Spatiotemporally encoded single-shot MRI based on de-convolution reconstruction on 3.0 T human scanner

Jianfeng Bao[1,2], Congbo Cai[2], Zhong Chen[2], and Jianhui Zhong[1]
[1]*Department of Imaging Sciences, University of Rochester, Rochester, NY, United States,* [2]*Department of Electronic Science, Xiamen University, Xiamen, Fujian, China*

Target audience: Basic scientists and clinical scientists who are interested in ultrafast imaging, fMRI and DTI.

Purpose: Due to its good temporal resolution, echo planar imaging (EPI) plays an essential role in capturing the rapidly changing physiologic processes, and commonly used for DTI, fMRI and other dynamic imaging. However, EPI is highly susceptible to the B0 field inhomogeneity, which will distort image. Frydman et al. proposed a novel encoding approach called spatiotemporally encoded (SPEN) single shot method, which is based on a linear frequency swept exaction and a conjugate gradient reconstruction algorithm, to overcome off-resonance effects due to B0 inhomogeneity [1]. More recently, our group demonstrated the de-convolution reconstruction algorithm was superior to originally conjugate gradient (CG) reconstruction method [2] in simulation and on a 7 T small animal scanner. In this presentation, the B0 inhomogeneity-insensitive advantages of SPEN single shot MRI with de-convolution reconstruction method is implemented on a human 3.0 T MRI scanner for human brain studies.

Theory: In the encoding period of SPEN, a chirped adiabatic pulse together with a linear gradient will put an extra quadratic phase to the spin, with which this method can resist the B0 inhomogeneity. After a slice selective 180° pulse, the signal is acquired by similar EPI acquisition method and the quadratic phase is then resolved by the blip gradients in reverse order. However, the spatial resolution is low by nature with the method [1], and a super resolution method to improve it. Here, the de-convolution algorithm proposed recently by our group was applied to obtain super resolution images on phantom and *in vivo* human brain.

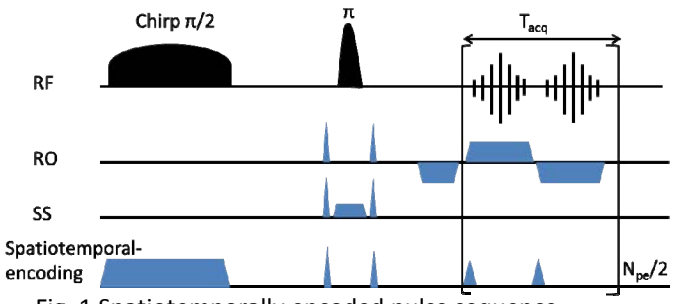

Fig. 1 Spatiotemporally encoded pulse sequence.

Method: The SPEN single-shot RF sequence is shown in the Fig.1. All experiments were conducted on a 3.0 T Siemens Tim Trio human MRI scanner with body coil. The scan parameters were the same for both EPI and SPEN method: FOV = 300 mm, slice thickness = 5 mm, matrix size = 64×64. The chirp pulse duration was 4 ms and the bandwidth was 64 kHz. A T1W structural image was also acquired for reference.

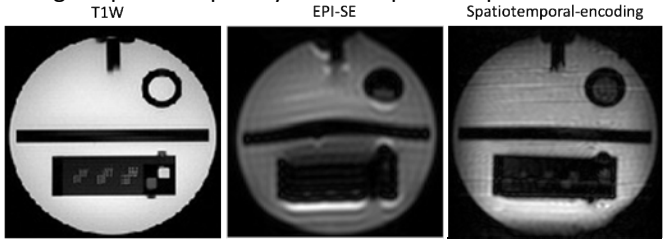

Fig. 2 Comparison phantom MR Images.

Results: Fig. 2 compares common EPI-SE method and the SPEN method on a structural water phantom. It is obviously that the EPI image has some distortions between the interface between water and plastic structure, where the B0 field is inhomogeneous. However, the SPEN image is mostly artifacts free. Fig. 3 compares the coronal images on a human brain. The B0 field on the top of head and around the ear canals is usually very inhomogeneous. Therefore, the EPI image shows serious distortions in these regions. In the SPEN image, these distortions nearly disappear even around ear canals regions.

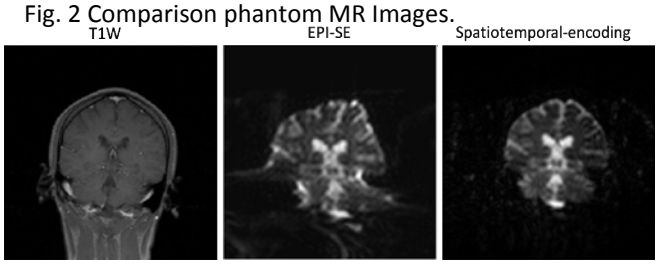

Fig. 3 Comparison of human brain MR Images.

Conclusions: We demonstrated that the SPEN method combined with the de-convolution reconstruction algorithm can achieve an inhomogeneity-insensitive single shot MRI on the 3.0 T human scanner on phantom and human brain. This emerging ultrafast MRI method may provide an alternative way to obtain artifact-free fMRI and DTI.

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Reference: [1] Ben-Eliezer N, Irani M, Frydman L. Super-resolved spatially encoded single-scan 2D MRI. Magn. Reson. Med. 2010; 63:1594-600. [2] Cai C, Dong J, Chen Z. An efficient de-convolution reconstruction method for spatiotemporal-encoding single-scan 2D MRI. J. Magn. Reson. 2013; 228:136-47.