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Early Detection of Tumorsin Human Brain MRI Using Wavelet and Support Vector Machine

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Abstract

Brain tumor is a serious problem. Brain tumor detection and classification is most important in medical analysis and interpretation. More number of methods has already been proposed in last decades. Here presented a method to classify the brain image has normal or abnormal.In human body there are numerous cells died and new cells born. If the older cells unabletodie, form tumor.In brain two types of tumor occur. Malignant and benign tumor. Malignant tumor is cancerous and spread to other parts of the body. Benign tumor is non cancerous and do not spread to other parts of the body. Here MR images are taken as input. Perform segmentation which provides meaning fullregion, size and structure oft heimage. Convert gray scale image to binary by using thresolding technique.More number of features is available hence need to reduce features by Discrete Wavelet Transform (DWT). Feature extraction is done by using Principle Component Analysis(PCA).Finally classification of tumoris done byusing SupportVectorMachine (SVM). SVM has high accuracy, elegant mathematical tractability and direct geometric interpretation. More number of features is considered here. If the features are more classification will be good.

Keywords

Braintumor, MRI, PCA, DWT and SVM.

I. Introduction

The brain is a smooth, slenderand soft mass of tissue. A tumor is unworthy growth of sick cells. A tumor increases the pressure within the skull. Tumor can affect all the healthy cells. It can also subsidiary damage good cells by gathering other parts of brain and causing inflammation, brain enlargement and force within the skull. Brain tumor is a group of unnatural cells that develop inside of the brain or around the brain. Brain tumore it her occurs in the brain itself, blood vessels, in the cranial nerves,in the brain envelopes,skull,pituitary, pineal gland, or spreads from cancers primarily located in other organs.

There are two types of brain tumor primary and secondary. Primary brain tumors begin from brain cells, the membrane around the brain, nerves or glands. Primary brain tumors are divided into malignant and benign. Benign brain tumor usually has edges and can be removed. Benign tumors don't distribute on other parts of the body and it can press sensitive part of the body causes serious health problem. Malignant tumor spread on other parts of the body and causes serious health problem. Magnetic resonance imaging is an imaging technique that produces high grade images of the anatomical structure of the human body, especially in the brain, and provides abundant information for clinical diagnosis and biomedical research. MRI (Magnetic Resonance Imaging) provides a digital reproduction of tissue characteristics that can be acquired in any tissue plane.

Magnetic Resonance Imaging scan images are model source for detecting, identifying and classifying the septic regions of the brain. Wave let transform is useful tool for future extraction from MR brain images. This technique requires heavy storage and computationally overpriced. In order to reduce the dimension of the future, use PCA (Principle Component Analysis) is used. PCA is mathematical tool for extracting significant data from disorder data set. The dimensionality and computation cost of the data are reduced by PCA. Next problem of classifying of data arises. SVM technique which is supervised classification technique is used for classification of data. SVM has useful advantage of high accuracy, Superior mathematical manageability and direct geometric interpretation. Here, kernel SVM is used. This SVM classify the brain as normal or abnormal.

The rest of the paper is organized as follows: section II describes the Related Work; Section III tells the problem statement; Section 1V gives Methodology; Section V gives the obtained results with conclusion and finally V gives the future work.

II. Related Work

Numerous contemporary proposals in segmentation, classification and processing of Brain Tumor detection were outlined in various studies.

Kusum Rani et al. [1] presented a review on various image fusion techniques like simple average, simple maximum, simple minimum, DWT, PCA and then concluded that combination of PCA and DWT can be moulded further for better results.

W. M. Wells et al. [2] Presents an automatic method adaptive segmentation for correcting the intensity of MRI images. This technique increases the automation level and improves the 3-D reconstruction for disease research, planning of surgery, evaluation of therapy and other purposes.

Ilya Pollak Willsky et al. [3] introduced differential equations of first-order having multiple dimensions. It demonstrates the applicability of these equations for the processing of images.

