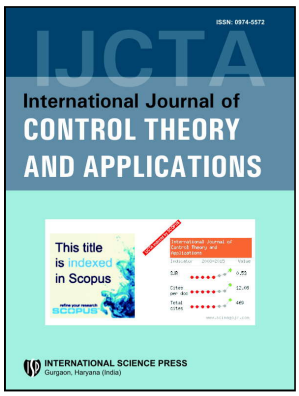

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Brain Tumor Detection and Classification Using Discrete Wavelet Transform and Artificial Neural Network

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Abstract: This paper present brain tumor detection and classification using discrete wavelet transform and artificial neural network. The system uses three level decomposition using discrete wavelet transform for detection of tumor in the brain. Finally the artificial neural networks classifies the tumor into its different type they are benign , malignant and metastatic. The image processing system consist of pre-processing, discrete wavelet transform and artificial neural network so this is called as multistage image processing. In pre-processing for contrast enhancement histogram equalization is used, extraction of feature is done using three level discrete wavelet transform and finally classifier has been developed for classification of tumor into Benign, Metastatic, Malignant. using probabilistic artificial neural network. The complete system is tested in two phases Training phase and recognition phase.

Keywords: Brain tumors, Classification, detection, 2D Gabor wavelet transform, Wavelet decomposition, Pre-Processing, Post- Processing, Probabilistic neural network.

1. INTRODUCTION

Brain tumor is an abnormal and infinite growth of the tissue in the brain. The factors of tumor like the type of tumor, its location, its size and its state of development decide the level of tumor. Tumors mainly divided into two types. Noncancerous tumor involve benign tumor and cancerous tumor involve malignant and metastatic. Characteristics of benign brain tumors are, this tumor is belong to the Low group , the growth of the tissue is slow and its noncancerous tumor is also called as non metastatic tumor because benign tumor do not contain secondary stage. Characteristic of malignant brain tumors are, in this tumor the growth of the tissue is very fast, this tumor are called as cancerous brain tumors and it is the second stage of the cancerous tumor. The growth of the tissue is disorganized this type of tumor are called as metastatic tumor and it is also called as cancerous tumor. Metastatic tumor is first stage of the cancerous tumor. Initiate growth of similar tumors in distant organs. cancerous brain tumors can be counted among the most dangerous and deadly diseases.

World Health Organization (WHO) can be classified the brain tumor into the following groups:

Group I: Benign tumor, it is slow growing, with well defined borders, noncancerous.

Group II: Astrocytoma, slow growing, tissue rarely spreads with a well defined border, non cancerous.

Group III: Anaplastic Astrocytoma, metastatic, cancerous grows faster.

Group IV: Glioblastoma Multiforme, malignant most invasive, spreads to nearby tissues and grows rapidly.

For the detection and classification of brain tumor different methods are use. For the early detection of brain tumors CT, PET, MRI is use. In this paper we use magnetic resonance imaging (MRI). MRI is more efficient than the other imaging technique. it is efficient in the brain tumor detection and the identification, also it is efficient in providing information about the location and size of tumors. Classification of tumor is the very difficult task. For classification purpose the biopsy and spinal tap method is introduce but this methods is painful and time consuming. methods. In Biopsy technique the surgeon make a small hole in the scalp this hole called as a burr hole and take the sample of tissue to check the presence of cancerous cell sample of tissue from the brain tumor. It is very painful method. In spinal tap method, surgeon take the sample of cerebrospinal fluid and check for the presence of cancerous cells. This method is also time consuming and painful. For overcoming this problem in this paper we use discrete wavelet transform and probabilistic neural network method for detection and the classification. PNN classify the MR images into benign, metastatic and malignant brain tumor.

2. LITERATURE REVIEW

This paper presented a diagnosis algorithm for the problem of tumor description which include different tissue characteristic. As the change in necrotic and increasing part of the brain tumor after radiation therapy becomes important, also applied the Tumor-cut segmentation to classify the tumor tissue into its necrotic and improving parts. They presented validation information over a artificial tumor database and real tumor databases: one from tumor repository and another from a medical database of tumors that go through radio surgery planning. more explanation, changes over fluctuate initial genesis were also presented as standard variation, and shown to be important in valuation [1].

This paper includes, novel multifractal (multi-FD) feature extraction and classification techniques for upgraded brain tumor detection.. On the other hand, the new approach is AdaBoost algorithm considers large variability in texture characteristic across MRI images of hundreds patient for modified tumor and non tumor tissue classification. trial results with 14 patients involving 309 magnetic resonance imaging parts confirm the efficiency of novel multi- FD characteristics and for automatic patient independent tumor segmentation used modified AdaBoost classifier [2].

This paper proposed , identification of the tumor type associated with the multi-ion image of a given sample. In addition, the algorithm has the capability to reject samples for which either the corresponding tumor type is unknown or there is a great degree of uncertainty in classifying the sample into one of the known tumor types. The proposed framework is modular as new tumor models can be added without the need to retrain the classifier on all existing tumor models [3].

