Real-Time Back-Projection of Fetal ECG Sources in OL-JADE for the Optimization of Blind Electrode Positioning

Danilo Pani*, Stefania Argiolas and Luigi Raffo

DIEE - Dept. of Electrical and Electronic Engineering, University of Cagliari, Cagliari, Italy

Fetal electrocardiogram (FECG) extraction from non-invasive biopotential recordings is strongly affected by the intensity of the FECG contribution to the input signals. The higher the FECG contribution the higher the SNR and consequently the quality of the separation. The definition of a subject-specific good electrodes positioning is an open issue, sometimes addressed performing ultrasound-based preliminary examinations. In this paper we present a blind technique potentially exploitable for the real-time interactive electrodes placement, embedded into the OL-JADE extraction algorithm, a 2-stage online ICA algorithm. The underlining idea is that an estimate of the FECG power at the electrodes (lost in the estimated sources due to ICA scaling ambiguity) could be achieved inverting the blind extraction process only for the FECG estimated sources, exploiting this information for an iterative arrangement of the electrodes positions in order to find a good placement for a specific subject, improving SNR. When using OL-JADE, the main problem is that the recursive sample-by-sample nature of the first stage (whitening) prevents the identification of a single whitening matrix for a block of input samples. A good approximation of the inverse of such process can be found as a Least Squares solution obtained by the method of normal equations. On the contrary, the inversion of the second stage of OL-JADE is exact. FECG sources are virtually back-projected at the electrodes so that the input FECG power levels can be estimated. From simulations on real and synthetic signals we found that the approximated back-projection is effective in producing an FECG contributions power ranking. An optimized version of the proposed method has been integrated with OL-JADE on a floating point DSP. The real-time performance is achieved with wide margin, opening to the realization of a blind interactive electrodes positioning procedure in real scenarios.