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Enhanced Segmentation Algorithm for Hyper-spectral Imaging (HSI)

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Abstract: Image Segmentation is most widely used to divide the images into the segments. This is used to find objects and boarders in images. Hyper-spectral imaging (HSI) is a spectral imaging acquisition where each pixel of the image was employed to acquire a set of images within certain spectral bands.Segmentation is most widely used activity that will divide the any image into multiple segments or into different object. The aim of the segmentation is to unravel and transform the rendition of an image into substitute thing that is to analyze.In this paper, the Enhanced Segmentation Algorithm (ESA) is introduced to overcome the various issues in processing the HSI. The dataset used in this paper is Indian Pines dataset and this consists of agriculture, forest or other natural perennial vegetation. The performance can be shown with the comparative results of SVM and ESA.

Keywords: Image Segmentation, HSI, ESA, Indian Pines.

1. Introduction

The image is most widely used to transfer the information, and the image consists of huge information. Image segmentation is one of the sub-domains in image processing and it is vision of computer. It is having some criteria to divide the given input image into number of the similar data within the image and it extracts the region where the people are interested to work on it. Based on the image analysis the extraction of image features and segmentation.

Hyper-spectral image analysis (HIA) is very powerful and rapid technology in the area of the remote sensing and aerial reconnaissance in recent years. It involves the capture of spectral information over a myriad region and the consequent analysis and interpretation of the acquired data. Hyper-spectral image involves the identification and recognitions of various pixels on the basis of their spectral signatures. These signatures are unique so that an object can be uniquely differentiated. Hyper-spectral sensorsare collect information as a set of thin images say band. These bands represent a narrow wavelength range of the electromagneticspectrum named as spectral band.

Segmentation is most widely used activity that will divide the any image into multiple segments or into different object. The aim of the segmentation is to unravel and transform the rendition of an image into substitute thing that is to analyze. This is the segmentation finally observe the variations based on the intra and inter subject.

Classification is most widely used in many applications for the research and this will check the every pixel of the image and find the Correlations between spatially adjacent pixels [1]. To classify the various hyper-spectral images the performance is increased with the accuracy. In any case, if the classification which is pixel wise that will not take the categorical data of sensed materials into account. Every pixel is created and classified every value that will not affect the image. By observing these results, it is most widely important to improve spectral spatial classification methods that are compatible which consider the spatial variations between pixels [2].

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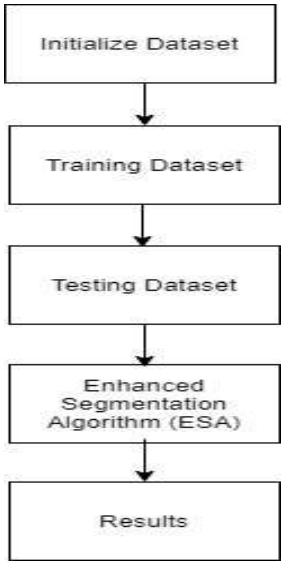

Figure 1: System Architecture

2. Literature Survey

The author explained about the image segmentation and the approach is called as labelling which is using Fuzzy c-means clustering algorithm [2]. The author described about the nature of the multispectral remote sensing of images that makes the pixel classification is used to develop for segmentation [3]. Another research is based on new supervised segmentation algorithm which is remotely sensed the various hyper-spectral image data which integrated the spectral and spatial information [4]. The new spectral-spatial classification scheme for hyper-spectral data is proposed by [5]. The author introduced the detection method that was developed by the performing k-means clustering with the feature vectors and the proposed algorithm was simple in computation yet effective in identifying meaningful changes which makes it compatible for real-world applications [6]. In [7], the tedious issue is this more expensive based on the cost with various clustering methods are solved. In [9] various image segmentation methods are discussed and this used for multiband reduction is illustrated.

SVM

SVM is the regulated grouping calculation that depends on the factual information of remote detecting pictures [13]. From the previous not many years this is embraced for grouping of hyper-unearthly remote detecting pictures [14]-[15]. SVM is a non-parametric matched classifier that finds the perfect hyper plane between the two classes to disconnect them in another high-dimensional part space by considering only the readiness tests that lie on the edge of the class distributions known as support vectors. Also, it doesn't require the notion of commonness and is heartless toward the scourge of dimensionality. SVMs have routinely been found to give higher course of action correctness's than other extensively used model affirmation strategies, for instance, the best likelihood. In addition, SVMs appear, apparently, to be especially priceless inside seeing heterogeneous classes for which just relatively few getting ready tests are open. The SVMs were at first developed to deal with twofold gathering issues. The use of SVMs in multiclass request issue is possible by characterizing SVMs clearly as a multiclass upgrade issue, yet as the amount of the classes ought to have been masterminded fabricates, the amount of parameters to be evaluated extends, it thus impacts the SVMs gathering execution to the extent exactness. All the three classifiers were used to amass an image to inspect for an incredible classifier.

