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Segmentation of brain tumour using Enhanced Thresholding Algorithm and Calculatethe area of the tumour

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Abstract: *Automatic segmentation of brain tumor using computer analysis aided diagnosis in clinical practice but it is still a challenging task, especially when there are lesions needing to be outlined. In the applications of image-based diagnosis and computer-aided lesion detection, image segmentation is an important procedure.*

Features extracted from image analysis in companion with image segmentation algorithms are used to provide region-based information for clinical evaluation procedures. Brain tumor diagnosis is easy by using these medical equipments. The physician needs the correct measurement of the tumor area for the further treatment, this need to extract the abnormal part from the 2D MRI scan accurately and measure the region of interest. The Human-Computer interaction is helpful for this procedure. In this search the Enhanced Thresholding Algorithm is used to Area calculation of tumor.
Keywords*: Medical Image Enhancement, Thresholding Algorithm , Area calculation , Matlab.*

I. Introduction

The image segmentation is the process of segmented the image into different regions which have the same feature and structure and they used to extracted region of interests [1].

The arrival of medical imaging sources such as Computed tomography (CT), Positron emission tomography (PET) and magnetic resonance imaging (MRI) has improved the diagnosis of various diseases of human being. The medical image segmentation is one of the difficult tasks in the image processing and segmentation of ROI may give accurate measurement or in accurate measurement.

Medical imaging provides a reliable source of information of the human body to the clinician for use in fields like reparative surgery, radiotherapy treatment planning, stereotactic neurosurgery etc. Several new techniques have been devised to improve the biomedical research. MRI is a non-invasive technique for medical imaging that uses the magnetic field and pulses of radio waves. It gives better visualization of soft tissues of human body[2].

In this search presents a novel technique for the detection of tumor in brain using segmentation thresholding. The proposed method can be successfully applied to detect the contour of the tumor and its geometrical dimension. This technique can be proved to be handy tool for the practitioners especially the physicians engaged in this field.[3]

Brain tumor is a cluster of abnormal cells growing in the brain. It may occur in any person at almost any age. It may even change from one treatment session to the next but its effects may not be the same for each person. Brain tumors appear at any location, in different image intensities, can have a variety of shapes and sizes. it can be malignant or benign [2]. Low grade gliomas and meningiomas which are benign tumors, and glioblastoma multiforme is a malignant tumor and represents the most common primary brain neoplasm. Benign brain tumors have a homogeneous structure and do not contain cancer cells. They may be either monitored radiologically or surgically destroyed completely, and they seldom grow back. Malignant brain tumors have a heterogeneous structure and contain cancer cells[4].

In the field of brain MRI, Gibbs et al. [5] introduced a morphological edge detection technique combined with simple region growing to segment enhancing tumors on T1- weighted MRI data.

Fletcher-Heath et al. [6] proposed a combination of unsupervised classification with FCM and knowledge based image processing for segmentation of non-enhancing tumors. Dou et al. [7] have proposed a fuzzy information fusion framework for brain tumor segmentation using T1-weighted, T2-weighted and PD images Baskaran et al. [8] has proposed a method for texture based classification using binary decision tree. One such technique is presented by Suzuki and Toriwaki in [2] which proposes a knowledge guided thresholding technique for brain tumor segmentation.

II. Methodology

The algorithm has two stages, first is pre-processing of given MRI image and after that segmentation and then perform morphological operations. Steps of algorithm are as following:-

Step 1: Give MRI image of brain as input.
Step 2: Convert it to gray scale image.
Step 3: Apply high pass filter for noise removal.
Step 4: Apply median filter to enhance the quality of image.
Step 5: Compute threshold segmentation.
Step 6: Calculate the number of white points In the image.
Step 7: Calculate the size of the tumour using the formula.
Step 8: Display the size and stage of tumour.
All above steps are explained here in detail.

A. Image Acquisition

Images are obtained by MRI scan of brain and the output of MRI provides gray level images. A gray scale image is a data matrix whose value represents shades of gray. The elements of gray scale matrix have integer values or intensity values in range [0 255]. For applying different techniques, the digital images obtained from MRI are stored in matrix form in MATLAB. The MRI scan of patient suffering from tumor shows some region having high intensity. The objective of the algorithm is to detect the exact the location and size of this high intensity region. MRI images can involve some noise also. So the next step is to remove this noise and get enhance image for better detection.

B. High Pass Filter

A high-pass filter is a filter that passes high frequencies well, but attenuates frequencies lower than the cut-off frequency**[9]**After that image is given as an input to high pass filter. A high pass filter is the basis for most sharpening methods. An image is sharpened when contrast is enhanced between adjoining areas with little variation in brightness or darkness. A high pass filter tends to retain the high frequency information within an image while reducing the low frequency information. The kernel of the high pass filter is designed to increase the brightness of the center pixel relative to neighboring pixels. [10]

C. Median filter

Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal.[10-11] This filter enhance the quality of the MRI image.

$$\hat{f}(x, y) = \underset{(s,t)\in S_{xy}}{\text{median}} \{g(s, t)\} \qquad \text{.......(1)}$$

D. Threshold Segmentation

Segmentation refers to the process of partitioning a digital image into multiple regions (sets of pixels). The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). Segmentation is mainly used in medical imaging, Face recognition, Fingerprint recognition, Traffic control systems, Brake light detection, and Machine vision.[12]