Y. Zhang et al, [4] presented a method for the classification of MR image as normal or abnormal. In this paper firstly features are extracted from image using wavelet transformation, then in order to reduce dimension of extracted features, principle component analysis is used and are passed to support vector machine (KSVM). They uses four different kernels HPOL, LIN, IPOL and GRB to increase the accuracy and robustness of their classifier.

Bing Nan Li et al. [5] presented a new fuzzy level set algorithm. This method is further modified with regular local evaluation. They facilitated the manipulation level set to extract the boundaries of region of interest resulting in reduction of manual intervention.

III. Problem Statement

Early detection of brain tumor is very important. The main problem is classification of brain as normal or abnormal. In order to detect tumor correctly more features are required. In the previous approaches limited features are used, hence accuracy will be limited. In order to increase efficiency powerful technique must be needed.

IV. Methodology

This section explains the proposed system design and methodology which concerns its fundamental design and the features of each of three parts of proposed method. The proposed method consists of number of phases such as Feature extraction from MRI data set using Wavelets. Feature reduction using principal component analysis (PCA) to select most valuable features. This section also explains the classification stage in which support vector machine is used for classification. The procedure for classify whether the brain is normal or abnormal consist few steps. They are

1. Preprocessing: It involves feature extraction and feature reduction. Feature extraction is done by using discrete wavelet transform and feature reduction uses principle component analysis.
2. Training the kernel SVM.
3. Propose new MRI brain to the training kernel SVM and predict the result.

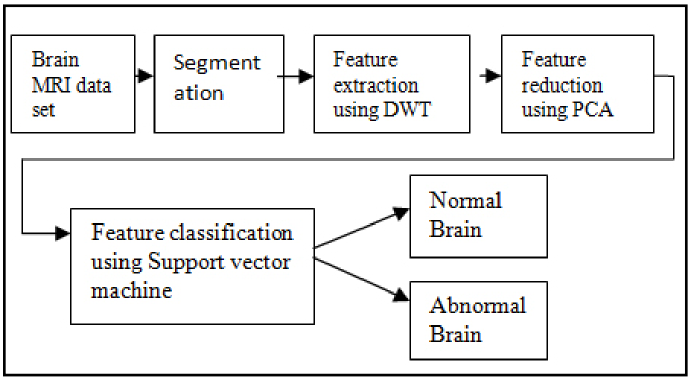

Fig.1: Methodology of proposed Algorithm

1. Segmentation

Image segmentation is the process of partitioning an image into accumulation of united sets of object. Segmentation can be done into Regions, which usually cover the image.

- ➢ Linear structures, such as
- Line segments
- curve segments
- ➢ 2D shapes, such as
- Circles
- Ellipses
- ribbons (long, symmetric regions)
- ➢ Otsu's method

The segmentation of image involves thresholding, which is the simplest method of image segmentation. Otsu method is used to automatically perform clustering-based image thresholding, or, the reduction of a gray level image to a binary image. The algorithm assumes that the image consists two classes of pixels following bi-modal histogram (foreground pixels and background pixels), it then evaluate the optimum threshold separating the two classes so that their combined spread (intra-class variance) is minimal, so that their inter-class variance is maximal. The extension of the original method to multi-level thresholding is referred to as the multi Otsu method.

2. Feature extraction

Signal analysis can be done by using Fourier transform but which losses the time information. Fourier analysis can also be done by using short time Fourier transform which keep both time and frequency information but uses constant window size. Hence discreet wavelet transform which keeps both time and frequency information with different window size.

Discrete wavelet transform (DWT) decomposes a signal into set of mutually orthogonal wavelet basis functions. These functions differ from the sinusoidal basis functions. Wavelet functions are dilated, translated and scaled version of a common function pi called mother wavelet. The wavelets are specially localized that is nonzero over only part of the total signal length. The properties of wavelet functions involves

1. Wavelet functions are specially localized.
2. Wavelet functions are dilated, translated and scaled version of a common mother wavelet.
3. Each set of wavelet functions forms an orthogonal set of wavelet basis functions.

