Impact of the Approximated On-Line Centering and Whitening in OL-JADE on the Quality of the Estimated Fetal ECG

Danilo Pani*, Stefania Argiolas and Luigi Raffo

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

OL-JADE is an on-line algorithm for the separation of the Fetal ECG (FECG) from non-invasive potential recordings able to work in real-time on a DSP. It is conceived to join the separation quality of the batch JADE algorithm with the ability to follow time-varying mixing processes, with limited permutations in the order of the estimated sources, typical of sample-by-sample methods. As every Independent Component Analysis (ICA) algorithm, OL-JADE is composed of a pre-processing Second Order Statistics (SOS) stage followed by a Higher Order Statics (HOS) stage. With respect to the original JADE algorithm, OL-JADE preserves the HOS stage substituting the SOS one with a recursive sample-by-sample approximated centering and whitening. Such approximation partially violates the requirements of the JADE HOS stage so that its impact on the output quality should be carefully evaluated. This paper presents a comparison of OL-JADE with another state-of-the-art algorithm, tracking BLISS (with the HOS stage of JADE), and a manually-reordered block-by-block version of JADE. Several tests have been carried out on real trans-abdominal potential recordings in literature and on artificial mixtures of real sources either assuming time-invariant or time-variant mixing processes. The results show a substantial equivalence of OL-JADE with respect to the other algorithms with exact SOS stages. Permutations, mainly ascribable to a poor knowledge of the statistics of the noise and to unrealistic abrupt time variances, disappear enlarging the samples window for the HOS stage. Compared to tracking BLISS, which is quite similar in terms of working principle, OL-JADE presents a slightly reduced complexity and, in case of permutations due to time variances in the mixing process, permutations are confined to the involved sources but in turn these last show more distortion than in the BLISS case. The impact of the approximated SOS seems to be significant only on the noise sources.