Interpolated Compressed Sensing MR Image Reconstruction using Neighboring Slice k-space Data

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Introduction: Sparse MRI [1, 2] has been introduced to reduce the acquisition time and raw data size by significantly undersampling the *k*-space. In this project, we propose an interpolation method to increase the signal to noise ratio (SNR) or imaging speed for multi-slice two-dimensional MR imaging. The raw data of each slice is multiplied by a weighting function and then used to estimate the missed k-space data of the neighboring slice, which helps improve the SNR of the neighboring slice. In-vivo MR of human feet has been used to investigate the feasibility of the proposed method, showing obviously increased SNR of the neighboring slice.

Theory and method: In multi-slice two-dimensional MR imaging, the raw data of two adjacent slices have some similarity, therefore it is potential to increase the SNR by interpolate the missed k-space data of one slice by using some k-space data from another slice multiplied by a weighting function, while keep the original raw data of the slice unchanged. It is potential to increase the SNR of 2D sparse MRI where the k-space is dramatically undersampled. Following is the reconstruction strategy:

1. Variable-density sampling scheme and Mote-Carlo incoherent sampling strategy were firstly used to choose the *k*-space samples [1] for each slice;
2. The k-space sampling of the two slices were compared;
3. The k-space data from one slice was multiplied by the weighting function and interpolated into the k-space of the neighboring slice to estimate the missed k-space data;
4. Non-linear conjugated gradient was used to perform image reconstruction using the interpolated k-space data.

Fig.1 shows the diagram of the proposed method. To investigate the feasibility of the proposed method, a healthy human foot was used in in-vivo MR imaging at GE whole body 7T scanner with the following imaging parameters: TE=2.76ms, TR=10ms, matrix size =512×512, field of view (FOV) =14cm, slice thickness =2mm, number of excitation=1. In plane resolution was 0.276mm. The undersampling rate is 1/20 for each even slice while 1/4 for each odd slice as shown in Fig.2. Each odd slice is used to estimate the missed k-space data of the neighboring even slice.

Results: Fig.3 shows foot MR images of 3 adjacent slices on sagittal plane. The first row is the images reconstructed from full k-space data for reference; the second and third rows are the images reconstructed using the original compressed sensing and the proposed method. It is demonstrated that the SNR has been greatly improved by using the k-space data from adjacent slice to estimate the missed k-space data for reconstruction.

Conclusions and discussions: The interpolated Compressed Sensing reconstruction method has been proposed in this work to improve the SNR or increase the imaging speed for the significantly undersampled sparse MRI. The missed k-space data are estimated using the neighboring slice k-space data, resulting in higher SNR without acquiring more k-space data. In-vivo MR images of human foot has been demonstrated the feasibility of the proposed iCS method.

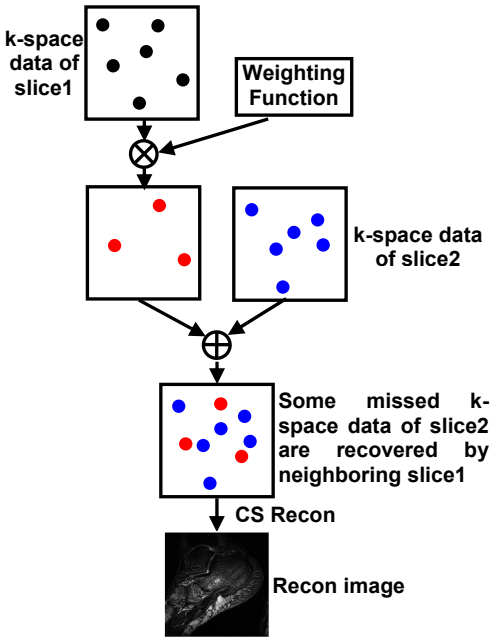

Fig.1 Diagram of the proposed interpolated compressed sensing (iCS) method.

References: [1] Lustig M, et al, Magn Reson Med 2007; 58: 1182-1195. [2] Jung H, et al, Magn Reson Med 2009; 61: 103-116.

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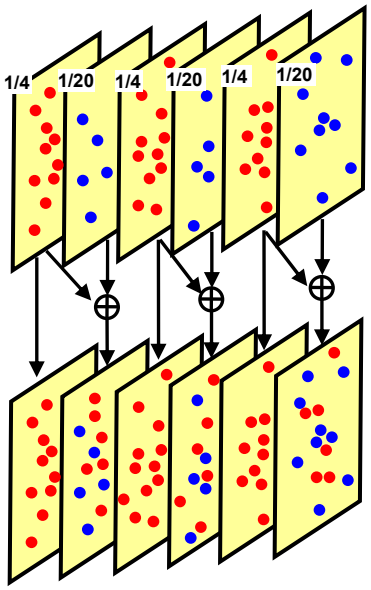

Fig.2 Multi-slice image reconstruction strategy used in the MR experiment. The undersampling rate is 1/20 for each even slice while 1/4 for each odd slice. Each odd slice is used to estimate the missed k-space data of the neighboring even slice.

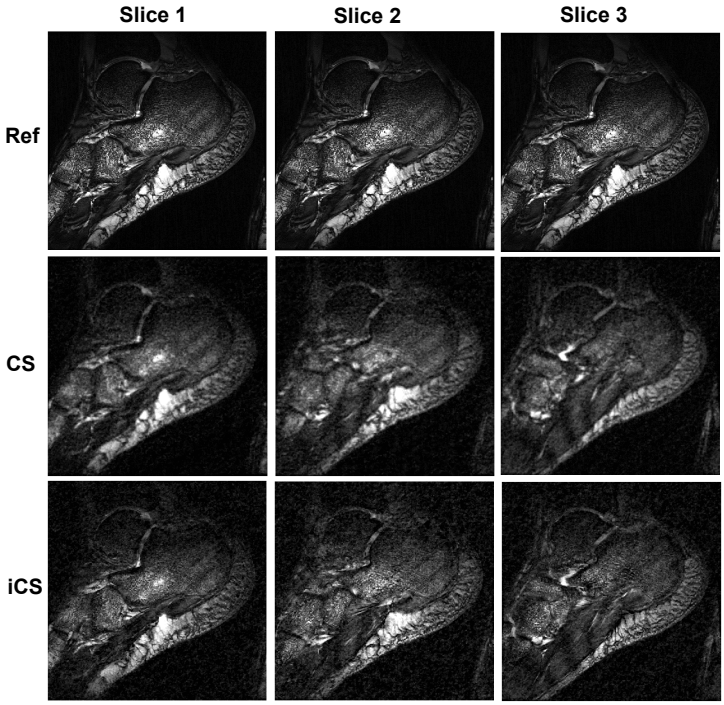

Fig.3 In-vivo MR images of human feet in 3 sagittal planes. The first row are reference images reconstructed from full k-space; the second row are images reconstructed using CS at 1/20 undersampled rate; the third row are images reconstructed using proposed iCS method at the same rate. It is demonstrated that the SNR can be greatly improved.