

TEXTURE ANALYSIS OF MRI IN PATIENTS WITH MULTIPLE
SCLEROSIS BASED ON THE USING SVM & ANN

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Abstract:-Due to the complexity & variance of automated MRI segmentation of brain MS became a complex task. In this paper a structural texture analysis method on MS segmentation scheme is presented, that emphasis on structural analysis of MS as well as on normal tissues..

Methods:- MRI of any number of MS patients & healthy subjects were selected & that much ROI were chosen from MS patients MRI & healthy subject MRI(magnetic resonance imaging) for LWM(lesion white matter),NAWM(Normal appearing white matter) & NWM(Normal white matter) respectively. All of the ROI were analyzed by gray-level difference statistics & contrast, angular second moment, mean & entropy those 4 texture features were extracted .Finally statistic significance was tested among three groups .An ANN & SVM are used for classification. This approach is designed to investigate the differences of texture features among macroscopic LWM, NAWM in & MRI from patients with MS & NWM.

Keywords:- MS, Gray level difference statistics, T.A.(texture analysis),MRI ,LWM,NAWM,NWM.

Introduction:-Multiple sclerosis is a chronic idiopathic disease resulted in multiple areas of inflammatory demyelization in the CNS(Central nervous system).MS lesion formation often leads to unpredictable cognitive decline & Physical disability. Due to the sensitivity in detecting MS lesions, MRI has become an important tool for diagnosing MS & monitoring its progression.

Over the past decade, the demand for accurate detection & quantification of MRI abnormalities increase rapidly. Thus it is crucial to use image analysis techniques to extract diagnostically significant image features.

Texture analysis refers to a set of processes applied to characterize spatial variations of pixel's gray levels in an image. Texture analysis which is used to quantify pathological changes that may be undetectable by conventional MRI techniques, has the potential to detect the subtle changes in tissues & supports early diagnosis of MS.

In this paper, texture analysis was performed on brain MRI of MS patients & normal controls. Texture features from gray-level difference statistics were extracted,& statistical analysis method GLCM(Gray-level co-occurrence matrix) was applied between LWM,NAWM & NWM.

1. Prior Work:-

All the previous methods are classified into 4 types. 1) Thresholding method:-

This method is frequently used for image segmentation, simple & effective method for images with different intensities. It has the drawback of generating only two classes therefore this method fails to deal with multichannel images. It also ignores the spatial characteristics due to which an image becomes noise sensitive which corrupts the histogram of the image.

2) Region growing method:-

This technique is not fully automatic. It is also noise sensitive therefore extracted regions might have holes or even some discontinuities.

3) Shape based method:-

This method has limited degree of freedom & semi-automatic.

4) Supervised & unsupervised segmentation methods:-

2. Proposed work:-

In this paper texture analysis method using SVM & ANN is presented & applied to MRI brain MS segmentation. Firstly sample MR images will be selected & then the MR image is divided into small elements to extract the different kinds of features which quantify the intensity, symmetry &

texture properties of different tissues as shown in Fig.1. We used gray-level

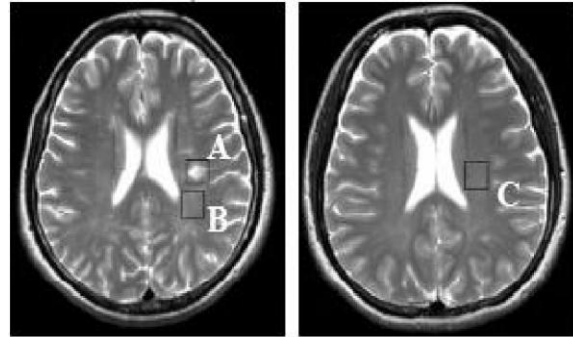


Fig. 1. ROI selection from MRI of MS patients and normal controls.

Left: MRI from a MS patient; Right: MRI from a healthy subject.

A: ROI of LWM ; B: ROI of NAWM; C: ROI of NWM co-occurrence matrix approach introduced by Harlick which is well-known statistical method for extracting second-order texture information for images. The assumption is that local texture of tumor cells is highly different from local texture of other biological tissues.

From GLCM we extracted the textures features like contrast, angular second moment, mean & entropy. For segmentation & classification we used ANN & SVM to detect various tissues like white matter, Gray matter & MS.

