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 ΔB_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 ΔB_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 ΔB_0. Therefore, the phase difference between them is used to adjust the field map. Finally, W and F are recomputed using the refined ΔB_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.

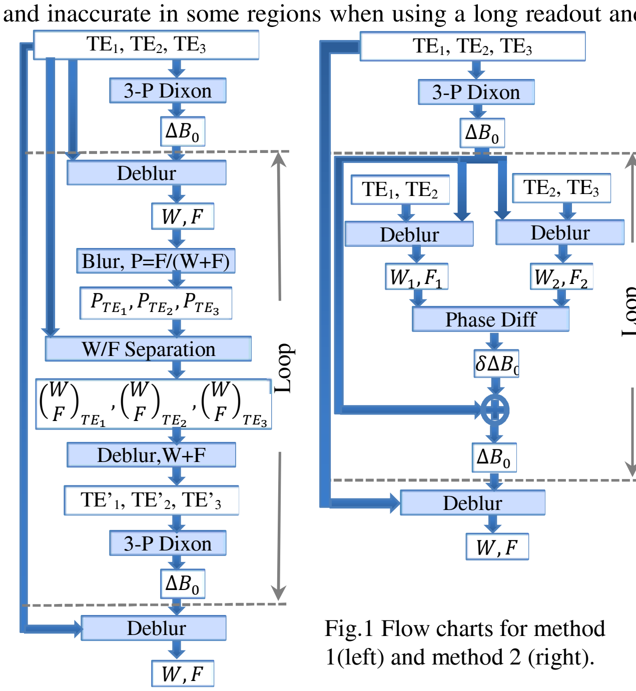

Fig.1 Flow charts for method 1(left) and method 2 (right).

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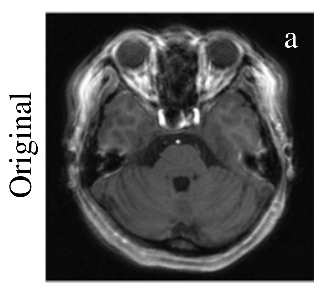
References: [1] E. K. Brodsky, et al. MRM 59:1151-64, 2008. [2] P. Börnert, et. al. JMRI 32:1262-7, 2010. [3] E. Aboussouan and J. G. Pipe, ISMRM 20: 2413, 2012. [4] D. Wang and J. G. Pipe, ISMRM 20: 364, 2012. [5] D. C. Turley and J. G. Pipe, MRM: 70(2): 413-9, 2013.



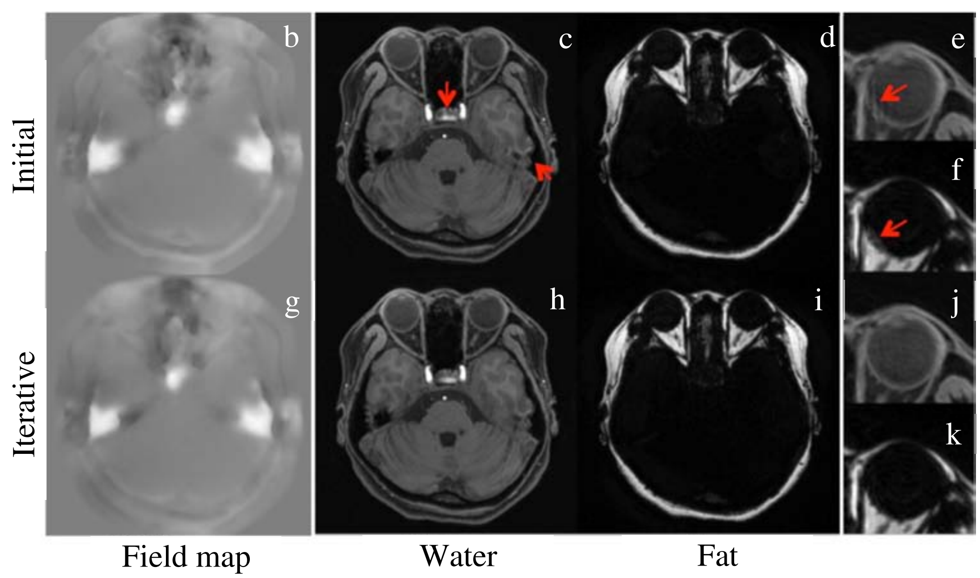


Fig. 2 Results of method 2. (a) is one of the original images. The initial field map (b) is refined to (g). W and F images (c-f) are computed using (b) and (h-k) are computed using (g). (e, f, j, k) show the left eye. Note the imperfections pointed to by the arrows are mitigated by the iterative method. Imaging parameters: ADC = 9.3 ms, $1 \times 1 \times 2\ mm$ res., 300 × 300 mtx..

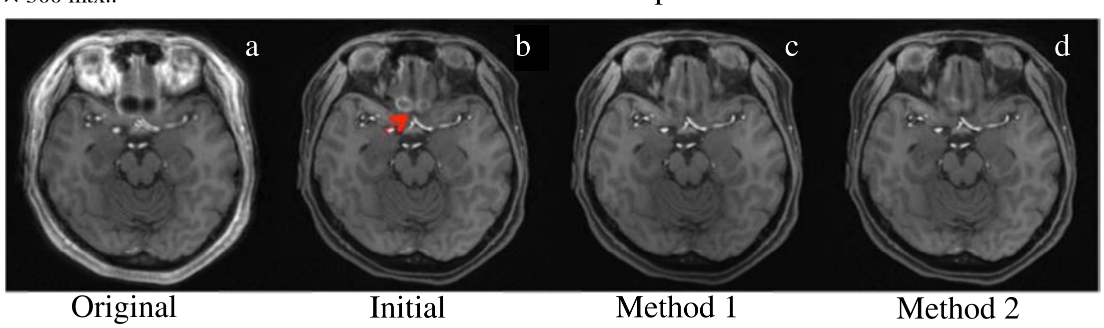


Fig. 3 Comparison of method 1 and 2. (a) One of the original images. (b) (c) (d) are the water images using initial field map, method 1 and method 2, respectively. Note the area pointed to by the arrow is better improved by method 1.