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FUZZY DIAGNOSIS OF BIOMEDICAL IMAGES

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ABSTRACT - Brain tumor is unrestrained growth of cells in Brain. These cells prove to be lethal when transformed into tumor. The objective of this paper is to classify and detect the tumor from Magnetic Resonant Images (MRI) of Brain. Also, the paper targets at calculating the area of the tumor. Here, first the segmentation of Brain MR Images is done by RGB Thresholding technique followed by feature extraction and then classifying the Tumor by using Fuzzy Classifier.

Keywords
Computer Tomography (CT) scan, Magnetic Resonant Imaging (MRI), Red Green Blue Thresholding (RGB Thresholding), Fuzzy Classifier.

I. INTRODUCTION

Brain tumors are the most intricate cancer diseases renowned universally. Brain tumors can be of two types: Primary brain tumors and Secondary brain tumors. A primary brain tumor originates from brain and remains confined to brain only whereas Secondary brain tumors are caused due to tumors from other body organs. The common type of brain tumor found in children is glioblastoma which is caused due to glial cells of brain. Astrocytoma is common type of brain tumor in adults. Astrocytoma is due to astral shaped (Star) cells in the human brain.

There are various treatments available for treating these oncogenic cells which comprises chemotherapy, surgery and radiotherapy. Early discovery of tumor type is an important factor which can be done by advanced medical imaging techniques that include MRI and CT scan followed by Biopsy. Biopsy is still not appropriate for many patients with brain cancer and hence can be life threatening. Manual classification of brain tumor is thought-provoking duty. Furthermore, it can lead to countless errors such as inter-observer unpredictability and human error. Automatic classification technique is therefore desirable.

The main objective of this paper is to detect the Tumor in its early stage and classify it. The volume and area of the tumor can also be calculated which will prove to be beneficial in the field of medical science.
The segmentation technique used here is RGB Thresholding. The feature extraction of Image is done followed by classification of Image by Fuzzy classifier. The output of Fuzzy classifier is then used for calculating area of tumor. [1]

II. LITERATURE SURVEY

Segmentation of Image plays a crucial role in detection and classification of tumor. There are several methods through which we can categorize tumor. Till date, many studies have been offered by scholars for MR brain images separation techniques. Few methods are elaborated in this section.

2.1. Clustering and Spatial Segmentation:

Image segmentation and image clustering are dissimilar. In image segmentation, the grouping of the image is carried out in spatial domain. In image clustering, grouping is performed in the measurement space. Overlapping regions can be the result of clustering whereas it is not possible to produce overlapping regions from segmentation. Clustering and spatial segmentation can be combined to form spatial clustering, which combines histogram techniques with spatial linkage techniques for better results. Spatial Clustering is a process of sorting of objects into diverse groups, segregating of data sets into clusters. Density function is set and then following cluster center is designated as greatest potential value. This procedure is reiterated to generate clusters until maximum potential value in the current iteration.
Drawbacks- This is sluggish process. Time required to move from one cluster to another cluster is more. [2]

2.2 Split and Merge method:

The split method begins with the entire image, and repeatedly splits each segment into quarters if the homogeneity criterion is not gratified. The merge method joins adjacent segments of the same object. If a region is not segmented fully, correction can be made by adding boundaries or splitting certain regions that

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contain parts of different objects. If a region is segmented more than the necessity, corrections can be made by eliminating false margins and merging neighboring regions if they be appropriate to the same object or feature.

Drawbacks- This is not perfect technique and gives blunders at times. [3]

2.3. Region Growing:

Region growing is a technique in which a specific region of image is extracted on predefined norms. The main goal of segmentation is to partition an image into regions. Region growing is a technique in which a particular region of image is extracted on predefined criteria. Region based segmentation is a technique for determining the region directly. The basic formulation is:

$$\bigcup_{i=1}^{n} R_i = R$$

The first step in region growing is to select a set of seed points. The initial region begins as the exact location of these seeds. The regions are then grown from these seed points to adjacent points depending on a region membership criterion. The criterion could be, for example, pixel intensity, gray scale texture, or color.

Drawbacks- Region growing is not often used alone because it is not appropriate to segment brain erections accurately. However, this method mainly relies on condition that the neighboring pixels within a region must have same intensities which are not always conceivable. It is computationally affluent. It is a native method with no universal view of the problem. It is Sensitive to noise. Unless the image has had a threshold function applied to it, a continuous path of points related to color may exist which unites any two points in the image.[4]

2.4. Thresholding:

Thresholding procedure endeavours to decide an intensity value which separates the preferred classes. It is used as initial step in sequence of image processing. From a grayscale image, thresholding can be used to create binary images. Thresholding converts multilevel image into binary image. Integrated thresholding based tumor detection uses watershed and histogram analysis.