A computer software system is designed for distribution and the images are classified into benign and malignant brain tumor . This paper include, the authors introduce a method to select both superior run length and texture characteristic occur together of wavelet calculation tumor region of each part to be divided by a support vector machine . inverse 2D wavelet is performed on the brain tumor image to avoid the unwanted material. The images considered for this study belong to 208 tumor slices. Seventeen characteristic are removed and six characteristic are selected using test. This study include the SVM and neural network classifiers with the selected characteristic. The classification accuracy of both classifiers is evaluated using the k fold cross confermation m method. Determinable observation between ground truth and the segmented tumor is presented in terms of accuracy and error of the segmentation. The given system gives some advanced texture characteristic have an

important contribution in classifying tumor slices efficiently and accurately. The practical results show that the suggested SVM classifier is able to reach great accuracy of segmentation and classification is effective in measurement of sensitivity and selectivity [4].

This paper proposed the GW based analysis of functional brain images by assimilate the 2D Gabor wavelet graph of the images for grouping and this is used in the study of unbalance disease. The 2D GW representation of the brain images is presented by means of a principal component analysis for element n and support vector machines for image classification. This method gives the 96% accuracy in classification with 100% sensitivity, thus becoming an accurate methextractiood for image classification [5].

This paper proposed a novel method to detecting Brain tumor from MRI images using regional Characteristic. This paper proposed the two algorithm these are, First is segementation algorithm for division and second is super-pixel division algorithm. segmenatation algorithm is apply for taking the division of skull and head area using average of brain MRI images and local adaptive threshold technique. And second algorithm is used in order to generate classified part on the divided brain image. After applying the algorithm paper proposed the extraction of regional characteristic, which are texture characteristic and intensity. After Applying above all methods Finally, the support vector machine classifier detects the tumor from the brain using MRI images and this region is classifie according to different super-pixel parameters. This paper gives the successful results in detection of tumor region. This paper gives yhe 60% accuracy on the brain magnetic resonance [6].

This paper proposed the data mining methods. Data mining methods are used for classification of Magnetic Resonance Imaging images. This method uses the some technique for brain tumor classification these are support vector machine and fuzzy c-means. This paper introduce a algorithm. combination of support vector machine (SVM) and fuzzy c-means made this algorithm and this algorithm helps in the classification of brain tumor. This algorithm applied the enhancement techniques for enhanced the images for improving the quality of images such as contrast improvement, and mid-range stretch. After applying the enhancement technique taking the skull deconstruction using morphological operations and Double thresholding . for the segmentation of the image Fuzzy c-means clustering is used. For the detction of brain tumor Fuzzy c-means clustering is used . Grey level run length matrix is used for taking out the characteristic from the brain image. In this paper for classification purpose Support vector machine used. This proposed work gives the error free and more correct result of classification of brain MRI image using support vector machine[7].

This paper proposed the methods for the diagnosis of the brain tumor, doctor combine their medical knowledge , scan MRI images and pathological characteristics of brain tumors for deciding the treatment Process. Taking large number of MRI scans of each patient for physical detection and division of brain tumor, this process is apply for the inter and intra observation of variable detection and variable division . In the recent years, for the detection and classification of brain tumor many methods have been proposed. But doctor can not accepted the automated technique for treatment purpose because some methods gives the fault in the result, this is related to its precision and toughness . This paper consists the techniques for detection of brain tumor, the deconstruction of skull is use as a one method for detection and for division of brain tumor is use.

3. 2D DISCRETE WAVELET TRANSFORM

The wavelet Transform is a most important and effective transform for the detection of image. Discrete Wavelet transform is apply for obtaining the coefficient of wavelet transform from Magnetic Resonance Imaging images. Wavelet Transform implement the Discrete Wavelet Transform (DWT) using the scales and positions of coefficient. The basic fundamental principle of Discrete Wavelet Transform is in as follows:

Let, x of t is a square-integral function, then the continuous Wavelet Transform of x of t relative to a given wavelet ψ of t is defined as,

$$W_{\psi(a,b)} = \int_{-\infty}^{\infty} x(t)\psi_{a,b}(t)dt \tag{1}$$

Where, mother wavelet Ø of t is calculated the wavelets by discussion and translation of factor a and b resp. which are real positive numbers.

$$W_{(a,b)}(t) = \frac{1}{\sqrt{a}}\psi\left(\frac{t-a}{b}\right) \tag{2}$$

Equation (1) can be perform the discrete wavelet transform by restraining a and b to a discrete lattice to give the discrete wavelet transform, which can be expressed as,

$$a_{j,k}(n) = DS\left[\sum_n x(n)g_j\left(n-2^j k\right)\right] \tag{3}$$

$$d_{j,k}(n) = DS\left[\sum_n x(n)g_j\left(n-2^j k\right)\right] \tag{4}$$

Where, the coefficients of wavelet transform refer to the approximate and detail components.

