Tumor Detection from Brain MRI Image Using Neural Network Approach

Heena U. Deshmukh[1], S. S. Thorat[2]

[1]*Electronics and Telecommunication Department, GCOE, Amravati (MH), India*

[2]*Assistant Professor, Electronics and Telecommunication Department, GCOE, Amravati (MH), India*

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Abstract - *An Brain Tumor is uneven or uncontrolled growth of cells .Tumors mostly affect the functioning of affect body part and hence required diagnose and provide proper treatment on it. Brain tumor must be detected, diagnosed and evaluated in earliest stage. The proposed method which is found to be accurate for tumor detection, makes use of Grey Level Co-occurrence Matrix (GLCM) and Grey Level Run Length Matrix (GLRLM) with Artificial Neural Network Classifier (ANN). This method comprises of three major steps. To begin with, the input image is given to the pre-processing step where it is made suitable for further processing by applying median filtering. Next, the feature extraction method is accomplished using two techniques such as spatial (GLCM) and Grey Level Run Length Matrix (GLRLM) and miscellaneous based features. For spatial feature extraction, Grey Level Co-occurrence Matrix is used to extract texture features for MR Images, Then Grey Level Run Length Matrix (GLRLM) and miscellaneous based feature extraction. Finally, the GLCM, GLRLM and miscellaneous features extracted, are applied individually and jointly to Artificial Neural Network Classifier (ANN) to find whether the input MR Image is tumor image or normal image, Then the segmentation, of the brains abnormality using kirsch operator*

Key Words: Back-propagation Algorithm,*Grey Level Run Length Matrix (GLRLM), kirsch operator, Grey Level Co-occurrence Matrix* etc

1. INTRODUCTION

Tumor is one of the most common brain diseases, so its diagnosis and treatment have a vital importance for more than 400000 persons per year in the world (based on the World Health Organization (WHO) estimates). On the other hand, in recent years, developments in medical imaging techniques allow us to use them in several domains of medicine, for example, computer aided pathologies diagnosis, follow-up of these pathologies, surgical planning, surgical guidance, statistical and time series (longitudinal) analysis. Among all the medical image modalities, Magnetic Resonance Imaging (MRI) is the most frequently used imaging technique in neuroscience and neurosurgery for these applications. MRI creates a 3D image which perfectly visualizes anatomic structures of the brain such as deep structures and tissues of the brain, as well as the pathologies. The recent years has witnessed the advancement of medical imaging techniques which are accepted in surgical planning, longitudinal (time series) analysis, surgical guidelines and computer based pathologies diagnosis. In neuroscience and neurosurgery, the brain MRI is widely accepted imaging technique. The MRI of brain gives a perfect visualization of brain anatomic structures like deep structures, brain tissues by generating the 3D image. But for segmentation and detection of brain tumor more number of MRI scans are need to be taken for each patient. Thus to overcome the problem of manual segmentation the computer based train tumor segmentation and detection is required. To overcome this, many numbers of mechanisms were presented but there is no such automated mechanism is found by doctors as per the accuracy and robustness is concerned. The artificial intelligences mechanisms like Digital Image Processing (DIP) are found cooperative with machine learning, fuzzy logic and pattern recognition in imaging techniques.

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2. LITERATURE SURVEY

In their research, R. B. Dubey[5] used a Gaussian Filter to remove noise from the input MRI image. Applying a Gaussian filter is similar to Weierstrass Transform which involves convolving using a Gaussian Function. The application of a gaussian filter results in a smooth image. This is similar to viewing the image through a translucent screen. As noise is usually present in the high -frequency regions of an image, so a gaussian filter is a low pass filter.

