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Study of various DIP Techniques used for Brain Tumor detection and tumor area calculation using MRI images

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***Abstract*— This paper is focused on a study of various techniques of brain tumor detection of MRI images using DIP techniques. The study of various techniques is useful for successful diagnosis and treatment planning of brain tumor. Magnetic Resonance Imaging (MRI) method is used for brain imaging and analyzing internal structures in detail. The accuracy of detecting the brain tumor location and size with good quality takes the most important role of detecting the brain tumor. The brain tumor segmentation carried manually from MRI images is very crucial and time consuming task. Therefore, to avoid that, it needs to use computer aided method for detection of brain tumor. The brain MRI images using various image processing methods like preprocessing, segmentation, morphological operation are used; based on different feature combinations as color (intensity), edge, texture and calculated the tumor area as well as measure the quality of input then output images, it gives a satisfactory result. This research work is helpful in the medical field to detect brain tumors and suggest a treatment plan to the patient**

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Keywords- Area, Brain tumor, MRI, Segmentation, Morphological Operation

I. INTRODUCTION

Brain is most complex part of the human body; many complex functions are controlled by the brain. Brain tumor is an abnormal mass of tissue formed by the uncontrolled growth cell division [1]. Brain tumor detection is considered a challenging task in medical image processing. The brain tumor extraction is very challenging task on the basis of colour (intensity), other than tumor different part of the brain having also high intensity, in this situation to identify brain tumor and extraction of tumor is very difficult. There are many methods developed but they have different results in each image. There is a need to find a method by which detection of tumor can be done uniquely and accurately.

Magnetic resonance (MR) images are a very useful tool to detect the tumor. Generally, a CT scan or MRI that is directed into intracranial cavity produces a complete image of the brain [2]. The output image is visually examined by the physician for detection & diagnosis of brain tumor. The brain tumor segmentation which is carried out manually from MRI is a time consuming and crucial task. The accuracy of detecting the brain tumor location and size takes the most important role in the successful diagnosis and treatment of tumor and the brain tumor detection needs to be fast and accurate.

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Our aim is to achieve a high accuracy in tumor detection, separation and tumor area calculation through a combination of several techniques for preprocessing, image segmentation, feature extraction and classification. At the end of the process the tumor is extracted from the MR image and tumor area is calculated.

In this paper, the next section is proposed methodology of brain tumor detection techniques plan. Then in the following section we explain different Methods which are used for brain tumor detection and tumor area calculation methods and sub-methods like Preprocessing, Segmentation, Morphological operation, Feature extraction then the tumor area calculation. The fourth section is Results and Discussion; in this section results are shown which are calculated using Matlab function. And the fifth final section is conclusion; in this section it is concluded that how our research is useful for brain tumor detection in the medical field as per our results.

II. PRAPOSED ALGORITHM

The proposed algorithm for detection of brain tumor consists of the following processes, as shown in Fig.1. Pre-processing, Segmentation, morphological operations and result of brain tumor detection and tumor area calculation.

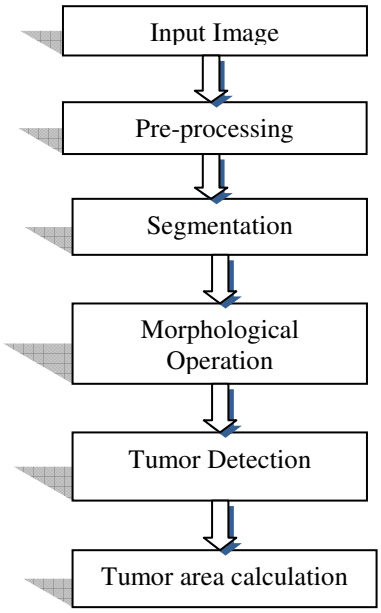

Figure 1. Flow Chart of Proposed Method

III. METHODS AND TECHNIQUES

A. Data Processing (Preprocessing)

Preprocessing is very important in image processing because different types of noise and error are occurring in image acquisition or in storage or during transportation. In this phase preprocessing method implemented by applying preprocessing methods on the image before applying any special purpose processing. It improves the image quality and removes the noise.

There are various types of noise and noise removals techniques are introduced in image processing. Many researchers have used different noise removal techniques, but every technique having its advantages and disadvantages. The satisfactory output can be achieved by using several de-noising techniques, like, Gaussian filter, median filter, Weiner filter, etc.de-noising or noise removing method is very important for good visualization of objects in an image.