Where,

Function g (n) → Coefficients of the low-pass filter

Function h (n) → Coefficient of high-pass filter.

j and k → Denote the scale and translation factors of wavelets, respectively.

DS → operator is used for down sampling.

2 Dimensional Discrete Wavelet Transform decomposed in four sub bands, these are LL, LH, HL, HH at each scale. Approximation component of the image is LL sub band, which is used for next two dimensional Discrete Wavelet Transform. Whereas, LH is the component of the image along the horizontal axis, HL is the component of the image along the vertical axis, HH is the component of the image along the diagonal as shown in the below figure.

Where,

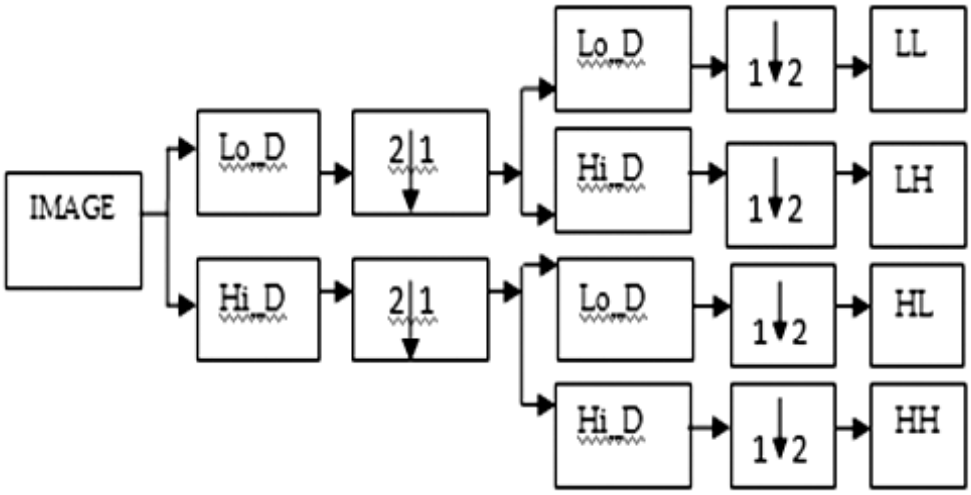
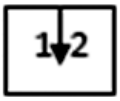


Figure 1: 2 Dimensional Discrete Wavelet Transform

Lo_D – Low Pass Filter , Ho_D – High Pass Filter

DS columns: even indexed columns.



DS rows: even indexed rows.

From the above Literature review observe that the 2D discrete wavelet transform is considered as the better option than the other wavelets for detection and LH and HL sub-bands had great performance than the LL sub band. Hence in this method, a four level decomposition using 2 Dimensional discrete wavelet transform is perform. The characteristic is obtaining from LH and HL sub bands using Discrete Wavelet Transform.

4. PROBABILISTIC NEURAL NETWORK

Probabilistic Neural Network (PNN) is one of the type of Artificial Neural Network. Probabilistic neural network is also known as the Radial Basis Neural Network, which provides a general solution for classification of the images. Probabilistic neural network is applied to implement the MRI image classification. Probabilistic neural network classify the brain tumor into benign, metastatic and malignant. Probabilistic Neural Network (PNN) contain three layers, as shown in the figure, these layers are 1] Input layer, 2] Radial Basis Layer, 3] Competitive Layer. Radial Basis Layer perform the evaluation between the vector distances, input vector and row weight vectors in the form of weight matrix. These evaluated distances are scaled by nonlinearly with Radial Basis Function. Then the Competitive Layer evaluates the shortest distance between them, and from their distance evaluates the training pattern closest to the input pattern.

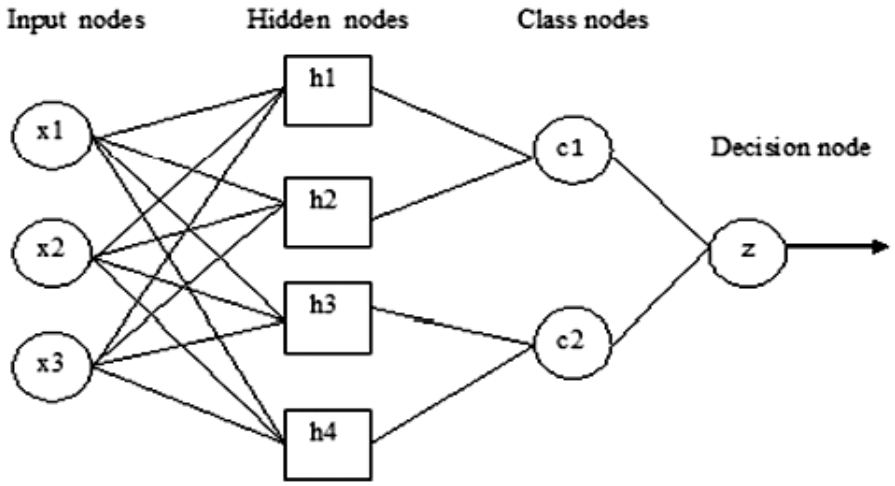


Figure 2: Architecture of a Probabilistic Neural Network

A Probabilistic Neural Network is mostly a classifier since it can draw any input pattern into a number of classifications. The main advantages that differentiate Probabilistic Neural Network are, it is the fast training process, it is permanent parallel structure, PNN guaranteed to connect to an optimal classifier as the size of the illustrative training set increases and training samples can be added or removed easily without considerable retraining. Accordingly, a Probabilistic Neural Network is more easy to learn than other neural networks model

