Component selection method of noise rejection based on Independent Component Analysis for MCGs

Morio Iwai(1), Koichiro Kobayashi(1), Masahito Yosizawa(1), Yoshinori Uchikawa(2), Francis M.Bui(3)
(1)Iwate University, (2)Tokyo Denki University, (3)University of Saskatchewan

[Background]

In recent years, a magnetocardiogram (MCG) measurement which can detect heart disease early has become important in clinical research. However, it is difficult to know the exact heart activity without noise rejection because MCGs are extremely small compared with the environmental magnetic noise. The most effective noise rejection method is that of using a magnetically shielded room (MSR). But, the MSR has problems on cost and weight. Then, MCG measurement without the MSR is desired.

To solve this problem, we studied noise rejection methods using independent component analysis (ICA). In many cases, noise rejection methods using ICA are performed qualitatively and manually because we must perform component selection with experimental judge from waveforms of components separated by ICA. We proposed new component selection method to carry out this process quantitatively and automatically.

[Algorithm]

The proposed method is based on average of autocorrelation function peaks. First, we calculate component's autocorrelation function which is time-shifted from 0 to T-1 seconds (T is measurement time and calculate blocks are 1 second). After getting autocorrelation function, we get that peaks and calculate average of that peak values. Finaly, we distinguish noise from MCGs signal components using that value.

[Simulation]

We performed simulation to compare experimental judge from waveforms and the proposed method. Three simulation data (0, -10, -20 [dB]) this simulation used were made from row noise data and row MCGs signal data. These data were measured by using 64ch-SQUID magnetometer at the sampling frequency 500Hz.

[Result and Conclusion]

Fig.1 shows averages of peak values calculated from each components separated by ICA at 0 dB simulation data and those waveforms. Fig.2 shows averages of peak values calculated from each components separated by ICA at 0, -10, -20 dB simulation data and these averages are arranged in decreasing order. White bars indicate noise components by experimental judge from waveforms. Black bars indicate MCGs signal components by experimental judge from waveforms. Fig.1 and Fig.2 show first 8 components from high contribution ratio.

As shown in Fig.1, the proposed method can distinguish noise form MCGs signal components as experimental judge from waveforms. As shown in Fig.2, the boundary between peaks average of noise and MCGs signal components is 0.6 when simulation used simulation data at 0, -10, -20 [dB].

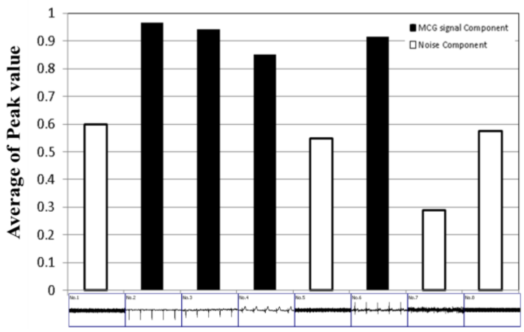

Fig.1 Average of peak values at 0dB

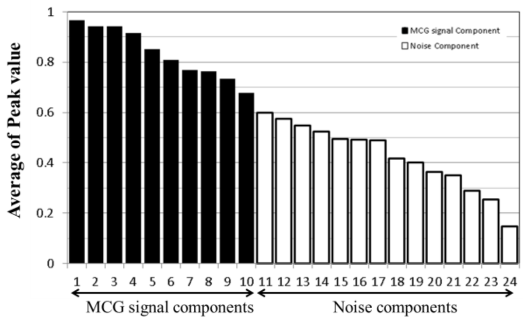

Fig.2 Average of peak values at 0, -10, -20 dB