Drawbacks- No assurances of object coherency: may have holes, inessential pixels, etc. High time consuming output [6]

2.5. RGB Thresholding:

In this technique, the image is alienated into three planes. They are Red, Green and Blue planes. The Blueness, Redness or Greenness of the planes are taken as reference and subtracted from the remaining two planes. In this paper, blueness is considered as reference. Thus, the subtracted image gives us a particular threshold and segmented tumor image is obtained.

2.6. Neural based Networks:

Neural network based segmentation methods use artificial neural network computational models consisting of processing elements (called neurons) and weighed connections between them. MLP, HNM, SOM etc methods are used in these segmentation process.

The image processing chain contains different tasks: preprocessing, data reduction, segmentation, object recognition and image understanding. The neural-network applications we reviewed had various designs ranging from relatively straightforward to highly complex, modular approaches.

2.7. Hybrid methods:

It is mixture of all methods of machine algorithms.

The researches till date by various other researchers have been listed in the table.

Table 1: Literature Survey in Tabular form

Title and Author	**Work Done**
SURVEY: Image Segmentation Techniques [2]	Clustering and spatial segmentation can be combined to form spatial clustering, which combine histogram techniques with spatial linkage techniques for better results.
Machine Vision [3]	The split method splits each segment into quarters. The merge method joins adjacent segments of the same object.
Image Processing Analysis, and machine vision [4]	Region growing connects the neighbouring points to make a large region.
A short overview of MRI artifacts [5]	Techniques of Image segmentation
Adaptive Image Segmentation based on fast thresholding & Image merging [6]	A thresholding procedure attempts to determine an intensity value which separates the desired classes.
Skull Striping based on Region growing for Magnetic	Region growing is a technique in which a particular region of image is extracted on predefined criteria.

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Resonance Brain Images [7]	
Image processing with neural Networks-a review [8]	Neural network based segmentation methods use artificial neural network computational models consisting of processing elements (called neurons) and weighed connections between them.
An Overview of Image & Video Segmentation[9]	Fuzzy logic is a set of mathematical principles for knowledge representation.
Foundations of Neural networks, Fuzzy Systems and knowledge Engineering [10]	Hybrid system is a mixture of different methods of machine learning algorithms.

After comparing all these methods, it was concluded that RGB Thresholding is the best method of all which not only detects the tumor but also finds its area and thickness with ease and simplicity.

III. METHODOLOGY

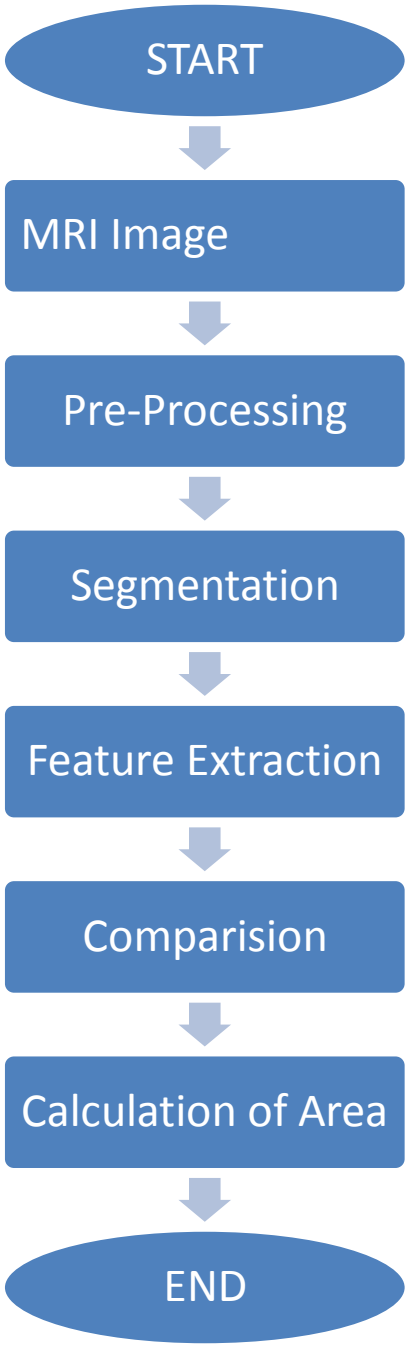

Fig 1: Flowchart of the Project

3.1. MRI Image:

Magnetic Resonant Images are taken as input and processing is done. MRI of brain is generally preferred over Computer Tomography (CT) Scan as it does not encompass any ionization radiation making MRI reasonably safer for children and other patients. Additionally, MRI has greater obtainability of soft tissue contrast and it portrays anatomy in superior details. MRI Images are more sensitive and specific for abnormalities brain. Due to all the benefits of MRI over CT Scan, these images are preferred mostly.

