Bilateral filtering with cosine transform based brain tumor classification

[1]Dr C.Berin Jones, [2]Dr C. Murugamani
[1]Professor, [2]Professor
[1]Computer Science & Engineering, [2] Information Technology
[1]Bhoj Reddy Engineering College for Women, Hyderabad,
[2]Bhoj Reddy Engineering College for Women, Hyderabad,

Abstract:

In this modern era the clinical laboratory have greater attention to produce an accurate result for every test particularly in the area of Brain tumor. The brain tumor is very essential to detect as well as to follow the treatment of many diseases like benign, malignant etc. For the identification of brain tumor three phases are used. First phase is the segmentation and the segmentation used here is the threshold based segmentation. While using the threshold based segmentation we get better result when compared to the previous method. Second phase is the feature extraction here the feature is extracted using the GLCM feature. And the third or final phase is the classification. Here three classifiers are classified they are Support Vector Machine classifier, Adaboost classifier and Naive Bayes classifier. By using the above three classifiers Naive Bayes classifier gives high accuracy i.e.99%. The simulations are done on MATLAB application.

Index Terms: **Adaboost, Bilateral filtering, Brain tumor, Naïve Bayes classifier, SVM**

I. Introduction:

A growing of irregular cells in the tissues of the brain is known as brain tumor. Brain tumor are of two types one is benign and the other one is malignant. The benign is the cell which has nope tumour cells and the malignant is cell which has tumour cells that spreads very fast. Several major brain tumors will start in the brain where other kind of the brain tumor is the metastatic it will start in another portion of the body and it will move to the brain.Two methods are as follows Benign and Malignant. **Benign** there is no cancer cells: Generally benign tumors impassive and they rarely grow back, benign brain tumors frequently have

an clear border and presses on the thoughtful areas of the brain, sometimes benign brain tumors may grow into malignant. **Malignant** contain cancer cells: Malignant is also called as brain cancer, usually malignant is very thoughtful and frequently danger to life and malignance cells may possibly be missing from malicious brain tumors and blow-out to new parts of the brain.

II.Related work:

Nilesh Bhaskarrao Bahadure et al provide skull stripping technique to remove all the non-brain tissue from the brain images. For segmenting the brain tumor image Berkeley wavelet Transformation method was used. To classify the brain tumor image SVM classifier was used [1]. Rohini Paul Joseph et al uses median filter to eliminate the noise from the MRI brain image. Then it was segmented using K-means clustering along with morphological filtering. Morphological operations were used to thinning and thickening of object [2]. Marco Alfonse et al proposed median filter for enhancing the image and high pass filter was used to remove the noise from the MRI brain image. Chow and Kaneko approach and local thresholding was used to segment the image. For improving the accuracy Fast Fourier transform algorithm was used to extract the feature. For classifying the regular and irregular brain image SVM classifier was used [3]. E. A. Zanaty proposed a hybrid technique based on combining fuzzy clustering, seed region growing and Jaccard similarity coefficient algorithms for measuring the gray and white matter tissue volume from the MRI brain image [4].

Jianhua Yao et al use active contour method to segment the MR image. The features are extracted using wavelet transform and it was classified using SVM classifier [5]. P. Kumar et al implemented Wiener filter to reduce the unwanted noise and it was segmented using region growing algorithm. The MR image features are extracted by using Histogram and Co-occurrence matrix. Finally the image was classified using Kernal based SVM classifier [6]. For preprocessing Ayse Demirhan et al uses anisotropic diffusion filter. Stationary wavelet transform technique was used to extract the feature from the MR image and Self Organizing map was used as segmentation tool [7]. R.B. Dubey et al provide Gaussian filter for reducing the noise in the MR brain image. For segmenting the image region growing technique was used, the drawback of this method is the accuracy depends on the initial seed point selection [8].

In [9] Swapnali Sawakare and Dimple Chaudhari uses K-means clustering to segment the MR image. For classification Probabilistic Neural Network was used. Robert M et al present discrete wavelet transformation for extracting the features from the MR images [10]. N.Varuna Shree and T.N.R.Kumar uses morphological operations to remove and add pixels to boundary regions. Features from the MR brain image are extracted using DWT, GLCM and then it was classified using Probabilistic Neural network classifier [11]. Kailash D.Kharat et al proposed Feed forward neural network and Back propagation neural network approaches for the detection of brain tumor from the MR images [12]. Ruchi D.Deshmukh et al give information about many segmentation methods and their advantages and disadvantages are compared [13].

