A Novel Compressed Sensing-based Approach for Fast MRI Reconstruction from Highly Undersampled K-Space Data

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Introduction. Magnetic Resonance (MR) imaging is a multiparametric imaging technique allowing the diagnosis of a wide spectrum of cardiovascular diseases. Unfortunately, MR acquisitions tend to be slow, limiting patient throughput and limiting potential indications for use while driving up costs. Compressed sensing (CS) is a method for reducing MR scan time by acquiring less data through under-sampling of k-space. Unfortunately, CS prolongs image reconstruction time, since it requires execution of a computationally intensive optimization algorithm that iteratively estimates the whole image from undersampled data. In this study we formulated a novel CS based-approach to speed up reconstruction procedure.

Methods We embedded in a nonconvex weighted total variation-based approach for MR image reconstruction starting from highly undersampled k-space data, a further fidelity term between the gradient of the solution and the gradient of an image containing a good map of the gradient of the ideal image. This approach was tested for the reconstruction of cardiac images in 10 delayed contrast enhanced MR (DCE-MR) acquisitions, using different k-space masks. Fully sampled MR images and the reconstructed images obtained using a different number of sample lines were compared by means of peak- and signal-to-noise ratio (PSNR and SNR) metrics.

Results and Conclusions. Radial mask allowed the reconstruction of images of comparable quality (PSNR $\in [30\ 40]$) but using less information compared to other k-space filling trajectories. In all the 10 DCE-MR images we obtained a good reconstruction with similar SNR of corresponding fully sampled images using less than 20% of the original samples. The proposed approach allowed a fast and accurate reconstruction compared to the conventional CS framework.

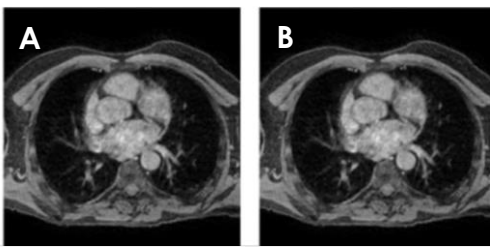

Figure. A. Original DCE-MR image obtained with a fully sampled k-space (SNR=0.28); B. DCE-MR image reconstructed using 17% of the fully sampled k-space (PSNR = 29.2, SNR =0.30)