Optimal Sampling and Reconstruction Patterns for Magnetic Resonance Inverse Imaging and MR-Encephalography

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Purpose:

MR acquisition methods, inspired by electroencephalography (EEG) and magnetoencephalography (MEG) source localization techniques have been presented in literature. In this work, a review of two techniques is presented, i.e., dynamic magnetic resonance inverse imaging of human brain function (InI) and MR-Encephalography. These methods are compared and potential applications are discussed.

Outline of Content:

Due to the low temporal resolution of the traditional MRI acquisition techniques employed for noninvasive hemodynamic-based functional brain imaging, gradient switching hinders the unambiguous detection of possible rapid nonhemodynamic changes [1]. A method is introduced in [1], which utilizes an array of parallel receivers to measure the functional contrast and dynamic statistical parametric maps of brain activation with millisecond temporal resolution and without the gradient-encoding scheme. This method is termed dynamic magnetic resonance inverse imaging of human brain function (InI). Initially, InI was evaluated using simulated data, compared with conventional BOLD fMRI and applied to measure BOLD hemodynamic time curves at 20-ms temporal resolution using a 90-channel head array. In addition to discussion about the InI experiments, the combined mathematical framework for InI by using basic parallel MRI reconstruction methods and MEG source localization reconstruction methods is reviewed in detail in this work. Thereafter, in order to optimize the InI mathematical framework, different methods are reviewed based on modification of proposed accelerated MRI acquisition schemes [3], [4], image reconstruction algorithms and InI source-space specifications.

In MR-Encephalography [2], high temporal resolution of 10–100 measurements per second is achieved by using multi-coil receiver array, where the spatial resolution during continuous observation is determined by the sensitive volume of each coil and no spatial encoding gradients are employed. This technique is capable of measuring and monitoring the hemodynamic response, ECG- and breathing-related signal fluctuations. Application of 1D spatial encoding either parallel or orthogonal to the cortex identifies the vascular signals by the signal variation at the ECG-frequency. In this work, initial results of the experiments using this technique are reviewed. Specifically, the methods are compared with the InI technique described earlier.
In addition to that, potential strategies to optimally combine this technique with the high-resolution imaging methods [5] are discussed.

Summary:

Two methods, InI and MR-Encephalography, for enhancing the temporal resolution in MRI are compared. Applications of these techniques in neuroscience are briefly discussed in this work. Different optimization techniques are hypothesized for these methods to acquire the data efficiently according to the desired spatial and temporal resolution.

References:

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