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# Detection of Brain Tumour from MRI Images using Anisotropic filtering and Thresholding Segmentation

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**Abstract** — Now a days, Medical image processing is the most vital challenging and emerging field. Processing of MRI images is one of the part of medical field. This paper describes the proposed strategy to detect & extraction of brain Tumor from patient’s MRI scan images. Tumour is a pre-stage of cancer which becomes serious issue in this era. In this method , it is possible to detect whether the tumour is present or not which incorporates some noise removal functions, segmentation and morphological operations those are the basic concepts of image processing. Brain Tumour Detection in MRI scan images is implemented by MATLAB software.

*Key Words — MRI, Segmentation, Morphology, MATLAB*

## SECTION .I : INTRODUCTION

Tumour is the abnormal growth of the tissues. Brain tumor is the collection of an abnormal cells which grow and divide more uncontrollably that control normal cells. Brain tumors can be malignant (cancerous) or benign (non-cancerous) that occur in different parts of the brain. Brain tumor is classified as primary tumor which starts with brain and secondary tumor which mostly spread from other area of the body . A metastatic brain tumor is a cancer that has spread from other body parts to the brain.Epilepsy is a neurological disorder in which brain activity becomes abnormal, causes unusual behavior, sensations, and sometimes loss of awareness.

Magnetic resonance imaging (MRI) is a medical imaging technique that uses a magnetic field and computer-generated radio waves which used to produce high quality of detailed images of the organs and tissues in your body. From the high-resolution images, we can extract the detailed information about human brain development and discover abnormalities. Nowadays there are several techniques for classifying MR images, which are fuzzy methods, neural networks, atlas methods, knowledge-based techniques, shape methods, segmentation etc.

First stage is pre-processing contains filtering technique which removes noise by using anisotropic filter from brain MRI image. Second stage contains segmentation of tumor from filtered image using thresholding

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technique. Third stage contains morphological operations which shows the location of the tumor on original image.

The morphological operations are basically applied after image segmentation. Two important operations of morphology are dilation and erosion. To segment out the tumour location from the image, it is required to create a binary tumour masked window by putting the tumor mask on dilated brain MR image with 255 intensity to identify the tumour part in the image.Finally image is obtained with detected tumour.

## SECTION .II: METHODOLOGY

The algorithm has two stages, first given input MRI image is pre-processed and segmentation using Thresholding and then perform morphological operations. Following are the steps of algorithm as follows:-

1) Take brain MRI image as input.
2) Convert it to gray scale image.
3) Noise removal using Anisotropic filter.
4) Segmenting the tumour region by applying thresholding.
5) Apply morphological operation to detect tumor location
6) Create a bounding box across tumor
7) Getting tumor outline by image filling, eroding, subtracting
8) Subtracting eroded image from original BW image
9) Finally inserting the tumor outline in the filtered image, we get exact tumor location

All above steps are explained here in detail.

### *A. Grayscale Imaging*

MRI images are magnetic resonance images which can be acquired by computer to show some desired part of the body which is under . Generally MRI images on computer looks like black and white images practically called as gray scale image. it also known as halftone where possible pure black and pure white shades are possible. The brightness levels of RGB components in color images are represented by binary 00000000 to 11111111. The brightness of the gray is directly proportional to the number representing in the brightness levels because there are 8 bit s in the binary representation of the gray level, this imaging method is called 8-bit grayscale. The black shade represents the total absence of transmitted or reflected light and white shade represents the transmission or reflection of light at all visible wavelengths. So first we pre-processing the MRI image to convert into grayscale image. By converting into binary image , it reduces the complexity and simplifies the recognition and classification of image process.

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### *B. Anisotropic filter*

For signal processing, it is desirable to perform noise reduction technique in an image or signal. Thus filter is a nonlinear digital filtering technique often used to reduce the noise which is a typical pre-processing step to improve the results of further processing.

After gray scaling we need to remove the noise in the input image. For this purpose, filtering technique is used. Anisotropic filter is used here to remove the entire noise from the input image or for denoising purpose. In this filtering section we are initializing some variables, they are: num_iter=10, delta=1/7, kappa=15, option=2.Then image will be preprocessed, after that anisotropic filtering is applied. 'anisodiff.m' is a file in which input image is converted to double and them PDE is applied. This file includes pixel distances and here anisotropic diffusion, discrete PDE solution was done. The main function of filtering is to remove noise from the input image using anisotropic filter.

### *C. Threshold Segmentation*

Thresholding is the simple and widely used method in image segmentation. This method is based on a proper selecting threshold value T to convert a gray level image into a binary image. all the gray level values below this Threshold T will be classified as black (0), and those above T will be white (1). The segmentation process is selecting the proper value of threshold T.

The thresholding technique can be described as:

$$T = T[x, y, p(x, y), f(x, y)]$$

Where T is the threshold value. x and y are the coordinates of threshold value.

P(x, y) and f(x, y) are gray level pixels of the input image.

