Post-doc Position in EEG Signal Processing/Machine Learning for Brain-Computer Interface and Video Gaming

Starting date: in between October 1, 2009 and Jan 1, 2010
Duration: 12 months, renewable to 18 months
Location: GIPSA-lab, Campus Universitaire, Grenoble, FRANCE.
Salary: about 2,000€ net / month
Supervision: Marco Congedo, PhD, Senior Scientist, cnrs, marco.congedo[AT]gmail.com
Other collaborators at GIPSA-lab: Christian Jutten, Bertrand Rivet, Gelu Ionescu.

The post-doc is part of the **Open-ViBE2 project**, recently funded by the French National research Agency (ANR).

Brain-Computer Interface (or BCI) corresponds to the direct use of brain signals to send "mental commands" to an automated system such as a robot, a prosthesis, or a cursor on a computer screen. In the previous ANR OpenViBE1 project (Dec.2005-May2009) we have developed an open-source platform to easily design, test and use BCI (http://openvibe.inria.fr/). In addition, we have opened new research areas in the field of BCI, EEG signal-processing and in Virtual Reality (VR) technologies supporting BCI applications. This involved four partners of the current proposal (INRIA, INSERM, GIPSA-Lab, CEA).

In OpenViBE2 we aim at adapting, in real-time and in an automated fashion, the interaction protocol itself as well as the content of the remote/virtual environment (VE). Our project focuses on **videogames and more particularly on the emerging market of serious games**, which is a new field of application for BCI. The consortium gathers partners from the leading French videogame industry (Ubisoft, Capital-Games, Black Sheep, Kylotonn) as well as a partner (CHArt) of the ANR project 'LUTIN-GameLab' that developed techniques for gameplay assessment. In videogames, the mental state of the user is known to be an important parameter, not to say the ultimate target of game design. The goal of OpenViBE2 is thus: "**exploiting EEG information to measure, identify and use the mental states and brain responses of the user to adapt both the way the user can interact with the videogame and the content of the videogame".**

In a brain-computer interface digital signal processing algorithms for relevant feature extraction should be fully adaptive. It is well known that EEG task-related activities (such as focusing or movement imagination) have a high inter-individual variability. Therefore, the feature extraction process must adapt to the individual by means of a learning process. In a videogame setting such learning process should be carried out seamlessly and should not require additional efforts by the user.

The candidate will focus on optimizing digital signal processing/machine learning strategies. The major challenge is to transpose known feature extraction strategies in a fully on-line adaptive context, a path that has been followed only recently in the BCI literature. New strategies will be evaluated as well, namely, those allowing following brain dynamics in time, space and frequency simultaneously (e.g., Hidden Markov Models).

The candidate should have a strong background in the theory of digital signal processing and/or machine learning. He/she should have good programming experience for coding and testing the new algorithms. Previous experience with biomedical data and particularly with EEG or MEG and with BCI is sought and would be a plus. The candidate will become part of a group of researchers moved by common objectives. The candidate should possess good knowledge of spoken and written English. The position will be filled between October 1,

2009 and January 1, 2010. Please forward CV and names of three recommending colleagues to the contact person (here above).

References:

Congedo, M. (2006). Subspace Projection Filters for Real-Time Brain Electromagnetic Imaging. IEEE Trans on Biomedical Engineering, 53(8), 1624-1634.

Congedo, M., Gouy-Pailler, C., Jutten, C. (2008). On the blind source separation of human electroencephalogram by approximate joint diagonalization of second order statistics. Clinical Neurophysiology, 119, 2677-2686.

Congedo, M., Lotte, F., Lécuyer, A. (2006). Classification of movement intention by spatially filtered electromagnetic inverse solutions. Physics in Medicine and Biology, 51, 1971-1989.

Congedo, M., Lubar, J.F. and Joffe, D. (2004). Low-resolution electromagnetic tomography neurofeedback. IEEE Trans on Neural Systems and Rehabilitation Engineering, 12(4), 387-97.

Sameni R., Jutten, C., Shamsollahi M. (2008) Multichannel Electrocardiogram Decomposition Using Periodic Component Analysis, IEEE Trans on Biomedical Engineering, 55(8), pp.1935-1940.

Sameni R., Shamsollahi M., Jutten, C. (2008) Model-based Bayesian filtering of cardiac contaminants from biomedical recordings, Physiological Measurement, 29(5), pp. 595-613.

Sameni R., Jutten, C., Shamsollahi M., Clifford G. (2007) A Nonlinear Bayesian Filtering Framework for ECG Denoising, IEEE Trans on Biomedical Engineering, 54 (12), pp. 2172-85.

Jutten C., Comon P. (Eds). Séparation de sources; Vol. 1 : Concepts de base et analyse en composantes indépendantes. Vol. 2 : Au-delà de l'aveugle et applications. Lavoisier, 2007.

Jutten C., Hérault H. (1991) Blind separation of sources, part i: an adaptative algorithm based on neuromimetic architecture, Signal Processing, vol. 24, pp. 1–10.

Rivet B., Souloumiac A., Attina V., Gibert G.(2009). xDAWN algorithm to enhance P300 evoked potentials: application to brain computer interface. IEEE Trans on Biomedical Engineering. In press.

Rivet, B., Girin, L., Jutten, C. (2007). Log-Rayleigh distribution: a simple and efficient statistical representation of log-spectral coefficients. IEEE Trans on Audio, Speech and Language Processing, 15(3), 796-802.