International Journal of Mathematical Archive-2(9), 2011, Page: 1591-1596
Available online through www.ijma.info ISSN 2229 – 5046

An Efficient Fuzzy C-Means Algorithm for Segmenting Color Based Satellite Image Data

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(Received on: 14-07-11; Accepted on: 01-08-11)

ABSTRACT

This paper presents a new approach for color based image segmentation by applying Fuzzy c-means algorithm. This segmentation process includes a new mechanism for clustering the elements of high –resolution images in order to improve precision and reduce computation time. Normally, due to the progress in spatial resolution of satellite imagery, the methods of segment-based image analysis for generating and updating geographical information are being more and more important.[5] So, in this work we present a novel image segmentation based on color features with fuzzy c-means algorithm. The main objective of this paper is to get a non-overlapping of image and a reliable output.

***KEY WORDS**: Data mining, remote sensing, color separation, Fuzzy C-Means algorithm, noise removal, satellite image, pixels.*

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1. INTRODUCTION

The image segmentation is an effort to classify similar colors of image in the same group. It clusters colors into several groups based on the closeness of color intensities inside an image. Segmentation refers to the process of partitioning a digital image into multiple regions. The goal of implementation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in the images. [3] The result of image segmentation is set of regions that collectively cover the entire image or set of contours extracted from the image. Each of pixels in a region is similar with respect to some characteristics or computed property, such as color, intensity or texture. The advancements of various remote sensing plat forms have resulted in the production of huge amounts of satellite image data. Modern forms of satellite image data are quite often multispectral or hyper spectral, and provide more and more data in the frequency domain as well as in the spatial domain; much more than what the human eye can "see" from space. There is need for effective sorting, querying and browsing of information in these image databases. In order to take advantage and make good use of satellite images we must able to extract meaningful information from the imagery. Color segmentation of the image is a crucial operation in the image analysis. In many computer vision, image interpretation, and pattern recognition system, with application in scientific and industrial fields such as medicine, remote sensing, and microscopy content based image retrieval, document analysis industrial automation and quality control [23, 15].

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2. METHODOLOGY

The present works organized as follows: section-A describes the noise removal of the satellite image. Section-B describes the color transformation of image. Section-C describes the local contrast stretching method. Section-D describes the Fuzzy C-means Clustering algorithm. Section-E proposed method of segmentation of image based on colour with Fuzzy C-means clustering is presented and discussed. For this proposed work we are represents systematically (Figure-1).

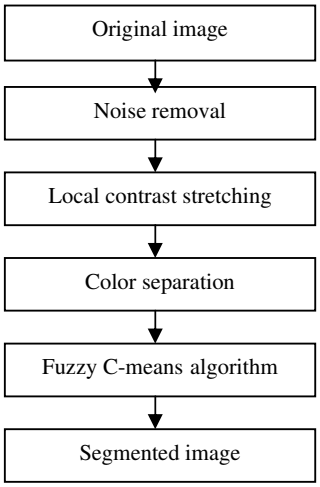

Fig-1 proposed work architecture

A. NOISE REMOVAL

An adaptive noise removal filtering using the wiener filter is applied for noise removal of images. The wiener filter can be consider as one of the most fundamental noise reduction approaches and widely based for solution for image restoration problems. In our system we use 3x3 neighborhoods of filtering size.[15] Noise reduction techniques are procedures that are used to remove the unwanted signals from an image. Noise reduction techniques are conceptually very similar regardless of the signal being processed, however a priori knowledge of the characteristics of an expected signal can mean the implementations of these techniques vary greatly depending on the type of signal [8].

All denoising methods depend on a filtering parameter 'h'. This parameter measures the degree of filtering applied to the image. For most methods, the parameter 'h' depends on an estimation of the noise variance σ^2.[10,15] The result of a denoising method D_h can be defined as a decomposition of any image 'v' as given in below Equation

$w = D_h v + n (D_h, v)$ where $D_h v$ is smoother than v.

$n (D_h, v)$ is the noise guessed by the method.

