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Research paper

Implementation of Ga Based Fodpso for Efficient Segmentation of Hyper Spectral Satellite Images

[1]V.Vedanarayanan, [2]S. Ramesh Kumar

[1]Asst Prof. Dept. of ETCE, Sathyabama Institute of Science & technology, Old Mamallapuram Road, Chennai – 19
[2]CEO, Averzs Technologies, Alandur, Chennai – 16.
Corresponding Author Email: veda_gopal@rediffmail.com

Abstract

Hyperspectral satellite images have a high trough of Geospatial information. A great number of traditional segmentation algorithms have been implemented for segmentation of hyperspectral satellite images. But there exist the problems of under or over segmentation which affects the data retrieval process. The wireless hyper-spectral images can identify minerals better than multispectral images because of their high spectral resolution. However, a pixel might include more than one mineral, as wireless hyper-spectral images have low spatial resolution. In these situations, the number of minerals can be estimated in mixed pixels but their spatial position cannot be known. This is one of the biggest obstacles that prevent effective use of wireless hyper-spectral images in mineral exploration. Hence it necessitates the exploration of some hybrid methodology for the extraction the information's from the hyperspectral images. In this research work we have Proposed a, GA based FODPSO for high-resolution image processing which leads to an efficient segmentation. The main aim of this work is to propose a computationally intelligent and efficient method, for partitioning remote sensing images into multiple regions. After the separation of images, intelligent data retrieval process can be implemented to get the required information from the remote sensing satellite images. However, a pixel might include more than one mineral, as hyper-spectral images have low spatial resolution. So we have to apply the principle to convert from low resolution image to high resolution using interpolation technique then do segmentation.

Keywords: *Fuzzy C Means Segmentation, Hyper spectral image, Genetic Algorithm*

1. Introduction

Hyperspectral Imagery

The remote sensing images should be always subjected to preprocessing technique in order to restore the image and then enhance it to increase the contrast and intensity of the image to go for proper segmentation and classification [1]. The figure 4 shows that the input hyper-spectral image with speckle noise content. The figure (a) show that the input hyper-spectral image with speckle noise content.

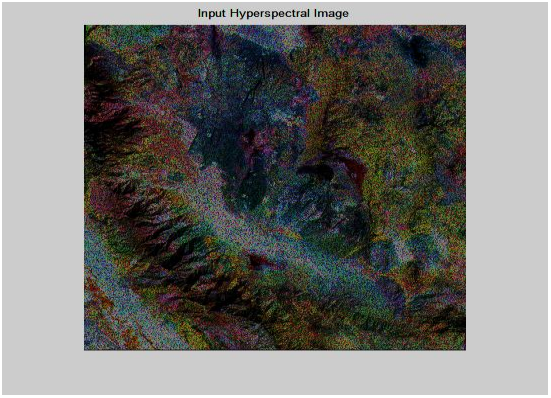

Figure a: Input Hyper-spectral Image

The most critical achievement in remote detecting has been the advancement of hyperspectral sensors and programming to break down the subsequent image information. Over the previous decade hyperspectral picture investigation has developed into a standout amongst the most great and quickest developing innovations in the field of remote detecting. The "hyper" in hyperspectral signifies "over" as in "too much" and alludes to the extensive number of estimated wavelength groups. Hyperspectral pictures are frightfully overdetermined, which implies that they give adequate unearthly data to recognize and recognize frightfully one of a kind materials. Hyperspectral symbolism gives the possibility to more exact and point by point data extraction than conceivable with some other kind of remotely detected information [3]. Most hyperspectral imagers, then again, measure reflected radiation at a progression of limited and adjoining wavelength groups. When we take a gander at a range for one pixel in a hyperspectral picture, it looks especially like a range that would be estimated in a spectroscopy research facility.To beat the extreme partition of K implies, fuzzy C-method (FCM) changed into presented, that is a speculation of the standard fresh k-means clustering plan, wherein a measurements point can have a place with all groups with various degrees of participation. In spite of the fact that FCM is an advancement on k-means clustering, it is recognized for being difficult to its underlying group arrangement and can fall into problematic arrangements. Subsequently, inside the literature, analysts have attempted to enhance the versatility of the FCM method by means of streamlining it with bio-stimulated improvement techniques e.g., particle swarm optimization (PSO) [4]. Other applications include urban area development, criminal

