Edge Preserving and Noise Reducing Recontruction for 4D Magnetic Particle Imaging

Martin Storath[a], Christina Brandt[b], Martin Hofmann[c], Tobias Knopp[c], Alexander Weber[d], Andreas Weinmann[e]

[a] Image Analysis and Learning Group, Universität Heidelberg, Germany
[b] Department of Applied Physics, University of Eastern Finland, Kuopio, Finland
[c] Section for Biomedical Imaging, University Medical Center Hamburg-Eppendorf, and Institute for Biomedical Imaging, Hamburg University of Technology, Germany
[d] Bruker Biospin, Ettlingen, Germany, and Institute of Medical Engineering, University of Lübeck, Germany
[e] Helmholtz Zentrum München and University Darmstadt, Germany

Magnetic Particle Imaging (MPI) is an emerging imaging modality which determines the concentration of magnetic nanoparticles by measuring their non-linear magnetization response to an applied magnetic field. MPI offers a high dynamic spatial and temporal resolution and it allows for real time in vivo imaging even in 3D. The high temporal resolution in turn leads to large amounts of data which have to be handled efficiently. But as the system matrix of MPI is non-sparse, the on-line image reconstruction gets computationally demanding. Therefore, currently only basic image reconstruction methods such as Tikhonov regularization are used.

We propose an efficient edge preserving and noise reducing reconstruction method for MPI. As regularization model, we propose to use the nonnegative fused lasso model. Moreover, we devise a discretization that is adapted to the acquisition geometry of the preclinical MPI scanner considered in this work. We develop a customized solver based on a generalized forward-backward scheme which is particularly suitable for the dense and not well-structured system matrices in MPI. We demonstrate the improvement in reconstruction quality over the state-of-the-art method in an experimental medical setup for an in-vitro angioplasty of a stenosis.