A Hybrid Technique Based on Fuzzy Methods and Support Vector Machine for prediction of Brain Tumor

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***Abstract*—Magnetic Resonance Imaging (MRI) is the most significant approach, in sensing the life threatening illness like brain tumor. During this research data mining techniques are applied for classification of MRI pictures. The proposed contrivance is a fusion of Support Vector Machine (SVM) and fuzzy methods for brain tumor detection. An innovative hybrid approach based on the merger of Support Vector Machine (SVM) and fuzzy c-means is suggested for brain tumor classification. In this process enhancement techniques such as spatial domain method and frequency domain method are used to enhance the picture. Skull striping is performed by mathematical morphology methods and Fuzzy c-means (FCM) clustering is applied for the segmentation of the picture to expose the incredulous domain in brain MRI pictures. The Gray Level Co-ocurrence Matrix (GLCM) method is used for extracting texture features from the brain pictures, subsequently SVM method is applied to categorize Tumor and Non-Tumor brain MRI pictures, which gives furnish and more efficacious outcome for classification of brain MRI pictures**.

Keywords- Data Processing, Fuzzy C Means , GLCM, MRI, SVM.

I. Introduction

Data mining is a way of examining large pre-existing databases in order to create new information. One of the essential stream of data mining is classification. Various classification techniques are accessible in this domain for medical images alike artificial neural network (ANN), Bayesian classification, decision tree, fuzzy c-means (FCM) clustering and support vector machine (SVM). Now a days with all these medical imaging techniques some advanced techniques such as computed tomography (CT), positron emission tomography (PET), x-ray and magnetic resonance imaging (MRI) is in prevalence for brain tumor detection but majority of researchers have applied MRI imaging for detecting tumor because of its higher resolution quality. In this research, the MRI pictures were amplified using Contrast enhancement and Mid-range Stretch techniques. After that segmentation of amplified image can be completed easily. Segmentation is a technique to excerpt incredulous domain from images. For Segmentation of MRI pictures Fuzzy C-Mean (FCM) clustering techniques were implemented. Afore implementing FCM clustering technique, skull striping has been done[9].Feature extraction is a sort of dimensionality reduction that conveniently represents essential parts of an image as a compact feature vector. The Gray Level Co-occurrence Matrix (GLCM) method is used for extracting texture features from the brain pictures [3]. The decreased GLCM features are assessed to support vector machine for coaching and testing. A Support vector machine constructs a hyperplane or set of hyperplanes in a high or infinite-dimensional space, which can be used for classification [11] .The prime objective of this paper, is to establish a hybrid approach, which can easily classify the brain MRI pictures efficiently through Fuzzy C- means and support vector machine (SVM). This work is an adequate classification method is to diagnose the tumor in MRI pictures.

II. RELATED WORK

Support vector machines were implemented in various research work which are given in [1,2,4,7]. A Padma and R. Sukanesh [3] has proposed a dominant gray level run length statistical texture feature extraction method .The extracted texture features are optimized by Genetic Algorithm for improving the classification accuracy and reducing the overall complexity Then the optimal texture features are fed to the SVM classifier to classify and segment the tumor region in brain CT images. Mohd Fauzi Bin Othman, Noramalina Bt Abdullah et al [5] have implemented Wavelet Transform for feature extraction of brain MRI image and then classification of these selected feature are done by ‘c-svc’ i.e multi-class SVM and Radial Basis Function has been used as a kernel parameter. K.M Iftekharuddin, J.Zhang et al [6] have used Piecewise –Triangular-Prism-surface-Area (PTPSA) to obtained fractal feature and the fractal feature is computed by fractional Brownian motion (fBm) model that integrates both fractal and multiresolution wavelet analysis for tumor detection .For image segmentation Self Organizing Maps (SOM) algorithm is used .After segmentation first neural network and then SVM are used to classify the tumor segments.G Faris , M Santos and V.Lopez [1] have merges two techniques to classify signals through wavelet-SVM classifier, They have used Wavelet transform to reduce the size of the biomedical spectra and then SVM is applied to match the spectra to the kind of tumor.Noramalina Abdullah,Umi kalthum Ngah and ShalihatunAzlin Aziz [4] applied Wavelet approximate coefficient of a brain MRI as the input for SVM which classify brain images as normal or abnormal.They have used Lab view Advanced Signal Processing toolkit for experimental work .M.Murugesan and R.Sukanesh [2] have utilized SVM technique for classification of EEG signals that contains credible cases of brain tumor. Author have used following concepts in brain tumor detection such as artifacts , electro-oculogram (EOG) , spectral analysis and SVM. G Rajesh Chandra , Dr.Kolasani Ramchand H Rao[10] have focused on the interest of soft thresholding DWT for enhancement and genetic algorithms for image segmentation. This method uses the ability of GA to solve optimization problems with large search space.Guo-Duo Zhang, Xu-Hong Yang et al [7] have applied SVM technique for image denoising.A. Lakshmi M.E et al [8] have proposed three steps for pre-processing of brain MRI image first one is noise removal by curvelet transform second one is artifact removal and third step is skull removal and image segmentation is done by using Spatial FCM technique which forms the clusters by grouping the similar data points in the feature. Parveen and Amritpal singh[9] have proposed a new combined approach based on the Support Vector Machine and segmentation technique for brain tumor classification.

