A Fast and Simple IHS-Like Method For Pansharpening Landsat 8 Imagery With High Spectral Quality: Case Study in Thailand and Japan

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Abstract: Most image pansharpening methods, including the commonly-used Intensity-Hue-Saturation (IHS) algorithm, tend to distort spectral information for multispectral (MS) bands outside the spectral range of the panchromatic (PAN) band. This color distortion can cause errors for many types of image analysis including image classification, change detection, and calculation of vegetation indices. Since maps produced by the image analysis are important for agricultural and natural resource management (i.e. monitoring crop area coverage, land use/land cover, plant stress, etc.), they must be as accurate as possible. Color distortion is particularly an issue for Landsat 8 because only two of its MS bands (Green and Red bands) are located totally within the PAN band's spectral range, while five other useful bands for land and water studies (the Coastal, Blue, Near-Infrared, and 2 Shortwave-Infrared bands) are outside of its range. Some other pansharpening algorithms can minimize this color distortion, but typically at the expense of either (a) a significant reduction in spatial quality, or (b) much higher computation time and complexity.

Based on these limitations, a new *n*-band IHS-like algorithm was proposed for pansharpening Landsat 8 imagery (bands 1-7) that minimizes the effects of local spectral mismatching between the IHS Intensity band (I) and the PAN band through analysis of trends in reflectance across multiple scales. The algorithm involves first downsampling PAN to a spatial resolution coarser than I (Pan_{coarse}), and then multiplying the spatial details obtained from the PAN band by a trend-based modulation factor, determined by the trend in reflectance across PAN, I, and Pan_{coarse}. The modulation factor applies greater weight to IHS's spatial adjustment factor if a trend in reflectance is consistent across scales, and less weight if it is inconsistent across scales. Based on a thorough quantitative evaluation in an agricultural area in Thailand and an urban area in Japan, the proposed algorithm was found to produce pansharpened images of higher quality than (a) two conventional IHS pansharpening algorithms and (b) a fast statistically-based algorithm; Bayesian Data Fusion. Due to its speed (only slightly slower than IHS), simplicity (it can be easily implemented in most GIS/Remote Sensing software), and spectral and spatial quality, the proposed algorithm is a good candidate for pansharpening Landsat 8 images. Eventually we plan to make this algorithm available for download as a custom ArcGIS tool to promote its use among non-experts in Remote Sensing.

Keyword: Landsat, Pansharpening, Image fusion