and have a variety of applications. Based on above facts and advantages, Probabilistic Neural Network can be viewed as a advantageous neural network and give the proper result than the other. MATLAB software use For the implementation of this algorithm.

5. METHODOLOGY

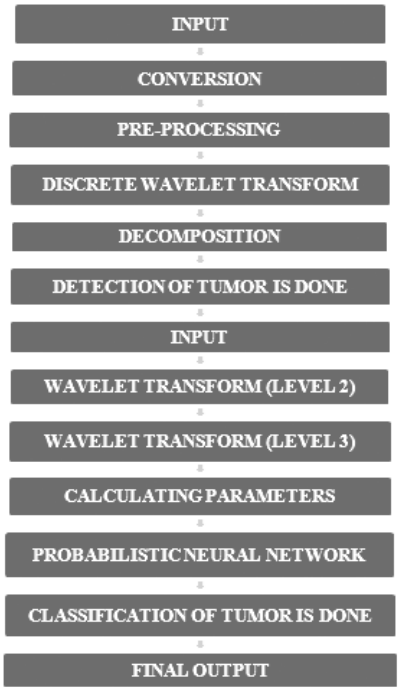


Figure 3: Flow Chart of Project

Fig 3 shows the flowchart of the project. This flow chart shows the methodology of the project,

1. Take the infected or uninfected MRI images of the brain.
2. Convert the color image into the grey scale image.
3. Apply the pre-processing using Gaussian filter for enhancing the image.
4. Apply the 2D discrete wavelet transform for the detection of tumor.
5. Discrete wavelet transform decomposes the image into different frequency band. These bands are Low-Low (LL), Low- High (LH), High-Low (HL), High-High (HH).
6. Detection and feature extraction of tumor is done using discrete wavelet transform.
7. Take the output of level 1 of discrete wavelet transform.
8. Give the output of level 1 as a input to the level 2 and level 3 of discrete wavelet transform.
9. Calculate the parameters and trained this parameter for neural network.
10. Apply the Probabilistic neural network.
11. Compare the calculated parameter with the trained parameter.
12. Probabilistic neural network Classify the image into Benign, Metastatic, Malignant.
13. Take the output.

6. RESULT

6.1. Results of Benign brain tumor

Take the input image for the benign brain tumor. Apply the pre-processing on the image for enhancement of the image using Gaussian filter. After enhancement of image apply the discrete wavelet transform. Discrete wavelet transform (Level-1)decomposes the image into four frequency band LL, LH, HL, LL. And then apply the post processing on the LH and HL output Image and take the output of level 1 shown in fig.4.

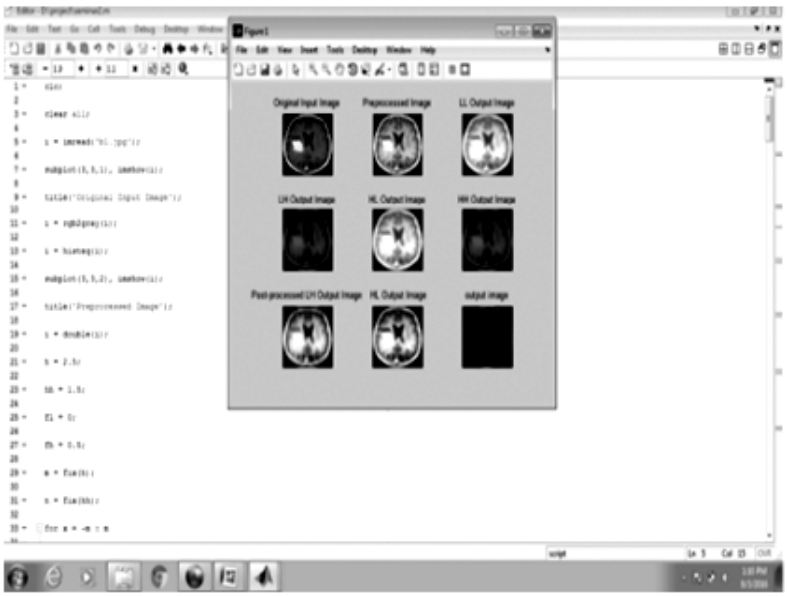


Figure 4: Result of Level 1 of DWT of Benign brain tumor

Take the output of level 1 as a input for level 2 and level 3 of discrete wavelet transform. and again decompose the image into four frequency band and the result is shown in figure 5.

