Clustering of HIRIS data

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Abstract

Along with the development of imaging sensors, hyperspectral imaging technology is growing rapidly and contributing to many fields of science nowadays. However, the bulky size and complex structure make it difficult to be processed. Focused on in this paper is the clustering utility, implemented in HYVIEW, a program involving tools and functions to manipulate with hyperspectral images. The clustering process aims to partition the surface of the imaged area into subregions by grouping the spectra subject to the similarity of spectra.

I. Introduction

Hyperspectral imaging is an emerging technique in optical remote sensing and it can contribute to many application fields such as the environmental analysis, agriculture, geology, and military [1].

By taking advantage of hundreds of narrow and continuously spectral bands, the hyperspectral image provides an opportunity for detecting materials that can not be solved from multispectral images [2].

Different materials will reflect diversely at a given wavelength so that they will bring out different spectra. However, each has a certain shape of spectrum that is a believable feature for recognizing the material by matching the spectra. In this paper, the implementation of clustering/ classifying the hyperspectral image is investigated using some spectral matching measures broadly recognized nowadays.

II. Spectral matching measures

Spectral matching is studied in an attempt of determining the similarity between two spectra. The measures play an important role on the accuracy of the classification. Two spectra are said to be similar if the spectral distance between them is small.

Of many previous measures, the Euclidean Distance and the Spectral Angle are those used fluently due to their simplicity but effectiveness.

The Euclidean Distance which is defined by Eq. 1 measures, as its name, the Euclidean distance between the two vectors.

$$ED(\mathbf{x},\mathbf{y}) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \qquad (1)$$

where n is the number of bands (e.g the length of the vectors). The main disadvantage of the measure is that it is difficult to priorly set a threshold for classification because this threshold is dependent of the data being used (e.g the number of bands). As the number of bands increases, the ED increases as well.

The Spectral Angle [3] calculates the angle between the two vectors in n dimension to measure the similarity. The definition for this measure is as follows:

$$SAM(\mathbf{x},\mathbf{y}) = \arccos\left(\frac{\langle \mathbf{x},\mathbf{y}\rangle}{\|\mathbf{x}\|_2\,\|\mathbf{y}\|_2}\right) \qquad (2)$$

where $\langle\bullet\rangle$ indicates the dot product; $\|\bullet\|$ represents the norm of the vectors. The measure has some advantages that make it used in almost software packages. At first, the method is simple in definition and easily understandable. Also this method is not affected by solar illumination factors due to the independence of the angle towards the vector length. The other is that it represses the influence of shading effects to strengthen the target reflectance characteristics [4].

III. Implementation

In HYVIEW, the two above mentioned measures are implemented for clustering and classification by matching spectra. This work is affected heavily by noisy bands in hyperspectral data. In order to diminish this intervention, the noisy bands are removed by considering the correlation coefficients (as Eq. 3) between two adjacent bands throughout the data; a small value indicates a noisy band pair. Noisy bands are randomly different that make the correlation coefficient between them or between a noisy band and a well reflected band big.

$$r_{ij} = \frac{\sum (x - m_i)(y - m_j)}{\sigma_i \sigma_j} \qquad (3)$$

where r_{ij} is the correlation coefficient; m_i, m_j are in turn the mean of ith and jth bands; σ_i, σ_j are the variances of those bands, respectively; x, y are the pixel values in the bands.

On the same data, however the clustering using each of the measures returns alternative results. In order to enhance the performance of the classification, the two measures are combined in the following manner: firstly using one measure to cluster the original image, and then using the other to further cluster each of the classes obtained. By this way the combined measure benefits from each of the individual measures so that the clustering is improved in terms of accuracy.

IV. Conclusions and future works

In this paper, the implementation of clustering hyperspectral image is presented. The experimental results point out that, although sharing the same purpose, different measures may return diverse classification results. In order to enhance the performance of measures, the combination of individual measures is implemented. The experimental result has proven the validation of the combination process. The future work will include the spectral matching, that is, classifying the hyperspectral image based on a pre existed spectral library in which we can find the exact shape of alternative materials.

References

[1] Chang, C.I, 2003. Hyperspectral Imaging: Techniques for Spectral Detection and Classification, Kluwer/Plenum Academic Publishers.

[2] Ben Dor, E., N. Levin, and H. Saaroni, 2001. A spectral based recognition of the urban environment using the visible and near infrared spectral region. A case study over Tel Aviv, Israel, International Journal of Remote Sensing, 22(11): 2193 2218.

[3] Kruse, F.A., Lefkoff, A.B., Boardman, J.W., Heidebrecht, K.B., Shapiro, A.T., Barloon, P.J., Goetz, A.F.H., 1993. The spectral image processing system (SIPS)-interactive visualization and analysis of imaging spectrometer data. *Remote Sensing Environ. 44*, 145-163.

[4] De Carvalho, O.A. and Meneses, P.R. (2000). Spectral Correlation Mapper (SCM); An Improvement on the Spectral Angle Mapper (SAM). Summaries of the 9th JPL Airborne Earth Science Workshop, JPL Publication 00 18, 9p.