Transformation of DWT is linear transformation perform on a data vector whose length is an integer power of two; convert it into numerically different vector of the same length. DWT is a tool that separates data into distinct frequency components and studies each component with resolution equivalent to its scale.

3. Feature Reduction

Extreme features increase the computation time and storage memory. Hence needs to reduce the features. At some time excessive features make classification more complication. Hence need to reduce features.

Principle Component Analysis (PCA) is an efficient tool for the reduction of features in an image, by reducing the dimension of the data. Data set consist of more number of inter related variables; PCA retains the most of the variations. It is accomplished by transforming the data set to a new set of ordered variables consistent with their importance.

PCA has three effects

1. It orthogonalizes the components of the input vectors so that uncorrelated with each other.
2. It organizes the resulting orthogonal components so those with the highest variation come first.
3. Excludes those components give least to the variation in the data set.

Input vectors should be normalized to have zero mean and unity variance before performing PCA.

4. Support Vector Machine

Support Vector Machine (SVM) introduced by Cortes is generally used for classification purpose. SVMs are efficient learning approaches for training classifiers based on several functions like polynomial functions, radial basis functions, neural networks etc. It is considered as a supervised learning approach that produces input-output mapping functions from a labeled training dataset. SVM has significant learning ability and hence is broadly applied in pattern recognition.

Support vector machines are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification. The basic SVM takes a set of input data and for each given input, predicts which of two classes forms

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the input, making it a non-probabilistic binary linear classifier. Best hyper plane is the one that represents the largest separation or margin between the two classes. So choose the hyper plane so that the distance from it to the nearest data point on each side is maximized. If such a hyper plane exists, it is known as the maximum margin hyper plane and the linear classifier it defines is known as a maximum classifier.

V. Implementation

The complete implementation is done using MATLAB. The implementation involves following steps.

➢ Access the input

The data base used is from American society of cancer.

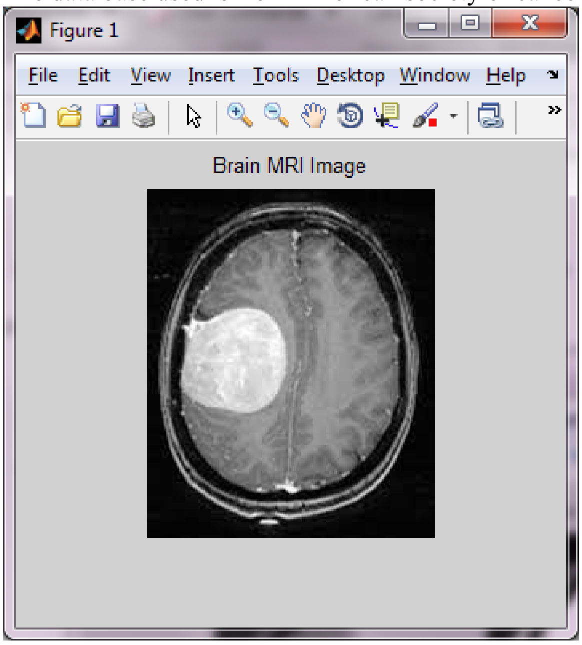

Fig. 2: MRI Brain Image

MRI images consist of gray and white matter and the region containing the tumor has more intensity.

The thresholded image is shown in Fig 3. Otsu thresholding is applied here, which convert the gray scale image into binary image.

1. Compute Histogram and probability and probabilities of each intensity level.
2. Set up initial $\omega_i\,(0)$ and $\mu_i(0)$.

$$\omega_i\,(0) = \sum_{t=0}^{t-1} p(i)$$

$$\mu_0(t) = \sum_{i=0}^{L-1} i\frac{p(i)}{w_0}$$

Where w is the weight, p is the probability and μ is the mean value.

