Implementation of Brain Tumor Detection using Morphological and Fuzzy Methodology: Comparative Analysis

Siddhi M. Thakur[1], Akshita J. Mali[2], Malhar R Joshi[3], Anil Hingmire[4]
[1, 2] Department of Computer Engineering
[1, 2] VCET.

Abstract- *Brain tumor is not a restricted growth of tissues in human brain. This tumor, when turns in to cancer become life threatening. Medical imaging, is used to find the location of tumor and its category. For detecting tumor in magnetic resonance image, segmentation of MRI plays an vital role. This paper includes survey on two different segmentation techniques applied to MR Images for detecting the tumor. It includes two different methods for the same one is using Fuzzy C-Means clustering algorithm and other is using morphological operations that incorporates some segmentation and noise filtering functions which are the basic concepts of image processing an algorithm to find area of tumor. The MATLAB software is used for the extraction of tumor from MRI images.*

Keywords- Magnetic Resonance Imaging (MRI), Image segmentation, Fuzzy C-Means, Morphology.

I. INTRODUCTION

A brain tumour arises due to an abnormal growth of cells that has grown in an uncontrolled manner. The tumours are graded according to how belligerent they are, with lower-grade tumours often being benign and higher-grade tumours being malignant. When normal cells get damaged or grow old, they either get repaired or undergo organized cell death. However, mutations can occur in the cellular DNA that dirange these regulatory processes and cells that would normally die, go on to survive and multiply. These cells proliferate and give rise to more cells that all contain the anomalous DNA. Eventually, these collecting cells form a mass called a growth or tumour. All different types of brain tumors may produce indications that differ depending on which part of the brain is involved. These symptoms may be head-aches, vision problems, vomiting, and few mental changes. The headache is classically worse and goes away with vomiting. there might be difficulties while walking, speaking and sensing things. The severe effects also include unconsciousness. MRI is an medical imaging technique that produces high deginition images of the various parts of human body. MRI is often used when it comes to brain tumors, ankle, and foot. Using these high-resolution images, we can analyse detailed information to supervise human brain development and find anomalies. There are several methods used for segmenting the MRI's, which are fuzzy methods, soft computing based techniques, neural networks, variation segmentation, shape methods.

Noise removal techniques and enhancement of images in image analysis is performed by a vital step known as Pre-Processing of MRI. The algorithm has been tried on a number of patients.

II. RELATED WORK

A. Description of Tumor.

The synonym for the word neoplasm is Tumour. The abnormal growth of cells leads to tumour. Tumor is something totally different from cancer.

Types of Tumor: There are three common types of tumor:

1) Benign Tumor: The tumour that does not expand in an abrupt way is the one that we call as the Benign Tumour; it doesn't affect its neighboring healthy tissues and also does not expand to non-adjacent tissues. The common example of benign tumors are Moles.[1]
2) Pre-Malignant Tumor: Premalignant Tumor is a pre-cancerous stage, which is considered as a disease. It may lead to cancer it not treated properly.[1]
3) Malignant Tumor: Malignant is the type of tumor, that grows worse with the period of time and in the end results in the death of a patient. Malignant is fundamentally a medical term that describes a grave progressing disease. [1]

B. What is segmentation

Segmentation is extremely important part in image processing. Partitioning of an entire image into several parts which is something more meaningful and easier for further process. These several parts that are again joined will cover the entire image. Segmentation also depend on various features that are contained in the image. It may be either color or textured. Before removing noise of an image, it is segmented to recover the original image. The main aim of segmentation is to reduce the information for easy analysis. Segmentation is also useful in Image Analysis and Image Compression.[2]

Segmentation can be classified as :

- Region Based
- Threshold
- Model Based
- Edge Based
- Feature Based Clustering.

