VALIDATION OF RAT BRAIN MR IMAGE INTENSITY NON-UNIFORMITY CORRECTION USING SURFACE COIL IMAGES

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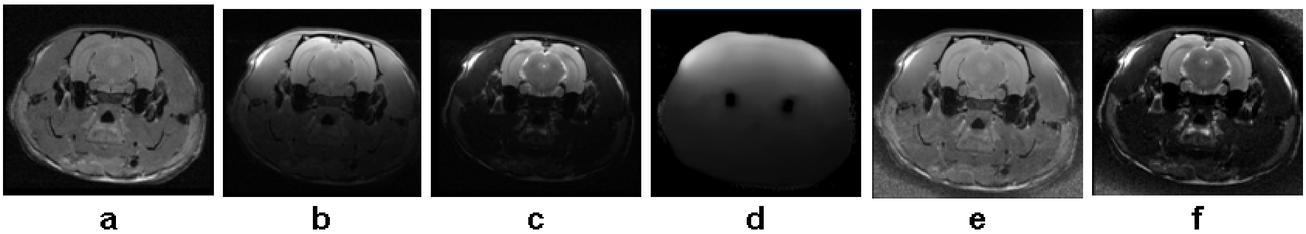
Introduction: Non-uniform intensity artifacts confound the quantitative analysis of magnetic resonance (MR) images of animal studies, particularly when using surface coils and high-field magnets. The use of correction methods proposed and validated on human brain images [1] such as the n3 algorithm [2] has previously been reported only on mouse images acquired with a volume coil [3]. Here, we evaluate the performance of n3 specifically on MR rat brain images acquired with a surface coil.

Methods: MRI scans were obtained from a 300-gram rat on a Bruker Biospec 70/20 scanner (7T) using a 4 element surface coil and three sequences: a) Proton Density weighted sequence (PDs: TE = 14ms TR= 5000ms NA = 1); b) the same sequence with only 20% of k-space filled (PD_20s), and c) a T2-weighted sequence (T2s: TE = 56ms TR = 4096ms NA = 8). All scans had a matrix size of 256 x 256 x 34, and a voxel size of 0.1367 x 0.1367 x 0.8 mm3. The first PD sequence was also acquired with a linear resonator and NA=4 (PDL) to obtain a ground-truth field bias estimation; since this image is not affected by non-uniformity, it was used to estimate the reference bias field by dividing the PDs by PDL [4] and applying a median filter (20x20) to the result. The n3 algorithm for non-uniformity correction was applied to T2s, PDs, and PD_20s (algorithm parameters: FWHM = 0.15, stop = 0.0001, distance = 8 mm, iterations = 250). For quantitative evaluation, inhomogeneity fields were compared with reference field using Pearson's correlation coefficients r.



Results: Central slice for: PDL (a), PDs (b), T2s (c); reference bias field (d); corrected images for PDs (e) and T2s (f). Correlation values between the reference field and the inhomogeneity field calculated by n3 were 0.9805, 0.6941 and 0.9808 for PDs, T2s and PD_20s respectively.

Conclusions: The inhomogeneity field correction calculated from the PDs sequence (r > 0.98) is better than the one obtained from the T2s (r < 0.70), because the low signal to noise ratio outside brain tissue in T2 sequences makes n3-based corrections more difficult. Moreover, correction using the minimum amount of information from a reduced k-space acquisition (sequence b) was equivalent to that from the full PDs image. This demonstrates the feasibility of automatic bias field correction of surface coil rat brain images using the n3 algorithm, and shows that a surface coil fast PD sequence is very well suited to calculate this correction, and can speed up the acquisition process by reducing the percentage of k-space acquired, without decreasing the quality of inhomogeneity correction results.

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