The intensity of the median of the pixels in the pattern becomes the output intensity. Dr. M. Karnan[1], A.Lakshmi[2] and Dr. A. S. Bhalchandra[3] all opted for using a median filter to remove noise in their experiment

The paper by Sneha Khare[9] uses Segmentation based on Genetic Algorithm. These are algorithms that are based on natural selection and evolution. These belong to a subclass of an evolutionary algorithm, as it uses evolutionary techniques and natural selection to solve optimization problems

A paper "Tumor Detection in Brain MRI Image Using Template based K-means and Fuzzy C-means Clustering

Algorithm" presented by Rasel Ahmmed and Md. Foisal Hussain worked on an robust segmentation method which is the integration of Template based K-means and modified Fuzzy C-means (TKFCM) clustering algorithm.

A paper "Proposal of a Content Based Retinal Image Retrieval System Using Kirsch Template Based Edge Detection" presented by Sivakamasundari J1, Kavitha. G2, Natarajan. V1 and Ramakrishnan In this work, a Content Based Image Retrieval (CBIR) frame work is developed based on edge detection method for diagnosis of diabetic retinopathy. Normal and abnormal retinal funds images are subjected to preprocessing methods to enhance the edge information. Two different methods namely Kirsch template and Canny edge based detection techniques are considered for segmentation of blood vessels

Feature Extraction And Feature Matching:

A paper "Multi-fractal Texture Estimation for Detection and Segmentation of Brain Tumors" presented by Atiq Islam, Syed M. S. Reza and Khan M. Iftekharuddin worked on A stochastic model for characterizing tumor texture in brain MR images is proposed. The efficacy of the model is demonstrated in patient-independent brain tumor texture feature extraction and tumor segmentation in magnetic resonance images (MRIs). Due to complex appearance in MRI, brain tumor texture is formulated using a multi resolution-fractal model known as multi-fractional Brownian motion (mBm).

A paper "Tumor Detection on Brain MR Images using Regional Features: method and preliminary results" presented by Kang Han Oh School of Electronics & Computer Engineering, Chonnam Soo Hyung Kim Myungeun Lee worked on s a novel approach to detecting tumor in the brain magnetic resonance images using regional features

Classification

In their paper, Sneha Khare[9] proposed using a Support Vector Machine along with Curve Fitting for further classification. Support Vector Machines are machine learning models with learning algorithms which are used for classification.

2. METHDOLOGY

The brain tumor detection is very complicated process to detect the brain tumor manually and hence the image processing techniques are used for tumor detection. The proposed system is designed using the Brain Tumor Detection in Magnetic Resonance Images (MRI) is crucial in medical diagnosis as it provides data related to anatomical structures with potential abnormal tissues, necessary for treatment planning and patient follow-up. The proposed system is designed using Grey Level Co-occurrence Matrix (GLCM) and Grey level Run Length with Artificial Neural Network (ANN). This method comprises of three major steps

1. Pre-processing,
2. Feature extraction and
3. Tumor classification.

To begin with, the input image is given to the pre-processing step where it is made suitable for further processing by applying median filtering and skull stripping. Next, the feature extraction method is accomplished using two techniques such as spatial (GLCM) and Grey level Run Length (GLRL) based features. For spatial feature extraction, Grey Level Co-occurrence Matrix is used to extract texture features for MR Images. Then Grey level Run Length (GLRL) is used for based feature extraction. Finally, the GLCM and GLRL features extracted, are applied individually and jointly to Artificial Neural Network to find whether the input MR Image is tumor image or normal image.

3.1 Block Diagram Proposed System

The brain tumor detection system is divided into two subsystem i.e. training phase and testing phase. The training phase system mainly consist the block of image pre-processing for skull stripping of brain MRI image, Multi perceptions Artificial Neural Network, architecture used will be feed forward network and backpropogation as learning/training algorithm. For segmentation, using kirsch method. The complete process of training phase is applied on the training brain MRI images, some are cancerous and some are non cancerous images. This used to create database for evaluation of query images provided by user, which is followed by testing phase process. In the same way of training phase, testing phase consist of the block of pre-processing for skull stripping and testing image, feature extraction and feature matching for classification of brain MRI image provided by user for tumor detection the main objective of training phase is to create database of feature extracted from the segmented image of the training data and the testing phase process is used to find out the best match of feature extracted from the query image with the database of the feature extracted from the training MRI images. The block diagram of Automatic Brain Tumor Detection system is given in figure