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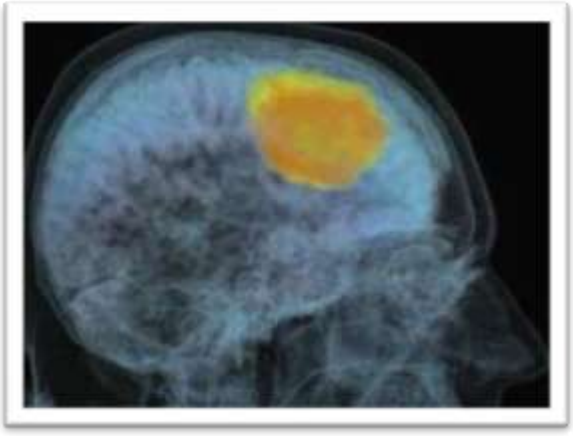

Fig 3.1: Original MRI Image

3.2. Pre-Processing:
This is the stage in which the input image of brain is enriched to make every possible small detail evident. It also helps to reduce extraneous material present in image such as noise. The contrast level of the image can also be enhanced in order to intensify the worth of image.
The Pre-Processing of image involves two steps:

3.2.1. Histogram Equalization:
Histogram Equalization is a graph representing grey level frequencies of image. The Histogram Equalization method spreads out intensity values over the complete array of image thus, augmenting the contrast of image. [14]

Fig 3.2.2: Histogram of Image

3.2.2. Morphological Operations:
These operations are used as preprocessing outfits to refine the provinces and seal the fissures of the image obtained. There are in all four basic morphological operations namely Erosion, Dilation, Opening and Closing. In this proposed paper, only Dilation and Erosion are used. In Erosion, every pixel touching the background is converted into background making image smaller. Erosion can be mathematically expressed as:
$(A\Theta B)(x)=\{x\in X, x=a+b: a \in A\ b\in B\}$ [14]

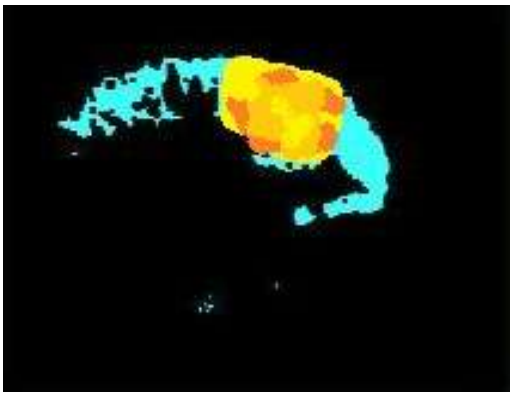

Fig 3.2.3: Image of Erosion

In Dilation, the pixel of background touching the object is converted into object thus making the object bigger. Mathematically, Dilation can be described as:
$(A\Theta B)(x)=\{x\in X, x=a+b: a \in A\ b\in B\}$ [14]

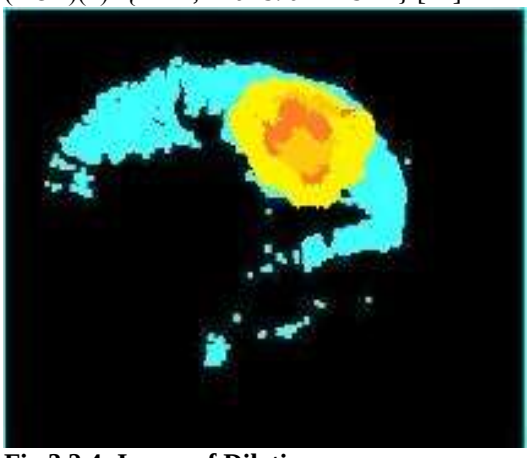

Fig 3.2.4: Image of Dilation

3.3. Segmentation:
Various segmentation techniques exist. Some of them are region growing, region splitting, region merging, split & merge, K-Means clustering, Ant Colony Optimization, Fuzzy C-Means, etc. Out of all these methods, RGB threshold is used for segmentation in this paper. In this technique the image is split into three planes that is red, green and blue; one of the colour is taken as reference and a threshold is set. In this paper the blueness of the image is considered. The entire image which is divided into three planes is subtracted from the blueness of the one plane. Thus, we obtain a segmented image.

