Distance Weighted B1 Uniformity Correction for Multiple Channel Image Reconstruction

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Introduction

Image reconstruction using multiple-channel receive coils for data acquisition is desirable since it improves overall image quality due to increased signal-to-noise. Conventional multiple-channel image reconstruction techniques use a sum-of-the-squares algorithm to combine images from multiple receive coils(1). One drawback of this technique is image pixel hyper-intensity near coil elements and variations in image uniformity. Several post-processing techniques(2,3,4) exist to address this issue and we present a novel approach to this problem by using the images from each channel to automatically generate coil sensitivity maps that can be applied during image reconstruction to compensate for B1 non-uniformity.

Methods

Data were collected using a 1.5 T General Electric (GE) Optima MR450w scanner (GE Healthcare, Waukesha, WI, USA) equipped with a high bandwidth 2.5 MHz data acquisition subsystem and a gradient coil capable of 50 mT/m at a maximum slew rate of 200T/m/s. Conventional T2-weighted fast spin echo (FSE) scans were performed using an 8-channel head coil (Invivo, Waukesha, WI, USA). Data were collected from a number of human subjects under approved institutional review board agreements. Raw data were saved and reconstructed off-line using MATLAB.

Results

An FSE/XL sequence was used with the following scan parameters: 2D, Axial, flow comp, tailored RF, TR=5006msec, TE=101msec, field of view = 24 cm, flip angle =90, slice thick=5mm, skip=1mm, ETL=24, 512x512, 2 NEX. Individual coil images were generated, and then coil sensitivity maps for each channel were derived. To generate the coil sensitivity maps, first the (x,y) maximum pixel intensity for each coil image is found. Then the Euclidean distance, $d_i(x,y)$, to the maximum points from each pixel for all coil images is computed. The weights are determined for each pixel as the ratio of the distance from each pixel to the local coil maximum over the summation of the distances to the maximum locations for all coils. These coil sensitivity maps are shown with their corresponding magnitude images in Fig 1. Once generated, the coil sensitivity maps are applied multiplicatively to each individual coil image prior to combination.

Discussion and Conclusion

Combined images generated with the proposed technique are compared to those generated using sum-of-the-squares(1) with no intensity correction, SCIC(2) and PURE (See Fig. 2). The proposed technique is simple and robust and provides effective B1 uniformity correction. The technique eliminates the need for a reference scan and reduces misregistration artifacts that may occur due to patient motion in between the reference scan and the multiple-channel acquisition.

References

1. PB Roemer et al., MRM, vol .30, pp. 145-142, 1990.
2. GB Avinash, US Patent No. 5,943,433, Aug. 24, 1999.
3. JW Murakami et al., MRM, vol. 35, pp. 585-590, 1996.
4. JD Jensen, US Patent No. 5,600,244, Feb. 4, 1997.

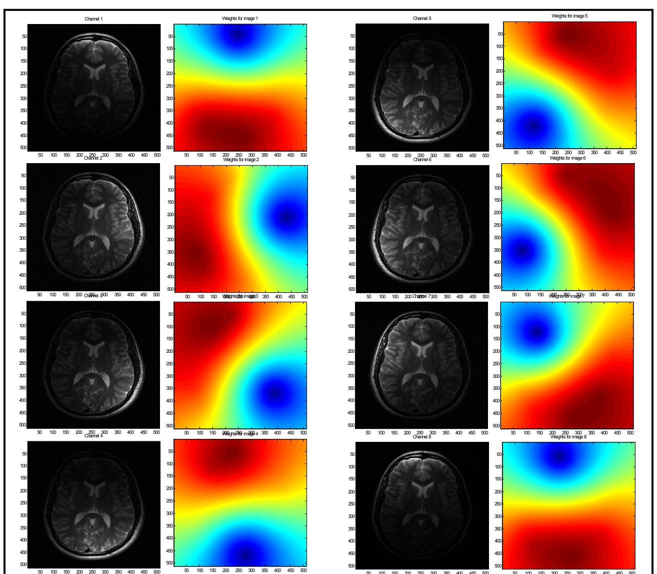

Fig. 1 – Magnitude images from each receive channel with corresponding coil sensitivity maps dervived from Euclidean distance of the maximum pixel intensity from within the individual coil image.

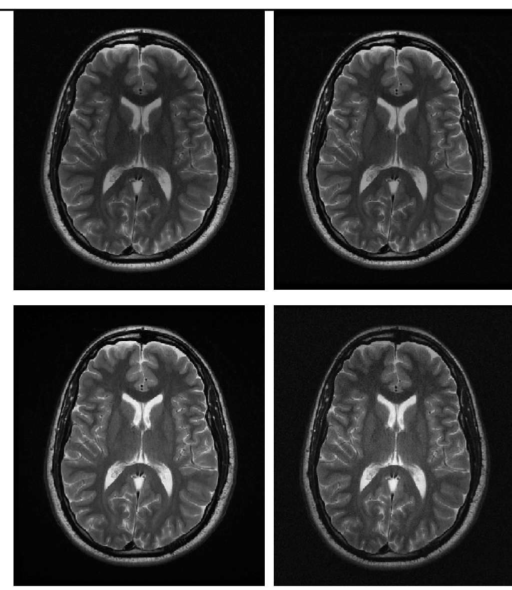

Fig. 2 – Combined magnitude images. Upper left – No correction; Upper right – SCIC; Lower left – PURE; lower right – Using Coil Sensitivity maps derived from Fig 1.