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AN ANN APPROACH FOR CLASSIFICATION OF BRAIN TUMOR USING IMAGE PROCESSING TECHNIQUES IN MRI IMAGES

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ABSTRACT

A brain tumor is defined as the growth of abnormal cells in the tissues of the brain. Brain tumors can be benign (noncancerous) or malignant (cancerous). MRI represents an interesting approach for the anatomical assessment of brain tumors since it provides superior soft tissue contrast and high-resolution information. MRI scan images are taken for this project to process further. This work proposed artificial neural network approach namely Back propagation network (BP-ANN).Image segmentation is done by using region growing algorithm which is used to detect the tumor present in the brain MRI images. GLCM is used for extracting the brain features in the images. This system proposed two modes namely training and testing phase which is used to classify the output.

KEYWORDS: MRI, Brain tumor, Region growing, GLCM, BPNN.

INTRODUCTION

The brain is the anterior most part of the central nervous system [1]. The location of tumors in the brain is one of the factors that determine how a brain tumor affects an individual's functioning and what symptoms the tumor causes. Brain tumor is an abnormal growth caused by cells reproducing themselves in an uncontrolled manner [2]. Magnetic Resonance Imaging (MRI) is the commonly used device for diagnosis. Accurate *detection* of size and location of brain tumor plays a vital role in the diagnosis of tumor. In order to overcome such scenario a classification system is required. Image processing techniques are used to improve the performance and to classify Brain tumor in MRI images.

The proposed techniques, weighted median filter for noise removal, region growing method for segmentation, gray level co-occurrence matrix (GLCM) to extract second order statistical texture features for Brain tumor images and Back propagation Neural Network (BPNN) for classification are analyzed for best results and maximum accuracy for detecting the brain tumor. The primary objective o f the proposed work is to classify the brain tumor using Artificial Neural Network in MRI images. MATLAB is an interactive tool for doing numerical computations with matrices and vectors. Hence MATLAB has been taken into consideration and all the techniques have been implemented using MATLAB

PROPOSED METHODOLOGY

Weighted Median Filter

For filtering the image, a weighted median filtering with 3×3 window is employed. Where the weight is W = [1, 1, 1; 1, 4, 1; 1, 1, 1]/12. It is same as median filter, only difference is the mask is not empty. It will have some weight. To make a 3x3 weighted mask into a 1x9 mask.

$$
\begin{aligned}
y(i,j)=[&W(n)\times x(i-1,j-1) \quad W(n)\times x(i-1,j) \quad W(n)\times x(i-1,j+1)\\
&W(n)\times x(i,j-1) \quad W(n)\times x(i,j) \quad W(n)\times x(i,j+1)\\
&W(n)\times x(i+1,j-1) \quad W(n)\times x(i+1,j) \quad W(n)\times x(i+1,j+1)];
\end{aligned}
$$

$$
\begin{aligned}
z(i,j) = \text{median}\{&y(i-1,j), y(i-1,j), y(i,j), y(i,j)\\
&y(i,j), y(i+1,j), y(i+1,j)\}
\end{aligned}
$$

Where z (i, j) is the output image.

Where x (i, j) is the original image (i= rows, j= columns) and n=1, 2...9. After convolution (multiplication), arrange the 9 pixels in ascending or descending order. Choose the median from these nine values. Place this median at the center and move the mask throughout the image.

Region Growing Method

Region growing is a simple region-based image segmentation method. It is also classified as a pixel-based image segmentation method since it involves the selection of initial seed points. This approach to segmentation examines neighboring pixels of initial "seed points" and determines whether the pixel neighboring pixel should be added to the region [3]. The following steps are performed to find the initial seed point.

1. Convert the given image into a gray image
2. Count the number of pixels whose intensities are greater than hundred and less than hundred and Store them in separate variables.
3. Find the difference between both the variables, if the difference is smaller (Less than 0.2) then go to image enhancement else convert the image into binary image.
4. Calculate the maximum length and breadth of the image.
5. Calculate the sum of all rows and columns and store in separate arrays.
6. Find the intersection of row and column having maximum sum. This is taken as seed Point.

