Brain Tumor Detection Using Image Processing

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ABSTRACT : *Medical image processing is the most demanding and emerging field now a days. MRI is an advanced medical technique providing information about the tissue present in the brain. Brain tumor is dangerous disease that affects the health and life of human being. The conventional method of detection and segmentation of brain tumor is done by human inspection. This process is so time consuming. So to avoid human intervention and save time, the application software of brain tumor detection and segmentation is develop. This research paper consists of Otsu method, k-means , fuzzy c means and morphological operations. All these techniques used in this paper shown great potential. Otsu method and k means are used for segmentation whereas morphological operations provide a systematic approaches to analyze the geometric characteristics of images and are widely used to many applications such as edge detection, noise suppression etc. This method successfully detect the presence of brain tumor with high accuracy. Morphological operations provide different features value used in detection of brain tumor. All these factors helps in extracting the useful information from MRI images. The combination of medical and information technology provides great achievement in both fields.*

Keywords - *MRI images, otsu's method, k-means, fuzzy c-means, morphology and classification.*

I. INTRODUCTION

Brain is the main and important part of the human body. So its protection is also important. Brain tumor is very dangerous disease. It is due to the growth of abnormal cells in the brain. Brain tumor can be divided into two parts - Primary stage tumor and secondary stage tumor. Primary stage tumor is also called **Benign**. It is not that much dangerous as compare to secondary stage tumor. Secondary stage tumor is called **Malignant**. Malignant stage is very dangerous and unrecoverable. From this stage it is not easy to recover back from the tumor. So to detect the tumor at its early stage can save human life. To detect the tumor one's need to go under CT scan or MRI. CT scan stands for Computed Tomography whereas MRI is Magnetic Resonance Imaging.

This paper focus on detection of brain tumor through image processing. Image processing techniques are used to convert an image into digital image . After digitalization, some operations are performed to enhance the quality of image and at last information is extracted related to the signs of the brain tumor. MRI is advanced medical imaging technique. MRI produces high quality of images of the body parts. In this paper MRI images are processed to detect the presence of tumor. Image processing helps in increasing the quality of image. It gives the enhanced image. It treated images as a two dimensional signals. It convert the image into 2D by adjusting its pixels. Then it work on that image. Image processing is a rapidly growing technologies. It is an active research area also. The purpose of image processing are visualization, image sharpening and restoration, Image retrieval, measurement of pattern, Image recognition. Image processing currently works in Remote sensing, Intelligent transportation system, Defense surveillance, biomedical imaging techniques etc. This paper is focused on detection of brain tumor with high accuracy by processing the MRI images. This research paper provides the promising result because it provides fully automated system for brain tumor detection using K-means, Fuzzy c-means, Otsu's method and classification. K-means is an effective segmentation method which aims to divide the image into a fixed number of clusters. Otsu's thresholding divides the image into two classes of regions namely foreground and background. Fuzzy c-means uses fuzzy logic by assigning membership values to each pixel. Thresholding works by defining a threshold and then testing various pixels of an image against the threshold.

II. RELATED WORK

Many sophisticated algorithms are proposed in past by many researchers to detect the presence of brain tumor and its severity using MR Images. Manoj K Kowar and Sourabh Yadav et al, 2012[12] , they found the new techniques for the detection of tumor in brain using segmentation, histogram and thresholding .

Rajesh C. Patil and Dr. A. S. Bhalchandra [5], they focused on Meyer's flooding Watershed algorithm for segmentation and also applied some morphological operations on MRI images to detect the exact location of the tumor. This method fails in detecting the boundary of the brain.

Vinay Parameshwarappa and Nandish S. et al, 2014 in his paper "Segmented morphological approach to detect tumor in brain images", they proposed an algorithm for image segmentation. M. Karuna and Ankita Joshi et al, 2013, in his paper "Automatic detection of Brain tumor and analysis using Matlab" they presents the algorithm incorporates segmentation through Nero Fuzzy Classifier. The system work on neural network. This test successfully work on few images only. The developed system is used only for tumor detection not for other abnormalities.

