Faster and More Robust MRI Using Sharable Information Among Images With Different Contrasts

Feng Huang[1], Yu Li[2], Wei Lin[1], George Randy Duensing[1], and Arne Reykowski[1]
[1]*Invivo Corporation, Gainesville, FL, United States,* [2]*Radiology Department, Cincinnati Children's Hospital Medical Center*

Introduction

A typical clinical MR examination is composed of a number of scans to acquire images with different contrasts, such as T1 weighted (T1w), T2 weighted (T2w) and diffusion weighted imaging. Currently, the acquisition and reconstruction schemes of these scans are independent to each other. In the presented work, we propose to jointly optimizing the acquisitions and reconstructions of a multi-scan MRI examination for faster and more robust MRI. Preliminary results have shown that the faster and more robust MR imaging can be achieved by using the sharable information among images with different contrast.

Theory

One of the most important features of MRI is that it can provide images with different contrasts for complementary diagnostic information. Since the same subject is scanned in the same system using the same RF coil, the information such as B_0, B_1^-, optimized acquisition trajectory and reconstruction parameters, etc, can be shared among these scans for different contrasts to improve the image quality. Figure.1 graphically explains the concept. This idea is fundamentally different from previous method that using one set of acquisition to artificially produce images with different contrasts [1]. In the proposed scheme, data for each contrast are still acquired independently. However, the acquisition order, acquisition trajectory and reconstruction methods will be optimized jointly, and some common information will be either shared or generated jointly.

Methods and Results

As an example for faster MRI, a two-scan examination consisting of T1w and T2w contrasts with a gradient echo sequence was acquired, on a Philips 1.5 T Achieva system with an 8-channel head coil. Optimization of acquisition protocol: In this scenario, the acquisition of T1w image is faster than T2w image for the same resolution. Hence, the T1w image was acquired first with low reduction factor, 2. The T2w image was acquired after the analysis of the reconstruction of T1w image with net reduction factor 5. Generate sharable information: Pre-scanned low resolution image was used for the sensitivity maps in the reconstruction of the T1w image. Given the reconstructed full *k*-space of T1w image, the sensitivity maps were updated using the high resolution T1w image; the optimized regularization parameter was experimentally found for self-feeding sparse SENSE [2] (SFSS); the optimized acquisition trajectory (location of acquired PE lines) was detected for SFSS [3]. Application of sharable information: The data for T2w image was acquired using the optimized trajectory from the previous step. SFSS was applied with the updated sensitivity maps and optimized parameter to reconstruct the T2w image. Figure 2 shows the results of the proposed method. Using this scheme, the total acquisition time for the T1w and T2w images can be reduced from 192 sec to 56 sec. The cost was root mean square error (RMSE) of 5.4% (Fig. 2a) and 8.8% (Fig. 2b) for T1w and T2w image respectively. The RMSE of the T2w image would be 23% (Fig. 2d) without using the sharable information. Fig. 2c was the error map of Fig. 2b, and was brightened 5 times. No change of contrast can be observed in the error map Fig. 2c.

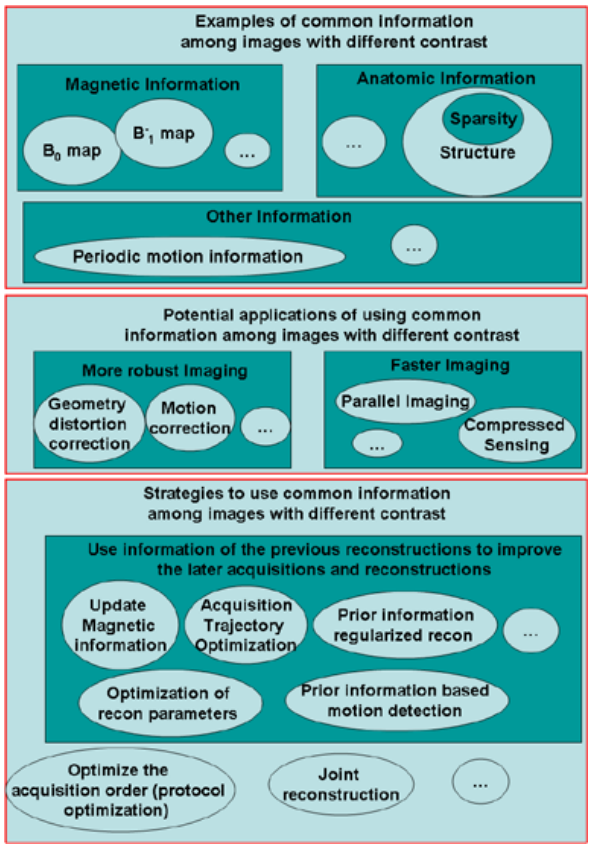

Figure 1. Common information among images with different contrast: examples, potential applications, and strategies

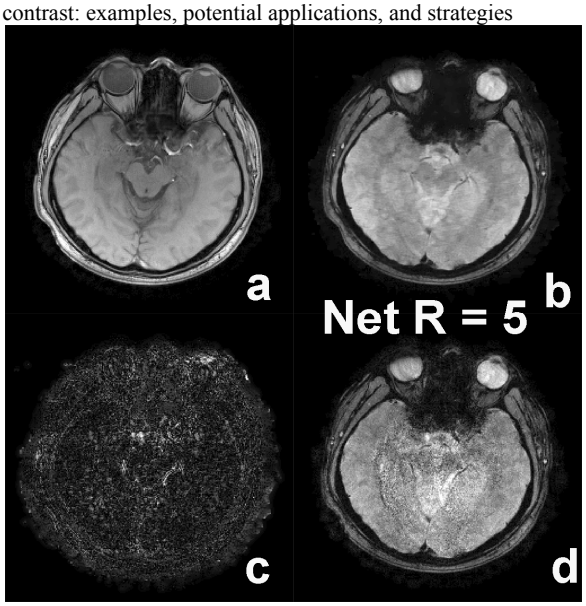

Figure 2. An example of the proposed method using an 8-channel head coil. a) and b) are reconstructed T1w and T2w image at net reduction factors 2 and 5 using the proposed method. c) error map of b), brightened 5 times. d) reconstructed T2w image using the conventional method at net reduction factor 5.

Discussions and Conclusion

The basic concept of imaging with sharable common information is demonstrated. The example in Figure 2 shows that the use of common information can improve image quality (RMSE dropped from 23% to 8.8%) at high reduction factor (net reduction factor 5 with 8-channel data). When multiple contrast images are reconstructed jointly, the sharable common information can be updated jointly and/or iteratively to further improve the reconstruction. Preliminary results on the application of this concept for motion compensation, and geometry distortion correction are reported in additional abstracts. Besides the common information used in this example, some contrast related information, such as forcing all images share the same sparsity features [4] and image correlation [5], can also be shared. In short, imaging with shared information can have a major impact in fast and robust MRI, but needs more attentions and researches.

References

[1] Song, H. K., et. al. MRM 2000; 44: 825-832.
[2] Huang, F., et. al. MRM 2010; 64:1078-1088. [3] Seeger, M., et. al. MRM 2010;63:116-126. [4] Bilgicl, B., et. al. ISMRM 2011; 71.
[5]. Li, Y. et al. ISMRM 2011; 19: 745