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Automatic Control and Systems Engineering

The Department of Automatic Control & Systems Engineering is pleased to announce the following seminar:

Efficient Methods for decoding motor imagery-related activities from electroencephalogram

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Friday, 25 November 2016 at 14:00
LT02, Sir Henry Stephenson Building

Abstract
This talk addresses signal processing techniques to decode electroencephalogram (EEG) during motor imagery. The first part devotes to discussing how to select useful data from a set of multiple trials, and the second part deal with a method for reducing the number of trials to estimate spatial patterns from EEG.

In the first part, I address a sparsity-aware method to data selection from a set of multiple EEG recordings during motor-imagery tasks, aiming at brain machine interfaces (BMIs). Instead of empirical averaging over sample covariance matrices for multiple trials including low-quality data, which can lead to poor performance in BMI classification, I introduce weighted averaging with weight coefficients that can reject such trials. The weight coefficients are determined by the l1-minimization problem that lead to sparse weights such that almost zero-values are allocated to low-quality trials. The proposed method was successfully applied for estimating covariance matrices for the so-called common spatial pattern (CSP) method, which is widely used for feature extraction from EEG in the two-class classification. Classification of EEG signals during motor imagery was examined to support the proposed method. It should be noted that the proposed data selection method can be applied to a number of variants of the original CSP method.
In the second part of the talk, an efficient method for dimensionality reduction in classification of multi-class electroencephalogram (EEG) during motor imagery (MI) aiming at brain–machine interfacing is proposed. In this method, the reduction of dimensions is achieved by spectral decomposition of a given graph, which is defined by a geometrical distribution of electrodes on the head surface. The resulting subspace reduces the dimension of EEG signals, and therefore, the size of the sample covariance matrix (SCM) of EEG can also be reduced. The reduction method is combined with a differential geometry-based approach called tangent space mapping (TSM) that can map a SCM in a Riemannian manifold onto an element in an Euclidean space called a tangent space. Thus, any machine learning algorithm that works in the Euclidean space can be applied. Results of two-class and four-class classification of EEG during MI show that the proposed method of dimensionality reduction increases the recognition accuracy even in the case of a training dataset having a small number of elements.

Biography
Toshihisa Tanaka received the B.E., the M.E., and the Ph.D. degrees from the Tokyo Institute of Technology, Meguro, Japan, in 1997, 2000, and 2002, respectively. From 2000 to 2002, he was a JSPS Research Fellow. From October 2002 to March 2004, he was a Research Scientist at RIKEN Brain Science Institute. In April 2004, he joined the Department of Electrical and Electronic Engineering, Tokyo University of Agriculture and Technology, where he is currently an Associate Professor. In 2005, he was a Royal Society Visiting Fellow at the Communications and Signal Processing Group, Imperial College London, U.K. From June 2011 to October 2011, he was a Visiting Faculty Member in the Department of Electrical Engineering, University of Hawaii at Manoa.
His research interests include a broad area of signal processing and machine learning including brain and biomedical signal processing, brain–machine interfaces and adaptive systems. He is a coeditor of Signal Processing Techniques for Knowledge Extraction and Information Fusion (with Mandic, New York, NY, USA: Springer, 2008).

He served as an Associate Editor and a Guest Editor of special issues in journals including Neurocomputing and IEICE Transactions on Fundamentals. He currently serves as an Associate Editor of IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS, Computational Intelligence and Neuroscience (Hindawi), and Advances in Data Science and Adaptive Analysis (World Scientific). Furthermore, he serves as a Member-at-Large, Board of Governors of Asia-Pacific Signal and Information Processing Association (APSIPA). He was a Chair of the Technical Committee on Biomedical Signal Processing, APSIPA. He is a Senior Member of the IEEE, a Member of the IEICE, APSIPA, and Society for Neuroscience

Light refreshments will be served in the foyer of the Sir Henry Stephenson Building following the seminar