

2021-03930 - Post-Doctoral Research Visit F/M Eye-tracking and Electrodermal activity real-time measurements for attention analysis during neurofeedback training.

Type de contrat : CDD

Niveau de diplôme exigé : Thèse ou équivalent

Fonction : Post-Doctorant

A propos du centre ou de la direction fonctionnelle

The Inria Rennes - Bretagne Atlantique Centre is one of Inria's eight centres and has more than thirty research teams. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative SMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Contexte et atouts du poste

Key words : eye-tracking, electrodermal activity, skin conductance, signal processing, machine learning, BCI, Neurofeedback, EEG, fMRI

Project infos:

This 2-years postdoctoral position is part of an **Exploratory Action** funded by the research national institut Inria. This means we are exploring original ideas to address difficult challenges.

You will be working in the **Empenn** research group, one of the very few lab in the world, equipped with the bi-modal EEG-fMRI neurofeedback technology, at the **Neurinfo** platform (located at the University Hospital of Rennes).

Domain:

This position lies at the interface of signal processing, behavioural neuroscience and neurofeedback.

Context:

Neurofeedback approaches (NF), also known as restorative brain-computer interface (restorative BCI), consist in providing real-time feedback to a subject or patient about his or her own brain activity in order to self-regulate brain areas or networks, targeted by the neural rehabilitation or by a given task.

The estimation of neurofeedback scores is done through online brain functional feature extraction relying for the majority on electroencephalography (EEG) or functional magnetic resonance imaging (fMRI) and some very recent ones employing both for bi-modal EEG-fMRI NF sessions (i.e., NF scores are estimated synchronously by features from both modalities), providing a more specific estimation of the underlying neural activity.

NF is a very promising brain rehabilitation technique for psychiatric disorders, stroke and other neurological pathologies, yet with moderate results.

One central question in NF training, is to identify the origin of a failure which can be due to the signal recording and artefacts, a too difficult task, the patient's inability to learn via NF, or a lack of attention from the participant during the task (he/she should be preserved from boredom to not disengage from the task). Also, motivation should be enhanced, and participant's prevailing attention should be monitored.

Salary

For a postdoctoral position, the gross salary is 2653 euros per month.

Mission confiée

Eye-tracking (ET) and skin conductance (SC) devices are used in behavioural neuroscience to measure different aspects of patient's mental states related to focus, arousal, mind wandering, mental load or anxiety. All key indicators for a precise assessment of patient's motivation.

Electro-dermal activity (EDA), measured via SC system, detects changes in the conductivity of the skin owing to perspiration. ET is a technology that measures eye movements at a high spatio-temporal resolution.

Assignments:

To analyse participant's motivation, the recruited postdoctoral fellow will integrate measure from eye-tracking and EDA signals and help the research engineer on the set-up and data acquisition at the Neurinfo platform (University of Rennes).

The main objective of this position is to determine robust features of ET and EDA signals to characterise each of the mental states of interest (i.e. mind wandering, mental load, arousal and focus) that cannot be described with a single parameter. The temporal delays (around 4-5 seconds) between the stimuli and EDA (and ET) signals are not a problem for a use with EEG-fMRI recording, as the fMRI signal also accounts for a haemodynamic response delay of few seconds (depending on the brain location).

The methodological work will be two steps:

- Identifying measures, robust across subjects, for motivation evaluation and changes detection.
- Modelling the impact of motivation measures on EEG and fMRI signals, and on EEG-fMRI

Informations générales

- **Thème/Domaine :** Neurosciences et médecine numériques
- **Ville :** Rennes
- **Centre Inria :** CRI Rennes - Bretagne Atlantique
- **Date de prise de fonction souhaitée :** 2021-11-01
- **Durée de contrat :** 2 ans
- **Date limite pour postuler :** 2021-08-22

Contacts

- **Equipe Inria :** EMPENN
- **Recruteur :**
Cury Claire / claire.cury@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3500 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 180 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

We are looking for a researcher with experience in EDA and/or eye-tracking signals analysis. The applicant must be autonomous enough to conduct exploratory research, and be pro-active to find original solutions. Knowledges in EEG and fMRI data is a plus.

The candidate should also have experience in signal processing, machine learning and/or modelling, and programming skills (Python, Matlab or C++).

It is also essential that the candidate present good communication skills, as he/she will have to interact with researchers and engineers presenting various expertise, located on different sites.

Your application must contain an updated CV, a motivation letter including your professional perspectives and the presentation of your favourite own publication, reports from the reviewers of your PhD thesis, a link toward the PDF of your PhD thesis, 2 reference letters.