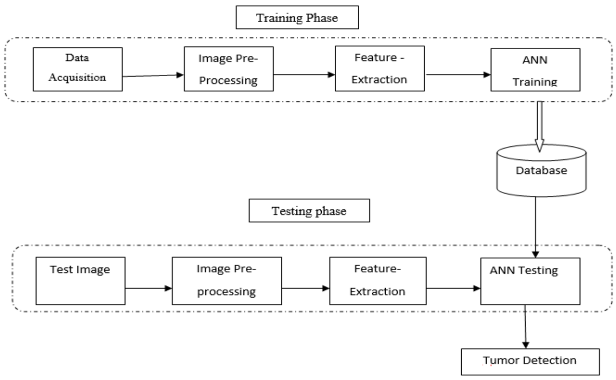

Fig -1: Block Diagram for brain Tumor Detection System

Image Pre-processing

The input image is subjected to a set of pre-processing steps so that the image gets transformed to be suitable for further processing. MRIs usually contain one or more types of noise and artifacts. The pre-processing operation removes seeds from images and increases contrast between normal and abnormal tissues. In pre-processing step, initially input image is passed through a Median filter.

1. Image Acquisition

Scanning technique are widely used in medical field for medical examination of defect in parts of body various scanning technique are used to get the images for processing to detect the deformities in brain. The medical imaging is the important procedural method which helps in diagnosis of any disease. The interest towards the use of medical imaging concept in tumor detection has been increased in recent past. In case of brain cancer detection, the localization of brain structure is the biggest challenge. The existing techniques of brain imaging are MRI, CT, Electroencephalography (EEG), PET, Magneto Encephalography (MEG), Biopsy and X-Ray. *Magnetic Resonance Imaging (MRI)* This is an imaging method which measures the magnetic field vectors produced after the excitation with heavy magnetic field and radio frequency pulses in hydrogen atoms nuclei exist within the water molecules of the patient's tissues. The water content in different parts of the tissues differs and is possible to quantify the differences of radiated magnetic energy. Under the controlled conditions, if the magnetic vector components, the different images can be acquired, tissue information. The major region of interest for MRI is brain. The brain image obtained by MRI scan is read and stored as 3-D array of pixels and with size of 256×256×3 pixels in the DICOM format. . Images Acquisition The proposed approach is applied to analyse the simulated MRI images taken from publicly available sources. This dataset consists of brain MR images in which somde images with tumor and the remaining brain images are normal and the dataset is divided as training dataset and testing dataset.

Median filter

Median filtering is a nonlinear process useful in reducing *impulsive* or *salt and pepper noise*. It is also useful in preserving edges in an image while reducing the random noise. Impulsive or salt and pepper noise can occur due to a random bit error in a communication channel. In a Median filter, a window slides along the image and the Median intensity value of the pixels within the window become the output intensity of the pixel being processed. The Median filter substitutes a pixel by the Median of all pixels in the neighborhood particularly.

The Binary morphological operators are applied on the binarized image. The main purpose of the morphological operators is to eliminate hurdle and noise from the image and also to fill the gaps in the binarized image. After applying the morphological operator, the white pixel regions are removed so that the skull stripped image can be obtained.

2.Feature Extraction

Feature analysis is a quantitative method to quantify and detect structural abnormalities in different brain tissues. As the tissues present in the brain are very difficult to classify using the shape or the grey-level intensities, texture feature extraction is very important for further classification. Texture is that innate property of all surfaces that describes visual pattern that contains important information about the structural arrangement of the surface also characterized by the spatial distribution of gray levels in a neighborhood. The spatial features are extracted by using the grey-level co-occurrence matrix (GLCM) and also gray level run length matrix (GLRM) . Feature extraction is done for extracting the features of the images. It is used for minimizing the complexity and processing time for the analysis of the required images. The Gray Level Co-occurence Matrix as well as texture features are used for feature extraction which are explained in next session.

