

Program#/Poster#:	583.02/QQ17
Presentation Title:	Increasing brain-machine interface robustness using low dimensional projections of neural activity
Location:	Hall F-J
Presentation time:	Tuesday, Oct 16, 2012, 9:00 AM -10:00 AM

Authors: ***J. C. KAO**[1], P. NUYUJUKIAN[2,3], S. D. STAVISKY[4], S. I. RYU[6,1], K. V. SHENOY[1,2,5];
[1]Electrical Engin., [2]Bioengineering, [3]Sch. of Med., [4]Neurosciences Program, [5]Neurobio., Stanford Univ., Stanford, CA; [6]Dept. of Neurosurg., Palo Alto Med. Fndn., Palo Alto, CA

Abstract: Brain-machine interfaces (BMIs) aim to restore aspects of lost motor function to patients suffering from neurological motor deficits. Despite several compelling proof-of-concept demonstrations, barriers to clinical translation remain. Of significant importance is the potential for the loss of neurons in recordings during and across days (Chestek et al., JNE 2011). Here, we present an algorithmic advance that improves the robustness to neuron loss of an online closed-loop BMI system. In our BMI system (Nuyujukian et al., COSYNE 2012), the velocity of a 2D cursor is driven by multi-unit spiking activity (-4.5 RMS threshold) from 96-channel intracortical electrode arrays spanning dorsal premotor and primary motor cortex in monkeys.

To address the problem of unexpected neuron loss, we used PCA to project binned multi-unit spiking activity into a low dimensional subspace ("neural state"). The time-series of the neural state was then used to fit the observation process of a ReFIT Kalman filter (Gilja et al., COSYNE 2010). We found in two monkeys (J & L) that a BMI using neural state ("PCA-ReFIT") is controllable and achieves performance not significantly different from the full dimensional BMI (“ReFIT") using binned multi-unit spike counts ($p > 0.6$, both monkeys). This suggests that a significant proportion of neural information useful for our BMI task is low dimensional. To test robustness to unexpected neuron loss between PCA-ReFIT and ReFIT, we simulated electrode loss in our closed-loop BMI, dropping anywhere from 0-70% of the electrodes in a randomized order. We found that while the performance of both decoders declined with electrode loss, PCA-ReFIT sustained higher bitrates than ReFIT did after 15% and 20% of the electrodes were randomly lost for monkeys J and L, respectively. A parametric 2-way ANOVA shows a significant difference in the average bitrates of PCA-ReFIT and ReFIT for monkey J ($p < 0.05$) and a significant interaction effect between the decoder used (PCA-ReFIT and ReFIT) and the number of electrodes dropped for monkey L ($p < 0.05$). Hence, these results indicate that following neuron loss, the observation process of a Kalman filter using a low dimensional neural state is in general more robust than one using the full dimensional multi-unit activity. Therefore, projecting neural activity into a low dimensional subspace may improve intraday, and perhaps interday, robustness to unexpected neuron loss.

Disclosures: **J.C. Kao:** None. **P. Nuyujukian:** None. **S.D. Stavisky:** None. **S.I. Ryu:** None. **K.V. Shenoy:** None.

Keyword(s): Brain-machine interface

Intracortical

Principal Component Analysis

Support: NIH Pioneer Award 1DP1OD006409

DARPA REPAIR contract N66001-10-C-2010

NSF Graduate Research Fellowship

Stanford MSTP

NSF IGERT

[Authors]. [Abstract Title]. Program No. XXX.XX. 2012 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2012. Online.