A Survey of Benign Tumor Diagnosing Techniques using fuzzy knowledge based Tools

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***Abstract*— A benign tumor is an uncontrolled growth of tissues in human body. This tumor, when turns into malignant and further into cancer then become life threatening. It is very necessary to diagnose the benign tumor tissues in early stages with their exact location to save the life of human being. This paper includes a survey on different segmentation techniques to diagnose the benign tumor cells in MRI images and it also includes the proposed for the same using fuzzy c- means algorithm to find out the benign tumor tissues**

***Keywords*— Magnetic resonance image (MRI), benign tumor, malignant tumor, Image segmentation, Fuzzy K- means clustering, Fuzzy C- means clustering.**

I. INTRODUCTION

In, India most of the time tumors are the main factors that are highly responsible for the death of human being. So by diagnosing the tumor cells in initial stage may be increases the chances of survival for a healthy life. Our body consist a lot of cells that perform their individual specific functions to maintain the proper function of human body and generation of new cells as required by the human body for growth as well as for replacement of dead cells. When the controlling system for generation of new cells and replacement of dead cells are failed then extra cells are frequently generated in an uncontrolled manner and when these extra generated cells gains some mass, called tumor. Tumor is also known as neoplasm, is an abnormal mass of tissue that may be solid or liquid filled.

On the basis of their shape, the origin of cell, and type of tissues as they appear, they can be divide into two parts; Benign and malignant.

A. Benign tumor

Benign tumor are not cancerous and cannot spread in other part of body because they are covered by SAC i.e. a mechanism performed by your immune system that separates it from the rest of your body. Benign tumors can be serious if they press on vital structures such as blood vessels or nerves. Adenomas, Fibromas, Hemangiomas and lipomas are the main type's benign tumor and they do not return back after being removed by a small surgery without damaging the surrounding tissues.

B. Malignant tumor

Malignant tumor are cancerous means metastasize same as original one and can spread rapidly in other part of body through blood stream and start to affect nearby healthy tissues. Now, according to type of cell of tumor, doctor group the malignant tumor in four groups. Cells of low grade malignant tumor (I & II) looks normal and grow more slowly as compared to high grade malignant tumor (III & IV).

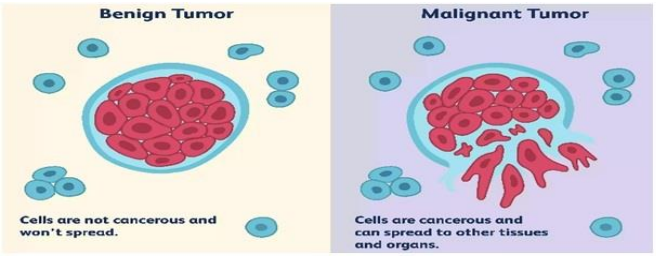


Fig.1 Benign and Malignant tumor

There are a lot of techniques available to diagnose the malignant tumor as compared to benign because benign tumor is the initial stage of tumor development and having slower growth rate. So now days to diagnose the benign tumor in initial stage are a challenging field and more helpful in survival of healthy life

II. LITERATURE REVIEW

Rajeev Ratan et al (2016) presented an improved watershed segmentation technique to diagnose the breast tumor. According to his research paper the breast tumor tissues can easily be segmented in 6-8 minutes using watershed segmentation technique based on two dimensional MRI datasets with high level of precision and reproducibility with respect to supervised (manual) segmentation techniques that takes more than 2 hours. [1]

Xiangzhi Bai et al (2016), reached on a conclusion that to segment a low contrast infrared ship image we have to extract the intensity feature, local spatial feature and global spatial features so with the help of unimodal threshold techniques, intensity features of infrared images are extracted then saliency detection, region rowing and morphology processing is employed for local spatial feature extraction and then finally with the help of partial region growing and weighted distance transformation, global spatial features are extracted.[2]