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Fig 3.3: Segmented Image

3.4. Feature Extraction:

In feature extraction, the segmented center vectors are grouped together to form a cluster. The image is then segmented to make the bright pixels brighter and dark pixels darker. The purpose of feature extraction is to reduce the original data set by measuring certain properties that distinguishes one input pattern from another input pattern. The features that can be calculated are given below with their mathematical formulae. [15]

- Contrast=$\sum_{i,j}|i-j|^2 p(i,j)$
- ASM=$\sum_{i,j} p^2(i,j)$
- HOM=$\sum_{i,j} \frac{p(i,j)}{1+|i-j|}$
- IDM=$\sum_i \sum_j \frac{1}{1+(i-j)^2} p(i,j)$:
- E=$\sum_{i,j} p(i,j)^2$
- EN=$\sum_{b=0}^{L-1} p(i,j) \log_2\{p(i,j)\}$
- VAR=$\sum_i \sum_j p(i,j)p(i,j) - \mu^2$

After this step, the output image is further given to fuzzy classifier.

3.4.1. Fuzzy Classifier:

The Fuzzy if/then rules framed for MR brain tumour classification are as follows:

- If A=contrast=0, B=Correlation=0, C=Energy=0, D=Entropy=0, E=IDM=0, F=variance=0 then output=0.
- If A=contrast=255, B=Correlation=255, C=Energy=255, D=Entropy=255, E=IDM=255, F=variance=255 then output=255.

Output as 255 indicates that a tumor is present. This image is further given to calculate area whereas output 0 indicates absence of tumor.

3.5. Comparison:

The input image is then compared with the image from the data base to detect and classify the type of tumor.

3.6. Area Calculation:

This is the last part of the paper in which area calculation is done. The following steps must be followed for area calculation:

Step 1] Consider a segmented Image. Convert the RGB image into grayscale image.
Step 2] Calculate the number of rows and columns. Let Rows=R and Columns =C.
Step 3] Initialize a variable a
Step 4] for i=1:1:R
for j=1:C
if a(i,j)==255
do
a=a+0
else
a=a+1
end
Display the Output [15]

IV. RESULT

Take an input image and calculate the result. The images below show the result of cancerous image.

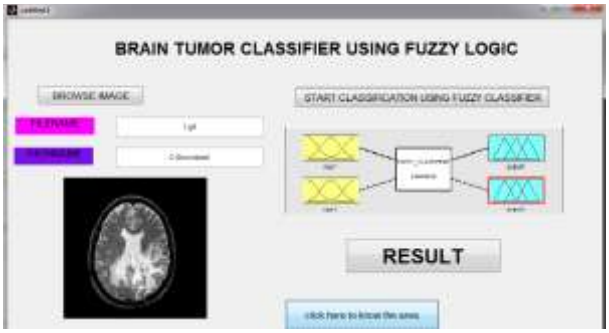

Fig 4.1: Take Input

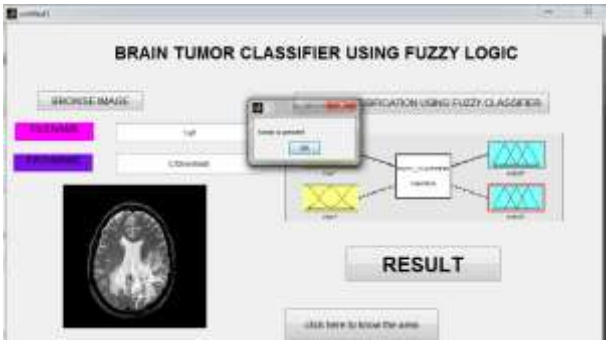

Fig 4.2: Result obtained as tumorous brain

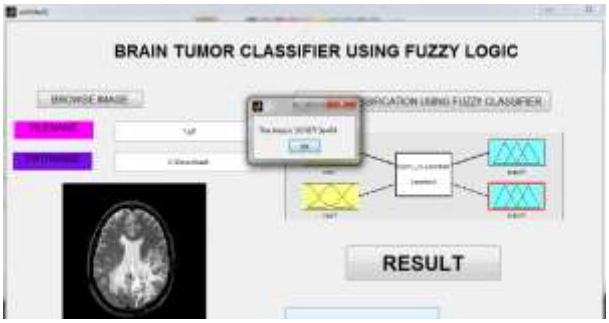

Fig 4.3: Area of Tumor

V. CONCLUSION

This paper includes classification of Brain MR Image using Fuzzy classifier along with area calculation which helps to reduce observational errors caused by Humans thus increasing level of accuracy.

VI. FUTURE SCOPE

The ANFIS architecture can be used to achieve high classification accuracy and measure thickness of the tumor. More advanced hybrid ANFIS Classifiers can be developed to provide 100% accuracy in detection and classification.

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