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Accelerated coronary mri using compressed sensing with transform domain dependencies: a feasibility study

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Introduction

Coronary MRI still faces major challenges including lengthy acquisition time, limited spatial resolution, signal to noise (SNR) and contrast to noise ratio (CNR). Parallel imaging has been used to accelerate coronary MRI. However, image quality significantly degrades at higher rates (>2). Compressed sensing (CS) has been recently proposed to further accelerate acquisition time; although its use in CMR has been very limited. In this study, we sought to develop a highly under-sampled coronary MRI method based on CS that uses the dependencies of the transform domain coefficients to reduce image blurring and artifacts.

Materials and methods

CS exploits the sparsity of the image in a transform domain to accelerate image acquisition [1,2]. CS reconstruction optimizes an objective function which combines a fidelity measure of image consistency and a weighted regularizer (typically l_1 norm) that captures the sparsity of the image in a transform domain (e.g. wavelet). In previous CS reconstruction methods, transform-domain coefficients are treated as independent random variables. However, there is correlation between the wavelet coefficients of a given neighborhood. Both this correlation and the sparseness of the wavelet transform can be captured using a Gaussian scale mixture (GSM) model [3]. Thus, we propose an algorithm, where at each iteration the reconstructed image is first updated for data consistency, using data from all coils and then sparsified using a Bayesian least-squares approach that exploits the GSM model (BLS-GSM) describing the correlation between neighboring wavelet coefficients [3].

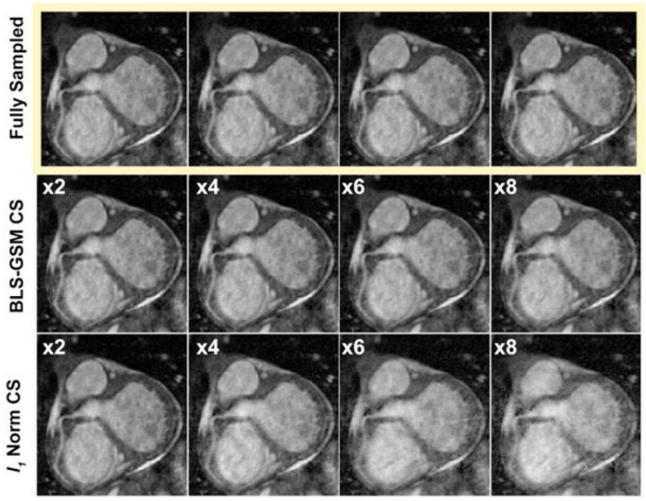

Figure 1
Example right coronary images reconstructed with a fully sampled data (first row-repeat images), the proposed reconstruction method using Bayesian Least Squares with Gaussian Scale Mixture (BLS-GSM) (second row), and conventional l_t norm minimization (third row) for different acceleration factors of 2 to 8.

The proposed method was implemented in Matlab for off-line reconstruction. Images were acquired on a 1.5 T Philips Achieva magnet with 5-channel cardiac coil. A 3D, free-breathing ECG-triggered SSFP (TE/TR/α = 4.3/2.1/90°, spatial resolution = 1 × 1 × 3 mm^3) sequence with T_2-prep and spectrally-selective fat saturation was used for imaging the right coronary artery. The relative B_1 coil map was reconstructed from the fully-sampled data without any further post-processing. The k-space data were under-sampled by factors of 2,4,6 and 8 by keeping 16 phase-encode lines around the center while randomly discarding data in the outer region. Images were reconstructed using both the proposed method and l_1 norm minimization [2].

Results

Figure 1 shows an example right coronary MRI reconstructed with a fully sampled *k*-space data, acceleration rates of 2,4,6, and 8. Images are reconstructed using the proposed and l_1 method.

Conclusion

We have demonstrated the feasibility of compressed-sensing coronary MRI with transform domain dependencies which reduces image blurring.

References

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