SMALL FOV IMAGING USING WAVELET ENCODING WITH 2 DIMENSIONAL RF PULSES AND GRADIENT ECHO

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Introduction:

Several magnetic resonance imaging (MRI) applications, such as cardiac imaging and functional MRI, require the use of small Field of View (FOV) imaging to achieve dynamic MR studies[1]. However, using small FOV with Fourier encoding results in aliased images in the phase encoding direction. Several approaches have been used to solve the aliasing problem[2]. Among the proposed techniques, wavelet encoding appears to be a promising alternative, since it localizes regions of interest, which allows for FOV size reduction without folding. Most of the MRI wavelet encoding (WE) sequences uses spin-echo sequence for imaging[3], which is time consuming. In this work we propose the use of a modified gradient-echo sequence where phase encoding is replaced by wavelet encoding using RF pulses; which play the role of the wavelet functions in wavelet encoding process[3, 4]. Two dimensional RF pulses are used to achieve simultaneously slice selection and wavelet encoding in the echo-planar k-space RF pulse trajectory[5].

Material and methods:

A gradient-Echo (GE) sequence has been modified by removing the phase encoding gradient and inserting a 2D RF pulse with an echo-planar k space trajectory (Figure 1). Wavelet encoding is achieved using RF pulses with profiles resembling wavelet functions (Haar functions in this application). The wavelet encoding is performed by dilating and translating the Haar functions. These operations are achieved by increasing the strength of the fast gradient (Gy), and shifting the frequency of the RF pulses[3,4]. Slice selection is achieved by applying a slow gradient (Gz). Saturation RF pulses are applied in the slice direction to eliminate unwanted signal lobes generated in the slice direction by the 2D RF pulse. Wavelet encoding and gradient echo images from a cylindrical phantom with different structures filled with doped water are acquired. The results show that the WE image is free of aliasing as compared to a GE image with reduced FOV (Fig. 2).

Conclusion:

Although the WE technique provides MR images with lower signal to noise ratio (SNR) than a GE sequence[6], it does allow for reduction of FOV without aliasing in the same acquisition time. This acquisition time could be reduced by combining wavelet encoding with parallel imaging while maintaining SNR[7].

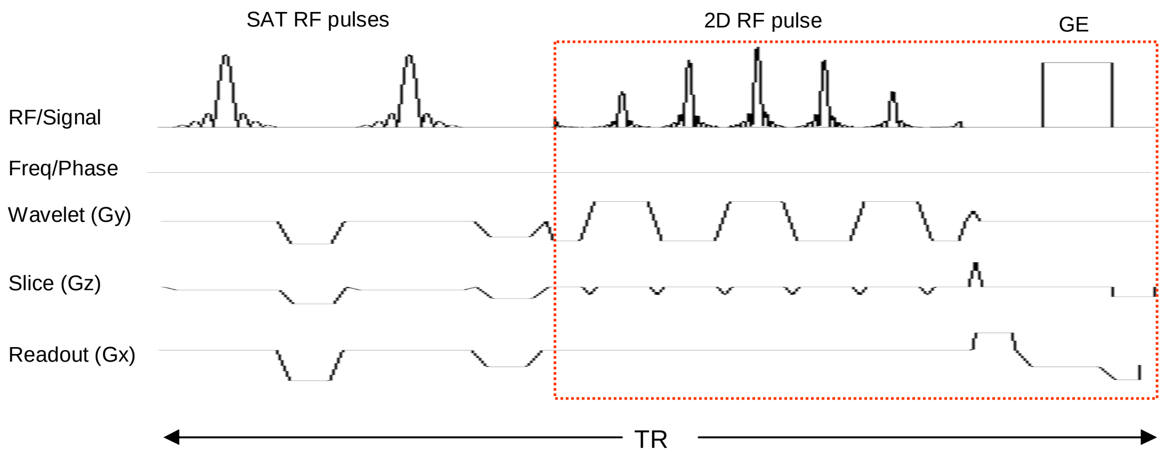
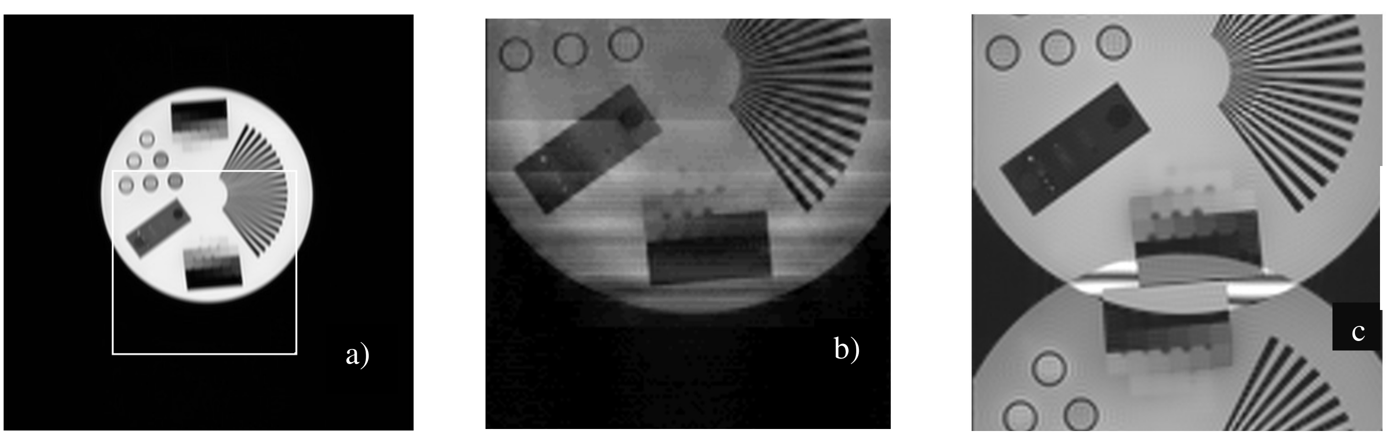


Figure 1: Wavelet encoding sequence diagram using a 12.8 ms 6 lobes 2D RF pulse with echo-planar trajectory, with wavelet encoding performed in the zigzag direction (Gy) and slice selection in the blip direction (Gz). Saturation RF pulses are used in front to eliminate signals from side lobes. Gradient echoes are acquired in the readout direction (Gx).

Figure 2: Scout image (a) acquired with Siemens GE sequence at 3T (FOV: 400mm, slice thickness: 5mm, TR: 100ms, TE: 10ms, flip angle: 25º, 128x128). Small FOV WE image (b) with no folding as compared to the GE image (c). Acquisition parameters for the small FOV GE and WE images are: slice thickness: 10mm TE: 11 ms TR: 200 ms flip angle: 45° and image size 128 by 128. The SNR of the WE is approximately 20% of the SNR of the GE[6]. The WE image intensity is less homogeneous in the lower part due to spin contributions from side lobes in the slice direction; this is due to the poor performance of the saturation RF pulses.



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