tracking, and disaster management. Notwithstanding, a favored issue with these methods, together with the PSO calculation, is that they will get caught in nearby surest components, in the kind of way that it will be fruitful in a couple of issues; anyway flop in others [4]. To moreover improve the existing systems, we combine FCM with Genetic algorithm based FODPSO for hyper-spectral applications. The Genetic algorithm based FODPSO algorithm provides from a cooperation paradigm wherein debris inside every swarm cooperate with each other, while more than one swarms contend to find the most sufficient arrangement, i.e., the most noteworthy quality arrangement [8]. By joining the Genetic calculation based FODPSO with the FCM strategy, in this meant as Genetic algorithm based FODPSO-FCM, each particle can be represent to by method for a given bunch arrangement and the FCM objective capacity. The rising aggregate homes of the FODPSO, all in all with a partial request pace and an arrangement of acclaim rules intended to recreate hyper-spectral pixel choice instrument, will merge to the best cluster setup. Similarly, so as to accelerate the clustering manner, the histogram of hyper-spectral image intensities is proposed for use instead of the raw hyper-spectral statistics. Hyper-spectral image segmentation is an important area in examine of images in remote.

2. Proposed Methodology

Block Diagram of proposed system

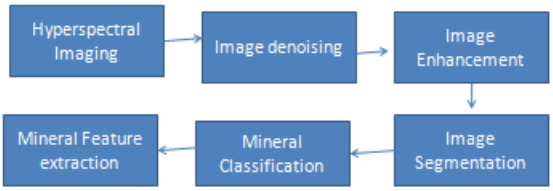

Figure 1: Schematic representation of the proposed system

The above figure 1 represents a schematic view of the proposed research work. After acquiring the image enhancement is performed. The following sessions deals with them in detail.

Preprocessing process

In this is step Median filtering is used to remove the unwanted noises or information's present in the images. Median filtering is the best in the group among liner filtering methods. Median filter without damaging the overall information present in the image removes the unwanted information's and highlights the foreground information's. The results of Median filtering is provided in figure 2.

GA based FODPSO algorithm

The Darwinian Particle Swarm Optimization (DPSO) was detailed looking for a superior model of regular choice utilizing the PSO calculation. Each swarm separately performs simply like a customary PSO calculation with tenets administering the accumulation of swarms that are intended to recreate characteristic choice. In spite of the likenesses between the PSO and Genetic Algorithms (GAs), PSO does not utilize hereditary administrators like hybrid and change, in this way not being viewed as a transformative strategy. In FODPSO couple of parameters, for example, I) starting swarm populace; ii) most extreme and least swarm populace; iii) beginning number of swarms; iv) greatest and least number of swarms; and v) dormancy limit are to be adjusted by (GA)Genetic algorithm. Genetic algorithm is the golden standard for evolutionary based optimization. Genetic algorithm deals with genetic operators such as cross over and mutation. The various governing parameters are tuned automatically based on this evolutionary schemes .Hence the intelligent of the proposed system increases [9].

3. Methodology

Image Enhancement using Histogram mean adjustment

Image enhancement is the path toward changing advanced image. [2]Diminish picture will have low pixel regards while a splendid picture will have high pixel regards. Recipe is given by,

Enhancement = X(I,j)-Xmin(I,j)/Xmax(I,j)- Xmin(I,j)

$f(x,y) = a1*x + a2*y + a3 + e(x,y),$ (2)

Calculate the values a1, a2, a3, i.e. $\hat{a}1$, $\hat{a}2$, $\hat{a}3$,

$$S^2 = \sum_x \sum_y [\hat{a}1*x + \hat{a}2*y + \hat{a}3 - f(x,y)]^2, \quad (3)$$

