A Novel Appraoch for Brain Tumor Detection using SOM and Fuzzy Classifier

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Abstract : ***Nowadays Diagnosis of diseases using medical image is became cherished tool in medical science. Brain tumor pathologies are the utmost conjoint loss in the existing situation of health care society. Henceforth, precise recognition of the type of the brain irregularity is extremely indispensable for treatment planning which can minimalize the incurable results. Medical imaging technology simplifies the doctors to see the interior portions of the body for easy diagnosis. It also assisted doctors to make aperture surgeries for reaching the internal parts without actually opening too much of the body. In this paper we have proposed a novel approach using SOM feature and fuzzy C-means classifier for brain tumor detection, which will improve the accuracy.***

IndexTerms - MRI,RGB,PCA,MLP,BWT,SVM.

I. INTRODUCTION

In these days diagnostic imaging is an invaluable tool in medical science. Magnetic resonance imaging (MRI), computed tomography (CT), digital mammography Pet Scan, and different imaging modalities provide an efficient means for noninvasive mapping the anatomy of an issue. These technologies have a greater increase of knowledge of normal and unhealthy anatomy in medical analysis and are a critical component in diagnosing and planning of treatment. With the increasing symptoms of disease and number of medical pictures, the use of computers facilitating their processing and analysis has become necessary. With the growing age, there is an advancement in each and every field. As far as the medical field is concerned, it additionally has every day progress in the medical field in,it has grown substantially in recent years, and has generated additional interest in strategies and tools for the management, analysis, medical image data communication. for the improvement in neuroscience department research it needs computational tools to organize, analysis, and visualization the large amounts of new information being created about the structure and the function of the brain.

The objective here is to effectively distinguish and fragment the tumor area from the cerebrum MRI image. Despite the fact that the current technique comprises of relevant data of a voxel in the picture prompting smoothness in the division comes about, the many-sided quality of the mind MRI pictures could be impeding in perceiving the mind tumor division errands utilizing the fix include. MRI exploits the phenomenon of nuclear magnetic resonance (NMR) to produce high quality structural images of the internal organs and other tissues. When undergoing a structural MRI scan, the patient is placed in a powerful static magnetic field, with which the spins of hydrogen atoms in their body align. Applications of MRI segmentation include the diagnosis of brain trauma where a signature of brain injury, white matter lesions may be identified in moderate and mild cases. MRI segmentation methods are also useful in diagnosing multiple sclerosis, including the detection of lesions and the quantization of lesion volume using multispectral methods.

Detection of brain tumor by means of MRI image, there are some phases which is explained in fig.-1.

Fig.-1 Recognition phases

- **Image Preprocessing**: After the input image first step for every processing is appropriate preprocessing for successful application. Thus, the primary step is cropping of images in windows with stem area. It is the primary step within the algorithm. In the project, consider about the influence of a speckle noise.
- **Feature Extraction**: The feature extraction used to condense the dimension of the input data and minimize the training time taken by the classifier. Multiple feature which includes geometrical moments, statistical moment and texture moments are extracted from the region of interest. The features are of image characterized by their chromaticity values, which prompt colors hue and saturation, evading the luminance constituent. The chromaticity is attained by normalizing the RGB components of the image, named the R, G and, B components.

$$\begin{cases} r=R/(R+G+B) \\ g=G/(R+G+B) \\ b=B/(R+G+B) \end{cases} \quad (1)$$

Feature Vector: ADRC (Feature Vector) is Defined as:-
Adaptive Dynamic Range Coding (ADRC):

$$ADRC(x) = \begin{cases} 0, \text{ if } x < x_{av} \\ 1, \text{otherwise} \end{cases}$$

- **Classification**: The training and classification are completed using different classification methods. Different classification technology offers a variety of tools such as learning and adaptation, generalization and robustness, feature extraction and distributed representation.

In our proposed method we have used Multi wavelet GHM based preprocessing.

Multi wavelet GHM

Multi wavelet GHM used for removal of noise. Multi wavelet originated from the generalized of scalar Wavelet. Instead of one scaling and one wavelet function, multiple scaling and multi wavelet function are used in the project.

Multi wavelet GHM performs a single level 2D Multi wavelet decomposition using GHM multi wavelet with four multi-filters.

Y= GHM(X) computes the approximation. Coefficient matrix LL and details coefficients matrices LH, HL, HH, obtained by a multi wavelet decomposition of the input matrix X and put the result in:

Y= [LL, LH; HL, HH].