III. PROPOSED TECHNIQUE

The proposed technique expressed by a set of phases starting from procuring brain MRI pictures. The sequence which has been followed is given in Figure 1. This hybrid approach associates the following main steps such as enhancement, skull striping, segmentation, feature extraction and training the SVM classifier using MRI pictures with GLCM features, assembling the database and coaching. All the above quoted steps are associated in coaching phase, using the new MRI pictures with GLCM features to SVM and brain MRI pictures are classified. This research used dataset of 100 patients MRI brain pictures and classified them as normal and abnormal.

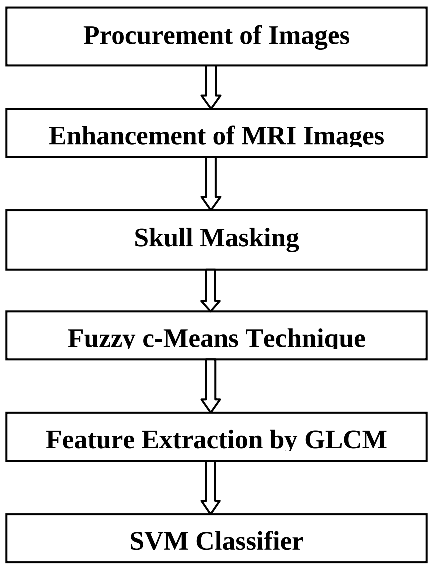

Figure 1. Proposed Methodology

A. Procurement of images

Brain MRI pictures were acquired from various medical centres. These brain MRI pictures were changed into two dimensional matrices using MATLAB (R2013a).

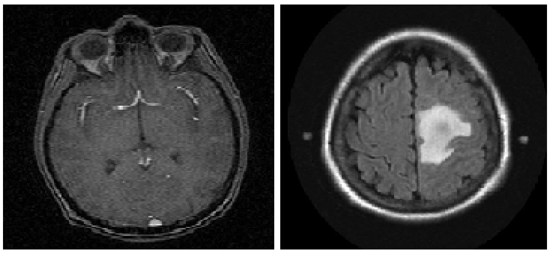

Figure 2 a) Non-Tumor Brain Image b) Tumor Brain Image

B. Enhancement of MRI images

The qualities of images are enhanced using enhancement technique. It is necessary to improve the image information for individual viewers, so that authentic outcomes are attained. The methods mentioned below are applied for enhancement of brain MRI images[9]. The initial step is enhancement of MRI images. The brightness of the images was increased to raise visibility.

Contrast improvement- MRI images (RGB) are converted into gray scale images. These gray scale images are called intensity images by using imadjust (MATLAB function) increases the contrast of the image by mapping the values of the input intensity image to new values such that, by default, 1% of the data is saturated at low and high intensities of the input data.