K.Vaidehi et al (2015) developed an automatic breast mass characterization system based on fuzzy c- mean's algorithm used to analyze the digital mammograms. It is able to diagnose and categorizes the mass of benign and malignant tumor by calculating the GLCM (Gray level co-occurrence matrix) texture feature like contrast, correlation, energy and homogeneity with an accuracy of 93.75%.[3]

Surabhi Kaushal (2017) developed a segmentation technique based on gray matter and white matter. she is able to diagnose the location of brain tumor is easily within MRI brain images and also located the volume of tumor on the white matter with a accuracy of more than 90 %. [4]

Ritu Rana and Parvinder singh (2015) reached on a conclusion according to his research paper, diagnosis of tumor cells in human body is more complicated and highly

sensitive, so she develop a advance brain tumor detection algorithm based on MRI (Magnetic Resonance Imaging) images that is more fruitful in computer aided detection system (CAD) in lot of stages for diagnosis purpose. [5]

Rajeev Ratan et al (2009) developed a brain tumor detection technique based on multi-parameter MRI (2D &3D) image analysis. According to him this method does not required any initialization while other required. First of all he calculates the area of tumor on a single slice of MRI data set and then calculates the volume of tumor from multiple MRI data sets. [6]

Rohini Paul Joseph et al (2014) developed a computer aided system for brain tumor detection based on K-mean's clustering algorithm followed by morphological filtering (used to avoid the un-clustered regions) and he is able to detect the tumor cells from different brain MRI data sets with higher order of accuracy and reproducibility.[7]

Arpita Das and Mahua Bhattacharya (2008) proposed a computer assisted treatment planning system based on neuro-fuzzy approaches. Significant input feature vector are easily calculated by Genetic algorithm and with the help of adaptive neuro fuzzy based classifier the prognosis of the disease either benignancy or malignancy clearly predicts with 87% of satisfactory level. [8]

Reza Farjam et al (2007) developed an automatic technique to diagnose the malignancy from the pathological images with a texture-based algorithm that is used to diagnose the glandular regions of an image. After combing all extracted features related to glands, generate an index proportional to the malignancy of cancerous tissue. The experimental results are tested on two data sets of 91 and 199 images of different magnifications and illuminations with the accuracy of about 98% and 95%.[9]

Guang-Ming Xian (2010) reached on a conclusion by developing an application based on fuzzy support vector machine (FSVM) with pre-image processing to diagnose the liver tumor (Benign & Malignant) based on GLCM texture parameters. FSVM diagnose the benign and malignant tumor more efficiently as compare to SVM with an overall accuracy of 97%. [10]

Pham N. Tra et al (2016) proposed a MRI brain image segmentation technique based on threshold algorithm for edge detection of tumor structure. First of all the brain image is enhanced by using unsharp approach after that segmented by using Otsu method that provide a suitable threshold value to segment the tumor from image.[11]

R. Saranya et al (2014) proposed a image segmentation technique based on a fuzzy region growing that start with a seed pixel and according to statistical measurement of these seed pixels, fuzzy membership functions are prepared then the masses of benign and malignant tumor is easily classify from the resulting region that is finalized by region growing algorithm.[12]

Bekaddour Fatima and Chikh Mohammed Amine (2012) proposed an algorithm for recognition of breast tumor based on Adaptive Neuro-fuzzy Inference system (AFFIS). According to his research paper, the experimental results on the basis of WBCD (Wisconsin breast cancer diagnosis) database having an accuracy of 98.25%.[13]

Mohamed N. Ahmed et al (2002) developed a modified fuzzy C- means algorithm based Bias field estimation and segmentation of MRI data image : According to M.N. Ahmed et al have suggested a novel approach for segmentation and estimation of intensity in homogeneities using fuzzy logic for MRI(Magnetic Resonance Imaging) data Images. He modified the objective function of standard fuzzy c- means algorithm with the help of advance algorithm to requite for such types of homogeneities. [14]

T. Manikandan and N. Bharathi (2015) proposed to a technique to improve the efficiency of lung cancer detection system based on fuzzy inference algorithm. First of all the with the help of wiener filter followed by region growing segmentation technique, primary noise from CT lung images is removed after that extracting the features like diameter, shape and intensity values the segmented nodules is classified either as benign or malignant with higher degree of sensitivity about 92.3%.[15]

