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Imaging of Low-Field Magnetic Resonance Data Using Multiplicative Regularization

Merel L. de Leeuw den Bouter* (1), Martin B. van Gijzen (1), and Rob F. Remis(2)
(1) Delft Institute of Applied Mathematics, Delft University of Technology, 2628 XE Delft, The Netherlands; e-mail: M.L.deLeeuwdenBouter-1@tudelft.nl; M.B.vanGijzen@tudelft.nl
(2) Circuits and Systems Group, Delft University of Technology, 2628 CD Delft, The Netherlands; e-mail: R.F.Remis@tudelft.nl

Extended Abstract

Recently, there has been a significant interest in the development and application of low-field magnetic resonance (MR) scanners [1]. Such scanners utilize background fields that are at least one order of magnitude lower than the background fields used in commercial high-field scanners commonly found in hospitals and medical centers in the developed world. Consequently, image quality is typically lower than in high-field MR imaging, but due to advances in permanent magnet design, radiofrequency and gradient coil optimization, and image processing, images of diagnostic value may still be produced by a low-field scanner. Furthermore, low-field scanners are portable, have much lower maintenance and installation costs, and much lower power requirements than commercial MR scanners. Low-field scanners may therefore be of great diagnostic value in rural areas in the developing world, where modern imaging systems are usually not available at all.

In this paper, we present an image reconstruction technique in which the MR imaging problem is posed as an optimization problem. Specifically, the image is obtained by minimizing an objective function that consists of a data fidelity term and a total variation-type regularization term. However, as opposed to more standard regularization approaches, where the regularization term is weighted by a regularization parameter and added to the data fidelity term in the total objective function, we multiply the regularization term and the data fidelity term [2]. This approach has been successfully applied in the Contrast Source Inversion (CSI) method for inverse acoustic and electromagnetic (wave)field problems [3] and here we demonstrate its effectiveness in low-field MR imaging. Specifically, we present imaging results for experimental data obtained with the low-field Halbach scanner described in [4,5]. We demonstrate that the method is able to effectively suppress noise even for data with a very low Signal to Noise Ratio (SNR), which is typical for measured low-field MR signals. Moreover, since regularization is carried out in a multiplicative rather than an additive manner, the proposed reconstruction method can be used in a “plug-and-play” fashion, since no (sub)optimal regularization parameter has to be computed. Image reconstructions of several objects that have been placed in the low-field scanner of [4,5] will be presented and possible extensions of the technique will be briefly discussed as well.

References

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