Efficient framework for model-based tomographic image reconstruction using wavelet packets.

Abstract:

The use of model-based algorithms in tomographic imaging offers many advantages over analytical inversion methods. However, the relatively high computational complexity of model-based approaches often restricts their efficient implementation. In practice, many modern imaging modalities, such as computed-tomography, positron-emission tomography, or optoacoustic tomography, normally use a very large number of pixels/voxels for image reconstruction. Consequently, the size of the forward-model matrix hinders the use of many inversion algorithms. In this paper, we present a new framework for model-based tomographic reconstructions, which is based on a wavelet-packet representation of the imaged object and the acquired projection data. The frequency localization property of the wavelet-packet base leads to an approximately separable model matrix, for which reconstruction at each spatial frequency band is independent and requires only a fraction of the projection data. Thus, the large model matrix is effectively separated into a set of smaller matrices, facilitating the use of inversion schemes whose complexity is highly nonlinear with respect to matrix size. The performance of the new methodology is demonstrated for the case of 2-D optoacoustic tomography for both numerically generated and experimental data.