FEATURE EXTRACTION METHODS BASED ON WAVELETS TRANSFORM AND ORTHOGONAL PROJECTIONS APPLIED TO HYPERSPECTRAL IMAGES

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1. Introduction.

Hyperspectral imaging is the acquisition of a considerable number of images taken over hundreds of narrow and contiguous spectral bands. This property was exploited in remote sensing to collect more precise characterization and discrimination. The wealth of information generates a large amount of data which burdens the storage, the processing, the visualization and the interpretation tasks.

One idea is to perform a preprocessing which reduces dimensionality and optimizes data representation. Our work consists of the implementation of some algorithms based on feature extraction methods which we apply to airborne hyperspectral data collections acquired by AVIRIS and ProSpecTIR-VS sensors. First, we implement the principal component analysis (PCA) to separate the correlated data and concentrate the pertinent content into few new channels. This method fails when noisy (real) data are considered. To settle this problem, we developed an adjusted version of PCA called minimum noise fraction transform (MNF). Another idea was proposed to reduce data dimensionality exploiting the wavelet transform which is applied on spectral signatures. Those signatures are highly compressed the general form of spectral responses is preserved but not the spectral sense.

The obtained results were encouraging: high reduction levels were reached keeping the significance of the data.

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2. Methodology adopted and used data

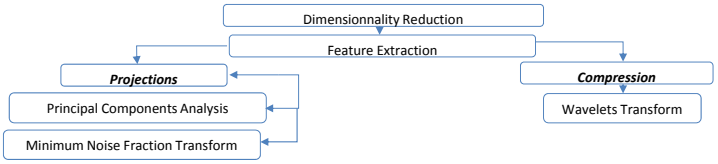
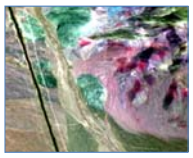


Diagram illustrating the various methods of reducing the dimensionality developed

AVIRIS (channels 183,193,207)



ProSpecTIR-VS (channels 303,319,340).

Sensor	Spectral dimension	Spectral coverage	Spectral résolution	Images dimensions
AVIRIS	*224 bands*	*0.42475µm → 2.4790µm*	*About 10nm*	*350x400 pixels*
ProSpecT IR-VS	*271/ 357 bands*	*0.42475µm → 2.35853µm*	*2.9nm (VNIR) 8.9nm (SWIR)*	*400x320 pixels*

Description of data collections used during the tests.

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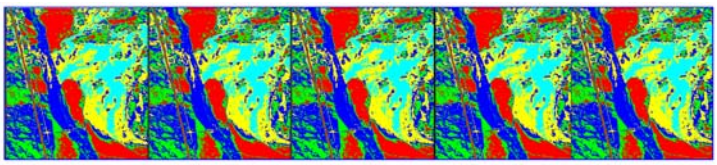
2. Methodology adopted

2.1. Generation of neo-channels by the principal component analysis

Under the assumption that the multidimensional treated data are highly correlated, this principal component analysis is based on second order statistics and eigenvalue decomposition.

Informative content of spectral bands is condensed in a way that creates new uncorrelated and ordered channels. The first neo-channels denote the principal component.



Comparison of the reference image with those obtained considering different spaces generated by the PCA with decreasing dimensionalities (12, 6, 3 and 1).

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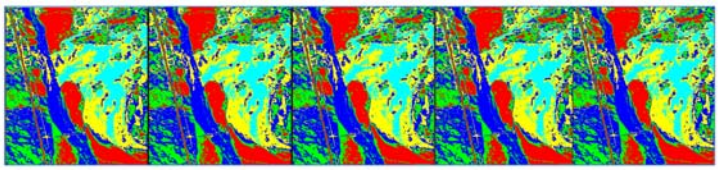
2. Methodology adopted

2.2. Generation of neo-channels by the minimum noise fractions transform

The minimum noise fraction transform is a method derived from the principal component analysis. It was developed to avoid that noisy component appeared in the first components which should be significant.



Comparison of the reference image with those obtained considering different spaces generated by the MNF with decreasing dimensionalities (12, 6, 3 and 1).

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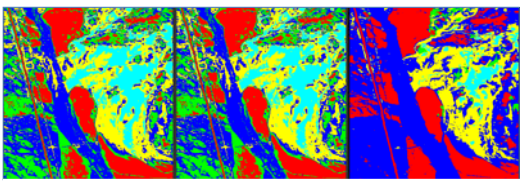
2. Methodology adopted

2.3. Compression of spectral channels by the wavelet transform

The wavelet transform provides a multi-resolution and multi-scale description obtained by successive projections involving a specific function called mother wavelet which is applied to translation and dilation at several levels.

This reduction technique has been successfully used in multidimensional spaces hence the idea of its exploitation for the volume reduction such is the case of hyperspectral remote sensing data.



Classified images from the original data (left), from the reduced data by wavelet Db1 taking (centre) and D5 (right).

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3. Conclusion

During our first experience in the field of hyperspectral imaging, we focused on dimensionality reduction stage which is a crucial step towards the exploitation of high dimensional data. Our objective was to implement few methods available in literature. We focused on the feature extraction approach.

We come to achieve satisfactory reduction rate with an accurate representation of the data. Generally, the order statistics are not sufficient to describe variations in hyperspace.

As a perspective of this study, we will use the independent component analysis and projection pursuit transform.

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Thank you for your attention

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