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.

Gaze&EEG project

At the University of Grenoble, France, for the scientific project "GAZE&EEG" funded by the National Research Agency, two positions are open :

- **Post-doc in EEG signal processing** (12-18 months, beginning about October 09)
- **Software or Electrical Engineer** (12 months, beginning about October 09)

Project description:
The core of this project is the **joint processing of electroencephalogram (EEG) and eye tracking (ET) signals**, using the advanced methods of stochastic signal processing to better understanding the simultaneity between eye movements and neural activities. Synchronizing these two sources of data is essential
(1) for better **denoising EEG** signals which are contaminated by the electric activity generated by eye movements,
(2) for exploring the **functional role of eye movements** (at the saccades and the microsaccades level) by directly associating them to neural markers and
The context of the project is highly interdisciplinary: it involves researchers in stochastic signal processing, statistics, biomedical EEG signals, oculometry, visual and textual

processing, visual perception, neuro-cognition and psycho-cognition. Several results are expected: (1) a technical platform for the acquisition and analysis of joint EEG/ET recordings to be implemented in the **Open-ViBE platform** (http://openvibe.inria.fr), (2) new techniques for removing EOG artifacts in EEG, (2) new method for extracting eye micro-saccade contributions in EEG -which is actually a very challenging issue-, (3) scientific results on the functional role of saccades and micro-saccades and (4) a cognitive model able to predict an average user scanpath on a complex document composed of text and image, in information searching domain.

The partners of this project are :

Grenoble , GIPSA-lab (http://www.gipsa-lab.inpg.fr/), Signal Processing and Visual perception

Grenoble, LPNC: (http://webu2.upmf-grenoble.fr/LPNC/), Cognitive Psychology

Grenoble, TIMC : (http://www-timc.imag.fr/), Computer Science

LUTIN, Paris : (http://www.lutin-userlab.fr/accueil/), Cognitive Psychology

Post Doctoral position in EEG Signal Processing

Salary: starting 2,100€ net / month depending on experience

Starting date: October 1er 2009

Duration: 12 months, renewable to 18 months

Location: GIPSA-lab, Campus Universitaire, Grenoble, FRANCE.

Contact information: Marco Congedo, Senior Scientist cnrs, GIPSA-lab, marco.congedo[AT]gmail.com

The EEG signals are contaminated with extra-cerebral artifacts of biological origin, and the most energetic artifact come from eye-movements. To remove these artifacts, the most popular approach is the “Blind Source Separation” (BSS) based on “Second-Order Statistics” (SOS) or based on “Higher-Order Statistics” (HOS). These methods are in fact sub-optimal for the separation of eye-movements (linear model, no double dipole modeling, etc). Moreover, the question of the possibility to separate the miniature eye movements (microsaccades) has never been addressed so far. The simultaneous and synchronous EEG/ET recording provides an unique opportunity to remove efficiently eye-related artefacts exploiting the additional information provided by ET (exact position in time with high temporal position). The post-doc will conduct research on innovative digital signal processing algorithms for on-line separation and elimination of eye-movements artefact from the EEG based on EEG/ET recording. The developed algorithms will be implemented in the OpenVibe software environment (**Open-ViBE: Open platform for Virtual Brain Environment** http://openvibe.inria.fr/) with the aid of software engineers working within the Open-ViBE project. The candidate should have a strong background in theoretical digital signal processing and good programming experience for coding and testing the new algorithms. Previous experience with biomedical data and particularly with EEG or MEG and/or ET is sought and would be a plus. Previous experience with and knowledge of blind source separation will also be a plus. The candidate should be keen to work in a team. 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).

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. doi: 10.1016/j.clinph.2008.09.007

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.

Software or Electrical Engineer position
Salary: starting 2,100€ net / month depending on experience
Starting date: October 1er 2009
Duration: 12 months
Location: GIPSA-lab, Campus Universitaire, Grenoble, FRANCE.
Contact information: Gelu Ionescu, Research Engeneer cnrs, GIPSA-lab, gelu.ionescu@gipsa-lab.inpg.fr

The engineer will be responsible of developing the platform for joint EEG/ET recordings and to deploy it to the other partners of the project. This platform will be developed using the OpenVibe environment (Open-ViBE: Open platform for Virtual Brain Environment: http://openvibe.inria.fr/). OpenViBE is free and open source (under the term of the L-GPL v2+ licence). The whole software is developed in C++. It consists of a set of software modules that can be integrated easily and efficiently to design applications for Brain Computer Interfaces, neurofeedback and any other real-time EEG application and/or for interaction with virtual environments. Key features of the platform are modularity reusability and portability. The candidate should have excellent skills in C++ programming/software development and should be keen to work in a team. Experience with EEG and/or eye-tracking data is a plus but not necessary. The candidate should possess good knowledge of spoken and written English. Position is available and should be filled October 1, 2009, however a short delay for starting date is possible. Please forward CV and names of three recommending colleagues to the contact person (here above).