DISCRIMINATION OF VEGETATION-IMPERVIOUS SURFACE-SOIL CLASSES IN URBAN ENVIRONMENT USING HYPERSPECTRAL DATA

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Objective of this research is to assess suitability of hyperspectral data for separating vegetation-impervious surface-soil (VIS) classes - especially detection of impervious surfaces such as concrete, asphalt and so on - in Indian urban set up. Secondary goal is to begin the efforts for creation of knowledge base of spectral signatures by creating a prototype spectral library. We investigate here both the methods of creating spectral knowledgebase: using satellite imagery, and using field spectrometer. Further we investigate, if image based calibration method such as Internal Average Relative Reflectance (IAR) provides accurate enough signatures for VIS classification of urban area using Spectral Angle Measurement (SAM).

We used recently (April 2013) acquired EO1 - Hyperion image for Pune region - a fast growing Indian urban conglomerate from Maharashtra state. After converting the DN values of each channel to radiance values, we used a novel extension of improved dark object technique to hyperspectral data to correct the additive component of atmospheric effects. After these steps we calculated relative (to average) reflectance by dividing each pixel (spectrum) by average spectrum over the whole image. We then extracted signatures of known materials from the image and used them as reference spectra for VIS classification. Further, we measured filed signatures of some urban land covers over 350-1050 nm range using portable field spectrometer by Spectra Vista.

The signatures of VIS classes - with 10 nm spectral resolution are sufficient to differentiate and detect them. Preliminary results using image derived signatures show very good classification accuracy for VIS classes (86% overall accuracy). While broad level VIS classes are separable spectrally, some of the subclasses show similar signatures. Road concrete and road asphalt show very similar signatures with flat reflectance values without any diagnostic absorption. Concrete show higher reflectance values than that from the road asphalt. Though the bright spots (e.g. play grounds) in the image have different spectral shape, they are at times confused with built-up classes. Spectral matching technique such as NS3 that take into account reflectance information as well would be helpful in such a scenario.

Hyperspectral data has not been used as extensively for impervious surfaces as it is used for vegetation or water studies. Further, Urban composite materials (such as concrete) change their signatures with variation in their raw materials. Hence, the signatures in libraries (like USGS) for such materials would not be useful and would require knowledgebase of local materials for hyperspectral detection. USGS, ASTER spectral libraries cover variety of materials including minerals, vegetation, and limited numbers of urban land covers such as roofs and pavements etc. in American region.

Internal Average Relative Reflectance (IAR), Flat Field methods are commonly used image based calibration methods that produce spectrum resembling a laboratory spectrum. Such spectra can then be used for target detection using spectral matching techniques such as SAM. IAR has been found to be suitable in arid regions (with less vegetation) for mineral mapping. Suitability of IAR for regions with heterogeneous land covers such as urban area needs further investigations.

Key words: Hyperspectral, EO1-Hyperion, SAM, Impervious surface.