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Hybrid Segmentation Method for Malignancy Detection Using Fuzzy-C-Means and Active Contour Model

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Abstract:–Image segmentation is the first stage of processing in many practical computer vision systems. Development of segmentation algorithms has attracted considerable research interest, relatively little work has been published on the subject of their evaluation. Hence this paper enumerates and reviews mainly the image segmentation algorithms namely Fuzzy C means, Active Contour Model. The rapid progress in computerized medical image reconstruction, and the associated developments in analysis methods and computer-aided diagnosis, has propelled medical imaging into one of the most important sub-fields in scientific imaging. The proposed paper is an innovative frame work of hybrid segmentation technology with region based techniques and active contour models. The drawback of the parametric Active contour models is manual control points. But the proposed technology automatically assigned control points using Fuzzy-c-means clustering techniques. This approach is suitable for medical application like cancer cells for MRI, PET scan. Since the medical images are in very low contrast. Fuzzy-C-means gives the approximated boundary from that the control points are randomly selected. This combined approach will give accurate result for especially cancer cell detection.

Keywords:–Segmentation,Fuzzy-C-Means,ActiveContourModel,HybridSegmentation

I. INTRODUCTION

Today Image Segmentation is rapidly developing are of digital image processing [1]. Image segmentation attracts more attention due to the increasing computational potentialities of personal computers ad possibility of the usage for Image processing. Nevertheless, this problem remains less investigated then segmentation of medical images. There are many application areas for image segmentation, one of them clustering algorithms. Segmentation is the first stage in operation. The rapid development and proliferation of medical imaging technologies is revalorizing medicine. Physicians and scientists non-invasively gather potentially life-saving anatomical information using the images obtained from these imaging devices. The need for identification interaction with anatomical tissues by physiologists has the aortic arch in the abdomen for an aneurysm operation enables a surgeon preoperatively to plan an optimal stent design and other characteristics for the aorta. Each of the imaging modalities captures a unique tissue property. Magnetic resonance imaging [2](MRI) uses the heterogeneous magnetic property of tissue to generate the image. The response to an applied magnetic field is revolutionizing medicine. Physicians and scientists non-invasive gather distinctive for each tissue and is reflected in the image. Doppler ultrasound, on the other computed tomography (CT) imaging is based on absorption.

Cancer begins in cells, the building blocks that make up tissues. When normal cells grow old or get damaged, they die, and new cells take their place. Sometimes, this process goes wrong. New cells form when the body doesn’t need them, and old or damaged cells don’t die as they should. The build-up of extra cells often forms a mass of tissue called a growth or tumour. Tumours in the pancreas can be benign (not cancer) or malignant (cancer). Benign tumours are not as harmful as malignant tumours: Benign tumours and Malignant growth.

The FCM[3] performed the skin detection based on decision rules in hybrid space. [3] a novel segmentation technique for color images is presented. The segments in images are found automatically based on a novel FCM algorithm by using I and H components in HIS color space to form a new feature. [4] SWFCM cluster algorithm and we called it NSWFCM. The system can be used as a primary tool to segment unknown colour images. The algorithm has been implemented on a set of images. Results show that the system performance is robust to different types of images compared to FCM and SWFCM. The difficulty over re-initialization process is handled by Chumming Li et, al. In this paper level set method without re-initialization procedure was introduced. Here the new variation AL formulation of level set function with a closed sighed distance function is used to eliminate the costly re-initialization process. clustering algorithms namely centroid based K-Means and representative object based Fuzzy C-Means. These two algorithms are implemented and the performance is analyzed based on their clustering result quality. The behavior of both the algorithms depends on the number of data points as well as on the number of clusters [5].points are generated by two ways, one by using normal distribution The drawback of this method is the active contour will be resulted over with the minimum of 250 to 600 iterations depends on the nature of the image.

