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Image Segmentation and Classification To Extract Region of Interest (ROI) in Satellite Images

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ABSTRACT: Remote sensing image processing is nowadays a mature research area. The techniques developed in the field allow many real-life applications with great societal value. For instance, urban monitoring, fire detection or flood prediction, deforestation and crop monitoring, weather prediction, land use mapping, land cover mapping can have a great impact on economical and environmental issues. It is universal known fact that satellites scan the images of earth surface. But in practical it is impossible to verify manually all those images for the required region.Then it would better to focus on those images that contain the required region. So there should be a method to identify the required region lies within that particular image. In this paper, a simple method to extract regions of interest (ROI) from images is proposed using segmentation and classification techniques. Segmentation is achieved by using Mahalanobis Distance and Classification is achieved by using support vector machines.

KEYWORDS: Remote sense image processing, Region of Interest, Mahalanobis Distance, Supervised Classification, Unsupervised Classification

I. INTRODUCTION

Remote sensing image processing is nowadays a mature research area. The techniques developed in the field allow many real-life applications with great societal value. For instance, urban monitoring, fire detection or flood prediction, deforestation and crop monitoring, weather prediction, land use mapping, land cover mapping can have a great impact on economical and environmental issues. From acquisition to the final product delivered to the user, a remotely sensed image goes through a series of image processing steps. Segmentation of the image to extract regions of intereset (ROI) is important step. Infact, segmentation of a satellite image into differently textured regions 'classes' is a difficult problem. Usually, one does not know a priori what types of textures exist in a satellite image, how many textures there are, and what regions have certain textures. The monitoring task can be accomplished by supervised classification techniques, which have proven to be effective categorisation tools. Unfortunately, these techniques require the availability of a suitable training set for each new image of the considered area to be classified. However, in real applications, it is not possible to rely on suitable ground truth information for each of the available images of the analysed site. Consequently, not all the satellite images acquired on the investigated area at different times can be used for updating the related land-cover maps. In this paper we propose an unsupervised algorithm for image segmentation using Mahalanobis algorithm followed by support vector machines (SVM) for classification. The Mahalanobis will take the input image and performs clustering. At the output of this step, the image pixels would be divided into groups of pixels, each group corresponds to one cluster. The second step is to apply multi class SVM (MCSVM) to take these clusters and classify them.

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II. PROPOSED SYSTEM OVERVIEW

Figure.1 and Figure.2 illustrates the block diagram and flow chart of the proposed system respectively. In this system, the input satellite image is taken and it is read by the algorithm which is written using MATLAB Software from which the hue information is extracted. For this hue image, histogram is applied. Then Gaussian probabilities are calculated using final mean and variance which are obtained through expectation and maximisation techniques. Then the image is segmented using Mahalanobis Distance. At the same time, the image is classified into clusters (i.e. group of pixels that have similar characteristics) and the class names would be provided (ex. Forest class, water class, habitat class and so on)

