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BRAIN TUMOR DETECTION AND SEGMENTATION USING ANISOTROPIC FILTERING FOR MRI IMAGES

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Abstract: A brain tumor may be a fatal disease that can't be confidently detected without MRI. To detect the tumor we use the filtering and morphological operations. To pave the way for morphological operations on MRI image, the image was first filtered using an Anisotropic Diffusion Filter to scale back contrast between consecutive pixels. Then the image was resized and utilizing a threshold value the image was converted to a black and white image. On this semi-processed image morphological operations are applied and knowledge on solidity and areas of the plausible locations was obtained. A minimum value of both of these characters has been determined from a statistical average of various MRI images containing the tumor. Though this simulation routine can give the correct result most of the time, it fails to perform when the tumor's size is too small or the tumor is hollow. The goal of the paper is to build a database of image data of tumors from the MRI images taken from a different angle of a particular human and by analyzing them to point out the exact location of the tumor. To fulfill this, tumor detection and segmentation methods were developed for achieving better accuracy so that detection can be more reliable.

Keywords: anisotropic filtering, thresholding, erosion, dilation, boundary extraction, accuracy

I. INTRODUCTION

Nowadays the MRI Images are very useful in the Medical field for understanding and analyzing Medical images. The brain tumor defines the unusual growth of tissues and uncontrolled cell proliferation. So due to this, the natural pattern of cell growth and death is failed. The brain tumor is of two stages [1]:

1. Primary stage
2. Secondary stage.

When a tumor is spread in any part of the brain then it is known as a brain tumor. A brain tumor can be identified by several symptoms including seizures, mood changing, difficulty in walking and hearing, vision and muscular movement etc. The brain tumor is classified into Gliomas, Medulloblastoma, Epeldymomas, CNS Lymphoma and Oligodendroglioma.

In recent years, one among the most reasons for rising levels of morality i.e., reduction within the lifespan of the adolescents is affected by the brain tumor disease. It has been observed from contemporary studies that the enumeration of the people vanishing due to the brain tumor has risen to 300% [2]. So, brain tumor detection is an urgent need for today's smart world as radiation growing into a dangerous case of causing sudden deaths of birds. Brain tumor detection has a lot of applications such as clinical outlining and medication devising. Brain tumor detection faces a lot of challenges as tumors in the brain are size variant, shape variant, location variant, and image intensity variant. The problem occurs due to the inaccurately locating area of the tumor. The imaging of brain tumor can be done by-

1. MRI scanning that is magnetic resonant image
2. CT scanning i.e. computer tomography
3. Ultra sound etc.

Magnetic Resonance Imaging (MRI) may be a medical imaging technique utilized in

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radiology to take pictures of the anatomy and therefore the physiological processes of the body. MRI scanners use strong magnetic fields, magnetic flux gradients, and radio waves to get images of the organs within the body. MRI doesn't involve X-rays or the utilization of radiation, which distinguishes it from CT and PET scans. MRI may be a medical application of Nuclear resonance (NMR). NMR can also be used for imaging in other NMR applications, such as NMR spectroscopy [3]. Pre-processing of MRI images is that the primary step in image analysis which performs image enhancement and noise reduction techniques which are wont to enhance the image quality, then some morphological operations are applied to detect the tumor in the image. The morphological operations are basically applied to some assumptions about the dimensions and shape of the tumor and within the end, the tumor is mapped onto the first grayscale image with 255 intensity to form visible the tumor within the image. Computerized tomography (CT) [4] scan combines a series of X-ray images taken from different angles around your body and uses computer processing to make cross-sectional images (slices) of the bones, blood vessels and soft tissues inside your body. CT scan images provide more detailed information than plain X-rays do.

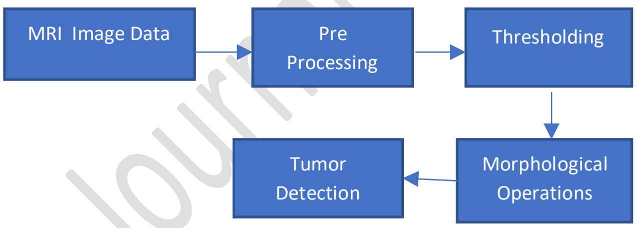

Fig1:Block diagram for tumor detection

There are several methods to detect brain tumors so that we can diagnose and detect more easily. Some edges are nuclear network algorithm watershed and edge detection, fuzzy c-means algorithm, asymmetry of the brain is employed to detect an abnormality. The problem of edge detection is that the one among the foremost attractive problem for the image processing thanks to this it's various applications. Canny-edge detection is the one of the most a useful feature in image segmentation. F-transform is an intelligent method to handle uncertain information. This is useful for the detection of tumor boundaries. It is a very easy method for detection and is a promising and efficient method for future and edge extraction progress.