A.1 De-noising

In this study, a median filter is used. Median filtering is a nonlinear filter that is used as an effective method for removing noise. It works by moving pixel by pixel through the image, replacing each value with the median value of neighbouring pixels. The pattern of neighbours is called the ‘‘window,’’ which slides pixel by pixel over the entire image [3].

The median is calculated by first sorting all the pixel values from the window in numerical ascending order, and then replacing the pixel being considered with the middle (Median) pixel value [4]. Median filtering is better than other filtering for removing noise in the presence of edges. The output of this sub-step in preprocessing is the noise free MRI image.

B. Image Contrast Enhancement

The effect of poor contrast, defects have a greater impact on the contrast of the acquired image. In this case, the gray level of each pixel is scaled to improve the contrast of the acquired image. Contrast enhancement step sometimes proves to be one of the important pre-processing steps, especially in case when the image has a poor contrast. In the present work, the contrast of the smoothened image is enhanced using the image processing toolbox functions. This improves the visualization of the original image and thus makes the object of interest more clearly visible [5].

C. Segmentation

Image segmentation is the process of partitioning a image into different regions [6]. The level of partitioning is carried depends on the problem being solved, and the segmentation should stop when the edge of the tumor is able to be detected and main interest is to isolate the tumor from its background. The main problem with the disease, detection process is that the cancer cells appear dark on the MRI, which is very confusing in the image processing. Image preprocessing is necessary before applying algorithms. Still a number of researchers used various numbers of Segmentation techniques for tumor detection. In our study thresholding gives good results.

C.1 Threshold

It is an intensity-based segmentation. Thresholding or image binarization is one of the important techniques in image processing and computer vision. It is used to extract the object from the background. The segmented image, which is obtained by thresholding, has the advantage of smaller storage space, fast processing speed, and ease of manipulation; Compared with a gray level image which usually contains a large number of gray levels (maximum 256 levels). The output of this step is the segmenting image with a dark (black) background and light (white) tumor area [7].

D. Region Props

Region props compute all the shape measurement and pixel value measurement specifying the proportion of the pixel which are present in the region and calculate the area. In this study “Solidity” properties of Shape measurements embedded with area properties which is used in the pixel value measurement. This properties present in Region props method available in Matlab Software.

E. Morphological Operation

Morphology is a broad set of image processing operations that process images based on shapes. Morphological

operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbours. Morphological opening method removes small objects from an image while preserving the shape and size of larger objects in the image. Dilation and erosion are often used in combination to implement image processing operations like morphological opening of an image has been an erosion followed by a dilation, morphological closing of an image, is the reverse: it consists of dilation followed by an erosion with the same structuring element [8,9].

F. Feature Extraction

Feature extraction is identifying relevant features leads to faster, easier, and better to understand images. The feature extraction process affects significantly the quality of the classification process. MRI image texture contains a rich source of information such as characterize brightness, colour, shape, size, and other features. Therefore, it is required to compute the digital image characteristics to describe its texture properties numerically and this is called image feature extraction [10].

G. Tumor area calculation

The dimension of each image is 256 × 256 pixels Therefore; the pixel dimension is fixed to 1 mm × 1 mm.
The binary image can be represented as a summation of total number of white and black pixels [10].
An image (I) is given by

$$I = \sum_{w=0}^{255}\sum_{H=0}^{255}[f(0) + f(1)] \quad (1)$$

Where,
Pixels = Width (W) X Height (H) = 256 X 256
f (1) = white pixel (digit 1)
f (0) = black pixel (digit 0)

$$\text{No\_ of\_ white pixel } P = \sum_{w=0}^{255}\sum_{H=0}^{255}[f(1)] \quad (2)$$

Where,
P = number of white pixels (width*height)
1 Pixel = 0.264 mm (3)
The area calculation formula is
Size_ of_ tumor, S = [(√ P)* 0.264] mm^2 (4)

Where,
P= no-of white pixels,
W=width,
H=height [11].

H. Quality Measurement

In image processing different parameters are used for quality measurement. There are few of them are used, for eg.
SNR - Signal to noise ratio,
PSNR - Peak signal to noise ratio, Higher the PSNR values, better the quality of image.
MSE - Mean square error, Lower MSE value of an image means less error and high quality of the image.
PSNR and MSE are inversely proportional to each other [12].