2. Classification

The detection of brain tumor is performed using Artificial Neural Network. Artificial neural networks (ANNs) are a family of models inspired by biological neural networks.

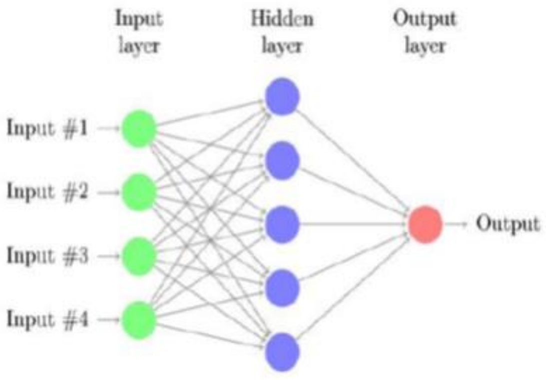

Fig -2: Structure of an ANN.

An ANN is an information processing paradigm that is inspired by the way a biological nervous system process information . A trained neural network can be thought of as an expert in the category of information it has been given to analyze. Some of the advantages of an ANN are:

It has the capacity of adaptive learning.

It has the capacity of self-organization.

It has the capacity of real-time opearation

Artificial Neural network shown in Figure 2 is a mathematical modeling of the computational neuroscience therotical.

Figure 2: An ANN consist of three layers the input layer, the hidden layer and the output layer with two modes of operation: the Training mode and the Testing mode. In the training mode the ANN is trained with the input feature values and in testing mode validation of the used algorithm is carried out. Table 3 discusses the parameters that were used in configuring the neural network.

Artificial Neural Network (ANN) classification are used for this purpose. Here, classification is done using the ensemble classification based on the neural network. In this the back propagation algorithm is used as the base classifier using different methods .

The classification is done on the basis of features extracted from the segmented images. Simple averaging is used for the combination of results from each classifier. The data is divided into the training and testing data. The data classified as training data is then used for training the neural network. Remaining data is used for the testing purpose. The training and testing dataset involves both normal as well as abnormal MRI images. Then classification is done into normal and abnormal. It provides better results compared to single neural network that has accuracy of about 90%. In the remaining sections of this topic, you will follow the standard steps for designing neural networks to solve problems in four application areas: function fitting, pattern recognition, clustering, and time series analysis. The work flow for any of these problems has seven primary steps. (Data collection in step 1, while important, generally occurs outside the MATLAB® environment.)

1 Collect data

2 Create the network

3 Configure the network

4 Initialize the weights and biases

5 Train the network

6 Validate the network

7 Use the network

Back-propagation Learning Algorithm

1 Initialize the weights to small random values.

2. Randomly chosen an input pattern $X^{(u)}$.

3 Propagate the signal forward through the network.

4. Compute δi^{L} in the output layer.

$$\delta i^{L} = g'(hi^{L})[di^{L} - yi^{L}]$$

Where h_i^L represents the net input to the i^{th} unit in the i^{th} layer, g' is the derivation of the activation function g.

5 Compute the deltas for the preceding layer by propagating the error backwards

$$\delta i^{L} = g'(hi^{L})[Wij^{i+1}j^{l+1}]$$

For l = (L-1),....

6 update weight using

$$\Delta Wji^{L} = \eta \delta i^{L} yj^{l-1}$$

7 Go to step 2 and repeat for the next pattern until the error in the output layer is below a prescribed threshold or maximum no of itration is reached.

Training Of System

The proposed method has been explained with the help of flow chart in Figure3..3.1,In this firstly training has been performed using Artificial Neural Network on few sets of tumor and non-tumor images as shown in Fig 2. The features like mean, median range filter and entropy has been calculated for tumor and non- tumor images which helps in classifying between healthy and non- healthy image. The method then proceeds to the initialize of an ANN The architecture specified was a multilayer feed forward network, which requires the definition of an input layer, one or more hidden layers and output layer. Simulations were carried out with one or two hidden layers. The performance of the trained network was verified with back propagation learning algorithm. The number of nodes in the input layer was defined by the size of input data. The supervised training process using back propagation involves a prior selection of all samples and indication of the number of training and validation pixels to be considered for each class. Furthermore, it was necessary to define in advance the training parameters, which includes the learning rate, the momentum factor and the stopping criteria. The last one controls the end of the process and includes three aspects: the value of the acceptable mean square error (MSE), the number of iterations and the accuracy rate. Several simulations were performed varying the number of iterations and analyzing the training statistics, which included: values of the test and validation errors, number of iterations and accuracy rate computed from the test and validation pixels collected for the classes. Finally at lest error obtained the save the network.

