2022-05575 - Master 2 Internship – EEG signal processing of signal recorded during EEG-fMRI acquisition

Niveau de diplôme exigé : Bac + 5 ou équivalent
Fonction : Stagiaire de la recherche

A propos du centre ou de la direction fonctionnelle

The Inria Rennes at Rennes University 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 PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Contexte et atouts du poste

Electroencephalography (EEG) directly measures changes in electric potentials occurring in the brain in real-time with an excellent temporal resolution (milliseconds), but a limited

spatial resolution (around a centimetre), due to cortical currents volume conduction through head tissues, and the ill-posed inverse problem of source localisation. On the other hand, functional magnetic resonance imaging (fMRI) offers a better spatial resolution (a few millimetres) but has slow dynamics (one or two seconds) as it measures hemodynamic

activities, which occur in general, a few seconds after a neural event. Both EEG and fMRI are non-invasive methods that are indirectly coupled and measure complementary aspects of human brain activity.

Simultaneous EEG-fMRI recording has been used to understand the links between EEG and fMRI in different states of brain activities and has received recognition as a promising multi-modal measurement of brain activity. Furthermore, recent studies [Perronnet et al. 2017] have shown the high potential of combining EEG and fMRI in a bimodal Neurofeedback training (i.e., feeding back in "real-time" a subject with a score reflecting his or her own brain activity to self-regulate brain areas or networks, targeted by a neural rehabilitation) to achieve advanced self-regulation, by providing a more specific estimation of the underlying neural activity.

However, EEG-fMRI analysis is limited by the corruption of EEG signals under the MRI environment. During EEG-fMRI acquisition, EEG signals are altered by extremely strong gradient artefacts and, as the motion of a closed electrical circuit in a magnetic field induces an electric current (Lenz-Faraday law), the signal is also affected by artefacts induced by any motion or vibration in the strong static magnetic field (MR motion-related artefacts) such as head motion, the pulsatile motion of scalp arteries, the vibration of the ventilation system, and cardiac activity. Gradient artefacts can be fairly by a hybrid mean and median moving average corrected [Grouiller et al. 2016] or Optimal Basis Sets [Niazy et al. 2005] approaches. For MR motion-related artefacts, methods were proposed based on Optimal Basis Set [Wu et al. 2016] or ICA [Mayeli et al. 2016]. However, the evaluation of artefact correction
methods' performance is not trivial since the true EEG signal without artefacts is unknown. Also, most studies evaluate the reduction of the artefacts but without addressing the problem of signal preservation, and it has been shown that over-filtering degrades the EEG signal [Steyrl et al. 2019].

Mission confiée

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Scientific environment: Empenn team, IRISA-Inria, Campus de Beaulieu, 35042 Rennes Cedex, France https://team.inria.fr/empenn

Duration: 5 to 6 months, starting in 2023

Keywords: Signal processing, EEG, bi-modal, Neurofeedback

Objectives:

The goal of this internship is first, to implement and compare the different state-of-the-art approaches found in the literature that allows reducing the noise on EEG signals when recorded under fMRI. Then the aim of the internship is to explore different metrics related to the EEG signal that can help to assess the quality of the EEG signal correction and determine the metrics or the combination of metrics that best describe the quality of the corrected EEG signal. We will focus on the artefact correction related to cardiac activity.

Principales activités

- Bibliographic research
- Processing EEG signals with different software
- Implementation of a state-of-the-art method
- Designing an EEG signal processing pipeline
- Definition of adapted metric to measure the EEG signal quality
- Take part in the acquisition of EEG-fMRI data (with or without neurofeedback training)
- Present the work progress during lab seminar
- Interact with other researchers

additional activities:

- Take part in the acquisition of EEG-fMRI data (with or without neurofeedback training)
- Present the work progress during lab seminar
- Interact with other researchers

Compétences

Informations générales

- **Thème/Domaine :** Neurosciences et médecine numériques
  Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Ville :** Rennes
- **Centre Inria :** Centre Inria de l'Université de Rennes
- **Date de prise de fonction souhaitée :** 2023-03-01
- **Durée de contrat :** 6 mois
- **Date limite pour postuler :** 2023-03-31

Contacts

- **Equipe Inria :** EMPENN
- **Recruteur :**
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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

Please send us the following information and documents:

- Updated CV

- Your grades and ranking of your master degree

- A motivation letter

- A recommendation letter, or the contact of a teacher or a supervisor who could recommend your application.

- The 6 months during which you are due to complete your master internship.

Consignes pour postuler

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.

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.

- Good knowledge in applied mathematics and/or computer science.

- Strong interest in neuro-imaging.

- Knowledge in signal processing.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs

Rémunération

Grant of 3.90 € per hour