Comparison and assessment of image fusion methods applied to high-resolution satellite imagery

【Summary of the thesis】
Image fusion is a useful tool for integrating low spatial resolution multispectral (MS) images with a high spatial resolution panchromatic (PAN) image, thus producing a high resolution multispectral image for better understanding of the observed earth surface. With the development of new imaging sensors, image fusion has become an important issue for various remote sensing (RS) problems such as land classification, change detection, object identification, image segmentation, map updating, hazard monitoring, and visualization purposes.

When applied to remote sensing images, a common problem associated with existing fusion methods has been the color distortion, or degradation in the spectral quality. This often results in the difficulty in the precise interpretation of the pan-sharpened images generated through the image fusion. Thus, the main purpose of this dissertation is to evaluate the quality of fused images. Comparison is made among different fusion methods, putting emphasis on the preservation of the spectral information originally provided in the MS images. In this dissertation, we examine the effectiveness of the following five techniques: Gram-Schmidt (GS), fast Fourier transform (FFT) -enhanced IHS (FFT-E), modified intensity-hue-saturation (M-IHS), high pass filter (HPF), and wavelet-principal component analysis (W-PCA).

Another problem of available methods has been the lack of systematic way for evaluating the fusion products. This means that the result is often dependent on the operator’s skills, with no assurance of general applicability. In order to improve this situation, the second purpose of this work is to establish an automatic and reliable way for the evaluation of the pan-sharpened images, on the basis of both qualitative and quantitative metrics. The suitability of the fused images is examined from the viewpoint of their application to land classification studies. In order to achieve accurate classification, we apply the support vector machine (SVM) based on radial basis function kernel.

We have carried out fusion experiments for images obtained from typical high resolution satellite images of QuickBird, WorldView-2, GeoEye and OrbView. The spectral characteristics of fused images based on five different methods are qualitatively and quantitatively analyzed in view of the color preservation and spatial improvement. It is found that the GS and FFT-E fusion methods are superior to other tested algorithms in terms of better color preservation and minimized spatial distortion, as well as better suitability for further image analysis of land classification and change detection.

【Related Publication】