GLCM Feature Extraction

1.	*Energy*	$F1 = \sum_{i,j=0}^{N=1} Pi,j2$
2	*Contrast*	$F2 = \sum_{i,j=0}^{N=1} P\,(i,j) * (i,j)2$
3	*Homogeneity*	$F3 = \sum_{i,j=0}^{N=1} \frac{p(i,j)}{1+(i-1)^2}$
4	*Disimilarity*	$F4 = \sum_{i,j=0}^{N=1} P(i,j) * \mid (i,j) \mid$
5	*Entropy*	$F5 = \sum_{i,j=0}^{N=1} P(i,j)\,[-ln(P(i,j))]$
6	*Maximum Probability*	$F6 = \max i,j\; p(i,j)$
7	*Inverse*	$F7 = \sum_{i,j=0}^{N=1} \frac{p(i,j)}{(i-1)^2}$

Table 3.1: Texture Features Formula

A statistical approach that can well describe second-order statistics of a texture image is a Co-occurrence matrix. Gray level co-occurrence matrix (GLCM) was firstly introduced by Haralick. A gray-level co-occurrence matrix (GLCM) is essentially a two-dimensional histogram. The GLCM method considers the spatial relationship between pixels of different gray levels [11]. The seven common textures features are shown [5]. All these features are extracted using GLCM methods at four directions (i.e.0º, 45º, 90º and 135º) for every feature [6] [9] [10].

BP-ANN Classification

Back propagation neural network (BPNN) is a simple and effective model of Artificial Neural Network (ANN).This network is also known as a feed forward back-propagation neural network [7]. This network requires a lot of input and target pairs for training the network. Furthermore, the internal mapping procedures work as a black box that may not be easily understood, and there is no indication that the system can generate all acceptable solutions. Back propagation neural network contains three layers which are input, hidden and output layers. In the training phase, the training data is fed into the first input layer. It is propagated to both the hidden layer and the output layer. This process is called the forward pass. In this stage, each node in the input layer, hidden layer and output layer calculates and adjusts the appropriate weight between nodes and generate an output value of the resulting sum. The actual output values will be compared with the target output values. The error between these outputs will be calculated and propagated back to hidden layer in order to update the weight of each node again. This is called backward pass.

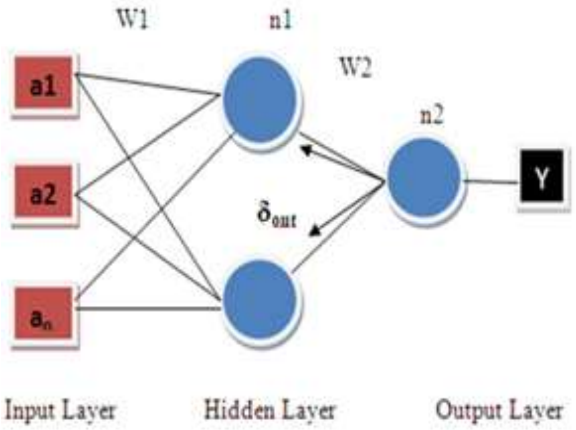


Fig 4.1 Simple Back Propagation Neural Network Architecture

The network will iterate over many cycles until the error is acceptable. After the training phase is done, the trained network is ready to use for any new input data. During the testing phase, there is no learning or modifying of the weight matrix. The testing input is fed into the input layer, and the feed forward network will generate results based on its knowledge from the trained network [8].
BPNN (Back propagation neural network) consist of an interconnection of simple components referred to as neurons. It consists of one or more layers. Each layer has one or more neurons [9].

