2D-Selective RF Excitations Based on a Half-Fourier Blipped-Planar Trajectory

J. Finsterbusch[1,2]

[1]Department of Systems Neuroscience, University Medical Center Hamburg-Eppendorf, Hamburg, Germany, [2]Neuroimage Nord, Hamburg-Kiel-Lübeck, Germany

2D-selective RF excitations (2DRF) [1] can be used to excite arbitrarily shaped regions-of-interest and have found applications in reduced field-of-view imaging [2], single-voxel spectroscopy [3,4], and, in particular at higher magnetic field strength, to correct B_1 inhomogeneieties. However, the blipped-planar trajectory which is often used in these applications, suffers from the fact that half of its duration needs to be considered in the echo time of the sequence. Thus, its usage in applications which require short echo times, like single-voxel spectroscopy or proton-density-weighted imaging, is hampered. To overcome these limitations, the combination of the blipped-planar trajectory with the half-Fourier method, well-known from imaging [5] and slice-selective excitations [6], is presented. It allows to reduce echo times in sequences using 2DRF to values comparable to those obtained with slice-selective RF excitations because only half of a single line of the trajectory contributes to the echo time.

Methods

Covering only half of the *k*-space during an excitation distorts the desired profile because it is convoluted with the Fourier transformation of the Heaviside function. To compensate this distortion, two acquisitions can be performed with the excitation covering one half in the first and the other half in the second acquisition. The complex average of the two acquisitions then yields the desired profile. This approach was applied to 2DRF excitations where both excitations were chosen to start at the outer k-space and to end in the centre in order to minimize the echo time contribution. Because the central line was covered by both excitations, its intensity needs to be scaled by a factor of 0.5.

Measurements were performed on a 3T whole-body MR system (Siemens Magnetom Trio) using a standard twelve-channel head coil and a water phantom. The excitation profile, a square of 15 mm edge length, was acquired with a spin echo sequence (one echo per shot) with an in-plane resolution of 2x2 mm^2. Fast spin echo images were acquired with 7 echoes per shot, an echo spacing of 11.9 ms, and a spatial resolution of 1x1 mm^2. To fulfil the CPMG condition an additional refocusing RF pulse was introduced for the full-Fourier 2DRF to avoid an excessive echo spacing of the echo train. No such pulse was necessary for the half-Fourier 2DRF.

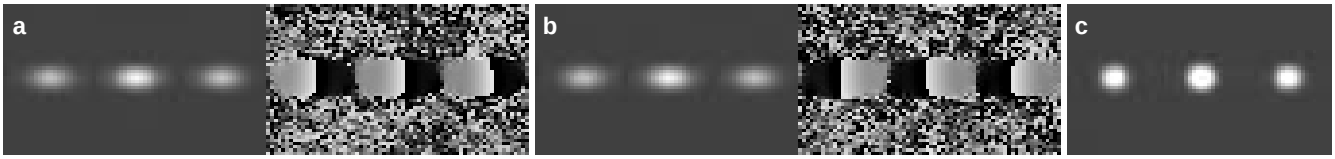

Figure 1: (a, b) Magnitude (left) and phase images (right) of the individual half-Fourier 2DRF excitations and (c) their complex sum.

Results

Figure 1 shows the excitation profiles obtained with the individual half-Fourier 2DRF covering the upper and lower half of *k*-space, respectively, and their complex sum. Both individual profiles are blurred in blip direction (left-right), however, the complex sum delivers the desired excitation profile. Compared to the corresponding full-Fourier profile (Figure 2), no major deviations are observed. Imaging results for a fast spin echo sequence acquired on a water phantom are shown in Figure 3. With a slice-selective excitation, a short echo time suitable for proton-density weighting (12 ms) can be used. Applying a 2DRF allows to reduce the field-of-view in phase-encoding direction without aliasing. But because in the full-Fourier case, half of the blipped-planar trajectory has to be considered in the echo time, a much longer echo time is needed (47 ms). With the half-Fourier trajectory an echo time of 12 ms can be used as for the slice-selective excitation. Furthermore, the SNR was improved by about 60% compared to two averages of the full-Fourier 2DRF excitation in the phantom used.

In summary, half-Fourier 2DRF may help to overcome limitations of blipped-planar 2DRF for applications which require or profit from short echo times.

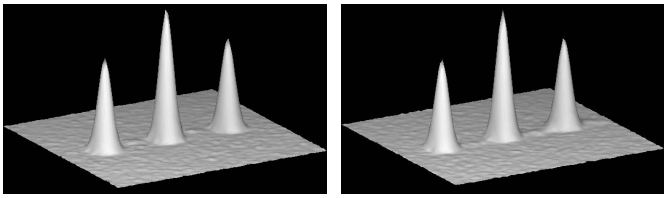

Figure 2: Excitation profiles of the full-Fourier (left) and the half-Fourier (right) 2DRF excitations.

Figure 3: Fast spin echo acquisition with slice-selective (left, echo time 12 ms), full-Fourier excitation (middle, 47 ms), and half-Fourier 2DRF excitation (right, 12 ms)

References

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