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Study on Various Methods for Detecting Tumor on MRI Images

Hemang J. Shah[1]
Department of Computer Engineering
Parul Institute of Engineering and Technology (PIET)
Vadodara – India

Hetal Vala[2]
Asst. Prof.
Department of Computer Science and Engineering
Parul Institute of Engineering and Technology (PIET)
Vadodara – India

Henita R. Rana[3]
Department of Computer Science and Engineering
Parul Institute of Engineering and Technology (PIET)
Vadodara – India

Zubin Bhaidasna[4]
Asst. Prof., Head of Department in CE and IT
Parul Polytechnic Institute
Vadodara, India

Abstract: ***Image segmentation is one of the fundamental approaches of digital image processing. During past few years, brain tumor segmentation in magnetic resonance imaging (MRI) has become a popular research area in the field of medical imaging system. MRI is used in radiology for analyzing internal structures in detail. In the work of research and application for images, people are interested in only specific parts of images, which we can say as target or object which are to be extracted, and generally correspond to the specific area and which are of unique nature in images. In this paper we are going to compare different image segmentation methods for evaluating their performance in the segmentation of tumor.***

Keywords: Image Segmentation, Magnetic Resonance Imaging (MRI), Level set, Difference in strength, Watershed.

I. INTRODUCTION

In the work of research and application for images, people are interested in only specific parts of images, which we can say as target or object which are to be extracted, and generally correspond to the specific area and which are of unique nature in images. Image segmentation refers to the technology and process in which images are segmented into regions each with a distinct identity, and extract certain interested objects according to some features of the images. Segmentations play a large role in object recognition. This paper presents an objective and quantitative study of segmentation algorithms that will be described further. Currently, magnetic resonance imaging (MRI) is an important tool to identify the location, size and type of brain tumor. Tumors are examined for finding exact location, size and shape so that it can be detected and with respect to that necessary steps can be taken for curing it.

There are several image segmentation methods which take advantage of only some of the characteristics in image formation and are certain to be limited. Therefore we could select the desired method with respect to the practical application. In this paper we compare several methods for selecting threshold and different edge detection technique which are beneficial for detecting tumor in MRI images.

This paper is organized as follow. In section II, we describe several image segmentation algorithms [1].Section III presents different methods for detecting tumor and comparison between them. Section VI represents conclusion.

II. IMAGE SEGMENTATION ALGORITHMS

In Computer vision, image segmentation is the process of partitioning an image into meaningful regions or objects. It divides a divides a digital image f(x, y) into its continuous, disconnect and nonempty subset f1, f2, f3, f4… fn, due to which extraction of attribute becomes easy. Image segmentation process is divided into two basic principles i) Characteristics of pixels and ii) The information in the surrounding regions[1]. There are mainly three categories of Image Segmentation viz ., (a) Edge-

based segmentation-edge is a set of connected pixels lying on the boundary between different regions where the characteristics of image such as color ,variety in texture , distortion in shape might be discontinuous, so image can be divided into parts by finding those discontinuities. (b) Region-based segmentation- in this the image is divided into regions based on similar properties according to the predefined criteria.(c) Special theory based segmentation- Special algorithms can be made from other fields of knowledge like morphology, wavelet transformation, genetic algorithm, artificial intelligence etc.

The Table I show classification of different segmentation algorithms with their advantages and disadvantages if any.