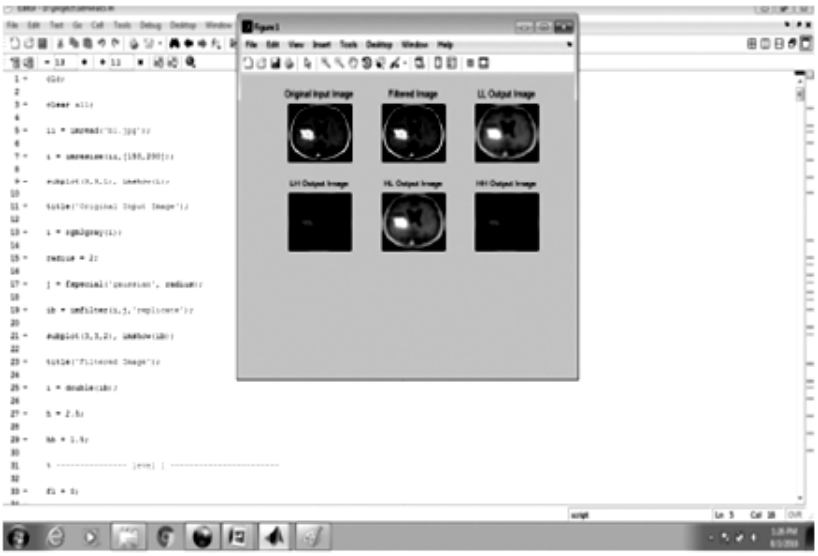


Figure 5: Result of Level 2 and level 3 of DWT of Benign brain tumor

Discrete wavelet transform detect and extract the brain tumor after detection of tumor calculating the parameter and trained for the Neural network and classify the brain tumor. In neural network the trained parameters are as follows

Table 1
Parameters for Benign Brain tumor

Type of tumor	Energy	Average Mean	Standard Deviation	Entropy
Benign	0.0015	1.276	2.6675	-0.0143

Trained Prameters are compared with calculated parameters and classify the image into different types result shown in figure 6.

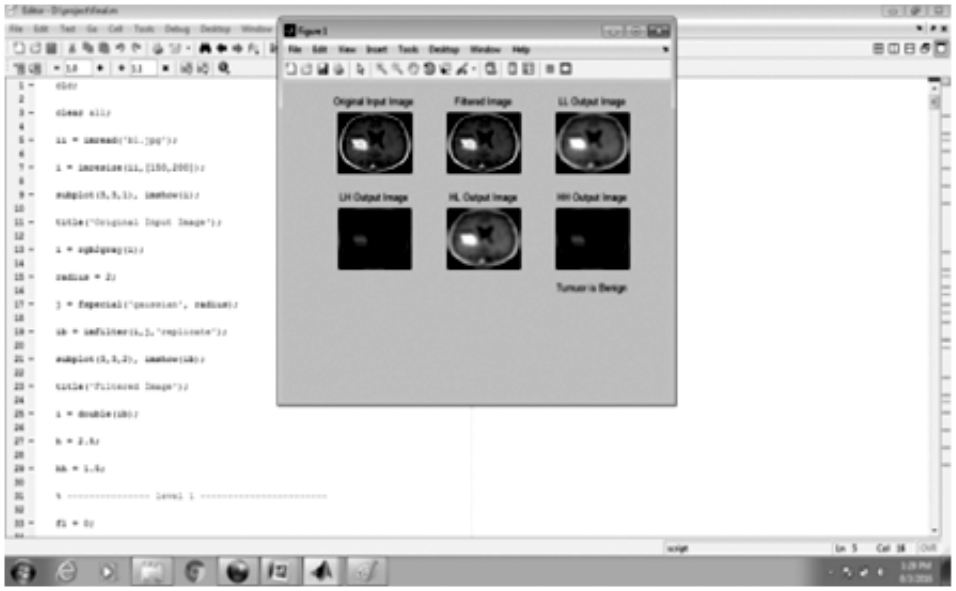


Figure 6: Result of classification of Benign brain tumor

6.2. Result of Metastatic Brain tumor

Take the input image for the Metastatic brain tumor. Apply the pre-processing on the image for enhancement of the image using Gaussian filter. After enhancement of image apply the discrete wavelet transform. Discrete wavelet transform (Level-1)decomposes the image into four frequency band LL, LH, HL, LL. And then apply the post processing on the LH and HL output Image and take the output of level 1 shown in figure 7.

Take the output of level 1 as a input for level 2 and level 3 of discrete wavelet transform. and again decompose the image into four frequency band and the result is shown in figure 8.

