An Efficient Tumor Segmentation of MRI Brain Images Using Thresholding and Morphology Operation

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Abstract

In medical image processing, segmentation of the internal structure of brain is the fundamental task. The precise segmentation of brain tumor has great impact on diagnosis, monitoring, treatment planning for patients. Various segmentation techniques are widely used for brain Magnetic Resonance Imaging (MRI). The aim of this paper presents an efficient method of brain tumor segmentation. Morphological operation, pixel extraction threshold based segmentation and Gaussian high pass filter techniques are used in this paper. Thresholding is the simplest approach to separate object from the background, and it is an efficient technique in medical image segmentation. Morphology operation can be used to extract region of brain tumor. This system converts the RGB image to gray scale image and removes the noise by using Gaussian high pass filter. Gaussian high pass filter produced sharpen image and that improves the contrast between bright and dark pixels. This method will help physicians to identify the brain tumor before performing the surgery.

Keywords: *Image segmentation, Thresholding, Morphology operation, Preprocessing*

I. INTRODUCTION

Various segmentation techniques are used in medical images processing for different accuracy and degree of complexity. Image segmentation is the method of separating an image into different regions which is performed to detect, extract and characterize the anatomical structure of brain. Tumor is one of the most dangerous diseases in any part of the body, and has different characteristics and different types. The tumor occurs in fatal parts of the body in which total system is dysfunctional, when it is in the brain [1]. Brain tumor is an abnormal mass of tissue in brain and is classified based on the involved tissue type, tumor location whether it is benign or malignant, and other factors. Abnormal tissues will make more mistakes for brain area. Although many efforts and favorable results in the medical imaging community, accurate and performance segmentation and characterization of abnormalities are still a challenging and difficult task [2]. MRI segmentation is an imaging technique used to provide invaluable information about anatomical structure of brain. This paper presents an efficient method based on thresholding and morphology operation for brain tumor segmentation using MRI images. Medical images have very complex distribution of intensity so segmentation using thresholding often fails. However, thresholding methods are often combined with other segmentation methods. Thresholding is an efficient method for image segmentation because it reduce computational time, and faster than other method. But the spatial characteristics of an image do not work into account [3].

Brain tumor segmentation would be difficult to solve because it usually involves an enormous data. These facts are the most challenging and difficult in many medical images. Brain involved many types of tumor which have various shape and size. In this paper, accurate segmentation of brain tumors are identify in MRI images. In first stage is pre-processing operations. The second stage is brain tumor segmentation using thresholding. And then extract the tumor in segmented image using morphology operation.

Nowadays, many segmentation techniques can be considered using manual segmentation method. This method will become an error-prone and time consuming task for the expert. Brain MRI segmentation can help the radiologists and clinicians, who they decide accurately the patient's condition. Moreover it can effectively not only physicians but also patients. In fact, physician can identify the brain tumor before performing surgeries. Furthermore, patients can get accurate treatment from physicians by using segmentation of MRI imaging. The remainder of the paper is organized as follow. The next section is the concern of the brain tumor system. In section 3, we discuss the preprocessing step of the system. In section 4, addresses the metrologies of the system. In section 5, discuss the proposed system. In section 6, addresses the experimental results of the system. Finally section 7 presents the conclusion.

II. RELATED WORKS

Abnormality, surgical planning and post-surgery are significant tasks in medical application.

Dey, et al.in [4] addressed robust watershed segmentation of noisy image using wavelet. This paper describes that using soft threshold wavelet on the region

based watershed segmentation on noise image contribute a very effective result.

Alpana, et al.in [5] presented an effective method based on convolutional neural networks (CNN). Preprocessing used median filtering to remove the noise. Finally the CNN is used to identify brain tumor using MRI images.

Pooja Thakur et al.in [6] discussed brain tumor segmentation and detection. These methods are based on watershed segmentation and morphological operation. This paper described very good segmentation results, and reduced the computational time by using watershed segmentation. Furthermore, it detected the brain tumor. This paper will help the physician to surgery because watershed segmentation and morphological operation can calculate the area of brain tumor.

Ivana Despotovi et al.in [7] discussed image segmentation in medical application. The important steps of image segmentation are fundamental concepts of MRI segmentation of the human brain and basic concept of MRI segmentation methods. Image definition involves two dimensions and three dimensions of image. Furthermore image features and brain MRI intensity distributions. Then this paper reviewed preprocessing steps and the most popular image segmentation methods.

ARCHANA CHAUDHARI et al.in [9] proposed seed selection method. These method discuss using region growing algorithm. Automatic seed selection in segmented tumor is used fuzzy c- mean algorithm from MR brain images.