C. Ostu's Method

This method is contemplated as a alternative of iterative thresholding method. It is a clustering method based upon maximizing the difference between class variance. It is based upon defining well defined threshold classes as clusters with clusters lying tightly adjacent to each other and there is a minimal overlap . The within class variance can be defined as summation of variance of each class as : sum of pixel values in background = sum of pixel values in foreground variance of pixels in background variance of pixels in foreground. From the proved methods ,the between class variance is given as: where μB and μO are cluster means. To find an optimal threshold value is to maximize the between class variance and this is relatively an easier calculation than calculation within class variance which would be minimized by maximizing between class variance. This method also works by assuming an image with a bimodal histogram[3]

D. Clustering

Implementation of Clustering Algorithms This system is implemented using four Clustering algorithms. They are,

- K-means Clustering Segmentation
- Clustering using Self Organizing Maps
- Hierarchical Clustering
- Fuzzy C-Means Clustering[4]

III. METHODOLOGY

Already there is a lot of work which has been done in the area of brain tumor detection. For the detection of tumour CT or MRI are uses. In proposed methodology MRI images are used. The most important role in detecting the brain tumour is played by segmentation Its success is based on how well the histogram of an image can be partitioned. Morphological operations and Fuzzy method are the two methods used for the detection of brain tumour.

A. Morphological Methodology

i. Filtering

Median Filtering for Noise Removal

Median filter is a non-linear filtering technique used for noise removal. Median filtering is used on the converted gray scale image to remove the salt and pepper noise. The value of the center pixel is replaced with the median of the intensity values in the proximity of that pixel. In the presence of impulse noise median filters are extremely effective. The Impulse noise is also known as salt and pepper noise because of its appearance as black and white dots covered on image. In the MRI images the salt and pepper noise is removed using the median filter.

i. Gray-scaling of Image

Grayscale Imaging

MRI images are images which can be obtained on computer when a MRI machine is used to scan a patient. A MRI image of any part of the body which is under test can be acquired or desired. Normally when we see MRI on computer they looks like white and black images. Gray scale images is sometimes called as 'black and white', but technically it is wrongly named. True white and black, which is also called as halftone, the only possible shades are pure white and pure black. The sceptre of gray shading in a halftone image is obtained by exhibiting the image as a grid of black dots on a white background , with the sizes of the individual dots determining the approx lightness of the gray in their neighbourhood. The halftone technique is normally used for printing photographs in newspapers and as MRI image is taken on computer. In the case of transmitted light, the brightness levels of the red, green and blue components are each represented as a number from, binary 00000000 to 11111111 or decimal 0 to 255. For every pixel in a red-green-blue (RGB) grayscale image, R = G = B. The lightness of the gray is directly proportional to the number representing the brightness levels of the primary colors. [6]

ii. Thresholding

Thresholding is the process of converting a gray scale image by using an optimum threshold value T to a bi-level image. It is a process of partitioning an image into object pixels and background pixels. An individual pixel is made an object pixel if the pixel value is greater than a certain threshold value and a background pixel otherwise. There are two types of thresholding algorithms:

I. global thresholding method.
II. local or adaptive thresholding method.

Global thresholding methods uses a single global value of threshold to partition an image into distinct regions where as a local method uses different local value of threshold for different areas.[6]

Iterative Thresholding

This method is based on assuming an initial value of threshold T . The best way for selecting a threshold value according to this algorithm follows these steps:

1. An initial estimate T has to be taken which can be presumed to be the average of maximum and minimum intensity value(though this is not fixed ,any value can be chosen as initial T).
2. Using this value T an image is divided into two pixels regions,T1 (with all pixel values<T)and T2(with all pixel values>T).
3. Compute the average intensity values m1 and m2 of regions T1 and T2 respectively.
4. Compute a new value of T as T=(m1+m2)/2
5. Repeat the above steps from 2 to 4 till difference between two successive values of T is minimal

Iterative method is best suited for an image that has a bimodal histogram. Its success is dependent on how well the histogram of an image can be partitioned

iii. Segmentation

Watershed Segmentation

It is one of the best methods to group pixels of an image on the basis of their intensities. Pixels are grouped together depending on their intensities. It is a good segmentation technique for dividing an image to separate a tumour from the image.

iv. Morphological Operations

Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, it creates an output image of the same size. Value of each pixel is compared with pixel in input image of its neighbor. By selecting the size and shape of the neighborhood, you can use a morphological operation that is sensitive to particular shapes in the input image.

