Clustering and Classification of Satellite Images Using Moving KFCM and Neural Network Classifier

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ABSTRACT

This paper presents an improvised Moving kernel based fuzzy C-means(MKFCM) for clustering of trees, shade, building and road. It starts with the single step preprocessing procedure in which first the input image is passed through a median filter to reduce the noise and get a better image fit for segmentation. The pre-processed image is segmented using the Moving KFCM algorithm and classified using feed forward neural network classifier. KFCM with moving property is used to improve the object segmentation in satellite images. Simulation result show that classification accuracy for different regions using Moving KFCM is better than KFCM using Neural Network Classifier.

Keywords

Segmentation, classification ,feature extraction, Moving KFCM

1. INTRODUCTION

Clustering has long been a popular approach to unsupervised pattern recognition. In this paper, it is focused on clustering methods by minimization of objective function and apply them to segment images. In the last decades, fuzzy segmentation methods, especially the fuzzy c-means algorithm (FCM) [1], have been widely used in the image segmentation [2], [3] and such a success chiefly attributes to the introduction of fuzziness for the belongingness of each image pixel. This allows for the ability to make the clustering methods able to retain more information from the original image than the crisp or hard segmentation methods [4].In this paper, a kernel-based fuzzy c-means algorithm (KFCM) is used. KFCM adopts a new kernel-induced metric in the data space to replace the original Euclidean norm metric in FCM. By replacing the inner product with an appropriate 'kernel' function, one can implicitly perform a nonlinear mapping to a high dimensional feature space without increasing the number of parameters. The Kernel-based FCM clustering algorithm was not considered the moving properties for segmenting the satellite image. Hence, the Kernel-based FCM clustering algorithm will be modified such a way that the moving property will be used in it to improve the object segmentation in high resolution satellite images.In this paper, an efficient classification technique using satellite image with Moving KFCM and Naïve Bayes classifier is developed and used for segmentation.The rest of the paper is organized as follows:. The proposed work is presented in Section 2. Results and discussions are presented in Section 3. Conclusions are summed up in Section 4.

2. NEW SEGMENTATION TECHNIQUE OF TREE, SHADOW, BUILDING AND ROAD USING MOVING KFCM

Satellite image segmentation technique is one of the challenging problems in image segmentation process. In proposed work, new segmentation technique of tree, shadow, building and road using moving KFCM.

2.1 PREPROCESSING

Satellite images cannot be given directly as the input for the proposed technique. Thus, it is indispensable to perform pre-processing on the input image, so that the image gets transformed to be relevant for the further processing

2.2 CLUSTERING

Clustering is done using two clustering techniques..

2.2.1 Segmentation Using KFCM

KFCM confines that the prototypes in the kernel space are actually mapped from the original data space or the feature space. That is, the objective function is defined as

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

Usually, only the Gaussian kernel $k(x,y)=\exp(-\|x-y\|^2/r^2$ is applied in KFCM. Here, 1 − $k($**x**j , **o**$i)$ can be considered as a robust distance measurement derived in the kernel space [12]. For these KFCM applying Gaussian kernels [13], we iteratively update the prototypes and memberships as

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

$$u_{ij} = \frac{(1-k(x_j,o_i))^{-1/m-1}}{\sum_{l=1}^{c}(1-k(x_j,o_l))^{-1/m-1}}$$

2.2.3 Segmentation Using Moving KFCM

The algorithm is called moving KFCM because during the clustering process, the fitness of each centre is constantly checked and if the centre fails to satisfy a specified criterion

the centre will be moved to the region that has the most active centre.
The algorithm is designed to have the following properties:

a) There is no dead centre as the centers will have the same fitness in term of the fitness criteria.

b)More centers will be allocated at the heavily populated data area but some of the centers will also be assigned to the rest of the data so that all data are within an acceptable distance from the centers

c) The algorithm is capable of avoiding poor local minima as the algorithm can reduce the sensitivity to the initial centers