Jin Liu et al.in [8] described brain tumor segmentation in MRI images. Segmenation methods describe overview. Authors discussed the preprocessing of MRI images. Furthermore, brain tumor segmentation methods are discussed. There are conventional methods, thresholding-based methods, region- based methods, classification and clustering methods. In this method, some algorithm used to implement the development.

Shilpa Kamdi et al.in [9], discussed image segmentation and region growing algorithm. This paper described three methods: threshold-based, edge-based and region- based. Region growing method is better result over conventional segmentation method. This algorithm is determine with regard to noise.

III. PRE-PROCESSING

Pre-processing has to be solved before any segmentation operations which are directly related to the accuracy of the segmentation results. Pre-processing operations include many methods such as de-nosing, skull stripping, intensity normalization etc. These operations directly impact the results of brain tumor segmentation.

Image de-noising is an essential pre-processing stage for MRI images processing. Noise in MRI image makes it difficult to precisely delineate regions of interest between brain tumor and normal brain tissues [9]. Therefore enhancement and noise reduction techniques are necessary to pre-process MRI image. There are many de-noising methods for MRI image.

Median filtering is used to remove ``salt-and-pepper´ ´like noise, and could give good results. Median filtering technique calculates the median pixels within the median window, and then the selected median value gets placed at the position corresponding to the center of the median window in the output image. High pass filter produced sharpen image and that improves the contrast between bright and dark pixels.

Gaussian high pass filter is utilized to enhance the boundary of the object in the image and will blur edges and reduce contrast [6].

IV. BRAIN TUMOR SEGMENTATION METHODS

Usually brain tumor segmentation methods are classified into three main categories such as manual, semi- automatic, and fully automatic segmentation based on the degree of needed human interaction. Fully automatic brain tumor segmentation method, determines the segmentation of brain tumor without any human interaction, may obtain better result than manual and semi-automatic segmentation. The proposed system segmented MRI images by using two methods such as thresholding and morphology operation.

A. Thresholding

Thresholding an image $g_{th}(x, y)$ can be defined;

$$g_{th}(x,y) = \begin{cases} 0 \text{ if } f(x,y) \leq \text{thres} \\ 1 \text{ if } f(x,y) > \text{thres} \end{cases},$$

Where, *thres* is threshold. Thresholding operation, input could be a gray scale image or color image and its output is a binary image. Thresholding techniques can be categories into three techniques. These are global thresholding, local thresholding and adaptive thresholding.

B. Morphology Operation

Morphology-based image processing can be performed on image, and it involves many operations. These methods are driven by operations applied by the structuring elements (SE's) on the image matrix, which use ones and zeros to perform operation based on the distributions of said ones and zeros [10]. Erosion and dilation operations are fundamental to morphology processing and these operations are defined in term of set notation. In morphology erosion, erosion of E by F, denoted $E \ominus F$, "is the set of all elements y for which $(y+c) \in E$ for every F. That erosion shrinks or

thins object in binary image. Dilation of E by the structuring element F is denoted $E \oplus F$. E overlaps by at least one element. Dilation operation causes thickening of foreground areas.

V. PROPOSED SYSTEM

Image segmentation is mostly used for measuring the brain's anatomical structure, brain changes, treatment and surgical planning. Brain tumor segmentation is the process of separating abnormal tissue from normal tissue. The normal tissue is White Matter (WM), Gray Matter (GM), and Cerebrospinal Fluid (CSF). The accurate segmentation of brain tumor Magnetic Resonance Imaging (MRI) is still challenging and difficult task, so it cannot solve all the way because of the various types of tumor intensity, shapes, and location. This system is proposed to solve above the difficulty and challenging.

The proposed system includes preprocessing, segmentation, morphological operation. In preprocessing steps, first step converts the RGB images to gray scale images. Second step used Gaussian high pass filter. This filter will increase the contrast between bright and dark pixel to produce a sharping image. Segmentation is carried out by thresholding algorithm. In thresholding algorithm, the proposed` system used Otsu's thresholding method and then morphology operation is used to segment the MRI image. The number of pixels of the brain tumor segmented area is calculated using Matlab 2018a. The block diagram of the proposed system is shown in Fig. 1.

