International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
National Conference on
Innovative Technologies in Electrical Engineering (NCITEE2K19)
Volume 5, Special Issue 05, May-2019.

A Novel Approach for Brain Tumor Detection Using Anisotropic Filtering and SVM Classifier from MRI

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Abstract:-

Brain tumor is a dangerous disease and its early detection is very important to save life. The tumor region can be detected by segmentation of brain Magnetic Resonance Image (MRI). With the help of radiologic evaluations the suspected brain tumor location and size of tumor can be determined. The report of this decision is very important for further diagnosis and treatment. The early and correct diagnosis of brain tumors plays an important role. In order to extract tumor from MRI images of brain different image segmentation techniques are used. For cancer diagnosis the brain tumors segmentation can be done manually from MRI, which gives the poor level of accuracy and identification. So, The classification of abnormalities manually is not predictable and it is a time consuming task for physician. Hence the automatic segmentation of brain tumors are important research area in present day scenario. Several automated segmentation algorithms have been proposed. But still segmentation of MRI brain image remains as a challenging problem due to its complexity and there is no standard algorithm that can produce satisfactory results. The aim of this research work is to propose and implement an efficient system for tumor detection and classification. The different steps involved in this work are image preprocessing for noise removal, feature extraction, segmentation and classification. Proposed work preprocessed the MRI brain image using anisotropic diffusion filter for noise removal, By applying the fast bounding box (FBB) algorithm, the tumor area is displayed on the MRI image with a bounding box and the central part, and SVM classifier for segmentation and morphological operations for separating the affected area from normal one.

Keywords: — Brain Tumor, Magnetic Resonance Imaging (MRI), Anisotropic filter, SVM Classifier

I. INTRODUCTION.

Brain tumor can be detected using CT (Compute Tomography), MRI (Magnetic Resonance Imaging), PET (Positron Emission Tomography) etc. images. Among all of them MRI is preferred for its better performance. Image filtering is a great challenge for noise removal from an image. For this purposes, the common filters such as median filter, adaptive filter, averaging filter, Gaussian filter, un-sharp masking filter . Image segmentation is a technique by which an image is partitioned into various regions. There are many methods for image segmentation and they are thresholding, clustering, level set method etc. [4]. Some methods include supervised and unsupervised learning. In supervised learning, training data sets are provided and in unsupervised learning, data sets are not provided. Morphological operations are used as post processing method for extracting the tumor from the image. In general dilation, erosion, open filter, close filter are used for this purpose. These operations are applied on the binary image and finally by adding all the disjoint objects the tumor is located in the MRI brain input image.

II. LITERATURE REVIEW

There have been the research works regarding segmentation algorithms. The existing methods of brain tumor detection from the MRI brain images are Marker-Controlled Watershed Algorithm (MCWA), Learning Vector Quantization (LVQ), Fuzzy C-means (FCM),K-means, Stationary Wavelet Transform (SWT) and so on. Marker-Controlled Watershed Algorithm (MCWA) method resulted in improved visibility of tumor region, failed to validate with the standard datasets.. Fuzzy C-means giving the best result for overlapped data set and comparatively better than K-means algorithm but FCM is an iterative algorithm, it is considered as very time consuming clustering method. K-means algorithm is a fast technique but accuracy is less compared to FCM. So, there are many algorithms and techniques available for image segmentation but still there needs to develop an efficient, fast technique of medical image segmentation

III. PROPOSED METHODOLOGY

The proposed system can be summarized in three stages. First stage contains filtering technique which removes noise by using Anisotropic Filter (AF) from the brain MRI image and then adjustment based segmentation which segments the region of the tumor from the filtered image using a structuring element. Third stage contains morphological operation which shows the location of the tumor on the original image. Fig.1 shows the proposed system flow chart.

