Alternative Techniques of Neural Signal Processing in Neuroengineering

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Neural Signal processing is a discipline within neuroengineering. This interdisciplinary approach combines principles from machine learning, signal processing theory, and computational neuroscience applied to problems in basic and clinical neuroscience. The ultimate goal of neuroengineering is a technological revolution, where machines would interact in real-time with the brain. Machines and brains could interface, enabling normal function in cases of injury or disease, brain monitoring and/or medical rehabilitation of brain disorders.

Much current research in neuroengineering is focused on understanding the coding and processing of information in the sensory and motor systems, quantifying how this processing is altered in the pathological state, and how it can be manipulated through interactions with artificial devices including brain-computer interfaces and neuroprosthetics. Our brains are buzzing with electrical activity moving in and out of neural cells, sending electrical impulses along their axons, and exchanging chemical messages. Neural signals allow us to observe neuronal activity in real time.

This special issue aims to cover some problems related to neural signal processing. The origin of this volume is in the Special Sessions on Challenges in Neuroengineering (SSCN) within the International Conference on Neural Computation Theory and Applications (NCTA). A selected choice of papers based on the presentations delivered at SSCN has given rise to this issue of Cognitive Computation.

The papers hereinafter deal with the following topics:

- Temporal synchronization of neuronal activity plays an important role in various brain functions such as binding, cognition, information processing and computation. A review of two methods (MSS-estimator and MPS-estimator) for synchronization analysis within multivariate time series is presented in the paper by M. Jalili.

- Can EEG be used as a tool to investigate emotional valence and discriminate various emotions? The answer could be found in the paper by K. Hiyoshi-Taniguchi, M. Kawasaki, T. Yokota, H. Bakardjian, H. Fukuyama, A. Cichocki and F. Vialatte; in which they introduce a controlled perturbation in the emotional system of the brain by multi-modal stimuli and investigate whether such emotional stimuli could induce reproducible and consistent changes in EEG signals. Such markers could be used for the design of monitoring systems and the development of passive brain-computer interfaces.
- The problem of scene classification for mobile robots in an outdoor environment is investigated in the paper by J. Zhao, C. Du, H. Sun, X. Liu, and J. Sun. They present a novel model that combines biologically inspired features and cortex-like memory patterns, showing that incremental model improves the classification accuracy rates and significantly reduces training costs compared with other biologically inspired feature-based approaches.
- The auditory modality has been insufficiently explored for Brain-Computer Interface (BCI) applications, compared for instance with the numerous visual modality-based studies A novel method for the extraction of discriminative features in Electroencephalography (EEG) evoked potential latency for spatial auditory BCI is presented by Z. Cai, S. Makino and T. M. Rutkowski. Their work indicates that a full surround sound auditory brain-computer interface paradigm has potential for an online application.
- The potential of using speech features in order help in the early diagnose of the Alzheimer's disease is investigated in the paper by K. Lopez-de-Ipiña, J.B. Alonso, J. Solé-Casals, N. Barroso, P. Henriquez, M. Faundez-Zanuy, C. Travieso, M. Ecay-Torres, P. Martinez-Lage, and H. Egiraun. Results are relevant and can help researchers to better understand the most prevalent form of progressive degenerative dementia which has a high socioeconomic impact in Western countries.
- Finally, an implementation of the most critical parts of the Second Order Blind Identification (SOBI) algorithm with a fixed-point algorithm on a commercial

Field-Programmable Gate Array (FPGA) development kit is presented in the paper by X. Zhang, F.B. Vialatte, C. Chen, A. Rathi and G. Dreyfus. Their result is of prime importance for real time applications such as Brain Computer Interfaces (BCI), cognitive neuroscience or clinical neuro-monitoring, where the artefact rejection/denoising part has to be effectively performed in real time.

By no means has the range of topics in this Special Issue covered all directions in neural signal processing. We would rather consider it a sample presenting several areas in progress. In any case, we hope that they will be of interest for the readers of Cognitive Computation.

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