Previous Abstract

TH 305

Functional MRI Using Regularized Sensitivity Encoded Echo-Planar Imaging

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Introduction

Functional MRI utilizing BOLD contrast to differentiate the state of the brain activity us uses echo-planar imaging (EPI) to achieve sufficient spatiotemporal resolution. Recent advances in the parallel MRI acquisition can potentially further improve the spatiotempo resolution and to reduce the artifacts of EPI by simultaneous data acquisition from multi receiver coils and a reduced k-space trajectory (1,3). However, the loss of SNR and cont to-noise ratio (CNR), due to the reduced data sample and the noise amplification during unfolding aliased images is not fully investigated. Previously we reported a regularized SENSE imaging reconstruction approach to reduce the noise derived from image unfold (2). Here we report the enhanced CNR in block-design fMRI experiments using regularization, compared to standard SENSE reconstructions.

Methods

The functional MRI data were acquired from a 3T scanner (Siemens Medical Solution, Inseln, NJ) with an 8-channel head phased array coil and a 1.5 T scanner (GE medical, Milwaukee, WI) with a 4-channel head phased array coil. Two healthy subjects were recruited to the study after the approval from the Institutional Review Board. At 3T scar visual checkerboard fMRI with block-design paradigm was performed. Imaging acquisi used a 2D segmented gradient echo echo-planar imaging (EPI) sequence with parameter TR=2000 msec, TE=40 msec, slice thickness=3 mm with 1.5 mm gap, 10 slices, FOV=2 mm x 200 mm, image matrix size=128 x 128, EPI phase encoding step per shot=43 or 3 Volumetric functional data of 75 time points were acquired. At 1.5T scanner, motor fing tapping fMRI with block-design paradigm was performed. Imaging acquisition used a 2 gradient EPI sequence with parameters as: TR=2000 msec, TE=50 msec,slice thickness= mm (no gap), 8 slices, FOV=240 mm x 240 mm, image matrix size=128 x 128, EPI pha encoding step per shot=64. Volumetric functional data of 64 time points were acquired i 2min

Each segment of EPI volume was reconstructed to achieve 3.0-fold and 4.0 fold accelera in visual fMRI data, and 2.0-fold acceleration in motor fMRI data. Regularized SENSE reconstruction was computed based on the L-curve technique (2). To quantify the impro detection power using regularization, receiver-operating-characteristic (ROC) curves we computed for the t-statistics calculated from regularized and non-regularized reconstruct

Results and Discussion

Figure 1a shows the t-statistics of the fMRI data using full k-space, regularized and unregularized SENSE fMRI acquisitions at 3.0- and 4.0-fold accelerations. Note that at t same t-statistics level, fewer activation pixels are present in SENSE acquisitions. The lo BOLD SNR is due to the reduced data samples in SENSE accelerations. Regularized an unregularized SENSE reconstructions show qualitatively similar activations maps. Figu compares the ROC curves of regularized and unregularized SENSE fMRI detection usin full phase-encoding acquisitions as a gold standard. In 3.0- and 4.0-fold accelerations, regularized SENSE reconstructions have higher sensitivity and specificity in compariso unregularized reconstructions. Compared to standard SENSE reconstruction, regularizat also improved the detection power in motor fMRI (Figure 2).

References
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The t statistics maps and ROC curves of full k-space acquisition, 3.0- and 4.0-fo SENSE accelerations with/without regularization in 3T visual fMRI data.

The t statistics maps and ROC curves of full k-space acquisition, 2.0-fold SENS accelerations with/without regularization in 1.5T motor fMRI data.