TABLE I

Classification of Image Segmentation Algorithms

Edge Based Segmentation	**Gray-Histogram Technique**	Uneven for the impact of noise and difficult to search for the maximum and minimum gray value	
	Gradient-Based Method	If the change of gray value near edge is intense enough and there is little image noise then it works well. The segmentation result is adaptive to the direction of gradient	
Region Based Segmentation	**Thresholding:** Chooses proper thresholds *T* to divide image pixels into several classes and separate the objects from background	**Global Thresholding**	T depends only on gray value f(x, y). Only one threshold value for all regions. E.g.: Otsu, which have very high, Processing rate and it is very slow
		Local Thresholding	T depends on both f(x, y) and p(x, y). Different threshold value for different region. E.g.: K-means, which is more efficient, less computing time and faster in 3D thresholding
		Dynamic Thresholding	Several objects taking up different gray level regions
	Region Operating: Find the aim regions directly. Requires lots of computation time	**Region Growing**	Group up pixels or sub regions into larger regions based on predefined criteria
		Region Splitting and merging	Users can divide an image into a set of arbitrary, unconnected regions
Special Theory Based Segmentation	**Fuzzy Clustering**	Introduce Fuzzy Set Theory into image segmentation	
	Neural Network Based	It is a learning algorithm imitating the working pattern of neural networks	
	Physically Based Segmentation	Utilizing the physical characters of images to partition	

III. METHODS FOR DETECTING TUMOR

The MRI images are subject to various types of noises such as irregularities etc. These noises may degrade the quality of MRI images and due to it we cannot get correct information for image segmentation and edge detection. So for improving the quality of images operations are to be done so that degradation in image can be can be removed or decreased. So for this different methods can be used for detecting tumor. They are explained below.

A. Level Set Segmentation [3]

This is powerful tool for MRI brain tumor segmentation. Level set methods can handle any of the cavities, concavities and splitting/merging. Despite so many advantages, this method require the prior choice of the critical parameters such as the initial location of seed point, the appropriate propagation speed function and the degree of smoothness. The level set methods embed the initial position of the moving interface Co(*x*) as the zero level set of a higher dimensional function ϕ , the signed distance to *Co* , and link the evolution of this new function ϕ to the evolution of the interface itself through a time-dependent initial value problem. At each time, the contour *C* (*t*) is given by the zero level set of ϕ. This condition states that

$$(C(t), t) = 0 \Rightarrow t + \Delta(C(t), t).\partial c / \partial t = 0 \quad (1)$$

Since $\partial C / \partial t = Fn$ and outward normal vector is given by $\nabla \phi / |\nabla \phi|$, this gives the following equation for ϕ:

$$t + F|\nabla| = 0$$

$(x, 0) = Co(x)$ (2)

For reasons of causality, it is possible to restrain the computation domain to a band of cells around the zero-level set of ϕ (x, t) for the reduction of the computational cost. The level set methods require specifying initial curves and can only provide good results if these curves are placed near to the object boundary.

B. K-means clustering [4]

In this method initial intensity mean value of each region in the image was defined according to the image histogram because the locations of peaks and valleys of a histogram indicate the clusters of similar-spectral pixels in an image. The goal of this method is to find a partition of the data points that minimizes sum of squared distance to the centre of the cluster was founded. At first, points were assigned at random into sets. Then each point was assigned to the set whose mean center is the closest. This was repeated until no point changes of set. In this method the average value of each group was initialized from image histogram, and then the labels of the pixels that belong to which group is initialized using gray levels difference between every pixel and the mean value of each group, and then compared the results with minimum distance (denoted equal 255 gray levels). The mean value of the group that have been calculated and the labelled values were updated. The output image has different intensity regions. Then the gradient values of this image were calculated using gradient operator.

C. Difference in Strength Technique [4]

It is used for checking the result of image segmentation. DIS for each pixel was calculated using the equation (7) [4]. DIS map was obtained. If the value of DIS is large then it indicates that more the pixel is likely located at the edge. At this step, a 3x3 window runs pixel by pixel on the input image. When the window runs over the border of the input image, pixels outside the border are given the gray level of the input nearest to it. The DIS for the center pixel was calculated. One can expect that the values of DIS should be small in the smooth regions obtained by k-means. The greater DIS value represents that the pertaining pixel is on the area that changes severely in gray levels. With the DIS map one can check with the result of image segmentation based on K-means. DIS map consists of all edge information about the input image even on the smooth regions. Since the DIS of the smooth region is small (weak edge), one can use a threshold T to eliminate fake edges and thus obtain larger regions. The DIS map provides the complete edge information about the image. By this information, one can accurately locate the boundary of an object. The value depends on one closed boundary and two edge strengths gradient values. Incorrect choice of threshold results in worst image segmentation.

