Source inversion technique using probabilistic Bayesian inference: MEG/EEG/fMRI imaging

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Source inversion techniques have been investigated in various areas such as geophysics, biomedical imaging, remote sensing, and so on. Source inversion has the inherent ill-posedness problem. Investigators have been commonly making efforts in developing the methodologies to avoid the effect of the ill-posedness, but recently proposed probabilistic Bayesian inference analysis [1,2] has opened a new eye in dealing ill-posedness. It does not make any attempt against ill-posedness, but accepts its inherence. Regardless of how a given problem is ill-posed and complicated, under the Bayesian frame the likelihood distribution function (forward modeling) and the priori distribution (any priori data and information) are easily combined to release the posterior distribution. Through a sampling technique, likely solutions are sampled from the posterior probability distribution. Then solutions are used to yield a reasonable solution confidence region.

In biomedical brain imaging, several different brain imaging modalities have been developed and used for brain disease diagnosis and neuroscience research. In general, each imaging modality has its own advantage and disadvantage, thus investigators have been recenlty developing strategies combining multi-modalities in a most effective way. The Bayesian inference analysis can be one of conceptually simple and easy tools for this purpose. In this work, we introduce the Bayesian inference analysis which is applied for spatiotemporal biomedical imaging - MEG/EEG/fMRI imaging. We focus on efforts to develop combined analysis on MEG/fMRI or MEG/EEG, and some related issues on this effort are discussed.

[1] Schmidt *et. al*, 1999. Human Brain Mapping 7, 195-212.
[2] Jun *et. al*, 2005. Neuroimage 28, 84-98.