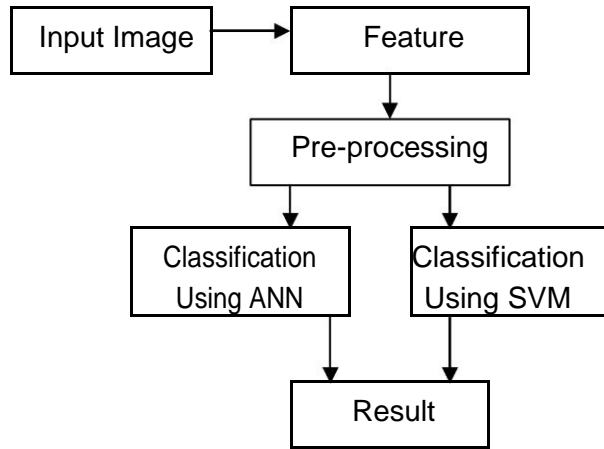


Fig.2 Block diagram of proposed work

3. Methods:-

3.1Need for Texture Analysis:-

In the early Multiple sclerosis (MS) stages when only subtle pathological changes occur ,it is very hard to detect MS damage in MRI by visual examination or conventional measures such as lesion volume & number[5].Thus tissue discrimination between Lesion white matter(LWM) & Normal White Matter(NWM) is of critical importance to the early detection of MS. Texture analysis on MRI in essence is the analysis of Gray-level variations between image pixels in ROIs which capture the spatial & intensity information from the possible microscopic MS lesions. Texture features that are extracted by texture analysis techniques quantify both macroscopic lesions & microscopic abnormalities that may be undetectable to conventional measures.

3.2 Terms used in Texture Analysis:

Gray-level difference statistics is

commonly used in texture analysis. Suppose $g(x,y)$ is a pixel point of image, the gray difference between this pixel and its neighborhood pixel $g(x+\Delta x, y+\Delta y)$ is as below:

$$g_{\Delta}(x,y)=g(x,y)-g(x+\Delta x,y+\Delta y) \quad (1)$$

$g_{\Delta}(x,y)$ in (1) is defined as gray difference. $g_{\Delta}(x,y)$ of each pixel is calculated by moving (x,y) through the image. Suppose gray difference level is m , the number of each $g_{\Delta}(x,y)$ is counted up, and histogram of $g_{\Delta}(x,y)$ is drawn. Finally occurred probability $P_{\Delta}(i)$ of each $g_{\Delta}(x,y)$ is calculated based on histogram Texture characteristic is closely related to $P_{\Delta}(i)$. If $P_{\Delta}(i)$ changes rapidly along with variation of i , texture of image is coarse, whereas it is fine if $P_{\Delta}(i)$ distributes smoothly. In this study , texture features including contrast, angular second moment, mean and entropy were extracted from the graylevel difference statistics. Their mathematical expressions are as below

1. Contrast:- $CON = \sum_i i^2 P_{\Delta}(i)$
2. Angular second moment:- $ASM = \sum_i (P_{\Delta}(i))^2 i$
3. Mean:- $Mean = 1/m \sum_i i P_{\Delta}(i)$
4. Entropy:- $Ent = - \sum_i P_{\Delta}(i) \log P_{\Delta}(i)$

These 4 texture features describe the texture characteristics of image from 4 different texture analysis aspects.

Many modern scientists believe the human brain is a large collection of interconnected neurons. These neurons are connected to both sensory and motor nerves. Scientists

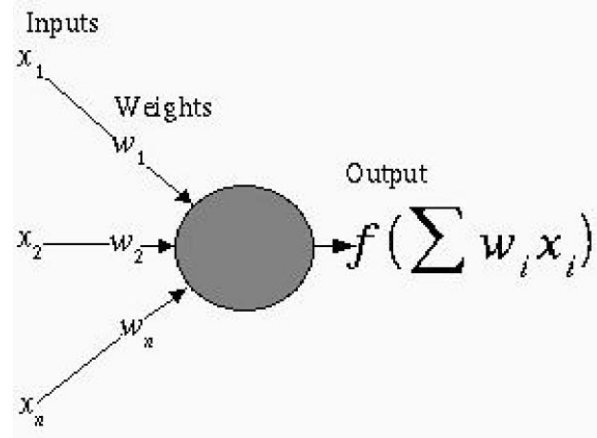


Fig-3 Structure and functioning of a single neuron

The Artificial neural network [3] is basically having three layers namely input layer, hidden layer and output layer. There will be one or more hidden layers depending upon the number of dimensions of the training samples. Neural network structure used in our experiment is consist of only two hidden layers having 14 neurons in the input layer and 1 neuron in the output layer as shown in

believe, that neurons in the brain fire by

emitting an electrical impulse across the synapse to other neurons, which then fire or don't depending on certain conditions. Structure of a neuron is given in fig.3

4. Artificial Neural Network

The Neural networks [3] developed from the theories of how the human brain works.