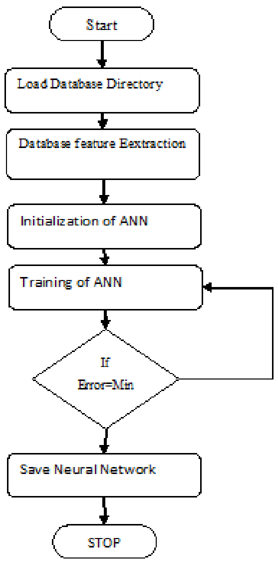

Fig -2: Flow chart of training of system

Testing Of System

After training the ANN, the classification was performed using testing algorithm. Flowchart of testing of tumor is shown in figure 3.4.2 first load the DICOM brain MRI after it followed by pre-processing and the feature- extraction by GLCM and GLRLM. Then testing is by ANN it classified the input brain MRI is tumors or non tumours. If result in non tumours flow of testing stop and give output. If tumors brain MRI then further processed for segmentation and to detect the type of brain tumor.

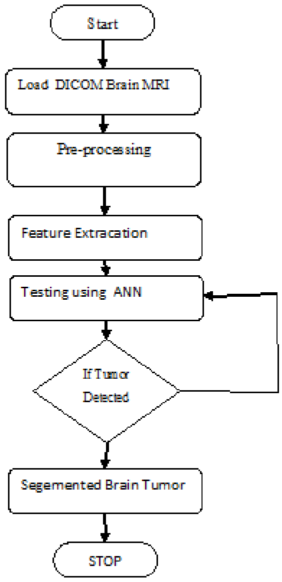

Fig -3: Flow chart of testing of ANN

4. RESULTS AND DISCUSSION

To evaluate the performance of the automatic brain tumor detection system using GUI neural network,This provides an overall performance investigation of the experimental models based on training and testing of Artificial neural network. At the end of this , based on various parameters their comparative analysis is done. Also, comparison of proposed design

4.1 Description of GUI Interface

A multifunction graphical user interface (GUI) ANN system for brain tumor detection, segmentation, and classification has been developed. The system has been designed for pro-cessing MRIs in DICOM formats. The overall view of the GUI is displayed in Fig. 5–(a). The GUI provides 11 buttons as; out of which 5 for training buttons and 5 for testing and one for exit. Testing load DICOM from MRI are used to load the data base load MRI image is used to select the target MRI image. Pre-processing button used to To enhance the image and remove noise. Feature extraction button are used extract the feature of DICOM MRI. A test using ANN image button classifies the input MRI as a unormal or abnormal image. Segmentation Tumor type button is used to classify the tumor type into brain metasis or cerebral Abscess. The segmentation section includes different approaches like kirschs opertor. The system GUI with all functions and parameters used for tumour classification into brain metasis and cerebral abscess or is shown in fig 5.

The GUI-ANN system was developed in MATLAB R R2013 a using graphical user interface (GUI). The machine is equipped with an Intel R Core R i3 processor operates at 2.6 GHz with 4 GB of RAM and Windows R 64-bit operating system.

4.2 Training of ANN

The GUI provide the training of an ANN load database directory are used to load database obtained from hospital. Fig 5 shows the To enhance the image and remove noise the noise the median filter has selected. Database Feature extraction button used to extract the feature using Grey level Co - Ocurrance matrix and Grey Level Run Length matrix after the feature has got, the feature has been used to training the ANN with BP. Initialize ANN button used to initialize the training In the training step 14 MRI image from (Hospital) in DICOM format have used, 7 MRI with tumor and 7 with an non tumor. Check the minimum error using training button if get the least error then save the network.

