Automated Brain Tumor Segmentation Using Region Growing Algorithm by Extracting Feature

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ABSTRACT

In this paper, we propose a methodology for fully automated Brain Tumor segmentation from Magnetic Resonance Images. Contrast Normalization is performed in input image. Algorithm has been designed to extract the feature points. Feature points relating to Tumor are then identified and extracted using morphological operation but before go through that use wavelate transform and then thresholding then use feature point as seeds for further region growing. Feature points are obtained by fusion of wavelet methods and image edge map and threshoding. Superimposed used between the input image and feature point . Our method gives a sparse representation of the information (region of interest) in the medical image and thereby vastly improves upon the computational speed for tumor segmentation results.

Keywords:- Brain Tumor, Feature point, wavelet transform, Thresholding, morphological operation

1. INTRODUCTION

Brain tumor, which is one of the most common brain diseases, has affected and devastated many lives. According to International Agency for Research on Cancer (IARC) approximately, more than 126000 people are diagnosed for brain tumor per year around the world, with more than 97000 mortality rate . Despite consistent efforts to overcome the problems of brain tumors, statistics still shows low survival rate of brain tumor patients. To combat this, recently, researchers are using multi-disciplinary approach involving knowledge in medicine, mathematics and computer science to better understand the disease and find more effective treatment methods. Magnetic resonance (MR) imaging and computer tomography (CT) scanning of the brain are the two most common tests undertaken to confirm the presence of brain tumor and to identify its location for selected specialist treatment options. Currently, there are different treatment options available for brain tumor. These options include surgery, radiation therapy, and chemotherapy. The choice for the treatment options depends on the size, type, and grade of the tumor. It also dependents on whether or not the tumor is putting pressure on vital parts of the brain. Whether the tumor has spread to other parts of the central nervous system (CNS) or body, and possible side effects on the patient concerning treatment preferences and overall health are important considerations when deciding the treatment options. Tumor segmentation from MRI data is an important but time-consuming and difficult task often performed manually by medical experts. Radiologists and other medical experts spend a substantial amount of time segmenting medical images. However, accurately labeling brain tumors is a very time-consuming task, and considerable variation is observed between doctors. Subsequently, over the last decade, a large amount of research has been focused on fully automatic methods for detecting and segmenting brain tumors from MRI scans .Generally, the automatic segmentation problem is very challenging and is yet to be satisfactorily solved. The aim of this detection approach is to locate and segment the tumor automatically. It takes into account the statistical features of the brain structure to represent it by significant feature points. Also, the time spent to segment the tumor is vastly reduced due to the sparse representation of the medical image by optimal number of feature points. Most of the early methods presented for tumor detection and segmentation may be broadly divided into three categories: region-based, edge-based and fusion of region and edge-based methods. Well known and widely used segmentation techniques are k-means clustering algorithm, Fuzzy c-means algorithm, Gaussian mixture model using Expectation Maximization (EM) algorithm, statistical classification using Gaussian Hidden Markov Random Field Model (GHMRF) and supervised method based on neural network classifier[2] . Region-based techniques look for the regions satisfying a given homogeneity criteria and edge based segmentation techniques look for edges between regions with different characteristics . For the region-based segmentation category, adaptive thresholding, clustering, region growing, watershed and split and merge are the well known methods for segmentation . After they have proposed an automatic method for segmentation of homogeneous brain tumors in MR images that used a manually segmented atlas as spatial information to correct the KNN classification results. The EM algorithm was adapted to brain tumor segmentation. In the brain tumor segmentation domain, MRFs have been used in some works to refine the results of the EM segmentation such as in .Proposed a simple system for the segmentation of brain tumors.

Many tumor segmentation methods are not fully automatic as they need user interaction to place a seed inside the tumor region. Their automated selection can be based on finding pixels that are of interest. The focus of this study is to develop an automatic region growing algorithm that can accurately segment primary brain tumors in MR Images. The interest or salient region is called Region Of Interest (ROI) which is the most informative and important part of a medical image. ROI is composed of salient points or visually significant feature points which can represent the local properties of image[1]. If these salient points can be extracted, large amount of computation may be reduced during segmentation as well as retrieval of cases from a database depending upon the medical application. In order to extract feature points from a medical image, we propose a novel significant feature point detector. Then, the texture features are extracted from random patches of the medical image with uniform gray level intensities. This information is used to reduce the number of feature points to identify the seed points. Finally, a region growing algorithm is used to extract the brain tumor from the MR image. In this paper, we consider the brain tumor as the primary brain tumor. We have taken axial slices of T1 weighted images with contrast enhancement. This method combines region and edge information to segment brain tumors in MRI. This method is fully automatic and the quality of segmentation in the borders of tumor is relatively good because of using edge information.

