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FAST MULTI-LEVEL RECONSTRUCTION OF BIOMEDICAL IMAGES USING WAVELET SPARSITY CONSTRAINTS

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Wavelet-domain ℓ_1-regularization is a powerful approach for solving inverse problems. In their 2004 landmark paper, Daubechies et al. proved that one could solve such linear inverse problems by means of a "thresholded Landweber" (TL) algorithm [1]. While this iterative procedure is simple to implement, it is known to converge slowly. Here, we present a multilevel version of the algorithm that is inspired from the multigrid techniques used for solving PDEs, but with one important difference : instead of cycling through coarser versions of the problem (REDUCE part of multigrid), the multilevel algorithm cycles through the successive wavelet subspaces. The method works with arbitrary wavelet representations ; it typically yields a 10-fold speed increase over the standard TL algorithm, while providing the same restoration quality. We illustrate the applicability of the method to three biomedical image reconstruction problems : the deconvolution of 3D fluorescence micrographs [2], the global reconstruction of dynamic PET from time measurements [3], and the reconstruction of magnetic resonance images from arbitrary (non-uniform) k-space trajectories. We present experimental results with real data sets in all three cases.

References

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