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Date of offer : 13/07/2012

**TITLE :**

**Experimental Research with the  
Brain-Computer Interface Video-Game “Space Invaders”.**

**SUPERVISOR :**

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**PLACE :**

Departement “Images and Signal” of GIPSA-lab, CNRS, Grenoble University, Grenoble  
Institute of Technology (INP), ENSE<sup>3</sup>, Campus of Grenoble.

**DURATION:**

The training will last 5 months, starting on February 1<sup>st</sup> 2013.

**CONTEXT :**

This project is part of an ongoing research on *brain-computer interfaces for video-games* carried out at *team ViBS* (Vision and Brain Signal Processing) of *GIPSA-lab* since 2009. It makes use of the following technological resources of team ViBS:

- the experimental room PERSEE, equipped with state-of-the-art electroencephalography equipment (64 active gel-based electrodes or 16 “dry” electrodes).
- the real-time software platform OpenViBE (<http://openvibe.inria.fr/>), which is able to acquire, process and display EEG data on-line.
- a dedicated “Brain Invaders” application communicating with the OpenViBE platform and managing the experiments.

**SUBJET :**

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A Brain-Computer Interface (BCI) aims at computer control (and electronic equipments control in general) without any muscular output thanks to a direct communication between a computer and the user's brain. BCI exploits spontaneous and volitional production of selective brain activity as recorded by electroencephalography (EEG). The user is equipped with an EEG cap and the computer classifies certain classes of EEG signal to achieve the desired result. BCI is a rapidly growing area of research and several impressive prototypes are already available (Figure 1).

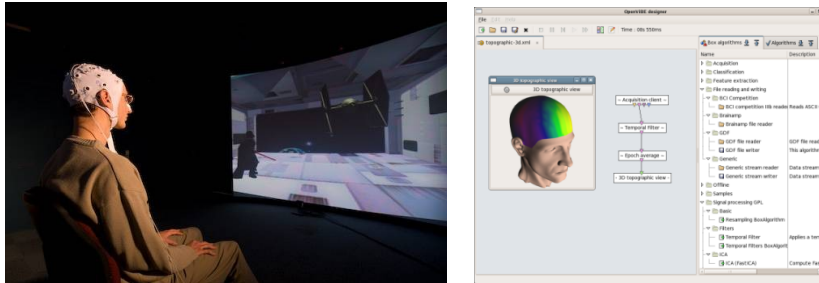


Figure 1 – On the left, through a BCI the user interacts with a virtual object (the “Star Wars Tie-Fighter”). On the right, the screenshot of the Open-ViBE software platform used to analyze the EEG data on-line.

Recently, several companies started proposing low-cost EEG headsets (Figure 2), which paved the way to massive applications of BCI.



Figure 2 – Emerging EEG commercial headsets. Example of products proposed by company EMOTIV© (left) and NEUROSKY© (right).

BCI control capabilities are still not comparable to other Human-Computer Interaction (HCI) peripherals such as joysticks or classical computer mice. Our objective is to pursue a radical shift of perspective about the use of a BCI. Instead of considering the poor bit rate of a BCI as a limitation, we conceive it as a challenge. A video-game is a suitable application of BCI technology because “mental control”, despite the low bit-rate, is an interesting challenge from the gamer perspective. We also consider the possibility to merge a BCI with traditional peripherals such as joysticks, mice and other devices, all possibly being used simultaneously in a video-game context. Here BCI is not seen as a replacement, but as a complement of classical HCI.

The aim of this stage is to conduct psychological experimental research with the “Brain Invaders” video-game developed from the ViBS team (Congedo et al., 2011). The game is based on the well known vintage video game “Space Invaders” (Figure 3). In our “Brain Invaders” a number of aliens are displayed in a grid and the player has to destroy a particular alien, the target, only by concentrating on it. The game makes use of a state-of-the-art P300 oddball paradigm to select the alien to be destroyed at a regular pace based **only on user concentration** (no movement whatsoever), given current probabilities assigned to each alien by a learning machine continuously analyzing and classifying the user’s electroencephalographic stream (the OpenViBE platform, Renard et al. 2010).

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Figure 3 – The interface of the vintage game “Space Invaders”

### OBJECTIVS OF THE TRAINING :

The candidate will perform experimental research in order to test the effect of increasing difficulty of the game (for example, by adding distracters) on BCI accuracy and bit rate. The candidate will thus learn how to perform research in the field of real-time EEG and how to analyze the EEG data.

### KEYWORDS :

Electroencephalogram (EEG), Brain-Computer Interface (BCI), P300, Video-games, Space Invader.

### CONDITIONS :

The training is remunerated 1/3 of French SMIC during 5 months.

### COMMENTS :

The candidate should have good predisposition for experimental research and data analysis. Good theoretical skills in digital signal processing or physiological mechanisms underpinning the generation of the P300 brainwave would be an advantage.

### PUBLICATIONS :

Congedo M, Goyat M, Tarrin N, Varnet L, Rivet B, Ionescu G, Jrad N, Phlypo R, Acquadro M, Jutten C (2011) “Brain Invaders”: a prototype of an open-source P300-based video game working with the OpenViBE platform, Proceedings of the 5th International BCI Conference, Graz, Austria, 280-283.

Renard Y, Lotte F, Gibert G, Congedo M, Maby E, Delannoy V, Bertrand O, Lécuyer A (2010) OpenViBE: An Open-Source Software Platform to Design, Test and Use Brain-Computer Interfaces in Real and Virtual Environments. *PRESENCE : Teleoperators and Virtual Environments* 19(1), 35-53.

### GIPSA-lab

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