EOG Artifact Correction for Brain-computer Interface Application Using GALME-ICA

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Background and Objective

It is an established fact that neurological activity is a useful source of control in any brain-computer interface (BCI) system and artifacts are undesirable signals. We present a novel technique to reduce electrooculogram (EOG) artifacts that corrupt electroencephalogram (EEG) signals in BCI applications.

Method

We introduced the basic idea of genetic algorithm based independent component analysis (GA-ICA) and applied it to reduce additive noise from biomedical signals using kurtosis [1]. Following on this idea to develop an efficient framework which reaches better solutions and hence better performance, we implemented and tested a *G*enetic *A*lgorithm using *L*arge *M*utation rates and population *E*litist selection (GALME) [2] replacing genetic algorithm.

In traditional GA-ICA as implemented in [1], low mutation is usually a background operator and it is usually crossover which improves the performance. GALME uses large mutation to produce offspring's that are as different as possible from their parents, to examine regions of search space not yet explored. Gradually decreasing mutation rates enables GALME to find better fitness values by performing local search, using good solutions obtained. The presented GALME-ICA uses mutual information (MI) as a fitness function to reduce the EOG artifacts which corrupt the recorded EEG channels. It also reduces correlation between the recorded EEG channels. Data corrupted with eye-blinks used for this work were obtained from the BCI competition IV website (Graz data set 2B). EEG channels (C3, Cz and C4) corrupted with eye blinks recorded at the beginning of the session from file B0202T were used.

Results

The performance of GALME-ICA was compared with that of Fixed Point ICA, Amuse ICA and Sobi ICA algorithms; it is seen that GALME-ICA achieves lower PSD values for all three channels and therefore higher EOG artifact reduction. The maximum value of power spectral density (PSD) for EEG signal with EOG artifacts was 17.91 (at 3 Hz, corresponding to eye blink activity). The peak values of PSD obtained after GALME-ICA, Amuse-ICA, FP-ICA and Sobi-ICA were 9.11, 10.78, 12.97 and 11.2 respectively.

Discussion and Conclusion

In this work we have presented a fully automated method to reduce EOG artifacts for offline BCI analysis which shows improved results compared to other ICA methods. However care should be taken in tuning the parameters of GALME so that it does not converge to a local minimum. A repetition of several runs might also be necessary to obtain good solutions and the execution time for the proposed framework is higher than that of ICA algorithms. For future work, classification of the BCI competition IV (Graz dataset 2B) will be performed after reducing the EOG artifacts using the developed method.

Keywords: Brain-computer interface; Electroencephalogram; Electrooculogram, Genetic algorithm; Independent component analysis

Reference

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