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Detection of Tumor in MRI Images Using Artificial Neural Networks

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ABSTRACT:Automatic defects detection in MR images is very important in many diagnostic and therapeutic applications. Because of high quantity data in MR images and blurred boundaries, tumour segmentation and classification is very hard. This work has introduced one automatic brain tumour detection method to increase the accuracy and yield and decrease the diagnosis time. The goal is classifying the tissues to two classes of normal and abnormal. MR images that have been used here are MR images from normal and abnormal brain tissues. Here, it is tried to give clear description from brain tissues using Multi-Layer Perceptron Network,energy, entropy, contrast and some other statistic features such as mean, median, variance and correlation. It is used from a feature selection method to reduce the feature space too. This method uses from neural network to do this classification. The purpose of this project is to classify the brain tissues to normal and abnormal classes automatically, that saves the radiologist time, increases accuracy and yield of diagnosis**.**

KEYWORDS:MRI Images, GLCM Features and Multi-Layer Perceptron Network.

I.INTRODUCTION

Brain tumor is any mass that results from an abnormal and an uncontrolled growth of cells in the brain. Its threat level depends on a combination of factors like the type of tumor, its location, its size and its state of development. Brain tumors can be cancerous (malignant) or non-cancerous (benign). Benign brain tumors are low grade, non-cancerous brain tumors, which, grow slowly and push aside normal tissue but do not invade the surrounding normal tissue. They are homogeneous, well defined and are known as non- metastatic tumors, because they do not form any secondary tumor. Whereas, malignant brain tumors are cancerous brain tumors, which grow rapidly and invade the surrounding normal tissue. Malignant brain tumors or cancerous brain tumors can be counted among the most deadly diseases [1].

An artificial neural network (ANN), generally called neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network contains of an interconnected group of artificial neurons (processing element), working in unison to solve specific problems. ANNs, like people, learn by example. The neuron has two modes of operations: The training/learning mode and the using/testing mode. In mainly cases an ANN is an adaptive system that converts its structure based on external or internal information that flows through the network in the learning phase. Recent neural networks are non-linear statistical data modelling tools. They are generally used to model complex relationships between inputs and outputs or to find patterns in data. Multi-layer perceptron learning algorithm is a supervised learning algorithm. It is one of the most important developments in neural networks. This learning algorithm is applied to multilayer feed-forward networks consisting of processing elements (neurons) with continuous differentiable activation functions (Tan-sigmoid and log-sigmoid). For a given set of training input-output pair, this algorithm provides a procedure for changing the weights in a BPN to classify an input correctly. The concept for this weight update algorithm is basically the gradient-descent method as used in case of simple perceptron networks with differentiable units. This is a way where the error is propagated back to hidden unit. The aim of the neural network is to train the net to achieve a balance between the net's ability to respond (memorization) and its ability to give reasonable responses to the input that is similar but not identical to one of that is used in training [2].

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II.LITERATURE REVIEW

The various tumor detection approaches are classified into 4 categories. These are as follows: 1) Thresholding approaches, 2) Region growing approaches, 3) Genetic Algorithm approaches, 4) Neural network approaches. Several authors suggested various algorithms for segmentation. The threshold technique is by making decision based on the local raw pixel information and Edge based method is centered on contour. Jaskirat Kaur, Sunil Agrawal & Renu Vig.'s paper presented thresholding and edge detection being one of the important aspects of image segmentation comes prior to feature extraction and image recognition system for analyzing images. It helps in extracting the basic shape of an image, overlooking the minute unnecessary details. In this paper using image segmentation (thresholding and edge detection) techniques different geo satellite images, medical images and architectural images are analyzed. [8]. Manoj K Kowar, SourabhYadav, proposed a method based on histogram thresholding[9]. They follow a concept that after dividing the image into two equal halves, histograms are compared to detect the tumor and cropping method is used to find an appropriate physical dimension of brain tumor. In the Region basedtechnique the images are partitioned by organizing the nearest pixel of similar kind. N. Senthilkumaran and R. Rajesh proposed region-based techniques with an assumption that adjacent pixels in the same region have similar visual features such as grey level, color value, or texture. Split and merge approaches were used & its performance largely depends on the selected homogeneity criterion [10]. Instead of tuning homogeneity parameters, the seeded region growing (SRG) technique is controlled by a number of initial seeds. If the numbers of regions were approximately known & used it to estimate the corresponding parameters of an edge detection process, it is possible to combine region growing and edge detection for image segmentation. The important process in the automated system is brain image classification. The main objective of this step is to differentiate the different abnormal brain images based on the optimal feature set. Though this approach claimed a faster convergence rate, it may not be much useful because of its low accuracy than Artificial Intelligent (AI) techniques. Ahmed Kharrat&KarimGasmi proposed a hybrid approach for classification of brain tissues in MRI based on genetic algorithm [11]. The optimal texture features are extracted from normal and tumor regions by using spatial gray level dependence method. It is concluded that, Gabor filters are poor due to their lack of orthogonality that results in redundant features at different scales or channels. While Wavelet Transform is capable of representing textures at the most suitable scale, by varying the spatial resolution and there is also a wide range of choices for the wavelet function. Application of various artificial neural networks for image classification is analysed by classifying MR brain images into normal, cancerous and non-cancerous brain tumors in particular, is a crucial task, a wavelet and co-occurrence matrix method based texture feature extraction and Probabilistic Neural Network for classification has been used as new method of brain tumor classification[1].