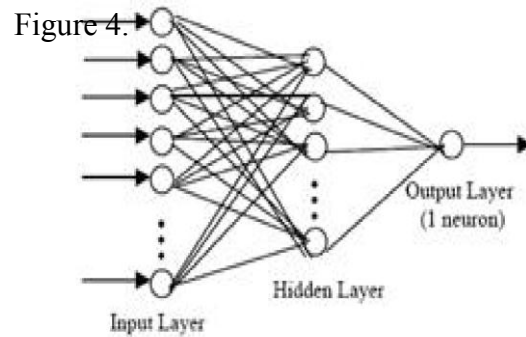


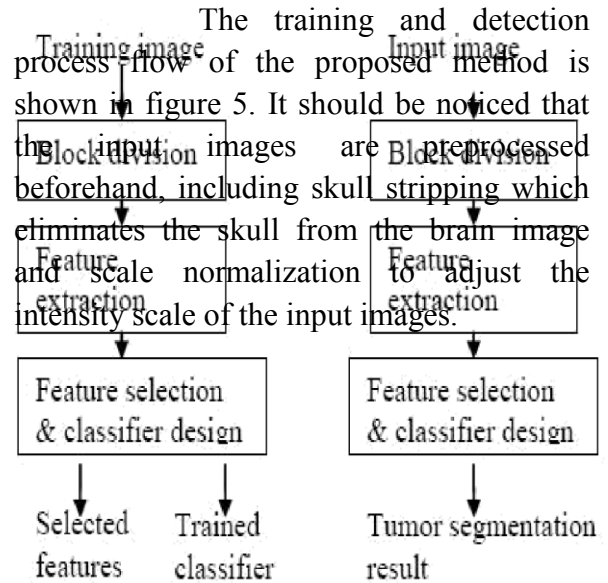
Fig-4 Simple Neural network Structure

A learning problem with binary outputs (yes / no or 1 / 0) is referred to as binary classification problem whose output layer has only one neuron. A learning problem with finite number of outputs is referred to multi-class classification problem whose output layer has more than one neuron. The examples of input data set (or sets) are referred to as the training data. The

algorithm which takes the training data as input and gives the output by selecting best one among hypothetical planes from hypothetical space is referred to as the learning algorithm.

The approach of using examples to synthesize programs is known as the learning methodology. When the input data set is represented by its class membership, it is called supervised learning and when the data is not represented by class membership, the learning is known as unsupervised learning. There are two different styles of training i.e., Incremental Training and Batch training. In incremental training the weights and biases of the network are updated each time an input is presented to the network. In batch training the weights and biases are only updated after all of the inputs are presented. In this experimental work; back propagation algorithm is applied for learning the samples, Tan-sigmoid and log-sigmoid functions are applied in hidden layer and output layer respectively, Gradient descent 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 called „block“. Further steps are all based on the blocks. For training process, firstly different features are extracted block by block in one image. When a new image comes, only those selected features are extracted and the trained classifier is used to categorize the tumor in the image.



The training and detection process flow of the proposed method is shown in figure 5. It should be noticed that the input images are preprocessed beforehand, including skull stripping which eliminates the skull from the brain image and scale normalization to adjust the intensity scale of the input images.

Fig-5 (Left) the training process flow(Right)The tumor segmentation process flow

Support vector Machine:-

MS slices based on visual examination by radiologist/physician may lead to missing diagnosis when a large number of MRIs are analyzed. To avoid the human error, an automated intelligent classification system is proposed which caters the need for classification of image slices after identifying abnormal MRI volume, for MS identification. In this research work, advanced classification techniques based on MATLAB Support Vector Machines(SVM)

are proposed and applied to brain image slices classification using features derived from slices. Support vector machines are a set of related supervised learning methods which analyze data and recognize patterns. In this paper we are using it only to train the algorithm to recognize the lesions as well as the clean white cells. We use only the in built MATLAB svm functions to train and classify.

6.Comparison Of Performance Of

Classifiers:-

In this paper we performed the classification using two techniques SVM& ANN. Experiments were performed on MR images. In this work, we have considered two different training and test sets as explained in the earlier section. The experiments were carried out on PC. The performance of classifier using Support

G. Conclusion

In this study, texture analysis using SVM & ANN based on Gray-level difference statistics was performed on brain MRI of MS patients and normal controls. The results suggested that texture features of NAWM with MS patients were significant difference Vector Machine (SVM) & Artificial neural network(ANN) was evaluated.

For comparative analysis SVM and ANN classifiers we have considered two different training and test sets as explained in the earlier section. The results obtained from the SVM & ANN classifier .But ANN has a higher accuracy of classification over ANN classifier.

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