Spectral Grouping For Image Classification

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Abstract: **This paper presents a spectral based approach for image classification. The method divides the image into several groups by determining the closeness of each image pixel to each of the samples selected from the image using mahalnobis distance as a measure of similarity. Each pixel is then assigned to its closest sample. The result is an image composed of sample IDs.**

Keywords: Image Classification, Pixel Labelling, Mahalanobis Distance

I. Introduction

Based on the image primitive used viz., pixel based or object based, image classification methods are broadly of two main categories. Pixel based method as described in this paper classify individual pixels using only the spectral patterns. Object based methods use the spectral, spatial and contextual information of the objects to perform image Classification.

The input image is Landsat 7 pan image of Pyongyang, North Korea acquired on September 17, 2002 **[Ref.1,** www.nasa.gov**].**

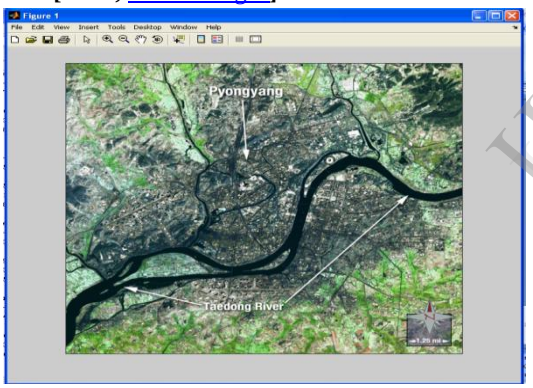

Fig:1 Input Image

This is a natural-color image using ETM+ bands 3, 2, 1. In this image, Pyongyang appears grey in color and is surrounded by vegetation (in green). The Taedong River, shown in dark blue, travels through the city.

II. Methodology

Samples are selected based on the expected. Number of classes in the image. Spectral grouping is done by determining the closeness of each image pixel to each of the samples selected from the image.The pixel is assigned to its closest sample based on Mahalanobis distance measure of closeness.

The Mahalanobis distance *D* as defined below, is used a measure of closeness or similarity.

$$D = \sqrt{(x-\mu)\sum(x-\mu)^T} \quad \text{--------- (1)}$$

In (1), x is the pixel spectral vector, μ is the mean spectral vector of a sample in a multiband image, Σ is the covariance matrix of the sample, T denotes the transpose of the matrix.

III. Implementation

The programming has been done using MATLAB 7.0.1 [**Ref.2** Lonesome M.Malambo 2009]. The sequence of steps involved in the developed code are

- The image data is loaded using MATLAB's imread function**[Fig:1]**
- RGB is converted to double format to facilitate floating point calculations.
- The image is smoothed using a Gaussian filter to reduce noise. fspecial command together with imfilter command are used to achieve this.
- Individual bands are separated.
- Samples are selected from different classes Viz., vegetation, water, settlement and barren regions**[Fig:2]**
  MATLAB's built in function roipoly is used to select regions of interest.
  roipoly returns a binary image that can be used as a mask for masked filtering.
- Statistics of the samples (mean & covariance) are calculated.
  MATLAB's mean and cov functions are used for calculating the mean and covariance respectively.
- The samples are Labelled (ID no. is given)
- Mahalanobis distance is then calculated between each pixel and each instance of sample set. pixels close to a sample are assigned the same sample ID.
- The result is an image composed of sample IDs
- Finally the classified image is observed using MATLAB's reshape function.

IV. Results

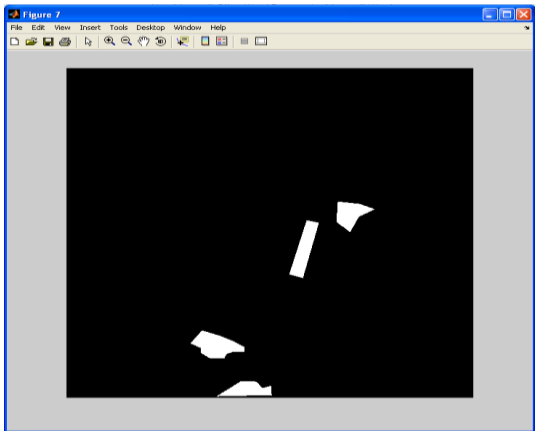

Fig:2 selected samples using **roipoly** function

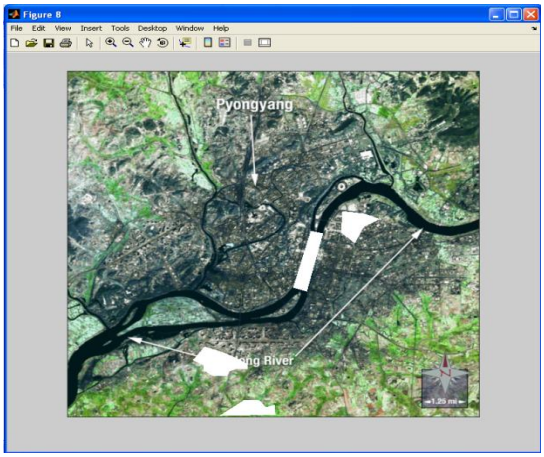

Fig:3 selected samples superimposed on the input image

Sample 1: Vegetation , Sample 2: water
Sample 3: Settlement, Sample 4: Barren

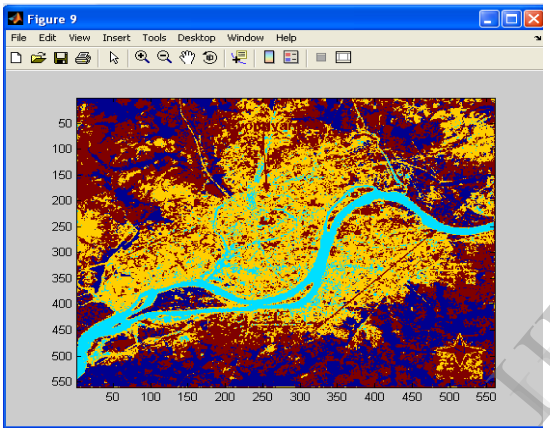

Fig: 4 output Classified image

Vegetation: dark blue Water: light blue
Settlement: yellow Barren: Red

Mean and Co-Variance of vegetation sample:

0.4355 0.6661 0.3177

0.0087 0.0083 0.0086
0.0083 0.0140 0.0093
0.0086 0.0093 0.0128

Mean and Co-Variance of water sample:

0.0474 0.1330 0.1545

0.0106 0.0100 0.0095
0.0100 0.0095 0.0091
0.0095 0.0091 0.0088

Mean and Co-Variance of settlement sample:

0.4376 0.4813 0.4533

0.0292 0.0256 0.0239
0.0256 0.0228 0.0213
0.0239 0.0213 0.0205

Mean and Co-Variance of barren sample:

0.6508 0.6743 0.6184

0.0281 0.0273 0.0296
0.0273 0.0283 0.0293
0.0296 0.0293 0.0326

V. Conclusion

Good results have been obtained as can be seen by comparing the input and output classified images. The classification result is influenced by the samples and also the number of samples. However pixel based methods suffer from mixed pixel problem. This can be overcomed by object based methods which uses spectral, spatial and contextual information of the objects to perform image Classification.

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