2.METHODOLOGY

Any Digital Image processing system consists of following steps that need to be performed to get desired result:

[1] Image Preprocessing
[2] Image Enhancement
[3] Feature Extraction
[4] Recognition and Identification

[1]Image pre-processing

This step includes number of steps is as follow:

Image Reading

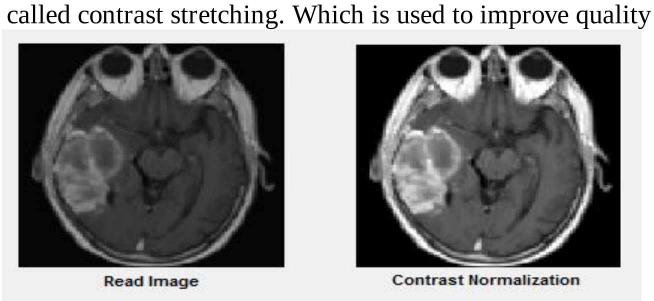
The Image is loaded using uigetfile() function, which is Matlab inbuilt function And the image is show using imshow() function and display in figure window.This step is come under preprocessing.

RGB To Gray

Why to do this?Because RGB Image consist of Red, Green and blue color three matrix and it is difficult to work with it hence Gray conversion is made and it is also useful and convenient for thresholding. Gray_scale = R+G+B/3 -→ Gray level , 3bit image means $2^3 = 8$ gray level (Range 0 to 7) it means the image consist of Pixel intensity ranges from 0 to 7 in image. For this rgb2gray() function is used.

Contrast Normalization

The contrast in an image is enhanced using imadjust () function. i.e. The intensity value in an image is stretch. Contrast normalization is also called contrast stretching. Which is used to improve quality of image



1 .Fig. Contrast Normalization

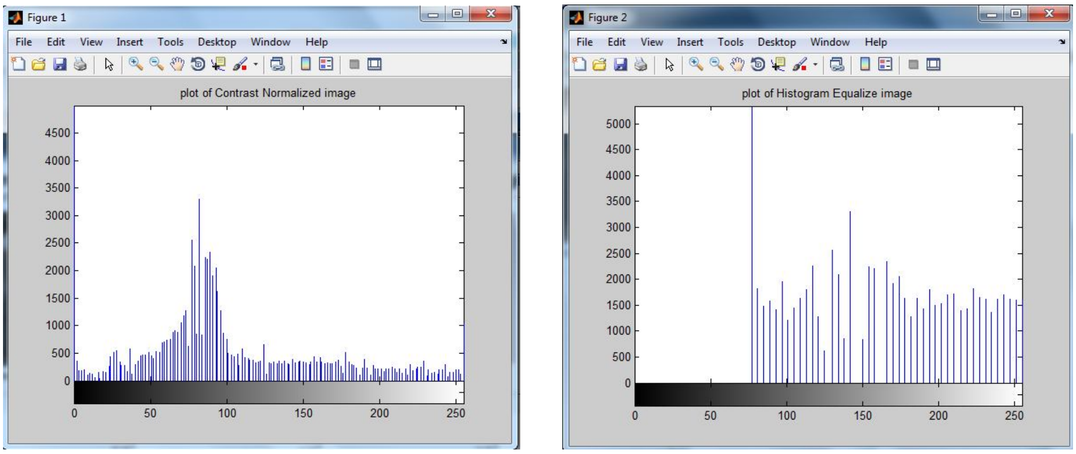
[2]Image Enhancement

This step includes number of steps is as follow:

Histogram Equalization

The histeq() function is used for performing Histogram Equalization of gray scale image this step gives useful for adjusting the gray scale value in an Image. The plot of histogram consist of on x-axis “range of Intensity” and on y-axis,it is “count of intensity value”.

(a)

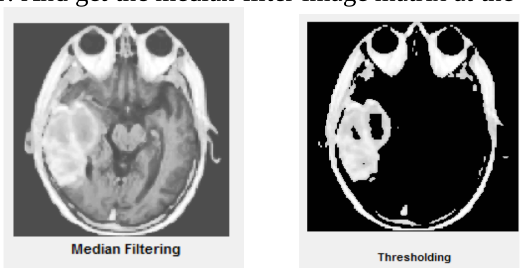


(b) (c)

2.Fig.Histogram of ‘range of intensity’ (a),(b),(c)

Median filter

Median filtered is applied for removing salt and paper noise or “Impulse noise”. It is spatial domain smoothing filter. medfilt2 () function is used for the median filtering, which is Matlab inbuilt function. In which first image matrix is zero padded and then 3X3 mask is rotated on image matrix and then obtained intensity value is arrange in ascending order and “Mid” element is consider. And get the median filter image matrix at the output, which is noise less.