Ganesh Vilas Madhikar et al provide modified region growing and normal region growing technique for segmenting the MR brain image. The segmented MR brain image was classified using neural network for the detection of brain tumor [14]. Abhishek Bargaje et al proposed K-means clustering to segment the MR brain image and the features was extracted using Discrete Wavelet Transform. After extracting the features Principle Component Analysis operation was carried out to reduce the dimensions of features. Decision tree with adaptive boosting was used to classify the brain tumor image as benign or malignant [15]. In [16] Janki Naik et al uses Decision tree algorithm to classify and detect brain tumor from the CT scan images.

Lalita Gupta et al presents Gabor filter to eliminate the redundant noise from the MR brain images. Otsu segmentation algorithm was used to segment the MR brain image and features are extracted for the detection of brain tumor [17]. R.Venkateswari et al have proposed K-means Clustering integrated with Fuzzy C means algorithm for segmentation and Neural Network classifier to classify the MR brain image [18]. C.Hima Bindu provides Optimized Otsu improved thresholding for segmentation to reduce the operation time and to improve the separability factor in medical image segmentation [19]. Umit Ilhan et al preserved threshold based segmentation for segmenting the MR image. For classifying Neuro-Fuzzy classifier was used. The disadvantage of this method is it was not automatic and it was in accurate in classification [20].

III. Methodology:

In the methodology the subsequent steps are used for finding the brain tumor. The initial step is the image acquisition here the input image is read and then resized. Second step is the pre-processing here the noises are removed using bilateral filtering. Third step is the post-pre-processing here the compression ratio is highly achieved using Discrete cosine transform. Fourth step is the Segmentation here based on the particular value threshold based segmentation is segmented. Fifth step is the feature extraction here the feature is extracted using GLCM feature. Sixth or the final step is the classification here the three classifier are classified for getting high accuracy they are support vector machine classifier, Adaboost classifier and Naive Bayes based classifier. While comparing these three classifiers we get better accuracy in the Naive Bayes based classifier.

Block Diagram:

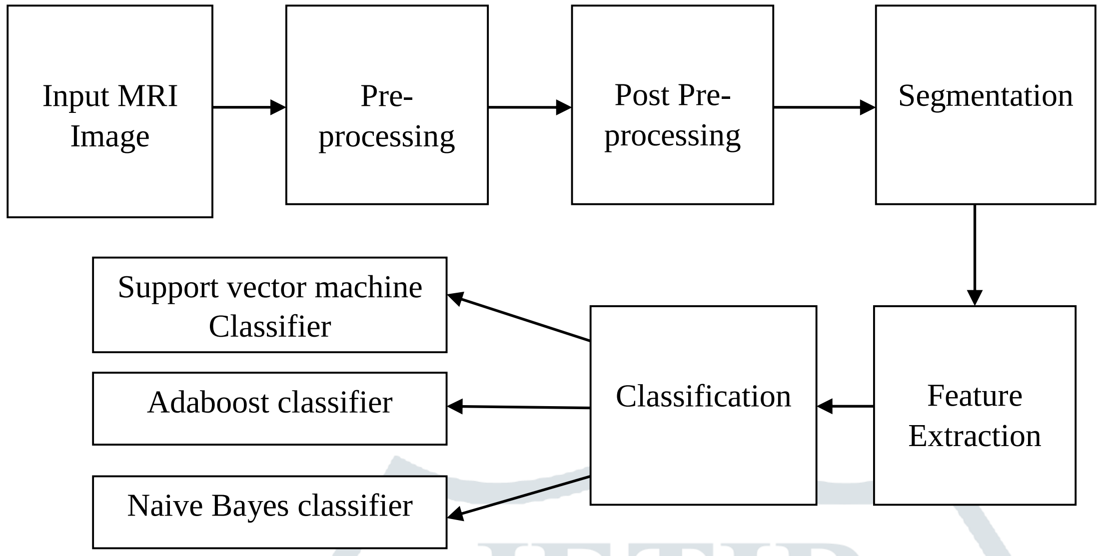

Fig:1 Architecture of Proposed method

1. Image acquisition:

In image acquisition the input images are read and then resized. The input images are taken from the laboratory for identifying the benign and malignant.