It gives

$\hat{a}1$, $\hat{a}2$, $\hat{a}3$ by

$$\hat{a}1 = \frac{\sum_x \sum_y x * f(x,y)}{\sum_x \sum_y x^2},$$

$$\hat{a}2 = \frac{\sum_x \sum_y y * f(x,y)}{\sum_x \sum_y y^2},$$

$$\hat{a}3 = \frac{\sum_x \sum_y f(x,y)}{\sum_x \sum_y 1}. \quad (4)$$

a1*x +a2*y + a3 + e(x,y) ,

$$\hat{a}1 = a1 + \frac{\sum_x \sum_y x * e(x,y)}{\sum_x \sum_y x^2},$$

$$\hat{a}2 = a2 + \frac{\sum_x \sum_y y * e(x,y)}{\sum_x \sum_y y^2},$$

$$\hat{a}3 = a3 + \frac{\sum_x \sum_y e(x,y)}{\sum_x \sum_y 1}. \quad (6)$$

It drives variances of $\hat{a}1$, $\hat{a}2$, $\hat{a}3$

$$\sigma^2_{\hat{a}1} = \frac{\sigma^2}{\sum_x \sum_y x^2}, \quad \sigma^2_{\hat{a}2} = \frac{\sigma^2}{\sum_x \sum_y x^2}, \quad \sigma^2_{\hat{a}3} = \frac{\sigma^2}{\sum_x \sum_y x^2},$$

(7)

From equations (2) (4) (6):

$$S^2 = \sum_x \sum_y e^2(x,y) - (\hat{a}1 - a1)^2 \sum_x \sum_y x^2 - (\hat{a}2 - a2)^2 \sum_x \sum_y y^2 - (\hat{a}3 - a3)^2 \sum_x \sum_y 1.$$

(8)

Now e(x,y) ~ N(0),

$$\frac{\sum_x \sum_y e^2(x,y)}{\sigma^2} \sim \chi^2_n, \quad (9)$$

$$n=\sum_x\sum_y 1. \quad (10)$$

$\hat{a}1 \sim N(a1, \sigma^2_{\hat{a}1}), \hat{a}2 \sim N(a2, \sigma^2_{\hat{a}2}), \hat{a}3 \sim N(a3, \sigma^2_{\hat{a}3}),$ (11)

with the variance given in equation (23), so

$$F=\frac{[(\hat{a}1-a1)^2\sum_x\sum_y x^2+(\hat{a}2-a2)^2\sum_x\sum_y y^2]/2}{S^2/(n-3)} \quad (5)$$

$$\frac{(\hat{a}1-a1)^2}{\sigma^2_{\hat{a}1}}=\frac{(\hat{a}1-a1)^2\sum_x\sum_y x^2}{\sigma^2}\sim \chi^2_1,$$

$$\frac{(\hat{a}2-a2)^2}{\sigma^2_{\hat{a}2}}=\frac{(\hat{a}2-a2)^2\sum_x\sum_y y^2}{\sigma^2}\sim \chi^2_1,$$

$$\frac{(\hat{a}3-a3)^2}{\sigma^2_{\hat{a}1}}=\frac{(\hat{a}3-a3)^2\sum_x\sum_y 1}{\sigma^2}\sim \chi^2_1. \quad (12)$$

Following the equations (9), (10), (12) ,

$$\frac{S^2}{\sigma^2}\sim \chi^2_{(n-3)}, \quad (13)$$

$U\sim \chi^2_j$, $V\sim \chi^2_k$, then

$$\frac{U/j}{V/k}\sim F_{j,k.}$$

$$\frac{[(\hat{a}1-a1)^2\sum_x\sum_y x^2+(\hat{a}2-a2)^2\sum_x\sum_y y^2]/2}{S^2/(n-3)}\sim F_{2,n-3.}$$

(14)

DN (Digital number)

DN = WF * RV + (1-WF) * DN(old), (15)

RV - > Reference value for the pixels

WF - > Weight vector

WF = max (WF1, WF2) (16)

(Image contrast enhancement)

$$WCON=\frac{DN\max(window)-DN\min(window)}{DN\max(image)-DN\min(image)} \quad (17)$$

Figure 2: Image enhancement

Figure 2 shows that the enhanced image by applying the adaptive mean adjustment. Here the contrast and brightness are improved well as shown in the figure.