II. CLUSTERING

Clustering can be considered the most important unsupervised learning problem; so, as every other problem of this kind, it deals with finding a structure in a collection of unlabeled data. A loose definition of clustering could be "the process of organizing objects into groups whose members are similar in some way". A cluster is therefore a collection of objects which are "similar" between them and are "dissimilar" to the objects belonging to other clusters. In this case we easily identify the 4 clusters into which the data can be divided; the similarity criterion is distance: two or more objects belong to the same cluster if they are "close" according to a given distance (in this case geometrical distance). This is called distance-based clustering. Another kind of clustering is conceptual clustering: two or more objects belong to the same cluster if this one defines a concept common to all that objects. In other words, objects are grouped according to their fit to descriptive concepts, not according to simple similarity measures. So, the goal of clustering is to determine the intrinsic grouping in a set of unlabeled data. But how to decide what constitutes a good clustering? It can be shown that there is no absolute "best" criterion which would be independent of the final aim of the clustering. Consequently, it is the user which must supply this criterion, in such a way that the result of the clustering will suit their needs.
For instance, we could be interested in finding representatives for homogeneous groups (data reduction), in finding "natural clusters" and describe their unknown properties ("natural" data types), in finding useful and suitable groupings ("useful" data classes) or in finding unusual data objects (outlier detection).

In this paper we propose two of the most used clustering algorithms K-means and Fuzzy-C-Means. Each of these algorithms belongs to one of the clustering types listed above. So that, K-means is an exclusive clustering algorithm, Fuzzy C-means is an overlapping clustering algorithm, Hierarchical clustering is obvious and lastly Mixture of Gaussian is a probabilistic clustering algorithm. We will discuss about each clustering method in the following paragraphs.

2.1 Distance Measure

An important component of a clustering algorithm is the distance measure between data points. If the components of the data instance vectors are all in the same physical units then it is possible that the simple Euclidean distance metric is sufficient to successfully group similar data instances. However, even in this case the Euclidean distance can sometimes be misleading. Figure shown below illustrates this with an example of the width and height measurements of an object. Despite both measurements being taken in the same physical units, an informed decision has to be made as to the relative scaling. Clustering carried out based on seed point and distance measures. Region grouping based on the intensity. The intensity value is low that belongs to same cluster and the intensity value is high that belongs to different cluster. The FCM method applied to image segmentation is a procedure of the label following an unsupervised fuzzy clustering. It suits for the uncertain and ambiguous characteristic in medical images. However the FCM exploits the homogeneity of data only in the feature space and does not adapt to their local characteristics.

III. USING FCM AND ACM –HYBRID SEGMENTATION

The proposed method image segmentation, during fcm to the control point and applying another technique acm that give the approximate boundary result. For the sake of completeness, this section gives idea about selecting the control point membership of each vector .

3.1. Fuzzy-C-Means

The FCM [2] method applied to image segmentation is a procedure of the label following an unsupervised fuzzy clustering. It suits for the uncertain and ambiguous characteristic in images. However the FCM exploits the homogeneity of data only in the feature space and does not adapt to their local characteristics. The FCM algorithm is an iterative algorithm that finds clusters in data and uses the concept of fuzzy membership instead of assigning a pixel to a single cluster. Each pixel will have different membership values on each cluster. The Fuzzy C-Means attempts to find clusters in the data by minimizing.

$$J = \sum_{i=1}^{N} \sum_{j=1}^{C} \mu_{ij}^{m} \left| x_i - c_j \right|^2 \qquad (1)$$

Hence J is the objective function. After one iteration of the algorithm the value of J is smaller than before. It means the algorithm is converging or getting closer to a good separation of pixels into clusters. where m is any real number greater than 1, uij is the degree of membership of xi in the cluster j, xi is the ith of d-dimensional measured data, cj 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 uij and the cluster centres cj by:

$$u_{ij} = \frac{1}{\sum_{k-1}^{c}\left(\frac{\|x_{i-}c_j\|}{\|x_{i-}c_k\|}\right)^{\frac{2}{m-1}}}$$

(2)

$$c_j = \frac{\sum_{i-1}^{N} u_{ij}^{m} \ .x_i}{\sum_{i-1}^{N} u_{ij}^{m}}$$

(3)

$$\max_{ij}\left\{\left|u_{ij}^{(k+1)} - u_{ij}^{(k)}\right|\right\} < \delta$$

This iteration will stop when ,

Where is a termination criterion between 0 and 1, whereas k are the iteration steps. This procedure converges to a local minimum or a point of Jm.