2. Pre-processing:

To improve the quality of the MR images the primary task is pre-processing. The main process of pre-processing is to develop such parameters in the MR images which are enlightening the signal-to-noise ratio, eliminating the irrelevant noise, increasing the visual appearance of MR image.

Bilateral filtering:

For preserving the edges of the smooth images bilateral filtering was used. While using the BLF the image is grown up quickly and also this filtering is now recycled in image processing for such application as image denoising, image enhancement etc. Bilateral filtering is a non-iterative process and it is simple to convey. At each pixel the weighted average of its neighbouring pixels in the BLF that treats the intensity value.

3. Post-Preprocessing:

In the post preprocessing the Discrete Cosine Transform is to achieve high compression ratio.

Discrete Cosine Transform:

To reach high compression ratio without humiliating of quality the Discrete Cosine Transform is used. The discrete cosine transform is same as that of Discrete Fourier Transform. The transformation of images from spatial domain to the frequency domain is known as DCT. And the main benefit of discrete cosine transform is it can compress both the color and the gray scale images. Also the DCT is good for unmovable image and cinematographic. It is the best transform for compression technique.

4.Segmentation:

Thresholding based segmentation:

Thresholding is the simple form of segmentation. Here each pixel in an MR image is linked with in the edge. A non-linear process that converts a gray-scale image into a binary image is known as thresholding.

The global threshold is used and the impartial task is

g(x, y) = $1\ if\ f\ x{,}y > T$

$0\ if\ \ x, \leq T$

Where

$f\ x$, is an input image,

g(x,y) threshold/segmented image,

T threshold value.

The procedure of thresholding based segmentation is:

1. Original assessment of edge T.
2. Achieve segmentation using T

   (i) P1, pixels sunnier than T

   (ii) P2, pixels dimmer than T.
3. Apply average amounts m1 and m2 , P1 and P2.
4. Calculate new threshold value Tnew = $\boldsymbol{m1}+\boldsymbol{m2}$
5. If │T - Tnew│>ΔT, repeat step 2. Else stop the process.

where m1 and m2 are mean of intensities, P1 and P2 is a probability of sunnier and dimmer pixels and T and Tnew are the thresholds and the new threshold. The intersecting of forces may be caused due to noise, variation in illumination across the image.

5. Feature Extraction:

GLCM:

The GLCM is a static geometric device for removing second order texture data from the MR images. A GLCM is a matrix at that time sum of rows and columns is equal to the sum of individual gray.

Energy:

Energy is computed by

$$En = \sqrt{\sum_{x=0}^{m-1}\sum_{y=0}^{n-1} f^2(x,y)} \qquad (1)$$

Contrast:

Contrast is computed by

$$C_{on} = \sum_{x=0}^{m-1}\sum_{y=0}^{n-1}(x-y)^2 f(x,y) \qquad (2)$$

Correlation:

Correlation feature is calculated by

$$C_{orr} = \frac{\sum_{x=0}^{m-1}\sum_{y=0}^{n-1}(x,y)f(x,y) - M_x M_y}{\sigma_x \sigma_y} \,(3)$$

Homogeneity:

Homogeneity is designed by

$$IDM = \sum_{x=0}^{m-1}\sum_{y=0}^{n-1}\frac{1}{1+(x-y)^2} f(x,y) \;(4)$$

Mean:

Mean is considered by

Mean$\mu_i = \frac{1}{N}\sum_{j-1}^{N} f_{ij}$ (5)

Standard Deviation:

Standard deviation is intended by

SD = $\sigma_i = \left(\frac{1}{N}\sum_{j-1}^{N}\left(f_{ij} - \mu_i\right)^2\right)^{\frac{1}{2}}$ (6)

Skewness:

Skewness is designed by

$$S_k(X) = \left(\frac{1}{m \times n}\right)\frac{\Sigma(f(x,y) - M^3}{SD^3} \quad (7)$$

Kurtosis:

Kurtosis is calculated by

$$K_{urt}\,(X) = \left(\frac{1}{m \times n}\right)\frac{\Sigma(f(x,y) - M^4}{SD^4} \,(8)$$

Entropy:

Entropy is considered by

$$E = -\sum_{x=0}^{m-1}\sum_{y=0}^{n-1} f(x,y)\log_2 f(x,y) \quad (9)$$

Where,

N is the over-all amount of pixels in the MR image.

