ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, Vol 9(4), DOI: 10.17485/ijst/2016/v9i4/85624, January 2016 ISSN (Online) : 0974-5645

Comparative Study of Different Methods for Brain Tumor Extraction from MRI Images using Image Processing

Neha Baraiya* and Hardik Modi

Charotar University of Science and Technology, Changa - 388421, Gujarat, India;
nehabaraiya@yahoo.in, modi8584@yahoo.com

Abstract

Background/Objectives: The objective of this paper is to study various segmentation methods implemented using MATLAB and to compare accuracy of each. **Statistical Analysis/Findings:** Preprocessing is required for better segmentation, as it removes noise and makes images having equal attribute so that accuracy to segment can be increased. Segmentation using Thresholding, region based segmentation and watershed segmentation, all the methods are performed and Comparison of accuracy of all the methods has been calculated on basis of actual tumor part and segmented tumor part. Morphological operations are used in all the methods in order to avoid noise part of segmented image and to have higher accuracy. Accuracy of the three methods which are region based, thresholding and watershed are 87.48, 91.34 and 92.76 respectively. Here we have used all T2-weighted Magnetic Resonance Imaging (MRI) images as it is noninvasive technique and having high contrast between tumor and normal part. **Application/Improvement:** Segmented tumor with higher efficiency leads to help doctor in anatomy and pathology to classify tumor type so that treatment could be started accordingly as soon as possible.

Keywords: Brain Tumor, Image Processing, MRI, Morphological Operations, Thresholding, Tumor Extraction

1. Introduction

Conventionally brain tumor was being decided according to biopsy, Human inspection, Expert opinion, etc. An expert also needs other experts to make decision, because he alone cannot detect type of tumor correctly. All these procedures take too much time to classify tumor correctly which delay the treatment. In addition to that the human prediction is not always correct[1]. Automated classification and detection of tumors in different medical images is simulated by the inevitability of high accuracy. At present with the rapid growth of the Artificial Intelligence (AI) development in Biomedicine, computer-aided diagnosis attracts more and more attention. It has been put to a test that double reading of medical images could lead to better tumor exposure. But the cost intended in double reading is very high, that's why good software to comfort humans in medical institutions is of great concern at present.

Discussed performance analysis of three methods to segment tumor viz., region growing, K Mean and Fuzzy C Mean methods, have used median filter for image denoising in order to reduce noise due to imaging devices. The performance was evaluated on the basis of 'error percentage as compared to ground truth'[2]. In[3] compared three different semi-automated methods, viz., Modified Gradient magnitude Region Growing Technique (MGRRGT), level set and a Marker Controlled Watershed Method (MCWM), and have evaluating their relative performance in the segmentation of tumor. Where images were preprocessed using image smoothing and contrast enhancement. In[4] developed numerous methods to detect and segment tumor from brain MRI and its features such as centroid, perimeter and area are calculated from the segmented tumor.

* Author for correspondence

The Flow chart of the segmentation technique is shown in Figure 1. According to flow chart first image is preprocess to convert into appropriate input image. Preprocessing includes filtration and registration of images; tumor is segmented and extracted afterward.

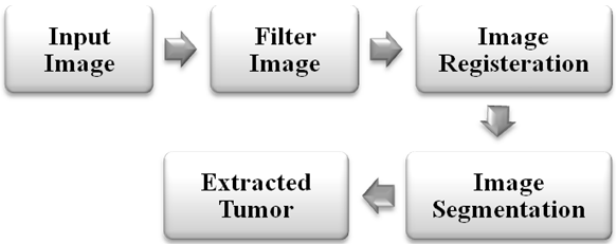

Figure 1. Process flow of tumor extraction.

2. Methodology

2.1 Preprocessing

2.1.1 Image Preprocessing

Image preprocessing is a manipulation of an image so that result would be more suitable than the original image[5] and hence preprocessing is necessary for accurate result. In preprocessing input MRI images are preprocessed in different ways like Filtering in order to reject noise and to consider only information contained in it, and registration to make all images comparable with each other. Both the processes are described here.

