

Channel Reduction with Multiple Receptions

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Introduction

In recent years, the need for high signal-to-noise ratio and fast imaging acquisitions has driven the development of MRI systems with more receive channels. However, such multi-channel systems are not always available in current clinical and research MR scanners. Array compression techniques [1-5] with the use of hybrids, Butler matrix or mode-mixing hardware allow the optimal use of existing channels. SNR as well as G-factors can be improved if the insertion loss caused by the additional hardware is well addressed. In this work, a straight-forward method by applying multiple receptions is proposed for channel reduction. Coupling among coil elements, cables and pre-amps is reduced, and a specific GRAPPA illustrates less fitting errors. We validate the method by using a 16-ch head array to 8 receive channels at 7T.

Method

The array with large coil elements was divided into two or more groups for continuous receptions with the existing receive channels. High-speed switches were inserted into the bias circuits of the system to perform the proposed multi-reception. Parallel imaging was then applied to compensate for the redundant scan time. A 16-ch head array (Nova Medical Inc.) was used to test the method on a MRI system with only 8 receiver channels. Fig.1 illustrates the criterion of coil grouping for the multi-reception method. With the proper grouping, the diagonal distributed large values in noise correlation matrix (Fig 1a) were arranged into I and III quadrants (Fig 1b). Through the twice receptions, the large values in I and III quadrants were removed (Fig 1c). Fig 1d shows the measured noise correlation matrix with the twice-reception. The mean value of the matrix was dramatically decreased from 0.037 to 0.013, which indicates the coil grouping significantly improved the isolation among coil elements.

Due to the multi-reception, specific GRAPPA with different sampling and filling scheme may be applied. K-spaces with different phase encoding lines are sampled in different receptions (Fig 2). The fitting error of the specific GRAPPA is highly related to the coil grouping. Fig 3 shows the subtractions of GRAPPA reconstructed image and sum-of-squares image. The artifact power (AP) [5], a factor indicating the fitting error of parallel imaging, was then calculated based on the subtraction images. Different coil grouping results in different AP values. With the proper coil grouping, the artifact from the specific GRAPPA decreased 22% of the regular GRAPPA.

Results

Fig.4 shows the human head images from the 16-element array with twice receptions and specific GRAPPA of reduction factor 2. The image is compared with that from an 8-element head array (Nova Medical Inc.) With the same scan time and the same receive channels, the image quality is comparable in terms of SNR and resolution. The proposed method has slightly stronger signal at the peripheral but slightly weaker signals at the central part of the head image.

Conclusion and Discussion

A new channel reduction method is proposed. With the use of multiple receptions and parallel imaging, arrays with larger coil elements can be used at the system with less receive channels. This method is particularly useful for densely placed coil array with low reduction factors.

References

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FIG. 4

(Left) 16-ch head array: 2 receptions with specific GRAPPA R=2
 (Right) 8-ch head array: sum-of-squares
 With the same scan time and receive channel number, the proposed method exhibits its similar image quality to that of the regular 8-ch array

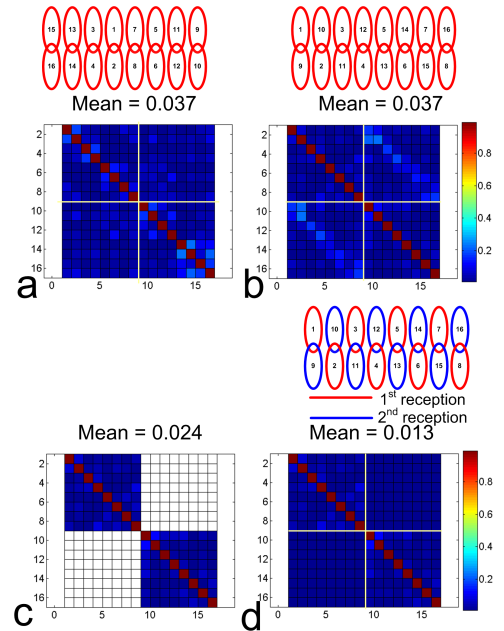
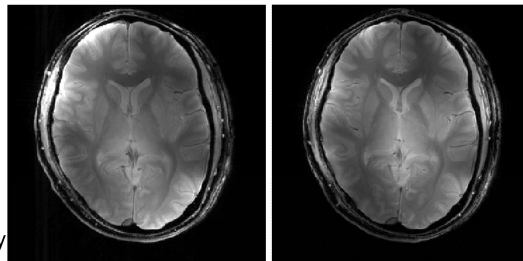


FIG. 1 Multi-reception to optimize noise correlation

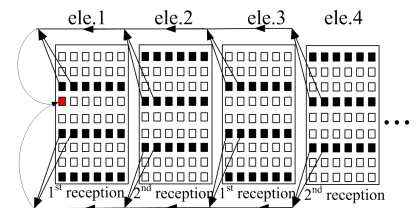


FIG. 2 Specific GRAPPA for multiple-reception

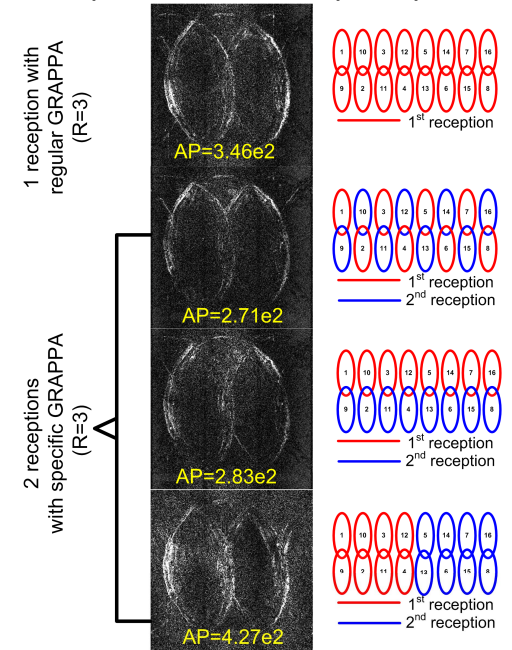


FIG. 3 With the proper grouping, the specific GRAPPA shows much less artifacts than the regular GRAPPA