Fatima S. Ahadi et al (2017) proposed a feature-based classification and diagnosis of breast cancer using fuzzy inference system to improve the efficiency to diagnose the benign tumor cells before it become malignant by using advanced fuzzy inference algorithm with higher order of accuracy and such systems handle the more complicated cancer perdition problems with best optimized results.[16]

S. Anhumozhi et al (2014) suggested a technique to reduce the uncertainty and redundancy of multiple input images for diagnosing the tumor cells by merging on a single fused image with the help of fuzzy logic because the fused image is more informative compare to single input image. He extracted the brain image texture and wavelet features of fused image by applying multilevel adaptive neuro-fuzzy classifier with the accuracy and sensitivity 99.695 & 99.9& respectively. [17]

A. Moghaddamzadeh and N. Bourbakis proposed a technique to recognize the pattern related to region of interest for input image segmentation is more important. It consist image compression and coding, one for fine segmentation with the help of histogram tables and other is coarse segmentation techniques followed by fuzzy logic. [18]

III. VARIOUS APPROACHES FOR TUMOR IMAGE SEGMENATATION

MRI, CT-scan image, mainly used for tumor diagnosis and treatment in clinic but MRI image is most probably used for tumor cell diagnosis because it provide beneficial features like multiplanar capabilities, potential of tissue characterization and no bone and teeth artifacts.

1. Thresholding Technique

Thresholding segmentation technique is simplest method to segment the image pixels according to intensity levels. It is mainly applied on those images, which having lighter object than background. There are two types of Threshold segmentation; Global Threshold and Local Threshold

a) Global Thresholding

In this technique a threshold operation g is performed which remapping the grey values and converted into binary. If 'v' is the grey value of image and 't' is the threshold value then threshold operation;

$$g(v) = \begin{cases} 0 & \text{if } v < t \\ 1 & \text{if } v \geq t \end{cases}$$

When an image is divided into several segments according to grey values then such type of thresholding is called multiple thresholding. In multiple thresholding, when all the pixels with a value < first threshold are assigned to first

segment and if lie between first and second threshold then assign to second segment. If n segments have threshold t1, t2….tn then

$$g(v) = \begin{Bmatrix} 0 & if \;\; v < t_1 \\ 1 & if \;\; t_1 \le v < t_2 \\ 2 & if \;\; t_2 \le v < t_3 \\ 3 & if \;\; t_3 \le v < t_4 \\ \vdots & \vdots \\ n & if \;\; t_n \le v < t_{n+1} \end{Bmatrix}$$

The values of threshold can be computed with the help of the peaks of the image histogram. If p1 and p2 are the grey values of two peaks in image histogram then threshold

$$t = \frac{p_1+p_2}{2} = \arg\{\min_{v\in(p_1,\,p_2)} H(v)\}$$

b) Local Thresholding

When the background illumination of an image is uneven the global thresholding is failed so in that situation by morphological top-hot operator is used to compensate the illumination of whole image uniformly. If 'v' is the grey value of image and 't' is the threshold value then morphological operator

$$g(v) = \begin{Bmatrix} 0 & \text{if } v < t \\ 1 & \text{if } v \ge t \end{Bmatrix} \qquad \text{Where } t = v_0 + t_0$$

2. Edge based segmentation Technique

The edge is the boundary between two regions with distinguished grey level properties so in edge based segmentation technique the whole image is divided into small segments according to abrupt change in intensity of the pixels near the edges. The detected edges in an image are assumed to represent the object boundaries and used to identify the object. There are two basic edge based segmentation methods viz. gray histogram and gradient based methods.

a) Grey Histogram Technique

In grey histogram segmentation first image is converted into histogram i.e. the graph between frequency v/s grey levels then grey histogram thresholding segmentation technique is applied and its result mainly depends upon the selection of threshold (T).

b) Gradient Based technique

The gradient based techniques are mainly used when there is an abrupt change in intensity in a region of an image and less image noise. This method is based on the difference between intensity values of neighboring pixels on an image. These methods based on gradient operators for image segmentation. The basic edge operators are Roberts's operator, Prewitt operator, Sobel operator, canny operator, Laplace operator, Laplacian of Gaussian (LOG) operator, frei-chen edge operator etc. out of these operators Sobel and canny operator provides better result compare to other in terms of accuracy and low noise.