MRI images are normally affected by Rician noise which may lead to false segmentation. In order to reduce the noise, image denoising algorithm can be applied. Various filters can be used such as Low Pass Filter or Median Filter for salt and pepper noise removal. Gaussian Filter is the best option here because of its ability to remove most type of noises. Characteristics of Gaussian method imply that it is less sensitive to extreme values and able to remove outliers without reducing sharpness of the image. Further the contrast of the image is enhanced to have better segmentation[3,6]. Excellent result can be obtained using adaptive filtering such as Bayesian processing, nonlinear anisotropic diffusion filtering, or filtering with wavelets transform[7]. Preprocessing of MR images should be done carefully since due to improper usage of noise removal model, noise may be increased or small detail may be eliminated[8].

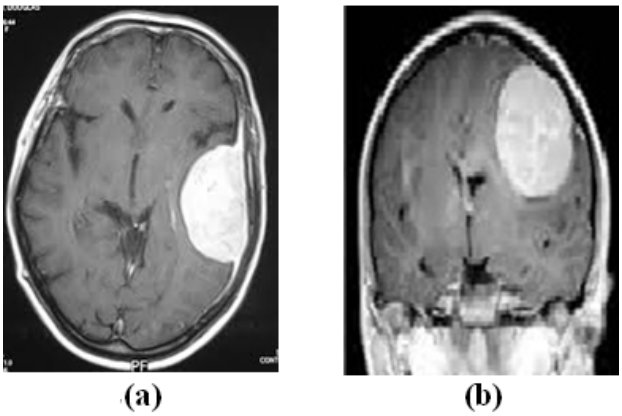

Figure 2. Two MRI images taken from different Imaging device having different image attributes[19,20].

2.1.2 Image Registration

Image registration[7] is also the part of preprocessing; it is an important application of digital image processing as it includes: bring an image into alignment with another image, incline an image with respect to another one, overlay images, change shapes and size of images, match intensity, rotate image, find matching between images, recover original image and many more. As it is not necessary that all images are taken form same imaging system, hence attributes of all input images may be different which is called as multimodal image. Multimodal images usually have different brightness ranges. To perform quantitative analysis requires compensating for geometric distortion caused by difference in viewing angle, distance and orientation, shift in object positions. MRI images shown in Figure 2 are taken by different devices and hence position of brain and intensity (brightness) in both the image varies. So we need to arrange all images in same manner, in order to make them perfect for classification.

2.1.3 Segmentation Techniques

Segmentation separates region of interest from background and from each other[7,9,17]. Segmentation can be treated as pattern recognition problem that is because it requires classification of pixels. Segmentation of tumor is the most important task of classification that is because all decisions depend on the segmented tumor. There are lots of algorithms available for segmentation of region of interest from other areas among them some algorithms is very effective to optimize segmentation tumor MRI images[18].

Various segmentation techniques are described as follows:

2.1.3.1 Region based segmentation

Region based segmentation includes region growing and region splitting and merging technique.

In region growing technique, grouping of pixels or subregion into larger region is performed according to predefined criteria[2,9,15]. The basic approach of the method is to define "seed" points and from where the region is grown by appending to each seed the neighboring pixels that have similar properties to the seed. This procedure is shown in Figure 5, 5(b) shows the seed points for input image and 5(c) represents the result of region growing. The result also includes noise which affects the decision, so it is needed to clear those noise parts. Erosion and dilation are done here also and the result is shown in Figure 5(d). Accuracy of this method is 87.48% that because due to irregularity in brain MRI image causes wrong "seed" points which leads to inappropriate segmentation.

Region splitting starts with whole image as a single region, then subdivide the image into its subsidiary regions again and again until a condition of homogeneity satisfies. Figure 3 shows the basic idea of region splitting, where image is splitted in four regions R1, R2, R3 and R4 and region 2 is splitted again as in figure. While region merging technique is contradictory to region splitting technique, as it starts from a small region and merge regions having similar characteristics like gray level, variance, etc.