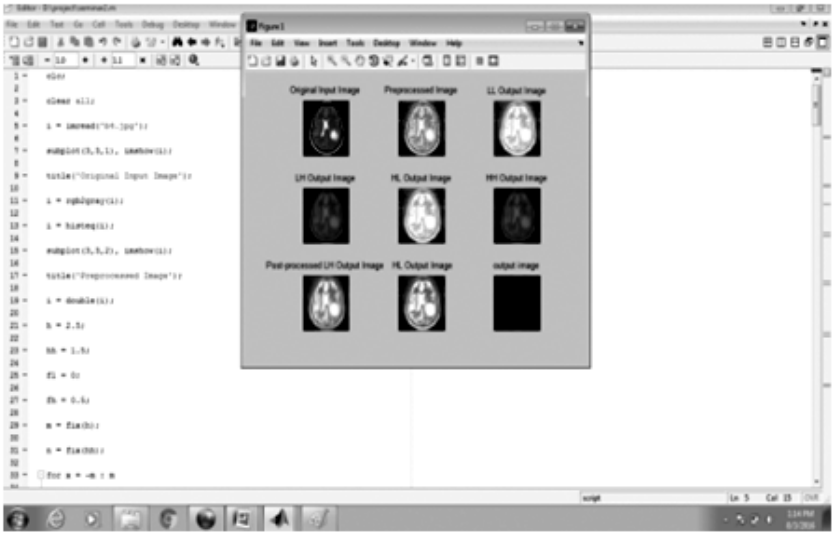


Figure 7: Result of Level 1 of DWT of metastatic brain tumor

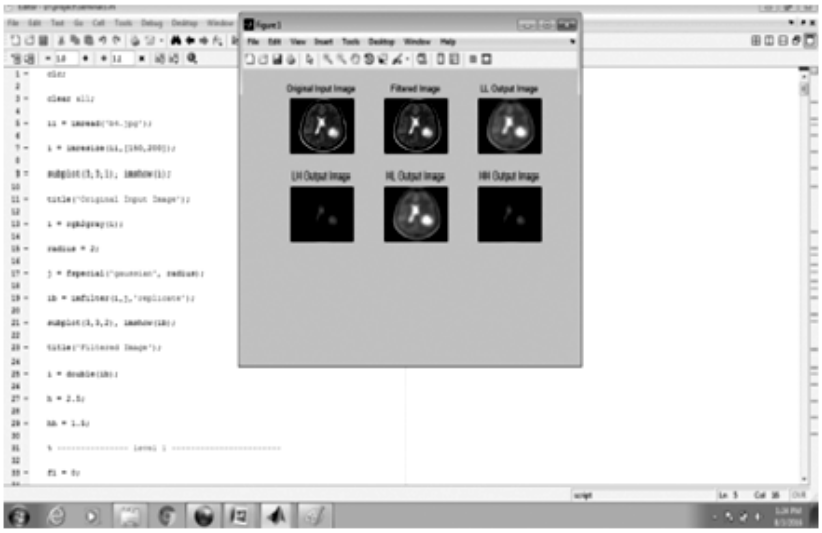


Figure 8: Result of Level 2 and level 3 of DWT of Metastatic brain tumor

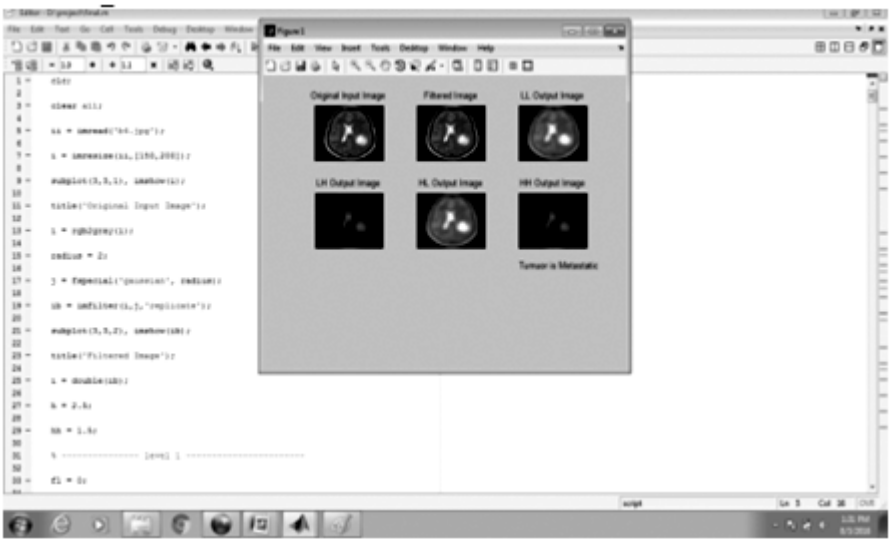
Discrete wavelet transform detect and extract the brain tumor after detection of tumor calculating the parameter and trained for the Neural network and classify the brain tumo

In neural network the trained parameters are as follows

Table 2
Parameters for metastatic brain tumor

Type of tumor	Energy	Average Mean	Standard Deviation	Entropy
Metastatic	0.0015	1.2538	1.5972	-0.0141

Trained Prameters are compared with calculated parameters and classify the image into different types result shown in figure 9.



