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Total Variation and Wavelet Regularization Methods in Emission Tomography

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ABSTRACT

A classical technique for reconstruction of Emission Tomography (ET) images from measured projections is based on the maxim likelihood (ML) estimation achieved with the Expectation Maximization (EM) algorithm. We incorporate the wavelet transform (WT) and total variation (TV) based penalties into the ML framework, and compare performance of the EM algorithm and the recently proposed conjugate barrier (CB) algorithm. Using the WT- and TV-based penalties allows one to embed regularization procedures into the iterative process. In the case of the WT-based penalty, we impose a subset of wavelet coefficients with a desired resolution on the objective function. It appears that the CB algorithm outperforms substantially the EM algorithm in penalized reconstruction. Properties of the optimization algorithms along with WT- and TV-based regularization are demonstrated on image reconstructions of a synthetic brain phantom, and the quality of reconstruction is compared with standard methods.

Keywords – medical imaging, positron emission tomography, expectation maximization, wavelets, total variation.