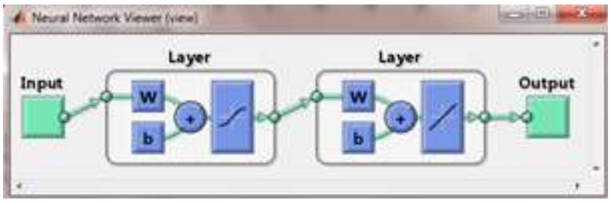
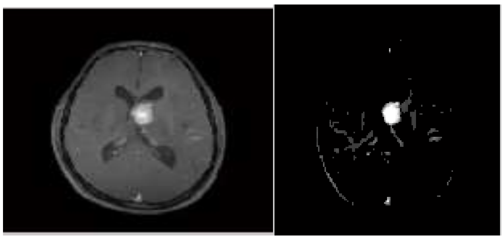


Fig 4.2 Neural Network Viewer

EXPERIMENTAL RESULTS AND DISCUSSION

The Brain tumor data set contains approximately 200 samples extracted from the MRI images. Tumor classification is the important area in image processing and pattern recognition fields.



Original Image ***Segmented Image***

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Texture features namely, energy, contract, Homogeneity, dissimilarity, entropy, and max probability, inverse. The Brain tumor dataset consists of 200 images, out of which 160 (80%) were taken as training data and 40 (20%) features were taken as testing data. The feature vector used for the research work is listed in following table,

Images	Energy	Contrast	Homogeneity	Dissimilarity	Entropy	Max Probability	Inverse
1	3.16	1.08	8.92	3.38	2.02	5.4	8.94
2	2.44	9.97	8.32	4.58	2.44	4.72	8.68
3	4.26	8.07	9.3	2.32	1.57	6.33	8.79
4	3.55	8.56	8.95	3.13	1.8	5.61	8.65
5	2.51	1.83	8.31	5.49	2.44	4.88	8.34
6	4	1.58	8.65	4.64	1.89	6.27	7.98
7	4.3	9.62	9.08	3.01	1.68	6.42	9.18
8	2.71	1.28	8.77	3.87	2.19	5	8.78
9	2.4	1.2	8.82	3.77	2.14	4.44	8.72
10	1.49	1.16	8.62	4.13	2.64	3.3	9.06

Table 3.2 Feature Values of the Images

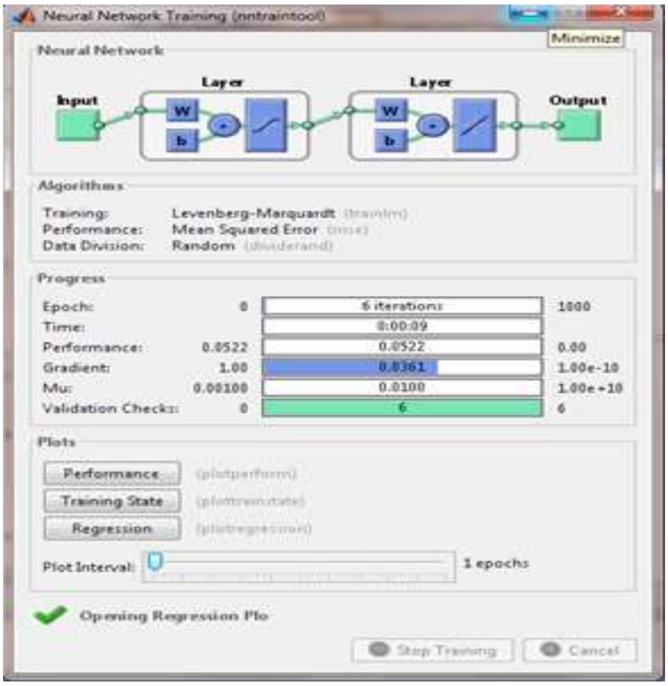

Fig 4.3 Back propagation neural network detection and identification.