3. Region based segmentationTechnique

Region based segmentation technique is based on division of image into homogeneous regions. It is used to find out the boundaries between regions based on discontinuities in intensity levels. The existing region segmentation methods are:

a) Region Growing

Region growing is a technique in which groups of pixels or subgroups into a larger region based on predefined criteria of growth. This approach is starts from a seed pixels i.e. set of pixels of having same constraints like intensity, color, texture, shape and size. It is iterative in nature, when neighboring pixels satisfy the predefined threshold then region is grow by dissolving the weak edge otherwise pixel is not included. The whole process continues until the whole pixels belong to the same region.

b) Region splitting and Merging

Region splitting and merging is a top-down approach according to predefine criteria. If the predefined criteria are satisfied then regions are merged otherwise split into different regions. Initially the whole image belong to a single region then we calculate the internal similarities of image pixels if it is large or more than threshold value then single region is split into sub regions. Let R_j & R_k are the two adjacent regions then basic steps of region splitting and merging approach are;

Step 1: Any region split into four quadrants when $Q(R_j)$=False

Step 2: when no further splitting is possible then merge any adjacent region in R_j & R_k when $Q(R_j \cup R_k)$=True.

Step 3: stop when no further merging is possible.

4. Watershed segmentation Technique

Watershed segmentation technique is also known as gradient based segmentation technique. The term watershed is related to geography means used to separate two catchment basins and ridge lines so this technique is used to separate the two touching objects in an image. The Basic steps involved in watershed segmentation algorithm

Step 1: Read the raw image and pre-process it.

Step 2: Convert the image into grayscale using RGB model

Step 3: Compute foreground makers or connect blobs and pixels

Step 4: Compute the background makers

Step 5: Compute the watershed transform of the segmented function

Step 6: segmented output image

The main advantage of watershed segmentation is simple and easy to use, obtained more efficient and accurate result but gives over segmentation.

5. Clustering segmentation Technique

The term cluster is the collection of objects which are similar to each other and are dissimilar to the objects belonging to that cluster. Clustering is an unsupervised learning technique which used to find out the structure in a collection of unbalanced data. There are two types of clustering methods

a) K- Means Clustering

In k- means clustering first of all number of clusters (group of images) are created on the basis of some predefined characteristics after that distance between the each pixels to centre of cluster is calculated by Euclidean function and pixel move to a particular cluster which has shortest distance. The basic steps of K- mean clustering approach is;

Step 1: Initialize the number of cluster and their mean values

Step 2: calculate the distance between each pixel to center of cluster

$$D(i) = arg\ min\|x_i - M_k\|^2 \quad , i = 1,2 \ldots\ldots, N$$

Step 3: Move the pixel in a cluster which has shortest distance

Step 4: Compute the new mean values of the each cluster

$$M = \frac{\sum_{i:c(i)=k} x_i}{n_k} \quad , k = 1,2 \ldots\ldots, k1,2,3\ldots k$$

Step 5: Repeat the step 2, 3 and 4 until the all the pixels are converges

The Main disadvantage of K- means clustering is that it is not suitable for overlapping clusters

b) Fuzzy C- Means clustering

Fuzzy C- means algorithm (FCM) is also known as soft clustering, advanced version of k-means clustering. The fuzzy C-Means algorithm is a very powerful method of clustering due to its flexibility, to analyze real life data and the closeness of fuzzy membership function to the qualitative nature of human perception.FCM is able to detect the object when clusters are overlapped. Fuzzy c-means clustering was developed by J.C. Dunn in 1973 and improved by J.C. Bezdek in 1981.on the basis of distance between cluster center and data point, membership values is assigned to each data point between 0 and 1. The basic steps of Fuzzy C-mean clustering approach is;