Consider a problem that has N data that have to be clustered into n_c centers. Let x_i be the i- th data and o_i be the i-th centre where i= 1, 2, ..., N and j = 1, 2, ..., n_c. Initially, centers o_i are initialized to some values and each data is assigned to the nearest centre and the position of the centre o_i is calculated according to:

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

Where,

$$u_{ij} = \frac{(1-k(x_j, o_i))^{-1/m-1}}{\sum_{l=1}^{c} (1-k(x_j, o_i))^{-1/m-1}} \quad (2)$$

In above equation, following kernel function can be used

$$k(x_i, x_j) = \exp\left(-\frac{\|x_i - x_j\|^2}{r^2} \right) \quad (3)$$

After all data are assigned to the nearest centers, the fitness of the centers is verified by using a distance function. The distance function is based on the total Euclidean distance between the centre and all the data that are assigned to the centre and update the equation

$$f(c_j) = \sum_{i \in c_j} (\|x_i - o_j\|)^2 \quad (4)$$

The moving KFCM can be implemented as:

(1) Initialize the centers and v_o and set $v_a = v_b = v_o$.
(2) Assign all the data to nearest center and calculate center positions using eq (1)
(3) Check the fitness of each centre using equation(4)
(4) Find c_s and c_l, the centre that has the smallest and the largest value of $f(\bullet)$.
(5) If $f(c_s) < \alpha_a f(c_l)$,

(5.1) Assign the members of o_s to o_l if $x_i < o_l$, where $i \in o_l$, and leave the rest of the members to o_l.

(5.2) Recalculate the positions cl according to:

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

$$u_{ij} = \frac{(1-k(x_j, o_i))^{-1/m-1}}{\sum_{l=1}^{c} (1-k(x_j, o_i))^{-1/m-1}}$$

Note that o_s will give up its members before step (5.1) and, o_s and o_l in equation (5) are the number of the new members of c_s and c_l respectively, after the reassigning process in step (5.1).

(6) Update α_a according to $v_a = v_a - v_a / n_c$ and repeat step (4) and (5) until $f(o_s) \geq v_a f(o_l)$

(7) Reassign all data to the nearest centre and recalculate the centre positions using eq (1)

(8) Update v_a and v_b according to $v_a = v_0$ and $v_b = v_b - v_b / n_c$ respectively, and repeat step (3) to (7) until $f(o_s) \geq v_a f(o_l)$.

2.3 Feature Extraction

From the 36 segments we are combining the corresponding segments and obtaining the corresponding 4 new segments such as tree, shade, road and building. These 4 new segments are used for the feature extraction process. These regions features are given as input to Classifier. Feature extraction step is formulated in the following step.

- For feature extraction calculate the histogram of h layer, s layer and l layer. A set of histogram values are obtained.
- The normalized histogram values are found out by dividing each value in the histogram with the sum of all values in the histogram.
- Sort the histogram values in descending order. Record the first three values from the values obtained in the above step.
- The values obtained are used for feature extraction.

2.4 Classification Using Neural Network Classifier

These features are given to Neural Network classifier to identify buildings ,shades, trees and roads in a given image as data base images are pretrained using neural network classifer..

3. Results and Discussion

In this section, results of the proposed technique are discussed. Satellite image is used as the input image which is to be classified into the regions of tree, shade, road and building. In proposed technique, the input image is subjected to a set of pre-processing steps which make the image is more suitable for segmentation. This image is segmented using the Moving KFCM algorithm. Bayesian classifier with four different kernels is used for classification. The classification accuracy obtained for tree, shade, road and building by the above four classifiers are better when compared with the segmented images obtained by KFCM.

The Figure 2 shows the input satellite image of an area taken from the satellite and contains the tree, shade, road and building which is to be classified into four regions using proposed technique.

