Brain Cancer Classification Using GLCM Based Feature Extraction in Artificial Neural Network

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Abstract—Brain tumor is one of the major reasons of death among people. It is indication that the chances of survival can be greater than before if the tumor is detected correctly at its early stage. This paper classifies the type of tumor using Artificial Neural Network (ANN) in MRI images of different patients with Astrocytoma type of brain tumor. The extraction of texture features in the detected tumor has been achieved by using Gray Level Co-occurrence Matrix (GLCM). This paper gives a brief overview to Brain Cancer, MRI, Co-occurrence Matrix, Artificial Neural Network and Back Propagation Network.

Index Terms—Brain Cancer, MRI, Co-occurrence Matrix, Artificial Neural Network (ANN) and Back Propagation Network.

1 INTRODUCTION

A brain cancer is a disease in which cells grow uncontrollably in the brain. Brain tumors have mainly two types [11]:

First is Benign tumors are unable of spreading beyond the brain itself. Benign tumors in the brain generally do not essential to be treated and their progress is self-limited. Sometimes they can cause complications because of their position and surgery or radiation can be helpful. And second is Malignant tumors are typically called brain cancer. These tumors can extent outside of the brain. Malignant tumors of the brain will always change into a problem if left untreated and aviolent approach is almost always warranted.

Brain malignancies can be divided into two categories [11]: Primary brain cancer originates in the brain. Secondary or metastatic brain cancer extents to the brain from another site in the body Cancer arises when cells in the body (in this case brain cells) divide without control. Generally, cells divide in a structured manner. If cells keep separating uncontrollably when new cells are not needed, a mass of tissue forms, called a progress or tumor. The term cancer generally refers to malignant tumors, which can attack nearby tissues and can extent to other parts of the body. A benign tumor does not extent.

MRI is an imaging technique used primarily in medical settings to produce high quality images of the inside of the human body. There is a horizontal tube running through the magnet from front to back. This tube is called as the bore of the magnet. The patient lying on his or her back slides into the bore on a specific table. Whether or not the patient goes in head first or feet first, as well as how far in the magnet they will go, is determined by the type of exam to be executed. Once the body part to be scanned is in the particular center or isocenter of the magnetic field, the scan can begin. MRI offers an unparalleled view inside the human body. The level of information we can see is surprising compared with any other imaging modality. MRI is the method of option for the diagnosis of many types of injuries and situations because of the incredible capability to tailor the exam to the specific medical question being asked. Some samples of MRI database have been showed in figure 1.

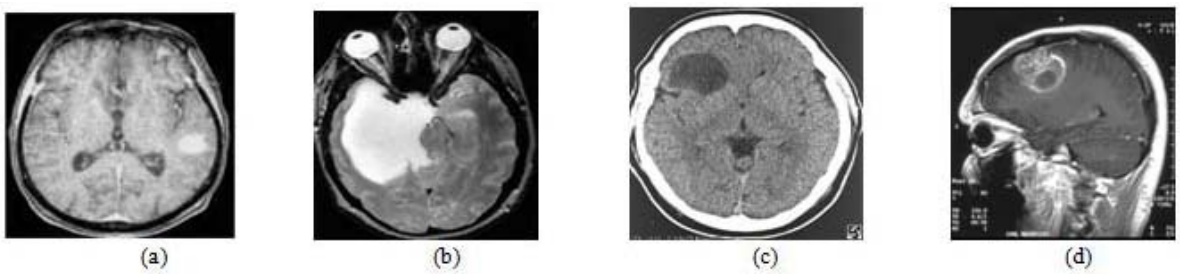

Figure 1: Sample data set (a) Grade I (b) Grade II (c) Grade III (d) Grade IV

A co-occurrence matrix or co-occurrence distribution (less often co occurrence matrix or co occurrence distribution) is a matrix or distribution that is defined over an image to be the spreading of co-occurring values

at a given offset. Mathematically, a co-occurrence matrix C is formulated over an n x m image I, parameterized by an offset (Δx, Δy),

$$C_{\Delta x,\Delta y}(i,j)=\sum_{p=1}^{n}\sum_{q=1}^{m}\begin{cases}1, & \text{if } I(p,q)=i \text{ and } I(p+\Delta x,q+\Delta y)=j\\ 0, & \text{otherwise}\end{cases}$$

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 operarions: The training/learning mode and the using/testing mode [16]**.** 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 modeling tools. They are generally used to model complex relationships between inputs and outputs or to find patterns in data**.**