Algorithm steps for image enhancement
Step1: Input the Filtered Image
Step2: Case 1: Input Image
Step3: Set the thresholding values (Median)
Step4: Set lower and upper thresholding values to calculate the Minima and Maxima.
Step5: Apply the double Precision to the Image
Step6: Apply Normalization
Step7: Calculate the Mean of the Gray Scale Value
Step8: Adjust the Mean Value
Step9: Case 2: Noisy Image
Step10: Set lower and Upper thresholding values to calculate the Minima and Maxima
Step11: Color Image Thresholding (Image Bandwidth)
Step12: Convert from Multispectral RGB Image to NTSC Color format
Step13: Calculate the Mean adjust value for Green layer using Color Image Upper Thresholding
Step14: Calculate the Mean adjust value for Blue layer using Color Image Lower Thresholding
Step15: For Case 1 and Case 2:
Mean Adjustment for First Layer
Calculate Minima and Maxima
Step16: Apply formula (Image-Minima/Maxima-Minima)
Step17: Enhanced Image Output.

4. Image Segmentation

Image segmentation assumes an essential role in image processing. It is a methodology which partitions an image into unmistakable areas utilizing pixels. Every pixel contains particular data dependent on some visual qualities. Image division is usually used to discover things and breaking points (lines, twists, et cetera) in image. Simply more unquestionably, image division is the path toward doling out a name to every pixel in an image to such a degree, to the point that pixels with a comparative name share certain qualities. The result of image division is a course of action of segments that all in all cover the entire picture, or a game plan of structures isolated from the image .Each of the pixels in a region are equivalent with respect to some trademark or handled property, for example, shading, power, or surface. Neighboring areas are by and large phenomenal concerning comparative properties.

PSO ALGORITHM

Outstanding amongst other known bio inspired algorithms is particle swarm optimization (PSO). The PSO comprises of various particles that all in all move in the hunt space looking for the worldwide ideal. Nonetheless, a general issue with the PSO and comparative streamlining calculations is that they may get caught in neighborhood ideal focuses, and the calculation may work in a few issues yet may bomb in others. To beat such an issue, exhibited the Darwinian PSO (DPSO). In the DPSO, numerous swarms of test arrangements performing simply like a customary PSO may exist whenever, with guidelines administering the accumulation of swarms that are intended to mimic common determination.

Nonetheless, in contrast to GA, PSO has no development administrators, for example, hybrid and change. Then again, the Darwinian Particle Swarm Optimization (DPSO) broadens the PSO to decide whether regular choice (Darwinian rule of survival of the fittest) can upgrade the capacity of the PSO algorithm to escape from neighborhood optima.

Hyper-spectral Image segmentation using modified fuzzy c means clustering

After preprocessing, the wireless hyperspectral image is highly qualified for segmentation and classification. If is (A_n) a decreasing sequence of elements of ε, i.e., $A_{n+1} \subseteq A_n$ then

$$c(\overset{n}{\cap} A_n) = \inf_n c(A_n)$$

Here we only consider Choquet capacities defined on $E := [0,1)$, and taking values in $[0,1]$ with $\varepsilon = B(E)$. Moreover, word capacity will stand for a Choquet - ε capacity on E. Let $c < c_{n>1}$ be a sequence of capacities defined on $[0,1)$, and $P := ((I_j^n)_{0 \le j \le \gamma_n})_{n \ge 1}$ a sequence of partitions of $[0,1)$. We assume that the following conditions are met:

$$\lim_{n \to \infty} \max_{0 \le j \le \gamma_n} | I_j^n | = 0$$

For all n, j, I_j^n is an semi open interval.

For all $n, j\ 0 \le j \le \gamma_n$ there exist k such that $I_j^n \subset I_k^{n-1}, \ (I_j^n \neq I_k^{n-1})$ where $I_0^0 = E$

For all $\alpha > 0, \lim\sup_{I \in P \ |I| = 0} | I |^{\alpha} \ k(I) < 1$ where

$$k(I_j^n) := \sup \left\{ \frac{I_j^n}{I_k^{n+1}}; I_k^{n+1} \subset I_j^n \right\}$$

Let $\alpha_n(n) = \dfrac{\log c_n(I^n(x))}{\log \mu(I^n(x))}$ which is defined when $c_n(I^n(x))\mu(I^n(x)) \neq 0$ and $\alpha(x) = \lim_{n \to \infty} \alpha_n(x)$ when this limit exists.

