Artifact and Resolution in Parallel imaging: An analysis of SENSE, SPACE RIP and GRAPPA

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INTRODUCTION :

Parallel imaging methods have been the subject of very active development in the last few years. These techniques allow for faster image acquisition, but affect image quality by introducing artifacts at higher accelerations. The coil sensitivity profile and the sampling strategy both impact the numerical conditioning of the image reconstruction problem. SENSE [1] samples k-space regularly, and Tikhonov regularization is typically employed for conditioning. GRAPPA [3] allows for a more general sampling pattern, while SPACE RIP [2], offers the most flexible k-space sampling options and is amenable to conditioning by Singular Value Decomposition (SVD) thresholding. Until now, no standard method of assessing image quality in parallel imaging has been adopted. In this work, standard American College of Radiology (ACR) tests were used to assess Artifact and Resolution performance of SENSE, SPACE RIP and GRAPPA for a fixed acceleration factor.

METHODS :

We computed ACR phantom reconstructions of three and four fold accelerated images acquired using an 8-channel array. A plot of a column in the image containing sharp intensity pixels was used to assess resolution and artifacts. For all reconstruction strategies, optimization was performed to minimize artifacts and maximize resolution. In the SENSE images, Tikhonov regularization was applied with regular k-space sampling. For the SPACE RIP reconstructions, both k-space sampling and regularization were applied. The k-space distribution was varied following an exponential parametric function. GRAPPA used a Hat distribution k-space function.

RESULTS:

The "Best outcome" SENSE, SPACE RIP and GRAPPA images are shown in Fig.1 for the different sampling strategies. A plot of the column demarcated in the images is shown for 3x and 4x accelerations in Figs 2 top and 3 top respectively. The regions shown under the box are expanded in Figs 2 bottom and 3 bottom. Visual comparison of the results indicates that the best reconstruction could be achieved using SPACE RIP. Examination of the column plots in Figs 2 and 3 shows that SPACE RIP results show less artifacts for the required resolution than the two other methods.

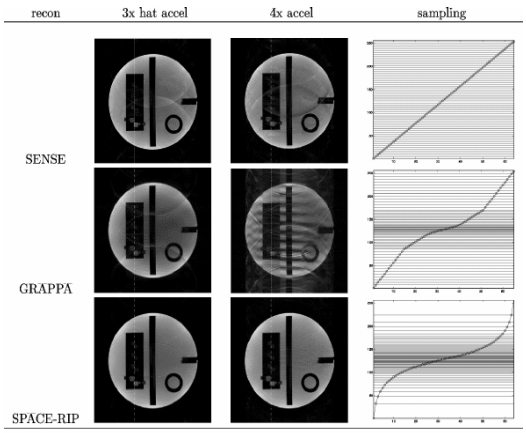

Figure 1:

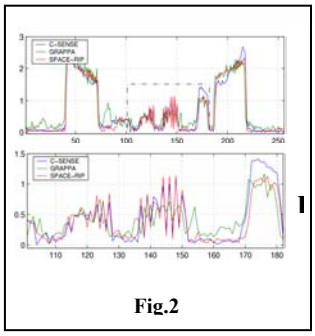

Fig.2

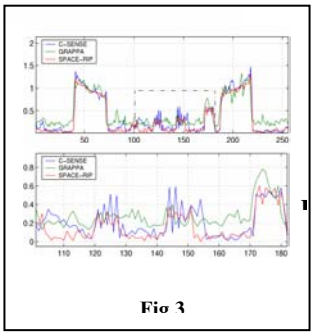

Fig 3

DISCUSSION:

An ACR phantom was used to assess image quality performance in SENSE, SPACE RIP and GRAPPA reconstructions. Results show that optimized irregular k-space sampling, coupled with proper numerical conditioning, allows finer control of image quality in SPACE RIP than in the other two techniques, yielding better artifacts suppression for a fixed resolution and acceleration.

REFERENCES:

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