Reduction of acquisition time in Magnetic Resonance Spectroscopic Imaging using Wavelet encoding method.

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Introduction:

Wavelet encoding methods have been useful in acquiring 2D magnetic Resonance Spectroscopic Imaging (MRSI) data (1). The results have shown that this technique allows acquisition time and pixel bleed reductions compared to the CSI technique (2). Expanding on the idea of Wavelet Encoding in 2D-MRSI, this technique allows a full coverage of a 3D space using a PRESS sequence. The RF pulses play the role of prototype functions called wavelets to localize sub-voxels according to a Wavelet encoding scheme (2, 3). Acquisition time is shortened and cross-voxel contamination is reduced.

Method:

Wavelet encoding (WE) MRSI method utilizes more of the TR time to encode the spatial information by performing multiple encoding steps without waiting a TR time in between. The space to be imaged is divided into sub-voxels by dilating (increasing gradient strength) and translating (RF frequency shift) the Haar wavelets (2, 3). The sub-voxels along the diagonal are excited without a TR time, thus acquisition time is reduced. This pattern should follow a specific order obeying the Wavelet encoding approach. A PRESS sequence is used for the 3D WE technique (Figure 1). The process is basically the same as for the 2D sequence (1). Single and dual band RF pulses, 12 ms duration and 1.5 KHz bandwidth, with a profile resembling a boxcar function (Haar wavelets) are generated. A cylindrical phantom consisting of 4 equidistant discs containing bottles filled with water or not (see figure 2) is used to acquire 4 axial GE localization images and a 4x4x4 3D WE-MRSI data. The acquisition parameters are TR = 3.5s, TE = 70 ms, FOV = 68 mm, Slice thickness = 200 mm, NEX = 2.

Figure 1: RF pulse combinations to reduce acquisition time in the 4 by 4 by 4 WE MRSI.

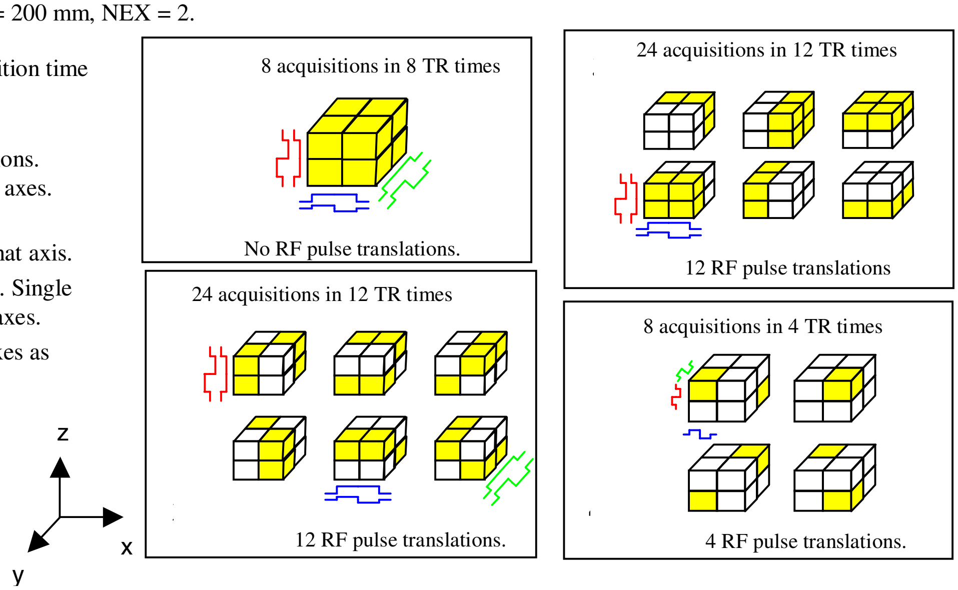
1) The imaged 3D space is covered in the 3 directions. Single and dual band RF pulses are played along 3 axes.

2) The imaged 3D space is covered in 1 direction. Single and dual band RF pulses are played along that axis.

3) The imaged 3D space is covered in 2 directions. Single and dual band RF pulses are played along these 2 axes.

4) Only dual band RF pulses are played along 3 axes as the 3D space is not covered in any direction.

Dualband RF pulse profile. Single band RF pulse profile.



Results/Conclusion

Figure 2 shows the reconstructed 4x4x4 3D WE water line spectra on the top of the axial first and third GE images. The 4x4x4 WE MRSI data is acquired in 4 min 30 s. With the classical CSI technique the time needed is 7 min 24 s. Acquisition time is reduced by 40% compared to CSI method at this spatial resolution and preserves the spatial signal distribution. The acquisition time reduction is proportional to the spatial resolution (2). The new 3D WE MRSI method could be an alternative to the CSI method especially at low spatial resolutions.

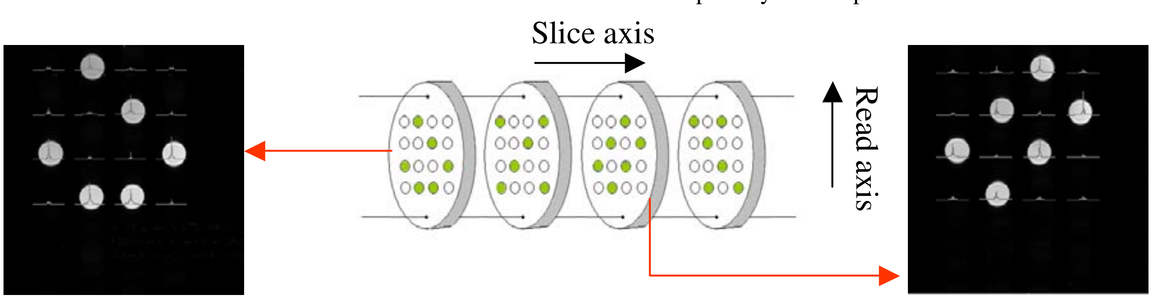


Figure 2: The 3D phantom used to acquire 4x4x4 WE MRSI data consisting of 4 equidistant discs, where bottles filled with water (green color) are placed in few disc holes. Each disc spectra of the acquired localized water lines using WE MRSI technique are on the top of the corresponding localization GE image of the disc. Spectra/images from the first and the third discs are displayed.

References:

1) Serrai H, et al. 21st ESMRMB, Copenhagen, pp 335, 2004.
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