Fig -5: GUI For Training and Testing of ANN

The criterion for choosing network was based on the performance of this technique which is shown in Fig. 6. Here the network consists of 19 input vector layers, one hidden layer with 25 neurons, and one output layer. Usually the network is consists of three layers like input layer, hidden layer, and output layer. The input and output layer is user defined nevertheless hidden layer is selected on the basis of performance. Hidden layer can be one or more for the analysis, but it is required that, in hidden layer the no. of layer should be least numbered.

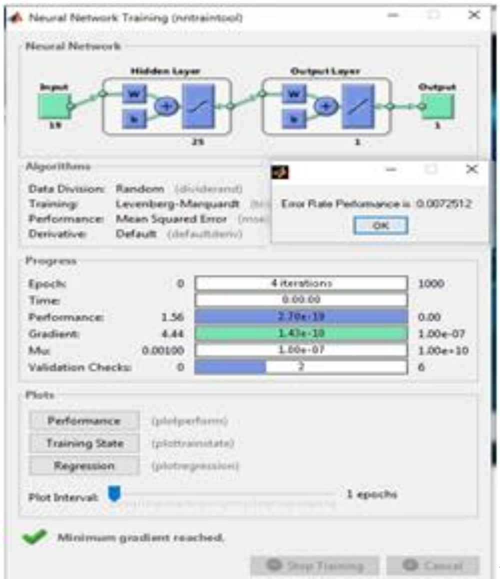

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Fig -6: Error Rate Performance for this method through neural network

This Fig. 8 shows how the gradient decreasing and reached descent value at 4 iterations. Also Levenberg-Marquardt optimization parameter (MU) increases and decreases at its given values. Besides, there is two validation check failure. The value of gradient is reached at 1.4273e-10 for the 4 epochs. Again the MU value is increased and decreased then proceeds to the value of 1e-07 at the 4 iterations. Finally there are 1 validation checks at the 4 epochs.

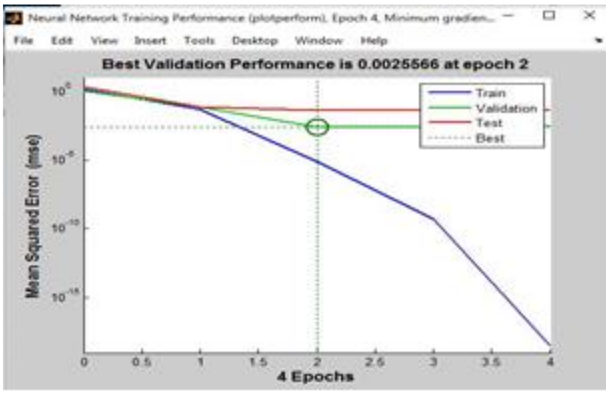

Fig -7: The Performance for this method through neural network

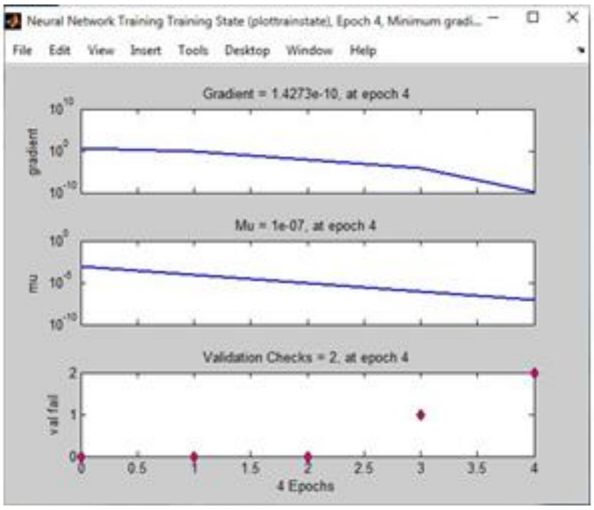

Fig -8: validation check, minimum gradient, and MU curve for the network

The regression process of the training, validation, test and all data are preceded in the Fig. 9. This shows that the regression to training is 0, to validation is 0, to test is 0.98858, and throughout all is 0.998588 which is so good. The curve describes the fitting of data to the ideal regression line. The small circular values are our data. The dotted line is the ideal regression line. And the full straight line with RGB color is our regression curve. Fig 10 shows the segmented brain tumour type.

