Evaluation of Pansharpening Techniques for Pixel-based and Object-based Image Classification

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Image fusion or pansharpening is typically used for improving the visual interpretability of images, though it can also be used as a preprocessing technique prior to digital image analysis like object-based image analysis (OBIA). Results of pansharpening techniques are usually evaluated using histogram analysis, interband correlation analysis, and various indices such as structural similarity index and divergence index. These measures, however, do not fully ensure that spectral separability is maintained after applying the pansharpening techniques. In addition, based on this study, these measure may give inconsistent result as to which method better preserves the spectral and spatial information. The use of spectral separability measures is introduced as additional parameter in the evaluation of the performance of various pansharpening techniques such as Hue Saturation Value (HSV), Brovey Color Normalized (BCN), CN Spectral Sharpening (CNS), Principal Components Sharpening (PCS), and Gram-Schmidt Sharpening (GSS). Spectral separability was examined by first running the ISODATA clustering algorithm to define the spectral classes detectable from the upsampled original multispectral images. The delineated class polygons were then used as regions of interest for evaluating the spectral separability in the original and fused images using the Jeffries-Matusita and Transformed Divergence indices. For the case of OBIA, multiresolution segmentation (implemented in eCognition 8) was carried out based on the original multispectral and panchromatic images. Using these objects, mean values for each image and correlation of object means were calculated. Results showed that interband correlations, namely multispectral-to-multispectral, panchromatic-to-multispectral, multispectral-fused were closest or highest for GSS, CNS, CNS, respectively. Cross-correlation, a measure of spatial structure preservation, was high for GSS, CNS, and BCN. CNS best preserves the spectral separability based on the least reductions in the values of the Jeffries-Matusita and Transformed Divergence indices for most of the spectral classes. For OBIA, objects delineated using the CNS and BCN closely resembled, in shape and numbers, those delineated from the combined multispectral and panchromatic image. Object-based correlation of mean values showed that GSS and CNS performed best in preserving relative within-object values while PCS and HSV performed poorly.

Keywords: pansharpening, spectral separability, OBIA, ISODATA