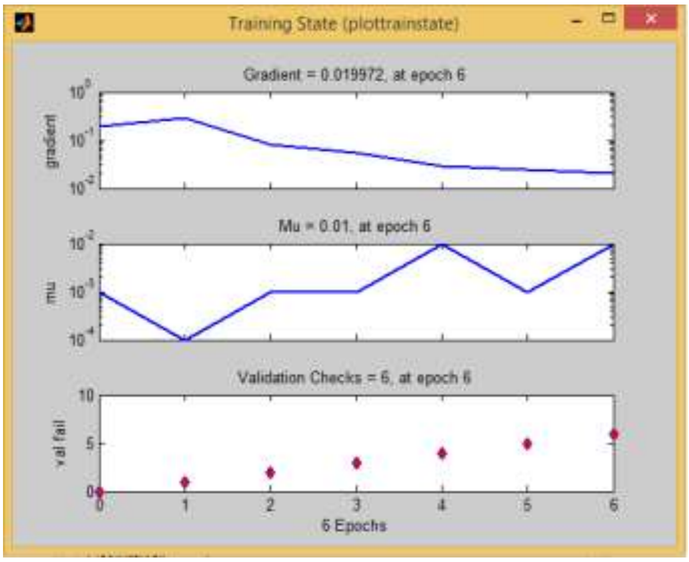

Fig 4.4 Back Propagation Neural Network –
Training State Results

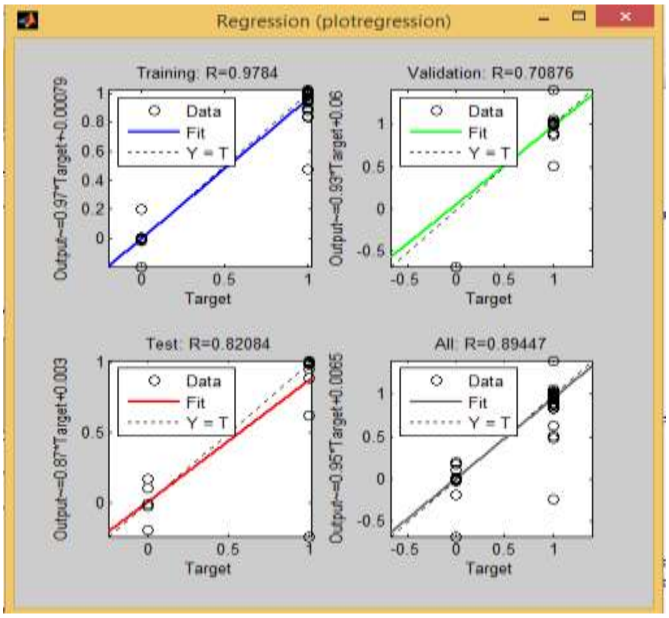

Fig 4.5 Back Propagation Neural Network – Regression Results.

Confusion Matrix

In the field of machine learning, a confusion matrix, also known as a contingency table or an error matrix, is a specific table layout that allows visualization of the performance of an algorithm, typically a supervised learning one. Each column of the matrix represents the instances in a predicted class, while each row represents the instances in an actual class. In predictive analytics, a table of confusion (sometimes also called a confusion matrix), is a table with two rows and two columns that reports the number of false positives, false negatives, true positives, and true negatives. This allows more detailed analysis than mere proportion of correct guesses (accuracy). Accuracy is not a reliable metric for the real performance of a classifier, because it will yield misleading results if the data set is unbalanced (that is, when the number of samples in different classes vary greatly). The proposed metrics evaluate the performance of given algorithm by comparing the qualities of input and output images.

True Positive Rate(TPR)
TPR = TP/P = TP/(TP+FN)
True Negative Rate(TNR)

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SPC=TN/N=TN/(FP+TN)
False Positive Rate (FPR)
FPR=FP/N=FP/(FP+TN)=1-SPC
False Negative Rate (FNR)
FNR=FN/P=FN/(FN+TP)
Accuracy (ACC)
ACC=(TP+TN)/ (P+N) `

Fig 4.6 Confusion Matrix-Accuracy

CONCLUSION

In normalization process, weighted median filter shows efficient impulsive noise suppression and an excellent image detail-preserving capability. The results confirm good performance, which could be used for filtering the Brain tumor MRI images. This filter can eliminate the noise without deteriorating the original image. In segmentation process, the Brain tumor images were clearly segmented using region growing segmentation method. The features of the Brain Tumor images were extracted in feature extraction phase by using GLCM technique. The extracted features were used for classification. From the experimental results of classification phase, it is shown that Back propagation Neural Network gives the better performance and 97 % of accuracy.

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