Multidimensional Data Recovery via Iterative Regularization based on Higher Order Singular Value Decomposition

With the recent advances of networking, sensors, and storage technologies, many multidimentional datasets are being generated in various fields. These datasets are often incomplete or contaminated during the acquisition process. Recovering the missing or noise-free data from degraded observations thus becomes crucial to obtaining precise information to refer to. The aim of this work is towards restoration of multidimensional (tensor) data. Specifically, we consider three problems: 1) tensor inpainting, 2) magnetic resonance image denoising and, 3) hyperspectral image denoising.

The theory of tensors has become popular in dealing with multidimensional data, due to the capability of tensors in exploiting additional structure in comparison with matrix based alternatives. The most commonly used decomposition of multidimensional data to date is higher order singular value decomposition (HOSVD). The HOSVD is an efficient way for eliciting intrinsic structure of multidimensional data. It offers a simple, adaptive and natural way to exploit sparsity among all dimensions of multidimensional data. The HOSVD decomposes a particular tensor data into the product of a sparse tensor and a few orthogonal matrices, each of which captures the subspace information corresponding to one dimension. In this work, we solve the restoration problems by employing the HOSVD transform and by exploiting the sparsity of the multidimensional signals. We enforce the sparsity using iterative regularization technique, which is shown to be very effective for our problems.

Keywords: Denoising, higher order singular value decomposition, hyperspectral, iterative regularization, MR images, patch-based, soft thresholding, sparse representation, Tucker decomposition.