IV. RESULTS AND DISCUSSION

In this research, various MRI brain images are used, these MRI scanned images are displayed in a two dimensional matrix which will have the number of pixels as its elements. The values of the gray scale image would range from 0 to 255, where 0 represents total black colour and 255 shows pure white colour. Any value in between 0 to 255 shows a variety of the intensities of gray colour.

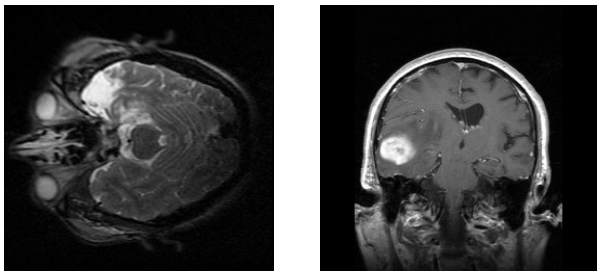

Figure 2. Input image

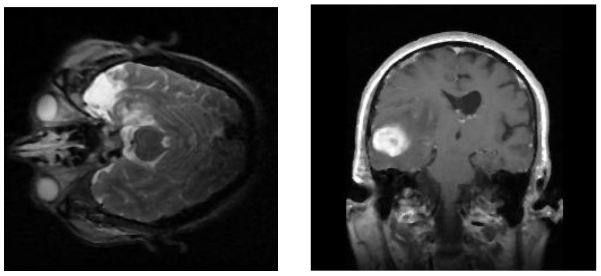

Figure 3. Median filter

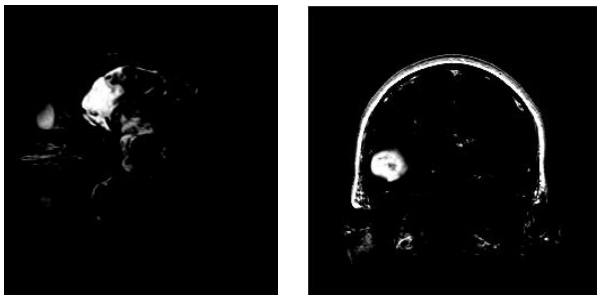

Figure 4. Contrast enhancement

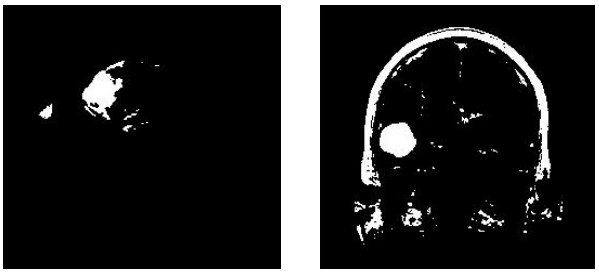

Figure 5. Threshold Segmentation

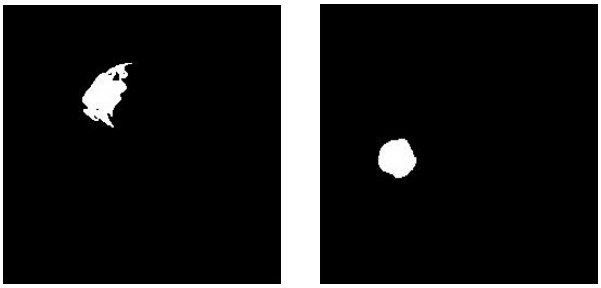

Figure 6. Region Props Solidity

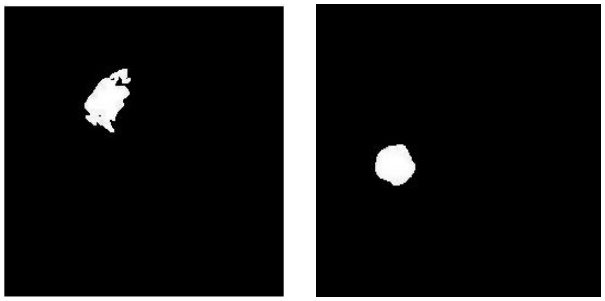

Figure 7. Morphological Operation

After tumor separation of MRI brain images by applying above various methods, calculate the tumor affected area. For calculating tumor area, the above mentioned equation 1 is used. The proposed technique is tested on various tumor images. Fig. 2 To Fig.7 are two different images shows the tumor extracted from MR brain images. The tumor portion of the MR image is visible, shown as white colour. This portion has the higher intensity than other regions of the image. The above methods are able to extract the brain tumor successfully.