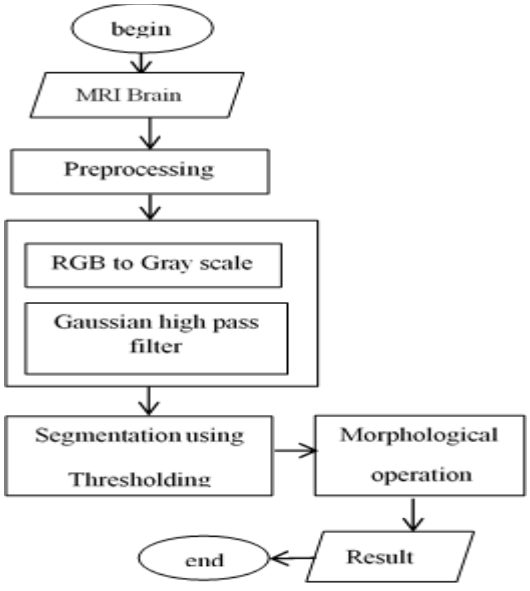

Figure 1. Block diagram of proposed system

Performance of each method would be calculated by using Peak Signal-to –Noise Ratio (PSNR) and Signal-to –Noise Ratio (SNR).

Peak Signal-to –Noise Ratio (PSNR) measures the quality of image. This quality based on pixels different between two images. PSNR is describes as

$$PSNR = 10 \log \frac{P2}{MSE}$$

Where P=255 for an 8 bit integer.

MSE= mean square error

$$MSE = \frac{1}{MN} \sum_{x=1}^{M} \sum_{y=1}^{N} \left[I(x,y) - \hat{I}(x,y) \right]^2$$

M and N are the value of row and column. x, y is current pixels position.

VI. EXPERMENTAL RESULT

The proposed system was tested with images from Internet by using 100 brain MRI images of different nature.

Figure 2(a), 3(a), 4(a), 5(a), 6(a) shows the original image of brain MRI. The original images are converted to gray scale images using Matlab as shown in Fig. 2(b), 3(b), 4(b), 5(b), and 6(b). The output of testing image is preprocessing using Gaussian high pass filter that is used to make image sharper and describes fine details in the image in Fig. 2(c), 3(c),4(c),5(c),6(c). The output of the segmentation stage is shown in Fig. 2(d),3(d),4(d),5(d),6(d). The output of the morphology operation is shown in figure 2(e), 3(e), 4(e), 5(e), 6(e). The number of white pixels (i.e., foreground regions), black pixel (i.e., background regions) and the total number of pixels are shown on the right of Fig. 2(e), 3(e), 4(e), 5(e) and 6(e).

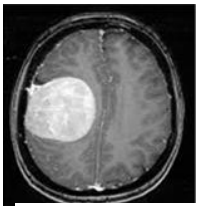

Figure 2. (a)

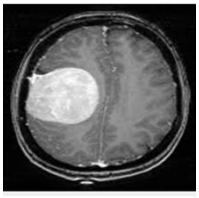

Figure 2. (b)

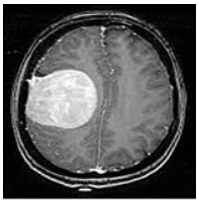

Figure 2. (c)

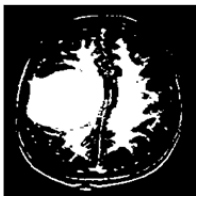

Figure 2. (d)

Figure 2. (e)

Total pixels=65536

White pixels=10606

Black pixels=54930

Figure 2. (f)

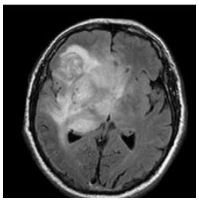

Figure 3. (a)

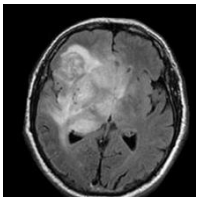

Figure 3. (b)

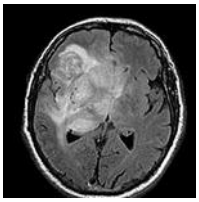

Figure 3. (c)

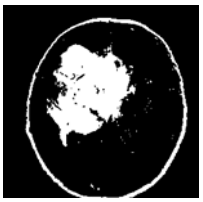

Figure 3. (d)

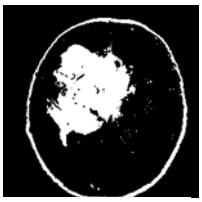

Figure 3. (e)

Total pixels=65536

White pixels=5966

Black pixels=59575

Figure 3. (f)

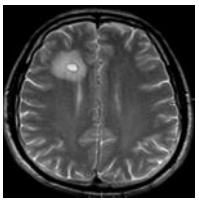

Figure 4. (a)

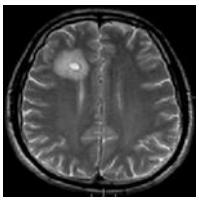

Figure 4. (b)

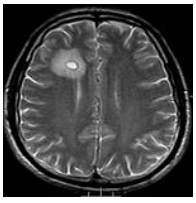

Figure 4. (c)