R. B. Dubey, M. Hanmandlu, ShantaramVasikarla et al, 2010, [1]compare the image segmentation techniques, they apply preprocessing techniques like; de-noising, image smoothing, image contrast enhancement and comparison of the level set methods and morphological marker controlled watershed approach and modified gradient magnitude region growing technique for MRI brain tumor segmentation. It is claimed that MGMRGT method gives better result in the form of accuracy.

R. Preetha and G. R. Suresh et al, 2014,[7] in his paper "Performance analysis of fuzzy C means algorithm in automated detection of brain tumor" they used fuzzy C means clustering for segmentation. FCM shows good performance result in segmenting the tumor tissue and give accuracy of tumor. The boundary of tissue can be seen clearly in their paper

Amer AlBadarneh, Hasan Najadat and Ali M. Alraziqi et al, 2012,[10] proposed the method for brain tumor classification of MRI images. The research work applied, based on Neural Network (NN) and k- Nearest Neighbor (k-NN) 100% accuracy is achieved using k-NN and 98.92% using NN for tumor classification.

The watershed method is combined with edge detection operation. The color brain MRI images can be obtained by this algorithm. In this the RGB image is converts into on HSV color image so that the image is separated in 3 regions which are known as *hue, saturation and intensity*. The canny edge detector is applied is applied to an output image for rebuilt process of edge occurs in this .at last combining the three images and the final resultant brain tumor segmented image is obtained. This algorithm is applied on 20 brain MRI images for excellent result [6]

III. IMAGE PROCESSING

Image processing is a method of converting an image into digital form, so that it become easy to study about that image. Image contains a lot of information like pixels, size, color, dimensions etc. To extract these information one need to go under the process of image processing. In image processing various operations are done on images to extract their information. In this paper image processing is combined with biomedical. Some techniques and algorithm are applied on medical images. In this paper MRI images are processed with the help of otsu's algorithm to obtain the threshold segmentation of the image. The otsu's method is discussed below.

A. OTSU'S Method For Image Segmentation

Otsu's method helps in the reduction of a gray level image to a binary image. The algorithm assumes that the image contains two classes of pixels following bi-modal histogram (foreground pixels and background pixels). It helps in diving the image into two categories i.e. back ground image and foreground image. It calculates the optimum threshold separating the two classes so that their combined spread is minimal, or their inter-class variance is $maximal$.

The formula for computing inter class variance & intra class variance is given in equation (1) and (2) respectively.

$$\partial_1^2(t) = \sum_1^t [i - u_i(t)]\ p(i)/q1_2 \quad \ldots..(1)$$

$$\partial_2^2(t) = \sum_{i=t+1}^{l} [i - u_2(t)]\ p(i)/q2_2 \quad \ldots(2)$$

Where l is the largest pixel value and t is the threshold

The formula calculate minimum variance ratio is given in equation (3)

$$\partial^2 w(t) = q1(t)\partial_1^2(t) + q2\partial_2^2(t) \quad \ldots..(3)$$

IV. PROBLEM IDENTIFICATION

A critical look at the available literature leads to the identification of following problems:-

A. Automated tumor detection and segmentation

The traditional process of detecting tumor was based on the doctors's experience. Earlier it was done manually by radiologists and clinical experts by MR images. The accuracy of tumor was not always correct. Sometimes doctor itself not able to find whether tumor is present or not. So it overcome these limitations, an automated tumor detection and segmentation framework come into scenario.

B. Severity of tumor

Tumor has mainly two stages. First is primary stage and second is secondary stage. Primary stage is recoverable. In this stage the cells are not grow so fast. If this stage is diagnosed at correct time then patient can recover back to normal. If this stage is not diagnosed then slowly it become the secondary stage in which cells are grown so fast. From this stage the chances of patient to back to the normal is less. So its important to diagnose the severity

of tumor because patient life depends on this.

