Improved Compressed Sensing Reconstructions with MOET

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Target Audience: Basic Scientists

Purpose: Iterative reconstruction methods such as Compressed Sensing (CS) [1] and CG-SENSE profit from incoherent k-space sampling for optimal results. Recently, a new 2D sampling scheme MOET (Multiple Oscillating Efficient Trajectories) [2] was proposed that can be implemented on standard clinical scanners providing an improved point spread function (PSF) over standard Cartesian and radial sampling. Here the advantages of MOET sampling are demonstrated in CS reconstructions of in-vivo real-time cardiac data.

Methods: MOET is a combination of radial sampling stretched to fill the full square k-space with oscillating gradients orthogonal to the readout direction. Variation of the orientation and the number of oscillations allows for high flexibility of the sampling pattern. Moet was implemented into a balanced SSFP sequence with gradient pairing to prevent eddy current artifacts. Fig.1 shows 16 projections of an example MOET trajectory with four oscillations and the corresponding radial trajectory together with their point spread functions.

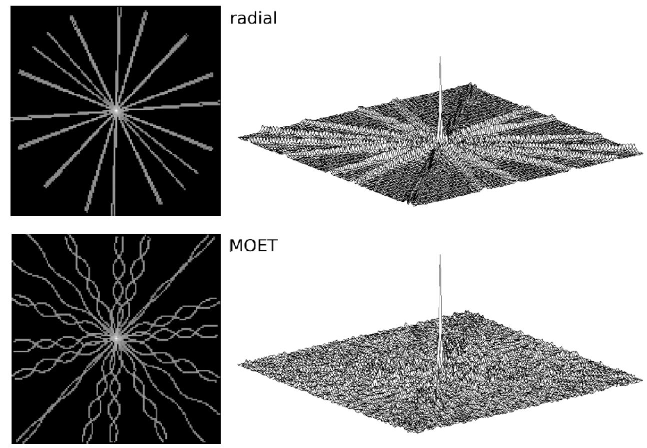

Fig 1: Point spread functions corresponding to radial and MOET sampling using 16 projections.

Ungated real-time Cardiac data of a healthy volunteer was acquired on a standard clinical 1.5T MRI scanner during a breath hold using a bSSFP sequence with a MOET trajectory with four oscillations and as well as a standard radial trajectory employing a golden angle reordering. Measurement parameters were TR=3.2 ms, flip angle = 60, receiver bandwidth = 890 Hz/Px, field of view 300 mm^2, slice thickness = 5 mm, total number of projections 4096 with a total measurement time of 13.1 s. The undersampled data (16 projections per frame) were reconstructed employing L1 minimization after sparsity transformation into xf-space [3].

Results and Discussion: Both the accelerated images and the reconstructions of two example frames in diastole and systole are shown in Fig.2. The MOET sampling scheme leads to less prominent aliasing artifacts so that more details can be observed in the accelerated images. The reconstructed images of the MOET data exhibit improved quality with lower blurring and fewer residual aliasing artifacts over the radial acquisition with otherwise identical parameters. As a large part of the incoherency in xf-space is resulting from the golden ration sampling in the temporal domain, the advantage of MOET is expected to be even more prominent in CS reconstructions exploiting sparsity directly in image space.

Conclusion: MOET is an efficient trajectory that provides incoherent aliasing artifacts in accelerated images. This is essential for Compressed Sensing reconstructions and leads to fewer reconstruction artifacts and allows for higher acceleration factors.

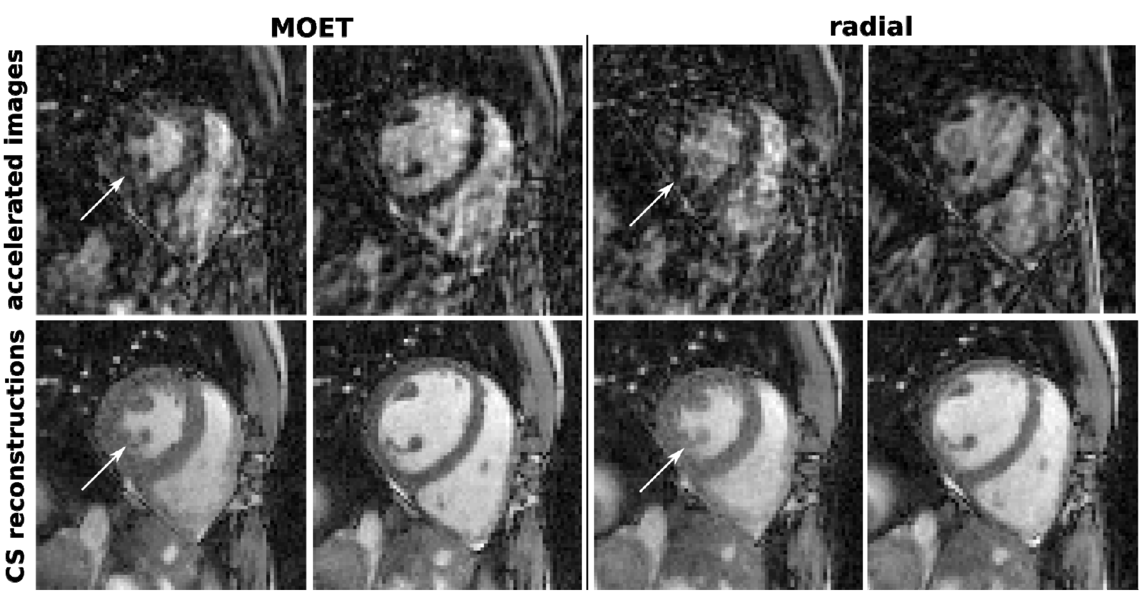

Fig. 2: Accelerated images and Compressed Sensing reconstructions of MOET and radial ungated real-time cardiac data using 16 projections per frame.

References:
[1] Lustig M., et al. IEEE SPM 2008;27:72-82. [2] Neumann D., et al. ISMRM 2012: 2263 [3] Lustig M., et al. ISMRM 2006: 2420

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