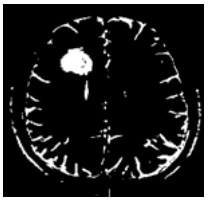

Figure 4. (d)

Figure 4. (e)

Total pixels=65536

White pixels=961

Black pixels=64575

Figure 4. (f)

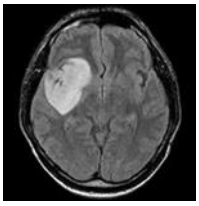

Figure 5. (a)

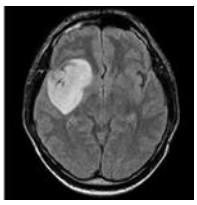

Figure 5. (b)

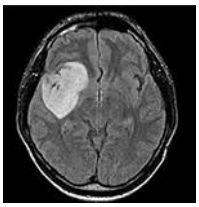

Figure 5. (c)

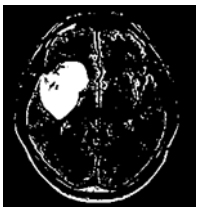

Figure 5. (d)

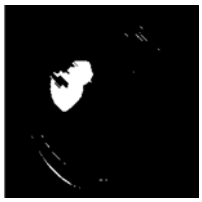

Figure 5. (e)

Total pixels=65536

White pixels=2239

Black pixels=63297

Figure 5. (f)

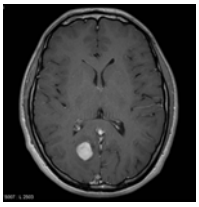

Figure 6. (a)

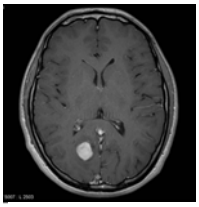

Figure 6. (b)

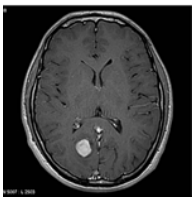

Figure 6. (c)

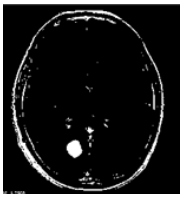

Figure 6. (d)

Figure 6. (e)

Total pixels=65536

White pixels=406

Black pixels=65130

Figure 6. (f)

The performance of this system is analyzed using Peak Signal-to-Noise Ratio and Signal -to -Noise Ratio. PSNR and SNR value of five images presented in table 1. Otsu's method and morphological operation were analyzed for segmentation. Using these two techniques, performance of difference images were measured by using PSNR and SNR. Performance evolution of proposed system analyzed by using Gaussion high pass filter. Otsu's and morphology operation do not use the Gaussion high pass filter method. An image produce better quality and sharer by using Gaussion high pass filter. Image qualities of proposed system are higher than Otsu's and morphological operation. Performance value of five images are presented in following table 1.

TABLE I. REPRESENT PSNR AND SNR VALUE OF FIVE IMAGES

Images	Proposed System		Otus's Method		Morphology Operation	
	PSNR	***SNR***	***PSNR***	***SNR***	***PSNR***	***SNR***
image2	20.3319	5.3941	19.5674	16.6256	20.2710	11.5211
image3	20.1152	5.1174	19.9301	16.7515	20.0156	9.1873
image4	19.8976	0.5580	19.3978	18.2357	19.8810	7.6215
image5	19.5674	4.9032	19.2759	16.7030	19.4284	7.6310
image6	20.1098	-9697	19.8782	17.0575	20.0045	5.7601

VII. CONCLUSION

MRI using segmentation method is an important for brain tumor. This paper has three steps, first is preprocessing of given MRI image and second is tumor segmentation and third step is extract of brain tumor. Preprocessing used RGB to convert gray scale image and Gaussian high pass filter is for improving the segmentation quality. Tumor segmentation proposes about thresholding for brain MRI and finally, morphology operation is used to extract of brain tumor. The number of total pixels, white pixels and black pixels are also calculated from the extracted brain tumor image. Brain tumor is extracted from any MRI images in this system.

Performance of each image is measured by value of PSNR. Performance of proposed system analyzed using Gaussion high pass filter, and this filter produce a sharper image and give better quality of image.

Furthermore, a large amount of computation time can be reduced in this system because Otsu's thresholding method takes less time of segment the image. Next, the area and location of extracted brain tumor will also be calculated in this system. The proposed system will be analyzed using MATLAB continuously.

ACKNOWLEDGMENT

I would like to thank Pro-Rector Dr. Soe Lin Aung , Head of University of Computer Studies (Magway), for his valuable knowledge and support and guiding me to get to right path. I would also like to give my sincere thanks to all the colleagues who support me during my research work.

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