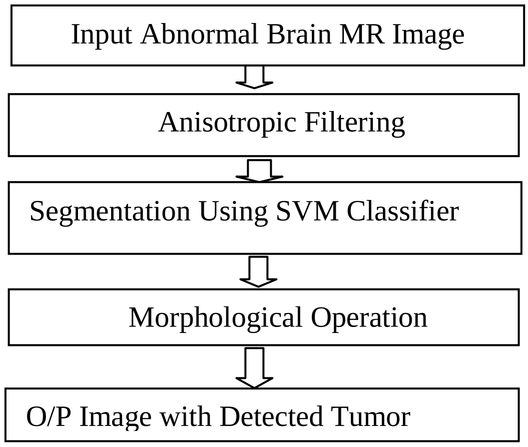
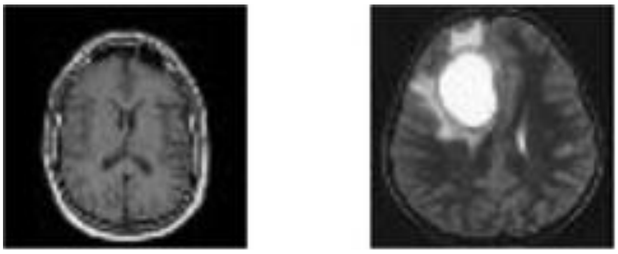


Fig. 1. Flowchart of the proposed system

A. Dataset:-

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



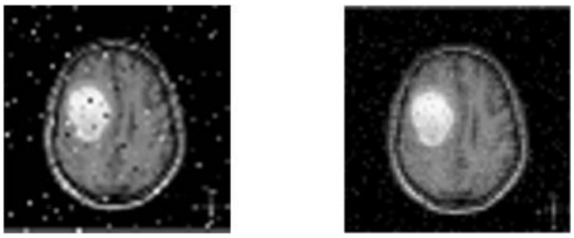
(a) Normal image (b) Abnormal image

Fig. 2. Brain MRI images

B. Anisotropic Filtering:-

The main objective of 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 many ways to get rid of the noise in the image. Most of the image processing algorithms do not work well in the noisy environment. This is why the image filter is used as a pre-processing tool. Among various filter Anisotropic Filter is used in this thesis for denoising purposes. The general anisotropic diffusion equation is introduced to describe the image diffusion process as follows [4]:

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



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

Fig. 3. Input and Output for Anisotropic Filter

C. SVM for Image Segmentation:-

The procedure of distribution an image into multiple parts is known as image segmentation. This is ordinarily applied to identify objects or other relevant information in digital images. Among all of the segmentation techniques Support Vector Machine (SVM) is used here. Let's consider the following simple problem to obtain the optimal belong to one of two classes, find a separating straight line.

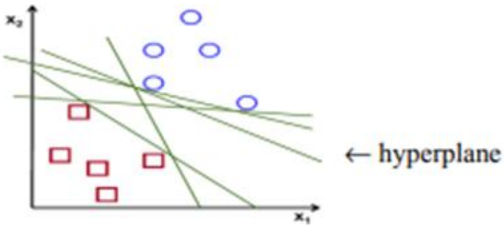


Fig. 4. For a linearly separable set of 2D-pointswhich

Let's consider the following equation which is used to define a hyperplane:

$$p(x) = \propto_0 + \propto^T z$$

Where, ∝ represents the weight vector and ∝0 as the bias. A vast number of various paths by scaling of ∝ and ∝0 describe the satisfactory hyperplane. Among all the feasible legation of the hyperplane, the following one is chosen:

$$|\propto_0 + \propto^T z| = 1$$

Where, z represents the training examples closest to the hyperplane. Commonly, support vectors are the nearest training examples to the hyperplane. Now we use the outcome of geometry that gives the difference between a point z and a hyperplane (∝,∝0):

$$D = \frac{|\propto_0 + \propto^T z|}{\|\propto\|}$$

The numerator is equal to one for the canonical hyperplane and the difference to the support vectors is

$$D_{support\ vectors} = \frac{|\propto_0 + \propto' z|}{\|\propto\|} = \frac{1}{\|\propto\|}$$

The following equation that is two times the difference to the nearest examples represents the margin, denoted as M

$$M = \frac{2}{\|\propto\|}$$

Ultimately, maximizing problem for M is identical to the minimizing problem for a function R(∝) subject to several confines. To classify correctly all the training examples z the confines model for the hyperplane is

$$\min_{\propto,\propto_0} R(\propto) = \frac{1}{2}\|\propto\|^2 \text{subject to } y_i(\propto^T z_i + \propto_0) \geq 1 \ \forall_i, (11)$$

Where, yi represents each of the labels of the training examples. This is a problem of Lagrangian optimization which can be solved using Lagrange multipliers to attain the weight vector ∝ and the bias ∝0 of the satisfactory hyperplane.