III.MODELLING AND SIMULATION

The method used for MRI brain tumor image classification is shown in Fig. 1. The various stages of the proposed method are MRI database (collected from radiologist), pre-processing, feature extraction and classification.

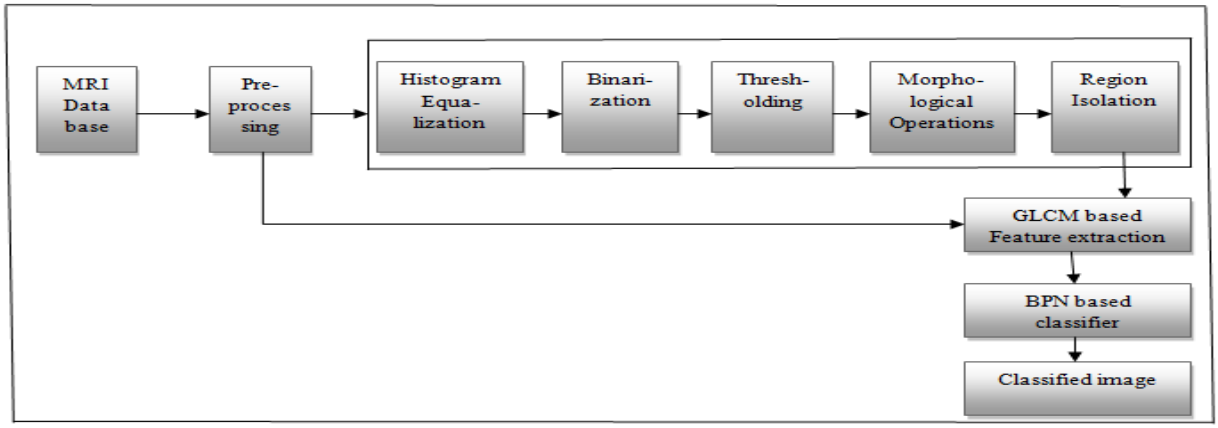

Fig.1 Block Diagram of Proposed Model

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A. Image histogram equalization

The first step is to perform histogram equalization on the MRI image. The given MRI is equalized using histogram. The Histogram of an image shows the relative frequency of occurrences of pixel in a given MRI image. The non-uniform changeable image due to external conditions is equalized to a uniform variation. Image binarization converts an image in 0 to 255 gray levels to a black and white image.

B.Morphological Operations

This is used as a image processing tools for sharpening the regions and filling the gaps for binarized image. The dilation operation is performed by imdilate command in matlab. This is applied for filling the broken gaps at the edges and to have continuities at the boundaries [3].

C. Segmentation by Thresholding

Thresholding often gives an easy and convenient method to achieve this binarization on the basis of the dissimilar intensities or colors in the foreground and background regions of an image. For the binarization of equalized image a thresholding technique is used as shown: Binarized Image bi, j = 255 if e (i, j) > T**,** Else bi, j = 0. Where e (i, j) is the equalized MRI image and T is threshold resultant for the equalized image.

D.Feature Extraction

Feature extraction is the procedure of data reduction to find a subset of helpful variables based on the image. In this work, seven textural features based on the gray level co-occurrence matrix (GLCM) are extracted from each image. Co-occurrence matrices are calculated for four directions: 0º, 45º, 90º and 135º degrees. The seven Haralick texture descriptors are extracted from each co-occurrence matrices which are computed in each of four angles [4].

D(a). Energy

It is minimalwhen all elements are equal.

$$Energy = \sum_i \sum_j C^2(i, j) \tag{1}$$

D(b). Entropy

It is a measure of chaos is maximal when all elements are equal.

$$Entropy = \sum_i \sum_j C(i, j) \log C(i, j) \tag{2}$$

D(c). Contrast

It has small values when big elements are near the main diagonal.

$$Contrast = \sum_i \sum_j (i - j)^2 C(i, j) \tag{3}$$

D(e). ***Variance***

It is a measure of the dispersion of the values around the mean.

$$Variance = \sum_i \sum_j (i - \mu)^2 C(i, j) \tag{4}$$

E. Classifier

The algorithm uses a multi-layer perceptron neural network the schematic representation of neural network with ‘n’ inputs, ‘m’ hidden units and one output unit. The extracted features are considered as input to the neural classifier. A neural network is a set of connected input/output units in which each connection has a weight associated with it. The neural network trained by adjusting the weights so as to be able to predict the correct class. The desired output was specified as 0 for non-cancerous and 1 for cancerous. The classification process is divided into the training phase and the testing phase. During training, the features are extracted from the images in which the diagnosis is known. After training is over, the trained networks are stored to be used in the algorithm. Whenever an image is taken as input in the algorithm, it is simulated with the trained net-works and goes for testing the data [5].