Morphological operators are applied after the watershed segmentation to detect the tumor.[6] Some of the commands used in morphing are given below:

Strel: It is a morphological structuring element;

Imerode (): bright areas get thinner and dark areas gets bigger

Imdilate (): Maximizing operation, which causes bright regions within an image to enhanced.

Results of morphological operations

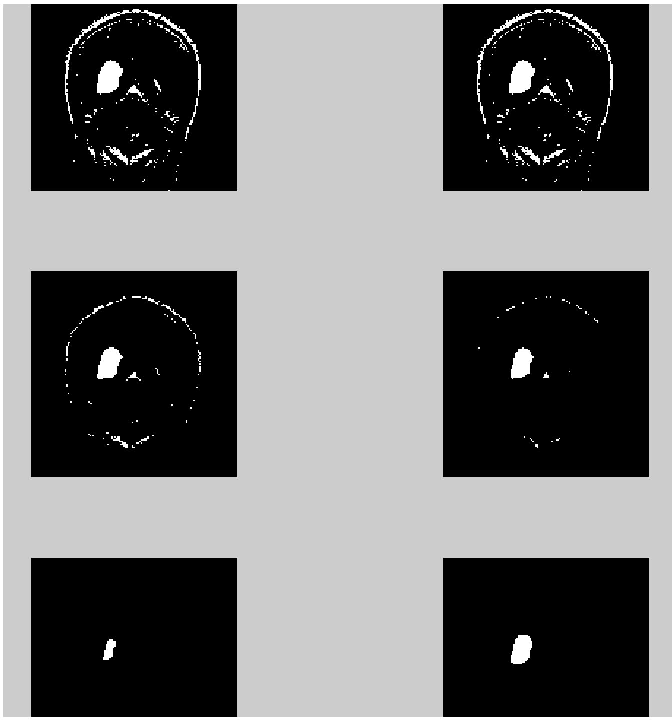


Figure 1. Results of morphological operations

B. Fuzzy Image Processing

The world is fuzzy, and so are images, projections of the real world onto the image sensor. Fuzziness quantifies indefinite and ambiguity, as opposed to crisp memberships. The types of uncertainty in images are manifold, ranging over the entire chain of processing levels, from pixel based grayness ambiguity over fuzziness in geometrical description up to uncertain knowledge in the highest processing level.

Fuzzy image processing is an attempt to translate this ability of human reasoning into computer vision problems as it provides an intuitive tool for inference from imperfect data. Fuzzy image processing is special in terms of its relation to other computer vision techniques. It is not a solution for a special task, but rather describes a new class of image processing techniques. It provides a new methodology, classical logic, a component of any computer vision tool. A new type of image understanding and treatment has to be developed. Fuzzy image processing can be a single image processing routine or complement parts of a complex image processing chain.[5]

Fuzzy Techniques

K-nearest neighbours

- Training: Identify (label) two sets of voxels X1 in object region and X2 in background
- Labeling: For each voxel v in input scenes . . .
- Find its location P in feature space
- Find k voxels closest to P from sets X1 and X2
- If a majority of those are from X1, then label v as object, otherwise as background
- Fuzzification: If m of the k nearest neighbor of v belongs to object, then assign μ(v) = mk to v as membership[7].

Fuzzy c-means clustering

- A partition of the observed set is represented by a c × n matrix U = [uik], where uik corresponds to the membership value of the kth element (of n), to the i th cluster (of c clusters).
- Each element may belong to more than one cluster but its “overall” membership equals one.
- The objective function includes a parameter m controlling the degree of fuzziness
- Computationally expensive
- Highly dependent on the initial choice of U
- If data-specific experimental values are not available, m = 2 is the usual choice
- Extensions exist that simultaneously estimate the intensity in homogeneity bias field while producing the fuzzy partitioning

i. Implemented method

Fuzzy C-Means (FCM) clustering

A partition of the observed set is represented by a c × n matrix U = [uik], where uik corresponds to the membership value of the k th element (of n), to the i th cluster (of c clusters). Each element may belong to more than one cluster but its “overall” membership equals one. • The objective function includes a parameter m controlling the degree of fuzziness.