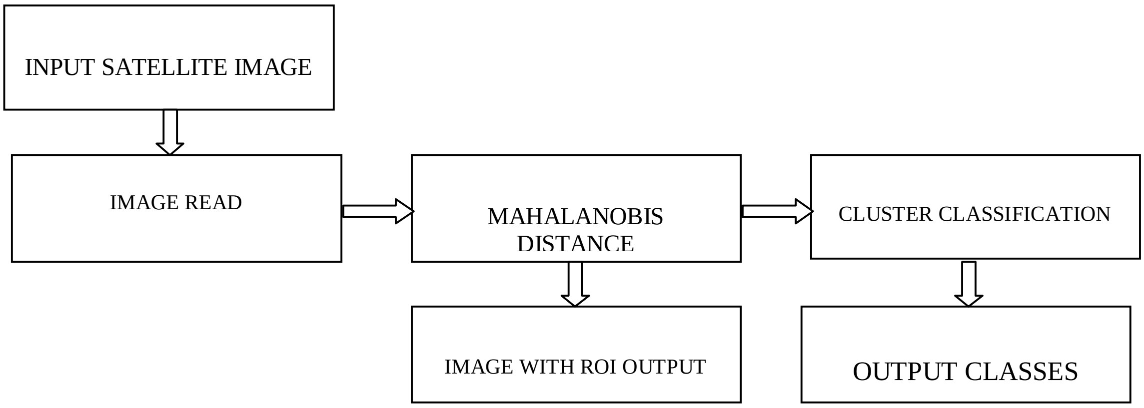

Figure.1

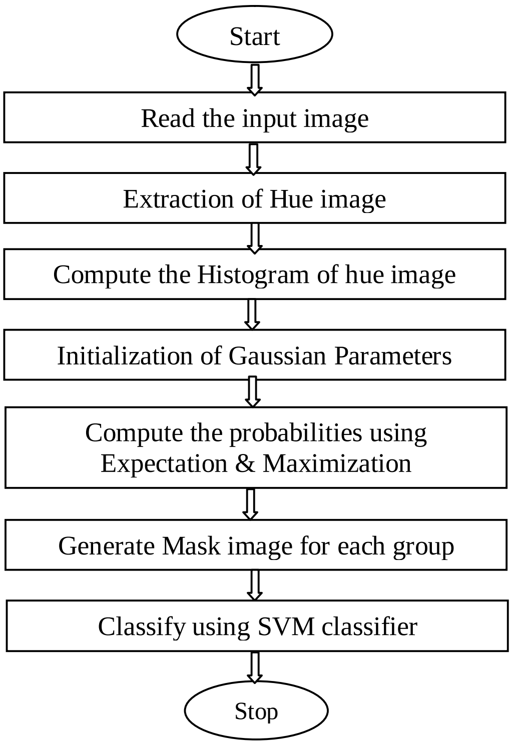

Figure.2

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IV. REGION OF INTEREST

A region of interest (ROI) is a subset of an image or a dataset identified for a particular purpose. In other words, region of interest (ROI) can be defined as a portion of an image which is needed to be filtered or to be performed some other operation on.

V. SEGMENTATION

Segmentation refers to the process of partitioning a digital image into multiple segments. In other words, grouping of pixels into different groups is known as Segmentation. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics

The division of an image into meaningful structures, image segmentation, is often an essential step in image analysis, object representation, visualization, and many other image processing tasks. But segmentation of a satellite image into differently textured regions (groups) is a difficult problem. One does not know a priori what types of textures exist in a satellite image, how many textures there are, and what regions have certain textures. The monitoring task can be performed by unsupervised segmentation and supervised segmentation techniques.

A. DIFFERENT COLOR MODELS AND CHOOSING BEST COLOR MODEL FOR THE SEGMENTATION

RGB Colour Space:
Generally the input satellite images would be in RGB colour space. RGB colour space has 3 primary colours. Using these 3 primary colours millions of colours can be produced. Any colour can be represented using these primary colours. Each component is represented by 8 bits. RGB data is represented in 24 bits. 8 bit data range is 0 to 255. That means red ranges from 0 to 255; green ranges from 0 to 255, blue vary from 0 to 255.

HSV Colour Space:
Hue is one of the main properties of a colour, defined technically as "the degree. Hue is the actual colour. Hue is in the range of 0 to 360 degrees. Saturation is the purity of a colour. High saturation colours look rich and full. Low saturation colours look dull and greyish.

Value is the lightness or darkness of a colour. Light colours are sometimes called tints, and dark colours shades. All high saturation colours have medium values (because light and dark colours are achieved by mixing with white or black).

For Segmentation, RGB colour space is needed to be converted into HSV colour space and hue is extracted from HSV because of two reasons. Image segmentation relies upon the colour information of the input image. But the shades change the colour. So it is needed to remove brightness and shadow components from the input image. The processing of data would be slower with RGB as it needs 24 bits to represent 1 pixel of an image whereas faster processing can be achieved with hue as it needs only 8 bits.

