An Artificial Neural Network Approach for Brain Tumor Detection Based on Characteristics of GLCM Texture Features

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Abstract- This paper outlines extensive lab work for artificial neural network based Brain tumor detection using MR images with texture features method. Gray Level Co-occurrence Matrix (GLCM) characteristics features are used with the patient's MR image for training of neural network. A new approach is introduced to modify the training data before training of neural network. The present method detects tumor area by darkening the tumor portion and enhances the image for detection of other brain diseases in human being. Present method is capable of brain tumor detection, which shows satisfactory lab results. The proposed algorithm successfully tested in the laboratory.

Keywords – Brain Tumor, Artificial Neural Network, GLCM, MR image, Tumor detection

I. Introduction

Brain Tumor Detection using Magnetic Resonance (MR) Imaging technology has been introduced in the medical science from last few decades. The tumor detection becomes most complicated for the huge image database. A software approach is needed to aid the accurate, faster clinical diagnosis. Introduction of Brain tumor, classification of brain tumor, image obtaining methods, details of Magnetic Resonance Imaging (MRI) and the related literature survey is discussed in [1].

Present work introduces the new method of brain tumor detection using combined approach of Artificial Neural Network (ANN) and Gray Level Co-Occurrence Matrix (GLCM). Hopfield ANN approach is more popular for the tumor detection. The present proposed method has been tested on MRI. However, the new algorithm can be applicable to CT scan images. GLCM texture features are considered as input data along with the MRI. Haralick et. al. [2] suggested GLCM texture features are used in this present work.

Lehana, Parveen, et al [3] introduces the new investigation technique using aura transform for enhancing the MR images. The enhanced image is suitable for the diagnosis purpose. However, the present new algorithm is not only detecting the brain tumor, darkening the tumor area, but also enhances the features of MRI to its possible good quality. Doctors can straightforwardly diagnose other diseases in the human brain with enhanced MRI. Killedar et al [4] suggested content based image retrieval approach for the tumor detection. The content based image retrieval approach is time consuming operation as compared with the other tumor detection method. Author covers full detailed available techniques for brain tumor detection, image enhancement and content based image retrieval methods. Linder Nina et al. [5] illustrated for the segmentation of epithelial and stromal tissue using texture features and an SVM classifier. Texture features are capable of providing classification of image and detection of object using intelligent approach. Sharma et al. [6] used the GLCM and Artificial Neural Network Fuzzy Inference System (ANFIS) for brain tumor detection. The proposed algorithm in [6] literature is complicated and hence suitable modified algorithm is developed in this present work. Vijayakumar et al.[7] suggested tumor cut segmentation and classification of MR images using texture features and feed forward neural networks approach.

The present paper is divided into six sections. Section I covers necessary introduction and relevant literature survey. Section II covers details of GLCM texture features used in this present work. Section III covers improved brain tumor algorithm. Results and discussion is covered in section IV. Conclusion and references covered in section V and VI respectively.

II. GLCM TEXTURE FEATURES

The GLCM texture features are extracted from the co-occurrence matrix usually called as dependence matrix in brain tumor detection [8,9] The texture analysis in image processing characterizes various properties of image under processing to identify the object. Tone and texture are the two important characteristics of an image for the processing. Tone and Texture helps to quantify and object identity present in an image using texture features. However, one always dominates the other. A gray tone spatial dependence matrix approach, introduced by Haralick which is a well known statistical method for extracting second order texture information from images, is used for this present work The various texture characteristics are as follows [1],

Let us denote the co occurrence matrix C and N be the number of distinct gray levels in the quantized image.

$$C_x(i) = \sum_{j=1}^{N} C(i,j) \quad \text{---------------------(1)} \qquad C_y(i) = \sum_{i=1}^{N} C(i,j) \quad \text{--------------------------(2)}$$

$$C_{x+y}(k) = \sum_{i=1}^{N} \sum_{j=1}^{N} C(i,j)_{i+j=k} \qquad k = 2,3,\ldots,2N \qquad (3)$$

$$C_{x-y}(k) = \sum_{i=1}^{N} \sum_{j=1}^{N} C(i,j)_{|i-j|=k} \qquad k = 0,1,\ldots,N-1 \qquad (4)$$

The following eight texture features are calculated

1. Angular second moment(ASM)

$$f1 = \sum_{i=1}^{N} \sum_{j=1}^{N} \{C(i,j)\}^2 \qquad (5)$$

2. Contrast(CON)

$$f2 = \sum_{n=0}^{N-1} n^2 \left\{ \sum_{i=1}^{N} \sum_{\substack{j=1 \\ |i-j|=n}}^{N} C(i,j) \right\} \qquad (6)$$