6. Classification:

i) Support Vector Machine

Support Vector Machine (SVM) is a supervised learning methods. It is used for classification and recession prediction tool to maximize the accuracy. It uses supposition space of a linear function and it can be used for different applications such as face analysis, handwriting analysis, mainly for shape classification and regression. The main properties of SVM is to achieve high simplification by maximizing the margin, and supports a well-organized learning of nonlinear functions. The original function of SVM classifier is dual classifier, output is either negative or positive. Two class SVM is used to train the data and classify the test images between regular and irregular cells. Different grouping is combined and given the output to the Adaboost classifier.

ii) Adaboost Classifier

Adaboost is the short form of adaptive boosting algorithm and is a machine learning meta algorithm to improve the performance. The objective of adaboost classifier is to decrease the error rate of the weak classifier by familiarising a new classifier. Here the output of SVM classifier is combined with adaboost classifier that signifies the concluding output of the adaboost classifier. Adaboost is complex to noise data and the adaboost algorithm is shown below.

$$H(x) = \sin\left(\sum_{t=1}^{T} \alpha_i \, h_t(x)\right) \quad (10)$$

Where,

$h_t(x)$ is the weak classifier,

α_i weight chosen such that error rate is miminum.

iii) Naive Bayes classification:

A Naive Bayes classification is a simple method for classification. Based on the mutual value of the classification the family of algorithm is not single. Naïve Bayes classification is a supervised learning algorithm. And this method is the maximum likelihood function. This arrangement is used for classifying the normal and the abnormal cells. It is the geometric classifier predict the class membership and has high accuracy compared to other classifier. Assume, characteristic value on a certain class is independent of the values of the other attributes and this is called class conditional independence, simplify the computation and this state is called naïve.

IV. Result and discussion:

In this result and discussion part the input brain image is taken from the rider database. Using Matlab 2017a the proposed method is implemented. The dataset consist of 80 images. Where 40 images are test images and 40 images are trained images.

At first the input image is taken for image acquisition step their image is read and then resized. After resizing the unwanted noises are detached using bilateral filtering. Then the input MR image is transformed using the discrete cosine transform. After DCT the image is segmented using the threshold based segmentation. Here the tumor cells are segmented separately. After that using the classifier images are classified as normal or abnormal cell

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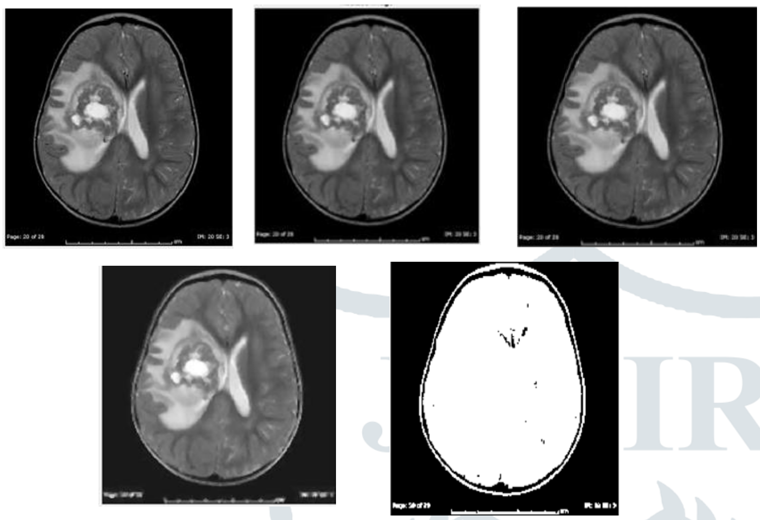


Fig:2 Result for benign image a)Input image b)Image acquisition c)Preprocessing d)Post Pre-processing e) Segmented tumor.