C. Accurate prediction of tumor behavior in the individual patient

Although satisfactory in many respects, they do not allow accurate prediction of tumor behavior in the individual patient, even they don't guide therapeutic decision making as precisely as patients and physicians would hope and need. In the proposed work we have calculated entropy value , skewness, kurtosis , energy , contrast , mean , standard deviation of each MR image. All these parameters tells about the tumor behavior.

V. PROPOSED WORK

The proposed phase methodology for detecting brain tumor follows four steps. These are image preprocessing, segmentation, feature extraction and classification. In proposed work, main emphasis is on the segmentation of the MRI images. This segmentation is done by combining three approaches (otsu , k means and fuzzy c means). This is done so to clearly see the tumor region. This is the main step of the proposed work. The complete flow diagram of proposed work is given in fig 1.

A. Image pre processing

MRI scan images are taken as and these MRI images are stored in dataset with the size of 200*200 pixels size. These images are stored in JPEG, jpg or png format. The entries of a gray scale image are ranging from 0 to 255, where 0 represents black color and 255 represents pure white color. In this phase image quality has improved. The finer details in the image has also improved and noise is removed from the image. Most commonly used enhancement and noise reduction techniques are used for the best results. This improved and enhanced image will help in detecting edges and improving the quality of the image. Edge detection helps in finding the exact location of tumor. Following steps are done in the preprocessing stage:

1) The input MRI image, taken from dataset is converted into gray scale image of size 200*200 pixels size.
2) Image is processed to remove any noise present in the image
3) Then this high quality and noiseless image undergo some operation to detect the edges of the image.
4) The obtained image is then added to original image for further enhancement.

B. Segmentation:

Image segmentation is the process of dividing the image into small pieces. It divide the image into regions. Division is done on the basis of similar attributes. The goal of segmentation is to represent the image into more meaningful image that gets easier in analysis of tumor. It extracts important features of image. It is a challenging task in the field of medical imaging. In this research, main emphasis is on segmentation. This proposed work do segmentation with the help of three segmentation methods.

- Otsu segmentation method
- Segmentation using k means
- Fuzzy c means

Three methods are used for segmentation because they together give the better and clear segmented image. This is shown in given figure. Single method don't give the clear segmented image. So there is a need to combine these three methods. K-means divide the image into a fixed number of clusters. Otsu's thresholding divides the image into two classes of regions namely foreground and background.

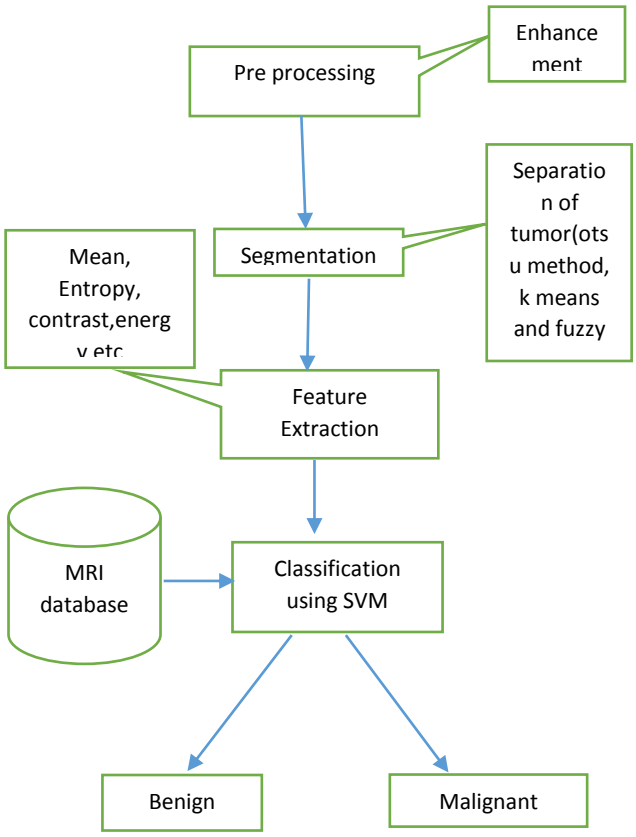


Fig 1:Block diagram of tumor detection

Fuzzy c-means uses fuzzy logic by assigning membership values to each pixel. Thresholding works

by defining a threshold and then testing various pixels of an image against the threshold.

