Classification of Images Using ABC-MKFCM and Neural Network Classifier

S. Praveena
ECE Dept, M.G.I.T,
Hyderabad.

Abstract: This paper presents a clustering algorithm and feed-forward neural network classifier for region clustering of trees, shade, building, grass and road. The image is clustered using the ABC-Multi-Kernel FCM (MKFCM) algorithm to obtain the effective clustering in satellite image and classified using neural network. The accuracy and DB-index of the proposed hybrid algorithm is compared with the algorithm like KFCM.

Keywords: Clustering, classification, features extraction, MKFCM.

I. Introduction

Satellite images play a vital role in providing information about geographical environment [1]. The satellite images are employed in formation of mapping few products for military, civil applications and many other applications, which has more societal value [4]. It is also used for mapping and categorization of land cover traits such as soil, water, vegetation and forests [5]. Nowadays, investigation are done in computer vision techniques executed on remote sensing images like object oriented, fragmentation, and knowledge-based methods for categorization of high-resolution imagery [6].

II. Review of Literature

Fuzzy clustering techniques, fuzzy cmeans (FCM) algorithm [1] is the generally well-liked technique which is used in image segmentation due to its robust features for uncertainty and can keep much more information as compared to hard segmentation techniques [2]. While the standard FCM algorithm works fit on most noise-free images, it is very aware to noise and other imaging artifacts, because it does not consider any data about spatial background. Tolias and Panas [3] have proposed a fuzzy rule-based technique also known the ruled-based neighborhood improvement system to impress spatial constraints by post processing the FCM clustering results. Noordam et al. [4] have proposed a geometrically guided FCM (GG-FCM) algorithm which is a semi-supervised FCM technique. Here, a geometrical condition is used the local neighborhood of every pixel. Pham [5] has customized the FCM objective function by counting spatial punishment on the membership functions. The punishment term leads to an iterative algorithm, which is extremely comparable to the original FCM and allows the evaluation of spatially flat membership functions. Ahmed et al. [6] have proposed the FCM_S where the objective function of the standard FCM is modified in order to recompense the intensity in uniformity and permit the labeling of a pixel to be affected by the labels in its neighborhood. The disadvantage of FCM_S is that the neighborhood labeling is computed in every iteration step which is very time-consuming.

In this work entire procedure is done in three steps.

i)Pre-processing

ii) Clustering using hybrid ABC-MKFCM

iii) Classification using Neural Network classifier

Initially pre-processing is performed to make the image suitable for segmentation. In segmentation, the pre-processed image is segmented using hybrid ABC-MKFCM algorithm that is developed by hybridizing the ABC algorithm and MKFCM algorithm to obtain the effective segmentation in satellite images. Then, feature is extracted and the classification of satellite image into four different labels (tree, shade, road and building) is done using Feed Forward Neural Network Classifier.

III. Hybrid Clustering Algorithm and Feed Forward neural network Classifier for Satellite Image Classification

3.1 Segmentation using ABC-MKFCM Algorithm

In this work, different colors of trees, roads, shades and buildings regions are taken in the database. Extract H,S,L,T,U,V layers. For each layer calculate features like mean and maximum value of histogram. Train these features using Neural Network Classifier.

During testing phase, a test image is given. For this apply the ABC-MKFCM clustering algorithm.

Step1: Generate the new solutions using Eq.(3)

In this process, the input pre-processed satellite image is converted different layers. i.e H, T and L layers are extracted from it. Thereafter, the ABC-MKFCM algorithm is applied on each layer (H, T and L) separately to cluster the pixels. Here, the MKFCM operator is incorporated in the ABC algorithm to segment the satellite image effectively.

After initial solutions are generated, the fitness is calculated for each solution. The calculation of fitness is as follows: initially the cluster centers in each solution are taken for clustering process and the clustering is done based on the minimum distance. The fitness is then calculated based on the eq(1):

$$fit_i = \sum_{i=1}^{c}\sum_{j=1}^{n} u_{ij}^m \left(1 - k(x_{j,}o_j)\right) ------(1)$$

$$k(x_j, o_j) = k_1(x_j, o_j) + k_2(x_j, o_j) ----(2)$$

$$k_1(x_j, o_j) = x_j^T + o_j ----(3)$$

$$k_2(x_j, o_j) = \exp(-\left\|x_i - o_j\right\|^2)/\sigma^2 ----(4)$$

In the above equation fit_i denotes the fitness of i^{th} solution, where i=1,2 ---J; and x_a denotes a^{th} pixel x in j^{th} cluster; and j=1,2 ---J ; A is the total number of pixels in j^{th} cluster, where; and Cj denotes the centroid C of j^{th} cluster.

The algorithm of ABC-MKFCM is as follows:

Step 1: Initialize the parameters of ABC and MKFCM including population size SN, maximum cycle number MCN, limit, clustering number c, m and ε;

Step 2: Initialize the kernel metrics and membership function for MKFCM.