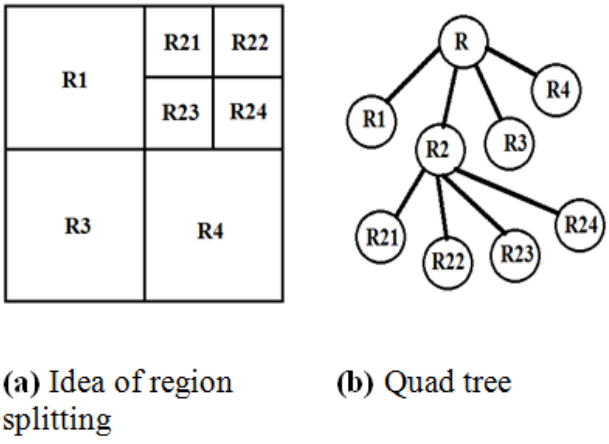

Figure 2. Two MRI images taken from different Imaging device having different image attributes[19,20].

2.1.3.2 Segmentation using thresholding

Thresholding method is based on intensity, for this method to implement first inspects pixel values of image and so that intensity of tumor part can be get. Then threshold image to get only region of image that is having tumor and having black background for all other regions [4, 10, 11]. As it can be seen that, this method is totally intensity dependent, some other region are having higher intensity can also present in segmented part. To remove those, edges are detected and morphological functions are performed on edges, and then subtracted from thresholded image. Figure 4(e) is showing Roberts edges and 4(f) is having those edges dilated. 4(f) is subtracted from 4(d), and final result is shown in 4(g). After doing all the processes again erosion and dilation process are done to remove noise, here we get tumor part only as depicted in 4(h). All the processes are shown in figure 4.This method is having accuracy of 91.34%, this method gives 100% accuracy for benign tumor, but since malignant tumors are non-homogeneous this accuracy get reduced. The advantage of this method is that it does not require manual intervention and having less complexity[3,12,13].

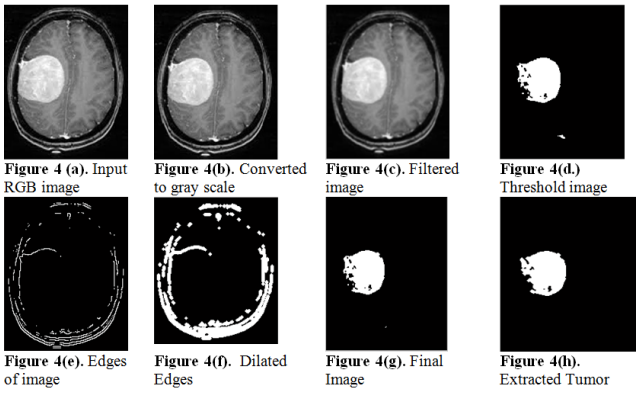

Figure 4. Segmentation using thresholding[21].

2.1.3.3 Watershed segmentation

In geography, a watershed is the ridge that divides areas drained by different river systems. A catchment basin is the geographical area draining into a river or reservoir. The watershed transform applies these ideas to gray-scale image processing in a way that can be used to solve a variety of image segmentation problems. Watershed segmentation is edge based segmentation which first

uses image acquisition technique and then gradient magnitude of the image is performed as shown in Figure 5(b). Gradient of f at coordinates (x,y) is defined as two dimensional column vector shown in Equation (1). And magnitude of vector ∇ f denoted as M(x,y) as in Equation (2). gx And gx are sobel operators, called as mask coefficient[3], shown in Equation (3) and (4).

$$\nabla f = grad(f) = \begin{bmatrix} gx \\ gy \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} \quad (1)$$

$$M(x,y) = mag(\nabla f) = \sqrt{gx^2 + gy^2} \quad (2)$$

$$gx = \frac{\partial f}{\partial x} = (z_7 + 2z_8 + z_9) - (z_1 + 2z_2 + z_9) \quad (3)$$

$$gy = \frac{\partial f}{\partial x} = (z_7 + 2z_8 + z_9) - (z_1 + 2z_2 + z_9) \quad (4)$$

Where, f is a brain MRI image[14]. Filter masks are shown in Figure 7, where 7(a) shows intensities of image points in a 3 x 3 region, while (b) - (c) shows Sobel mask coefficients. The watershed transform is often preferred to separate the touching objects in an image; it is more effective method than other methods that is because it can also segment non homogenous tumors providing the non-homogeneity is within the tumor region[16]. There are various watershed transforms are present like watershed segmentation using distance transform, watershed segmentation using gradients, marker controlled watershed segmentation, etc. Figure 6(c) shows marker controlled watershed transform. Here due to noise and other irregularity of gradient over-segmentation has been occurred. To avoid the situation area opening is done so that irregularity will not affect the segmentation. Then image is morphologically opened by using image reconstruction as shown in figure 6(e). Then image opening- closing is performed by image reconstruction, its results are depicted in figure 6(g). Segmented tumor is shown in 6(h) and tumor part imposed on brain MRI in 6(i). Watershed segmentation gives good accuracy which is 92.76%.

