Abstract

In process of hyperspectral unmixing, Endmember Extraction Algorithms (EEAs) search for a set of distinct spectral signatures called endmembers (EMs), of which all other pixels in the image can be modelled as a linear combination of this set. Hence, Endmember Extraction (EE) is the prominent stage in hyperspectral unmixing. Most of the conventional EEAs are not able to detect some materials signatures due to some difficulties. The first issue arising from conventional EEAs and unmixing methods refers to assuming the same effect for different bands which is considered as a conceptual defect. Another problem associated with these methods is related to the global search of image to extract EMs and unmix the image; due to the rare occurrences of the EMs (i.e. low proportion of EMs to the background), EEAs are prone of failure. This thesis is concerned with these two challenges to improve the unmixing process. We made it possible by taking advantage of local spatial information and considering the impact of bands weights in process of endmember initialization (EI), EE and unmixing as well. In order to weigh the bands, Variance Component Estimation (VCE) technique using redundancy number was applied. This method categorizes bands into homogeneous groups according to their noise variances; then, in an iterative process, the variance components are updated and this process terminates when the variance components converge to one. The bands weights matrix derived from VCE, allows treating the bands in a flexible manner and according to their quality in the unmixing procedures. Furthermore, to apply local methods, a method based on dividing image to smaller segments, was applied. In this method, the unmixing process including the EI, EE and inversion problem is performed separately in spatial sub-sections of the image. The proposed method was implemented on hyperspectral dataset of AVIRIS Cuprite. The experimental results indicate the combination of VCE and local methods reduces the number of replacements in EE process; it avoids the huge computational cost caused by global searching; it solves the difficulties of extracting less or rare endmembers and finally, it improves the accuracy of EE and detects all endmembers present in the scene with more that 90% purity and 97% spectral similarity as well. It was also found that the impact of bands weights derived from VCE method is more significant in case of being applied in initialization and extraction (about 25% in each Individual spatial case) rather

than being only applied in the inversion problem (13.7%, 17.8% and 18.1% in 1×1, 2×2 and 3×3 local spatial segmentation cases respectively).

Keywords: Variance Component Estimation (VCE), Endmember Extraction (EE), Local Algorithms, Hyperspectral unmixing