ABSTRACT

Super-resolution is the process of obtaining high-resolution images from one or more low-resolution observations. It has been a very attractive research topic over the last two decades and has resulted in many research findings, each developing new and powerful super-resolution algorithms for a specific purpose.

This thesis addresses the problem of image super-resolution using single frame image super-resolution techniques and various priors for regularization. The following contributions resulted in the development of novel algorithms for achieving single frame image super-resolution.

The initial estimate of HR image for the given LR image is obtained using DFT and DCT based learning technique. It is observed that DCT based method cuts the computational time and memory requirement and results in better quality of HR reconstruction. The SR algorithms developed in this thesis, regularizes the learned estimate of HR image using DCT based method.

A novel algorithm using sparse representation of images as prior has been implemented for single image super-resolution. The LR image is viewed as down sampled version of a HR image, whose patches are assumed to have a sparse representation with respect to an over-complete dictionary of prototype signal atoms. We have demonstrated the effectiveness of sparsity as a prior for regularizing the otherwise ill-posed super-resolution problem. We have used GLCM and SVD features of the training image patch pairs to regularize the HR estimate obtained by sparse representation. We have demonstrated that with SVD features an improvement in PSNR of the super-resolved image is 1.8 dB more than GLCM prior.

Two new approaches for multi-resolution fusion of satellite images has been proposed and implemented based on modeling LR MS images. In the first method, MAP estimation is used for initial image restoration and the result is further improved using edge information as a prior for regularization. The prior information is modeled using homogeneous MRF, while preserving discontinuities. The advantages of this approach are: minimum spectral distortion in the fused image, no need for registration of MS and PAN images, limited number of MRF parameters to be estimated Experimental results showed better performance over similar approaches. In the second approach use of MAP-MRF estimation for multi resolution fusion of remotely sensed images is proposed. The effectiveness of the approach was verified by conducting experiments on image database consisting of real satellite data captured by Quick Bird satellite. The merits of
the proposed approach are that it requires no registration between PAN and MS images; it produces minimal spectral distortion. The method can be applied to the fusion of PAN and MS images captured at different times using different sensors.

Finally, a novel algorithm for learning initial estimate of HR image using spectral histogram matching and regularizing the result using texture prior is proposed in this thesis. A new model-based approach employing spectral histogram has been implemented for obtaining initial estimate of the true HR image. MAP based model is used to super-resolve the learnt HR estimate with (IGMRF) prior as regularization parameter. The success of this method depends on how well the initial HR estimate is obtained. Since most of the images captured from natural scene are texture based, spectral histogram of images accurately model texture features. Therefore this method is better suited for Super-Resolution reconstruction of texture rich images. The experimental results showed that this approach is better than a similar method proposed in the literature.