(a) (b)

3. Fig (a)Median Filtering (b) Thresholding

Thresholding

TheThresholding of R,G, B value is done and obtained the desired image, which consist of region of interest (ROI). This step is not performed in base paper. The Threshold value for image is computed using Global Thresholding Algorithm. In this type of thresholding algorithm the single Threshold is computed for entire Image f(x, y).

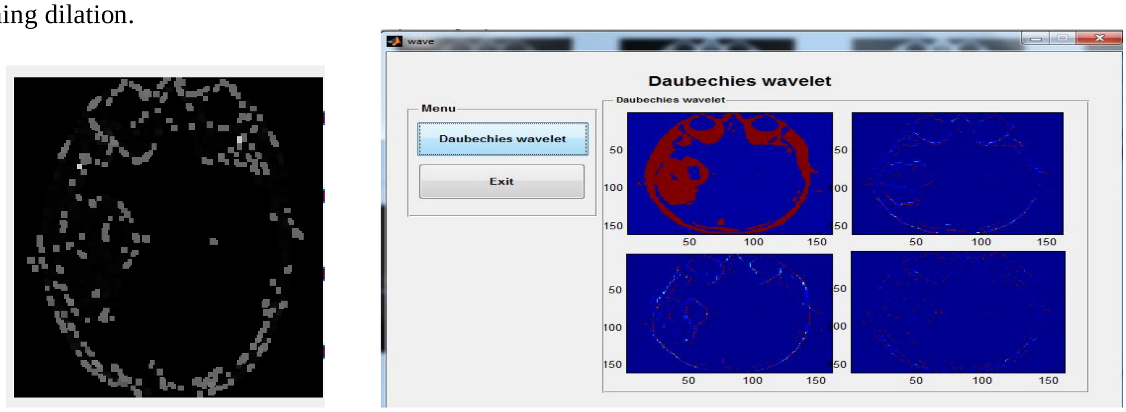
Feature Extraction

Daubechies Wavelet Transform

To obtain the feature point, the multiresolution decomposition is performed.The image is divided into multiple resolutions as HH (High-High), HL (High-Low), LH (Low-High) and LL (Low-Low). This is done in four different directions as vertical, horizontal and diagonal and Angular. The tumor area edge boundaries consist of High intensity hence it is necessary to performed wavelet Transform.

Feature point detection

To obtain the feature point morphological operation is performed. The dilation operation is performed with square structural element. The 3x3 square structural element is specify using strel() function and imdilate() function is used for performing dilation.



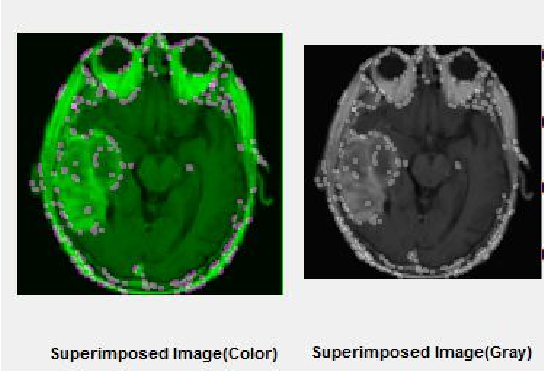
(a) **(b)**

4. Fig. (a) Feature point Extracted image (b) Daubechies wavelet transform

[3] Recognition and Identification:

Superimposed Image

To represent the extracted features on the original image. the fusion of two image is performed using imfuse() function.In this the fusion of image is performed between original image and feature extracted image.



