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Comparison between Conjugate Gradient and Landweber Based Regularization Approaches in L^p Banach Spaces for Microwave Tomography

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Innovative methods for the tomographic reconstruction of dielectric targets are incessantly proposed by the research community, and one of the main goals is the continuous improvement of both the regularization capabilities and the computational cost [1]–[3]. In this scenario, inversion techniques developed in the mathematical context of L^p Banach spaces appear to be particularly effective in the retrieval of the dielectric properties of the targets under test [4]. Initially, Banach space regularization approaches for the nonlinear microwave tomography have been exploited through inexact-Newton techniques that comprise an iterative Newton-based linearization and a truncated Landweber algorithm, which is usually employed for solving the resulting linear problem in a regularized sense.

However, Landweber-based regularization is not the only way to deal with the ill-posedness of the linearized scattering equation at each step of the inexact-Newton algorithm. In this respect, a conjugate gradient like technique which solves linear problems by operating a p-norm minimization in L^p Banach spaces has been recently proposed in [5]. The possibility of exploiting such technique in conjunction with an inexact-Newton approach clearly opens new opportunities for microwave imaging. Generally speaking, both the computational structure and the convergence behavior of conjugate gradient and Landweber based methods have relevant differences. However, as far as we know, extended comparisons between these two different approaches in L^p Banach spaces applied to microwave imaging problems cannot be found in the scientific literature.

Therefore, in the present work, the use of conjugate gradient and Landweber based techniques inside an inexact-Newton structure are thoroughly compared, adopting common numerical test sets and metrics. Some indications about the performance of these different techniques, when used for microwave tomography, are then presented. In particular, the regularization capabilities, the convergence speed, and the dependence upon the initial solution and data noise will be analyzed and compared.

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