Frequency Responses based Wavelet Decomposition

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Abstract:
Wavelet Decomposition (WLD) has been applied in the various disciplines to extract the desired signal. The wavelet represents functions that have discontinuities and sharp peaks, and for accurately deconstructing and reconstructing finite, non-periodic and non-stationary signals. Usually, three steps consist of WLD: 1) decompose the raw signal into some levels; 2) choose certain levels for the reconstruction of the desired signal; 3) the reconstruct the desired signal with the selected levels.

This presentation is specially focused on the second step. The most used methods for this step could be categorized into two groups: 1) calculate the correlation among the selected wavelet coefficients and the assumed desired signal, 2) calculate the frequency band of each levels of the signal. If the desired signal was known, the first procedure could be very good. However, this assumption is too strong in practice. The second method is according to the next criterion— the bandwidth at different levels in WLD can be roughly defined through the sampling frequency and two to the power of corresponding frequency levels. This method does not take into account of the information of the wavelet. In fact, to different wavelets, the frequency bands under the same level could be different. Hence, we design a special paradigm to include the information of the wavelet when choosing the levels for the reconstruction.

WLD can be regarded as a special digital filter too. So, the new methodology is based on the frequency response of a digital filter. It composes four steps: 1) the unit impulse is decomposed into levels, 2) each level is used for the reconstruction, 3) calculate the Fourier transformation of the reconstructed signal to obtain the frequency responses at each level, 4) select the proper levels for the reconstruction of the desired signal.

We apply such a frequency responses based WLD to study a special brain signal-event related potential (ERP). In contrast the digital filter, the performance of such WLD greatly outperforms the digital filter and contributes much better properties of the ERP.