B. *HISTOGRAM*
A histogram is a function m_i that counts the number of observations that fall into each of the disjoint categories (known as bins), whereas the graph of a histogram is merely one way to represent a histogram...

$$n = \sum_{i=1}^{k} m_i.$$

Where n = the total number of observations
k = the total number of bins
m_i = the histogram

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Hue is a variable which has a range of 0 to 360 degrees. By applying histogram on hue, the probability distribution of each hue value in the image can be known which helps in segmentation process

C. GAUSSIAN DISTRIBUTION

Gaussian distribution function is the probability distribution function that represents the probability of distributions of any observed data. Gaussian probability distribution function should be calculated to allocate each pixel of the image into one of the several groups. That is each group would be represented as one Gaussian distribution function. The Gaussian distribution can be represented as

$$G\left(\frac{x}{\mu}, \sigma^2\right) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\left(\frac{-1}{2\sigma^2}(x-\mu)^2\right)} \quad \textbf{if x is 1 dimensional data}$$

$$G\left(\frac{x}{\mu}, \Sigma\right) = \frac{1}{\sqrt{(2\pi\Sigma)}} e^{\left(\frac{-1}{2}(x-\mu)^T)\Sigma^{-1}(x-\mu)\right)} \quad \textbf{if it is multi dimensional}$$

Where x is variable
μ is mean
∑ is the variance

The equation $(x-\mu)^T)\Sigma^{-1}(x-\mu)$ is called as the "**Mahalanobis distance**".

To calculate Gaussian distribution of each group, the exact mean and variance are to be known. The actual mean and variance can be obtained by using Expectation and Maximization.

D. EXPECTATION AND MAXIMISATION CALCULATION STEPS

Expectation refers to computing the probabilities using assumed parameters while maximisation refers to computing the parameters using calculated probabilities. The steps to calculate final mean and variance are given in the fig.3. By performing expectation and maximization, the actual mean and variance values are obtained. By using these final mean and variance, Mahalanobis distance is calculated. By calculating this, it would be known whether the pixel belongs to a particular group or not. The Equation $(x-\mu)^T\Sigma^{-1}(x-\mu)$ is called as the Mahalanobis Distance where $x-\mu$ is the distance between the actual value of the variable and the mean of set of the variable. I.e. $x-\mu$ represents how much away from the mean.

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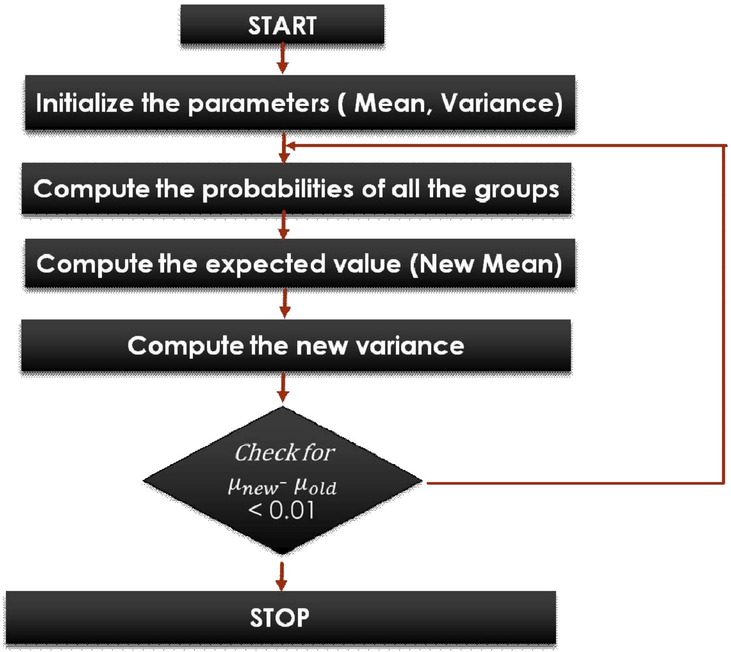

Figure.3

By using the probabilities, a mask image is generated. Mask is 2- dimensional array. The width and height of mask image are same as that of the input image. For example, if (m, n) element in mask image is 'x' then pixel in the input image present (m, n) belongs to group x.

III. **CLASSIFICATION**

The intent of the classification process is to categorize all pixels in a digital image into one of several classes, or "themes". There are two types of classification techniques.

Unsupervised Image Classification: In this output classes are obtained based on the software analysis of an image without providing sample classes by the user. The computer uses techniques to determine which pixels are related to which class and groups them into classes. The user can specify the algorithm the desired number of output classes but otherwise does not aid in the classification process.

