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MEDICAL IMAGE SEGMENTION BY MODIFIED FUZZY LOGIC ALGORITHM

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ABSTRACT:

The segmentation of image is considered as a significant level in image processing system, in order to increase image processing system speed, so each stage in it must be speed reasonably. Clustering of data is a method by which large sets of data are grouped into clusters of smaller sets of similar data. Fuzzy c-means (FCM) clustering algorithm is one of the most commonly used unsupervised clustering technique in the field of medical imaging. Medical image segmentation refers to the segmentation of known anatomic structures from medical images. Fuzzy C-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. Fuzzy logic is a multi-valued logic derived from fuzzy set theory. FCM is popularly used for soft segmentations like brain tissue model. And also FCM can provide better results than other clustering algorithms like KM, EM, and KNN. In this paper we presented the medical image segmentation techniques based on modified type of FCM algorithms. Fuzzy c-mean clustering is an iterative algorithm to find final groups of large data set such as image so that is will take more time to implementation. This paper produces an improved fuzzy c-mean algorithm that takes less time in finding cluster by using fuzzy k-means algorithm and Concatenates two segmented clusters to achieve better segmentation. This process is implemented in MATLAB R2012a tool and performance of modified Fuzzy logic is analyzed.

Keywords: medical imaging, segmentation, clustering, fuzzy logic algorithm, K-means algorithm.

INTRODUCTION

1.1 BACKGROUND

With the advances in imaging technology, diagnostic imaging has become an indispensable tool in medicine today. X-ray

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angiography (XRA), magnetic resonance angiography (MRA), magnetic resonance imaging (MRI), computed tomography (CT), and other imaging modalities are heavily used in clinical practice. Such images provide complementary information about the patient. While increased size and volume in medical images required the automation of the diagnosis process, the latest advances incomputer technology and reduced costs have made it possible to develop such systems.

Brain tumor detection on medical images forms an essential step in solving several practical applications such as diagnosis of the tumors and registration of patient images obtained at different times. Segmentation algorithms form the essence of medical image applications such as radiological diagnostic systems, multimodal image registration, creating anatomical atlases, visualization, and computer-aided surgery Tumor segmentation algorithms are the key components of automated radiological diagnostic systems.

Segmentation methods vary depending on the imaging modality, application domain, method being automatic or semi-automatic, and other specific factors. There is no single segmentation method that can extract vasculature from every medical image modality. While some methods employ pure intensity-based pattern recognition techniques such as thresholding followed by connected component analysis, some other methods apply explicit tumor models to extract the tumor contours. Depending on the image quality and the general image artifacts such as noise, some segmentation methods may require image preprocessing prior to the segmentation algorithm. On the other hand, some methods apply post-processing to overcome the problems arising from over segmentation.

Medical image segmentation algorithms and techniques can be divided into six main categories, pattern recognition techniques, model-based approaches, tracking-based approaches, artificial intelligence-based approaches, neural network-based approaches, and miscellaneous tube-like object detection approaches. Pattern recognition techniques are further divided into seven categories, multi-scale approaches, skeleton-based approaches, region growing approaches, ridge-based approaches, differential geometry-based approaches, matching filters approaches, and

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mathematical morphology schemes. Clustering analysis plays an important role in scientific research and commercial application. This thesis provides a survey of current tumor segmentation methods using clustering approach and provides both early and recent literature related to tumor segmentation algorithms and techniques.

Literature Survey

a) **A Robust Fuzzy Local Information C-Means Clustering Algorithm- SteliosKrinidis and VassiliosChatzis; IEEE transactions on image processing, vol. 19, no. 5, may 2010.**

This paper presents a variation of fuzzy c-means (FCM) algorithm that provides image clustering. The proposed algorithm incorporates the local spatial information and gray level information in a novel fuzzy way. The new algorithm is called fuzzy local information C-Means (FLICM). FLICM can overcomethe disadvantages of the known fuzzy c-means algorithms and at the same time enhances the clustering performance. The major characteristic of FLICM is the use of a fuzzy local (both spatial and gray level) similarity measure, aiming to guarantee noise insensitiveness and image detail preservation. Furthermore, the proposed algorithm is fully free of the empirically adjusted parameters incorporated into all other fuzzy c-means algorithms proposed in the literature. Experiments performed on synthetic and real-world images show that FLICM algorithm is effective and efficient, providing robustness to noisy images.

