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P077. Spatial Harmonic Analysis of EEG Data: A Comparison With PCA and ICA

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Introduction. In the analysis of multichannel EEG data, the spatial distribution of the measured potentials is of particular interest. We present a method for the spatial harmonic analysis (SHA) of irregularly sampled data, which can be regarded as a generalization of the Fourier analysis. Our objective is to compare SHA with the principal component analysis (PCA) and the independent component analysis (ICA) for the decomposition of EEG data. *Materials and methods*. The basis functions of SHA are computed by solving the Laplacian eigenvalue problem. The required Laplace–Beltrami operator was discretized by a FEM approach. The EEG data are decomposed by projection into the space of basis functions. This is similar to PCA or ICA, where projections into the space of principal or independent components are used. For the comparison, we use an own implementation of PCA and the FastICA[1] algorithm. Somatosensory-evoked potentials were recorded in eleven healthy volunteers. The median nerve of the right forearm was stimulated by bipolar electrodes. EEG signals were recorded with 256 channels (equidistant electrode layout) and 2 coupled 128 channel amplifiers. The positions of the EEG electrodes were digitized. The data were sampled at 2048 Hz and high-pass (2 Hz) and notch (50 Hz and 2 harmonics) filtered. All trials were manually checked for artifacts; the remaining trials were averaged. *Results*. The SEP data was decomposed by the 3 methods. The computational time to determine the SHA basis functions and the PCA components was below one second. The computational effort to determine the independent components by ICA was significantly higher (in the range of minutes). The time for data decomposition was similar for all three approaches. Three principal components (PCA), seven basis functions (SHA) and 98 independent components (ICA) out of 256 were required, on average, to describe 90% of the original signal's energy. *Conclusions*. The best result in reducing the data dimensionality in our application was achieved by PCA, closely followed by SHA. The advantage of SHA is that the basis functions can be computed prior the recording of the time series, because only the sensor positions are required for its determination. This is particularly beneficial for time critical applications.

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Reference

1. Hyvärinen, A. *IEEE Trans Neural Netw*. 1999;10(3):626-634.