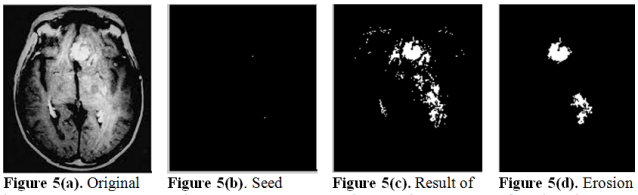

Figure 5(a). Original image | **Figure 5(b).** Seed points | **Figure 5(c).** Result of region growing | **Figure 5(d).** Erosion of resultant image

Figure 5. Segmentation by region growing[22].

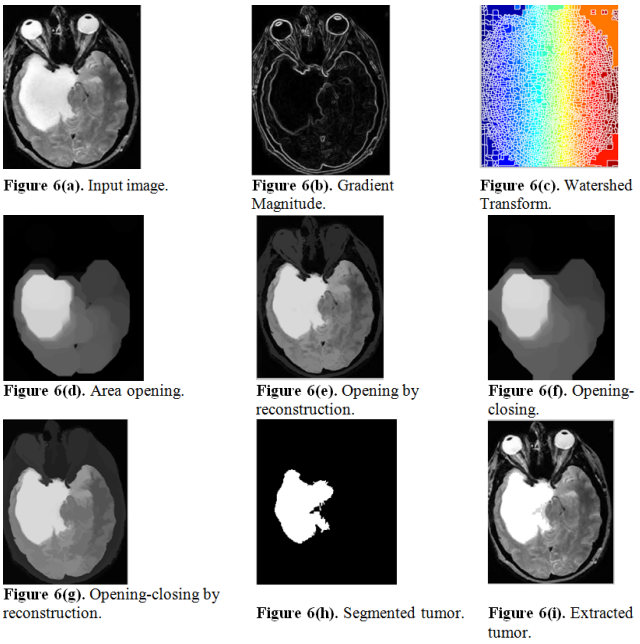

Figure 6(a). Input image. | **Figure 6(b).** Gradient Magnitude. | **Figure 6(c).** Watershed Transform.

Figure 6(d). Area opening. | **Figure 6(e).** Opening by reconstruction. | **Figure 6(f).** Opening-closing.

Figure 6(g). Opening-closing by reconstruction. | **Figure 6(h).** Segmented tumor. | **Figure 6(i).** Extracted tumor.

Figure 6. Watershed segmentation[23].

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

Figure 7(a). $3X\ 3$ Region of an image showing pixel intensities.

-1	-2	-1
0	0	0
1	2	1

Figure 7(b). Mask approximating partial derivative in x- direction.

-1	0	1
-2	0	2
-1	0	1

Figure 7(c). Mask approximating partial derivative in y- direction.

Figure 7. Gradient coefficients for sobel edge function[9,14].

3. Results and Discussion

Extraction of Tumor using segmentation techniques discussed above has been shown below. Here Thresholding or morphological technique, Region growing and watershed segmentation or gradient magnitude methods are performed and results corresponding to techniques are shown in Figure 4, 5 and 6. Here white part is corresponding to tumor region in final segmentation figures and normal regions are converted into black part.

4. Conclusion

In this paper we have demonstrated various methods and discussed merits and demerits of each method. The algorithms are implemented on personal computer (1.7

GHz CPU, 4GB RAM) using MATLAB 8.0.0.783 (2012b). Accuracy of each method is different due to some of the part of image may also present along tumor part which causes wrong decision. Accuracy of each method can be listed as:

Table

Method	Accuracy
Region based Segmentation	87.48
Segmentation using Thresholding	91.34
Watershed Segmentation	92.76

5. Acknowledgement

We would like to thank the Charotar University of Science and Technology for its constant support all the way through our work.