B. COLOR TRANSFORMATION

Convert image from RGB color space to L*a*b* color space. There color space enables you to qualify these visual differences. The L*a*b color space is derived from the CIE XYZ values. The L*a*b* space consists of a luminosity layer 'L*', chromaticity layer 'a*' indicating where color falls along the red-green axis and chromaticity layer 'b*' indicating where the color falls along the blue-yellow axis. All of the color information is in the 'a*' and 'b*' layers, we can measure the difference between two colors using the Euclidean distance metric convert the image to L*a*b*.[21,25] Euclidean distance is used for similarity matching in the present system. The Euclidean distance between two point's p = (p1, p2…pn) And Q = (q1, q2...qn), in Euclidean space, is defined as:

$$\sqrt{(p1-q1)^2+(p2-q2)^2+\cdots(pn-qn)^2} = \sqrt{\sum_{i=1}^{n}(pi-qi)^2}$$

System calculates the Euclidean distance of data of given query data to all other data in the data base.

C. LOCAL CONTRAST STRETCHING

Local contrast stretching is one of the image enhancement techniques which can be used to improving or locally adjusting the image picture element. So it is better to view in dark and bright portions of the image and local contrast

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stretching are performed KERNEL across the image and center element of the images is adjusted by the formula as given below. [14]

$$IP(x, y) = \frac{255[I(x,y)-min]}{max-min}$$

Through this formula we can found the minimum and maximum level of the image. In the local contrast stretching each range of color such as R, G, B are taken and calculated separately, that means the range of each color can be detected separately.

D. FUZZY C-MEANS ALGORITHM

Fuzzy C-means is a clustering method which allows a piece of data to belong to two or more cluster, which is frequently used in computer vision, pattern recognition and image processing. The FCM algorithm obtains segmentation results by fuzzy. Color based classification methods which group a pixel belong exclusively to one class.FCM approach is quite effective for color based image segmentation. [10] Several segmentation algorithms are based on fuzzy set theory. Fuzzy C-means is a clustering algorithm that used membership degree to determine each data point belongs to a certain cluster. FCM divided the n vectors X_i (i=1, 2, 3…..n) into C fuzzy group and computing the cluster center of each group making value function of non-similarity index to achieve the minimum.[6].

Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. It is based on minimization of the following objective function:

$$J_m = \sum_{i-1}^{N} \sum_{j-1}^{C} U_{ij}^{m} \|x_i - c_j\|^2$$

$1 \leq m < \infty$. where m is any real number greater than 1, u_{ij} is the degree of membership of x_i in the cluster j, x_i is the

ith of d-dimensional measured data, c_j is the d-dimension center of the cluster, and ||*|| is any norm expressing the similarity between any measured data and the center. [11] Fuzzy partitioning is carried out through an iterative optimization of the objective function shown above, with the update of membership u_{ij} and the cluster centers c_j by:

$$u_{ij} = \frac{1}{\sum_{k-1}^{c} \left(\frac{\|xi-cj\|}{\|xi-cj\|} \right)^{2/m-1}}$$

$$c_j = \frac{\sum_{i-1}^{N} U_{ij}^{m} \cdot xi}{\sum_{i-1}^{N} U_{ij}^{m}}$$ This iteration will stop when

$Max_{ij}[|U_{ij}^{(k+1)} - U_{ij}^{(k)}|] < \varepsilon$, where ε is a termination criterion between 0 and 1, whereas k is the iteration steps.

This procedure converges to a local minimum or a saddle point of J_m. the steps are given below.

Step:1 Initialize $U=[u_{ij}]$ matrix, $U^{(0)}$

Step: 2 At k-step: calculate the centers vectors $C^{(k)} = [c_j]$ with $U^{(k)}$

$$c_j = \frac{\sum_{i-1}^{N} U_{ij}^{m} \cdot xi}{\sum_{i-1}^{N} U_{ij}^{m}}$$

Step: 3 Update $U^{(k)}$, $U^{(k+1)}$

$$u_{ij} = \frac{1}{\sum_{k-1}^{c} \left(\frac{\|xi-cj\|}{\|xi-cj\|} \right)^{2/m-1}}$$

Step: 4 If $\| U^{(k+1)} - U^{(k)} \| < \varepsilon$ then STOP; otherwise return to step 2.

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E. **COLOR BASED SEGMENTATION USING FUZZY C-MEANS ALGORITHM**

In this paper the main objective is to segment colors in automated fashion using the L*a*bcolor space and Fuzzy C-means clustering. The entire process is carried out the following steps.