3. Inverse Difference Moment (IDM)

$$f3 = \sum_{i=1}^{N} \sum_{j=1}^{N} \frac{1}{1+(i-j)^2} C(i,j) \qquad (7)$$

4. Sum Variance (SVAR)

$$f_4 = \sum_{i=2}^{2N} (i - f)^2 \, C_{x+y}(i) \qquad (8)$$

5. Sum Entropy (SENT)

$$f5 = -\sum_{i=2}^{2N} C_{x+y}(i) \log\left(C_{x+y}(i)\right) \qquad (9)$$

6. Entropy (ENT)

$$f6 = -\sum_{i=1}^{N} \sum_{j=1}^{N} C(i,j)\log\left(C(i,j)\right) \quad (10)$$

7. Difference Entropy (DENT)

$$f7 = -\sum_{i=0}^{N-1} c_{x-y}(i)\log\left(c_{x-y}(i)\right) \quad (11)$$

8. Information Measure of correlation (IMC)

$$f8 = \frac{HXY - HXY1}{MAX(HX, HY)}$$

III. IMPROVED TUMOR DETECTION ALGORITHM

Brain tumor detection is a vital problem of clinical analysis using MR images. It is very much time consuming process to find tumor in an image from the large database of MR images. The present work is carried out in the laboratory to identify the brain tumor using MR images with the artificial neural network approach. The ANN is complicated network and prior to the use neural network, training of neural network is essential. The back-propagation algorithm is used for the training of neural network [1]. The present brain tumor detection algorithm is as follows

Step 1:- Load MR Image

MATLAB GUI is developed for the implementation of present work using MATLAB R2010B software. The GUI of proceeding work is shown in figure 2. GUI data handling between the different callbacks are possible with a global handle structure containing declared variables. Handle structure is defined to store the elements of loaded image. Elements of loaded MR image are stored in the variable 'MRI' and frequently updated the handle structure (GUIDATA) after each change in the structure variables.

Step 2:- Calculate Texture Features (TF)

The GLCM is used for calculation of different texture features listed in section 2. Function graycoprops in MATLAB image processing toolbox is also used to calculate the four texture features. However, few more parameters suggested by Haralick are required in this proceeding work [2]. New function GLCM1 is developed for the calculation of texture features of co-matrix. The function is defined as the input is the matrix of MR image and output is the structure containing texture features, stored in the variable 'stats'.

Step 3:- Detect tumor using symmetry analysis algorithm and prepare data for training

Improved brain tumor detection algorithm is used to obtain training database for neural network. Sudipta Roy et. al.[10] suggested symmetry analysis for the brain tumor detection. The training data is obtained using suggested algorithm by Sudipta Roy et. al. with modification in the resizing process of image matrix. Obtained training data for the training of Neural Network is stored in 'annin' and 'annout' structure variables.

Step 4:- Training of neural network using training data

Linear layer, neural network is initialized using function 'newlind' with lr=0.05, mc=0.001, epochs=3500, goal = 1e-8. Training data is modified before using the function 'train'. Input and target data to be feed for the training of neural network is suitably resized using function 'reshape'. Input training data, the matrix of original MR image and the texture feature, target training data are suitably modified for the training of neural network, as shown in the figure 1.

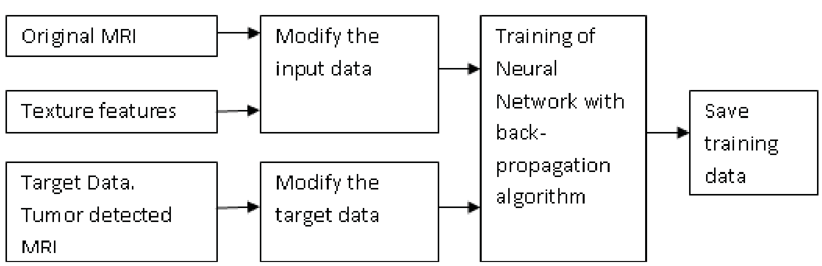

Figure 1 :- Training method of ANN

Step 5:- Use ANN for tumor detection

Neural Network is used for the brain tumor detection after suitable training. Load MR image and modify input data. The output data of neural network need to be re-modified for the display of desired image. Reshape the output image to the previous dimensions for proper display.

IV. RESULTS AND DISCUSSION

MATLAB GUI is shown in the figure 2. Integrated callback function is developed to join the different MATLAB functions. GUI provide most convenient, user friendly environment. Local and global variables are declared and data transfers or exchanges between these variables are possible.

