International Journal of Basic and Applied Biology (IJBAB)
Print ISSN: 2349 – 5820; Online ISSN: 2349 – 5839 ; Volume 2, Number 1; October, 2014 pp. 83 – 88

http://www.krishisanskriti.org/ijbab.html

Brain Tumor Detection Using FCM and BPNN

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Abstract : **Traditionally, computerized tomography (CT) and magnetic resonance brain images classification and detection is done by human inspection. Computerized Tomography and Magnetic Resonance images (MRI) contain an undesired sound (noise) caused by operator performance which can lead to serious inaccuracies in classification. In this paper, a new method for Brain Tumor Classification using Back Propagation Neural Network (BPNN) with Fuzzy C Means (FCM) is proposed. The complete work is completed in following steps: pre-processing, Decision Making is performed in two steps: i) High level segmentation (using FCM) and ii) Low level segmentation (using BPNN), and then analysis is done. In this, 25 brain tumor images are used to perform evaluation**.

Keywords— Brain Tumor; Back Propagation Neural Network (BPNN); Fuzzy C Means (FCM); Magnetic Resonance Images (MRI); Computerized Tomography (CT);

I. INTRODUCTION

A tumor is the name given for a neoplasm or a solid lesion which is formed by an abnormal growth of cells within the brain or the central spinal canal which looks like a swelling. Some tumors are brain cancers. The cells involved within the brain itself may be neurons or glial cells (which include astrocytes, oligodendrocytes, and ependymal cells). It is not necessary that brain tumor is always a brain cancer. It may also spread from the cancers which may be located primarily in the other organs (metastatic tumors). Detection of the brain tumor in its early stage is the key of its cure. There are many various types of brain tumors that make the decision very complicated [1].

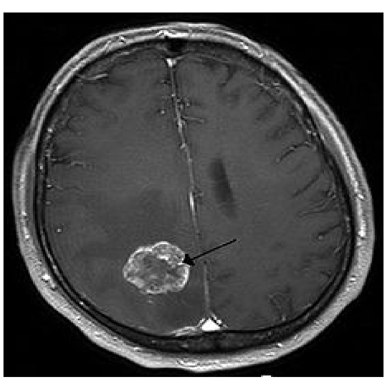


Figure 1: Brain metastasis in the right cerebral hemisphere from lung cancer shown on T1-weighted magnetic resonance imaging with intravenous contrast.

II. CLASSIFICATION OF BRAIN TUMOR

A tumor can be classified into three categories:

Benign: A benign tumor is a tumor that lacks all three of the malignant effects of a cancer. Thus, by definition, a benign tumor does not invade surrounding tissues, does not grow in an unlimited and aggressive manner, and does not spread to non-adjacent tissues (metastasize) but can cause severe pain, permanent brain damage, and death. They are also known as low- grade brain tumors.

Malignant: Malignant is derived from the word Malignancy which itself comprises two Latin words i.e. mal- = "bad" and -ignis = "fire". Malignant tumors do not stop growing; therefore, pieces of it travel to other parts of the body, where they also continue to grow. They are also known as high-grade brain tumors.

Premalignant: A precancerous condition (or premalignant condition) is a disease, syndrome, or finding that, if left untreated, may lead to cancer. It is a generalized state associated with a significantly increased risk of cancer. They are also known as mid-grade brain tumors.

In any classification system Dimensionality Reduction and Feature Extraction are very important aspects [5]. Images though small in size are having large dimensionality this leads to very large computational time, complexity and memory occupation. The performance of any classifier mainly depends on high discriminatory features of the images [6]. In the proposed method we used Clustering for both dimensionality reduction and feature extraction with the help of Fuzzy C Means technique.

The rest of this paper is organized as follows: Section III comprises a literature survey of brain tumor classification. Section IV defines the problem. Section V discusses Research Methodology used. Section VI explains Fuzzy C Means (a Clustering Technique) for segmentation of Brain Tumor images at a high level. Section VII describes the BPNN classifier which is used at a low level after high level segmentation. Section VIII shows experimental results, and discusses possible modifications and improvements to the system. Section IX shows conclusion. Section X presents references.