The size of the Y is double that of which should be a square matrix of size NxN where N is a power of 2 since X is vectorized by a repeated row preprocessing. LL, LH, HL and HH will the size NxN.

Further in this paper in section II we have gone through some literature and also given tabular comparison, in section III we will go through identified problem in existing systems, in section IV we will explain our proposed methodology, in section V we will explain implementation of proposed methodology, at last section we will conclude our research.

LITERATURE SURVRY

Yudong Zhang et. al. said that work aims at developing a novel pathological brain detection system (PBDS) to assist neuroradiologists to interpret magnetic resonance (MR) brain images. We simplify this problem as recognizing pathological brains from healthy brains. First, 12 fractional Fourier entropy (FRFE) features were extracted from each brain image. Next, we submit those features to a multi-layer perceptron (MLP) classifier. Two improvements were proposed for MLP. One improvement is the pruning technique that determines the optimal hidden neuron number. We compared three pruning techniques: dynamic pruning (DP), Bayesian detection boundaries (BDB), and Kappa coefficient (KC). The other improvement is to use the adaptive real-coded biogeography-based optimization (ARCBBO) to train the biases and weights of MLP. The experiments showed that the proposed FRFE+ KC-MLP + ARCBBO achieved an average accuracy of 99.53 % based on 10 repetitions of K-fold cross validation, which was better than 11 recent PBDS methods [Springer 2016].

Jes´us L´azaro et. al. describes a clustering technique using Self Organizing Maps and a two-dimensional histogram of the image. The two-dimensional histogram is found using the pixel value and the mean in the neighborhood. This histogram is fed to a self-organizing map that divides the histogram into regions. Carefully selecting the number of regions, a scheme that allows an optimum optical recognition of texts can be found. The algorithm is especially suited for optical recognition application where a very high degree of confidence is needed. As an example application, the algorithm has been tested in a voting application, where a high degree of precision is required. Furthermore, the algorithm can be extended to any other thresholding or clustering applications [Elsevier 2006].

Samir Kumar Bandyopadhyay said that For the past decade, many image segmentation techniques have been proposed. These segmentation techniques can be categorized into three classes, (1) characteristic feature thresholding or clustering, (2) edge detection, and (3) region extraction. This survey summarizes some of these techniques. In the area of biomedical image segmentation, most proposed techniques fall into the categories of characteristic feature thresholding or clustering and edge detection. We present current segmentation approaches are reviewed with an emphasis placed on revealing the advantages and disadvantages of these methods for medical imaging applications [IGRCS 2011].

JIŘÍ BLAHUTA et. al. hows how to classify the medical ultrasound intracranial images by using PCA method. The main goal is a classification of ROI substantia nigra in midbrain. The classification of images is useful to detection Parkinson´s disease (PD). Work is based on image processing and is realized with the help of artificial neural networks which has been simulated in NeuroSolutions 6 software environment. We have selected a PCA method for processing. This method is well applicable in NeuroSolutions. Author also concluded that principles of modeling neural network for image processing based on PCA method. Detailed description of PCA and all results are available in full paper. The future work will be based on ANN too, maybe with different method or approach. We have checked this simulation in MATLAB software with appropriate Neural Network Toolbox [IEEE 2011].

Neha Rani et. al. said that Brain is an organ that controls activities of all the parts of the body. Recognition of automated brain tumor in Magnetic resonance imaging (MRI) is a difficult task due to complexity of size and location variability. This automatic method detects all the type of cancer present in the body. Previous methods for tumor are time consuming and less accurate. In the present work, statistical analysis morphological and thresholding techniques are used to process the images obtained by MRI. Feed-forward backprop neural network is used to classify the performance of tumors part of the image. This method results high accuracy and less iterations detection which further reduces the consumption time [IJCA 2016].