The algorithm is composed of the following steps:

1. Initialize U=[uij] matrix, U(0)
2. At k-step: calculate the centers vectors C(k)=[cj] with U(k)

$$c_j = \frac{\sum_{i-1}^{N} u_{ij}^{m} \ .x_i}{\sum_{i-1}^{N} u_{ij}^{m}}$$

3. Update U(k) , U(k+1)

$$u_{ij} = \frac{1}{\sum_{k-1}^{c}\left(\frac{\|x_{i-}c_j\|}{\|x_{i-}c_k\|}\right)^{\frac{2}{m-1}}}$$

4. If || U(k+1) - U(k)||< ε then STOP; otherwise return to step 2.

$$u_{ij} \in [0,1] \qquad \forall i,j$$

$$\sum_{j-1}^{c} u_{ik} = 1 \qquad \forall i$$

Algorithm 1 Fuzzy-C-Means

3.2 Active Contour Model

Active contour are self deforming dynamic curves that moves under the influence f internal and external forces, towards the object boundaries of image features which we want to extract. To model an efficient active contour to perform the task of image segmentation in minimum time and with minimum cost. The shape of many objects is not easily represented by rigid primitives. When the segmented image only desired object discarding all other objects from an image having all similar kind of objects is impossible with other methods. In medical imaging, objects are similar but not exact. An exact representation of a vein's shape, for example

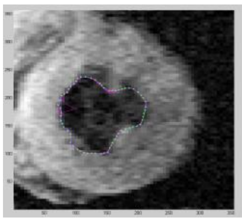


FIGURE 1: MR Image of the left ventricle of human heart

In this image is showing the poor quality of sampling artefacts. Unlike the other traditional segmentation methods. Acm use to detect object without sharp edges, cognitive contours and need n0 pre-smoothing, robust to noise. There are two types of ACM, Parametric active contour is represented explicitly as parameterized curves that deforms over a series of iterations

3.2.1 Parametric Active Contour

In parametric active contour, there are use classify like snake, balloon model, and GVF snake model. Geometric active contour model, denoted by C, are represented by the zero level set. We need to associate some energy functional to the active contours, in terms of its shape and its distance from the image features such that minimization of it makes the active contour to lock on to the image features.

E_{snake} = ∫0 1 Esnake(V(s))ds

= ∫0 1 Eint(V(s)) + Eimage(V(s)) + Econ(V(s)) ds (1)

Eint(V(s)): represents the internal energy of the spline due to bending
Eimage(V(s)): represents the image forces
Econ(V(s)): represents the external constraint force

Internal Energy:
Eint = (α(s)|Vs(s)|2 + β(s)|Vss(s)|2) / 2
The first-order term makes the snake act like a membrane
The second-order term makes it act like a thin plate.
The internal energy is composed of first-order term and second-order term. The first-order term, which controlled by α(s), adjusts the elasticity of the snake. The second-order term, which controlled by β(s), adjusts the stiffness of the snake.
Where the AC is parametrically defined as v(s)=(x(s),y(s))

The classical parametric active contours, proposed by Kasset al. are formulated by minimizing an energy functional that takes a minimum when contours are smooth and reside on object boundaries. Solving the energy minimization problem leads to a dynamic equation that has both internal and external forces. The external forces resulting from this formulation are conservative forces in that they can be written as gradients of scalar potential functions. Active contours using non-conservative forces, however, have been shown to have improved performance over traditional energy-minimizing active contours. Therefore, we now formulate parametric active contours directly from Newton's law, which permits use of the most general external forces. Mathematically, a parametric active contour is a time varying curve X(s; t) = [X(s; t); Y (s; t)] where s 2 [0; 1]is arc length and t 2 R+ is time.

ACM provide a unified solution to several image processing problems such as detection of light and dark lines and edges. It derived based on internal energy and external energy when it comes to an equilibrium. Internal energy moves towards the object or image using curvature function and External energy moves away from the object using gradient function.

IV. PROPOSED SYSTEM

The algorithm proposed in this paper the general flow of active contour algorithm. But it is based on the evaluation of region based classification. The contour is implicitly as the boundary of the region. The main advantage of this approach is the elimination of initial contour assignments iterations which is time consuming when iteratively on the processor array. Further more proposed system implements contour evaluation using very simple region classification, magnitude and directional information which results a accurate contour in fast implementation. The block diagram of the proposed system is shown in the figure-1

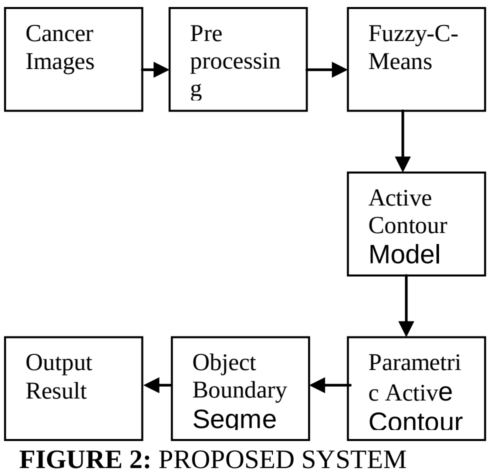


FIGURE 2: PROPOSED SYSTEM

The following hybrid algorithm is proposed in this method.