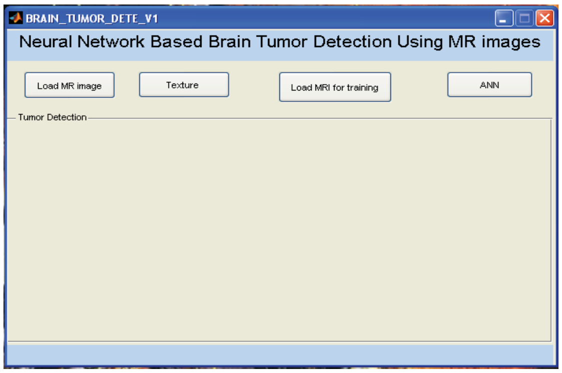

Figure 2 :- MATLAB GUI

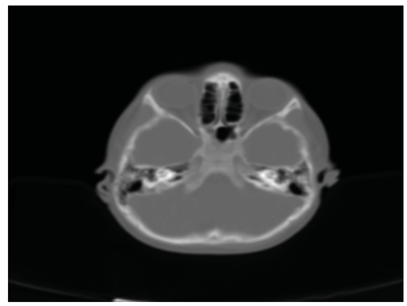

Figure 3 :- Sample MR Image

The load MR image, callback function is going to load the MR image for example; the loaded MR image is shown in the figure 3. Matrix image elements are stored in 'MRI' variable for the further processing. Loaded MRI image is of size 256 * 256.

The texture features are calculated based on the suggestions by Haralick. The different texture features are listed in the table 1. The texture features are stored in 'stats' variable.

Table 1 :- GLCM Texture Features

Texture Feature	**Value**
Autocorrelation	[1 1]
Contrast	[0 0]
Cluster Prominence	[0 0]
Cluster Shade	[0 0]
Dissimilarity	[0 0]
Energy/Angular Second Moment	[1 1]
Entropy	[-2.220446049250313e-016 -2.220446049250313e-016]
Homogeneity	[1 1]
Maximum probability	[1 1]
Variance	[9.689941406250000e-001 9.689941406250000e-001]
Sum average	[2 2]
Sum variance	[4 4]

Texture Feature	Value
Sum entropy	[-2.220446049250313e-016 -2.220446049250313e-016]
Difference variance	[0 0]
Difference entropy	[-2.220446049250313e-016 -2.220446049250313e-016]
Information measure of correlation1	[0 0]
Information measure of correlation2	[0 0]
Inverse difference normalized (INN)	[1 1]
Inverse difference moment normalized	[1 1]

Detected tumor using the symmetry analysis algorithm is shown in figure 4.

Figure 4:- Sample detected Tumor Image

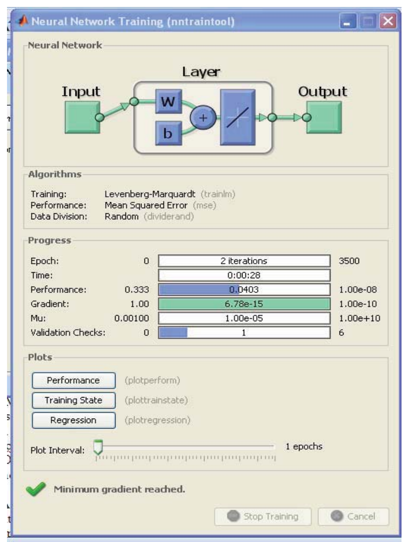

Figure 5 :- Neural Network Training window

The training of neural network is carried out as per the initialization and training window is shown in figure 5. Data division is random and training performance is based on mean square error method with 'trainlm' training algorithm.

The best validation performance of neural network training is 0.041205 at epochs 1.

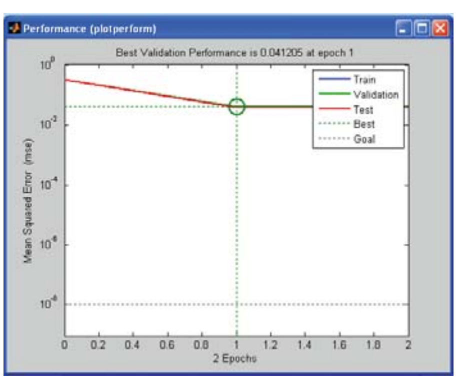

Figure 6 :- Neural Network Training Performance

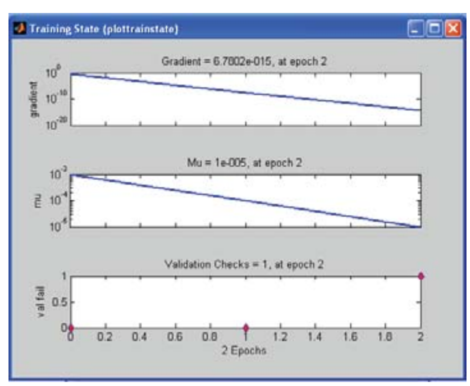

Figure 7 Neural Network Training States

Training states are having gradient of 6.7802e-015, Mu is 1e-005 and validation check is 1 at the epoch of 2.