Figuer 9: Result of classification of Metastatic brain tumor

6.3. Result of Malignant brain tumor

Take the input image for the Malignant brain tumor. Apply the pre-processing on the image for enhancement of the image using Gaussian filter. After enhancement of image apply the discrete wavelet transform. Discrete wavelet transform (Level-1)decomposes the image into four frequency band LL, LH, HL, LL. And then apply the post processing on the LH and HL output Image and take the output of level 1 shown in fig10.

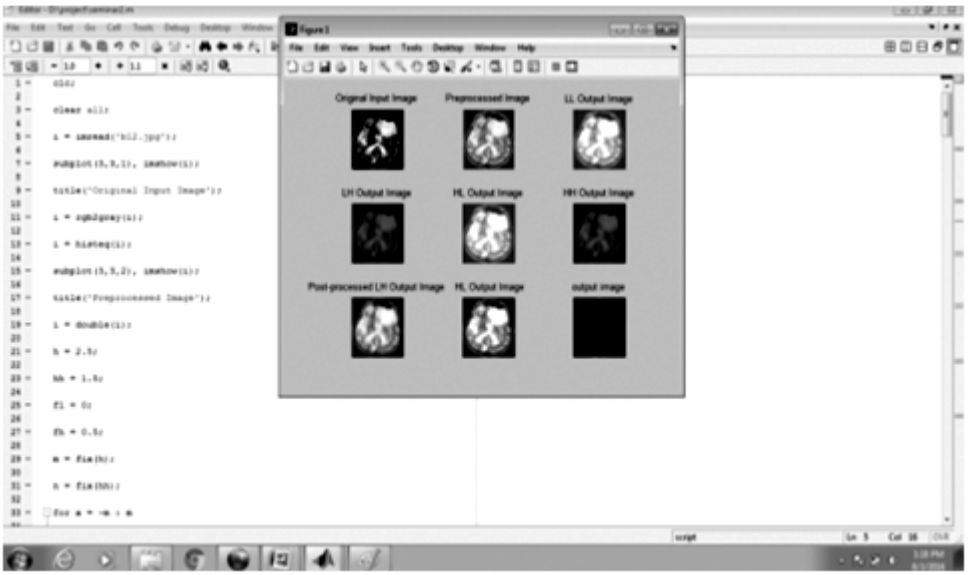


Figure 10: Result of Level 1 of DWT of Malignant brain tumor

Take the output of level 1 as a input for level 2 and level 3 of discrete wavelet transform. and again decompose the image into four frequency band and the result is shown in figure 11.

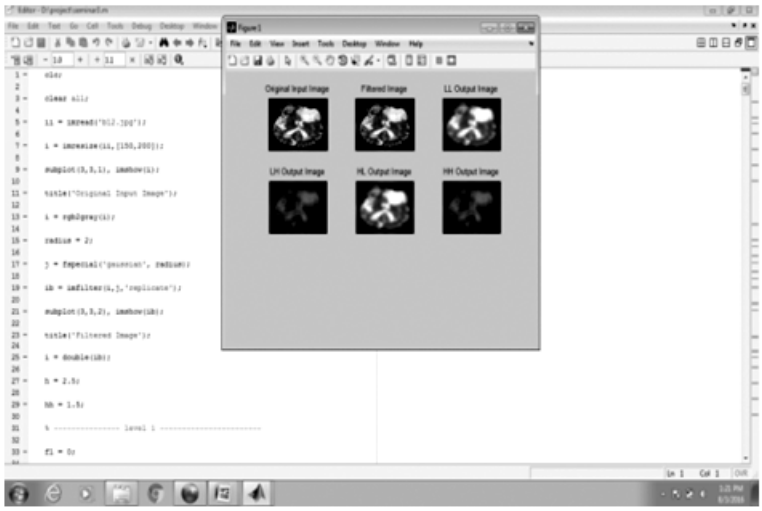


Figure 11: Result of Level 2 and level 3 of DWT of Malignant brain tumor

Discrete wavelet transform detect and extract the brain tumor after detection of tumor calculating the parameter and trained for the Neural network and classify the brain tumor.

In neural network the trained parameters are as follows

Table 3
Parameters for malignant brain tumor

Type of tumor	Energy	Average Mean	Standard Deviation	Entropy
Malignant	0.0015	1.2538	1.5972	-0.0141

Trained Prameters are compared with calculated parameters and classify the image into different types result shown in figure 12.

