The IEEE Pittsburgh Section Signal Processing and Engineering in Medicine & Biology Society Chapters Present:

Decoding Hand Movements from Magnetoencephalographic Brain Computer Interfaces: Challenges and Solutions

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11:30 to 12:00 – Refreshments
12:00 to 1:00 - Presentation

Magnetoencephalography (MEG) has been considered as a promising non-invasive neuroimaging method that is complementary to electroencephalography (EEG) and functional magnetic resonance imaging (fMRI). In this talk, efficient algorithms for movement decoding of an MEG-based brain computer interface (BCI) will be presented. The objective of BCI is to provide a direct control pathway from brain to external devices. It is a radically new communication option for those with neuromuscular impairments that prevent them from using conventional augmentative communication methods.

In particular, this talk will focus on two technical challenges associated with MEG-based movement decoding. First, MEG signals are extremely weak (e.g., 50~500 fT), thereby resulting in low signal-to-noise ratios. Second, in a typical experimental setup, only a small number of (e.g., 100) training trials are collected, while the feature space constructed from all MEG channels is high-dimensional. In this case, the movement decoding algorithm must be carefully designed to prevent the decoder from over-fitting the training data. Several efficient signal processing and machine learning algorithms, including a robust signal space separation algorithm (rSSS) and a clustering linear discriminant analysis algorithm (CLDA), are proposed to address these challenging issues. Our experimental results demonstrate an average accuracy of 87% for single-trial movement decoding of four directions (i.e., up, down, left and right). It, in turn, offers strong evidence that with an appropriately designed decoding algorithm, MEG can be used to provide accurate two-dimensional control for brain computer interfaces. This work is in collaboration with the Medical School at University of Pittsburgh.

Xin Li received the Ph.D. degree in Electrical and Computer Engineering from Carnegie Mellon University, Pittsburgh, PA in 2005. He is currently an Assistant Professor in the Department of Electrical and Computer Engineering at Carnegie Mellon University. In 2005, he co-founded Xigmix Inc. and served as the Chief Technical Officer until the company was acquired in 2007. Since 2009, he has been appointed as the Assistant Director for FCRP Focus Research Center for Circuit & System Solutions (C2S2), a national consortium of 13 research universities (CMU, MIT, Stanford, Berkeley, UIUC, UMich, Columbia, UCLA, among others) chartered by the U.S. semiconductor industry and U.S. Department of Defense to work on next-generation integrated circuit design challenges. His research interests include computer-aided design and neural signal processing.

Dr. Xin Li served on the Technical Program Committee of Design Automation Conference (DAC) in 2011, the Technical Program Committee of International Conference on Computer-Aided Design (ICCAD) from 2008 to 2010, the Technical Program Committee of International Workshop on Timing Issues in the Specification and Synthesis of Digital Systems (TAU) in 2010 and 2011, the Technical Program Committee of International Conference on VLSI Design (VLSI) in 2009, the Technical Program Committee of International Conference on Image Theory and Applications (IMAGAPP) in 2009, and the IEEE Outstanding Young Author Award Selection Committee in 2006. He received the Best Paper Award from Design Automation Conference (DAC) in 2010, the Best Session Award from Semiconductor Research Corporation (SRC) Student Symposium in 2006, and the IEEE/ACM William J. McCalla ICCAD Best Paper Award in 2004. He also received the Inventor Recognition Awards from Focus Center Research Program (FCRP) in 2006, 2007 and 2009.