The training regression analyses are found to be 0.90358 for training, 0.90135 for validation, 0.9035 for test and overall regression is 0.90312 for the training session.

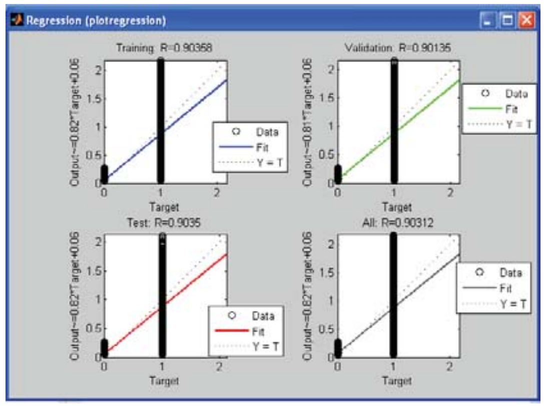

Figure 8 :- Neural Network training Regression analysis

The ANN results are shown in figure 9 to figure 16. ANN is trained for the tumor detection within the edges of MR image. The dark area within the boundary is indicating tumor area. The tumor area can be calculated for the further analysis.

V. CONCLUSION

Present Brain Tumor Detection Algorithm is not only detecting the tumor area by darkening malign brain cells but also enhances the MRI to help the doctors for the detection of various diseases in human brain. The extensive lab work has proved that proposed algorithm detects tumor. GLCM texture features are capable of extracting useful information and ANN classifier shows the satisfactory results.

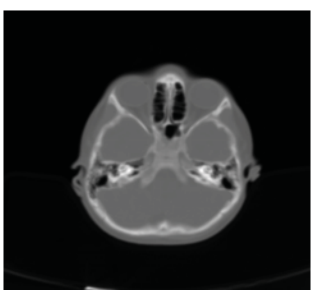
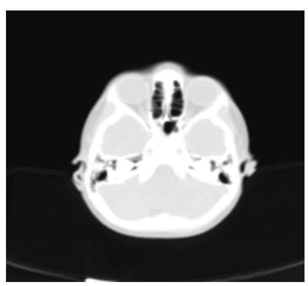
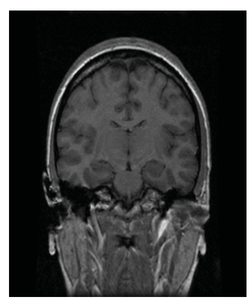
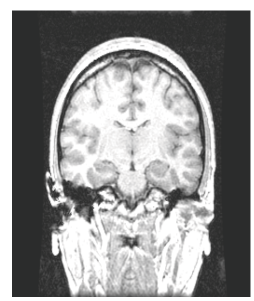

Fig.9 ANN input Image 1 Figure10 ANN output Image 1 Figure11ANN input Image 2 Fig.12 ANN output Image 2

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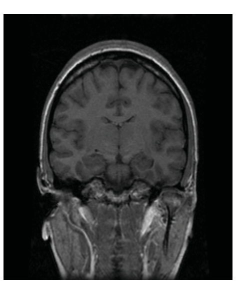
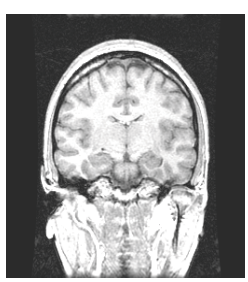
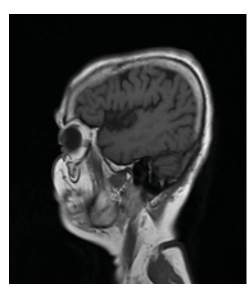
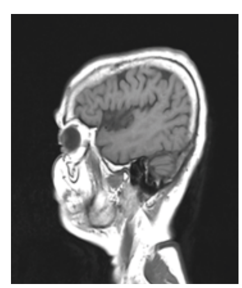

Fig.13ANN input Image 3 figure14 ANN output Image 3 Figure15ANN input Image 4 Fig.16 ANN output Image 4

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