3. Step through all possible threshold t=1….maximum intensity.
   1. Update μ_i andω_i .
   2. Compute $\sigma^2{}_b(t)$

      $\sigma^2{}_b(t)= \sigma^2 - \sigma^2{}_w(t) = \omega_0(\mu_0 - \mu_T)^2$

      Where $\mu_T = \sum_{i=0}^{L-1} ip(i)$

4. Desired threshold corresponds to the maximum $\sigma^2{}_b(t)$.

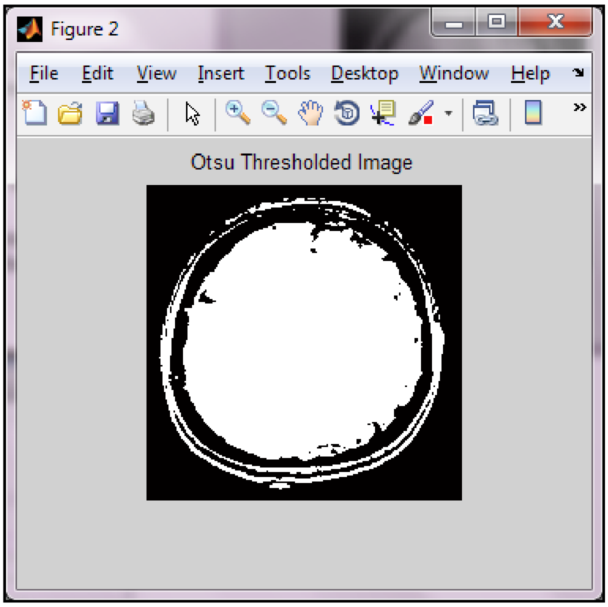

Fig.3: Threshold image

Clustering is the process of grouping a set of objects into classes of similar objects. The procedure for k means clustering is shown in Fig 4.

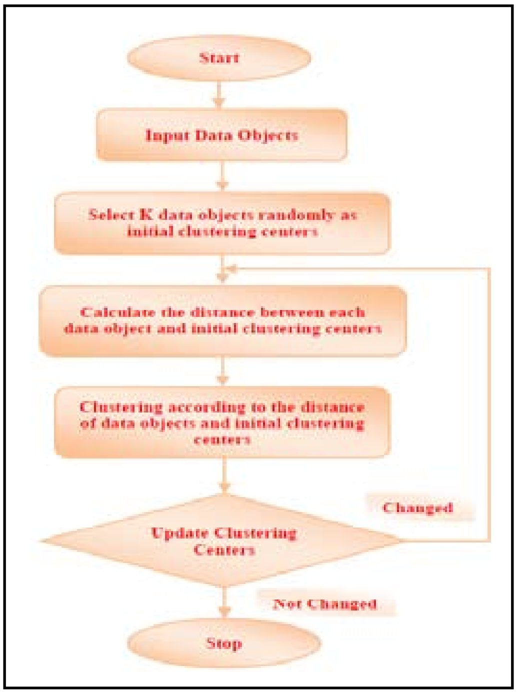

Fig.4: K –means Flow chart

From the K means clustering image obtained in cluster1 is shown in Fig 5.

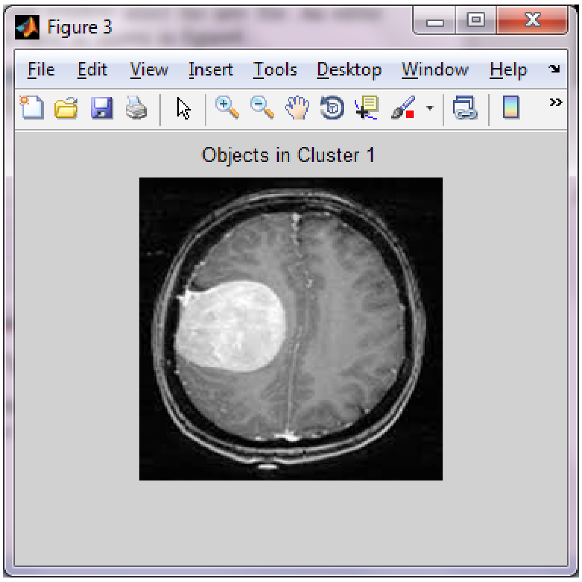

Fig. 5:Cluster1 Object

The segmented image is shown in Fig 6. Segmentation is the partitioning of image into collection of set of pixels. Otsu thresholding method is used here, which is more useful method. By using histogram Otsu thresholding method select the threshold value. The segmented image consists of only black and white color.

