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A Review on Various Approaches of Image Segmentation

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ABSTRACT

Image segmentation has been used in digital image processing for extraction of region of interest from images. In the process of image segmentation various images have been undergoes the process of segmentation so that valuable information from images can be extracted. In this paper various approaches of image segmentation has been discussed that has been used for feature extraction. Segmentation has been widely used in medical image processing so that various diseases can be easily extracted. In this paper clustering based approaches and threshold based segmentation approaches has been discussed.
Keywords : FCM, K-FCM, P-FCM and OSTU Method

I. INTRODUCTION

K.4 Digital Image Processing

Computerized picture transforming is the utilization of PC calculations to perform picture handling on advanced pictures. As a subcategory or field of advanced sign handling, computerized picture preparing has numerous preferences over simple picture transforming. It permits a much more extensive scope of calculations to be connected to the info information and can stay away from issues, for example assemble up of clamor and sign mutilation amid transforming. Since pictures are characterized more than two measurements (maybe more) computerized picture preparing may be demonstrated as multidimensional frameworks.

1.2 Image segmentation

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to 19nalyse. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity or texture. Adjacent regions are significantly different with respect to the same characteristic(s). When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes.

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K.4 Segmentation methods in image processing and analysis

Image segmentation is the process of dividing an image into multiple parts. This is typically used to identify objects or other relevant information in digital images. There are many different ways to perform image segmentation, including:

1.4 Methodes of Segmentation

1.4.1 Thresholding

The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and k-means clustering. Recently, methods have been developed for thresholding computed tomography (CT) images. The key idea is that, unlike Otsu's method, the thresholds are derived from the radiographs instead of the (reconstructed) image.

1.4.2 Clustering methods

The K-means algorithm is an iterative technique that is used to partition an image into K clusters. The basic algorithm is:

1. Pick K cluster centers, either randomly or based on some heuristic
2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center
3. Re-compute the cluster centers by averaging all of the pixels in the cluster
4. Repeat steps 2 and 3 until convergence is attained (i.e. no pixels change clusters)

1.4.3 Compression-based methods

Compression based methods postulate that the optimal segmentation is the one that minimizes, over all possible segmentations, the coding length of the data. The connection between these two concepts is that segmentation tries to find patterns in an image and any regularity in the image can be used to compress it. The method describes each segment by its texture and boundary shape. Each of these components is modeled by a probability distribution function and its coding length is computed as follows:

1. The boundary encoding leverages the fact that regions in natural images tend to have a smooth contour. This prior is used by Huffman coding to encode the difference chain code of the contours in an image. Thus, the smoother a boundary is, the shorter coding length it attains.
2. Texture is encoded by lossy compression in a way similar to minimum description length (MDL) principle, but here the length of the data given the model is approximated by the number of samples times the entropy of the model. The texture in each region is modeled by a multivariate normal distribution whose entropy has closed form expression. An interesting property of this model is that the estimated entropy bounds the true entropy of the data from above. This is because among all distributions with a given mean and covariance, normal distribution has the largest entropy [4]. Thus, the true coding length cannot be more than what the algorithm tries to minimize.

1.4.4 Histogram-based methods

Histogram-based methods are very efficient when compared to other image segmentation methods because they typically require only one pass through the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image. Color or intensity can be used as the measure. A refinement of this technique is to recursively apply the histogram-seeking method to clusters in the image in order to divide them into smaller clusters. This is repeated with smaller and smaller clusters until no more clusters are formed. One disadvantage of the histogram-seeking method is that it may be difficult to identify significant peaks and valleys in the image. Histogram-based approaches can also be quickly adapted to occur over multiple frames, while maintaining their single pass efficiency. The histogram can be done in multiple fashions when multiple frames are considered. The same approach that is taken with one frame can be applied to multiple, and after the results are merged, peaks and valleys that were previously difficult to identify are more likely to be distinguishable.

1.4.5 Region-growing methods

The first region-growing method was the seeded region growing method. This method takes a set of seeds as input along with the image. The seeds mark each of the objects to be segmented. The regions are iteratively grown by comparing all unallocated neighboring pixels to the regions. The difference between a pixel's intensity value and the region's mean, δ, is used as a measure of similarity. The pixel with the smallest difference measured this way is allocated to the respective region.