Sudipta Roy et. al. said that Tumor segmentation from magnetic resonance imaging (MRI) data is an important but time consuming manual task performed by medical experts. Automating this process is a challenging task because of the high diversity in the appearance of tumor tissues among different patients and in many cases similarity with the normal tissues. MRI is an advanced medical imaging technique providing rich information about the human soft-tissue anatomy. There are different brain tumor detection and segmentation methods to detect and segment a brain tumor from MRI images. These detection and segmentation approaches are reviewed with an importance placed on enlightening the advantages and drawbacks of these methods for brain tumor detection and segmentation. The use of MRI image detection and segmentation in different procedures are also described. Here a brief review of different segmentation for detection of brain tumor from MRI of brain has been discussed.[arxiv 2013]

S. No.	Author/Paper Title/Year of Publication	Method Used	Description
1.	Nilesh Bhaskarrao Bahadure et. al./ Image Analysis for MRI Based Brain Tumor Detection and Feature Extraction Using Biologically Inspired BWT and SVM/Hindavi 2017	Berkeley wavelet transformation (BWT) + SVM (Support Vector Machine)	The proposed method is suitable for integrating clinical decision support systems for primary screening and diagnosis by the radiologists or clinical experts. The experimental results achieved 96.51% accuracy demonstrating the effectiveness of the proposed technique for identifying normal and abnormal tissues from MR images.
2.	Yudong Zhang et. al./A Multilayer Perceptron Based Smart Pathological Brain Detection System by Fractional Fourier Entropy/Springer 2016	Multi-layer Perceptron	Author proposed a new PBDS of BFRFE + KC-MLP + ARCBBO. The experiments validated its effectiveness as achieved an average accuracy of 99.53 %. Author compared three different pruning techniques for MLP and showed KC is the most effective. Besides, we introduced the ARCBBO and proved it give better performance than BBO. Finally, the proposed PBDS is superior to 11 state-of-the-art PBDS methods.Proposed system takes input as medical brain images.
3.	V.P.Gladis Pushpa Rathi et. al./Brain Tumor Mri Image Classification With Feature Selection And Extraction Using Linear Discriminant Analysis/Researchgate 2013	PCA and LDA	In this paper PCA and LDA methods are used to reduce the number of features used. The feature selection using the proposed technique is more beneficial as it analyses the data according to grouping class variable and gives reduced feature set with high classification accuracy.The average correct rate by the method presented is 97.82% with FP of 1.0% and FN of 2.50%. All the features produce classification accuracy of 98.87% using LDA. The extracted four PCA components are classified using LDA and SVM classification and the accuracy achieved is 96%.
4.	V. Viswa Priya* and Shobarani/An Efcient Segmentation Approach for Brain Tumor Detection in MRI/IJST 2016	Contextual Clustering algorithm	Proposed work detects tumor using a new segmentation method and localisation in brain MR images. T e main aim of presenting this Contextual Clustering based segmentation technique is the improvement of the segmentation accuracy by the reduction of false segmentations.
5.	Neha Rani et. al./Brain Tumor Detection and Classification with Feed Forward Back-Prop Neural Network/IJCA 2016	Feed-forward backprop neural network	This paper shows that combination of feature extraction and classification analysis. After analyzing the results it is concluded that this method is better than the other existing methods in terms of computation time. Specificity is 97.2%, Sensitivity is 97.2% and accuracy is 99.2%. Comparison results of proposed methodology with other authors results shows that this method gives more accurate results with the accuracy of 99.2%

Problem Identification

The computerized brain tumor classification is as yet a testing undertaking. One of the reason is tumor's capricious properties, for example, size, shape and area unless the tumor improvement in time is explored and pictures from past examining are accessible. Considering just the free filtering, the greater part of the said properties are obscure. Along these lines normal design acknowledgment procedures depending on such properties and broadly utilized for protest identification what's more, extraction in both therapeutic and true pictures can't be utilized.

Motivation towards this research is there are several implementation for detection of brain tumor detection but the accuracy of existing are not up to the mark. In introduction section we have discussed that brain tumor identification involves different steps, image preprocessing, Feature extraction and image classification, if we use better techniques in this steps then we can increase the accuracy of brain tumor detection.

Much work carried out in this field still accuracy is less henceforth to increase the accuracy we can use some different preprocessing and classifier algorithm.

Input	Classification Method	Accuracy
MRI Images	BWT,SVM	96.51%

Medical brain images.	MLP	96%
MRI Images	PCA,LDA	97.8%
MRI Images	Feed Forward	97.2%

Table-1 Accuracy Comparison

PROPOSED METHDOLOGY

To improve the accuracy of disease detection we have changed the algorithm in different phases. First for preprocessing phase we have applied Mult- Wavelet.

