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Wavelet Based Medical Image feature Extraction by Segmentation using FCM and SVM

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Abstract: MRI is a very important technique for detecting brain tumour. In this paper, a new hybrid technique is used for the classification of MRI images. This is based on the support vector machine (SVM) and fuzzy c-means for brain tumor classification. This algorithm is a combination of support vector machine (SVM) and fuzzy c-means, a hybrid technique for predicting brain tumor. First the image is enhanced by using enhancement techniques like contrast improvement, and mid-range stretch. Then double thresholding and morphological operations are being used for skull striping. Fuzzy c-means (FCM) clustering, a very important technique of segmentation is used for the image to detect the suspicious region in brain MRI image. Wavelet based Grey level run length matrix (GLRLM) is used for extraction of features from the given brain image, then SVM technique is applied for classifying the brain MRI images, which gives accurate and effective result for the classification of brain MRI images.

Keywords: Support vector machine (SVM), Fuzzy C-means (FCM), MRI, GLRLM, Clustering, Segmentation, Feature Extraction, Enhancement, Skull stripping etc.

I. INTRODUCTION

Feature extraction is a reduction technique which is more widely used in data mining and knowledge discovery and feature extraction also does the elimination of irrelevant or not useful features, while holding the underlying discriminatory information, feature extraction means less data transmission or less effort and efficient data mining. Now data mining is an easy and important tool for extracting the information from large dataset by using different image processing techniques [1]. Classification is a part of data mining field. Several classification techniques are available for medical images like artificial neural network (ANN), fuzzy c-means (FCM), support vector machine (SVM), decision tree and Bayesian classification. Many researchers have implemented the classification techniques for medical images. At present there are several medical imaging techniques like (PET), X-Ray, CT, Resonance Imaging (MRI), for detecting tumour, out of these MRI imaging technique is good because of its higher resolution and most of the researchers have used this for designating tumor. In this paper, the MRI pictures were enhanced using contrast improvement and Mid-Range Stretch techniques. Once the image was enhanced, segmentation steps in and is often done simply. Segmentation as we all know is a technique for extracting suspicious region from the image. In this paper, Segmentation technique was done by using Fuzzy C-Mean (FCM) agglomeration [2].

Skull masking has to be done before applying FCM agglomeration technique. Feature extraction means to get the information of image. Here we use Wavelet based Grey Level Run Length Matrix (GLRLM) for extracting features [3]. This reduced GLRLM quality is defined to support vector machine (SVM) for coaching and testing. These brain MRI images are classified using SVM technique which is widely used in analyzing information and pattern recognizing. It creates a hyper plane in between information sets for pointing out that category to which it belongs [4]. The sole objective of this work is to develop a hybrid technique, which classify the brain MRI images with success and with accuracy via Fuzzy C- means and support vector machine (SVM). The work is an economical classification technique for observing the tumor in MRI images.

II. DIFFERENT METHODS BEING USED

Support vector machines (SVM) were applied in many researches. Those are given in [4-6]. H. B. Nandpuru, Dr. S. S. Salankar and academic. V. R. Bora worked on MRI brain cancer classification using support vector machine. Support Vector Machines (SVM) was implemented in brain image classification. In this paper feature extraction from brain MRI images were administrated by grey scale, symmetrical and texture feature. They achieved maximum of 84% accuracy result by quadratic kernel function [4]. A. Padma and R. Sukanesh, performed their study on SVM based classification of soft tissues in brain CT images using wavelet based dominant grey level run length texture features. They emphasized on medical CT imaging technique as one of the reliable technique which iswidely applied and used for detection and site of pathological changes efficiently by using SVM. They obtained better accuracy [5]. S.H.S.A.

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Ubaidillah, R. Sallehuddin and N.A. Ali, they worked on cancer found exploitation artificial neural network and support vector machine: A Comparative study. In this paper, a comparison is done on the performance on four totally different cancer datasets. They used SVM and ANN classifiers. during this study, the ANN classifier gated sensible classification performance on the datasets that have larger quantity of input options (prostate and Ovarian cancer datasets) SVM conjointlygiven sensible result with datasets of smaller quantity of input feature (breast cancer and liver cancer), But at last SVM classifier gives higher result for growth [6].

III. PROPOSED METHOD

This methodology consists of a group of stages beginning from grouping brain MRI images. The main steps are shown in Figure 1. This is a hybrid technique which involves the following steps like enhancement, Skull stripping, segmentation, feature extraction and coaching the SVM classifier using MRI pictures with GLRLM feature, storing the information and testing. All the steps which are mentioned above are unit concerned in testing part, exploiting the new magnetic resonance imaging pictures with GLRLM feature to SVM and brain MRI pictures are classified. The study uses dataset of 120 patient's brain MRI images and classified them as normal and abnormal.

The image is processed through hybrid technique:
- Reading & Enhancementof MRI Images
- Skull striping
- Segmentation through Fuzzy c-means
- Feature Extraction through GLRLM
- SVM Classifier (Hybrid)

1. Reading & Enhancement of MRI Images
Brain MRIpictures were collected from totally different medical centers. These brain MRIpictures were transform into 2 dimensional matrices.

