Abstract

Spectral unmixing methods are at the heart of object identification, land cover mapping from remotely sensed hyperspectral images. The reflectance pattern obtained from a pixel is the resultant of the reflectance of multiple elements due to the limited spatial resolution of the hyperspectral scanners used in remote sensing application. Spectral unmixing process encloses modeling of the data, identification of the pure spectral reflections and computation of abundance of these endmembers. Although hyperspectral data is originally of very high dimension, it lies in a significantly lower dimensional subspace. This subspace structure is of paramount interest to the researchers. In this thesis we explore the low-rank structure of the data and carry out different unmixing approaches.

To this aim, we first proposed efficient approaches for estimation of the number of endmembers present in the image. The proposed approach for estimating the number of endmembers aim to account for the diverse noises present in the data. The next contribution of the work lies in faster, and more efficient unsupervised unmixing method, that covered complete unmixing framework. Although a plethora of algorithms are present for unmixing of hyperspectral data, very few of these actually cater for the lower computational requirement while maintaining the accuracy in performance.

Library pruning approaches identify the image endmembers from the spectral library, and compute abundance matrix by inversion. The library pruning process greatly increases the accuracy of abundance computation and the runtime performance. However, the prevalent library pruning approaches often overestimate the number of endmembers, and show degraded performance in the presence of spectral library with high mutual coherence. We aim to propose exactly library pruning approaches that will mitigate the effects of high mutual coherence of the spectral library. We carry out library pruning for both linear as well as bilinear mixing model. Hyperspectral images often reside in a lower dimensional nonlinear manifold structure, and show significant levels of correlation in the spectral domain. We propose a novel band selection approach that accounts for the complex nonlinear structure prevalent in the data create issues in band selection. We explore manifold based band selection, and study the effects of band selection on unmixing performance.

Keywords: Hyperspectral unmixing; Subspace-based approach; Library pruning; Endmember estimation; Landcover mapping; Unsupervised unmixing; Semi-supervised unmixing; Sparse Inversion

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