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Improving motor imagery detection with a BCI based on somesthetic non invasive stimulations

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Introduction: One of the most prominent BCI types of interaction is Motor Imagery (MI)-based BCI. Users control a system by performing MI tasks, e.g., imagining hand/foot movements detected from EEG signals. Indeed, movements and imagination of movements activate similar neural networks, enabling the MI-based BCI to exploit the modulations known as Event-Related Desynchronization (ERD) and Event-Related Synchronization (ERS) [1]. However, two important challenges remain before using such MI-BCIs on a large scale: (i) be able to detect the MI of the user without any temporal markers for instructions (often given by sound or visual cues) and (ii) achieve sufficient accuracy (>80%) to ensure the reliability of a BCI device that could be used by the participants.

Method: To address these challenges, we argue that somesthetic non-invasive stimulations (tactile, vibrotactile or nerve painless stimulations) is a very promising approach. Indeed, previous studies have shown that painless Stimulation of the Median Nerve (MNS) induces an ERD during stimulation while an ERS appears after stimulation [2]. Most interestingly, a motor task performed during MNS would suppress the ERS patterns generated by this stimulation due to the gating hypothesis (i.e., ERDs and ERSs contract within a time window and cancel each other out; [3]). The same phenomenon seems to happen with passive skin or vibrotactile stimulation. Thus, we can envisage a routine system where the user would be regularly stimulated (e.g., at the median nerve position), while a BCI device would analyze the ERD and ERS modulations in the motor cortex to check whether the user is intending to move or not.

Result/Discussion: Using a MNS-based BCI on healthy users, our results show that the MI state is 19% more accurately detected compared to a standard BCI (i.e., based on MI vs Rest). For several subjects, the use of MNS improves performance by more than 20% [3, 4]. In this abstract, we show that somesthetic stimulations applied during MI tasks could be the keystone of a BCI specialized in the detection of MI without any cue (e.g., sound or visual) with a high detection rate. These results are very promising to improve the performance of MI-based BCI and could be extended to other forms of non-invasive stimulation (tactile and vibrotactile).

References