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E(a). Multi-Layer Perceptron Neural Network

MLP networks are feed forward networks with one or more layers of units between the input layer and the output layer. The network is termed feed forward since network signals flow only in forward direction. Starting at the input layer forward to hidden inputs and then still outputs are forwarded to output layers. The inputs to the i^{th} unit are weighted sum of outputs from the previous layers. The i^{th} unit net function X_{net} (i) is expressed in eq(1)

$$X_{net}(i) = \sum w(i,k)\varphi(k) + \theta(i) \quad (1)$$

Where $\varphi(k)$ denotes the output activation value of the k^{th} unit, w (i,k) is the weight from the k^{th} unit to the i^{th} unit, $\theta(i)$ is an additive bias.

The total mean square error E at the output is expressed as

$$E = 0.5 \sum_{p=1}^{Npattern} \sum_{i=1}^{Nout} (T_p(i) - o_p(i))^2 = \sum_{p=1}^{Npattern} E_p \quad (2)$$

Where the summations are over all N_{out} output units and $N_{pattern}$.O (i) is the actual i^{th} network for the p^{th} input pattern. Before training, all network weights must be initialized to small random numbers [6].

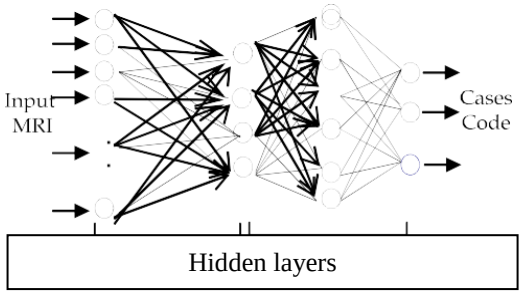

Fig.2 Multi-Layer Perceptron Network

In the Fig. 2, it showsMulti-Layer Perceptron Network with MRI Input as GLCM Features, Hidden Layes and Output as Normal and Abnormal cases.

F. Decision

All classification result could have an error rate and on occasion will either fail to identify an abnormality, or identify an abnormality which is not present. It is common to describe this error rate by the terms true and false positive and true and false negative as follows: [7]

- ***True Positive (TP)*** **–** counts of all samples which are correctly called by the algorithm as being cancer.
- ***False Positive (FP)*** **–** counts of all samples which are incorrectly called by the algorithm as being cancer while they are normal.
- ***True Negative (TN)*** **–** counts of all samples which are correctly called by the algorithm as being normal.
- ***False Negative (FN)*** **–** count of all samples which are incorrectly called by the algorithm as being normal while they are cancer.

IV.RESULTS AND DISCUSSION

Twenty brain MR images are used to evaluate ISO the proposed algorithm. Initially, histogram equalization technique is performed. Histogram equalization takes advantage of the neglected pixel values and provides better definition and more information for the doctors. Segmentation is followed after histogram equalization to segment the tumor regions from the complete image further; it provides a better means to assess the tumor region in the MR images. The

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developed algorithm automatically calculates the threshold for the images. Edge detection algorithms are able to detect the tumor region very well to help the doctors for treatment plan making. Mathematical morphology act as a tool for extracting image components that are useful in the representation and description of region shape such as boundaries, skeletons, etc. We are also interested in morphological techniques for pre- and post-processing, such as morphological filtering and dilation.

MRI Scanner is an alternative method to traditional human-based techniques, and optimally predicts the presence or absence of abnormality by using a non-invasive methodology. The application of neural networks models in non-invasive abnormality diagnosis, using sample images, represents a promising complementary method, enhancing and supporting the differential diagnosis of normal tissue and abnormalities made by physicians, in real time and with a high degree of accuracy, compared to traditional methods, but much faster.

