

Image Segmentation Using FELICM Clustering Method

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Abstract-

Clustering is the task of grouping a set of objects in such a way that objects are more similar to each other than those in the other groups. Various clustering algorithms were developed, but it ignores the spatial relationship between pixel values then noise can be added to the image and it does not provide edge detection accuracy. Fuzzy local information C-means is the best image clustering method used for image segmentation. The effects of noise are avoided by analysing spatial relationship between pixel values. One of the best image clustering method, called as Fuzzy c-Means with Edge and Local Information (FELICM) introduce the weights for a pixel values with in local neighbor windows which improves the edge detection accuracy. The canny edge detection mechanism is used for edge detection. Then different weight are set based on the local neighbors are separated by an edge or not. The different weighted pixel values of local neighbor windows are clustered separately the process is repeated until the final clustering result is obtained. The videos can be applied to this image clustering method which improves the edge detection accuracy and noise removal. FELICM also solves the problem of random distribution of pixels inside the regions.

Key words-Canny edge detection, local information, K-mean clustering, spatial clustering.

I. INTRODUCTION

Clustering is the one of the efficient method used for image segmentation. Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects are more similar to each other than those in the other groups. The clustering is an unsupervised learning problem it deals with finding a structure in a collection of unlabeled data. fields such as machine learning, pattern recognition, image analysis, information retrieval and bioinformatics.

A cluster is therefore a collection of objects which are similar between them and are dissimilar to the objects belonging to other clusters. It is the main task of exploratory data mining and a common technique for statistical data analysis. Two or more objects belong to the same cluster if they are close to each other and have smallest distance values. If the distance between two clusters is long, it belongs to different clusters. Applications of image clustering are Marketing, Libraries, Biology, Insurance, City planning, Earthquake studies and WWW. The goal of clustering is to determine the intrinsic grouping in a set of unlabeled data. Image clustering is an effective method for image segmentation.

II. RELATED WORKS

Various clustering algorithms were developed for clustering. Ignoring spatial relationship between pixel values, the noise can be added to the image. Smooth filters are used to reduce noise before

clustering. The spectral reduction or texture description decreases the difference between the pixel values in a region. In order to make image clustering method more robust, many spatial clustering methods are used which does not require filtering process before clustering. Bias-Corrected Fuzzy C-Means (BCFCM) was proposed by Ahmed [2]. In BCFCM, the label of pixel value is determined by both spectral features of the pixel and its mean-filtered neighbors and a parameter ' α ' controls the effect of neighbors. Spectral spatial method used for hyper spectral images was proposed by Tarabalka [14]. Results of support vector machine and clustering uses the majority voting technique to produce homogeneous regions. Adaptive FCM proposed by Liew [11] imposed local continuity and allows the suppression of noise to resolve ambiguities. The FCM with priori spatial information was proposed by Dulyaharn and Rangsanseri [6]. This method uses spatial information that improves the segmentation results.

Fuzzy Local Information C-Means (FLICM) is a robust image clustering method which was proposed by Krinidis and Chatzis [8]. It is a noise sensitive method without a priori knowledge. The clustering is dependent based on both the spectral and spatial information by using a fuzzy factor. This method assumes that the label of one pixel is related to the label of its spatial neighbors.

An image clustering method called Fuzzy C-Means with Edge and Local Information (FELICM)

introduces weights for a pixel value within a local neighbor window to reduce the edge degradation problems.

III. IMAGE CLUSTERING PROCEDURE

The input videos are converted in to number of frames by frame conversion method. The Principal Component analysis obtains gray scale images. Lot of edges are extracted for grayscale image by using canny edge detection algorithm which uses both high threshold value and low threshold value. The K-means clustering method is used for the purpose of segmentation of an image which divides the image in to multiple segments which reduces the complexity of edge detection. Through the analysis of edges, different weights are set to the neighbors with in local neighbor windows. FELICM algorithm clusters different weighted local neighbors using spatial information iteratively. Final clustering result can be obtained by processing edge pixels.