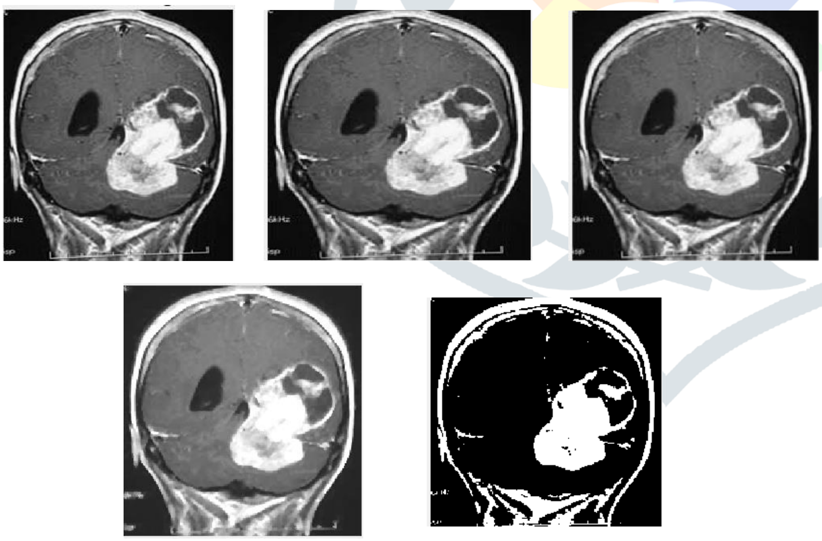


Fig:3 Result for malignant image a)Input image b)Image acquisition c)Preprocessing d)Post Pre-processing e) Segmented tumor.And the extraction for the GLCM features are extracted below

Table 1: Extracted features from brain image

Image no	contrast	correlation	energy	homogeneity	Mean	Standard Deviation	Skewness	Kurtosis	Entropy
1	0.012420635	0.91048191	0.8489836 37	0.993789683	0.5	0.023087036	5.16E-15	1	1
2	0.021618185	0.878375428	0.8011039 54	0.989190908	0.5	0.162210296	0	1	1
3	0.04427676	0.845709397	0.6707137 66	0.97786162	0.5	0.370311821	0	1	1
4	0.038366435	0.038366435	0.7219531 12	0.980816782	0.5	0.453821132	0	1	1
5	0.03931199	0.885895682	0.6177066 92	0.980344005	0.5	0.159664711	0	1	1
6	0.019876764	0.728026089	0.9074349 73	0.990061618	0.5	0.199404112	0	1	1
7	0.041679154	0.857949326	0.6666475 32	0.979160423	0.5	0.011596551	0	1	1
8	0.017188092	0.760345411	0.9113870 68	0.991405954	0.5	0.014778532	-7.98E-15	1	1
9	0.027594949	0.882738166	0.7378389 06	0.986202525	0.5	0.02761252	0	1	1
10	0.032301587	0.853233104	0.7486541 14	0.983849206	0.5	0.425218663	0	1	1

11	0.022602634	0.926160853	0.671801857	0.988698683	0.5	0.012445079	9.48E-15	1	1
12	0.023174603	0.790126475	0.866940703	0.988412698	0.5	0.130178358	-9.04E-16	1	1

The above table gives the value of contrast, correlation, energy, homogeneity, mean, standard deviation, skewness, kurtosis and entropy for 12 images. This 12 image gives the value of the normal and the abnormal cell.

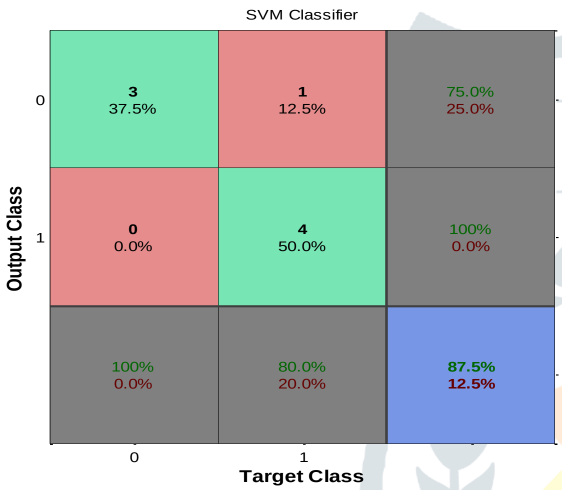


Fig: 4 SVM Classification

Figure 4 shows the confusion matrix output of SVM classifier and it gives the accuracy of 87.6% and the error value of 12.6%. So we go for adaboost classification for getting high accuracy.