Step1: choose the number of clusters (2< c< n) and select a value of fuzziness parameter 'm' (1.5 to 2) initialize the partition matrix

$$U_{ik} = 1 \ , whre\ i = 1,2 \ldots c\ \&\ k = 1,2 \ldots . n.$$

Step 2: calculate the center of each cluster;

$$v_i = \frac{\sum_{k=1}^{n} U_{ik}^m\, p(r) r}{\sum_{k=1}^{n} U_{ik}^m}$$

Step 3: calculate the convergence matrix of each cluster

$$G_i = \frac{\sum_{k=1}^{n} U_{ik}^m\ (x_k - v_i)(x_k - v_i)^T}{\sum_{k=1}^{n} U_{ik}^m}$$

Step 4: Calculate the new membership values using

$$U_{ik} = \frac{1}{\sum_{j=1}^{n} \left(\frac{\left|(x_k - v_i)^T G_i (x_k - v_i) - ln|G_i|\right|}{\left|(x_k - v_j)^T G_i (x_k - v_j) - ln|G_i|\right|}\right)^{\frac{2}{m-1}}}$$

Step 5: Compare, U^{k+1} and U^k if $|uk+1-Uk|<\varepsilon$ then stop otherwise go to step 2 till convergence criteria satisfied.

IV. PROPOSED METHODOLOGY

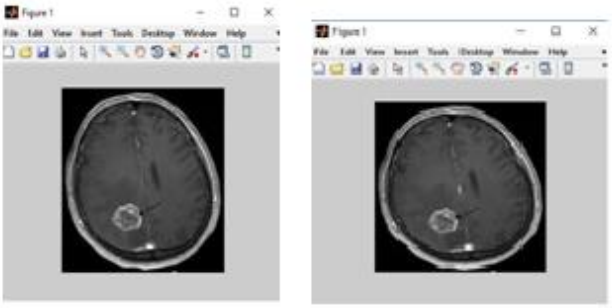
In the proposed methodology, to diagnose the tumorous cells present in the medical images, features will be extracted with the help of GLCM matrix coefficients then fed to FIS (Fuzzy inference system) after that on the basis of these parameters fuzzy rules will be prepared to detect an abnormality in the image. This proposed method consist of mainly, pre-processing stage, diagnosis of benign tumor cells by using advanced fuzzy c- means clustering and post processing stage.

a) Image Pre-processing

The raw image collected from the scan centre or websites are not suitable for direct processing due to the presence of various noises so preprocessing is used to enhance the chances of detecting the suspicious region and finer details of the images, which are relevant for further processing and analysis. Basic steps of image pre-processing are;

Step-I: Image Acquisition: It is used to acquire the input image

Step-II: Image filtering: It is used to remove the noise from the acquired image for 2 D data set median filter is used because it removes salt and pepper noise or impulse noise i.e. presence of white and black dots covered on image gray scale image. For 3D data set bilateral filter is used because it removes blur or unclearness of Gaussian filter.



Original image Pre-processed image

Fig.3: Comprative view of images after pre-processing

Flow chart of proposed methodology:

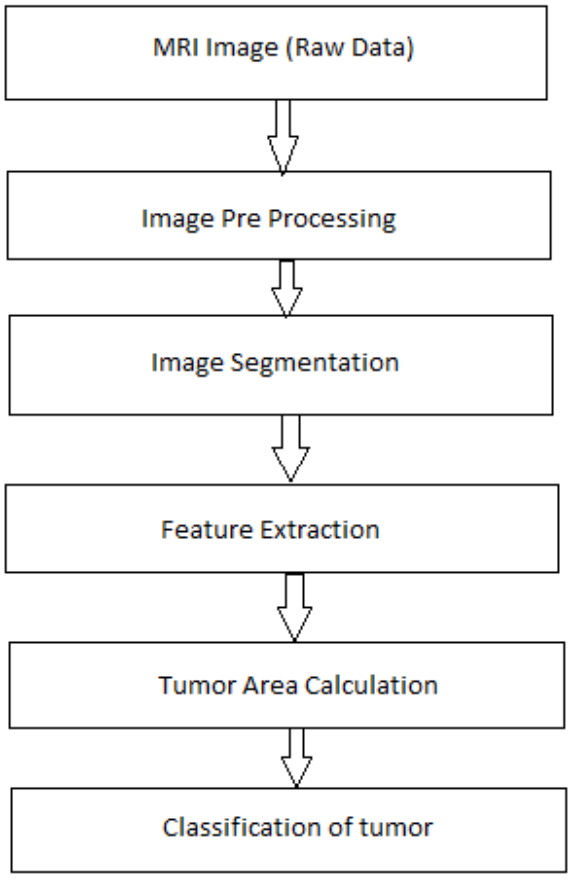


Fig.2 block diagram of proposed method to diagnose the benign tumor

Step-III: Image Enhancement: Image Enhancement is used to improve the visual appearance or better transform representation of an image with the help of Image Scaling, Color scale transformation and Contrast Enhancement.
Step-IV: Generation of Mask: for generation of mask Erosion and filling morphological operators are used to remove the pixels on boundaries and to "fills" a region of interest by interpolating the pixel values from the borders of the region.

B) IMAGE SEGMENTATION

Image segmentation is the process of partitioning a digital image into multiple segments to simplify change the representation of an image into something that is more meaningful and easier to analyze. There is lot of image segmentation technique but in proposed system fuzzy c-means algorithm is used for image segmentation.

C) FEATURE EXTRACTION

Most of the feature extraction methods based on intensity values because the result is more sensitive to noise arise from the image acquiring conditions.
Intensity based features

I. *Skewness:* Measure the degree of deviations from the centre point or mean value
II. Mean and standard deviation
III. Uniformity and Smoothness

Texture based features

I. *Angular second moment:* summation of squares of gray levels of the image is known as angular second moment or energy it is usually high when the intensity values are unequal. If p(i, j) is a input image then angular second moment f1 is

$$f_1 = \sum_i \sum_j \{p(i,j)\}^2$$

II. *Contrast:* Measure the local variation in gray level co occurrence matrix and it is low when the intensity values of the pixels are similar.

$$f_2 = \sum_{n=0}^{N_{g-1}} n^2 \{ \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j) \}$$

Where Ng is the number of gray levels in the original image

III. *Correlation:* The linear dependency of gray levels on the neighboring pixels is represented by correlation feature.

$$f_3 = \frac{\sum_i \sum_j p(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y}$$

Where μx, μy, σx, σy are the mean & S.D. of input image

IV. Variance : measure of how far the gray values are spread out in the input image

$$f_4 = \sum_i \sum_j (1-\mu)^2 p(i,j)$$

Where μ is the mean of whole image

V. CONCLUSION

This paper includes a brief overview of various image segmentation methodologies. On the basis of literature review there is no universal segmentation technique because the result of these segmentation techniques is affected due to lots of parameters. Thus there is no single method for image segmentation having higher order of accuracy and precision, so this field is always remains challenging in image processing. Due to uneven shape, size and properties of a MRI images the medical image segmentation facing lots of problems, so in this situation it is better to use unsupervised methods for image segmentation such as fuzzy C- means algorithm because of its simplicity and faster clustering. This work will be extended to development of new algorithms based on fuzzy C-means for classification and detection of benign tumor tissues in MRI image. Accuracy, precision and computational time are the main parameters and are to be considered for comparative study for fuzzy C- means is more efficient than exiting techniques for tumor diagnosis.

VI. FUTURE SCOPE

Diagnosing the benign tumor cells in early stage with better accuracy and precision in human being is a complicated task. Benign tumor cell detection using fuzzy c-means with reduced computational time is a new technique in medical imaging. Doctor's may easily diagnose the tumor cells on the basis of MRI images by applying the FCM instead of patient monitoring.

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