The objective function is[8]

$$J = \sum_{j=1}^{c} \sum_{i=1}^{n} (u_{ij})^m \left\| x_i^{(j)} - c_j \right\|^2$$

The FCM algorithm is iterative and can be stated as follow:

1) 1.Consider a set of n data points to be clustered, xi
2) 2 Assume number of clusters (classes) c, is known.2 ≤ c < n.
3) 3 Choose an appropriate level of cluster fuzziness, m ∈ R>1.
4) 4 Initialize the (n × c) sized membership matrix U to random values such that uij ∈ [0, 1] and $\sum_{j=1}^{c} u_{ij} = 1$.
5) 5Calculate the cluster centers cj using ,

$$\mathbf{c}_j = \frac{\sum_{i=1}^{n} (u_{ij})^m \mathbf{x}_i}{\sum_{i=1}^{n} (u_{ij})^m},$$

for j = 1 . . . c.

6) Calculate the distance measures

$d_{ij} = \left\| \mathbf{x}_i^{(j)} - \mathbf{c}_j \right\|$, for all clusters j = 1 . . . c and data points i = 1 . . . n.

7) Update the fuzzy membership matrix U according to dij . If $d_{ij} > 0$ then $u_{ij} = \left[\sum_{k=1}^{c} \left(\frac{d_{ij}}{d_{ik}} \right)^{\frac{2}{m-1}} \right]^{-1}$. If dij = 0 then the data point xj coincides with the cluster center cj , and so full membership can be set uij = 1.

8) Repeat from (5) until the change in U is less than a given tolerance.[8]

Result of fuzzy methodology

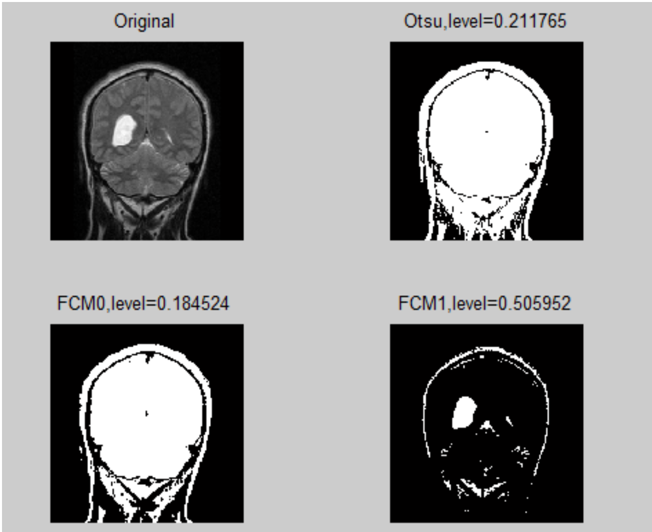


Figure 2. Result of fuzzy methodology

C. Area Calculation

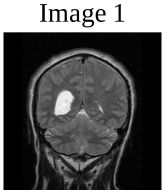
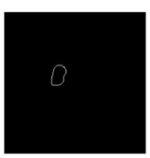
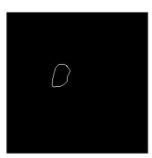
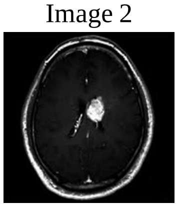
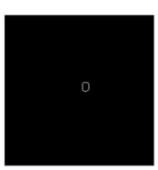
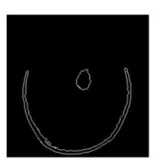
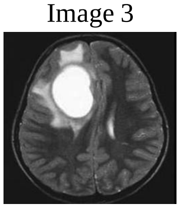
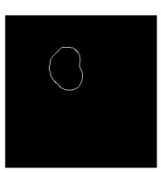
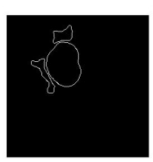
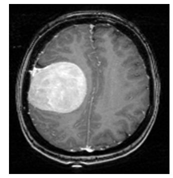
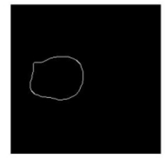
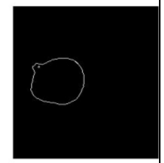
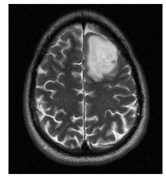
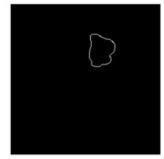
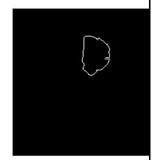
After the segmentation of tumor the area is calculated depending on the pixels brightness that is located. It estimates the area of n binary image.

