Title: **The Impact of Spatial Resolution on Information Class Separability in Hyperspatial Imagery**

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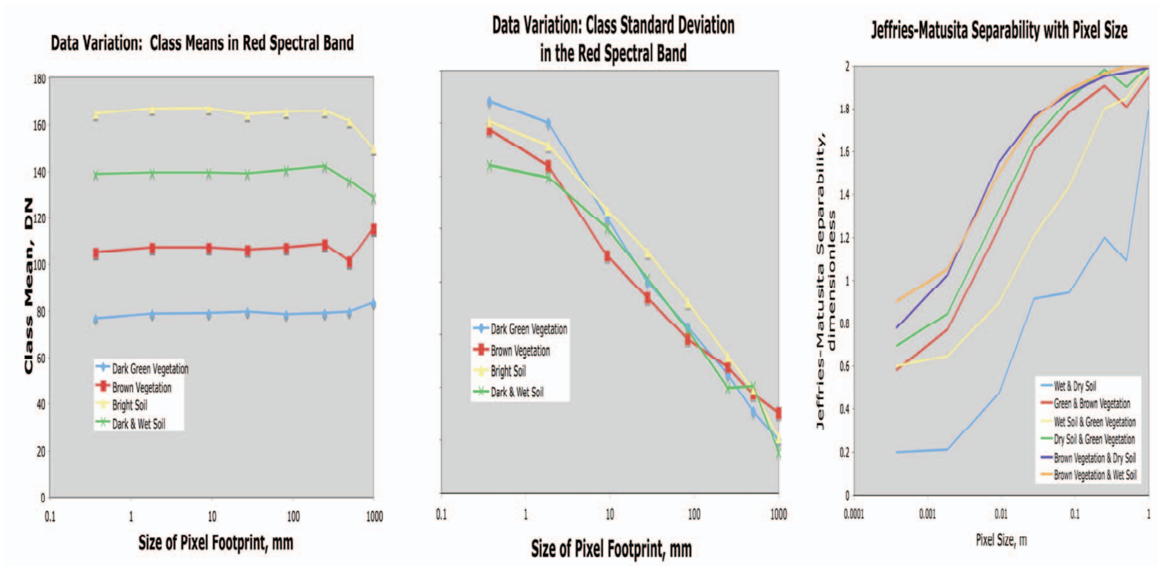
Overview. In satellite based remote sensing, one recent trend has been toward collection of imagery having ever smaller ground pixel footprints - fractions of one meter. Our research looked at image data having ground pixel footprints with sizes between 1m and 0.00037m, testing the hypothesis that spectral separability would decrease markedly as pixels became smaller. The results show that the Jeffries-Matusita measure of the separability of information classes decreased by a factor of as much as 10 as spatial resolution changed from 1m to 0.00037m. We expect - but did not show - that classification accuracy will display a concordant decrease. Our results suggest there may be limits to the need for ever increasing image spatial resolution if image analysis is to depend solely upon spectral classification algorithms.

Approach. We collected 110 images on a 10mx11m grid on the sloping side of a dike of a salt pond over one hour as the solar elevation varied from 24° down to 17° using a standard color digital camera equipped with a 38mm lens positioned vertically 2.1m above the soil with the aid of a monostand. Images were trimmed to 2700x2700 pixels representing a ground area approximately 1mx1m. Pixels in each image were boxcar averaged to obtain 110 new images each having 540x540, 108x108, 36x36, 12x12, 4x4, 2x2 and 1x1 pixels, respectively. Pixel DN values in the 110 images were adjusted to account for the changing sun angles and camera aperture and shutter speed. At each pixel resolution, we identified four information classes - dry bare soil, brown (dead) vegetation, green (healthy) vegetation and wet bare soil - and calculated class means and standard deviations and the six Jeffries-Matusita measures of separability between the four classes taken two at a time.

Results. The graph below shows that the mean value of the DN values representing each information class are approximately constant, changing little with pixel size in the red spectral band; similar results (not shown) were obtained for the green spectral band. The graph of class mean values also shows that the mean values of the information classes are different, each from the other three. The standard deviation (graphed below) representing each information class decreases monotonically as pixel size increases. The decrease in standard deviation with pixel size is also evident in the results (not shown) for spectral space; the size of the data cloud representing each information class decreases with increasing pixel size. All these results - nearly constant means and monotonically decreasing standard deviation as



pixel size decreases - suggest that the separability of information classes should increase with increasing pixel size, just as is shown in the graph of Jeffries-Matusita spectral separability. We did not compute classification accuracy at each pixel size, choosing instead to use the Jeffries-Matusita spectral separability as a surrogate.

Conclusions. The general increase in the Jeffries-Matusita spectral separability with increasing pixel size suggests classification accuracy would also increase with increasing pixel size, a result that would be consistent with results for pixel sizes from 0.3m to 1km (V.C.Vanderbilt et al., 2007). Our results here suggest a need for robust classification algorithms that perhaps incorporate both spectral and spatial information in the analysis process. In the absence of such robust spectral/spatial algorithms, the utility of sensors with markedly increased spatial resolution seems open to debate. On the one hand, increased spatial resolution would presumably allow creation of higher fidelity spatial maps of, for example, cadastral information. Such advantages must be balanced against the increased cost of higher spatial resolution systems - including the costs of data collection, handling and storage - and the potential for decreased classification accuracy unless pixels are aggregated.

Bibliography

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