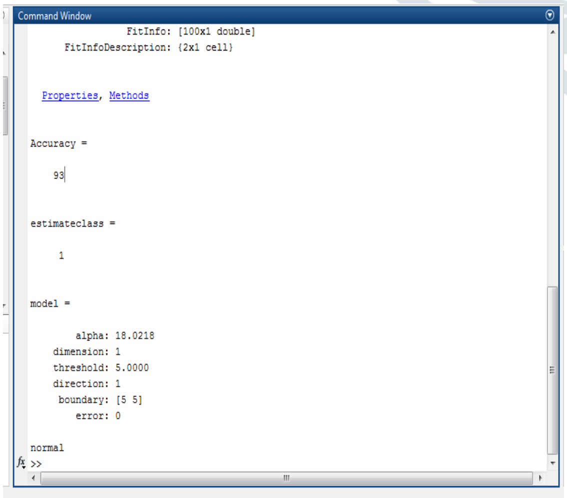


Fig: 5 Adaboost Classifier

Figure 5 shows the Adaboost classifier output. To classify the input MRI image into normal or abnormal cell . The accuracy of the SVM classifier is 87.6% and the accuracy of the Adaboost classifier is

93%.Adaboost classifier is adding a SVM classifier with adaboost classifier it gives the final output of the adaboost classifier.

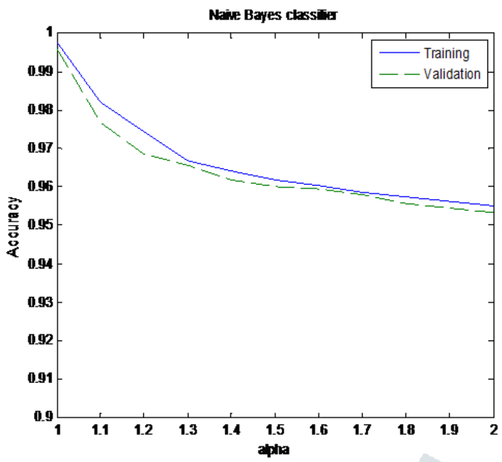
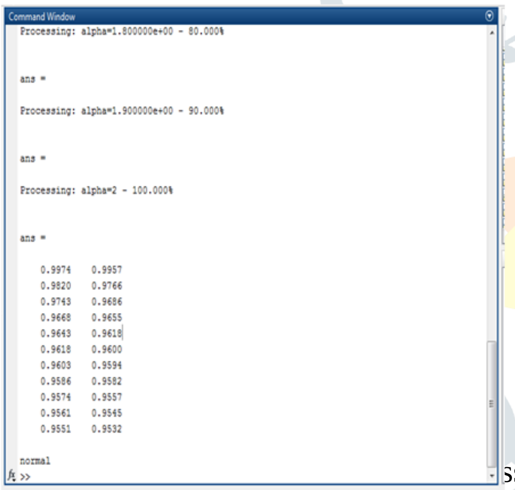


Fig: 6 performance measure of accuracy vs alpha

Figure 6 shows the performance measure of accuracy vs alpha here we get the high accuracy of 99% when compared to the other classifiers.



ssifier output and the accuracy of the classifier is 99 %. Naïve Bayes classifier shows the better accuracy compared to other classifier we have used.

V.CONCLUSION

In this paper various types of classifier is used to classify the brain tumor into normal or abnormal cell. The input image is pre-processed by filtering technique to remove unwanted noise. Features are extracted using GLCM feature and classified using the classifier by SVM, Adaboost and Naive Bayes classifier. From experimental results the accuracy of the SVM, Adaboost and Naïve Bayes classifier is 87%, 93%, 99%. Naive Bayes classifier has the high accuracy compared to SVM and Adaboost classifier i.e. 99%.

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