A Comparison of Methods for Reducing the Number of Channels for SENSE

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Introduction

Typically, each coil element in an array is connected to its own independent receiver channel. However, as the arrays have become larger, the cost of using individual receivers has become prohibitive and methods of switching or combining the coil elements are being explored. For example, the TIM system includes over 76 coil elements in its array (1) and is connected to a 32 channel receiver (2) using its Mode-Matrix method(3). In 2004, Reykowski proposed a method for combining array elements to reduce the receiver count and each channel would produce the optimal SNR at a point in the image (4). Recently, our group developed a method for optimizing the SNR in a region of the FOV for each channel (5). In this abstract, the point combined and region combined methods for combining arrays are compared for SENSE imaging(6).

Methods

A 64 element linear array of planar pairs(7) with 64 independent receivers(8) was used to acquire an image in the coronal plane parallel to the array. The signals from each channel were combined in software to simulate the coil combination. The coil sensitivities were computed using quasi-static methods. For the point combined method, the weighting coefficents were computed for equally spaced points along the center of the array(9). For the region combined method, the FOV was subdivided into rectangular regions and the weighting coefficents were computed to optimize the SNR over these regions(5). The combination reduces the number of receivers required from 64 to 8 or 16. Using the reduced number of channels, a SENSE reconstruction is performed and the final images reconstructed.

Results

The SENSE reconstructed images for the point combined and region combined methods are shown below. Reconstructions were done for reduction factors of 2 and 4 after combining the 64 element array down to 8 or 16 channels. The point combined method performs very well with little to no distortion in the SENSE reconstruction, however, the images look banded due to the sensitivity of the channels being focused on 8 or 16 equally spaced points. The region combined method did not perform well using SENSE. At a reduction factor of two, the sensitivity appears to be uniform, but there is blurring due. At a reduction factor of factor of four, the images are unrecognizable using the region combined method.

Discussion

The point combined method performs better than the region combined method when these methods are used for SENSE imaging. The sensitivity of each reciever channel using the point combined method is tightly focused on the chosen point. This results in each receiver having low sensitivity at any of the other chosen points and the receivers being nearly orthogonal. This is ideal for the SENSE reconstruction, but, if not enough receiver's are used, can result in a banded image due to nulls in sensitivity between the chosen points. The region combined method assigns each channel a section of the FOV and optimizes the SNR over that region. Using regions instead of points diffuses the sensitivity and results in more uniform coverage and eliminates the banding. However, the broadened sensitivity profile for each channel extends beyond the bounds of the assigned region and into adjacent regions resulting in correlation between receiver channels. This loss of orthogonaility between the channels is detrimental to the SENSE reconstruction.

In conclusion, the point combined method performs better for SENSE imaging by producing a more orthogonal basis set of receiver sensitivities, but may have nulls in sensitivity in the overall FOV if not enough points are used. The region combined method provides more uniform coverage, but results in significant artificacts in the SENSE reconstruction. This method might be improved by choosing smaller regions that aren't adjacent.

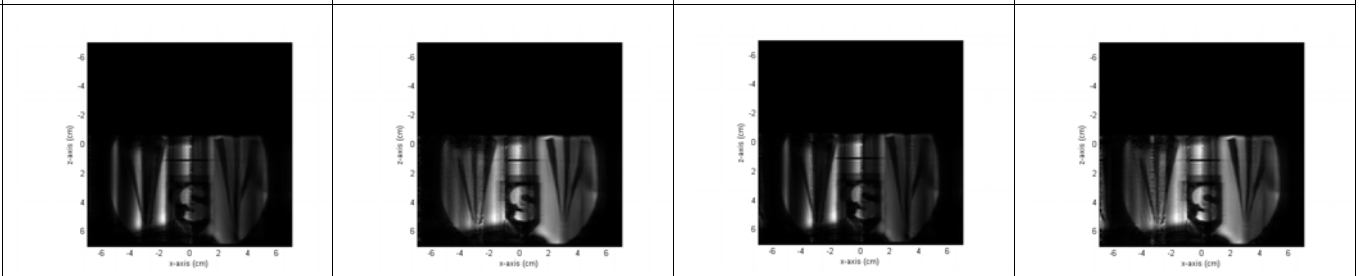
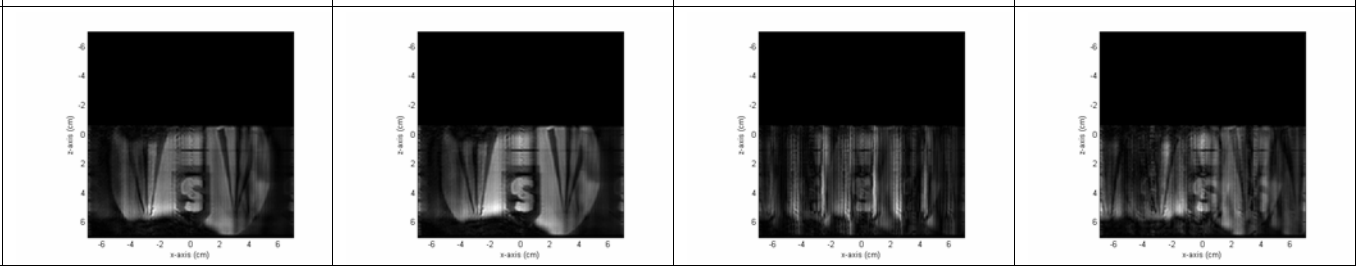
	Factor of 2 Reduction		Factor of 4 Reduction	
	8 channels	16 channels	8 channels	16 channels
Point Combined				
Region Combined				

Table 1. SENSE reconstructed images acquired using 64 element array combined to 8 or 16 channels at reduction factors of 2 and 4.

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