D. Watershed method

Watershed comes under the region-based segmentation. A watershed is defined as the line separating two catchment's basins. The image gradient can be viewed as a terrain. The homogenous regions in the image usually have low gradient values. Thus they represent valleys while the edges represent the peaks having high gradient values. Watershed is an efficient morphological segmentation tool. The aim of watershed is to search the areas having high intensity gradients (watersheds) that divide neighboured local minima (basins) [5].Watershed suffers from the problem of over segmentation (large number of segmented regions around each local minima in the image). A solution is to introduce markers [6][7]. The markers are connected component of an image. There are internal markers and external markers where internal markers are used for the actual object to be extracted and external marker are used extracting background. This method can be used mainly for the problems where adjacent objects are there in an image and we have to separate them using image processing operations. Thus this method can be effectively used so that proper detection of the region of interest can be achieved.

The Table II shows the comparison between different methods for detecting tumor Figures and Tables

TABLE III

Comparison between different methods for detecting tumor

Method	Advantages	Disadvantages
Level Set Segmentation	-Powerful tool for MRI brain tumor segmentation -Can handle any of the cavities, concavities & splitting/merging	-Prior choice of the critical parameters such as the initial location of seed point, the appropriate propagation speed function and the degree of smoothness
K-means clustering	-Find a partition of the data so that ROI can be obtained easily	-Output image has different intensity regions
Difference in Strength	-Effective checking the result of image segmentation	-Incorrect choice of threshold results in worst image segmentation
Watershed	-Used mainly for the problems where adjacent objects are there in an image -Robust procedure -Efficient and Accurate results	-Over Segmentation

IV. CONCLUSION

Traditionally, segmentation is performed manually in clinical environment that is operator dependent and very tedious and time consuming labor intensive work. However, automated tumor segmentation in MRI images poses many challenges with regard to the characteristics of image. There are several methods by which tumor can be detected, but there are some drawbacks of the existing methods. Out of that Watershed method can be used which can efficiently detect tumor, so that the result in improvement of performance in terms of execution can be achieved. With this approach we can reduce user interaction and speeds up the entire segmentation process.

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AUTHOR(S) PROFILE

Hemang J. Shah received the B.E. degree in Computer Engineering from the Mahatma Gandhi Institute of Technical Education and research Center (MGITER), Navsari, India in 2012.

He is currently studying toward the M.E. degree in Computer Engineering at Parul Institute of Engineering and Technology (PIET), Vadodara, India. His research area includes image processing.

Hetal Vala received the B.E. degree in Computer Science from MS University, Vadodara, India in 2007 and M.E. degree in Computer Engineering from Parul Institute of Engineering and Technology (PIET), Vadodara, India in 2013.

She is currently working as Asst. Prof. in Computer Science and Engineering department at Parul Institute of Engineering and Technology (PIET), Vadodara, India. Her research area includes image processing.

Henita R. Rana received the B.E degree in Computer Engineering degree from the Mahatma Gandhi Institute of Technical Education and research Center (MGITER), Navsari, India in 2012.

She is currently studying toward the M.E. degree in Computer Science and Engineering at Parul Institute of Engineering and Technology (PIET), Vadodara, India. Her research area includes image processing.

Zubin Bhaidasna received the B.E degree in Information Technology from Birla Vishvakarma Mahavidyalaya (BVM) Engineering College in V.V. Nagar, India in 2008 and M.E. degree in Computer Engineering from Parul Institute of Engineering and Technology (PIET), Vadodara, India in 2013.

He is currently working as Asst. Prof., Head of Department in Computer Engineering and Information Technology at Parul Polytechnic Institute, Vadodara, India. His research area includes image processing.