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Electromyagraphic artifact removal from electroencephalography using simulations and spatially constrained, optimised, wavelet enhanced independent component analysis

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Abstract

Electroencephalography (EEG) is used to measure electrical activity produced in the brain through multiple electrodes placed on the scalp. EEG has clinical, research, and brain-computer interface (BCI) device applications. EEG is susceptible to artifacts and noise, resulting in a diminished signal to noise ratio (SNR). A particularly challenging type of artifact is produced by muscles of the face and scalp, called electromyographic (EMG) artifacts.

This study aimed to develop an EMG artifact removal algorithm for EEG. An algorithm called spatially constrained, wavelet enhanced independent component analysis (SCWEICA) was adapted to enable EMG artifact removal. It was then improved by optimising the wavelet denoising parameters (WDPs).

The new optimised SCWEICA (O-SCWEICA) algorithm and two EMG artifact removal algorithms were used to remove EMG artifacts from various datasets of simulated 31-channel EMG artifact contaminated EEG (EAC-EEG). The datasets varied in duration and artifact topographies. The performance of the three algorithms were then compared.

O-SCWEICA was shown to be robust to changes in EMG artifact topography and well suited for offline EMG artifact removal from longer duration EAC-EEG recordings. On average, O-SCWEICA took 0.56 s to process the longest EAC-EEG recordings, those of 200 s, while maintaining high mutual information (MI) of 2.40 on average across the electrodes (AV). The worst case (WC) MI was 1.76, where WC refers to the channel with the largest EMG artifact. Compared to U-SCWEICA, O-SCWEICA was 1.14% and 12.3% more accurate in terms of AV and WC MI, respectively.