Field-free Line Magnetic Particle Imaging: Artifact Reduction for Time-dependent Tracer Concentrations

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Abstract

Magnetic particle imaging (MPI) is a promising still rather new tracer-based medical imaging technique, which does not depend on harmful radiation. Instead, magnetic material is injected into the patient's body being exposed to changing magnetic fields. Measuring the induced voltage signal resulting from the change in magnetization then allows to reconstruct the particle distribution within the body, hence enabling medical diagnostics. Different scanner implementations are available. We regard MPI using a field-free line (FFL) for spatial encoding. During data acquisition the FFL is steered through the field of view resulting in a scanning geometry resembling the one in computerized tomography (CT). Indeed, for static concentrations it has been shown that MPI data can be traced back to the Radon transform of the particle distribution. We extend this result towards time-dependent concentrations. Describing the corresponding dynamics using diffeomorphic motion models successfully applied in dynamic CT, we find that the MPI forward operator can be linked to an adapted version of the Radon transform. Finally, we jointly reconstruct particle concentration and adapted Radon data by means of total variation regularization for synthetic data.