Step 3: Generate the initial population (cluster center) cij , and evaluate the fitness function.

Step 4:ABC algorithm

4.1 Set cycle to 1

4.2 Set s to 1

4.3 FOR each employed bee { Produce new solution by MKFCM centers.

$$c_i = \frac{\sum_{l=1}^{n} u_{il}^m k(x_l, c_i) x_l}{\sum_{l=1}^{n} u_{il}^m k(x_l, c_i)}$$

Calculate the value fit_i Apply greedy selection process}

4.4 Calculate the probability values pi for the solutions (c_{ij})

$$\Pr_i = \left(\frac{0.25}{\max(fit)}\right) \times fit_i + 0.1$$

4.5 FOR each onlooker bee {Select a solution c_{ij} depending on $\Pr_i$ Produce new solution using MKFCM cluster centers equation. Calculate the value fit_i . Apply greedy selection process}

4.6 If the searching times surrounding an employed bee exceeds a certain threshold limit, but still could not find better solutions, then the location vector can be reinitialized randomly according to Eq. go to step 4.2

$$S_i^j = S_{\min}^j + rand(0,1)\left(S_{\max}^j - S_{\min}^j\right)$$

4.7 If the iteration value is larger than the maximum number of the iteration (that is, cycle> MCN, output the best cluster centers. If not, go to Step 4.1.

Step 5:MKFCM algorithm

5.1 Update membership matrix

5.2 Update the cluster centers

5.3Compute E i.e difference between old and new membership functions. If it is less than threshold value then , stop; If not, go to Step 5.1.

3.3 Classification using Neural Network Classifier

Classification step is to identify road, building, tree and shadow regions from original satellite image.

3.4 Evaluation Metrics

Accuracy

The evaluation of proposed technique in different satellite images are carried out using the following metrics as suggested by below equation.

$$\text{Accuracy} = \frac{\text{number of true positives} + \text{number of true negatives}}{\text{number of true positives} + \text{false negatives} + \text{true negatives} + \text{false positives}}$$

DB-index:

The Davies Bouldin (DB) Index is a metric exploited to evaluate the clustering algorithm. The DB-Index is an internal evaluation scheme that validates how well the cluster is done based on the quantities and features inherent to the dataset. The DB-Index calculation is as follows:

$$DBI = \frac{1}{N}\sum_{n=1}^{N} D_{n,n+1}$$

$$\text{Where, } D_{n,n+1} = \frac{d_n + d_{n+1}}{M}$$

$$d_n = \frac{1}{T}\sum_{b=1}^{T}\left|X_b - C_n\right|^2$$

$$M = \sum_{n=1}^{N-1}\sum_{f=n+1}^{N}\sqrt{\left(C_n - C_f\right)^2}$$

In the above equations DBI denotes the Davies Bouldin (DB) Index, N denotes total number of clusters, $D_{n,n+1}$ denotes clustering scheme measurement between each cluster, d_n denotes the value of distance between each data in the n^{th} cluster and centroid of that cluster, d_{n+1} denotes the value of distance between each data in the next cluster and the centroid of n^{th} cluster, M denotes sum of the Euclidean distance between each centroid, T is the total number of data in the cluster, X is the data in the n^{th} cluster and C_n is the centroid of n^{th} cluster..

Experimental Results

In this paper, the proposed algorithm results are compared with against KFCM. The accuracy value is computed by dividing the total number of similar pixels identified as land use to the number of pixels in the tree, shade, building and road region.

Accuracy	ABC-MKFCM	KFCM
Road	0.82	0.80
Building	0.85	0.83
Shade	0.84	0.8306
Tree	0.88	0.8207
Grass	0.85	0.812

Table(1): Comparison of accuracy

Table 2 indicates the comparison of DB-index values for two algorithms. The less value of DB-index indicates the better clustering algorithm. The two algorithms are applied on 5 input images. For all images it is found that proposed algorithm has less DB-index value which indicates the better performance.

Image index	**ABC-MKFCM**	**KFCM**
I_1	**0.063293**	0.0781
I2	**0.045774**	0.0472
I3	**0.061098**	0.084
I4	**0.060293**	0.08931
I5	**0.05774**	0.0682

Table(2): Comparison of DB-index

IV. CONCLUSION

In this paper, optimization algorithms for clustering with the intention of improving the segmentation in satellite images using Neural Network classifier are proposed. In segmentation, the image is clustered using hybrid ABC algorithm that is developed by hybridizing the ABC algorithm and MKFCM algorithm to obtain the effective segmentation in satellite images. Then, feature is extracted and the classification of satellite image into four different labels (tree, shade, road, grass and building) is done using Feed Forward Neural Network Classifier. Finally, classification accuracy and DB-index values are compared.

V. REFERENCES

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