First step is cropping of image and then fix it in window with tumor area and removal of speckle noise. For removal of speckle noise using GHM multi wavelet. The idea of Multi wavelet originate from the generalization of scalar wavelet. Instead of one scaling and one function, multiple scaling and multiple wavelet function are used. This leads to more degrees of freedom in constructing Multi wavelets. Therefore opposed to scalar wavelets, properties such as orthogonality, symmetry, higher order of vanishing moment, compact support can be gathered simultaneously in multi wavelets.

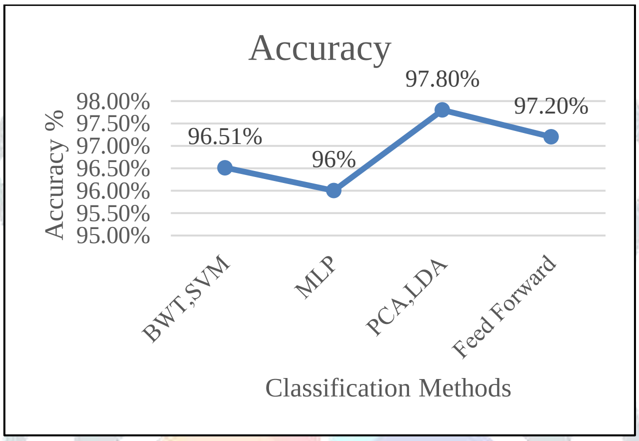

Fig.-2 Accuracy Comparison based on Table-1

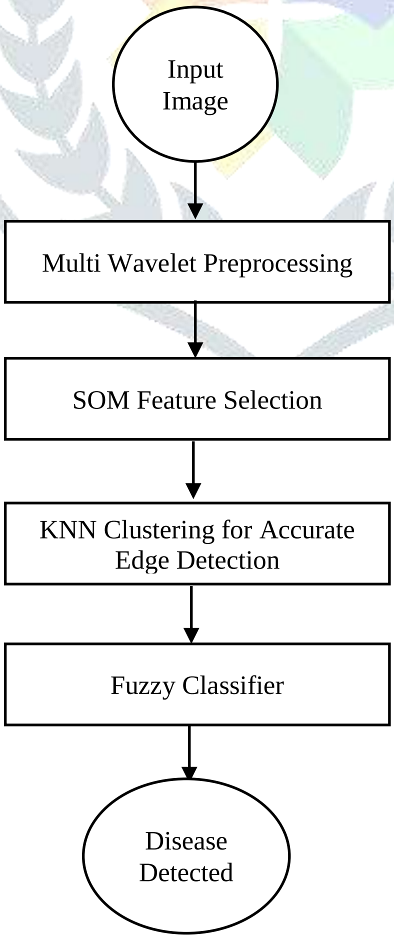

Fig-3 Propoesd Layout

SOM Feature Selection

```
SOM(im)
//im - input samples
map=8                    //map size    //[p1,p]=size(im)
mw=rand(map,map,1)            //initialize map
[m,n]=size(im)
wx=0wy=0sigma=0.0update_lrate=0.99
update_radius=map/3radius_decay=0.999
i=1
for t=1:10000              //iteratio
 if( i > n)              // finding winner neurons
   i=1
 end
[win,wx,wy]=winner(mw,im(i))
     gain=update_lrate * exp(-dis/(2 * update_radius))
         for a=1:m
         mw(x,y,a)=mw(x,y,a)+gain *(mw(wx,wy,a)-mw(x,y,a))
        end
      update_lrate=0.999/(0.999+(0.01*t))
   update_radius=1.0+(update_radius-1.0)*radius_decay
  return sommap=mw
```

Futher we have applied SOM fetured image for KNN clustering for better edge dtection, then image is supplied to fuzzy C-means classifier, algorithm as follows:

Fuzzy C-Means

Initialize $U=[u_{ij}]$ matrix, $U^{(0)}$

At k-step: calculate the centers vectors $C^{(k)}=[c_j]$ with $U^{(k)}$

$$c_j = \frac{\sum_{i=1}^{N} u_{ij}^{m} \cdot x_i}{\sum_{i=1}^{N} u_{ij}^{m}}$$

Update $U^{(k)}$, $U^{(k+1)}$

$$u_{ij} = \frac{1}{\sum_{k=1}^{C} \left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|} \right)^{\frac{2}{m-1}}}$$

If $|| U^{(k+1)} - U^{(k)}|| < \varepsilon$ then STOP; otherwise return to step 2.

In the FCM approach, instead, the same given datum does not belong exclusively to a well defined cluster, but it can be placed in a middle way. In this case, the membership function follows a smoother line to indicate that every datum may belong to several clusters with different values of the membership coefficient.