Algorithm:

Step 1: Get the input image.

Step 2: Pre processing - classify the input image using Fuzzy C-means.

Step 3: The control points are automatically selected from region of interest boundary.

Step 4: Parametric Active contour model has to be implemented with the following steps

4.1. The external energy is supposed to be minimal when the snake is at the object boundary position. External energy can be calculated from gradient information.

4.2. The internal energy is supposed to be minimal when the snake has a shape which is supposed to be relevant considering the shape of the sought object. So internal energy is calculated based on the curvature functions.

Step 5: Automatic Segmentation.

Step 6: Depends on the intensity. Response classify the pixels into object and boundary Pixels.

Step 7: Take the result to validation method.

Step 8: Get the segmented result.

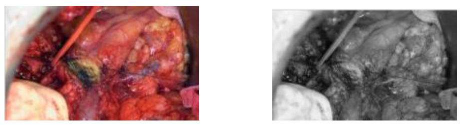
Algorithm 2. Proposed System

V. EXPERIMENTAL RESULTS

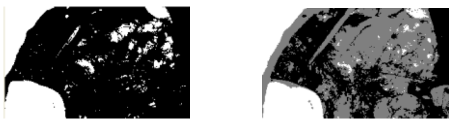
This section shows some experimental results obtained by our model. Our system was implemented in Matlab7.0 on a 2.4GHz Pentium IV machine running on 256MB RAM using the image processing toolbox and Modified FCM. The tests have been performed with the cancer images. It is totally experimented with 100 different images and the results are reported in this section. The size of each image ranged from 100 x 100 to 1024 x 1024. The input color image is normally in the form of RGB. Here the input image is converted Black and white. Since a single color model does not work best for all kinds of images, various color image make certain calculations more convenient or to identify colors that is more intuitive. Image is based on human perception. So, it is used for cluster formation. Drawback of using ACM is number of iteration process is too high. Applying two segmentation algorithms for this Hybrid model will give appropriate result principally cancer Images.

Imaging techniques work by producing images of body parts, the images thus created can help the doctor to detect and diagnose diseases. The doctor may ask the patient to take one or more of such scans to identify tumors, to locate tumors, to know whether the tumor is localized or spread to other areas of the body and to determine the stage of the tumor. The doctor will also examine for any lumps in the abdomen and neck, yellowing of skin and eyes, fluid in the abdomen etc. The patient may be asked to take some scans and blood tests in addition to the physical examination conducted in the clinic using with help of such a kind of Images.

5.1. Using FCM and KMeans Algorithms

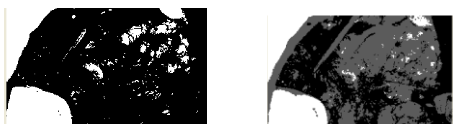


(a) input Image (b) BW Image



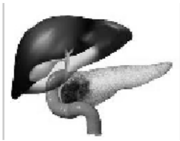
(using K-Means)

(c) After BW using K-means Clustering K=2 and the Elapsed time 0.297000 seconds. (d) After BW using K-means clustering K=3 and the Elapsed time is 0.422000 seconds.



(using FCM)

(e) After BW using FCM 2-clustering for Elapsed time is 0.750000 seconds (f) After BW using FCM 3-clustering for Elapsed time is 1.407000 second



(a) **(b)**

(c)

(a) Original Image (b) For manual initialization m(2,174,45:85:111)=1;and iteration count is 900, the elapsed time 15.251000 seconds. (c) In this image followed by hybrid segmentation, the iteration count is 65 and the elapsed time only 1.69000 seconds.

FIGURE 2 Sample Images and its Kmeans and FCM clustering result.

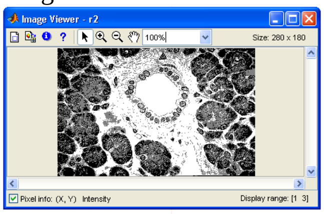


FIGURE 3 Sample Images and its intermediate Results

Figure 3 shown the input is colour(a) and convert into black and white.(b)In this sample images are used clustering technique using k-means and fuzzy clustering are showing a intermediate result and elapsed time is taken respectively. K-Means and Fuzzy C Means more or less same but fuzzy give more accuracy than kmeans. Since, in this paper we are using the FCM algorithm.