The function used is

area = bwarea(img);

IV. EXPERIMENTATION AND COMPARISON OF PERFORMANCE

Table 1.

Area / Image	Area of Tumour using Morphological Operations	Area of Tumour using Fuzzy Methodology
Image 1 		
Image 2 		
Image 3 		
Image 4 		
Image 5 		

V. FUTURE SCOPE

In future this programme can be done more advanced so that tumor can be classified according to its type. Also tumor growth can be determined by plotting graph which can be obtained by studying sequential images of tumor affected patient.

VI. CONCLUSION

Extraction of tumor using brain MRI is a main problem for doctors and practitioners to get valuable results. Previously proposed systems have certain problems that require crucial investigation. Under the project of automatic brain tumor segmentation we studied two methods of segmentation. Using morphological operations for extraction of brain tumor gave better results than watershed segmentation. In future this program can be done more advanced so that tumor can be classified according to its type. Also tumor growth can be analysed by plotting graph which can be obtained by studying sequential images of tumor affected patient. Extraction of the features of the tumor like size, shape, volume is also a possible work that can be done further.

REFERENCES

[1] Anam Mustaqeem, Ali Javed, Tehseen Fatima, " An efficient brain tumor detection algorithm using watershed & thresholding based segmentation ", I.J. Image, Graphics and Signal Processing, 2012, 10, 34-39 Published Online September 2012 in MECS (http://www.mecs-press.org/) DOI: 10.5815/ijigsp.2012.10.05

[2] R. Yogamangalam, B. Karthikeyan,"Segmentation Technique Comparision in Image Processing", R.Yogamangalam et al. / International Journal of Engineering and Technology (IJET)

[3] Raman Maini, PhD.Professor, Sheenam Bansal," A Comparative Analysis of Iterative and Ostu's Thresholding Techniques", International Journal of Computer Applications (0975 – 8887) Volume 66– No.12, March 2013

[4] P. Tamije Selvy, V. Palanisamy,"Performance Analysis of Clustering Algorithms in Brain Tumor Detection of MR Images", European Journal of Scientific Research ISSN 1450-216X Vol.62 No.3 (2011), pp. 321-330 © EuroJournals Publishing, Inc. 2011 http://www.eurojournals.com/ejsr.htm

[5] Vipin Y. Borole , Sunil S. Nimbhore , Dr. Seema S. Kawthekar "Image Processing Techniques for Brain Tumor Detection: A Review",International Journal of Computer Science Trends and Technology IJCST) Volume 5 Issue 1, Jan Feb 2017

[6] Rajesh C. Patil, Dr. A. S. Bhalchandra "Brain Tumour Extraction from MRI Images Using MATLAB",International Journal of Electronics,Communication & Soft Computing Science and Engineering ISSN:2277-9477,Volume2, Issue1

[7] J.selvakumar, A.Lakshmi, T.Arivoli, "Brain Tumor Segmentation and Its Area Calculation in Brain MR Images using K-Mean Clustering and Fuzzy C-Mean Algorithm", IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM - 2012) March 30, 31, 2012

[8] L´aszl´o G. Ny´ul "Fuzzy Techniques for Image Segmentation"