1) Segmentation using k-means:

K-means clustering is an unsupervised clustering technique. It generates a non-hierarchical clusters. It generates global cluster. It is numerical, non -deterministic and iterative method. Steps of k-means clustering are given below. It then combine the similar objects and dissimilar objects into different group.

Steps of k-means

- Give number of cluster value.
- Chose K cluster center randomly.
- Calculate the center of cluster.
- Calculate the Euclidean distance between the centers of cluster to each pixel.
- If the distance is less then it will be added to the cluster.
- If the distance is more then it will move to next cluster.
- Again re estimate the cluster
- Repeat the step until center convergence.

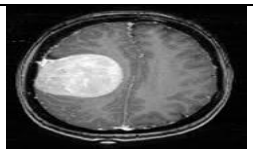
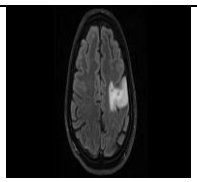
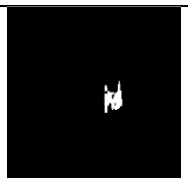
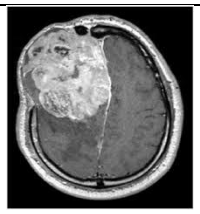
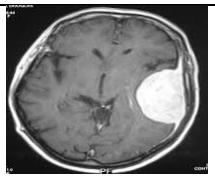
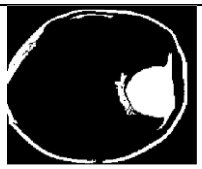
2) Segmentation using fuzzy c means:

Fuzzy c means is an unsupervised method. It works on membership value. It assign value to each pixels of cluster made by using k means clustering. The formula of fuzzy c means is given below. The sample four MRI images are taken as example in this paper. The segmented image of all these four images are given in table 1.

Fuzzy c means formula

- $Z_m = {}^{m}{}_{ij} |X_i - C_j|^2$
- K = number of cluster
- C = Total number of pixels
- m = fuzzy degree
- M_{ij} = degree of membership X_i in the cluster j
- C_j = Centre of cluster i
- $|X_i - C_j|^2$ = distance between C_j and pixel X_i

TABLE 1.
SEGMENTED IMAGES

Image ID	MRI image	Resultant Segmented image
I1		
I2		
I3		
I4		

C. Feature Extraction:

After converting the MRI image into segmented image in the above step. Now its time to extract the features from the segmented image. The purpose of feature extraction is to separate the tumor part from the image. Now only the tumor portion of the image is visible, shown as white color. This portion has the highest intensity than other regions of the image. The features like mean, standard deviation, entropy, skewness, kurtosis, energy, contrast, correlation and homogeneity are extracted from the segmented image. The definition of all these features are given below. These features are extracted to know the accuracy of the tumor. Example of four MRI images which are taken above is also elaborated by computing the values of these features.

- Mean (M) : The mean of an image is calculated by adding all the pixel values of an image divided by the total number of pixels in an image.
- Standard Deviation (SD) : it is the second central moment describing probability distribution of an observed population & can serve as a measure of inhomogeneity. The higher value indicates better intensity and high contrast of edges of an image.
- Entropy (E) : Entropy is calculated to characterize the randomness of the textural image. It is calculated by taking the log function.
- Skewness (S) : Skewness is a measure of symmetry or the lack of symmetry. The skewness of a random variable X is denoted as S.
- Kurtosis (K) : The shape of a random variable's probability distribution is described by the parameter called kurtosis.
- Energy (E) : Energy can be defined as the quantifiable amount of the extent of pixel pair repetitions. Energy is a parameter to measure the similarity of an image.
- Contrast (C) : It is a measure of intensity of a pixel and its neighbor over the image.
- Correlation (Cr) : correlation function describes the spatial dependencies between the pixels.
- Homogeneity : homogeneity is also called inverse difference moment(IDM). It is a measure of the local homogeneity of an image. It may have a single or a range of values so as to determine whether the image is textured or non textured.

