Reducing The Number Of RF Channels In Parallel Imaging

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INTRODUCTION:

Parallel imaging techniques require array coil elements oriented along phase encoding (PE) direction [1-7]. In order to maintain a sufficiently high SNR in the reconstructed image for various PE directions, acceleration factors and field-of-views (FOVs), the number of array coil elements has to be sufficiently large. This paper presents a generalized approach for array imaging involving pre-combined RF signals. The method serves to reduce the number of necessary RF channels for a given PE direction, acceleration factor and FOV. It is shown that pre-combining RF signals allows reduction of the number of necessary RF channels, while still maintaining the high SNR of the original large array for a given region-of-interest (ROI).

METHODS:

In general, parallel imaging techniques use a number of N coil elements to reduce data acquisition by a factor R=M with typically N≥M. Methods which operate in the image domain usually reconstruct the final image by separating the acquired data on a pixel-by-pixel basis.

When looking at the reconstruction method outlined by Pruessmann et al. [6], it is evident, that the procedure can be split into two steps:

In the first step, the original N coil signals are reduced to M coil signals which can be regarded as signals received by "virtual" coil elements, created by a weighted combination of the original N signals. The weighting factors for creating the new coil elements are equivalent to optimum array coil weighting factors given by Roemer et al. [8]. Thus, the new "virtual" array consist of M coils where each coil element I=1..M delivers optimum SNR at one of the pixel locations I=1..M which have to be separated.

In the second step, the M signals are combined in such a way that maximum sensitivity is achieved at one particular pixel location J while minimum sensitivity is achieved at all other locations I≠J.

The method outlined here reduces the amount of input data which has to be transformed from k-space to the image domain, by creating a fixed set of "virtual" Roemer weighted coils for points along the PE direction. This can be either done in hardware as outlined in [9] or in software, thus increasing the flexibility of the method with regards to different acceleration factors, PE directions and ROIs.

RESULTS:

In order to demonstrate the method, sensitivity data for a 32 channel array of rectangular coils placed around a cylinder of 25cm diameter has been generated using a full wave simulation based on [10].

Figure 1a shows the relative SNR (1/g-factor) map for the 32 channel array ith a reduction factor R=4 in up-down direction. Relative SNR at the center of the image is at 85%, equivalent to a g-factor of 1.18. Figure 1b shows a relative SNR map for a reduced data set using only 9 pre-combined signals. Note that the relative SNR at the center is exactly the same as in Fig. 1a. Figure 2 demonstrates, that even with a reduced data set using only 5 coil signals, relative SNR at the center of the image remains almost unaffected at 84%.

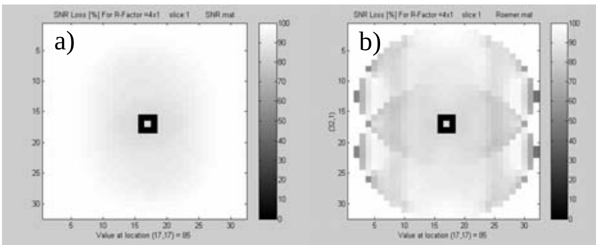

Figure 1: a) Relative SNR map of the original 32 channel array for R=4. **b)** Relative SNR map of the reduced 9 channel data set for same R=4.

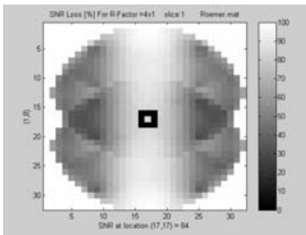

Figure 2: Relative SNR map of the reduced 5 channel data set for same R=4.

DISCUSSION AND CONCLUSIONS:

Using pre-combined array coil signals, the amount of input data for parallel imaging can be drastically reduced, thus leading to significantly shorter reconstruction times.

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