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Probability Mapping Based Artifact Detection and Wavelet Denoising based Artifact Removal from Scalp EEG for BCI Applications

Islam, Md Kafiul

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In EEG-based Brain-Computer Interface (BCI) applications, the EEG recording is often contaminated by different types of artifacts that can misinterpret the BCI output. Automatic detection and removal of such offending artifacts from EEG for online processing pose a great challenge. In this paper, we present a novel method that can map the artifact probability of an EEG epoch based on four statistical measures: entropy, kurtosis, skewness and Periodic Waveform Index PWI). Then a removal method is adopted based on stationary wavelet transform that can be applied to the epochs by setting a particular probability threshold from the user. This epoch by epoch preprocessing would allow the user to tune the threshold parameters after some initial training with the same EEG recordings and eventually can be applied to both offline and online processing. Experimental results with both simulated and real EEG data prove the efficacy of the method that it can reliably trace the artifactual epoch with reasonable accuracy and eventually reduces the artifacts from EEG with very little distortion to the signal of interest. Further testing with EEG datasets for BCI experiments also shows that artifact removal can significantly enhance the BCI performance in both motor-imagery (MI) and event related potential (ERP) based BCI applications.