III. LITERATURE REVIEW

There is a lot of work has been already done in brain tumor classification and it is also a topic of interest so that classification techniques can be improved for successful classification of brain tumor type. This section includes some brain tumor classification techniques which are designed for classifying different types of brain tumors.

In Year 2004, Azadeh Yazdan-Shahmorad performed a work," MRSI Brain Tumor Characterization Using Wavelet and Wavelet Packets Feature Spaces and Artificial Neural Networks". This paper presents Presented proposed methods and results for the analysis of the brain spectra of patients with three tumor types (Malignant Glioma, Astrocytoma, and Oligodendroglioma). After extracting features from MRSI data using wavelet and wavelet packets, Author use artificial neural networks to determine the abnormal spectra and the type of abnormality. Author evaluated the proposed methods using clinical and simulated MRSI data and biopsy results.

In Year 2010, Carlos Arizmendi performed a work," Diagnosis of Brain Tumors from Magnetic Resonance Spectroscopy using Wavelets and Neural Networks". In this brief paper, a method that combines data pre-processing using wavelets with classification using Artificial Neural Networks is shown to yield high diagnostic classification accuracy for a broad range of brain tumor pathologies.

In Year 2010, Mohd Fauzi Othman performed a work," Probabilistic Neural Network for Brain Tumor Classification". In this paper, Probabilistic Neural Network with image and data processing techniques was employed to implement an automated brain tumor classification. The conventional method for medical resonance brain images classification and tumors detection is by human inspection. Decision making was performed in two stages: feature extraction using the principal component analysis and the Probabilistic Neural Network (PNN).

In Year 2012, Yawar Rehman performed a work," Comparison of Different Artificial Neural Networks for Brain tumor Classification via Magnetic Resonance Images". Artificial Neural Network algorithms has been tested for the classification of patterns and best among them was implemented for the application of brain tumor classification as specified by World Health Organization standards via 2D MR images. The technique of Rajasekaran and Pai (sBAM) was found to give most successful results of classifying tumor into their correct classes.

IV. PROBLEM DEFINITION

Medical Images is one of the major concern of Image processing where the efficiency and accuracy both are required at very high level. Lot of work is already done in this area related to medical image segmentation, colorization, abnormality detection etc. Even then because of requirement of high accuracy it is the open research area. The proposed work is also in the same direction. In this we are improving the medical image preprocessing by using different filters along with Neural Network Approach. The neural network will be implemented on n × n size window blocks so that effective identification of abnormality will be done. On these filtered images the segmentation will be applied using some clustering algorithm to identify different image components clearly. While performing the segmentation the abnormal areas in the images will also be identified. This area may be some tumor or the problem area. The system will use two layers of processing. One level will be implemented to perform the segmentation and other to identify the abnormality. Once the normality is been identified, the classification of the tumor will be done respective to tumor size.

V RESEARCH METHODOLOGY

The proposed work is about the detection of brain tumor in the Medical Images. The presented work covers the following objectives: Analysis and Study of existing Brain Tumor Analysis Approaches. Collection of Brain PGM and DICOM images either from secondary or primary sources. Performing the Pre-processing to convert the image to Normalized format. Define a clustering approach to perform high level segmentation for tumor detection. Define the neural network based algorithm to perform low level segmentation and to optimize the result. Analysis of proposed work under different parameters.

The medical area is on of important application of Image processing. The detection of cancer, Disease by observing the MRI images, CT scan images is one of the most considered research area. But as the Medical science come under the Real Time application because of this area always requires the accuracy and the efficiency. The proposed work is in the same direction.

Figure 2: The flow chart of the proposed method

Sources of Data: The data here requirement is in the form of brain images. We can collect this data from the Secondary sources. It means the images used in existing research. This data will be collected either from the internet or submitting the request to the researchers. Primary data can be collected from the medical or hospitals. The images required with a 512*512 matrix and quantized with 16 bits. They were transferred into the Digital Imaging and Communications in Medicine (DICOM) format. The images include both the male and female brain image sets.

Algorithm (Img)

/*Img is the input Source Image Taken to identify Brain Tumor*/

Step 1: Load the medical image and perform image normalization on it. Image normalization is done by using scaling.