Thresholding technique can be used for MRI brain tumor segmentation. According to intensity/brightness is a simple technique for images which contain solid objects on a background of different, but uniform, brightness. Each pixel is compared to the threshold: if its value is higher than the threshold, the pixel is considered to be “foreground” and is set to white, and if it is less than or equal to the threshold it is considered “background” and set to black . Various versions of thresholding technique have been introduced that segments MR images by using the information based on local intensities and connectivity [4]. Most of the existing thresholding methods are bi-level, which use two levels to categorize the image into background and object segments. However, MR images have many different parts which make these methods non-applicable. Thus, the loss of information from the image may occur and diagnosis system may mislead physicians in their clinical task. Therefore, multi-level thresholding algorithms have been developed to ensure that all important information from MR images are retained, but they become computationally expensive, because a large no. of iterations would be required for computing the optimum threshold. Otsu’s global thresholding method is the most suitable image segmentation method to segment a brain tumor from a Magnetic Resonance Image. It selects that gray level value as threshold for which between-class variance is maximised. In general, thresholding algorithms do not use spatial information of an image and they usually fail to segment objects with low contrast or noisy images with varying background. [13] The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. The key of this method is to select the threshold value (or values when multiple-levels are selected). A zero matrix of same size of original image matrix is considered. Each pixel value of the image matrix is compared with the threshold point. If the value of pixel is greater than threshold, coordinate of c matrix is assigned a value 255 otherwise 0 is assigned to that. This process is repeated till all the pixel values are compared to threshold point[14]. A greyscale image is turned into a binary (black and white) image by first choosing a grey level **T** in the original image, and then turning every pixel black or white according to whether its grey value is greater than or less than T:

$$\text{A pixel becomes} \begin{cases} \text{white} & \text{if its grey level is} > T, \\ \text{black} & \text{if its grey level is} \leq T. \end{cases}$$

Matrix is then transformed into image using ***'imshow'*** command Below, in figure (1)

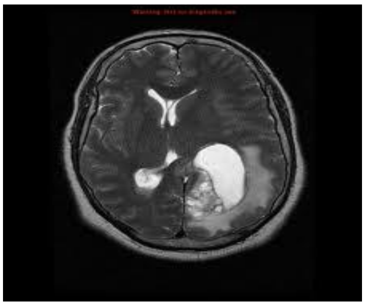


FIGURE (1) a. original image b. Threshold segmented image

E. Area calculation in MATLAB command window

In the approximate reasoning step the tumour area is calculated using the binarization method. That is the image having only two values either black or white (0 or 1). Here 256x256 jpeg image is a maximum image size. The binary image can be represented as a summation of total number of white and black pixels.[15] Area of an image is the total number of the pixels present in the area which can be calculated in the length units by multiplying the number of pixels with the dimension of one pixel:

Image, $I = \sum_{w=0}^{255} \sum_{H=0}^{255} [f(0) + f(1)]$ …………(2)

Pixels = Width (W) X Height (H) = 256 X 256

f (0) = white pixel (digit 0)

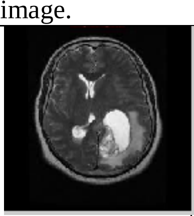
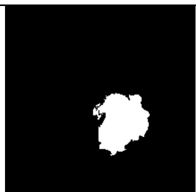
f (l) = black pixel (digit 1)

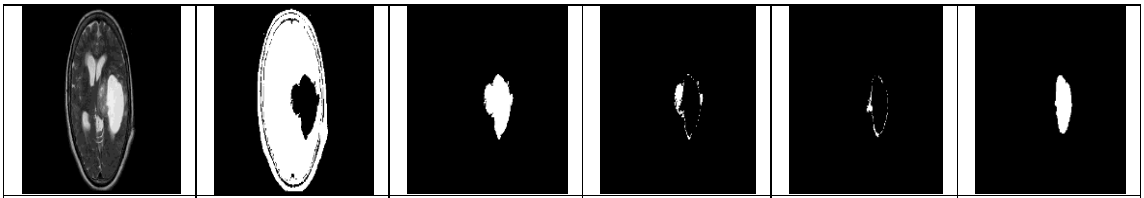
No_ of_ white pixel $P = \sum_{w=0}^{255} \sum_{H=0}^{255} [f(0)]$ …………(3) Where,

P = number of white pixels (width*height)

III. Result And Discussion

figures show the images as an output threshold image, Finally input image and extracted tumour from MRI image.

					
Original image no. 1	A1)Healthy Tissues	A2)Pathological Tissue	A3)Edema	A4)Solid part	A5)Fluid
Figure(2) shows the MRI for brain tumor images taken from internet.					



Original image no. 2	B1)Healthy Tissues	B2)Pathological Tissue	B3)Edema	B4)Solid part	B5)Fluid

Figure(3-b) shows the MRI for brain tumor images taken from Al khadema Teaching Hospital .

Summary of the results has been placed in a tabular form in the following:

Table 1:Contains image size with tumor size in pixels i.e tumor area in pixels with different images.

Image name	Image size	area in pixels
Original image no. 1	255×255	20830
A1	255×255	17867
A2	255×255	2963
A3	255×255	1690
A4	255×255	580
A5	255×255	687
Original image no. 2	276×162	14167
B1	276×162	12529
B2	276×162	1638
B3	276×162	357
B4	276×162	157
B5	276×162	1124

V. Conclusions and Future works

Conclusion:

In this study a technique to detect presence of brain based on thresholding technique has been developed. The segmentation of the brain is also being done while detecting the presence of the tumor. The physical dimension of the tumor which is of utmost importance to the physicians can also be calculated using the present technique. Enhanced thresholding algorithm is modified form of standard thresholding algorithm . In this work, first instead of considering each gray value as threshold initially, threshold vector is limited to intensity values in the region of interest marked by user. This leads to selection of an appropriate threshold. This also leads to high compression by saving only region of interest. Second, to enhance the performance of thresholding for tumor area extraction, thresholding is followed by reconstruction based morphology.

Future works:

1. The experimental results are compared with other algorithms.
2. designing a preprocessing step to assimilate various databases or different type of images in a certain database to make the algorithm more practical.

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