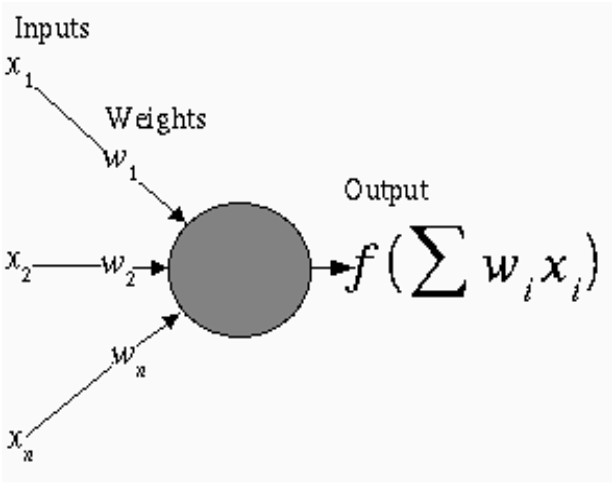

Figure 2: Structure and functioning of single neuron [9]

Back Propagation 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). The networks associated with back-propagation learning algorithm are also called back-propagation learning networks (BPNs) [15]. 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 (generalization).

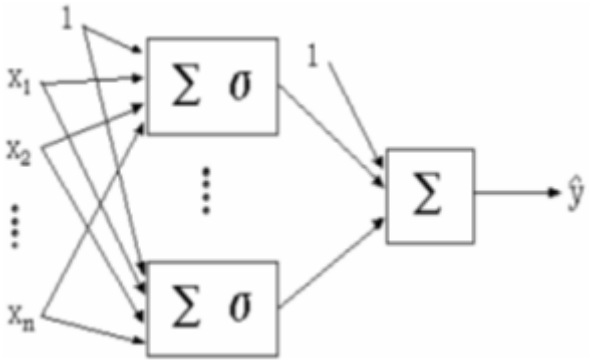

Figure 3: Neural network Feed forward architecture

Algorithm stages for BPN

1. Initialization of weights
2. Feed forward
3. Back propagation of Error
4. Updation of weights and biases

2 PROPOSED METHODOLOGY

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

The database consists of abnormal brain tumor images from Astrocytoma type of brain cancer classified into four tumor types namely pilocytic (grade I), low grade (grade II), anaplastic (grade III) and glioblastoma multiforme (grade IV). The database is constructed with the help of Google search Engine. The images are 256*256 gray level images with intensity value ranges from (0 to 255) [10].

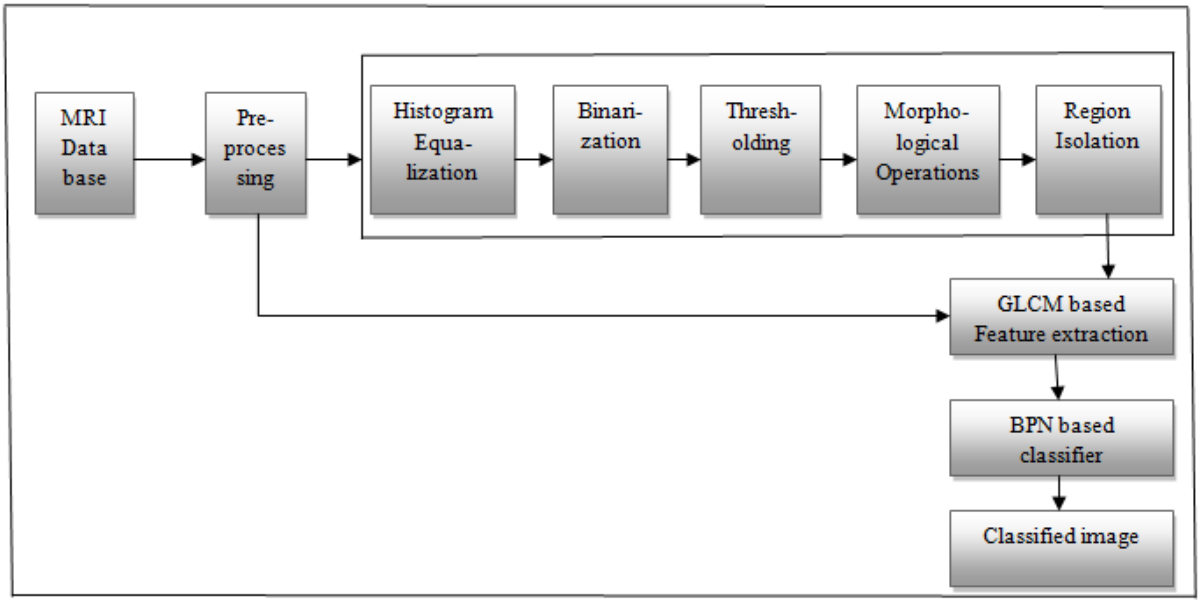

Figure 4: Proposed Methodology

2.1 Image preprocessing

Image preprocessing consists mainly of following steps.