Step 2: If the source image is in RGB format then convert it into a Grayscale image else not.

Step 3: After getting grayscale image, perform the enhancement on image by adjusting its brightness, contrast.

Step 4: Analyze Image under Intensity Distance.

Step 5: Perform Gray Threshold over Image to extract the Image features.

Step 6: Apply Fuzzy C Means to Divide the Image in Clusters.

Step 7: Divide the Image in Small Size Segments of N ˣ N.

Step 8: Setup Neural Parameters under MinMax Weighted Approach.

Step 9: Apply Neural Network to train the image blocks.

Step 10: Identify the Adaptive Thresholding from neural Analysis Response.

Step 11: Apply Threshold to Extract Tumor Area over Image.

Step 12: Measure Tumor Area.

Step 13: If Tumor Area>Threshold then display"Critical Tumor Identified” else "Tumor Identified"

Step 1: Pre Processing

It is a process to enhance the image in order to make it suitable for further processing. The main function of preprocessing is to improve the image such that it increases the chances for success of other processes. It includes the steps like image acquisition, image enhancement, filtration of the image, finding negative image, adjusting the brightness of image, color image to grayscale transformation, resolution reduction, noise separation etc.

Step 2: Image Segmentation

Next step deals with processing of the acquired image. In image segmentation step, given input image is partitioned into its constituent different parts. The key role of segmentation is to extract the boundary of object from the background. Usually, Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images, therefore, the output of segmentation stage consists of either all the parts in the region itself or boundary of the region.

Segmentation could be used for object recognition, occlusion boundary estimation within motion or stereo systems, image compression, image editing, or image database look-up [7]. The concept of Watersheds is well known in topography. It is a morphological based method of image segmentation. Segmentation using the watershed transforms works well if you can identify, or "mark," foreground objects and background locations [8].In the proposed work, a clustering technique, namely, Fuzzy C Means (FCM) is used which is explained in the next section , section VI.

Step 3: Brain Tumor Classification

After segmentation, the neural network is used for classification of brain tumor. In proposed work, Back Propagation Neural Network is used for classification of brain tumor and is explained in section VII. It is a supervised learning method, and is a generalization of the delta rule. It requires a dataset of the desired output for many inputs, making up the training set.

Step 4: Analysis

This step includes all experimental results and parameters which are taken for analysis. These parameters include mean, standard deviation, pixel count, volume. The experimental results are shown in section VIII.

IV. FUZZY C MEANS: A CLUSTERING TECHNIQUE

One of the most widely used fuzzy clustering algorithms is the Fuzzy C-Means (FCM) Algorithm which was developed by Dunn in 1973 and improved by Bezdek in 1981. Fuzzy C - Means (FCM) is a data clustering technique. In this technique, a dataset is divided into n clusters with every data point in the dataset belonging to each cluster to a certain degree. For example, if there is any data point lying close to the center of a cluster then it means there is a high degree of belonging or membership to that cluster and if another data point that lying far away from the center of a cluster indicate a low degree of belonging or membership to that cluster.

FCM clustering is performed by the fcm function present in the Fuzzy Logic Toolbox™. First of all, an initial guess is done for cluster centers, which are intended to mark the mean location of each cluster. Mostly, the initial guess for these cluster centers is likely incorrect. After that initial guess, fcm assigns every data point a membership grade for each cluster. For each data point, updating of cluster centers and membership grades is done again and again till fcm iteratively moves the cluster centers to the right location within a data set. These iterations are based on minimizing an objective function that represents the distance from any given data point to a cluster center weighted by that data point's membership grade.

VI. Back Propagation Neural Network: A Neural Network Classifier

Back propagation, is an abbreviation for "backward propagation of errors". It is a common method of training artificial neural networks. The way a child learns to identify a dog from examples of dogs, in the same way, from a desired output, the network learns from many inputs. It is a supervised learning method, and is a generalization of the rule. It requires a training set which consists of a dataset of the desired output for many inputs. It is most useful for feed-forward networks. Feed forward networks are those networks that have no feedback, or simply, that have no connections that loop. Back propagation requires differentiable activation function used by the artificial neurons (or "nodes"). The back propagation learning algorithm comprises of two phases: propagation and weight update.