It is very advantageous in separating the foreground from background. The binary image provides essential information about the shape and position of the objects of interest (foreground). The threshold image or segmented image g(x, y) can be defined as:

$$g(x, y) = \begin{cases} 1 & \text{if } f(x, y) > T \\ 0 & \text{if } f(x, y) \leq T \end{cases}$$

Any point (x, y) in the image at which f(x, y)>T is called a foreground point. if any point (x, y) in the image at which f(x, y)≤ T is called a background point.

### *D. Morphological Operations*

Morphological operation is applied after image segmentation. Morphological operations are used to identify the boundaries and skeleton of objects in the image. Morphology creates a window called a structure element (kernel). This window is place in all possible locations on the image and the corresponding pixel is compared with neighborhood.

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For morphological operations structuring element is required. Structuring element is a small binary image, i.e. a small matrix of pixe having the value of zero or one. The matrix dimensions indicates the size of the structuring element .the ones and zeros pattern specifies the shape of the structuring element. The structuring element is applied to interact with the image to get the resultant. The important characteristics to be considered for a structuring element are its shape, size and origin. The structuring element identifies the pixel of interest which is to be processed. The mechanism of structuring element resembles that of masks used in spatial filtering, it is moved all around the image to be probed to hit or miss at that location

The fundamental morphological operations are erosion and dilation.

**(i)** ***Dilation:*** The dilation operation makes an object to grow by size. The extent to which it grows depends on the nature and shape of the structuring element. Dilation process is basically used to fill the holes (missing pixels) in a continuous object. The dilation operation, since it adds pixels at the boundary of the object it effects the intensity at that location and as a result blurring effect can be observed.

**(ii)** ***Erosion:*** The erosion operation is complementary to dilation. Erosion operation causes object to lose its size. The erosion operation removes structure of smaller in size than that of the structuring element. So, it can be used to remove the noisy “connection” between two objects. Since the unwanted pixels are “erased” the net effect is sharpening of the object in an image. The erosion operation is analogous to sharpening high pass filter that are used in linear filtering of an image.

**(iii)** ***Image opening***

The opening of an image is a combinational operation of erosion and dilation. Opening operation is nothing but the erosion of an image by a structuring element and the resultant is dilated with the same structuring element. This operation smoothens the outline of an object clears the narrow bridges and eliminates minor extension present in the object

**(iv)** ***Image closing***

The closing of an image is also a combinational operation of erosion and dilation. It differs from the opening operation in the sense of order of occurrence of erosion and dilation operation. The closing operation smoothen the narrow breaks and thin gaps. As a result, it eliminates small holes and fills gaps in the objects boundaries.

After segmentation, morphological processing is applied to remove unwanted part of tumor or separates the affected area of the tumor. The morphological operation contains two important operations, first is erosion operation and second is dilation operation. At the end, the decision has taken whether the MRI image consists of tumor or not. If the image is having a tumor, then a bounding box will be created across tumor. Then we get outline by eroding the tumor walls by few pixels, subtracting the eroded image from original BW image. Finally, by inserting the tumor outline in the filtered image we get the location of tumor or detected tumor.

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## SECTION.III : PERFORMANCE ANALYSIS

### *(i) Performance Analysis of Anisotropic Filter*

Three types of noises (Gaussian, Speckle, Salt & pepper noise) are added to the input image and MSE and

MSE= $\frac{1}{q}\sum_{i=0}^{p-1}\sum_{i=0}^{q-1}||h(\mathrm{i}\,,j)-g(i,j)||^2$

PSNR value are calculated as following:

PSNR = 20 $\log_{10}\left(\frac{MAXf}{MSE}\right)$

Where h=symbolizes the matrix data of our original image.

g=symbolizes the matrix data of our degraded image.

p=symbolizes the row number of intensity values of the images and “i “symbolizes the index of the row

q=symbolizes the column number of intensity values of the images and “j” symbolizes the index of the Column.

$MAX_f$ is the maximum signal value that exists in our original image.

The following table contains MSE and PSNR value for anisotropic filter or Gaussian noise, Speckle noise, Salt & pepper noise that are added with original MRI brain input image to measure the performance of anisotropic filter.

| METHOD | PSNR VALUE (dB) | MSE VALUE | NOISE TYPE |
|---|---|---|---|
| Anisotropic filter | 73.90257 | 0.00231 | Gaussian noise |
| Anisotropic filter | 75.21810 | 0.00208 | Speckle noise |
| Anisotropic filter | 77.92357 | 0.00123 | Salt & pepper noise |

**Table.1. PSNR and MSE value calculation for Anisotropic Filter**

### *(ii) System Performance*

In this method, all images we had collected are tested to evaluate the system sensitivity, specificity and accuracy. The following attributes are used in the calculation.

- TP (True Positive): Existing tumor and detected correctly.
- TN (True Negative): Non-existing tumor and not detected.
- FP (False Positive): Non-existing tumor and detected.
- FN (False Negative): Existing tumor and not detected.