b) **A Region Entropy Based Objective Evaluation Method for Image Segmentation- Jiasheng HAO, Yi SHEN, Hongbing XUand Jianxiao ZOU; International Instrumentation and Measurement Technology Conference Singapore, 5-7 May 2009.**

Many image segmentation methods have been proposed over the last few decades. However, the results of segmentation are usually evaluated only visually, qualitatively, or indirectly by the effectiveness of the segmentation on the subsequent processing steps. Such methods are either subjective or tied toparticular applications. A few quantitative evaluation

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methods have been proposed, but these early methods have been based entirely on empirical analysis and have no theoretical grounding. In this paper, we put forward the concept of segmentation entropy, based on which a novel objective segmentation evaluation method is proposed. This method uses region entropy as the basis for measuring the uniformity of pixel characteristics within segmented regions and segmented entropy as a whole measure to provide a relative qualitative score that can be used to compare both various parameterizations of one particular segmentationMethod as well as fundamentally different segmentation techniques

c) **Local-based Fuzzy Clustering for Segmentation of MR Brain Images- Jianzhong Wang, Lili Dou, Na Che, Di Liu, Baoxue Zhang and Jun Kong**

Accurate segmentation of magnetic resonance images (MRI) corrupted by intensity inhomogeneity is a challenging problem and has received an enormous amount of attention lately. On the basis of the local image model we propose a different segmentation method for MR brain images without estimation and correction for intensity heterogeneity. Firstly, we obtain clustering context based on the distributing disciplinarian in anatomy that gray matter (GM) is always between white matter (WM) and cerebrospinal fluid (CSF) in brain, which ensure the three tissues exist together in each one. Then the size of the context is optimized by a minimum entropy criterion. Finally, FCM algorithm is independently performed in each context to calculate the degree of membership of a pixel to each tissue class. The proposed methodology has been evaluated for simulated images and shown the better results.

d) **Combined Wavelet and Curvelet Denoising of SAR Images using TV segmentation - Johannes R. Sveinsson and Jon AtliBenediktsson**

Synthetic aperture radar (SAR) images are corrupted by speckle noise due to random interference of electromagnetic waves. The speckle degrades the quality of the images and makes interpretations, analysis and classifications of SARimages harder. Therefore, some speckle reduction is necessary prior to the processing of SAR images. The speckle noise can be modeled as multiplicative *i.i.d.* Rayleigh noise. The

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discrete curve let transform is a new image representation approach that codes image edges more efficiently than the wavelet transform. On the other hand, wavelets transform codes homogeneous areas better than curve let transform. In this paper, two combinations of time invariant wavelet and curve let transforms will be used for denoising of SAR images. Both of the methods use the wavelet transform to denoise homogeneous areas and the curve let transform to denoise areas with edges. The segmentation between homogeneous areas and areas with edges is done by using total variation segmentation. Simulation results suggested that these denoised schemas can achieve good and clean images.

e) **Lip contour extraction using RGB color space and fuzzy c-means clustering-** VahidEzzatiChaharGhaleh, AlirezaBehrad

Lip contour extraction is very important issue in visual speech recognition systems (lip reading). To extract the lip contour, proper segmentation is needed. There are many approaches for image segmentation such as colour segmentation (histogram-based and clustering-based) that have been widely used in different areas. In this paper we use RGB colour space and fuzzy C-means clustering for lip segmentation. Compared to previous methods, we obtain a simple feature for lip region extraction using RGB components which can be used as input to C-means clustering algorithm for lip region extraction. Then the outputs of the C-means clustering algorithm are fed into active contour model to obtain final lip region. We tested the proposed algorithm with different images and results showed good segmentation for different speakers with different illumination.

IMAGE SEGMENTATION

OVERVIEW

Segmentation problems are the bottleneck to achieve object extraction, object specific measurements, and fast object rendering from multi-dimensional image data. Simple segmentation techniques are based on local pixel-neighborhood classification. Such methods fail however to “see” global objects rather than local appearances and require often intensive operator assistance. The reason is that the “logic” of a object does not necessarily follow that of its local image

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representation. Local properties, such as textures, edgeness, ridgeness etc. do not always represent connected features of a given object.