Phase 1: Propagation

Each propagation follows these following steps:

1. First of all, a training pattern's input is propagated forward in order to generate the output activations of the propagation. Therefore, this is a forward propagation.

2. After forward propagation, backward propagation occurs. In this output activations through the neural network using the training pattern target are propagated back to the network in order to generate the deltas of all output and hidden neurons.

Phase 2: Weight update

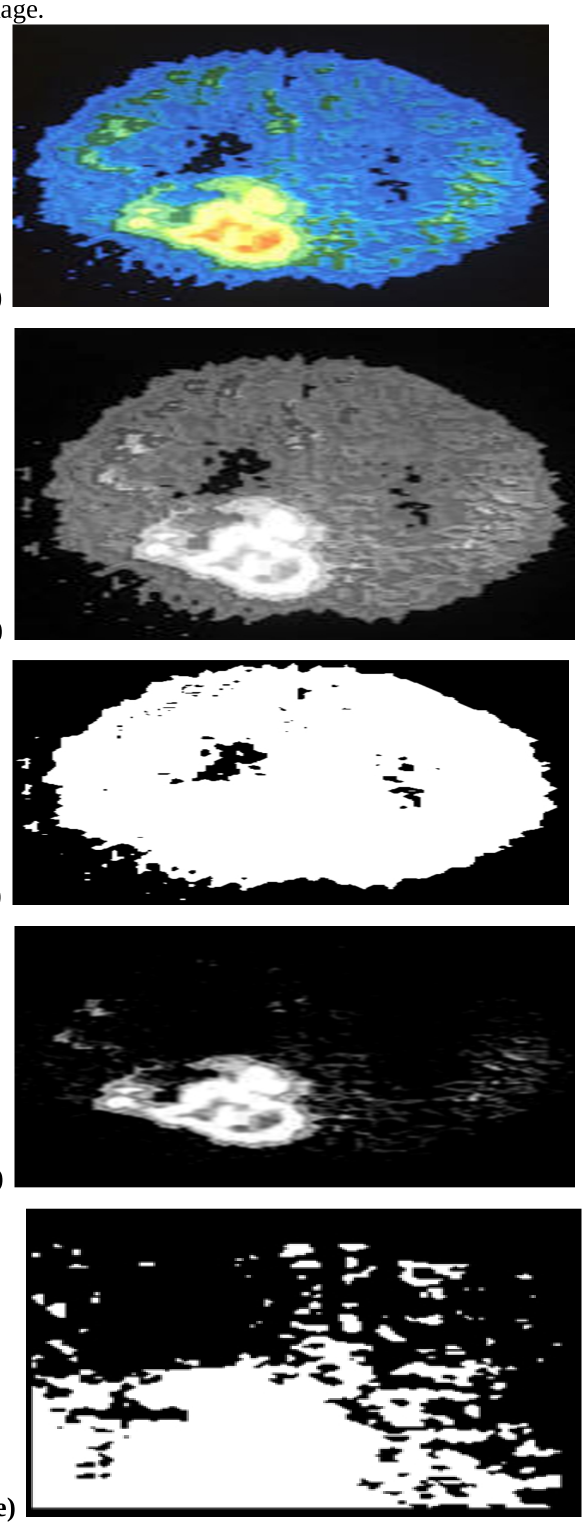
For each weight-synapse follow the following steps:

1. Multiply both, input activation and its output delta to get the gradient of the weight.
2. After that, subtract a ratio (percentage) of the gradient from the weight.

   This ratio (percentage) affects the speed and quality of learning; it is called the *learning rate*. The greater the learning rate, the faster the neuron trains; the lower the learning rate, the more accurate the training is. Repeat phase 1 and 2 continuously until the performance of the network become satisfactory.

VIII. EXPERIMENTAL RESULTS

The performance of the proposed method can be evaluated by using Matlab R2010a and 7.10 versions. Let us take one example in which we have one medical image Img1.jpeg, the RGB medical image ,which is converted into normalized format by using Scaling to obtain filtered image, then converted into negative image, and then high level segmentation is performed, then low level segmentation to extract the accurate infected region from the whole medical image.