D. Classification

The classification is the last step of detecting the tumor. It tells whether the patient have tumor or not. If the patient have tumor than what is the stage of tumor. There are two stages of tumor as already discussed in introduction part. Classification helps in classify the tumor as benign and malignant. It takes the MRI images from the dataset and features extracted from the above step as the input and then it classify the MRI image as benign and malignant as the output. The setup used in this paper is successfully able to detect the stages of the tumor.

VI. EXPERIMENT RESULTS

The experiment is done on the approx. 100 MRI images. These images are taken from the internet (biogps site). This site has a huge collection of biomedical images. All images of the dataset are tested on the tool "MATLAB". This tool is basically used for image processing. It has some inbuilt features that is beneficial for image processing. MATLAB stands for matrix laboratory. The experiment is done on each MRI image in the dataset. All give correct result. The accuracy is computed by the matrix given in section 6.1 of this paper. Accuracy computed is 91%. It also find the value of all the parameters used in the experiment.

To evaluate the performance of the system, the value of different parameters are calculated. The setup gives the correct result with high accuracy. It also calculated the value of each parameter used. As compare to different techniques used by other researchers, the proposed technique gives more accurate result. It also tell the stage of the tumor. The tested image and its result are shown in given figure.

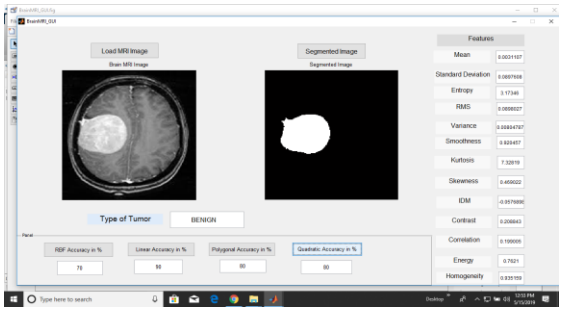


Fig3: Final output

TABLE 2.

EXTRACTED FEATURES

Image ID/ Features	**I1**	**I2**	**I3**	**I4**
Mean	0.003	0.005	0.03	0.009
Standard deviation	0.08	0.06	0.09	0.08
Entropy	3.17	1.51	3.5	3.6
Skewness	0.46	3.4	0.47	0.34
Kurtosis	7.32	8.35	6.52	5.81
Energy	0.76	0.81	0.73	0.75
Contrast	0.20	0.41	0.25	0.20
Correlation	0.199	0.2	0.74	0.11
Homogeneity	0.03	0.96	0.92	0.93

A. Accuracy Calculation

Matrix defining the terms TP,TN,FP and FN

EXPECTED OUTCOMES	**GROUND TRUTH** **POSITIVE** **NEGATIVE**	**ROW TOTAL**
POSITIVE	TP FP	TP+FP
NEGATIVE	FN TN	FN+TN
COLUMN TOTAL	TP+FN FP+TN	TP+FP+FN+TN

TP (Total positive) = total no of abnormal cases correctly classified

TN (Total negative) = total no of normal cases correctly classified

FP (False positive) = total no wrongly detected abnormal cases

FN (False negative) = total no of wrongly detected normal cases

These parameters are computed using the total no of samples examined in detecting the tumor.

Accuracy= (TP+TN/TP+TN+FP+FN)*100

No of test images = 150(normal= 70, abnormal= 30)

Where TP= 24, TN= 67, FP= 6, FN= 3

Therefore accuracy computed = (24+67/24+67+6+3)*100

= 91%

VII. CONCLUSION

Image processing techniques are applied to the MRI images. These techniques are successfully extracted the useful information from MRI images. Then the value of these features are computed from each MRI image. After computed the value, accuracy is find with the help of these features. The proposed method use otsu, K means and fuzzy c means for segmentation and morphology for feature extraction. The proposed work is showing efficient result and it also tells the stage of the tumor detected.

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