Then calculate the tumor area of output image Fig.7 using tumor area calculation equation 4 and result shown in table I. Tumor area calculated in mm^2.

Same methods are used for number of different images and good results are getting as per quality measurement and subjective knowledge.

Quality measurement method first applied on input images, then on output images. In quality measurement methods when output image PSNR value is high and MSE value is low as compare to input image PSNR, MSE value then output image quality is better than input image. Results of quality measurement for input images showed in table II. Quality measurement of output images results shown in table III. By comparing table II and table III results better results are obtained in output images. In the output images tumor area is separated and better visualize with better quality.

TABLE I. Tumor area in mm^2

Input Image	*White pixels*	*Area MM²*
Img1	1331	9.6314
Img2	961	8.184
Img3	1155	8.9731
Img4	718	7.0740
Img5	265	4.2976
Img6	1410	9.9131
Img7	331	4.8030
Img8	1866	11.4040
Img9	4001	16.6989
Img10	2202	12.3883

TABLE II. Quality measurement of input images

Input Image	*SNR*	*PSNR*	*MSE*
Img1	15.21	18.13	998.6
Img2	15.51	17.70	1.10
Img3	16.15	16.05	1.61
Img4	12.75	17.85	1.06
Img5	12.69	17.86	1.06
Img6	15.15	19.62	708.5
Img7	17.06	16.97	1.30
Img8	15.12	16.55	1.43
Img9	13.14	19.02	814.0
Img10	14.62	17.62	1.12

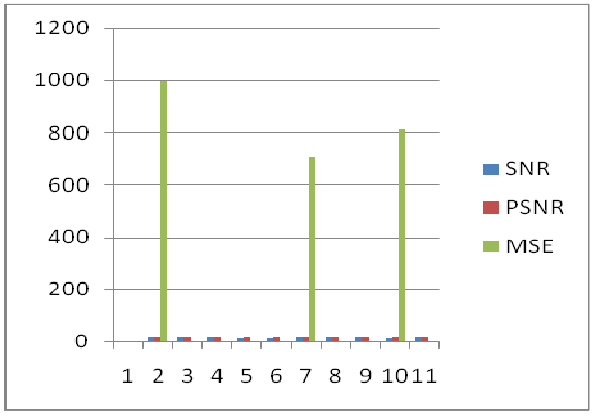

Figure 8. Quality measurement of input image

TABLE III. Quality measurement of output images

Input Image	*SNR*	*PSNR*	*MSE*
Img1	7.20	50.36	0.56
Img2	7.18	50.90	0.48
Img3	7.19	51.47	0.71
Img4	7.17	51.40	0.57
Img5	7.15	51.31	0.58
Img6	7.20	50.80	1.00
Img7	7.15	51.30	0.80
Img8	7.22	50.90	0.91
Img9	7.32	50.35	0.98
Img10	7.23	52.00	1.03

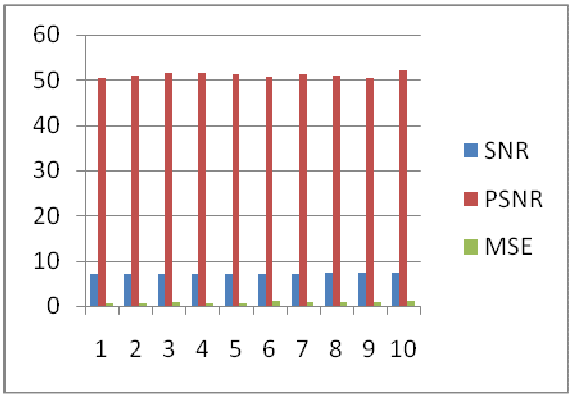

Figure 9. Quality measurement of output images

V. CONCLUSION

Image processing plays an important role in medical field for diagnosis of disease. Magnetic Resonance Imaging (MRI) modality is a medical imaging technique used to visualize the internal structure of the body and provide images. MRI contains useful and fine information which is used to improve diagnostic accuracy. In this paper, various digital image processing methods are used for tumor detection. The proposed algorithm detects the tumor affected area and separated from the background area (MRI Image), then calculates the tumor area, and measure the quality of images. With the help of this, the detection of tumor is done and on the basis of size whether patient is serving from stage 1, stage 2, stage 3, stage 4 are known. Finally the proposed algorithm gives the better accuracy results of brain tumor detection and tumor area calculation. In the output image tumor that is in non-uniform shapes. Tumor area is an important diagnostic indicator in effective treatment and surgical planning.

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