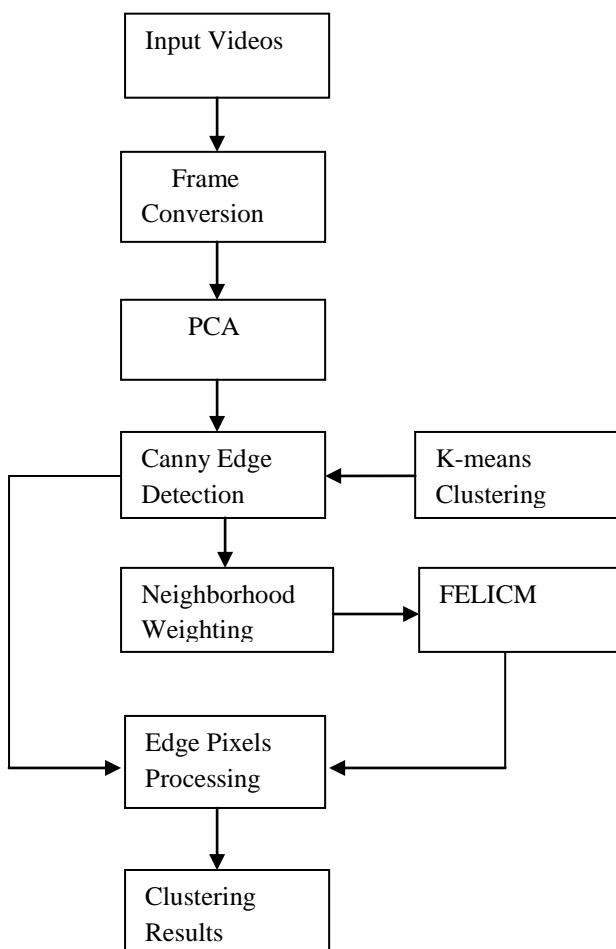


Fig. 1. System architecture

A. Edge Extraction

The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. It was developed by John F. Canny in 1986.

Canny edge detection method uses a canny operator to extract edges from the gray image. The basic steps of canny edge detection are

- 1) Noise reduction. The gray image is convolved with a 5×5 Gaussian filter with standard deviation $\sigma = 0.4$.
- 2) Finding the intensity gradient of the image.
- 3) Non maximum suppression.
- 4) Trace edges through the image and hysteresis thresholding.

Then all intensity gradients of an image are recorded in to the histogram. To reduce the complexity of number of cells, combine cells with low count values to one histogram and another one histogram containing cells with high count values.

If the pixel value of the window center is a candidate edge pixel, then gradient value of the pixel is set to

$$T_i = \frac{\sum_{j=1}^n T_j}{n} \quad (1)$$

where T_j and n are the gradient of candidate edge pixel and j the number of candidate edge pixels with in a window. The intensity gradient value can be calculated from (1)

A histogram is created by recording the gradients of edge pixels and the statistical mean is calculated by

$$u = \frac{\sum_{i=1}^l S_i}{l} \quad (2)$$

where S_i represents the count value of cell i which is greater than zero in the histogram and l is the number of cells whose count values are greater than zero.

From (2), the two thresholds are selected from this histogram to obtain more edges using canny edge detection. Therefore, no matter about how the length of video is, edges will be detected with canny operator.

1. K-means Clustering

K-means clustering is used along with the canny edge detection. It divides the image in to multiple segments to reduce the complexity of a process.

The main idea is to assign a centroid value for K clusters. First it initially computes the mean centroid value based on value of pixels. It divides the image into two clusters and then repeatedly calculates the centroid value and divides in to four clusters. This process is repeated until the cluster cannot be divided further.

- Make initial guesses for the means $\mathbf{m}_1, \mathbf{m}_2, \dots, \mathbf{m}_k$
- Until there are no changes in any mean, use the estimated means to classify the samples into clusters
 for i from 1 to k
 Replace \mathbf{m}_i with the mean of all of the samples for cluster end_for end_until

Finally, this algorithm aims at minimizing squared error function. The objective function is defined as

$$J = \sum_{j=1}^k \sum_{i=1}^n ||x_i^{(j)} - c_j||^2 \quad (3)$$

where $||x_i^{(j)} - c_j||^2$ is a chosen distance between a data point $x_i^{(j)}$ and the cluster centre c_j is an indicator of the distance of the n data points from their respective cluster centres

B. Neighborhood weighting

According to the method, a simple judgment can be made. If the straight line between two pixels is cut off by an edge, these two pixels belong to different regions. The different regions are used to find the most appropriate spatial neighbors, but they are not really different regions. Pixels in different regions will set weights which are different from those of pixels in the same regions. The weights for pixels of local neighbors can be set by the following method.