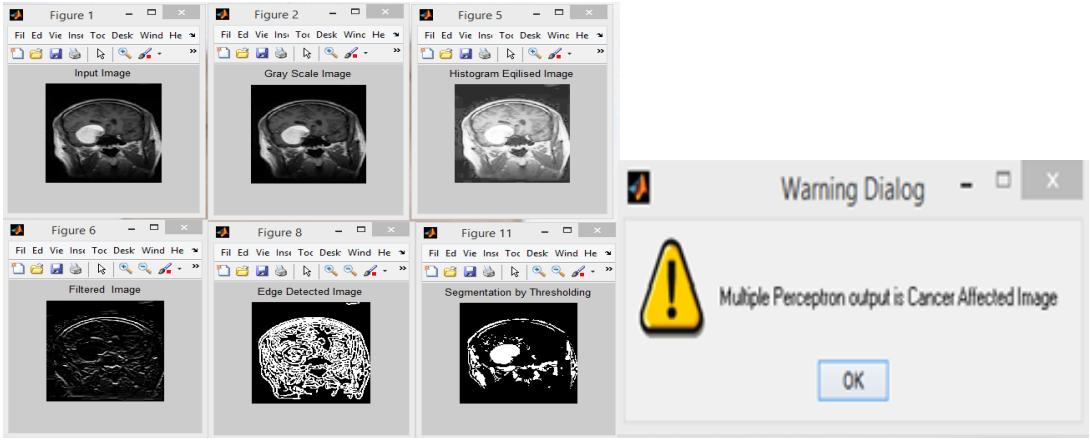

Fig.3 Result of a neural classifier detected as an (Abnormal) image.

In the Fig.3, it shows initially MRI image is loaded as a Input Image(Abnormal MRI Input)(Figure 1) and following pre- processing steps are performed such as Gray Scale Image(Figure 2), it is a range of shades of gray without apparent color, followed by Histogram Equalization(Figure 5), it enhances the contrast of the image, followed by Filtered Image(Figure 6), it filters the noise in the image, followed by edge detection(Figure 8), it is able to detect the tumor edges, followed by segmentation(Figure 11), it segments the tumor region from the Input Image and Multi-Layer Perceptron Neural Network(Warning Dialog) is used detect the image as Cancer Affected Image for Abnormal Brain MRI Input

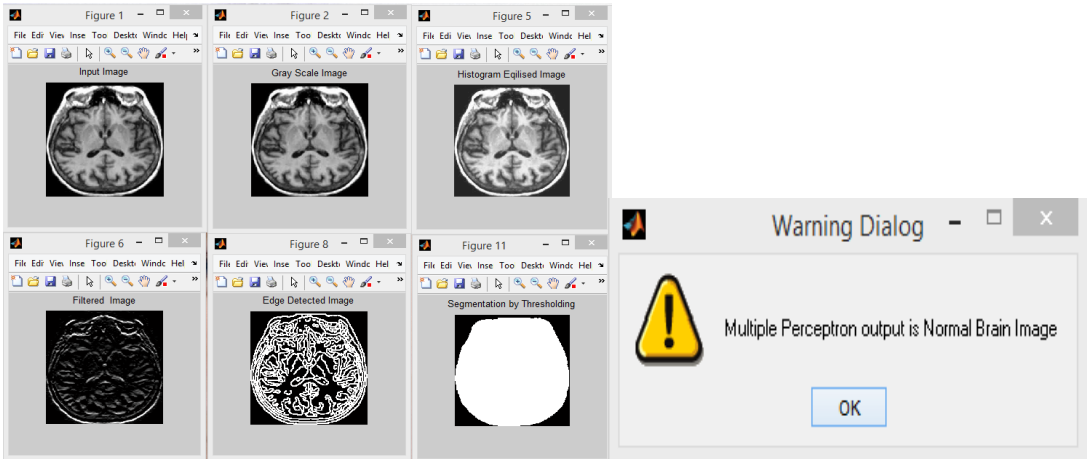

Fig.4 Result of a neural classifier detected a (Normal) image

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In the Fig. 4, it shows initially MRI image is loaded as a Input Image(Normal MRI Input)(Figure 1) and following pre-processing steps are performed such as Gray Scale Image(Figure 2), it is a range of shades of gray without apparent color, followed by Histogram Equalization(Figure 5), it enhances the contrast of the image, followed by Filtered Image(Figure 6), it filters the noise in the image, followed by edge detection(Figure 8), it is able to detect the tumor edges, followed by segmentation(Figure 11), it segments the tumor region from the Input Image and Multi-Layer Perceptron Neural Network(Warning Dialog) is used detect the image as Normal Image for Normal Brain MRI Input.

V.CONCLUSION

The proposed approach for Brain Tumor Detection based on artificial neural network categorized into Multi-layer perceptron neural network. The proposed approach utilizes a combination of this neural network technique and is composed of several steps including segmentation, feature vector extraction and model learning. The purpose is to develop tools for discriminating the two classes normal and abnormal from MRI input Scanner and assist on decision making in clinical diagnosis and this will help doctor to take or analyse in which stage of cancer the patient have and according to which he/she can take necessary and appropriate treatment steps. This work has introduced one automatic brain tumour detection method to increase the accuracy and yield and decrease the diagnosis time.

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