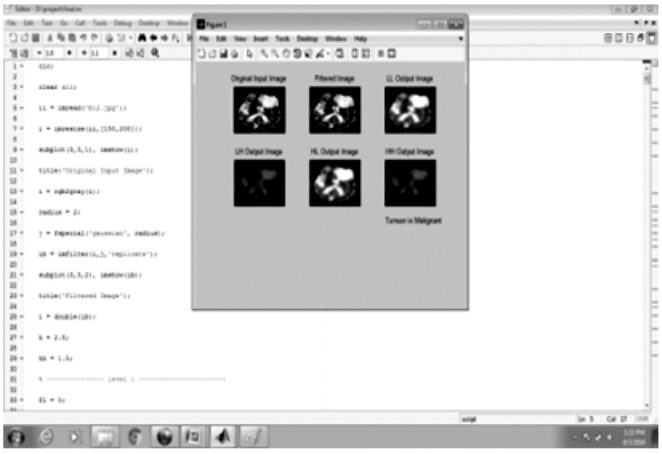


Figure 12: Result of classification of Malignant brain tumor

7. CONCLUSION

Many image processing systems determines location and size of the tumor only. Many cancer forms can only be diagnosed after a sample of doubtful tissue has been removed from the brain and tested (biopsied). In this paper use completely automated brain tumor detection and classification using 2 dimensional discrete wavelet transform and probabilistic neural network t is the type of artificial neural network. The design based on Image processing Techniques, 2 dimensional discrete wavelet transform and probabilistic Neural Network was successfully completed and used in the system to Detect and Classify the Brain Tumor. The multistage image processing system consist of pre-processing, discrete wavelet transform and artificial neural network. In pre-processing Histogram equalization is used for contrast enhancement, feature extraction is done using three level discrete wavelet transform and finally classifier has been developed for classification of tumor into benign, metastatic, malignant using probabilistic neural network. The above methodology effectively classifies the tumor types from MRI brain images taken under different clinical positions and technical state, which were able to show high variations that clearly specify the abnormalities and affected area with brain disease. The system has been tested with the above sample Images and the output of this sample images shows in result. The system can be designed to detect and classify the other types of tumors as well with few modifications. It is essential to use large number of patient's data and samples of image which will improve the accuracy of the system. More elements that could be added to the system include anabolic and genetic data of brain as well as anatomical features of the brain.

REFERENCES

[1] Andac Hamamci, Nadir Kucuk, Kutlay Karaman, Kayihan Engin, Gozde Unal, "Tumor- Cut:Segmentation of Brain Tumors on Contrast Enhanced MR Images .for Radio surgery Applications", in IEEE Transactions on .Medical Imaging, Vol. 31, No. 3, March 2012, pp 790 – 804.

[2] Atiq Islam, Syed M. S. Reza, Khan M. Iftekharuddin, "Multifractal Texture Estimation for Detection and Segmentation of Brain Tumors", in IEEE Transactions On Biomedical Engineering, Vol. 60, No. 11, November 2013, pp 3204 – 3215.

[3] Behnood Gholami, Isaiah Norton, Livia S. Eberlin, Nathalie Y. R. Agar, "A Statistical Modeling Approach for Tumor-Type Identification in Surgical Neuropathology Using Tissue Mass Spectrometry Imaging", in IEEE Journal Of Biomedical And Health .....Informatics, Vol. 17, No. 3, May 2013, pp 734 – 744.

[4] Anthagopal, A. P., Sukanesh, R., "Wavelet statistical texture features-based segmentation and classification of brain computed tomography images," Image Processing, IEEE, vol.7, no.1, February 2013, pp.25 – 32.

[5] P. Padilla, J.M. Go´rriz, J. Ramý´rez, R. Chaves, F. Segovia, I. Alvarez, D. Salas-Gonza´lez, M. Lo´pez, C.G. Puntonet, "Alzheimer's disease detection in functional images using 2D Gabor wavelet analysis", in IEEE Electronics Letters, Vol. 46, No. 8, April 2010.

[6] k. H. Oh, s. H. Kim and m. Lee, "tumor detection on brain mr images using regional features: method and preliminary results," *frontiers of computer vision (fcv), 2015 21st korea-japan joint workshop on*, mokpo, 2015, pp. 1-4.

[7] Y. Megersa and G. Alemu, "Brain tumor detection and segmentation using hybrid intelligent algorithms,"*AFRICON, 2015*, Addis Ababa, 2015, pp. 1-8.

[8] M. F. Othman and M. A. M. Basri, "Probabilistic Neural Network for Brain Tumor Classification," *Intelligent Systems, Modelling and Simulation (ISMS), 2011 Second International Conference on*, Kuala Lumpur, 2011, pp. 136.

[9] B. Hachemi, S. Oudjemia, F. Alim, S. Seddiki, F. Talbi and M. Abdelaziz, "Cerebral abnormalities detection by region-growing segmentation and KNN classification," *Innovative Computing Technology (INTECH), 2015 Fifth International Conference on*, Galcia, 2015, pp. 23-26.

[10] B. Shamsaei and C. Gao, "Comparison of some machine learning and statistical algorithms for classification and prediction of human cancer type," *2016 IEEE-EMBS International Conference on Biomedical and Health Informatics (BHI)*, Las Vegas, NV, USA, 2016, pp. 296-299.