(a) (b) (c) (d) **(e)**

Figure 3: shows (a) original image Img1.jpeg, (b) filtered image, (c) negative image (d) image obtained after high level segmentation (after performing clustering using FCM technique) , (e) image obtained after low level segmentation (after performing BPNN for classification)

The parameters used are as:

1) **Mean:** It may be defined as the average of the numbers present in the dataset. Here Mean Value indicates the average of pixels of an image.

2) **Standard deviation:** It is represented by a Greek symbol sigma (σ). It indicates the amount of variation or dispersion from the average exists. A low standard deviation means the data points tends to be very close to the mean or expected value and vice-versa.

3) **Volume:** There are many methods for the volume estimation like particle swarm optimization method, but the general method used for the volume estimation is, sum all pixels in the region (Nr) and multiplies the summation value with the corresponding pixel area (A). The result is multiplied by the distance between medical image slices (D) and computing the region volume. This method is less complex and takes less time for the computation.

$$\sum Nr \times A \times D$$

4) **Pixel Count:** It is defined as the measurement of number of pixels of medical image that represents the presence of brain tumour.

Table: Comparison of Existing and Proposed Scheme

Techniques	Images	Mean	Standard Deviation	Pixel Count	Volume
Mathematical Operators With Thresholding	Img1.jpeg	22.81	72.77	13440	2973.58
	Img2.dcm	30.32	79.662	13454	2854.57
	Img3.jpeg	36.31	84.564	14532	3245.00
	Img4.dcm	25.14	69.987	15431	2777.67
	Img5.dcm	45.34	87.754	13561	2543.54
FCM with BPNN	Img1.jpeg	85.0303	62.925	10223	2486.36
	Img2.dcm	76.35	66.789	12345	2345.76
	Img3.jpeg	90.34	77.772	11256	2865.34
	Img4.dcm	69.04	66.542	10563	2277.67
	Img5.dcm	105.21	79.907	8963	2312.39

We have taken 5 medical images that have been tested and analysed.

