MAGNETIC RESONANCE SPECTROSCOPY IMAGING WITH FIELD INHOMOGENEITY COMPENSATION

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INTRODUCTION: Magnetic resonance spectroscopic imaging (MRSI) offers the possibility to study the distribution of specific metabolites in the brain. In practice, its potential is limited by the low spatial resolution due to long acquisition times used to sample the chemical shift information. In this case of sparse spatial sampling, traditional Fourier reconstruction is impaired by voxel "bleeding". Constrained reconstruction method [1,2] has been proposed for fitting low-resolution measures to high-resolution compartments that are obtained a priori, e.g., from a segmented proton image. Nevertheless, constrained reconstruction methods are unfeasible in typical ^{1}H spectroscopy, since the effect of the B_0 field inhomogeneity is too important, even after shimming.

METHODS: We propose an extension of the constrained reconstruction method that compensates for the effect of the B_0 field inhomogeneity. The method can be formulated as a least-squares fit of the measured data to the unknown spectra, taking into account a priori information on the compartments and the field inhomogeneity. Specifically, we assume an MRSI acquisition consisting of $N_S x N_S x N_T$ measurements; we arrange the data in N_S^2 vectors $\mathbf{p}_i$ of length N_T. Then, the unknown spectra $\mathbf{q}^{(k)}$ of the K compartments are found by solving the following optimization problem:

$$\left\{\hat{\mathrm{q}}^{(k)}\right\} = \arg\min_{\left\{\mathrm{q}^{(k)}\right\}} \sum_{i=1}^{N_S^2} \left\| \mathrm{p}_i - \sum_{k=1}^{K} \mathrm{H}^{(k)} \mathrm{q}_i^{(k)} \right\|^2 . \quad (1)$$

The matrix-operators $\mathbf{H}^{(k)}$ include the effects of

1) spatial localization, as characterized by the a priori high-resolution spatial information on the compartments;
2) spectral mixing, which is due to the field inhomogeneity.

The solution to (1) yields a spectrum $\mathbf{q}^{(k)}$ for each compartment.

RESULTS: We demonstrate the feasibility of our approach by a preliminary experiment on a physical phantom. The phantom is a bottle where the outer shell is filled with oil and the inside with metabolites (NAA and Cre) in doped water. After shimming, we acquired a high-resolution measure of the B_0 field inhomogeneity (as in the AUTOSHIM method) and a high-resolution proton image (both 256x256); see Fig. 1. Then, we acquired the spectroscopic data (16x16x1024). The proton image was segmented into two indicator regions (outer shell and the inside) for MRSI reconstruction.

In Fig. 2, we illustrate our results by plotting the part of the spectrum of interest for the inside (with metabolite) with (right) and without (left) field compensation. Clearly, the spurious lipid peaks are suppressed correctly and the original spectrum is properly recovered.

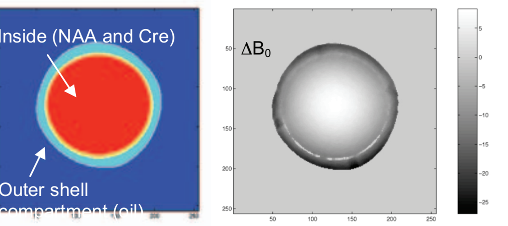

Fig. 1: Left: High-resolution compartments for physical phantom, obtained by segmenting the proton image. Right: High-resolution field inhomogeneity map.

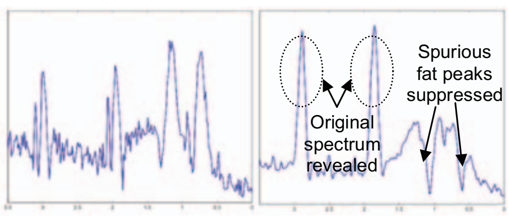

Fig. 2: Reconstruction of the spectrum: without field compensation (left), proposed method with field compensation (right); the range of interest is shown.

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