II. LITERATURE REVIEW:

Ranjeet Kaur, Amit Doegar [5] focussed on deep learning as well as machine learning optimization techniques to detect and further classify the brain tumor. A deep learning method like CNN is extremely expensive and requires a lot of datasets for achieving the simplest results. Also, it requires GPUs for faster execution whereas machine learning methods like SVM produce good leads to normal execution time. Hybrid approaches were also utilized by many researchers for achieving higher results.

Parasuraman Kumar, B. Vijay Kumar [6] the authors state Brain tumor is identified by an image processing technique. This identification required various processes like pre-processing using filter algorithm, segmentation using the clustering algorithm, feature extraction using a Grey level co-occurrence matrix and ensemble classification.The ensemble classifier classified the tumor and non-tumor region. Ensemble classifiers are a combination of different individual or separate classifiers. In their work, the ensemble classifier is made up of combined classifiers of feed-forward artificial neural network extreme learning machine and support vector machine classifier. Here the ensemble has high accuracy and less execution time and it is very efficient when compared to all other classifiers.

M. Sudharson, S.R. Thangadurai Raja Pandean [7] proposed a methodology to detect the brain tumor from CT/MRI brain images.The detected tumorous lesion is

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then segmented using image processing algorithms and the morphological operations are performed to obtain the vital parameters like Mean, Standard deviation, Third moment, Area, Entropy of the image. The results were depicted in two tabulations, one for CT and the other for MRI. From the obtained numerical results it is inferred that the values for an abnormal condition are always high.

Binu Thomas and PK Nizar Banu[8], define the various stages of MRI image processing and it also specifies different filtering and segmentation approaches. Different methodologies proposed by various researchers were considered, all of which show that image processing has a major role in brain tumor detection and classification, along with possible segmentation approaches. They describe Brain tumor detection using MRI images by means of segmentation using watershed, gray level threshold and canny edge detection algorithms. The achieved outcomes appeared in feature extraction which demonstrates efficient tumor detection by using K-Nearest Neighbour (KNN) algorithm.

Esmail Hassan and Abobakr Aboshgifa [9] states that far superior results can be obtained than the traditional techniques for tumor detection. The stat that GUI based programs allow to change the parameters without rewriting the program and allows fast and efficient detection of tumors. The results were more accurate and faster.

Prabhjot Kaur Chahal, Shreelekha Pandey, and Shivani Goel [10] state that efficient tumor identification, extraction, and classification are some of the challenging tasks for physicians and radiologists. Automation of those modules thus occupies a serious proportion of research within the domain of medical imaging. Several existing segmentation techniques are shown to realize good performance on different tumor datasets. regardless of the accuracy percentage reported by any automatic tumor detection system using the simplest segmentation approach, a second opinion remains required for better diagnosis in any of the cases. MR image contrast may be a significant factor because it highly influences the method of brain tumor detection. Similarly, systems combining two or more techniques are observed to report better performance. the mixture FKM is additionally observed to report overall enhancement in terms of accuracy also as computation time as compared to traditional approaches (k-means/FCM/SVM) and even hybrid FSVM to a moment extend.

III. PROPOSED METHODOLOGY

The proposed system is often summarized in three stages. The first stage contains a filtering technique that removes noise by using Anisotropic Filter (AF) from the brain MRI image then adjustment based segmentation which segments the region of the tumor from the filtered image employing a structuring element. The third stage contains morphological operation which shows the situation of the tumor on the first image. Fig.1 shows the proposed system's flowchart.

A. Dataset: A single abnormal MR image [11] is taken as input to detect the tumour. The input image is 256*256 pixels and 8-bitimage is 256*256 pixels and 8-bit grayscale.

