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Algorithm for Automatic Real-Time Electrooculographic Artifact Correction

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Abstract : Background: EEG is a non-invasive brain activity recording technique with a high temporal resolution that allows the use of real-time applications, such as neurofeedback. However, EEG data are susceptible to electrooculographic (EOG) and electromyography (EMG) artifacts (i.e., jaw clenching, teeth squeezing and forehead movements). Due to their non-stationary nature, these artifacts greatly obscure the information and power spectrum of EEG signals. Many EEG artifact correction methods are too time-consuming when applied to low-density EEG and have been focusing on offline processing or handling one single type of EEG artifact. A software-only real-time method for correcting multiple types of EEG artifacts of high-density EEG remains a significant challenge. Methods: We demonstrate an improved approach for automatic real-time EEG artifact correction of EOG and EMG artifacts. The method was tested on three healthy subjects using 64 EEG channels (Brain Products GmbH) and a sampling rate of 1,000 Hz. Captured EEG signals were imported in MATLAB with the lab streaming layer interface allowing buffering of EEG data. EMG artifacts were detected by channel variance and adaptive thresholding and corrected by using channel interpolation. Real-time independent component analysis (ICA) was applied for correcting EOG artifacts. Results: Our results demonstrate that the algorithm effectively reduces EMG artifacts, such as jaw clenching, teeth squeezing and forehead movements, and EOG artifacts (horizontal and vertical eye movements) of high-density EEG while preserving brain neuronal activity information. The average computation time of EOG and EMG artifact correction for 80 s (80,000 data points) 64-channel data is 300 – 700 ms depending on the convergence of ICA and the type and intensity of the artifact. Conclusion: An automatic EEG artifact correction algorithm based on channel variance, adaptive thresholding, and ICA improves high-density EEG recordings contaminated with EOG and EMG artifacts in real-time.

Keywords : EEG, muscle artifacts, ocular artifacts, real-time artifact correction, real-time ICA
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