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Effective and Efficient Fuzzy Local Information C-Means Clustering

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Abstract: **-** There are varieties of algorithms that provide clustering of an image. An improved algorithm is called fuzzy local information C-Means (FLICM). FLICM can overcome the drawback of the known fuzzy c-means and it segment the image that is influenced by outlier, noise and other artifacts. The proposed algorithm combines the neighborhood spatial information and gray level information. The major advantage of FLICM is that it uses both local spatial and gray level information to effectively work .FLICM ignores the noisy pixels that improve the accuracy of the image segmentation. FLICM is free from adjusted parameter selection. The segmentation using FLICM is more effective and efficient compare to standard FCM algorithm, it is also more noise robust.

Index Terms-Fuzzy c-mean algorithm, Spatial fuzzy c mean algorithm, Fuzzy Local Information C-Means algorithm

INTRODUCTION

IMAGE Segmentation objectives to partition an image into different regions that become more representative and easier to analyze. Image segmentation can be done on the basis of some attributes such as color, intensity or objects. Notwithstanding, the outline of effective and robust segmentation algorithm is still an extremely difficult research subject, because of the assortment and unpredictability of image. The image segmentation can be separated into four classes: thresholding, clustering, edge location and area extraction. In this paper, technique of clustering will be considered for image segmentation.

A. Fuzzy C-Means (FCM) Algorithm

Firstly, Fuzzy c means (FCM) clustering algorithm was introduced by Dunn and it was extended by Bezdek. FCM is an iterative process that generates an optimal partition through minimizing the weighted.
The objective functions of FCM:

$$\sum \sum \| \| \quad (1)$$

Here, data set $X=\{x_1,x_2,x_3,\ldots,x_N\} \in R^m$ .N is the total number of data item ,the number of cluster is c with $2 \le c \le N$, m is membership of cluster ,the degree of membership x_i and k^{th} cluster is u_{ik}, m is fuzzy membership ,z_k is the center of cluster ,the distance measurement between object and the center of cluster is $\| \|$.

The membership function is updated by the following:

$$= \frac{}{\sum (\frac{\| \|}{\| \|})} \quad (2)$$

The clusters are updated by the following:

$$= \frac{\sum}{\sum} \quad (3)$$

The algorithm of FCM as follows:

1) Fix the number of cluster c, fuzzification parameter m and stopping condition ε.
2) Initialize membership matrix $U^{(0)}$.
3) Initialize loop counter step=0.
4) Update the center of cluster using the equation (3).
5) Update the fuzzy membership matrix $U^{(step+1)}$ using the equation (2).
6) If max{U(step)-U(step+1)<ε} then stop, else step increment by 1 and go back to step 4.

Spatially Fuzzy C-mean clustering algorithm

FCM function gives good result on noise free image, .it neglects to segment image tainted by

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spatial context, causing it to be sensitive to noise and other imaging artifacts basically because of nonchalance of spatial local information in image. To defeat the noise issue of FCM algorithm we incorporate local neighborhood information and to get precise segmentation the phase congruency includes in the Spatially Coherent Fuzzy Clustering The objective functions of FCM_S:

$$= \sum \sum \| \| \quad (4)$$
$$\_ \sum \sum \sum \| \|$$

Here, total number of pixel is N,the gray level value of i^{th} pixel is x_i, z_k is the center of cluster, N_R is its cardinality ,the neighbor of x_i is represented by x_r. The effect of neighbor is controlled by the parameter α.

The calculation of partition membership matrix is:

$$= \frac{(\| \| \_ \Sigma) \| \|}{\Sigma (\| \| \Sigma \| \|)} \quad (5)$$

The cluster center is calculated as follows:

$$= \frac{\Sigma (\Sigma)}{\Sigma} \quad (6)$$

To reduce the computation, Chen and Zhang proposed a variant of FCM_S, FCM_S1which simplified the neighborhood term of FCM_S. The objective function of FCM_S1 with low-complexity cans be written as follows:

$$= \sum \sum \| \| \quad (7)$$
$$\Sigma \Sigma \| \| \|$$

The average of neighboring pixel is x_r that is lying within a window x_r. x_r can be calculated in advance. The calculation of partition membership matrix is:

$$= \frac{(\| \| \| \|)}{\Sigma (\| \| \| \|)} \quad (8)$$

The cluster center is calculated as follows:

$$= \frac{\Sigma}{\Sigma} \quad (8)$$

FCM_S,FCM_S1 algorithm:

