INVERSE RECONSTRUCTION TECHNIQUES IN MAGNETIC RESONANCE IMAGING

Martin Uecker

BiomedNMR, Göttingen, Germany

In the past, most magnetic resonance imaging (MRI) techniques have been designed in line with a simple image reconstruction by an inverse fast Fourier transform. This requirement restricts the MRI acquisition to a time-consuming line-by-line scanning of the Fourier data. More recently, however, this situation has markedly changed and led to the development of advanced iterative reconstruction algorithms. The main reasons are (i) the widespread availability of MRI systems with multiple independent receiver channels and the related success of parallel MRI, (ii) the improved performance of the gradient hardware and the corresponding interest in non-Cartesian sampling trajectories, and (iii) the emerging theory of compressed sensing. The new techniques treat the reconstruction as an inverse problem, which allows for improvements along different lines: Firstly, the model used in the formulation of the forward problem may include more physical effects (e.g., multiple coil sensitivities, a spatial spin distribution, and a relaxation effect). Secondly, a straight-forward extension of the numerical implementation facilitates the processing of data acquired with non-Cartesian trajectories. And thirdly, a priori knowledge may be directly integrated into the iterative optimization to exploit redundancies in the solution itself. While requiring more advanced mathematical tools for the regularized solution of nonlinear inverse problems, these reconstruction strategies remove many artificial restrictions imposed on the MRI acquisition process. In particular, they open the way to overcome the relatively long measurement times as one of its major limitations. After a discussion of the general ideas, some specific applications will be presented.