In trademark extraction, a size pattern or vector is handled to separate the highlights important to the problem underneath examine, which in a bad position of recognizing minerals. Our endeavors mindfulness on the use of hyper-spectral techniques of image investigation for division with the point of acknowledging two fundamental dreams: to acquire a solid and unfaltering division in general execution for the entire volume of records, and to restrain the human intercession.

In the wake of upgrading the image mineral is distinguished in the image utilizing altered PSO algorithm division strategy. Division is the way toward part a computerized picture into different portions. It is utilized to find items and limits in the picture. So the mineral zone is obviously appeared. The portioned image is bunched and the dim scale picture is changed over into paired picture utilizing limit. The delicate clustering fuzzy C means (FCM) clustering is utilized. In MPSO every pixel of the picture has a place with in excess of one cluster. To enhance the precision in the picture the otsu edge technique is utilized to naturally perform grouping based picture edge or decrease of a dim level image to a double image. This spatial affiliation is critical in clustering; hence another spatial object is characterized as:

$$S_{ij}^{*} = \sum_{k \in H(x_j)} U_{ik} \beta_{k1} + \frac{\sum_{k \in H(x_j)} U_{ik} \beta_{k2}}{\sum_{t=1}^{c} \sum_{k \in H(x_j)} U_{tk}} \tag{18}$$

where H(xj) stand for a quadrangle window centered on pixel xj in the spatial field. Initiated original spatial function has dual fractions. The second section is proscribed by βk 2 coefficient cause membership purpose quantitative according to space between pixels.

$$\beta_{k1} = \frac{1}{1 + \exp(\theta_1 \| j - k \|)} \tag{19}$$

$$\beta_{k2} = \frac{1}{1 + \exp(\theta_2 \| x_j - x_k \|)} \tag{20}$$

The spatial task is included into membership task as follows:

$$U_{ij}^{*} = \frac{U_{ij}^{p} * s^{*q}_{ij}}{\sum_{k=1}^{c} U_{kj}^{p} * s^{*q}_{ij}}$$

$$for \ \ i = 1,2,\ldots,c \quad and \quad j = 1,2,\ldots,n$$

To assemble a fitting target work, we event from the accompanying arrangement of provisions [8]: The space among clusters and the pixel directs assign toward them ought to diminish and the space between bunches ought to misuse [9]. The attraction among pixel and clusters is demonstrated by term (12); it is the strategy for the goal work. Wen-Liang We present another algorithm called Modified Fuzzy c-implies (M-FCM), which impressively improves the introduction of FCM because of a model driven learning of restriction α [10].[11,12] The equation of this parameter is:

$$\beta = \frac{\sum_{j=1}^{n} \left\| x_j - \bar{x} \right\|^2}{n} \qquad where \quad \bar{x} = \frac{\sum_{j=1}^{n} x_j}{n} \tag{23}$$

Be that as it may, the perception which must be expressed here is the general worth utilized for this imperative by the whole pixel at every cycle, which may get fault. We recommend another factor which smothers this incessant estimation of α and reestablish it by another bound like a weight to each vector.[13] So the weight is evaluated as pursues:

$$W_{ji} = \frac{1}{1 + \exp\left(-\dfrac{\left\| x_j - v_i \right\|^2}{\sum_{j=1}^{n} \left\| x_j - \bar{v} \right\|^2 * c / n}\right)} \tag{24}$$

Where w,j,i is weight of the indicate j in relative to the group i. This weight is used to adjust the fuzzy and representative division.[14]

Algorithm steps:

MFCM algorithm is given below:

- Step 1: Select the input image.
- Step 2: Fix m >1 and 2≤c≤n −1 and give c initial cluster centers Vi.
- Step 3: Compute Uij with Viby Eq. (19).
- Step 4: Compute βk1 and βk 2 by Eq. (20) and (21).
- Step 5: Compute S ∗ijand Wji by Eq. (19) and (20).
- Step 6: Update the membership matrices by Eq. (10), Update the centroids using (9).
- Step 7: if Vnew−Vold≤εStop the iteration otherwise, go to step 4.