SVM transforms the input space to a higher dimension feature space through a non-linear mapping function and construct the separating hyper plane with maxm distance from the closest points of the training set [6].

An efficient brain MR images classification technique using support vector machine was proposed. The features are extracted using wavelet transform decomposition and the obtained features are given as input to the SVM classifier. The output of SVM classifier was obtained as normal or benign or malignant.

D. Morphological Operation:-

Morphology is an instrument to extract image features useful in the legation and recital of region shape 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 and b) Erosion: It shrinks the object. Foreground pixel background is eroded away in the binary image by erosion operation. Morphological Opening is applied to image (a) after converting it into 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 detected tumor.

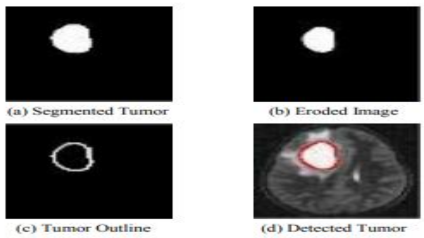


Fig. 5. Output for Morphological Operation

Fig. 5 displays the resultant images of Morphologic operation with detected tumor.

IV. RESULTS AND DISCUSSION

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

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

$$PSNR = 20 \log 10\left(\frac{MAX_f}{\sqrt{MSE}}\right)$$

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 q symbolizes column number of intensity values of the images and j symbolizes the index of that column MAXf is the maximum signal value that exists in our original “known to be good” image The following table contains MSE and PSNR value for various filters for Gaussian noise, Speckle noise and Salt & Pepper noise that are added with the original MRI brain input image to measure the performance of the filters**.** The performance of anisotropic filter is shown in following figures:

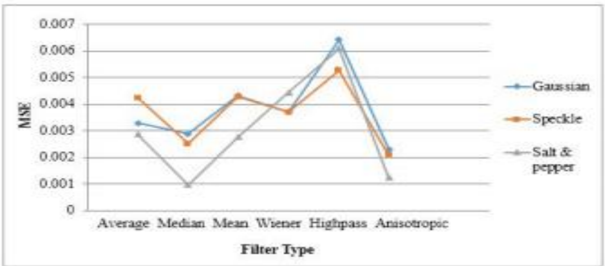


Fig. 6 (a). MSE value comparison for Gaussian, Speckle and Salt & Pepper noise among various filters

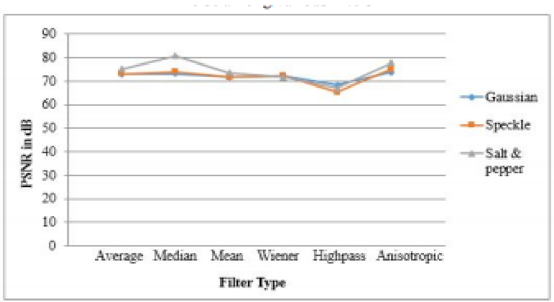


Fig. 6 (b). PSNR value comparison for Gaussian, Speckle and Salt & Pepper noise among various Filters