5.2 Existing ACM and Proposed FCM with ACM

(a) (b) (c)

FIGURE 4 sample Images and its intermediate Results.

(a) Original Image (b) For manual initialization m(54:120,110:220)=1 and iteration count is 1000, the elapsed time 47.518000 seconds. (c) In this image followed by hybrid segmentation, the iteration count is 60 and the elapsed time only 3.094000 seconds.

(a) **(b)** **(c)** **(b)**

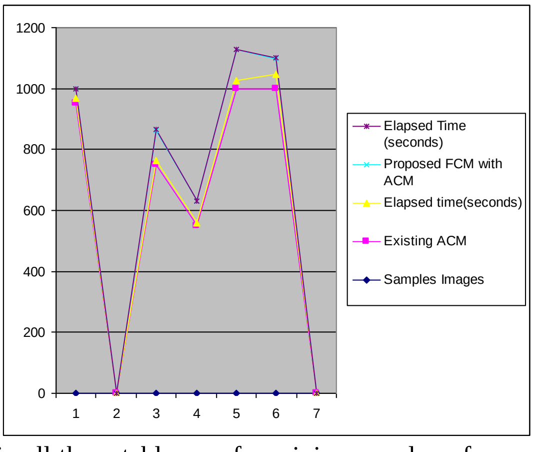
FIGURE 5 sample Images and its intermediate Results

(a) Original Image (b) For manual initialization m(2,174,45:85:111)=1;and iteration count is 800, the elapsed time 15.251000 seconds. (c) In this image followed by hybrid segmentation, the iteration count is 60 and the elapsed time only 1.67000 seconds.

	Existing ACM	Elapsed time(seconds)	Proposed FCM with ACM	Elapsed Time (seconds)
	950		30	0.969000
	750	13.960000	100	0.687000
	550	09.922000	70	1.516000
	1000	27.707000	100	1.985000
	1000	47.518000	50	3.094000

Figure 5 and 6 are shown the snake model represents a discrete version of this approach, original image with manual initialization and iteration count is high and computational time also long time. Basically single technique will not give accurate result, so combination of two algorithms will definitely show best result. In hybrid segmentation exactly the iteration and computational time are reduced. This paper will help the physicians and researcher can estimate result of the image and safe of the human life.

TABLE 1:. Effect of proposed system and comparison of Existing ACM



Note: The highlighted figures in all these tables are for minimum value of proposed system. It is observed that most of them elapsed time is too less compare to existing ACM. This indicates that proposed system gives the best result accuracy level and number of iteration value is reduced respectively.

5.3 Comparison for Fuzzy c Means and K Means - Time(seconds)

K-Means clustering and Fuzzy-C Means Clustering are very similar in approaches. The main difference is that, in Fuzzy-C Means clustering, each point has a weighting associated with a particular cluster, so a point doesn't sit "in a cluster" as much as has a weak or strong association to the cluster, which is determined by the inverse distance to the center of the cluster.

Fuzzy-C means will tend to run slower than K means, since it's actually doing more work. Each point is evaluated with each cluster, and more operations are involved in each evaluation. K-Means just needs to do a distance calculation, whereas fuzzy c means needs to do a full inverse-distance weighting.

Images	FCM		K Means	
	2-clustering	3-clustering	2-clustering	3-clustering
Image-1(in3.jpg)	0.469000	2.484000	0.203000	0.218000
Image-2(in4.jpg)	1.016000	2.252000	0.219000	0.219000
Image-3(in6.jpg)	0.329000	1.110000	0.140000	0.156000
Image-4(img-1.jpeg)	0.720000	1.548000	0.218000	0.219000
Image-5(img-4.jpeg)	1.672000	1.891000	0.203000	0.204000

TABLE 2. Comparison of FCM and K-Means for clustering variation in seconds

VI. CONCLUSIONS

This paper presents a contour based approach using clustering and active contour values to extract the object boundary from its background i.e., object segmentation. The numbers of clusters are given approximately to speed up the process. The proposed technique only requires the information of input image in grey scale form, no other assumption to be considered. This is an adaptive method with out human intervention the processing is carried out. For final segmentation the result need localization process. This process can be extended with the combination of both results for multiple object detection or overlap region detection. Fuzzy clustering methods can be important supportive tool for the medical experts in diagnostic.

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