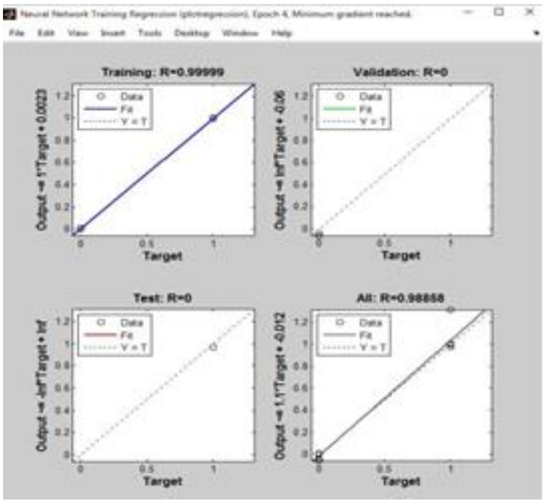

Fig -9: The regression curve for the network

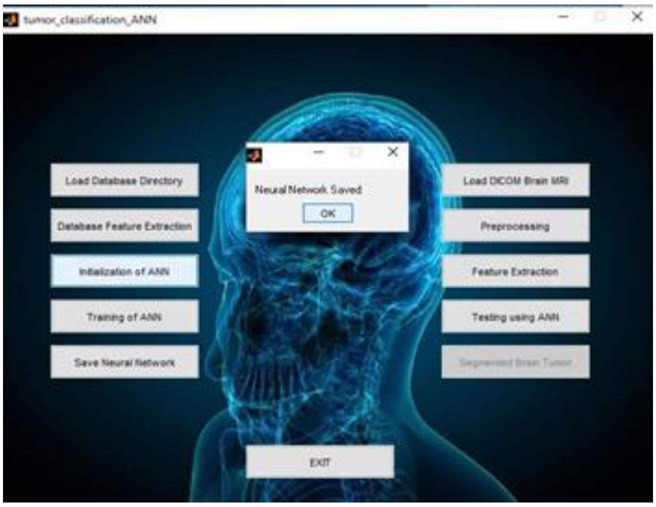

Fig -10: Segmented Brain Tumor Type

The results of the proposed method are compared with k-means clustering algortihm and SFCM method results and it is shown that the ANN method gives promising results. The simulated result shows that the test image taken GLCM and GLRLM feature extracted, classification of the tumor stage segmented abnormal region for the different classes

Table -1: The performance parameter

PARAMETER	K-MEANS	SFCM METHOD	ANN (PROPOSED METHOD)
Accuracy	81.818	90.9091	96.4%
Sensitivity	83.333	85.7143	96.43
Execution time in sec	20.646	15.666	5.8089

5. CONCLUSIONS

Proper diagnosis of brain tumor needs proper segmentation method to be used for MRI images to carry out a further diagnosis and treatment. Image Segmentation is one of the major challenging tasks in today's medical imaging. Currently, information is provided by many images from various slices required for accurate diagnosis, planning and treatment purpose using many methods, but use of a ANN based automatic detection is far more better as far as manual segmentation is concerned. So, using artificial neural network has been presented here. After simulation it was observed that the neural network configured was able to classify both the types of images with and without tumor with accuracy of 96.4% and consuming less amount of time P.Muthu Krishnammal, S.Selvakumar Raja .have proposed a methodology for brain tumor detection using spatial FCM and have obtained an accuracy of 90.90% [7].

From the above observations, it is found that the system proposed in this paper has better performance of tumor detection than that has already been reported.

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