Mid-range Stretch- this is one of the important enhancement technique. By this method, the middle range MRI image intensity values are stretched. So it improves the quality of brain MRI images. With this technique, intensity image pixels are mapped between 0 and 1 value by dividing 255 intensity values .

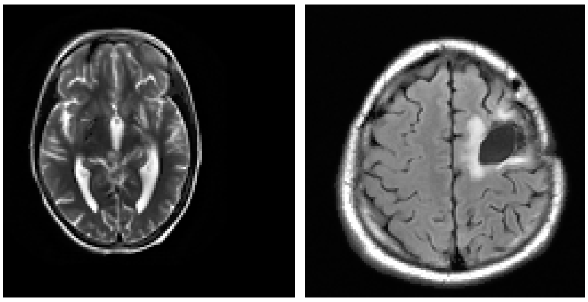

Figure 3: (a) Amplified Non-tumor image(b)Amplified Tumor image

C. Skull Masking

The removal of non- brain tissue is known as Skull masking like scalp, skull, fat, eyes, neck, etc. from MRI brain pictures. It is used for enhance the speed and correctness in medical applications applied to diagnose and prediction. Following steps are involved in skull masking

Double thresholding- This segmentation technique convert the image into binary form, that is gray scale image to binary image and generate the mask by setting each pixel in the range of 0.1*255-0.88*255 to 1 means white and remaining pixels to 0 means black. Non brain tissues pixels were eliminated in MRI image. In this technique two thresholds upper and lower are considered so it is known as double thresholding technique [9].

Erosion- in this stage unwanted pixels are removed from MRI image after thresholding. Thus the skull portions are removed.

Region filling- this method is used to fill the holes in the images. After the erosion, eroded images are filled using region filling algorithm. Here the associated background pixels are converted into forefront pixels so that the holes present in the eroded images are removed in brain MRI image[9].

Figure 4: (a) Skull striping Non-tumor image (b) Skull striping Tumor image

D. Fuzzy C-Means Technique

Segmentation partitions an image into distinct regions containing each pixels with similar attributes. To be meaningful and useful for image analysis. The skull stripes images are applied in image segmentation. It yields good outcomes for tumor segmentation. In this work, fuzzy c-means method was applied in MRI image segmentation. Fuzzy C-Means (FCM) technique is used to find out the apprehensive region from brain MRI image. This fuzzy c-means clustering technique gives better segmentation outcomes.

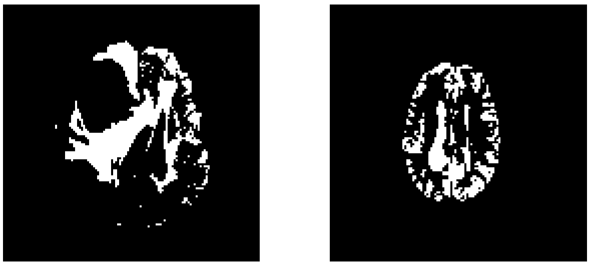

Figure 5. fuzzy c- means technique

E. Feature extraction using GLCM

Statistical texture analysis was used to extract the feature in the given image and computed on the basis of statistical distribution of pixel intensity at a given position relative to alternative pixels within the matrix. We utilize the first order statistics, second order statistics or high order statistics on the basis of the number of pixels or dots in each combination. Statistically calculation is used to calculate the primary order statistics texture measures from the original image values, like variance, without consideration of relationship with the neighboring pixel but the relationship between two groups is needed for the second order measures on the opposite hand the third and higher order texture(relationship among three or a lot of pixels) weren't possible to implement due to interpretation difficulties and longer time consuming calculation therefore their theoretical use were possible. The second order statistics use to analyze image as a texture is based on gray level co-occurrence matrix.

The gray- level Co- occurrence Matrix (GLCM) is a statically method it is also called the gray-level spatial dependence matrix because it considers the spatial relationship of pixels. Spatial relationship is specified between the pixel and the adjacent pixel.GLCM feature were extracted in this paper are as under dissimilarity Energy, contrast, cluster prominence, Auto correlation. Correlation, cluster shade, entropy, maximum probability, sum Average, add entropy, difference entropy, system of measurement of correlation, Homogeneity, add of squares, difference variance, and inverse distinction normalized .