Consignes pour postuler

Please submit online : your resume, cover letter and letters of recommendation eventually

Sécurité défense :

Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

signal coherence.

Data will be acquired during the postdoctoral stay to support methodological developments. 2 publications are expected: one with the research engineer on the new platform recording EEG, fMRI, ET and EDA signals, and one on the methodological developments.

For more details, please contact claire.cury@inria.fr and antoine.coutrot@insa-lyon.fr

Collaboration:

The recruited person will be collaborating with Dr Antoine Coutrot (CNRS), expert in eye-tracking and behaviour.

The recruited person will be closely working with the research engineer to set-up the platform recording EEG, fMRI, ET and EDA signals.

Some references:

- [1] I. P. Bodala, J. Li, N. V. Thakor, and H. Al-Nashash. EEG and Eye Tracking Demonstrate Vigilance Enhancement with Challenge Integration. *Frontiers in Human Neuroscience* 10, 2016. Publisher : Frontiers.
- [2] W. Boucsein. *Electrodermal Activity*. Springer Science & Business Media, Feb. 2012.
- [3] D. Clewett, C. Gasser, and L. Davachi. Pupil-linked arousal signals track the temporal organization of events in memory. *Nature Communications*, 11(1) :4007, Aug. 2020. Number : 1 Publisher : Nature Publishing Group.
- [4] C. Cury, G. Lioi, L. Perronnet, A. Lécuyer, P. Maurel, and C. Barillot. Impact of 1D and 2D Visualisation on EEG-fMRI Neurofeedback Training During a Motor Imagery Task. In *2020 IEEE 17th International Symposium on Biomedical Imaging (ISBI)*, pages 1018–1021, Apr. 2020. ISSN : 1945-8452.
- [5] T. Kootstra, J. Teuwen, J. Goudsmit, T. Nijboer, M. Dodd, and S. V. d. Stigchel. Machine learning-based classification of viewing behavior using a wide range of statistical oculomotor features. *Journal of Vision*, 20(9) :1–1, Sept. 2020. Publisher : The Association for Research in Vision and Ophthalmology.
- [6] F. Nijboer, N. Birbaumer, and A. Kübler. The influence of psychological state and motivation on brain-computer interface performance in patients with amyotrophic lateral sclerosis - a longitudinal study. *Frontiers in Neuroscience*, 2010.
- [7] I. M. Pavisic, N. C. Firth, S. Parsons, D. M. Rego, T. J. Shakespeare, K. X. X. Yong, C. F. Slattery, R. W. Paterson, A. J. M. Foulkes, K. Macpherson, A. M. Carton, D. C. Alexander, J. Shawe-Taylor, N. C. Fox, J. M. Schott, S. J. Crutch, and S. Primativo. Eyetracking Metrics in Young Onset Alzheimers Disease : A Window into Cognitive Visual Functions. *Frontiers in Neurology*, 8, 2017. Publisher : Frontiers.
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- [9] J. Smallwood and J. W. Schooler. The Science of Mind Wandering : Empirically Navigating the Stream of Consciousness. *Annual Review of Psychology*, 66(1) :487–518, 2015.
- [10] B. Sorger, F. Scharnowski, D. E. Linden, M. Hampson, and K. D. Young. Control freaks : Towards optimal selection of control conditions for fMRI neurofeedback studies. *NeuroImage*, 186 :256–265, Feb. 2019.

Principales activités

- Propose and develop new real-time metric for ET and EDA signals
- Propose signal processing of ET and EDA signals
- Develop method to analyse ET and EDA metric with EEG and fMRI data
- Design experimental protocol to reveal potential of ET and EDA measures during EEG-fMRI neurofeedback training and fMRI task sessions
- Write scientific publications
- Present the works and results in international conference

Compétences

Technical skills :

- Signal processing, knowledges
- Eye-tracking, substantial experience
- Skin conductance / EDA, substantial experience
- Computer Science (programming Matlab, python or C++, machine learning or modelling), substantial experience
- Protocol design on healthy subjects for fMRI task or neurofeedback sessions, some experience, knowledges or at least be interested in it
- Neuro-imaging: knowledges in EEG, fMRI is a plus
- Neuroscience, general knowledge and interest

Languages :

- Good English communications skills (listening, verbal, written)
- Some French communications skills (listening, verbal, written), for eventual non-english communication.

Relational skills :

- Managing Multiple Priorities
- Interpersonal Abilities
- Awareness
- Planning/Organizing

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs

Rémunération

Monthly gross salary amounting to 2653 euros

Politique de recrutement :

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

