8-Channel Image Reconstruction with Independent Component Analysis

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Abstract

Image reconstruction of data acquired from 8 independent receiver channels is desirable since it improves image quality due to increased signal-to-noise. One drawback to multiple channel image reconstruction is image intensity variations. These variations stem from near-field effects and coil-to-coil coupling. Independent Component Analysis (ICA) is a technique used to separate mixed signals. ICA can be used on the images from each channel to quantify image intensity variations and correct them in the combined image.

Introduction

Conventional multi-coil image reconstruction techniques involve creating an image from each channel and then combining these images in some fashion, usually by a weighted sum of the squares approach.(1) The resulting combined image often exhibits intensity variations based on the proximity of tissue to individual coil elements. Coil coupling effects can also be observed by close examination of the individual images from each channel.

Independent Component Analysis (ICA) has been used in fMRI and DTI to relate interesting signals from noise.(2) Another application of ICA explored in this study relates to multi-channel image reconstruction. ICA can be used to process the individual images from each channel and the combined image. The resulting component images are representative of the contributions of each coil, and of particular interest, a single component image results from the combination process itself when the combined image is provided as an input to ICA. The ICA results can be used to provide a weighting map that can be applied to the original combined image, improving image quality by reducing image intensity variation.

Methods

All data were acquired using a General Electric 1.5T MR scanner equipped with an high bandwidth (1 MHz), 8-channel data acquisition system (EXCITE) and a TwinSpeed gradient coil set capable of achieving 40 mT/m peak gradient gradient strength at a maximum slew rate of 150 T/m/s, using a conventional 2D Fast Spin Echo (FSE-XL) imaging sequence. An 8-channel domed head coil (MRI Devices) was used to collect data.

The 8 channel image data were acquired with the following parameters: 83 msec TE, 2000 msec TR, 3 mm axial slice thickness, +/-32.5 kHz RBW, 256x256 acquisition size, 4 NEX, and 24 cm FOV.

The intermediate images from each coil were saved, along with the combined image. The ICA algorithm used was Hyvärinen's algorithm(3), which estimates the independent components from given set of multidimensional signals.

Results

Figure 1 shows conventional images from each of the 8 channels used for this study. Since the coils are located in a constellation surrounding the head, image pixel intensity is greater in regions closer to the periphery.

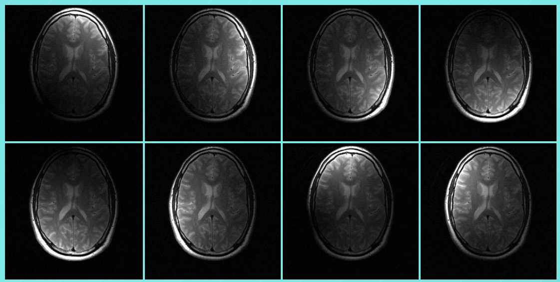

Figure 1. Images created from individual coil elements.

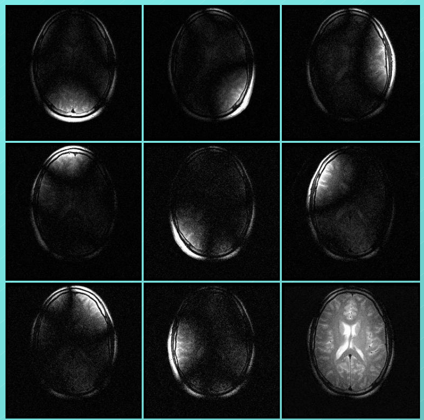

Figure 2. Independent Component Analysis results.

Figure 2 shows the component images resulting from ICA. Figure 3 compares two images created from the same data; a conventional combined image with no image intensity correction vs. the identical image corrected with an image intensity map formed using the ICA results. The image intensity corrected image has reduced center shading with minimal noise amplification.

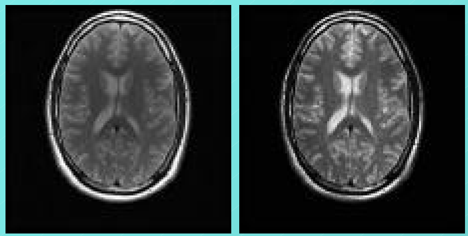

Figure 3. The image on the left is a conventional 8-channel image with no image intensity correction. The image on the right has been corrected using an image intensity correction map based on the results of ICA.

Conclusions

We have demonstrated that ICA can be used to separate images from individual coil elements, and to characterize the image combination process. The resulting components can be used to perform image intensity correction on the combined image. The corrected images show increased image intensity in regions farther away from the coil elements, thereby reducing image intensity variation and improving image quality.

References

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