Dis-Advantages of SVM

- Does not work well with larger datasets
- Sometimes, training time with SVMs can be high

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Enhanced Segmentation Algorithm (ESA)

ESA is the proposed system in this paper which calculates the every image based on the categories. This is the algorithm calculates the regions present in the system. Every region is divided with the different colours. The segmentation is done on different regions according to the training. The Indian pains dataset consists of many features and for every feature there will be testing and training. The following steps for algorithm.

Image Estimation: This is will estimate the background of the image and this is to fit the multivariate normal mixture model to a spatial sunset of the image.

Image Evolution: The image background calculated based on the probability value for all pixels in the image based on the estimated model.

Image Segmentation: The proposed system ESA used the every unique pixel to detect the various categories that perform the binary morphological closing in the threshold image.

Algorithm Steps are as follows:

Step 1 Initialize dataset

Step 2 Pre-processing (remove the noise with default filters)

Step 3 Segmentation process: To process the colour images the partitioning is involves for colour space, i.e. RGB or HSI space. The easy way which is based on some reference (or dominant) colour (R_0, G_0, B_0) and thresholding of Cartesian distances to it from every pixel colour

$$\mathbf{f}(a,b) = (\mathrm{Ra},b),\mathrm{G}(a,b),\mathrm{B}(a,b)):$$

$$g(a,b) = \begin{cases} 1\ if\ d(a,b) \le d_{max} \\ 0\ if\ d(a,b) \le d_{max} \end{cases};$$

$$d\ (a,b) = \sqrt{(R(a,b)-R_0)^2 + (G(a,b)-G_0)^2 + (B(a,b)-B_0)^2}$$

The binary area map after the threshold is represented as g(x,y). In the RGB space this threshold is represented in sphere shape and this is centred on reference colour. The pixels that are present inside the sphere area is indexed with 1 and all other pixels are in the 0.

Step 4 Results

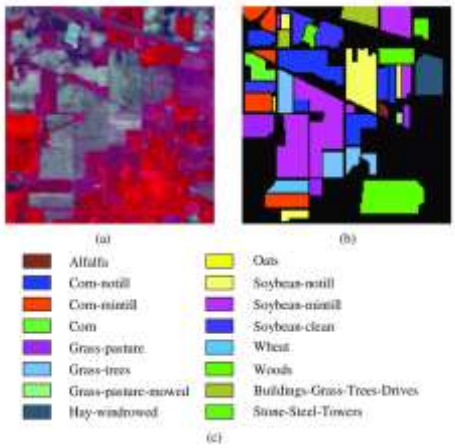

Figure: 1 Dataset description

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3. Experimental Results

The performance metrics are calculated by using the Indian Pines dataset that consists of 145\times145 pixels and 224 spectral reflectance bands in the wavelength range 0.4–2.5 10^(-6) meters. This scene is a subset of a larger one. This dataset scene consists of two-thirds agriculture, and one-third forest or other natural perennial vegetation. To develop the algorithm JAVA and JDK 1.8 with NETBEANS 8.0.2 is the IDE used to develop the algorithm. The hardware components such as 8 GB RAM, 500 GB hard disk are used. The performance metrics are as follows.

By utilizing the performance measures namely False Positive Rate (FPR), False Negative Rate (FNR), Sensitivity, Specificity and Accuracy, the performance of the system is estimated. The basic count values such as True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN) are used by these measures. Quality: this shows the quality of the output.

$$Quality = \frac{No.of\ TP + \ No.of\ TN}{No.of\ TP + No.of\ TN + No.of\ TN + No.of\ FP}$$

Accuracy: This will calculate the overall accuracy of the clusters.

