EFFECTS OF DENOISING IN THE ESTIMATION OF T2* FROM IMAGES ACQUIRED THROUGH DIXON IMAGING

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Target audience: this abstract is intended to be of interest for both clinicians and MRI researchers.

Purpose: There are medical applications where T2* relaxation is relevant for a better diagnosis of diseases. This abstract explores the effect of prefiltering in the estimation of T2* from images acquired through symmetric Dixon imaging.

Method: The distribution of noise of the real and imaginary parts of images acquired through Dixon imaging can be modeled as non-stationary Gaussian (Gudbjartsson and Patz, 1995). Considering this, real and imaginary parts of every echo were independently filtered with the adaptive non-local means method proposed by Manjón et al. (2010). This method was chosen for two reasons: a) non-local means is in considered the state-of-the-art for Gaussian noise removal and b) it considers spatial variations of the level of noise. Abdominal MRI was acquired using a 3.0 T Ingenia clinical MR-scanner (Philips). A phased array body coil was used for acquisition of symmetrically sampled 3D gradient eight echo in and opposite phase images with echo times of [1.14 2.29 3.44 4.59 5.74 6.89 8.04 9.19] ms, TR=10.65 ms and flip angle = 10°. The resulting resolution was 1.75mm isotropic. T2* was computed by fitting the magnitude of the four acquired in-phase images to a decaying exponential. The variation on the coefficient of determination of the curve fitting, R^2, was used for evaluating the improvement of the estimation due to noise reduction. Phase sensitive reconstruction (PSR) (Rydell et al., 2007) was run on the first two echoes in order to extract fat and water images. These images were used to create masks of fat- and water-dominant voxels (>80%). Also, region of interests (ROIs) were marked in the liver. These masks were used to compare the variation of R^2 in different areas of the image. The curve fitting method is advantageous for our purposes since it allows us to objectively evaluate the improvement exclusively due to the filtering, even if the data do not fit a specific model of the signal, such as the one used by IDEAL.

Results: Fig. 1-2 show the magnitude of the first two echoes of a patient with a fatty liver (see arrows). The region around the liver is noisier than others. Fig. 3-4 show the fat and water images extracted through PSR. Fig. 5-6 show maps of estimated T2* (in ms) with and without filtering respectively. Fig. 7-8 show histograms of R^2 for fat- and water-dominant voxels and ROIs in the liver respectively. The mean (SD) of R^2 in these regions is improved with the filtering from 0.73 (0.16) to 0.75 (0.14), from 0.84 (0.21) to 0.89 (0.17) and from 0.84 (0.17) to 0.93 (0.09) respectively.

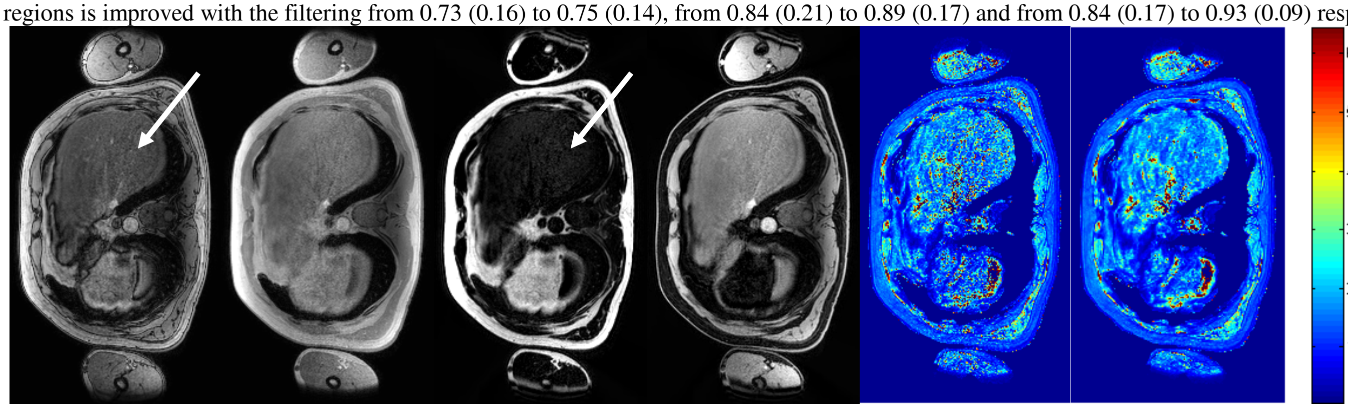

Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6

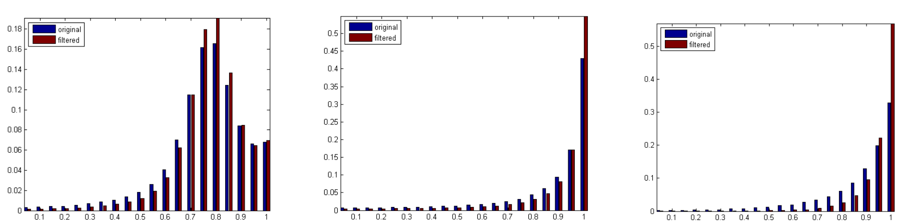

Fig. 7-9

Discussion: Since phase changes due to B0 inhomogeneities usually vary smoothly, good results can be obtained for fat/water separation by using standard low pass filters. However, T2* is more sensitive to noise due to the exponential involved and can vary quickly, so advanced filters are necessary for its estimation.

Conclusion: Prefiltering has a positive effect in the estimation of T2*, especially in voxels with non-negligible amount of both fat and water. Results suggest that advanced signal model fitting for computing T2* is mainly required in fat-dominant regions.

References:

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