Step-1: Read the image.

Step-2: Remove the noise of corresponding satellite image.

Step-3: For color separation of an image apply the local contrast stretching.

Step4: Convert image from RGB color space to L*a*b color space.

Step5: Classify the colors in 'a*b*' space using Fuzzy C-means Clustering.

Step-6: Label every pixel in the image using the results from Fuzzy C-means.

Step-7: Create images that segment the image color.

3. RESULTS

The various experiment carried out on the above said imagery in MATLAB vs 7.10. The complete process and the standard results are summarized in subsequent figure-2

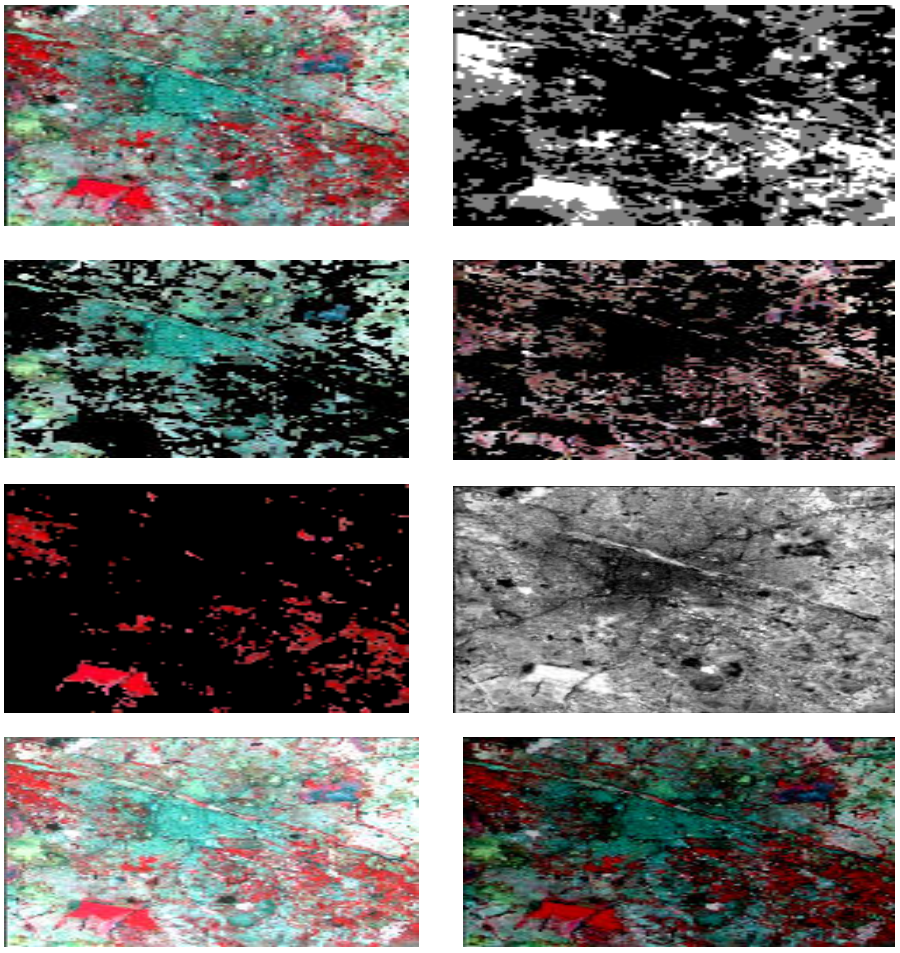

Fig-2 the results of colour segmentation

2. a. original image. (b) Cluster index image. (c) Object in cluster 1. (d) Object in cluster 2 (e) Object in cluster 3. (f) Before noise removal (g). Local contrast stretching image. (h) Suppressed image.

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4. CONCLUSION

In this paper color based image segmentation; it is possible to reduce computation time and improve the precision of image. The main objective of this paper is to get a non-overlapping and reliable output. This kind of color based segmentation may be used for mapping the changes in land use land cover taken over temporal period in general but not in particular. Color based segmentation of image is an analysis such as image interpretation, pattern recognition system with application in scientific and industrial fields.

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