Abstract

Image super-resolution (SR) has become increasingly important as a result of rapidly growing demands for high-definition (HD) applications in many scientific and technological fields including video surveillance, medicine, forensic science, and remote sensing, among other areas. Recent advances in sparse signal processing prompted the researchers to investigate different forms of image sparsity in order to develop efficient single-image super-resolution (SISR) algorithms. These methods provide excellent reconstruction quality, but they are computationally intensive and thus time consuming.

In this thesis, we develop fast sparse representation-based multispectral (MS) image SR algorithms that can reconstruct images with high spatial and spectral resolutions from a given LR input. The performance of the sparse representation method heavily depends on the quality of the trained dictionary. So, emphasis is given on developing an improved overcomplete dictionary from given MS images by adopting new feature extraction methods. Further, we have used the concept of pansharpening-based image fusion to develop a new MS image SR algorithm, which is able to keep the spectral characteristics intact. It is observed that using only the local sparsity prior to regularize the SR problem does not provide a sufficient improvement. Therefore, we have investigated different sparse representation strategies involving the concepts of self-learning, group-sparsity, and joint-sparsity to develop novel MS image SR algorithms. It is observed that taking *a priori* information such as non-local similarity in image for grouping non-local patches can significantly improve the performance of the traditional patch-based sparse representation methods. We have proposed a joint sparse representation-based algorithm for MS image SR by incorporating both patch and group-patch information into a common framework. It outperforms state-of-the-art SR methods including a few trending convolutional neural network (CNN)-based deep learning works.

Furthermore, to overcome the major limitation of the sparse representation-based methods of high computational burden, we have used Open Multi-Processing (OpenMP) parallel programming features and implemented the overall algorithm across multiple processor cores for high throughput. We have also developed a general-purpose graphics processing unit (GPGPU)-based fast MS image SR algorithm that uses joint sparse representation for near-real-time acceleration. Finally, to critically evaluate the importance of the proposed SR technique in real-world applications, remote sensing image analysis through end-members identification and land cover classification are performed on the SR reconstructed images and results are analyzed.