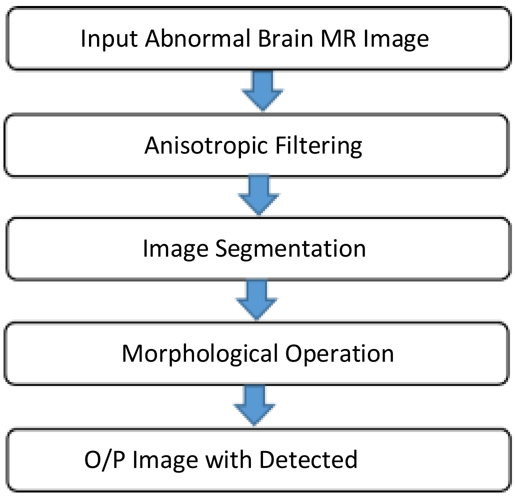

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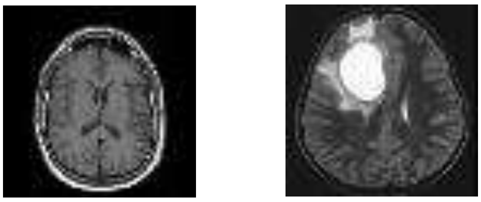
Fig. 2. Flowchart of the proposed system



(*a) Normal image* (*b) Abnormal image*

Fig. 3. Brain MRI images [11]

B. Anisotropic Filtering: An image is to remove the noises on the digital images. The quality of the image is attacked badly by the noises. There are some ways to urge obviate the noise within the image. Most of the image processing algorithms do not work well in a noisy environment. This is why the image filter is employed as a pre-processing tool. Among various filter Anisotropic Filter is employed during this thesis for denoising purposes. The general anisotropic diffusion equation is introduced to describe the image diffusion process as follows [12]:

$$\frac{\partial x}{\partial t} = \mathrm{div}(c(m,n,t)\nabla I) = \nabla c.\nabla x + (m,n,t)\nabla x \ldots \quad (1)$$

Where, ∇x denotes image gradient and c(m, n, t) denotes diffusion coefficient. The following notation shows a discretized approximation by the forward and backward differences.

$$I_{i,j}^{t+1} = I_{i,j}^{t} + dt \sum_{(k,1)\in N_4} g\left(I_{k,l}^{t} - I_{i,j}^{t}\right) \cdot \left(I_{k,l}^{t} - I_{i,j}^{t}\right) \quad (2)$$

$$g\left(I_{k,l}^{t} - I_{i,j}^{t}\right) = \frac{c_{k,l}^{t} - c_{i,j}^{t}}{2} \quad (3)$$

Where, N4 = {(i-1, j), (i+1, j), (i, j-1), (i, j+1)} denotes the 4-neighborhood of the central pixel $I_{i,j}^{t}$. From Eq. (3) we can see that noise pixel has strong diffusion action and signal pixel has weak diffusion action. Thus noise can be removed and signal will be kept. There are many diffusion models to adopt the constant step size for each iteration or whole iterative process of the image. Here a better iteration step is proposed in the Eq. (4).

$$dt = \frac{1}{4} C \quad (4)$$

Where, 1/4 is used to promise the convergence of the Eq. (2). Final output phase image is obtained by iterative process. For iteration process, iteration error (IE) is used for controlling the iterative number and its formula is:

$$IE = \frac{||I^{n} - I^{n-1}||}{||I^{n}||} \leq T_{ie} \quad (5)$$

When IE is less than or equal to tolerance T_{ie}, the iterative process is stopped.

(a) Noisy Image with Salt & Pepper Noise (b) AF output

Fig. 4. Input and Output for Anisotropic Filter

C. Image Segmentation :The segmentation is the most vital stage for analyzing image properly since it affects the accuracy of the next steps. However, proper segmentation is difficult due to the good verities of the lesion shapes, sizes, and colors along with side different skin types and textures. In addition, some lesions have irregular boundaries and in some cases, there's a smooth transition between the lesion and therefore the skin. To address this problem, several algorithms are proposed. They can be broadly classified as thresholding, edge-

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based or region-based, supervised and unsupervised classification techniques

• Threshold segmentation

• Watershed segmentation

• Gradient Vector Flow (GVF)

• K-mean Clustering

• Fuzzy C-means Clustering

D. Morphological Operation :Morphology is an instrument to extract image features useful within the legation and recital of region shapes such as- boundaries, skeletons, and convex hulls. For morphological operation structuring element (kernel) is required. The structuring element used in practice is generally much smaller than the image often a 3*3 matrix. Morphological Opening is applied to the image after segmentation. The two important operations of morphology are

a) Dilation: It works by object expansion, hole filling and finally adding all the disjoint objects

b) Erosion: It shrinks the object. The foreground pixel background is eroded within the binary image by erosion operation.

Morphological Opening is applied to the image (a) after converting it into a binary image. To segment out the tumor location from the image it is required to create a Binary tumor masked window. Normally, higher intensities comparing with other surrounding tissues are held by an abnormal brain MR image. By putting the tumor mask on dilated brain MR image the final image is obtained with the detected tumor. Fig. 5 displays the resultant images of morphological operation with the detected tumor.