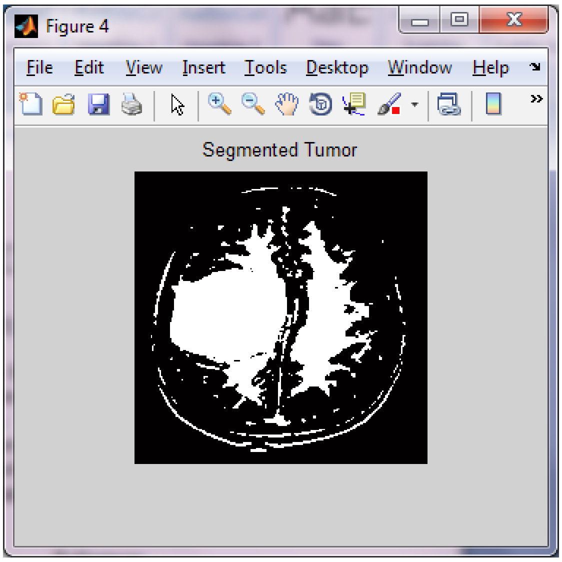

Fig.6: Segmented Tumor

The Final output for the given MRI is displayed in MATLAB window.
Discrete wavelet transform for feature extraction. Daubechies wavelet transform is used. DWT extract useful features and remove the unwanted features by applying low pass and high pass filter.
The result will be obtained by passing the image through high and low pass filter.

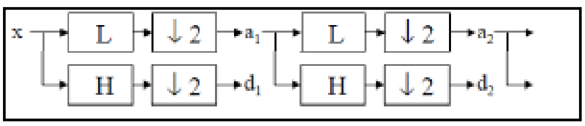

Fig. 7: DWT Tree

$$a_{j+1}[p] = \sum_{n=-\infty}^{+\infty} l[n-2p]a_j[n]$$

$$d_{j+1}[p] = \sum_{n=-\infty}^{+\infty} h[n-2p]a_j[n]$$

H and *L* denote high and low-pass filters. 2 denotes sub sampling.

Elements a_j are used for next step (scale) of the transform and elements d_j, called Wavelet coefficients, determine output of the transform[n] and h[n] are coefficients of low and high-pas filters respectively One can assume that on scale j+1there is only half from number of *a* and *d* elements on scale *j*. This causes that DWT can be done until only two a_j elements remain in the analyzed signal.

Fig. 8: Result of DWT

The next method involves feature reduction by using principle component analysis. The features reduction is performed since more number of features need more computation time. Fig 9 shows the result of PCA.

Fig. 9: Result of PCA

Result can be shown as malignant or benign tumor by using support vector machine.
Here GUI is constructed to see the result whether the tumor is malignant or benign. Fig 10 shows the result of the given MRI image.