- 1) Suppose that the pixels in $n \times n$ neighbor window may be affected by the label of the center pixel pi , the size of spatial neighbor window $S1i$ is $n \times n$, the subscript means that the window center is pi .
- 2) Get a $m \times m$ spatial neighbor window $S2i$ which has the same center as window $S1i$, where $m = 2 \times n + 1$.

3) Count the number of neighbor pixels which are not separated from the center pixel pi by edges in window $S2i$, and set the total number as t .

4) If t is more than n^2 , the weight of pixel pj within window $S1i$ is set as

$$w_{ij} = \begin{cases} 0.33, & \text{if } pi \text{ and } pj \text{ are separated by the edge} \\ 1, & \text{otherwise.} \end{cases}$$

If pi and pj are separated by edges, the weight of pixel pj should be set as zero. Here, we set the weight as 0.33 foredge detection.

5) If t is less than n^2 , the weight of pixel pj within window $S1i$ is $w_{ij} = 1$.

Based on this functions three cases arises.

Case 1. There is no edge within window $S1i$, the weights of all the pixels in $S1i$ are set as one.

Case 2. One edge exists in window $S1i$, and the total number t in window $S2i$ is more than n^2 , as Different weights will be set for then neighbor pixels in $S1i$. As the neighbor pixel pj and center pixel pi are separated by the edge, these two pixels may belong to different regions, so the weight of neighbor pixel pj is set as 0.33, and its impact on center pixel pi has also been reduced.

Case 3. The edges exist in window $S1i$, and the total number t in window $S2i$ is less than n^2 , as. This case may be caused by the noise or the edge error, and the weights of all pixels in window $S1i$ are set as one, so the effect of errors can be weakened by the spatial neighborhood.

C. FELICM

FELICM is one of the best clustering method. It clusters the result based on the weight value of pixel. The different weighted pixels are clustered separately.

The objective function is defined as

$$J = \sum_{i=1}^N \sum_{k=1}^c [Qki + Gki] \quad (4)$$

where N is the number of pixels, c is the number of clusters, and Q_{ki} is the distance between pixel p_i and the center of cluster k and is defined as

$$Q_{ki} = u_{ki}^m \|p_i - v_k\|^2 \quad (5)$$

where m is the exponent of weight and it has been set to three in the basic experiments from practical experience, u_{ki} is the membership degree of pixel p_i to the cluster k , and v_k is the prototype of the center of cluster k .

The distance G_{ki} between the spatial neighbors of pixel p_i and the center of cluster k is used to control the impact of noise and it is defined as

$$G_{ki} = \sum_{\substack{j \in S1i \\ i \neq j}} \frac{1}{d_{ij}+1} [w_{ij} (1 - u_{kj})]^m \|p_j - v_k\|^2 \quad (6)$$

Where pixel p_j belongs to the window $S1i$, whose center is pixel p_i , d_{ij} , is an spatial distance between p_i and p_j , and w_{ij} is the weight of pixel p_j in the window $S1i$.

IV. EXPERIMENTAL RESULTS

Many videos are tested to evaluate the performance of the proposed FELICM method. FELICM introduces the weight value for edge pixels to improve the edge detection accuracy.

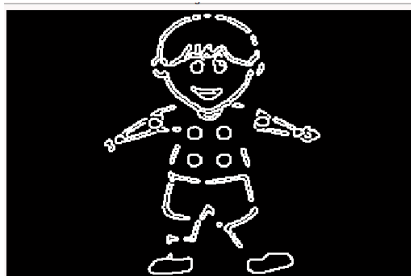


Fig.2. Edge detection

FELICM is the one of the efficient image clustering method used for image segmentation.

algorithm	Edge accuracy
FCM	68.4%
Meanshift	78.0%
FLICM	82.7%
FELICM	82.8%

Fig.3. Comparison of edge detection accuracies

FELICM algorithm increase the edge detection accuracy compared to the FCM, Meanshift, FLICM algorithm.

V. CONCLUSION

Various image clustering methods were developed which does not provide edge detection accuracy. The traditional image clustering methods usually regards image pixels as isolated samples, which usually result in isolated regions. FLICM uses local information to guarantee noise insensitiveness, but it often produces boundary zones due to the mix pixels near the edges of different regions. The FELICM is proposed, and it improves FLICM by introducing the weights for pixels within local neighbor windows. Thus the FELICM improves the FLICM for by introducing weights for the pixel values with in a local neighbor window. The videos can applied to this FELICM clustering process, it provides high edge detection and insensitive to noise. The experiments show that FELICM method is insensitive to the isolated regions and obtains more accurate edges than FLICM.

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