Efficient Dynamic Image Reconstruction with Motion Estimation

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Abstract

Large-scale dynamic inverse problems are typically ill-posed and suffer from complexity of the model constraints and large dimensionality of the parameters. A common approach to overcome ill-posedness is through regularization that aims to add constraints on the desired parameters in both space and temporal dimensions. In this work, we propose an efficient method that incorporates a model for the temporal dimension by estimating the motion of the objects alongside solving the regularized problem. In particular, we consider the optical flow model as part of the regularization that simultaneously estimates the motion and provides an approximation for the desired image sequence. To overcome high computational cost when processing massive scale problems, we combine our approach with a generalized Krylov subspace method that efficiently solves the problem on relatively small subspaces. Further, we explore subspace restarting and recycling to overcome limited memory constraints and preconditioning to accelerate convergence. The effectiveness of the prescribed approaches is illustrated through numerical experiments arising in dynamic computerized tomography and image deblurring applications.