REGION GROWING APPROACH

Region growing technique segments image pixels that are belong to an object into regions. Segmentation is performed based on some predefined criteria. Two pixels can be grouped together if they have the same intensity characteristics or if they are close to each other. It is assumed that pixels that are closed to each other and have similar intensity values are likely to belong to the same object. The simplest form of the segmentation can be achieved through thresholding and component labeling. Another method is to find region boundaries using edge detection. Segmentation process, then, uses region boundary information to extract the regions. The main disadvantage of region growing approach is that it often requires a seed point as the starting point of the segmentation process. This requires user interaction. Due to the variations in image intensities and noise, region growing can result in holes and over segmentation. Thus, it sometimes requires post-processing of the segmentation result.

CLUSTERING

Clustering can be considered the most important *unsupervised learning* problem so, it deals with finding a *structure* in a collection of unlabeled data. A*cluster* is therefore a collection of objects which are "similar" between them and are "dissimilar" to the objects belonging to other clusters

Clustering algorithms may be classified as listed below

- Exclusive Clustering
- Overlapping Clustering
- Hierarchical Clustering
- Probabilistic Clustering

In the first case data are grouped in an exclusive way, so that if a certain datum belongs to a definite cluster then it could not be included in another cluster. On the contrary the second type, the overlapping clustering, uses fuzzy sets to cluster data, so that each point may belong to two or more clusters with different degrees of membership. In this case, data will be

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associated to an appropriate membership value. A hierarchical clustering algorithm is based on the union between the two nearest clusters. The beginning condition is realized by setting every datum as a cluster. After a few iterations it reaches the final clusters wanted

K-MEANS SEGMENTATION

K-means is one of the simplest unsupervised learning algorithms that solve the well-known clustering problem. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early group age is done. At this point we need to re-calculate k new centroids as bary centers of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move any more. Finally, this algorithm aims at minimizing an *objective function*, in this case a squared error function.

HIERARCHICAL SEGMENTATION

A hierarchical set of image segmentations is a set of several image segmentations of the same image at different levels of detail in which the segmentations at coarser levels of detail can be produced from simple merges of regions at finer levels of detail. A unique feature of hierarchical segmentation is that the segment or region boundaries are maintained at the full image spatial resolution for all segmentations. In a hierarchical segmentation, an object of interest may be represented by multiple image segments in finer levels of detail in the segmentation hierarchy, and may be merged into a surrounding region at coarser levels of detail in the segmentation

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hierarchy. If the segmentation hierarchy has sufficient resolution, the object of interest will be represented as a single region segment at some intermediate level of segmentation detail.

A goal of the subject analysis of the segmentation hierarchy is to identify the hierarchical level at which the object of interest is represented by a single region segment. The object may then be identified through its spectral and spatial characteristics. Additional clues for object identification may be obtained from the behavior of the image segmentations at the hierarchical segmentation level above and below the level at which the object of interest is represented by a single region.

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.

EXISTING SYSTEM:

Fuzzy-logic based Segmentation:

The fuzzy c-mean algorithm is one of the common algorithms that used to image segmentation by dividing the space of image into various cluster regions with similar image’s pixels values. For medical images segmentation, the suitable clustering type is fuzzy clustering. The Fuzzy c-means (FCM) can be seen as the fuzzified version of the k-means algorithm. It is a clustering algorithm which enables data item to have a degree of belonging to each cluster by degree of membership. The algorithm is an iterative clustering method that produces an optimal c partition by minimizing the weighted within group sum of squared error objective function. Is widely used in image segmentation and pattern recognition.

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Following are steps of traditional fuzzy c-mean:

Step1: Choose random centroid at least 2 and put values to them randomly.

Step2: Compute membership matrix

$$U_{ij} = \frac{1}{\sum_{k=1}^{c}\left[\frac{|I_i - c_j|}{|I_i - c_k|}\right]^{\frac{2}{m-1}}}$$

Step3: calculate the clusters centers:

$$C = \frac{\sum_{i=1}^{n} U^m * H * I}{\sum_{i=1}^{n} U^m * H}$$

Step4: if C(k−1) − Ck< ε then Stop else go to Step2.