F.Classification through Support Vector Machine (SVM)

A Support vector machine is a concept of hyperplane or set of hyperplanes in a high- or infinite-dimensional space, which can be applied for classification .The original SVM algorithm was invented by Vladimir N. Vapnik and the current standard incarnation (soft margin) was proposed by Vapnik and Corinna Cortes in 1995[11].

Consider the training sample $\{(x_{i,}d_i)i = 1,2 \ldots \ldots . N\}$ } where $x_{i,}$is the input pattern for the i^{th} example and d_i is the corresponding desired response (target output(+1 or -1)).

Equation of hyperplane that does the separation is

$$w^T x + b = 0 \qquad (1)$$

Where x is an input vector, w is an adjustable weight vector , and b is a bias

Or it can be written as

$$w^T x + b \geq 0 \qquad \text{for } d_i = +1$$
$$w^T x + b < 0 \qquad \text{for } d_i = -1$$

weight vector (w) :- The weights represent the hyperplane by giving you the coordinates of a vector which is orthogonal to the hyperplane these are the coefficient given by SVM coefficient.

Bias(b):- The b in the SVM is to allow the learnt hyperplane to not pass through the origin without a **b** the SVM decision boundary is $w^T x$ =0 which means it has to pass through the origin, and this is rather unreasonable.For a given w and b, the separation between the hyperplane defined in Eq^n(1) and the closest data point is called the margin of separation denoted by ρ . The goal of SVM is to find the particular hyperplane for which ρ is maximum

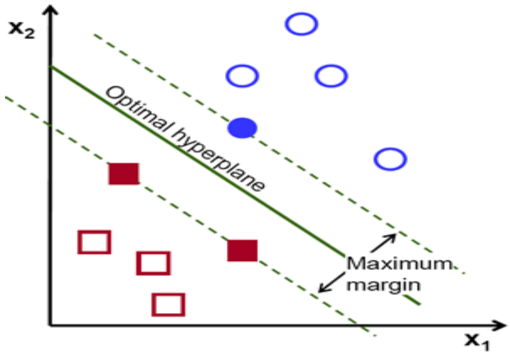

Figure 6 SVM Classification (linear)

Classification is the approach to assigned a suitable class to a given test sample which is assigned by the classifier during training. Here in this paper SVM classifier [9] is applied as a classifier.

IV. EXPERIMENTS AND RESULTS

During this paper, fuzzy c-means with gray level co-occurrence matrix and Support Vector Machine (SVM) is proposed for segmentation and classification of brain MRI pictures. An input of MRI brain pictures of 100 patients have been used to diagnose 'tumor' and 'non-tumor' MRI pictures. The non- brain tissue like scalp, skull, fat, eyes, neck etc in brain MRI pictures are disseminated with Double thresholding, Morphological applications and fuzzy c-means algorithm for clustering and gray level co-occurrence matrix for feature extraction. The SVM classifier is trained with 70 brain MRI pictures, after that the remaining 30 brain MRI pictures was used for testing the trained SVM. Initially SVM is trained by using 70 MRI brain picture training set. Once the SVM is trained, the classification veracity is approved using the testing set. The outcome for classification gives rigorous for large data sets.

Table 1. CLASSIFICATION ANALYSIS OF THE SVM CLASSIFIER FOR 100 MRI IMAGES

S. No.	**SVM Classifier Outcome**			
	Kernel Function	**accuracy**	**Sensitivity**	**Specificity**
1	**Linear**	**90%**	**33.25%**	**82%**
2	**Quadratic**	**93.65%**	**46.50%**	**85%**
3	**RBF**	**95%**	**50%**	**80%**

V. CONCLUSION

In this precise research work adoption of the hybrid approach for merging GLCM technique for feature extraction, fuzzy c-means clustering for distribution and support vector machine for classification of MRI images provides rigorous outcome for detecting the brain tumor. In future to achieve higher veracity and sensitivity some algorithm may be used for dimension reduction and by using different kernel function and large data sets performance of classifier can be improvised.

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