Segmentation involves partitioning an image into a set of homogeneous and meaningful regions, Such that the pixels in each partitioned region possess an identical set of properties. Image Segmentation is one of the most challenging tasks in image processing and is a very important preprocessing step in the problems in the area of image analysis, computer vision, and pattern recognition. In many applications, the quality of final object classification and scene interpretation depends largely on the quality of the segmented output.

II. REVIEW OF LITERATURE

Taherdangkoo, M. et al [1] Segmentation of medical images, particularly magnetic resonance images of brain is complex and it is considered as a huge challenge in image processing.. These two parameters have been then calculated by other researchers using genetic algorithm (GA) and particle swarm optimization (PSO) algorithm, which although it has reduced the time but no change obtained in the resulted segmentation quality. In this paper we calculate these two parameters using the artificial bee colony (ABC) algorithm aiming to both reduce the time and to reach a higher quality than that obtained by previous reports. Finally, we segment real MR images with our proposed algorithm and compare it with previous presented algorithms.

Yu Li et al [2] proposed the traditional Fuzzy C-Means (FCM) clustering algorithm is usually based on the image intensity, so the segmentation results are unsatisfactory when the images are impacted by noise. Considering this shortcoming, in this paper the FCM objective function is improved by adding two kinds of spatial information: the relative position information and the intensity information of the neighborhood. Moreover, Quantum Immune Clone algorithm (QICA) is used to optimize the spatial impact factors in the objective function. The proposed algorithm has been tested in synthetic and real synthetic aperture radar (SAR) images segmentation. Experimental results demonstrate that the proposed algorithm is feasible and effective, and it can lead to higher accuracy.

Beevi, S.Z. et al [3] explained the Segmentation is an important step in many medical imaging applications and a variety of image segmentation techniques do exist. Of them, a group of segmentation algorithms is based on the clustering concepts. In our research, we have intended to devise efficient variants of Fuzzy C-Means (FCM) clustering towards effective segmentation of medical images. The enhanced variants of FCM clustering are to be devised in a way to effectively segment noisy medical images. The medical images generally are bound to contain noise while acquisition. So, the algorithms devised for medical image segmentation must be robust to noise for achieving desirable segmentation results. The employed factor works on the assumption that the membership degree of a pixel to a cluster is greatly influenced by the membership of its neighborhood pixels. Subsequently, the denoised images will be segmented using the designed variants of FCM. The proposed segmentation approach will be robust to noisy images even at increased levels of noise, thereby enabling effective segmentation of noisy medical images.

Chuan Long Li et al [4] proposed the fuzzy c-means (FCM) algorithm is one of the most widely used method for data clustering, the standard FCM is not effective by itself to segment the image, as it fails to deal with the significant property of images, such as noise and intensity inhomogeneity. The second mechanism is not requirement of any similarity penalty term in FCM's objective function as some FCM's variants to reduce the influence of noise on the result of image segmentation, in addition, our method needs no requirement of setting parameter according to the image, and thus our method is more general and robust for image segmentation. We present the experimental results not only in the application of synthetic image segmentation, but also in the difficult application of synthetic aperture radar (SAR)image segmentation; it is shown that we propose a novel method to obtain the cluster for image segmentation.

Gagan preet et al [5] proposed Color image segmentation is a process of partitioning an image into disjoint regions, i.e. into subsets of connected pixels which share similar color properties. Region extraction in color images is a difficult process. Author proposed a new optimization method Pollination Based Optimization (PBO) to select best optimal clusters in color images. The methodology consisted of four steps: color space conversion, generation of candidate color cluster centers using Fuzzy K Means, pollination based optimization method to select optimum color cluster centers, image segmentation. Pollination in flowers is used for selecting optimal clusters in colored image. The optimization method worked well on images used. The total elapsed time used to compute segmentation also reduced considerably.