This traditional algorithm is an iterative algorithm that suffers from time and memory consuming because it computes membership value for each item in the data.

PROPOSED SYSTEM:

Modified Fuzzy logic based Segmentation:

The proposed algorithm is based on fuzzy K-means clustering, that's actually the input image clustered into two segments. For each two segments the fuzzy c-mean algorithm is applied as follows. The improved fuzzy c-mean use values that represent the frequency of things rather than actual values, in grey pictures the amount of values of it's going to be reached to total of 65,536 which it can take longer in process, however in the improved algorithmic rule can take, at the worst case, 256 item to method it. The projected algorithmic rule doesn't rely upon whole knowledge of image; it all depends on the knowledge that represents the frequency of every knowledge item in original image's knowledge. Variety of frequencies at the most is 256.

- **Step 1:**Let S represent the frequency of each item in Data. After fuzzy segmentation this two clusters concatenates to get final segment image.
- **Step 2:**Create vector I = min(Data) : max(Data)
- **Step 3:**Choose random centroid at least 2.
- **Step4:**Compute membership matrix:

$$U_{ij} = \frac{1}{\sum_{k=1}^{c}\left[\frac{|I_i - c_j|}{|I_i - c_k|}\right]^{\frac{2}{m-1}}}$$

- **Step5:** calculate the cluster center:

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$$C = \frac{\sum_{i=1}^{n} U^{m} * H * I}{\sum_{i=1}^{n} U^{m} * H}$$

- **Step6:** if C(k−1) − Ck< ε then Stop else go to Step4.
- **Step 7:**Concatenates two segmented clusters. This is final segmented image by using the modified fuzzy logic.

SIMULATION RESULTS:

Modified FCM algorithm is implemented in MATLAB 2014a version and for the MRI brain images. In medical imaging segmentation plays major role which is mainly used in detection of unwanted tissues, cancer cells in human body. For segmentation process the modified FCM algorithm gives better segmented results than previous clustering algorithms. In following MRI brain image and corresponding fuzzy segmented images is shown in below figures.

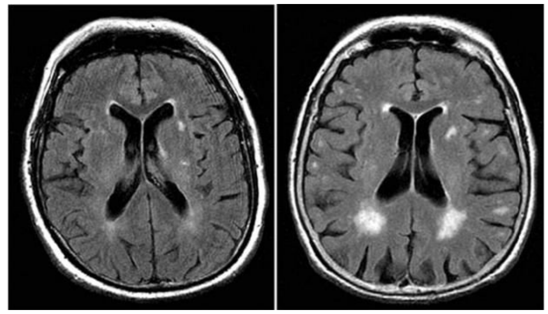

Fig.1. MRI brain image

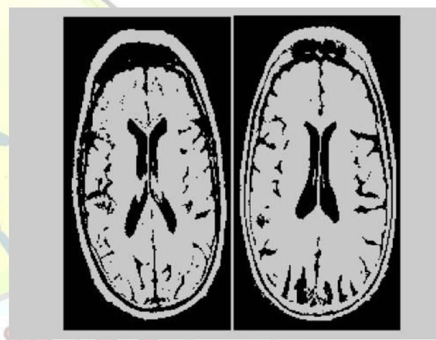

Fig.2 Modified FCM algorithm based segmented image

CONCLUSION:

In this work we have made a analysis about the performance of segmentation methods based on Modified Fuzzy C-Means algorithm. This fuzzy logic improves effectiveness, and the increased flexibility of segmentation. It gives less misclassification error, faster convergence and better accuracy. Modified FCM that incorporates the spatial information into the membership

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function to improve the segmentation results. The membership functions of the neighbors centered on a pixel in the spatial domain are enumerated to obtain the cluster distribution statistics. These statistics are transformed into a weighting function and incorporated into the membership function. This neighboring effect reduces the number of spurious blobs and biases the solution toward piecewise homogeneous labeling. This method provided that the effect of noise in segmentation was considerably less with the new algorithm than with the conventional Fuzzy logic.

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BIOGRAPHY

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