Towards Brain-Computer Interfaces based on Steady-State Somatosensory-Evoked Potentials

Jimmy Petit*†[1], José Rouillard[1], and François Cabestaing[1]

[1]Centre de Recherche en Informatique, Signal et Automatique de Lille (CRIStAL) - UMR 9189 (CRIStAL) – Ecole Centrale de Lille, Université de Lille, Centre National de la Recherche Scientifique : UMR9189 – Bâtiment ESPRIT, Université de Lille, 59655 Villeneuve d'Ascq Cedex FRANCE, France

Abstract

In reactive BCIs, the main characteristics of evoked responses detected in EEG waves remain almost constant among users. But most reactive BCI paradigms are dependent, i.e. they require some type of activity of a standard brain output pathway: eye movement for instance. On the other hand, most active BCI paradigms are independent, but markers of task-oriented mental activities are rather unique to each individual. We think that SSSEP-based BCIs could leverage the consistency of evoked responses among users while relying on a strictly independent paradigm. Steady-State Somatosensory-Evoked Potentials are resonance-like evoked responses of the brain to sustained vibrotactile stimuli. The frequency of the SSSEP is the same as the frequency of the stimulation, therefore its discriminant features are the amplitude and phase difference relative to the stimulus.
Several mental activities are known to modulate the SSSEPs' amplitude such as attention focusing or sensory gating. The latter is a well-described ability of the brain to filter out perceived stimuli that it considers as useless during specific goal-oriented activities. Therefore, BCI paradigms can be designed to spot these mental activities through detection of variations of SSSEP amplitudes. Such BCIs could be beneficial for users with major motor impairments but with intact tactile sensory pathways, such as people suffering from Spinal Muscular Atrophy (SMA). SMA is a particularly common hereditary disease of childhood and adolescence with an incidence outstripping 1:10000. During this thesis project, we will endeavour to develop and evaluate technical aids for alternative communication as well as environment control dedicated to people with SMA.
The present contribution introduces the Steady-State Somatosensory-Evoked Potentials paradigm; the advantages of studying the paradigm over an SMA population; and a first experimental design to assess several aspects of SSSEP-based BCIs.

Keywords: BCI, EEG, Steady, State Somatosensory, Evoked Potentials, HCI, Spinal Muscular Atrophy

*Speaker
†Corresponding author: jimmy.petit@univ-lille.fr