7) Fix the number of cluster c, fuzzification parameter m and stopping condition ε
8) For FCM_S1 compute the median or mean filtered image.
9) Initialize randomly the fuzzy membership matrix $U^{(0)}$.
10) Initialize loop counter step=0.
11) Update the center of cluster using the equation (6)(FCM_S) or (9)(FCM_S1)
12) Update the fuzzy membership matrix using equation (5)(FCM_S) or (8)(FCM_S1)
13) If $\max\{U^{(step)}-U^{(step+1)} < \varepsilon\}$ then stop, else step increment by 1 and go back step 4

B. Fuzzy Local Information-Means Clustering algorithm

The overcome the drawback of mentioned methods, the Fuzzy Local Information C-Means Clustering (FLICM) is introduced. An enhanced FCM method is acquainted with segment the image which is influenced by noise, outlier or some other artifact. The tradeoff weighted fuzzy factor depends at the same time on the space separation of every neighboring pixel and their gray level contrast. This algorithm is free of any parameter choice and also provoking the image division execution.
Improved Fuzzy Factor G_{ki}

$$\_\_ = \sum \| \| \quad (9)$$

Where pixel x_i is in the set of neighbors (N_i) falling into a window around the x_i pixel,$d_{i,j}$ is spatial Euclidean distance between pixels i and j, z_k is the center of cluster k.

General Framework of FLICM

The objective functions of FLCIM:

$$= \sum \sum [\| \|] \quad (10)$$

The calculation of partition membership matrix is:

$$= \frac{}{\Sigma (\| \|)} \quad (12)$$

The cluster center is calculated as follows:

$$= \frac{\Sigma}{\Sigma} \quad (11)$$

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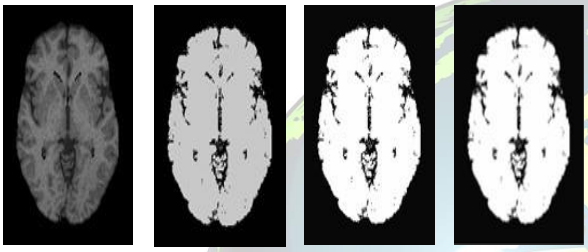
FLICM algorithm is given as follows.

1) Fix the number of cluster c,fuzzification parameter m and stopping condition ε
2) Initialize randomly the fuzzy membership matrix $U^{(0)}$.
3) Initialize loop counter b=0.
4) Update the center of cluster using the equation (13)
5) Update the fuzzy membership matrix $U^{(b+1)}$using equation (12)
6) If max{$U^{(b)}$-$U^{(b+1)}$<ε} then stop, else b increment by 1 and go back to step 4.

In this section, Experimental results of images are described by using various methods. There are total tree methods are used in this section i.e FCM, FCM_S, FLICM.



Comparison of segmentation results on an image (a) original image (b) using FCM result(c) using FCM_S result (d) using FLICM result

CONCLUSION

This paper presented the Effective and Efficient Fuzzy Local Information c-means (FLICM) algorithm for image clustering. The Proposed algorithm can distinguish the cluster of an image. FLICM can overcome the drawback of the known fuzzy c-means and it segment the image that is influenced by outlier, noise and other artifacts. This is accomplished by incorporating nearby spatial and gray level information. The FLICM presents another factor G_{ki} as a neighborhood. FLICM working without the prior knowledge of the noise, it is independent of the kind of the additional noise; also, as outliers. FLICM is free from any parameter selection. FLICM method automatically adjusts the balance between image detail and the image noise, improving simultaneously the clustering execution. This is too improved, by the reality that the various method of clustering working with the pre-calculated image, while FLICM is working on the original picture. FLICM improved the accuracy and it minimizes the time of computation with effective and efficient results, it also preserves the detail of an image.

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