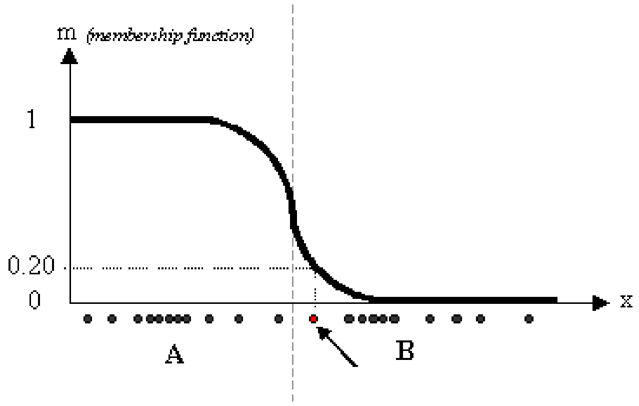

Fig.-4 FCM

In the figure-4, the datum shown as a red marked spot belongs more to the B cluster rather than the A cluster. The value 0.2 of 'm' indicates the degree of membership to A for such datum. We have used 3-class fuzzy c-means clustering.

It often works betterthan Otsu's methold which outputs larger or smaller threshold on images. Specification of mebership funcation as

sw is 0 or 1, a switch of cut-off position.
sw=0, cut between the small and middle class
sw=1, cut between the middle and large class

