Iterative Field Map Extraction for Spiral Water-fat Imaging

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Introduction: Both $B_0$ inhomogeneity and chemical shift of fat cause image blurring in spiral imaging. Previous spiral water-fat imaging approaches e.g. [1-2] often assume these two effects are sufficiently separable so that water-fat separation and deblurring can be performed sequentially. The computed field map of $B_0$ inhomogeneity can be blurred and inaccurate in some regions when using a long readout and/or in the presence of rapidly varying $B_0$. In this work, we propose two iterative approaches based on a joint water-fat separation and deblurring method presented in [3] to refine the field map.

Methods: In both approaches, the initial field map $\Delta B_0$ is calculated by an analytical three-point Dixon method [4] as shown in Fig. 1. In method 1, we first obtain deblurred water, $W$, and fat, $F$ [3]. $W$ and $F$ are then blurred back to each $TE$. The fat fraction $P$ at each $TE$ is used to separate the original images to $W$ and $F$ components. The blurred $W$ and $F$ are then deblurred and summed up to form three deblurred images, which is used to recalculate $\Delta B_0$.

In method 2, two pairs of two $TE$ points are used to separate and deblur water and fat. $(W_1, F_1)$ and $(W_2, F_2)$ should have the same phase with the ideal $\Delta B_0$. Therefore, the phase difference between them is used to adjust the field map. Finally, $W$ and $F$ are recomputed using the refined $\Delta B_0$.

Results and Discussion: Data were acquired using spherical distributed spirals [5] on a 3T Philips Ingenia scanner. Preliminary results suggest the feasibility of both methods (Fig.2-3). Method 1 was more effective when the initial $W$ and $F$ deviate substantially from the true values (Fig.3(c)). The time for three iterations was around 7-10 min per coil. Since the blurring and deblurring employ local convolutions, the reconstruction time is expected to reduce to 3-5 min per coil by applying the algorithms only to focused regions.

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