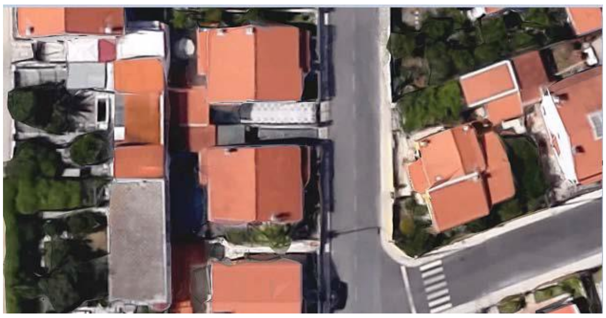

Fig 2.Input satellite image

The Figure 3 shows the final classified tree image from the input image.

Fig 3: Classified tree region from input image

The Figure 4 shows the final classified shade image from the input image.

Fig 4: Classified shade region from input

The Figure 5 shows the final classified road region from the input image.

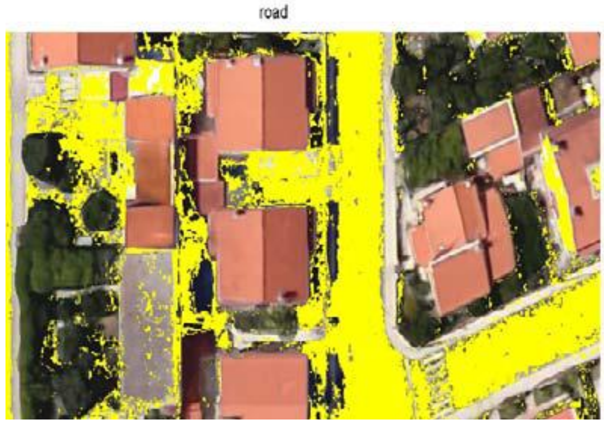

Fig 5: Classified road region from input

The Figure 6 shows the final classified build region from t he input image.

Fig 6: Classified build region from input

4. EVALUATION OF CLASSIFIER'S PERFORMANCE

The comparative analysis shows the performance analysis of the proposed technique with moving KFCM algorithm. 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. The following graphs signify the performance of the proposed technique compared with KFCM. Figure 7 shows the plot of accuracy graph- tree, shade, road and building region classification. It clearly indicates that MKFCM accuracy is greater than KFCM accuracy.

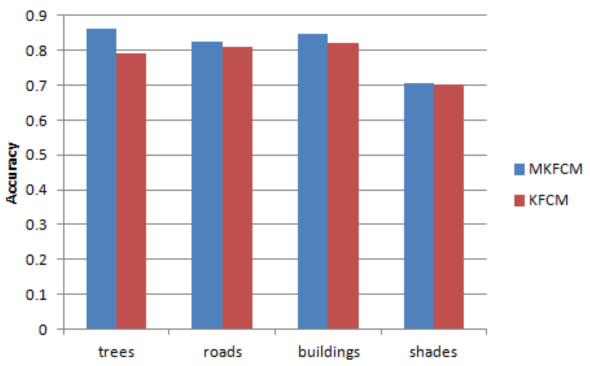

Fig 9:Accuracy graph-tree,shade ,road and building region classification

5. CONCLUSION

In this paper, an efficient image classification technique for satellite images with the aid of MKFCM is proposed. Here in proposed classification technique is made of four phases namely pre-processing, segmentation, feature extraction and final classification using Naïve Bayes classifier. In the pre-processing step, the input image is subjected a set of pre-processing steps which includes median filtering. The pre-processing results in transforming the input image into an image fit for segmentation. After the preprocessing, the image is clustered using Moving KFCM. For the clustered image all features are calculated and applied to neural network classifier. The neural network classifier identifies the different regions in the image. The experimental results have demonstrated the effectiveness of the proposed classification technique in classifying into road, building, trees and shade regions. The experimentation is carried out using the satellite images and the analysis ensures that the performance of the proposed technique is improved compared with KFCM.

7.REFERENCES

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