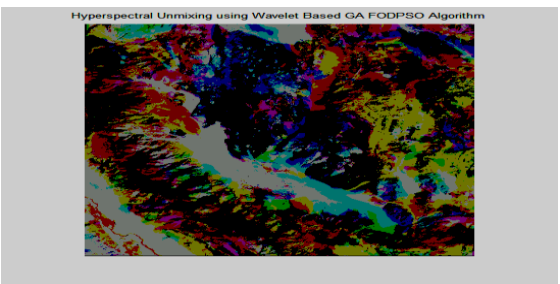

Figure 3: Segmented image

The figure 3 shows that the segmented images of minerals using MFCM clustering GA based FODPSO classification.[15]

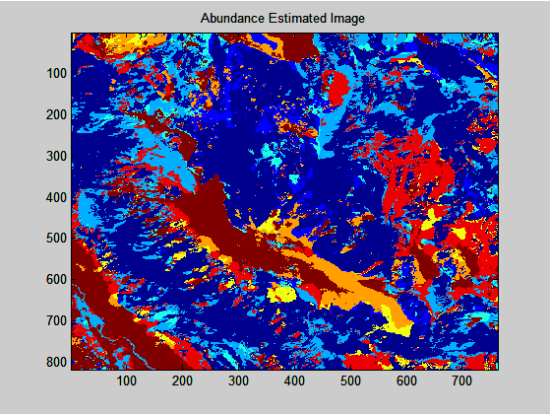

Figure 4: Abundance estimation

6. Related works

1. PedramGhamisi(2014)[6] in his paper titled, "Multilevel Image Segmentation Based on Fractional-Order Darwinian Particle Swarm Optimization" had applied FODPSO and SVM methods. The authors had concluded that FODPSO is more robust than PSO and DPSO, and it has higher potential for finding the optimal sets within less computational time.
2. Micael S. Couceiro et al (2012)[5] in his work titled," Introducing the fractional-order Darwinian PSO" had concluded that the speed of convergence of FODPSO depends on the fractional order α. It outperforms the traditional DPSO, PSO and FOPSO methods.
3. AmanpreetKaur et al(2014)[1] has proposed in his paper titled,"An Overview of PSO-Based Approaches in Image Segmentation" that PSO when combined with fuzzy sets, and or neural networks,results in a more effective approach. Clustering schemes based on wavelets, Genetic Algorithm, is found to be useful and it improves the segmentation process.

Table 1: Comparison of LOG and Hybrid Median Filter

Images	Hybrid median Filter		LOG Filter	
	PSNR	MSE	PSNR	MSE
Image 1	27.4725	0.1164	29.0002	0.0819
Image 2	24.387	0.2764	32,8376	0.0763
Image 3	23.676	0.3267	34.9473	0.0653
Image 4	22.8367	0.4938	36.9487	0.8467

From the above table 1, it is inferred that LOG Filter is best for hyper spectral image Enhancement process [16],[17]. Figure 2 shows the enhanced image [18,19] and figure 3 shows the proposed GA based FODPSO algorithm [20,21] output. Figure 9 shows Abundance estimation after Segmentation image [22].

7. Conclusion

The evolutionary feature of FODPSO depends on the tunable variables. FODPSO is faster than PSO or any other evolutionary algorithm.It takes minimum computational time. FODPSO is a more promising method to specify a predefined number of clusters with a higher between-class variance. The proposed approach is found to be more efficient than the DPSO The proposed modified FCM algorithm automatically define the clusters for image segmentation.

Future scope

Hyper-spectral image un-mixing algorithm can be applied to satellite imagery to locate the minerals on the images. Although this popular processing chain has established to be effective for un-mixing certain kinds of hyper-spectral images, it also has some drawbacks. The first one comes from the reality that the output of each degree is the subsequent one, which favors the propagation of mistakes within the un-mixing chain. A 2D problem is the massive variability of the outcomes received whilst estimating the number of end members of a hyper-spectral scene with one-of-a-kind latest algorithms, which impacts the rest of the system.

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