6. References

1. Sridhar D, Iyyanki V, Krishna M. Brain tumor classification using discrete cosine transform and probabilistic neural network. International Conference on Signal Processing Image Processing and Pattern Recognition (ICSIPR); Coimbatore. 2013. p. 92-6.
2. Hooda H, Verma OP, Singhal T. Brain tumor segmentation: A performance analysis using K-Means, Fuzzy C-Means and Region growing algorithm. International Conference on Advanced Communication Control and Computing Technologies (ICACCCT); Ramnathapuram. 2014. p. 1621-6.
3. Dubey RB, Hanmandlu M, Vasikarla S. Evaluation of three methods for MRI brain tumor segmentation. Eighth International Conference on In Information Technology: New Generations (ITNG); Las Vegas. 2011. p. 494-9.
4. Deepthi Murthy TS, Sadashivappa G. Brain tumor segmentation using thresholding, morphological operations and extraction of features of tumor. International Conference on Advances in Electronics, Computers and Communications (ICAECC); Bangalore. 2014. p. 1-6.
5. Naveen A, Velmurugan T. Identification of calcification in MRI brain images by k-Means Algorithm. Indian Journal of Science and Technology. 2015; 8(29):1-7.
6. Sasirekha N, Kashwan KR. Improved segmentation of MRI brain images by denoising and contrast enhancement. Indian Journal of Science and Technology. 2015; 8(22):1-7.
7. Bankman I. Handbook of medical image processing and analysis. SAN Diego, USA: Academic Press; 2008.
8. Sundararaj GK, Balamurugan V. Robust classification of primary brain tumor in Computer Tomography images using K-NN and linear SVM. International Conference on Contemporary Computing and Informatics (IC3I); 2014. p. 1315-9.
9. Gonzalez RC, Woods RE, Eddins SL. Digital image processing using MATLAB. Pearson Education India; 2004.
10. Yang, H, Zhao L, Tang S, Wang Y. Survey on brain tumor segmentation methods. IEEE International Conference on Medical Imaging Physics and Engineering (ICMIPE); 2013. p. 140-5.
11. Liu, J, Li M, Wang J, Wu F, Liu T, Pan Y. A survey of MRI-based brain tumor segmentation methods. Tsinghua Science and Technology. 2014; 19(6):578-95.
12. Yadav PS, Sahu C. Detection of brain tumor using self-organizing map with k-mean algorithm. International Journal on Advanced Computer Theory and Engineering. 2013; 1(2):2319-26.
13. Patil RC, Bhalchandra AS. Brain tumor extraction from MRI images using MATLAB. International Journal of Electronics, Communication and Soft Computing Science and Engineering. 2011; 2(1):1-4.
14. Hemalatha KH, Babu G, Sivakumar R. Lesion Area Detection (LAD) using super pixel segmentation. Indian Journal of Science and Technology. 2015; 8(15):1-6.
15. Dubey RB, Hanmandlu M, Gupta SK. Region growing for MRI brain tumor volume analysis. Indian Journal of Science and Technology. 2009; 2(9):26-31.
16. Ratan R, Sharma S, Sharma SK. Multiparameter segmentation and quantization of brain tumor from MRI images. Indian Journal of Science and Technology. 2009; 2(2):11-5.
17. Bhatia, M, Bansal A, Yadav D, Gupta P. Proposed algorithm to blotch grey matter from tumored and non tumored brain MRI images. Indian Journal of Science and Technology. 2015; 8(17):1-10.
18. Mahalakshmi S, Velmurugan T. Detection of Brain Tumor by Particle Swarm Optimization using Image Segmentation. Indian Journal of Science and Technology. 2015; 8(22):1-7.
19. Available from: http://www.drtimothysteel. com.au/Conditions/BrainSurgery/BrainTumours/tabid/79/Default.aspx
20. Available from: http://www.northwestneuro-surgery.com/conditions/benign-brain-tumors
21. Available from: http://jessicaoldwyn.blogspot.in/2010/04/1st-neurosurgen-appt.html
22. Available from: http://neurosciencenews.com/neurogenetics-brain-cancer-treatment-glioblastoma-500/
23. Available from: http://www.brain-surgery. com/malignant-brain-tumors/