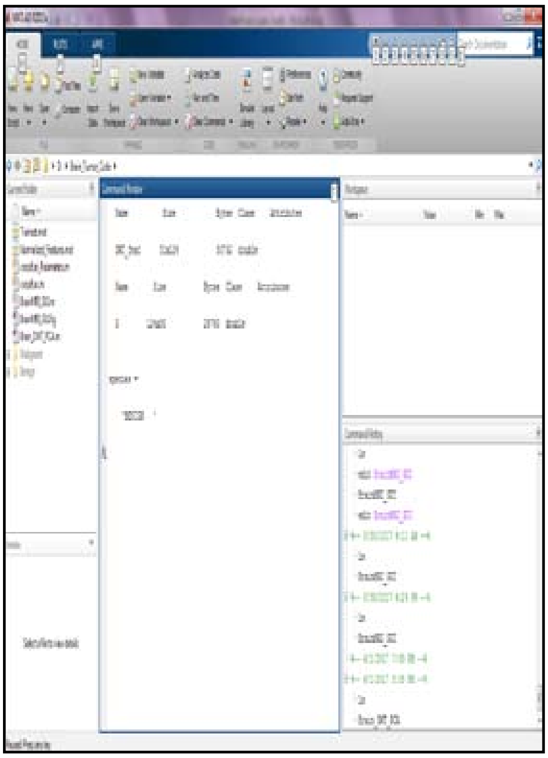

Fig.10: Final Result in the MATLAB

The features for image size 128×128 and 200×200 are shown in the Table 1. These features are very useful for accurate classification of image. These features provide characteristics of pixels, brightness, intensity, and dimensionality. By using these characteristics analysis will be good.

Table 1: Features of image

Features	**Image Size 128×128**	**Image Size 200×200**
Mean	0.00899918	0.00630907
Standard deviation	0.106249	0.0895928
Entropy	3.29167	3.20515
RMS	0.1066	0.0898027
Variance	0.0112921	0.00801767
Smoothness	0.94328	0.959133
Kurtosis	9.47708	12.2408
Skewness	0.994698	1.10481
IDM	0.0500173	1.2156
Contrast	0.463636	0.305895
Correlation	0.104403	0.142097
Energy	0.715579	0.786231
Homogeneity	0.914583	0.937931

VI. Result & Conclusion

In this project detection of tumor in brain is done and also classifies the tumor whether malignant or benign is performed. DWT, PCA and SVM technique of brain tumor detection is used. By using these methods for different stages in detection process, efficiency becomes more. Compared previous work more features is extracted and hence accuracy also becomes high. More than 15 features brain is taken and hence result in good performance.

From the Table1 the proposed system has more advantages with added features compare to existing system.

Table 2: Comparison of Accuracy for Benign Tumor

Image NO.	Image Size	RBF Accuracy (%)	Linear Accuracy (%)	Polygonal Accuracy (%)	Quadratic Accuracy (%)
Image1	180×218	90	90	80	90
Image2	216×234	80	90	70	80
Image3	225×225	70	90	70	90
Image4	207×244	80	90	80	90
Image5	221×228	80	90	70	70
Image6	158×158	80	90	80	70
Image7	211×239	70	90	80	70
Image9	211×239	70	90	70	80
Image10	202×249	70	90	80	70
Image11	230×219	80	90	90	80
Image12	225×225	80	80	80	80

The accuracy for different kernel is calculated. The table 1 shows the RBF, polynomial, linear and quadratic kernel have different accuracy. The average accuracy for benign tumor detection is tabulated and shows overall accuracy increment.

Table 3: Comparison of Accuracy for Malignant Tumor

Image NO.	Image Size	RBF Accuracy (%)	Linear Accuracy (%)	Polygonal Accuracy (%)	Quadratic Accuracy (%)
Image1	225×225	90	90	80	80
Image2	199×253	80	90	70	70
Image3	160×129	80	90	80	80
Image4	214×236	70	90	80	80
Image5	160×199	70	90	80	80
Image6	200×252	80	100	70	80
Image7	234×216	90	90	80	80
Image9	215×235	80	90	90	80
Image10	225×225	80	90	80	80
Image11	205×246	80	80	80	70
Image12	100×128	80	90	80	90

The accuracy for different kernel is calculated. The table 2 shows the RBF, polynomial, linear and quadratic kernel have different accuracy. The average accuracy for malignant tumor detection is tabulated and shows overall accuracy increment.

Table 4: Comparison of existing system with proposed system

SL.	Kernels	Existing system accuracy (%)	Proposed system accuracy (%)
1.	RBF	75	78
2.	Linear	60	89
3.	Polygonal	75	78
4.	Quadratic	75	79

The detection of tumor in brain is done and also classifies the tumor whether malignant or benign is performed. There were lots of works done for the detection of tumor. Earlier methods texture analysis was used. Texture analysis makes mistakes. Texture analysis have lots of parameters it is not clear how to set them. Texture analysis heavily depends on nature of the problem. DWT, PCA and SVM technique of brain tumor detection is used. Discrete wavelet transforms which is very useful method for feature extraction. DWT is the improvement of Fourier transform and short time Fourier transform. Principle component analysis method very good feature reduction technique. For classification SVM has high accuracy and elegant mathematical tractability.

