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Progressive Magnetic Resonance Image Reconstruction Based on Iterative Solution of a Sparse Linear System

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Abstract

Image reconstruction from nonuniformly sampled spatial frequency domain data is an important problem that arises in computed imaging. Current reconstruction techniques suffer from limitations in their model and implementation. In this paper, we present a new reconstruction method that is based on solving a system of linear equations using an efficient iterative approach. Image pixel intensities are related to the measured frequency domain data through a set of linear equations. Although the system matrix is too dense and large to solve by direct inversion in practice, a simple orthogonal transformation to the rows of this matrix is applied to convert the matrix into a sparse one up to a certain chosen level of energy preservation. The transformed system is subsequently solved using the conjugate gradient method. This method is applied to reconstruct images of a numerical phantom as well as magnetic resonance images from experimental spiral imaging data. The results support the theory and demonstrate that the computational load of this method is similar to that of standard gridding, illustrating its practical utility.