IV. RESULTS AND DISCUSSION

II. For implementation of proposed approach we have used MATLAB 2016b, taken MRI images for brain tumor detection.

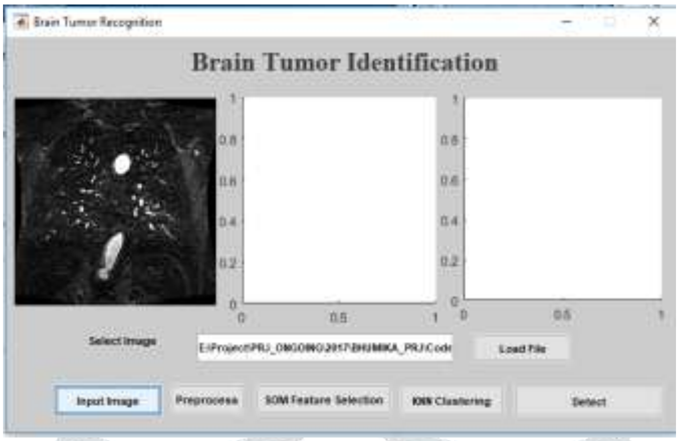

Fig.-5 Main UI of Proposed Approach

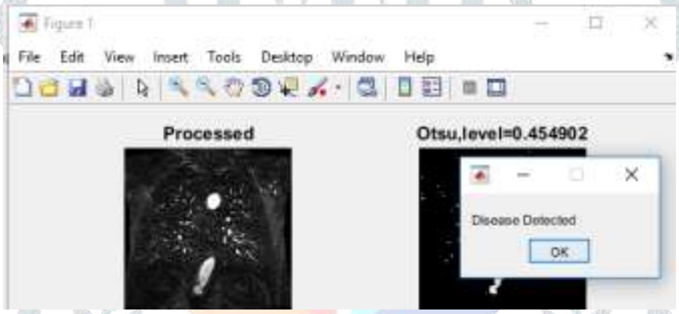

Fig.-6 Output of Disease Dtection

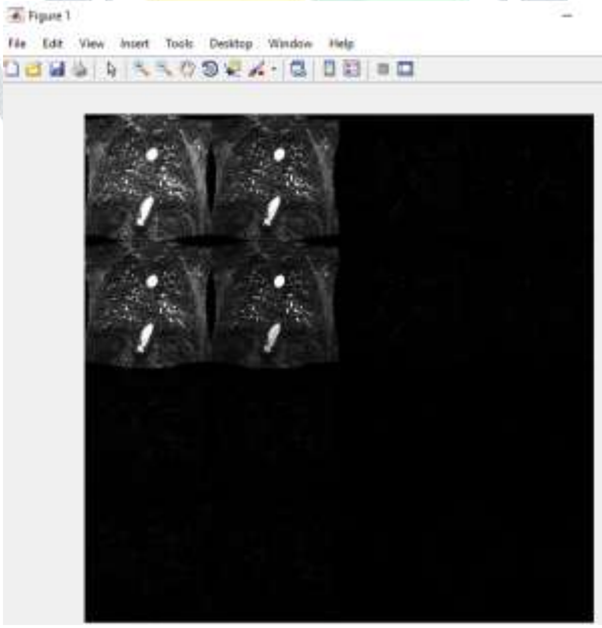

Fig.7- GHM Multi Wavelet Output

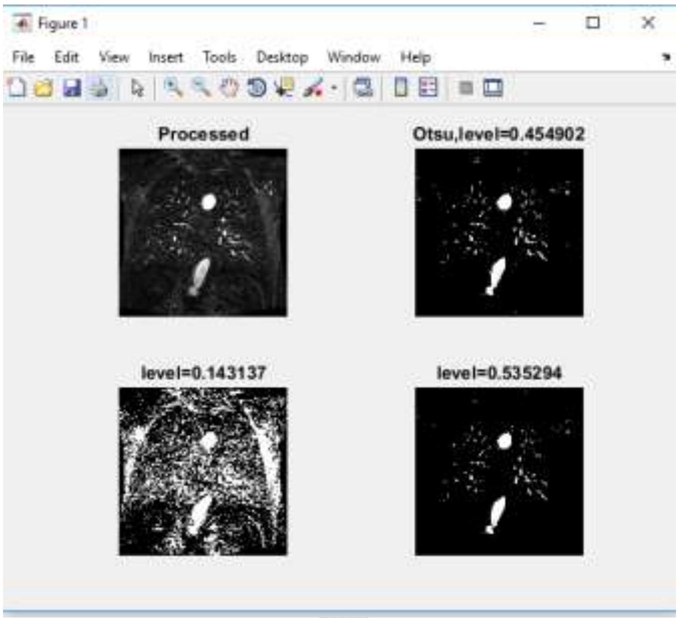

Fig.-8 Fuzzy Classifier

We have saved output of detection as if correct identified then 1 else 0 with reference to actual in spreadsheet and we have supplied this data to MATLAB classification learner.

Img ID	Actual	Predicted
1	1	1
2	1	1
3	1	1
4	1	1
5	1	1
6	1	1
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0

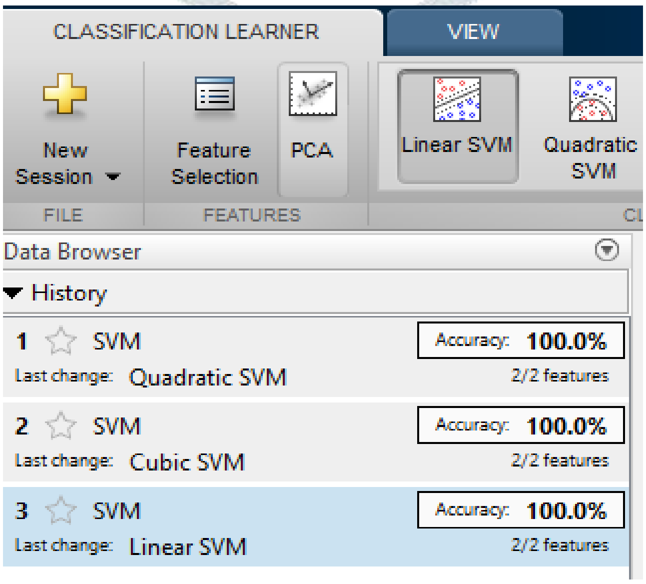

Fig.9 Classification Learner Output

S. No.	Classifier	Accuracy
1.	Linear SVM	100%
2.	Cubic SVM	100%
3.	Quadratic SVM	100%
Average%		**100%**

S. No.	Image Name	Proposed	
		PSNR	**MSE**
1.	1.png	64.4db	0.17
2.	2.png	67.9db	0.19
3.	3.png	68.9db	0.11
4.	4.png	67.8db	0.12
5.	5.png	73.7db	0.19

S. No.	Method	Accuracy
1.	Earlier (BWT and SVM)	96.51%
2.	Proposed	100%

CONCLUSION

Identification of BT (Brain Tumor) is challenging problem and there's still a lot of work has been done in this area. BT has expected substantial attention from scientists in neurology communities. This project associate approach that is that the integration of Multi wavelet based image, preprocessing and SOM based image feature selection and fuzzy classifier, which significantly will increase the accuracy that facilitates to diagnose BT. Result section shows we have achieved 100% accuracy.

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