Université de Rennes

Appel à projets - Année 2024

Contrats doctoraux «Ordinaires»

Direction de la Recherche et de l'Innovation

ECOLE DOCTORALE : Matisse **POLE DE RECHERCHE : Mathématique-Numérique**

Unité de recherche d'accueil

Unité de Recherche : UMR 6074 IRISA

Equipe : Empenn

Encadrement

Directeur de thèse : Pierre Maurel **Unité de recherche** : IRISA

Employeur/Établissement d'origine : Univ. Rennes

HDR : X oui non **Nb de thèses en cours** : 3

Mail : pierre.maurel@irisa.fr **Tél**. : 02 99 84 74 45

Encadrante de thèse : Claire Cury **Unité de recherche** : Inria / Empenn

Employeur/Établissement d'origine : Inria

HDR : □oui X non **Nb de thèses en cours** : 2

Mail : claire.cury@inria.fr **Tél.** : 02 99 84 22 13

Sujet

Titre : Methodology for enhanced and adapted neurofeedback trainings

Mots clés : neurofeedback, machine learning, signal processing

Cotutelle internationale (oui/non) : non **Si oui, préciser l'établissement et le pays de rattachement** :

Descriptif (15-30 lignes) :
Contexte socioéconomique et scientifique ; Les hypothèses et questions posées ; Les grandes étapes de la thèse et démarche ; Approches méthodologiques et techniques envisagées

The project operates at the intersection of signal and image processing, neuroscience, and neurofeedback. Neurofeedback (NF) involves real-time feedback to individuals about their brain activity to facilitate self-regulation, showing promise in brain rehabilitation for psychiatric disorders and neurological pathologies. Combining electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) in bi-modal NF training has demonstrated improved self-regulation.

In this context, the goal of this thesis is to investigate and propose methods to provide improved and adaptable NF trainings to participants. This thesis will seek to address 2 of the following challenges, regarding the candidate profile :

- (1) Monitoring and analyzing participant's motivation in real time during NF training. This objective will require to design a new protocol for NF training using eye-tracking and skin conductance devices, to first monitor signal, before analysis. Then optimal feature extraction will be studied to detect drops and increase in motivation.
- (2) Investigating adaptable targets to avoid the too difficult task issue, by proposing new NF scores computation and determining a hierarchy between different NF scores computations based on EEG and fMRI signals.This objective will focus on the differences and complementarity aspects of measures extracted from EEG and fMRI signals. New bi-modal EEG-fMRI NF target will be proposed and combinations between both modalities and different measures extracted will be analysed.
- (3) Modelling of EEG and fMRI signals to understand the link between those signals and optimise the feature extraction from EEG when used alone. This objective lies in the data fusion domain, as it is of great interest for neuroscience studies and for the previous objective to understand the link between measures extracted from both signals. This understanding will allow developing models to extract fMRI information using EEG signal.

➢ **Ce document est à renvoyer par la direction de l'unité de Recherche aux animateurs du Pole Recherche et à l'école Doctorale pour le 9 février 2024 au plus tard**