III. APPROACHES USED

FCM ALGORITHM: Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. This method (developed by Dunn in 1973 and improved by Bezdek in 1981) is frequently used in pattern recognition. It is based on minimization of the following objective function:

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^{m} \left\| x_i - c_j \right\|^2$$

where m is any real number greater than 1, u_{ij} is the degree of membership of x_i in the cluster j, x_i is the I th of d-dimensional measured data, c_j is the d-dimension center of the cluster, and ||*|| is any norm expressing the similarity between any measured data and the center.

Fuzzy partitioning is carried out through an iterative optimization of the objective function shown above, with the update of membership u_{ij} and the cluster centers c_j by:

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^{m} \left\| x_i - c_j \right\|^2$$

Where is a termination criterion between 0 and 1, whereas k is the iteration steps? This procedure converges to a local minimum or a saddle point of J_m. The algorithm is composed of the following steps:

1. Initialize U=[u_{ij}] matrix, $U^{(0)}$
2. At k-step: calculate the centers vectors $C^{(k)}$=[c_j] with $U^{(k)}$

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^m \left\| x_i - c_j \right\|^2$$

3. Update $U^{(k)}$, $U^{(k+1)}$

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^m \left\| x_i - c_j \right\|^2$$

4. If || $U^{(k+1)} - U^{(k)}$||<
5. Then STOP; otherwise return to step 2

In medical field minute details of image are also matter a lot that's why it is very difficult to process. They need to be divided in such a manner so that their minute details can be easily examined. To divide the image into parts is called segmentation. In this work image segmentation is used to find the region of interest (ROI). The segmentation will be accomplished using fuzzy C mean technique.

K-FCM ALGORITHM: In this approach the kernel based fuzzy C mean approach is used for the segmentation of the image. In this kernel based segmentation approach used for segmentation process this approach can be implemented to manipulate the input data into higher dimensions of feature vectors by using the nonlinear map. This feature space division of the image is known to be the small regions of the image that have been separated for the implementation of FCM to each single region by providing kernel values. In this approach the image is firstly de-noised by using nonlinear spatial filter to enhance the quality of the image. In this approach one advantage is that it automatically defines the number of clusters that have to develop using KFCM. This approach firstly utilizes kernel values and then computes the fuzzy membership functions for the image regions using the computation equations. It finds the centered for each sub feature space of the image and this process goes till to the best cluster centers has been found for each region of the image. This approach is more robust to noise and original clustered forms and outliers of the image. This approach includes class of robust non-Euclidean at distance measures for original data spaces. This approach simple retains computation simplicity.

PENALIZED FCM ALGORITHM: PFCM approach is an extension of FCM approach. In FCM approach spatial information about image is not taken into consideration it only depends on the different gray level information about the image. FCM is very sensitive to noise so Penalization of FCM is purposed. General Principal of this approach is only to interoperate neighbor pixel information. In order to incorporate the spatial context into FCM objective function is penalized by regularized term. This is inspired by NEM algorithm. Objective function given by

$$J_{PFCM} = \sum_{i=1}^{k}\sum_{i=1}^{c}(U_{ik)}q \;\; d^2 \;\; (\;\; x_k, v_i) \;\; + \gamma\sum_{i=0}^{n}\sum_{i=0}^{n}\sum_{i=0}^{n} U_{ik(1-U_{iq})^q w_{kj}} \quad (1)$$

This approach used for the image segmentation utilized regularization term for the removal of noise sensitive in the FCM. A function ɣ (<=0) controls the effect of penalty term used in the PFCM. Value of the penalty term should be minimum for the better execution of FCM algorithm in the process of image segmentation

IV. CONCLUSION

Segmentation has been used in various prospective of image processing's. In the process of segmentation images has been converted into gray scale format so that grey level intensity can be easily used for segmentation process. In this paper various approaches has been discussed that are based on clustering. In this process FCM is first method that has been used for image segmentation process so that images can be segmented using different clusters.

Image has been divided into various clusters on the basis of fuzzy mean values. All clusters have been segmented using threshold value and merged together to reform segmented image. Kernel based and penalty based FCM are the evolutionary concepts of FCM that provide major improvements in segmentation of the images.

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