***Sensitivity*** is the measure of successful determination of the person having a tumor. The sensitivity is given by:

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$$\text{Sensitivity (\%)} = \frac{TP}{TP+FN} * 100$$

***Specificity*** is the measure of successful determination of the person not having a tumor. The specificity is given by:

$$\text{Specificity (\%)} = \frac{TN}{TN+FP} * 10$$

***Accuracy*** is the measure of successful classification. The accuracy is given by:

$$\text{Accuracy (\%)} = \frac{TP+TN}{TP+TN+FP+FN} * 100$$

For system performance we had taken 60 MRI brain images as inputs and testing all these images one by one in the MATLAB software, we calculated the parameters such as sensitivity, specificity, accuracy.
The follwing table illustrates these paramaters.

| Number of total images | TP | TN | FP | FN | Sensitivity | Specificity | Accuracy |
|---|---|---|---|---|---|---|---|
| 60 | 31 | 20 | 1 | 8 | 79% | 95% | 85% |

**Table.2. Performance Table**

From the performance table, we noticed that

- Out of total 60 images, 31 images with tumor are correctly evaluated by the system.
- 20 images without tumor was correctly identified by the system as images without tumor with 100% success.
- 1 image without tumor was incorrectly identified.
- 8 images with tumor was incorrectly identified by the system.
- The sensitivity obtained is 79%, specificity obtained is 95% and the accuracy obtained is 85%
- So, the proposed approach gave a better result than the existing method.

## SECTION .IV: RESULT ANALYSIS

In this proposed method, we have tried to accurately detect the tumor in MRI abnormal brain images. The accuracy obtained from our proposed method is 85%. To fulfill the requirement, noise removal using anisotropic filtering, segmentation using thresholding and morphological operations should be performed.

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***Test Case 1:*** In this test case 1, an MRI abnormal brain image is taken as input. By performing the image processing steps like filtering, threshold segmentation and morphological operations on this input image using MATLAB Software, we found that the tumor was detected in this image.

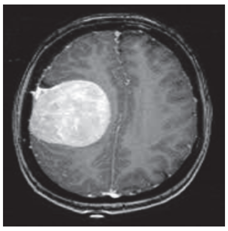
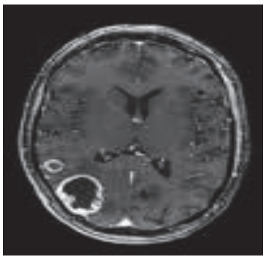


**Fig (a).Input Image for Case 1**

***Test Case 2:***

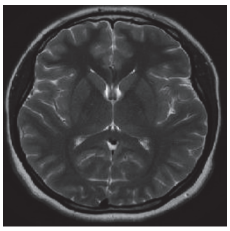
In this test case 2, an MRI normal image is taken as input. By performing the image processing steps like filtering, Threshold segmentation, Morphological operations on this input image using the MATLAB software, we found that the tumor was not present in this image.

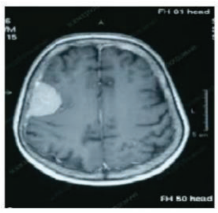


**Fig(b).Input image for case2**

The following figure shows the final output of every steps

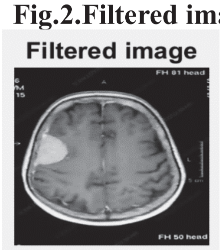
**Fig.1.Input Brain MRI Image**





**Normal image** **abnormal image**

**Fig.2.Filtered image and Bounding Box Image**



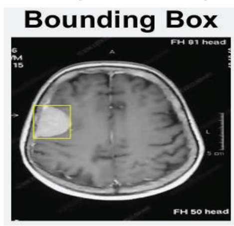



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**Fig.3.Tumour alone and Tumour outline**

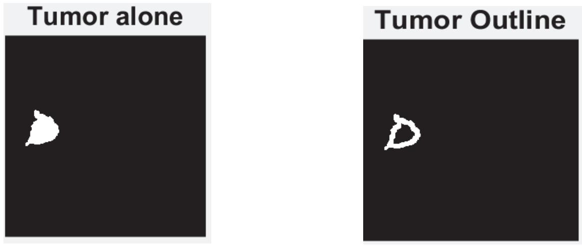
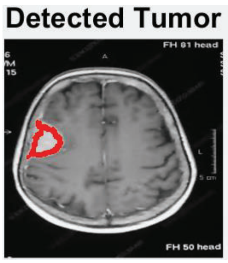



**Fig.4.Detected Tumor**




## SECTION.V : CONCLUSION

MRI images are best suitable for brain tumor detection. The MRI brain input image contains various noises. For proper segmentation and morphological operations, the input images should be noise free. That is why we have used anisotropic filter for its better performance. Thresholding for segmentation purpose. Morphological operations are used to extract the tumor from segmented region. Experimental result shows that thresholding has obtained 85% accuracy in segmentation. Finally, our proposed method gave better performance and accuracy as compared to the existing method.

## SECTION .VI : FUTURE SCOPE

In future, this method can be done more advanced so that tumour can be classified according to its type. Also tumour growth can be analysed by plotting graph which can be obtained by studying sequential images of tumour affected patient.

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