By using these methods for different stages in detection process, efficiency becomes more. Compared previous work more features is extracted and hence accuracy also becomes high. More than 15 features brain is taken and hence result in good performance. As shown in comparison table 4 accuracy of different kernel will be improved. It is possible to achieve about 3% to 4% accuracy for RBF, polynomial and quadratic kernel and about 19% linear accuracy can be achieved.

VII. Future Work

In future efficiency can be increased by identifying more features. A text categorization system may have lots of parameters. Often it is not clear, how to set them, it heavily depends on the nature of the problem. The proposed SVM based method could be used with other contrast mechanism. Future work can be improved by comparative validation.

Reference

[1]. Scapaticci, R., L. Di Donato, I. Catapano, and L. Crocco, A feasibility study on microwave imaging for brain stroke monitoring," Progress In Electromagnetics Research B, Vol. 40, 305{324, 2012.

[2]. Asimakis, N. P., I. S. Karanasiou, P. K. Gkonis, and N. K. Uzunoglu, \Theoretical analysis of a passive acoustic brain monitoring system," Progress In Electromagnetics Research B, Vol. 23, 165{180, 2010.

[3]. Chaturvedi, C. M., V. P. Singh, P. Singh, P. Basu, M. Singaravel, R. K. Shukla, A. Dhawan, A. K. Pati, R. K. Gangwar, and S. P. Singh. \2.45 GHz (CW) microwave irradiation alters circadian organization, spatial memory, DNA structure in the brain cells and blood cell counts of male mice, mus musculus," Progress In Electromagnetics Research B, Vol. 29, 23{42, 2011.

[4]. Emin Tagluk, M., M. Akin, and N. Sezgin, \Classi¯cation of sleep apnea by using wavelet transform and arti¯cial neural networks," Expert Systems with Applications, Vol. 37, No. 2, 1600{1607, 2010.

[5]. Zhang, Y., L. Wu, and G. Wei, \A new classi¯er for polarimetric SAR images," Progress in Electromagnetics Research, Vol. 94, 83{ 104, 2009

[6]. Zhang, Y., L. Wu, and G. Wei, \A new classi¯er for polarimetric SAR images," Progress in Electromagnetics Research, Vol. 94, 83{ 104, 2009}.

[7] Bhonde Nilesh, Shinde Sachin, Nagmode Pradip, D.B. Rane" Image Compression Using Discrete Wavelet Transform" International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 3, Special Issue, March-April 2013.

[8] P. Mohanaiah, P. Sathyanarayana, L. GuruKumar"Image Texture Feature Extraction Using GLCM Approach" , International Journal of Scientific and Research Publications, Volume 3, Issue 5, May 2013

[9] M. G. Mostafa and M. F. Tolba, Medical Image Segmentation Using Wavelet Based Multi resolution EM Algorithm, IEEE trans on Industrial Electronics, Technology and automation, IETA, 2001.

[10] N. Passat, C. Ronse., J. Baruthio, J. P. Armspach., C. Maillot, Magnetic resonance angiography: From anatomical knowledge modeling to vessel segmentation, Medical Image Analysis, pp. 259-274, 2010.

[11] J. H. Kazmi, K. Qureshi, H. Rasheed, An Implementation of SAN Filter and Edge Sharpening Method for MRA images, Malaysian Journal of Computer Science, 2007.

[12] R. Mishra, MRI based Brain Tumor Detection using Wavelet Packet Feature and Artificial Neural Networks, Department of computer science India Ghandi Institute of Technology Indraprastha University, Delhi, India, 2010.

[13] E. A. El-Dihshan, T, Hosney, A. B. M. Salem, Hybrid intelligence techniques for MRI Brain images classification, ELSEVIER, Digital Signal Processing, , Volume 20, pp.433-441, 2010