Low-Rank and Adaptive Sparse Signal (LASSI) Models for Highly Accelerated Dynamic Imaging

Abstract:

Sparsity-based approaches have been popular in many applications in image processing and imaging. Compressed sensing exploits the sparsity of images in a transform domain or dictionary to improve image recovery from undersampled measurements. In the context of inverse problems in dynamic imaging, recent research has demonstrated the promise of sparsity and low-rank techniques. For example, the patches of the underlying data are modeled as sparse in an adaptive dictionary domain, and the resulting image and dictionary estimation from undersampled measurements is called dictionary-blind compressed sensing, or the dynamic image sequence is modeled as a sum of low-rank and sparse (in some transform domain) components (L+S model) that are estimated from limited measurements. In this work, we investigate a data-adaptive extension of the L+S model, dubbed LASSI, where the temporal image sequence is decomposed into a low-rank component and a component whose spatiotemporal (3D) patches are sparse in some adaptive dictionary domain. We investigate various formulations and efficient methods for jointly estimating the underlying dynamic signal components and the spatiotemporal dictionary from limited measurements. We also obtain efficient sparsity penalized dictionary-blind compressed sensing methods as special cases of our LASSI approaches. Our numerical experiments demonstrate the promising performance of LASSI schemes for dynamic magnetic resonance image reconstruction from limited k-t space data compared to recent methods such as k-t SLR and L+S, and compared to the proposed dictionary-blind compressed sensing method.