Magnetic Dipole Localization Studies for Magnetoencephalography using Multiple Phase Inverse Analysis and the Experimental Verification

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Introduction and Methods: Present day Magnetoencephalography (MEG) is expected to stereo- graphically localize active brain regions where neuronal activities occur. Our objective is to develop a technique to localize active brain regions from MEG data. We have developed a novel technique for estimating the locations and magnitudes of magnetic dipoles which are used to describe neuronal activities. The method applies truncated singular value decomposition (TSVD), Akaike's information criterion (AICc), data clustering and downhill simplex method in the sequence shown as figure 1. We have also created an electric waveform generating unit shown as figure 2 to simulate brain wave emitted by the neurons in human brains. Measurement experiments using this unit were performed to demonstrate the validity of the proposed technique.

Results: Figure 3 shows the time-line data of the magnetic densities measured by the MEG sensors when the unit was generating a rectangular current wave in the coil. Figure 5 shows the estimation result of TSVD, AICc and the cutoff process applied on the measured MEG data (fig 4) iteratively. The hypothetical dipoles near the correct positions eventually remain. Figure 6 shows the estimation result of data clustering and downhill simplex computation using the data from figure 5. The position and magnitude of the estimated dipole are good agreement with the correct values.

Conclusion: We have demonstrated a novel method of estimating dipoles to localize active brain regions using MEG data. We will demonstrate the validity of our approach on a number of dipole coils with different waveforms.

References:
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