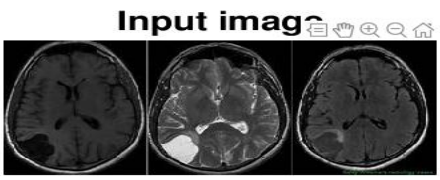


Fig 7 (a) Input Image

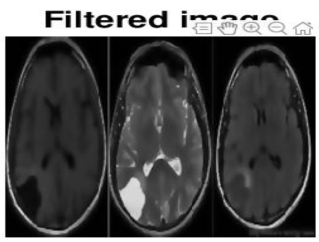


Fig 7 (b) Filtered Image

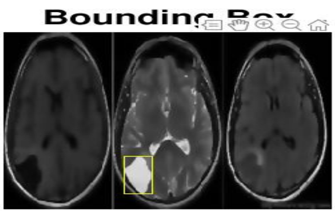


Fig 7 (c) Locating Bounding Box

Fig 7 (d) SVM Classifier O/P

Fig 7 (e) eroded image

Fig 7(f) tumor outline

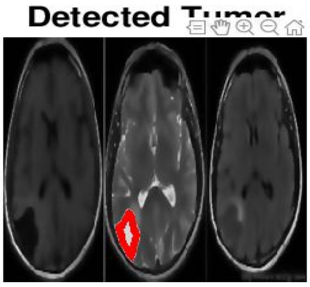


Fig 7(g) Detected Tumor

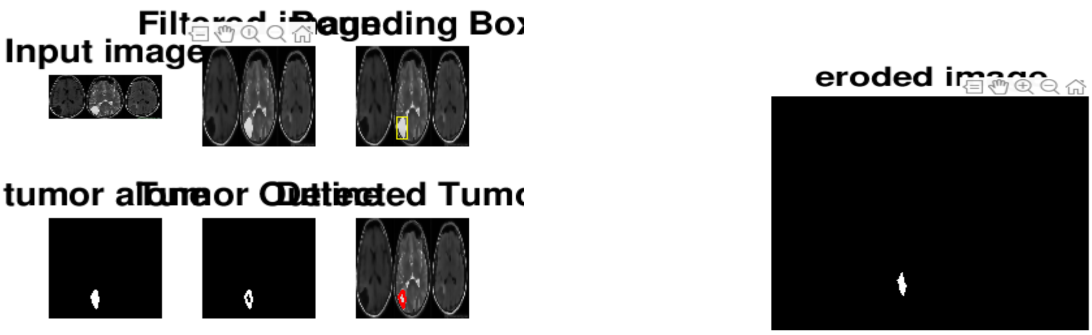


Fig. 8. Combine O/P for various operations for MRI brain Image: (a) Input Image; (b) Filtered Image; (c) Locating Bounding Box; (d) SVM Classifier O/P; (e) Eroded Image; (f) Tumor Outline; (g) Detected Tumor.

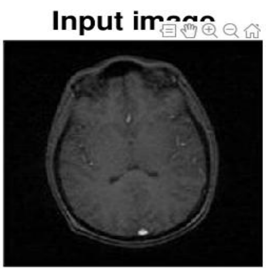


Fig 9 (a) Input image

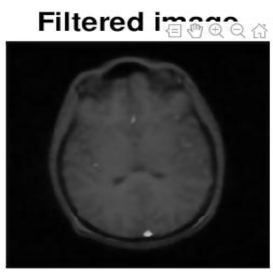


Fig 9(b) Filtered Image

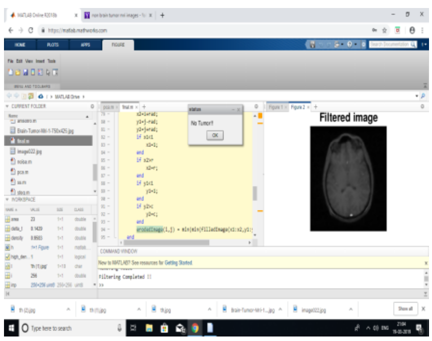


Fig 9(c) no tumor image

V. CONCLUSION

The MRI brain Input image may contain various noise. For proper segmentation and for morphological operation's performance the input images should be noise free. That is why we have used the anisotropic filter for its better performance. SVM classifier is used for segmentation purpose which classifies the pixels into two classes. Since we have designed our system for any MRI brain input image hence SVM is selected with kernel for unsupervised learning. Morphological operations are used to extract the tumor from the segmented region. Finally the system is able to detect the tumor accurately.

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