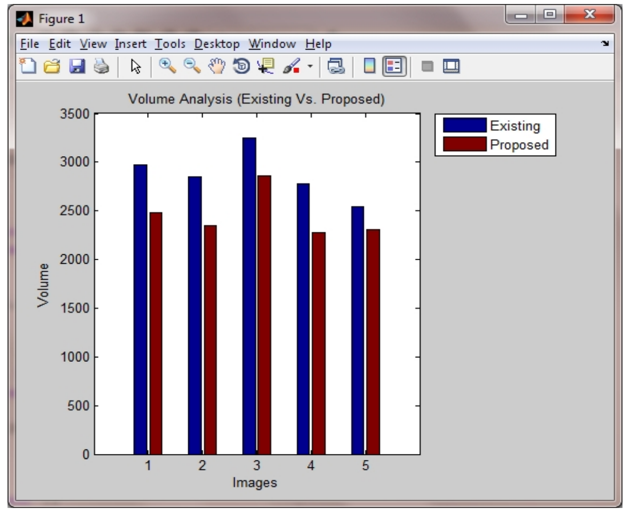


Figure 3: Comparison according to VOLUME value of 5 images

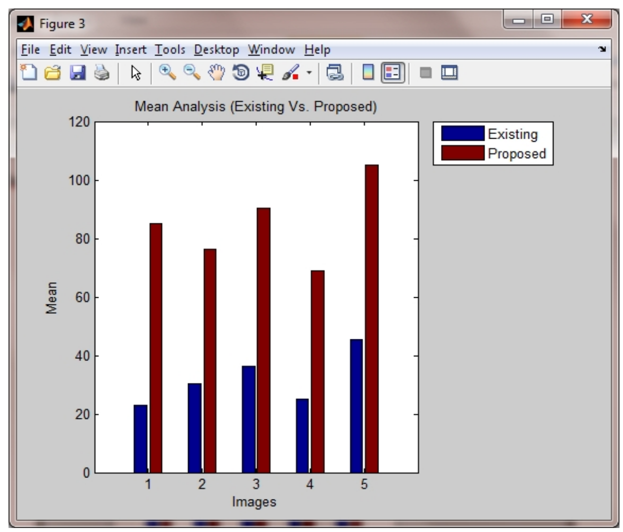


Figure 4: Comparison according to MEAN value of 5 images

Figure 3 shows the comparison of proposed and existing algorithm according to volume values of 5 images. It is observed that VOLUME values of proposed algorithm (FCM with BPNN) are less than the existing algorithm (mathematical operators with thresholding). Lesser the value of volume, more closely identifying the brain tumour and therefore gives better result. Figure 4 shows the comparison of proposed and existing algorithm according to MEAN values of 5 images. It is observed that MEAN values of proposed algorithm (FCM with BPNN) is more than the existing algorithm (mathematical operators with thresholding). More the value of MEAN gives better result.

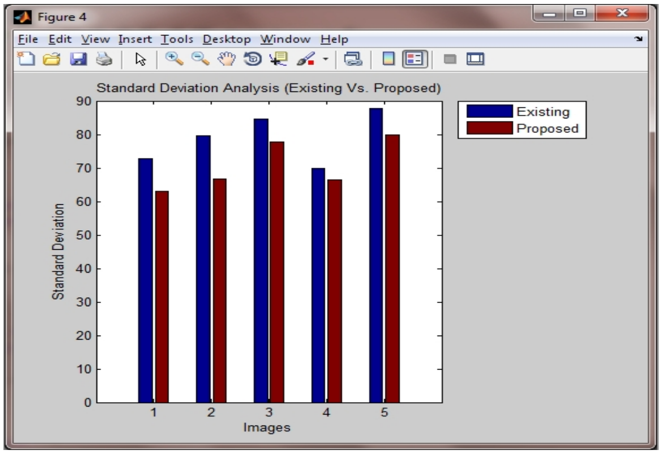


Figure 5: Comparison according to SD value of 5 images

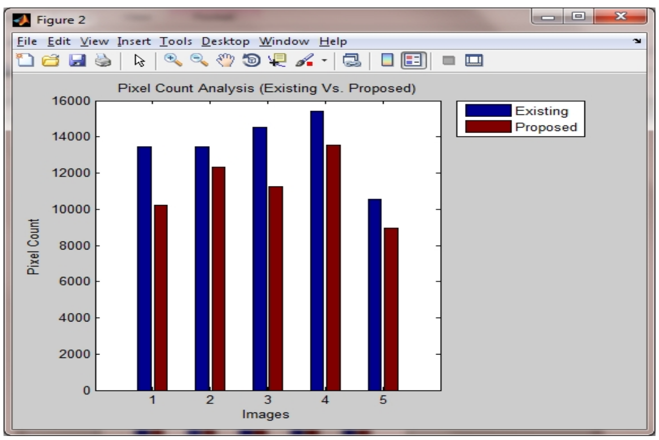


Figure 6: Comparison according to PC value of 5 images

Figure 5 shows the comparison of proposed and existing algorithm according to SD values of 5 images. It is observed that SD values of proposed algorithm (FCM with BPNN) are more than the existing algorithm (mathematical operators with thresholding). Less the value of SD gives better result. **Figure 6** shows the comparison of proposed and existing algorithm according to PC values of 5 images. It is observed that PC values of proposed algorithm (FCM with BPNN) are less than the existing algorithm [9] (mathematical operators with thresholding). Less the value of PC gives better result.

It is observed that the proposed technique (FCM with BPNN) is better than existing technique (mathematical operators with thresholding) in all parameters VOLUME, MEAN, SD, and PC. The proposed technique is an improvement over existing technique.

IX CONCLUSION

We have presented an improved technique for identifying the brain tumor area present in brain from the medical images with good method. Our scheme can be used for different medical image modalities. The experimental results indicate that the proposed scheme is feasible and given its relative simplicity, it can be applied to the medical images at the time of acquisition to serve in many medical applications concerned with brain tumor and its type and the extent to which it is present.

The experimental results show that our proposed technique is an improvement over the existing technique because it has less PIXEL COUNT value, high MEAN value, less VOLUME value and less SD value.

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