$$Accuracy\ = \frac{TP + TN}{TP + TN + FP + FN}$$

Class	**Training Samples**	**Testing Samples**	**SVM**	**ESA**
Alfalfa	**6**	**48**	**45.32**	**98.67**
Corn-no-till	**144**	**1290**	**85.32**	**98.56**
Corn-min-till	**84**	**750**	**73.54**	**96.78**
Corn	**24**	**210**	**68.23**	**98.67**
Grass-pasture	**50**	**447**	**92.12**	**98.56**
Grass-tree	**75**	**672**	**93.21**	**99.78**
Grass-pasture-mowed	**3**	**23**	**94.76**	**99.67**
Hay-windrowed	**49**	**440**	**97.98**	**97.67**
Oats	**2**	**18**	**4.23**	**98.76**
Soybean-notill	**97**	**871**	**77.89**	**98.67**
Soybean-mintill	**247**	**2234**	**88.98**	**98.67**
Soybean-clean	**62**	**552**	**87.67**	**97.67**
Wheat	**22**	**190**	**98.76**	**99.87**
Woods	**130**	**1164**	**96.56**	**98.78**
Buildings-Grass-Trees-Drives	**38**	**342**	**58.76**	**99.87**
Stone-Steel-Towers	**10**	**85**	**89.87**	**98.78**
Overall Accuracy			**86.98**	**99.87**
Quality			**78.98**	**98.89**
Time (Sec)			**56.98**	**43.98**

Table: 1 Performance of SVM and ESA

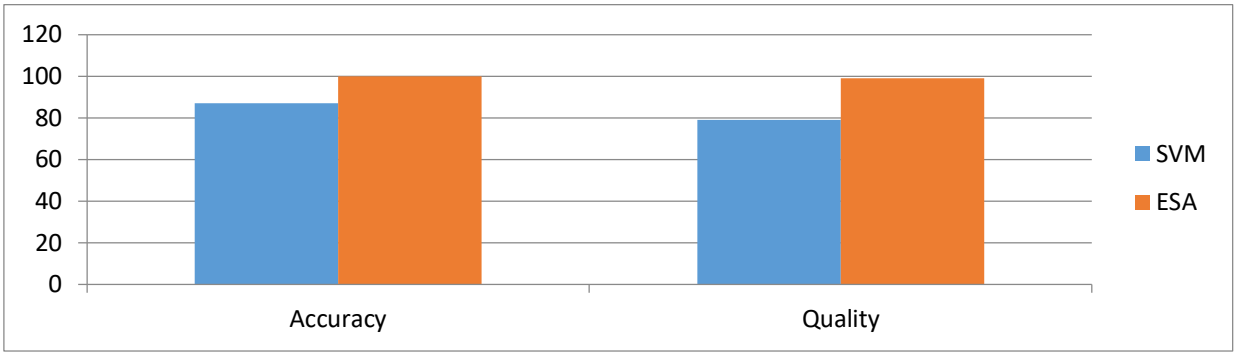

Figure 2: Performance comparison between SVM and ESA

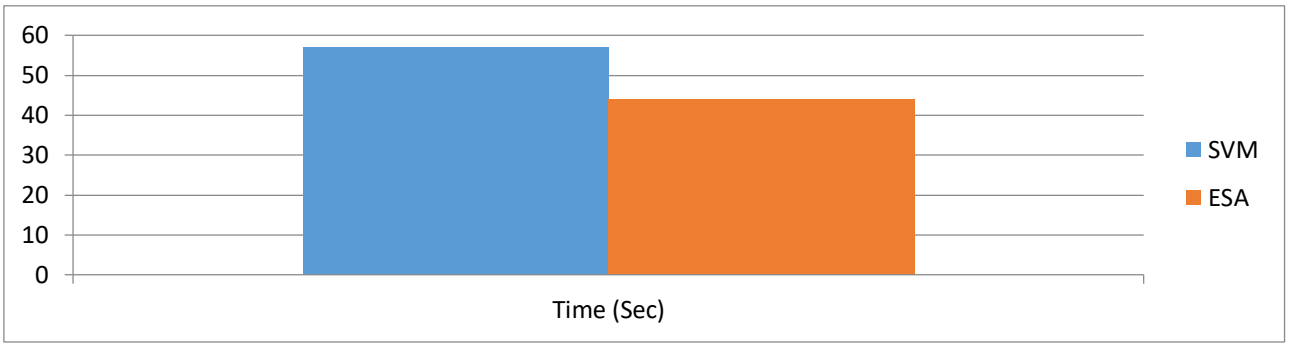

Figure 3: Time comparison between SVM and ESA

4. Conclusion

In this paper, the proposed system solving the issues in finding the various feature in hyper spectral images. Image segmentation is the most widely used basic concept in this system. The ESA involves in various conversions of the given input image into segments with the improved quality. The aims of ESA process only the very unique segments of the image instead of processing the overall image. The ESA is better compare with the various existing system algorithms. The performance is calculated with two parameters accuracy, quality and time.

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