Supervised Image classification: It is based on the idea that a user can select sample pixels in an image that are representative of specific classes. Then direct the image processing software to use these training sites as references for the classification of all other pixels in the image. Training sites (also known as testing sets or input classes) are selected based on the knowledge of the user. The user also designates the number of classes that the image is classified into.

In this paper Multi class support vector machines which is a supervised classification technique is proposed. In this method, training sets are provided to the computer so that program classifies the image into several classes depending upon their probabilities.

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IV. RESULTS

Figure 4 refers to the input satellite image. When this image is provided, the segmentation and classification results are obtained as in figure 5 and figure 6 respectively.

Figure.4 Input image

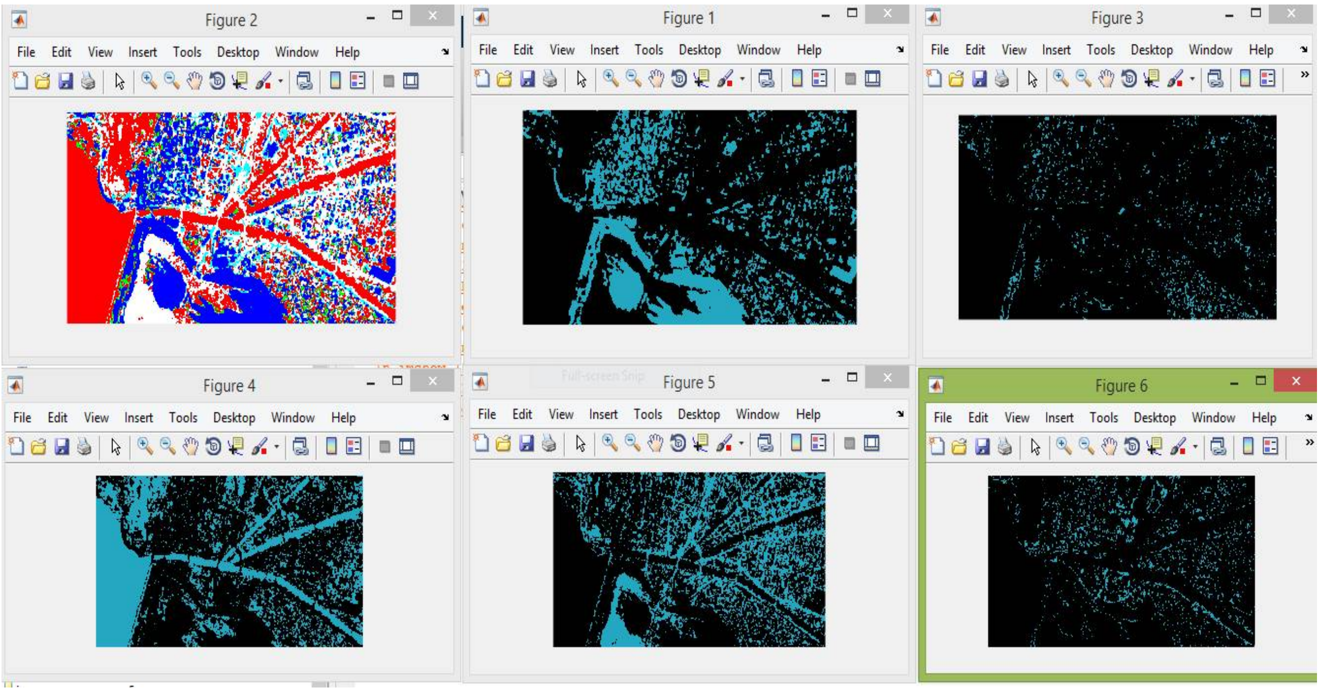

FIGURE.5 Segmentation Results

```
>> run_classify_n
Class Labels Assigned to the Image Are:
Green Vegitation
Solid Rocky Areas or Sands
Water
Habitat
```

FIGURE.6 Classification Results

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V. CONCLUSION AND FUTURE WORK

The segmentation and classification of satellite image is done efficiently with the proposed system. The future scope is if the label (Example: Water) is given, if it searches and provides all the images that contain that class then it would be better.

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