5.Fig. Superimposed of color and gray image

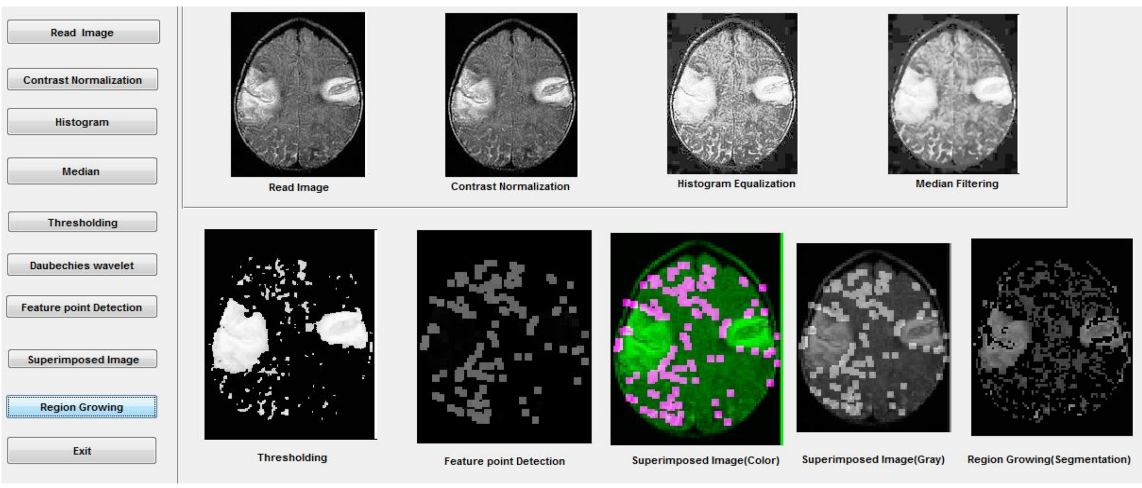
Region Growing

The seed feature point is considered, while segmenting the region in an image. The most feature point is located in the brain tumor area, which consist of highest intensity. hence that area is segmented using region growing algorithm. Region growing is one of the most popular techniques for segmentation of medical images due to its simplicity and good performance. The technique groups pixels or regions that have similar properties based on predefined criteria. It starts with a set of initial seed points that represent the criteria, and grow the region[4]. Many tumor segmentation methods are not fully automatic as they need user interaction to place a seed inside the tumor region. Their automated selection can be based on finding pixels that are of interest

6. Fig Region Growing

3.RESULT

Our experiment consist of database of 40 MRI image and followed above steps or procedure and come to the result which is showed below snapshot. In snapshot it will show these following steps.



4.DISCUSSION AND ANALYSIS

Here two quantities, precision and recall, are employed to evaluate the segmentation results from each segmentation Method. is calculated as follows : (Individual Image).

$$\text{Precision} = \frac{\text{True boundary pixels extracted pixels}}{\text{Total number of boundary pixels}} * 100$$

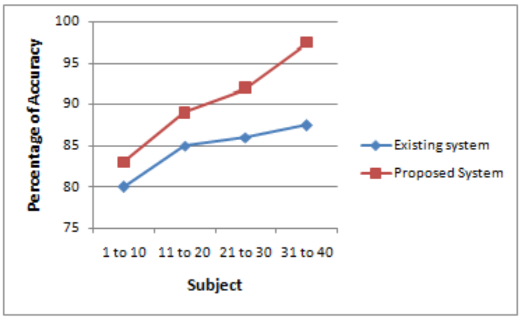
*** 100**

Precision: Is the probability that a detected pixel is a true pixel one.

$$\text{Segmentation Accuracy} = \frac{\text{Number of correctly segmented images}}{\text{Number of Input Images}} * 100$$

Table 1: Comparison of segmentation Techniques accuracy

Sr. No.	Segmentation Technique	Number of Input Image	Number of correctly Segmented Images	Segmentation Accuracy
1	Automated Tumor detection(proposed)	40	39	97.5
2	Existing Tumor Detection method	40	35	87.5



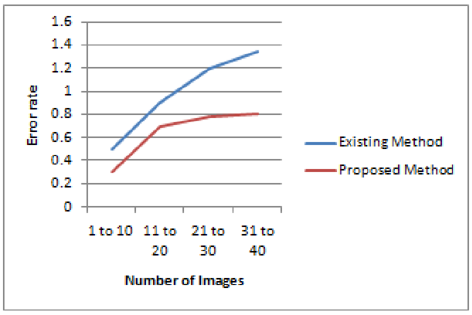
Graph: Accuracy chart of proposed Method with Existing Method

3) Segmentation Method error rate is calculated as follows:

$$\text{Error rate} = \frac{\text{Number of misclassified pixels}}{\text{Total number of pixels in the image}} * 100$$

Table 2: Comparison of segmentation Techniques Error rate

Sr. No.	Error rate	
	Existing Tumor Detection method	Automated Tumor detection(proposed)
1	1.34	0.80



Graph : Error rates of proposed Method with Existing Method.

This is following analysis which has been done using 40 images. According that segmentation accuracy and error rate has been calculated.On that basis graph related to both has been plotted which is shown in above graphs.

