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A periodic spatio-spectral filter for event-related potentials

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Abstract

With respect to single trial detection of event-related potentials (ERPs), spatial and spectral filters are two of the most commonly used pre-processing techniques for signal enhancement. Spatial filters reduce the dimensionality of the data while suppressing the noise contribution and spectral filters attenuate frequency components that most likely belong to noise subspace. However, the frequency spectrum of ERPs overlap with that of the ongoing electroencephalogram (EEG) and different types of artifacts. Therefore, proper selection of the spectral filter cutoffs is not a trivial task. In this research work, we developed a supervised method to estimate the spatial and finite impulse response (FIR) spectral filters, simultaneously. We evaluated the performance of the method on offline single trial classification of ERPs in datasets recorded during an oddball paradigm. The proposed spatio-spectral filter improved the overall single-trial classification performance by almost 9% on average compared with the case that no spatial filters were used. We also analyzed the effects of different spectral filter lengths and the number of retained channels after spatial filtering.

Keywords: Electroencephalogram, event-related potential (ERP) detection, brain-computer interface (BCI), spatial filters, spatio-spectral filters.

Introduction

Researchers and clinicians use patterns extracted from brain in order to identify the cognitive states of participants for different purposes, e.g., for developing brain-computer interface (BCI) systems. Considering the high temporal resolution, low costs, and ease of use (compared with other acquisition techniques), EEG data is one of the most commonly used sources of information about brain activity.