- Image histogram equalization.
- Binarization.
- Thresholding.
- Morphological operation.
- Region isolation.

1. 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.

2. Binarization: Image binarization converts an image in 0 to 255 gray levels to a black and white image. The easiest way to use image binarization is to select a threshold value, and classify all pixels with values above this threshold as white, and all other pixels as black. For this thresholding technique is used. For the equalized image the pixels are represented in a 0 to 255 gray level intensity. As the method is to extract the affected region or the accumulated region, a 2-level image representation would be satisfactory for better computation.

3. Thresholding: In various vision applications, it is helpful to be able to separate out the regions of the image corresponding to objects in which we are interested, from the regions of the image that correspond to background. 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 [11].

For the binarization of equalized image a thresholding technique is used as shown below:

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.

4. 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. A structuring element of 3x3 square matrix is applied to complete dilation operation.

5. Region Isolation: After the dilation operator, a filling operator is used to fill the close contours. Then centroids are calculated to localize the regions as shown beside. The last extracted region is then logically operated for extraction of Massive region in given MRI image.

2.2 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-occurence 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 [9].

- Angular Second Moment (ASM) / Energy.
- Contrast.
- Inverse Difference Moment (IDM) / Homogenety.
- Dissimilarity.
- Entropy
- Maximum Probability
- Inverse

1. Angular Second Moment (ASM)

$$f1 = \sum_{i,j=0}^{N-1} P_{i,j}^2$$

2. Contrast

$$f2 = \sum_{i,j=0}^{N-1} P(i,j) * (i-j)^2$$

3. Inverse Difference Moment (IDM)

$$f3 = \sum_{i,j=0}^{N-1} \frac{P(i,j)}{1+(i-j)^2}$$

4. Dissimilarity

$$f4 = \sum_{i,j=0}^{N-1} P(i,i) * |(i-j)|$$

5. Entropy

$$f5 = \sum_{i,j=0}^{N-1} P(i,j) * \left[-ln\left(P(i,j)\right)\right]$$

6. Maximum Probability

$$f6 = \max i,j\, P(i,j)$$

7. Inverse

$$f7 = \sum_{i,j=0}^{N-1} \frac{P(i,j)}{(i-j)^2}$$

2.3 Classification Using ANNs

The purpose of image classification scheme is to assign each input to one of 'Astrocytoma type of brain cancer' pattern classes. It is the process of assigning a label to each unknown input image. In this work, the artificial neural network approach namely, Back propagation network (BPNs) is used to classify the images shown in figure 5.

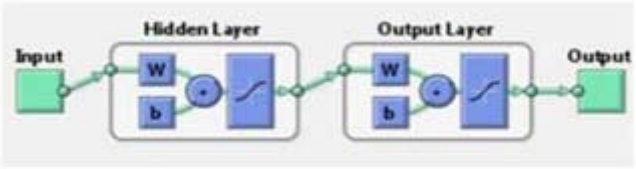

Figure 5

In this paper, back propagation algorithm is applied for learning the samples, Tan-sigmoid (tansig) and log-sigmoid (logsig) functions are applied in hidden layer and output layer respectively, Levenberg-Marquardt optimization (trainlm) is used for adjusting the weights as training methodology.

In this paper, each pixel together with a small square neighborhood is defined as a structure element, which is known as 'block'. Further are all based on the blocks. For training process, firstly altered features are extracted block by block in one image. When we use a new image for classification, only those selected features are extracted and the trained classifier is used to classify the tumor in the image [9].

3 CONCLUSION

This article describes Classification of Brain Cancer Using Feature Extraction in Artificial Neural Network. Firstly, MRI database are introduced, including Astrocytoma type of brain cancer classified into four tumor types namely pilocytic (grade1), low grade (grade2), anaplastic (grade3) and glioblastoma multiforme (grade4).Then the feature extraction are being discussed. Finally, architecture of artificial neural network are developed for classification of brain cancer.

The scope of this work is to improve the ANNs architecture with improvement of feature functions to achieve well separated data.

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