Table-1: Performance analysis

Sr. No.	Name of Image(brain MRI images)	Segmentation accuracy
1	Image 01	96
2	Image 02	94
3	Image 03	96
4	Image 04	88
5	Image 05	87
6	Image 06	92
7	Image 07	94
8	Image 08	93
9	Image 09	95
10	Image 10	90
11	Image 11	86
12	Image 12	84
13	Image 13	88
14	Image 14	89
15	Image 15	91
16	Image 16	87
17	Image 17	94
18	Image 18	95
19	Image 19	90
20	Image 20	91
21	Image 21	85
22	Image 22	86
23	Image 23	87
24	Image 24	88
25	Image 25	94
26	Image 26	90
27	Image 27	95
28	Image 28	84
29	Image 29	86
30	Image 30	89
31	Image 31	91
32	Image 32	90
33	Image 33	93
34	Image 34	94
35	Image 35	84
36	Image 36	87
37	Image 37	88
38	Image 38	89
39	Image 39	91
40	Image 40	83

Error calculation formula (for our paper)

Sr. No.	Name of Image(brain MRI images)	Existing system	Proposed system	Error rate
1	Image 01	98	96	2%
2	Image 02	93	94	1%
3	Image 03	96	96	0%
4	Image 04	89	88	1%
5	Image 05	89	87	2%
6	Image 06	91	92	1%
7	Image 07	94.5	94	0.5%
8	Image 08	94	93	1%
9	Image 09	96	95	1%
10	Image 10	92	90	2%
11	Image 11	90	86	4%
12	Image 12	84	84	0%
13	Image 13	89	88	1%
14	Image 14	89	89	0%
15	Image 15	92	91	1%
16	Image 16	87	87	0%
17	Image 17	95	94	1%
18	Image 18	92	95	%
19	Image 19	93	90	3%
20	Image 20	93	91	2%
21	Image 21	87	85	2%
22	Image 22	87	86	1%
23	Image 23	87	87	0%
24	Image 24	89	88	1%
25	Image 25	97	94	3%
26	Image 26	90	90	0%
27	Image 27	97	95	2%
28	Image 28	85	84	1%
29	Image 29	86.5	86	0.5%
30	Image 30	90	89	1%
31	Image 31	92	91	1%
32	Image 32	91	90	1%
33	Image 33	95	93	2%
34	Image 34	96	94	2%
35	Image 35	87	84	3%
36	Image 36	88	87	1%
37	Image 37	90	88	2%
38	Image 38	89	89	0%
39	Image 39	92	91	1%
40	Image 40	83	83	0%

5.CONCLUSION

In this paper, significant feature points based approach for primary brain tumor segmentation is proposed. Axial slices of T1-weighted Brain MR images with contrast enhancement have been analyzed. In order to extract significant feature points in the image, we proposed a novel algorithm based on a fusion of edge maps using morphological and wavelet methods. Evaluation of feature points thus obtained has been done for geometric transformations and image scaling. A region growing algorithm is then employed to isolate the tumor region. Preliminary results show that our approach has achieved good segmentation results. It require less Time because there is no mathematical formla used so this approach reduces a large amount of computation time. Accuracy oriented this method is better. How much portion is increased that also identified means tumor is detected in first stage.

REFERENCES

[1] Automated Brain Tumor Segmentation using Novel feature Point Detector and Seeded Region Growing. Mangipudi Partha Sarathi, Mohammed Ahmed Ansari, Vaclav Uher, Radim Burget, and malay Kishore Dutta.978-1-4799-0404-4/13/$31.00© 2013IEEE

[2] Sobri Muda, M. Mokji, “Brain Lesion Segmentation From Diffusion- Weighted MRI Based On Adaptive Thresholding And Gray Level Co- Occurrence Matrix”, J. Telecommunication Electronic and Computer Engineering, Vol. 3 No. 2, 2011.

[3] S. Cha, “Review Article: Update on Brain Tumor Imaging: From Anatomy to Physiology”, Journal of Neuroradiology, vol.27, pp.475- 487, 2006.

[4] J. R. Jimenez-Alaniz, V. Medina-Banuelos, O. Yanez-Suarez, “Datadriven brain MRI segmentation supported on edge confidence and a priori tissue information,” IEEE Trans. on Medical Imaging, vol.25, no.1, pp.74–83, 2006.

[5] R. Adams, L. Bischof, “Seeded region growing,” IEEE Trans. On Pattern Analysis and Machine Intelligence, vol.16, no.6, pp.641–647, 1994.