Delta-MRI: a framework for direct deformation estimation from longitudinally acquired single-coil and multi-coil MRI data

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Longitudinal MRI is a key medical imaging tool for evaluating treatment effects, monitoring therapy and tracking disease progression over time. However, the time-consuming nature of MRI gives rise to long waiting lists and patient discomfort at every scan session. The primary focus of longitudinal MRI studies is to analyze temporal changes, such as structural deformations. This is typically achieved by reconstructing images from raw MRI data (the k-space) at multiple points in time and subsequently comparing them either qualitatively or quantitatively (e.g., volume measurements). Since longitudinal changes are naturally sparse and localized, significant redundancy exists between images of the same subject acquired at different time points. This temporal redundancy is hardly exploited in state-of-the-art methods. Indeed, most algorithms designed to shorten MRI scan times focus on cross-sectional imaging by exploiting spatial redundancy within a single time point.

We propose Delta-MRI, a framework that estimates longitudinal deformations directly from a baseline image and strongly undersampled k-space data of a follow-up scan. Preliminary results show that our approach has the potential to significantly accelerate follow-up scans without compromising deformation estimation quality, both with single-coil and multi-coil follow-up acquisitions.