Wavelet Transform Used for Radio Frequency Coil Magnetic Field Evaluation

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Introduction. With wavelets, one can perform multiresolution analysis, literally sorting signal components by their location and resolution scale [1]. Whereas Fourier Transform methods sort signals into their spectra, the wavelet transforms sort signal or data details into a locale-scale collection. Wavelets already enjoy connection with many fields and nuclear magnetic resonance imaging is starting to use them for signal and image processing [2]. Magnetic field data represented by 2D Fast Discrete Wavelet Transform (DWT) shows new feature suitable eg for a new coil systems design. As an example for wavelet transform components display and evaluation, a bi-planar RF coil designed in a form of metal planes [3] was used. Small homogeneity differences show significant changes in selected wavelet components.

Methods. An RF narrow-gap planar coil system where the width-to-plane separation ratio (w/h) is more than 10:1 with limited dimensions of metal sheets was used as a model for wavelet transform based magnetic field inhomogeneities evaluation. Inhomogeneities of the generated magnetic field in a rectangular volume were expressed as Percentage field deviation (PFD) with respect to the coil`s centre value of magnetic field. The 4th order Coifman system "Coif4" as a low-pass filter representing the scaling function was used. The high-pass filters were automatically calculated from the low-pass filter coefficients.

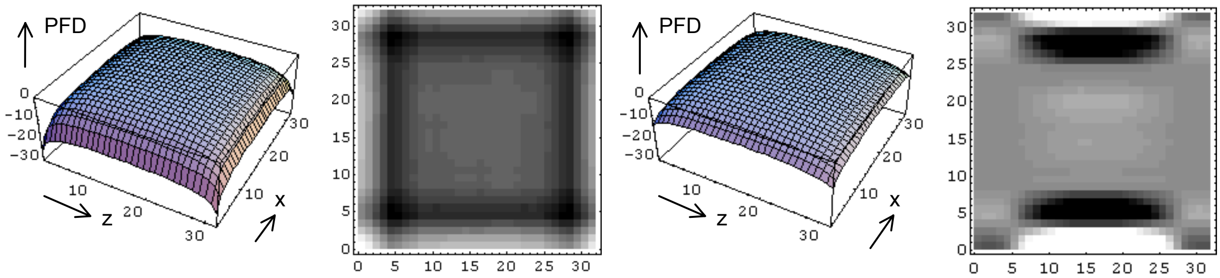

Fig.1 PFD of the magnetic field of planar RF coil depicted as a 3Dplot and as a density plot of the inverted Treshold2D Wavelet Transform. Left pair: non-homogeneous. Right pair: quasi-homogeneous field.

Results. For magnetic field evaluation the DWT procedure: trans=Transform2D[data] shows significant amplitudes increasing of low level wavelet components. We get similar results by Zero2DComponents[trans,c1,c2,c3,c4] procedure selecting lower levels components. After InverseTransform2D[trans] represented as a 3DPlot, the magnetic field components belonging to the selected wavelet components are seen. Threshold2D[trans, threshold] procedure for lower values of threshold levels shows substantial changes in the after-filtered InverseTransform2D[thresh], (DensityPlot), see Figure 1. Amplitudes of low level components for non-homogeneous magnetic field are increasing (in our example for about 100 %).

Conclusion. An attempt was made to use 2D Fast Discrete Wavelet Transform procedures for magnetic field of RF coils evaluation regarding their non-homogeneities. The method seems to be useful both for new coil systems design and also for testing the magnetic fields: RF, stationary or gradient, used in NMR imaging and/or spectroscopy. New resultant features of the presented magnetic field representation could be also a suitable tool for magnetic field correcting system design. More coil magnetic fields were tested by the 2D Fast Discrete Wavelet Transform.

References

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