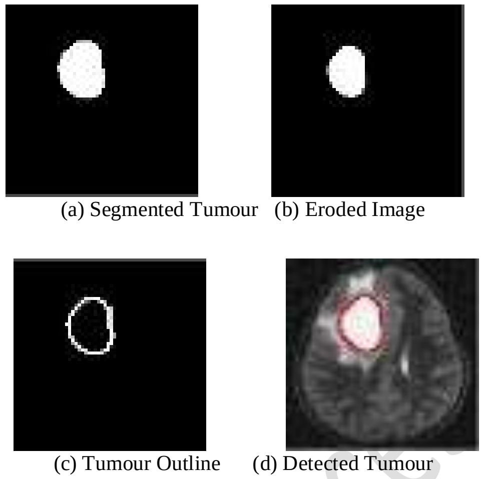

Fig. 5. Output for Morphological Operation

IV. RESULTS AND DISCUSSION

In this work, we have tried to accurately detect the tumour in MRI abnormal brain images. To fulfill the required intention noise removal using Anisotropic filtering, segmentation and morphological operations are performed.

Performance Analysis of AF Three types of noises (Gaussian, Speckle and Salt & pepper noise) are added to the input image and then MSE and PSNR value are calculated as following:

$$MSE = \frac{1}{pq} \Sigma_{\mathrm{i=0}}^{\mathrm{p-1}} \Sigma_{\mathrm{i=0}}^{\mathrm{q-1}} ||h(i,j) - g(i,j)||^2 \quad (6)$$

$$PSNR = 20 \log 10 \left(\frac{MAX_{\mathrm{f}}}{\sqrt{\mathrm{MSE}}}\right) \quad (7)$$

Where,

h symbolizes the matrix data of our original image

g symbolizes the matrix data of our degraded image in question

p symbolizes row number of intensity values of the images and

i symbolizes the index of that row

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q symbolizes column number of intensity values of the images and

j symbolizes the index of that column

MAX_f is the maximum signal value that exists in our original "known to be good" image

$$\text{Accuracy} = \frac{\text{Number of correctly classified test samples}}{\text{Total samples}} * 100\ \% \tag{8}$$

for segmentation purpose 16 pixels are taken & out of them 13 pixels are correctly classified

$$Accuracy = \frac{75}{90} * 100$$

$$= 0.8444*100$$

$$= 84.44\%$$

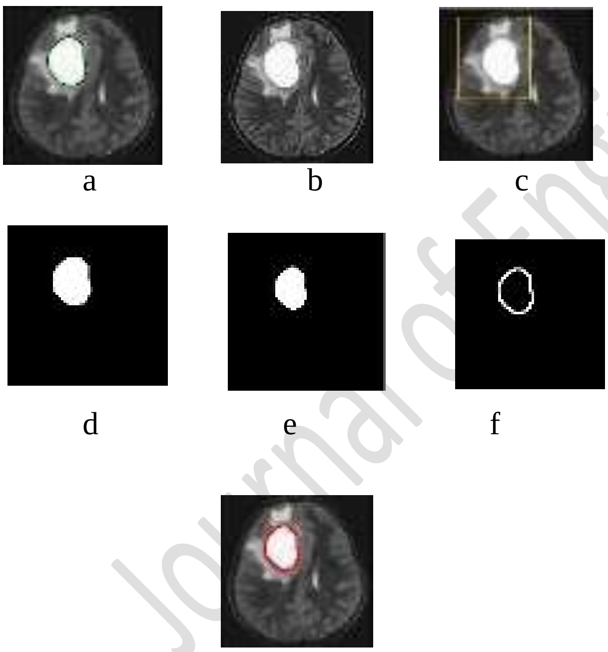

Fig. 6 Combine O/P for various operations for MRI brain Image: (a) Input Image; (b) Filtered Image; (c) Locating Bounding Box; (d) Segmented Tumour; (e) Eroded Image; (f) Tumour Outline; (g) Detected Tumour.

V.CONCLUSION

The MRI brain Input image may contains noise. For proper segmentation and for morphological operation's performance the input images should be noise-free. That is why we've used the anisotropic filter for its better performance. Anisotropic filtering here used for removing the noise at the edges and corners without disturbing the information. Morphological operations are used to extract the tumor from the segmented region. By applying different morphological operations we can remove additional noises and can get a clear vision of tumor presence. Finally, the system can detect the tumor accurately. The accuracy is calculated by dividing the number of samples correctly classified with the total number of samples.

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