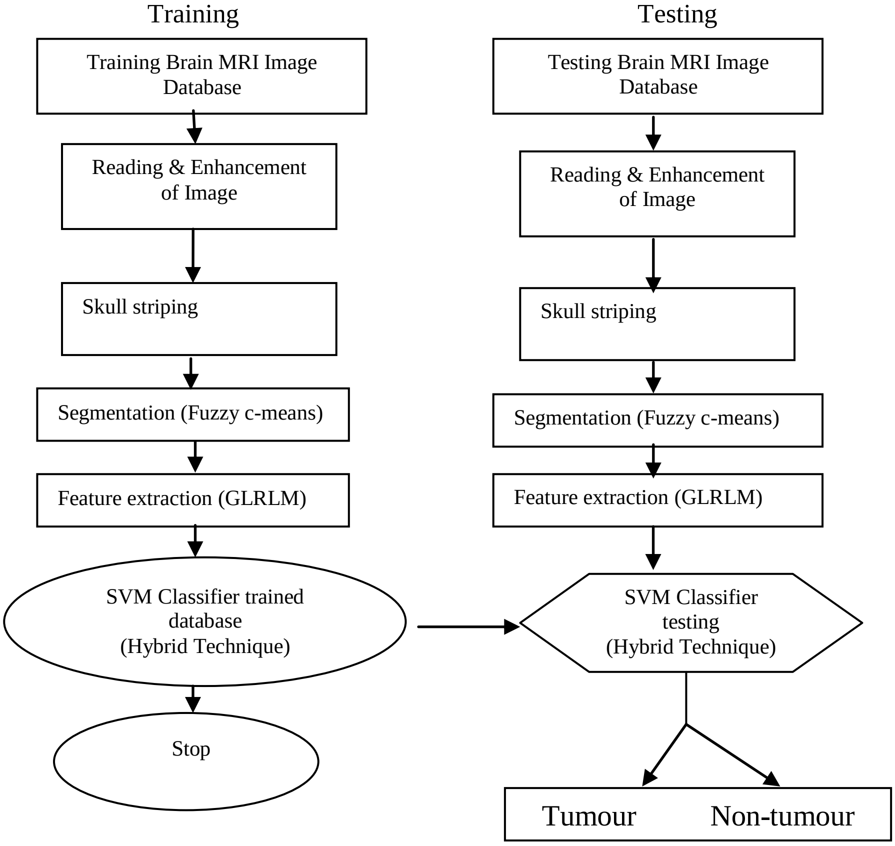

Figure 1: Flow Chart of Proposed Hybrid Classification System

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Using Feature Extraction by Wavelet based GLRLM.

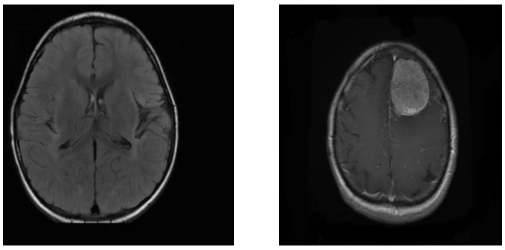

Figure 2: (a) Non-tumor MRI image (b) Tumor MRI image

Enhancement technique is used to improve the quality of the image or picture. It's essential to enhance the image information for human viewers, so that correct outcomes are achieved. The ways that are used for enhancement of brain MRI images are given below. The primary step in enhancement of MRI images is to increase the brightness of the photographs or images to enhance perceptibility. This was done to enhance the quality standard of the brain MRI pictures.

• Contrast improvement- MRI pictures are normally RGB pictures; these are transformed into grey scale pictures. These grey scale pictures are then known as intensity pictures. Intensity values here are mapped to low and max intensity values by using imadjust (MATLAB function).

• Mid-range Stretch- This is also in addition a technique.The center range MRI image intensity values are stretched in this technique. So, the standard of brain MRI image is improved. Grey scale image pixels are mapped between 0 and 1value by dividing 255 intensity values in this technique as given in eq. (1).

$$x_{ij} = \frac{image_i}{255} \qquad (1)$$

Here i for row index of brain image matrix and j for column. To compute the function f(x) on the x matrix this is obtained from eq. (1). The function f(x) is defined as follows.

$$f(x_{ij}) = \begin{cases} 0.5 * x_{ij} & , x_{ij} < 0.1 \\ 0.1 + 1.5 * (x_{ij} - 0.1) & , 0.1 \leq x_{ij} \text{ and } x_{ij} \leq 0.88 \\ 1 + 0.5 * (x_{ij} - 1) x_{ij} > 0.88 & \end{cases} \qquad (2)$$

Subsequently by applying the above function f (x_{ij}) of eq. (2) the gray-scale images are converted into indexed images. The output images which are obtained after applying all the operations and these are done to improve the quality of images.

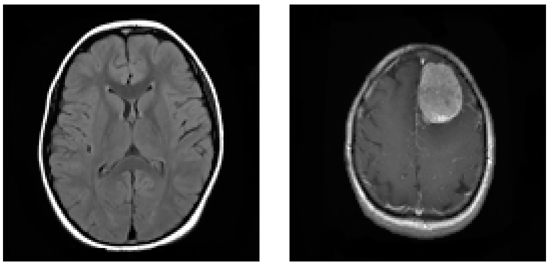

Figure 3: (a) Enhanced Non-tumor image (b) Enhanced Tumor image

2. Skull stripping
It is a remarkable step and the steps involved in skull stripping are given below.

• Double thresholding- It is a segmentation technique. In this method, the picture is transformed into binary form that is gray scale image to binary image. The method produce the mask by setting each pixel in the range [0.1*255-0.88*255] to 1 means white and the remaining pixels to zero means black. The non-brain tissue's pixels were discarded in MRI image. Here two threshold limits, upper and lower are considered and therefore is known as double thresholding technique [7].

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• Erosion-This stage cuts unwanted pixels from MRI image after thresholding. Thus, the skull areas are removed. Here disk of radius 3 is taken as a structuring element used in the removal of all unwanted pixels helping to the brain MRI images.

• Region filling- This technique is implemented for pouring the holes in the images.The eroded images, after the erosion are filled by using region filling algorithm. Here the related background pixels are converted to foreground pixels because of that the holes which are present in the eroded images are removed in brain MRI image.

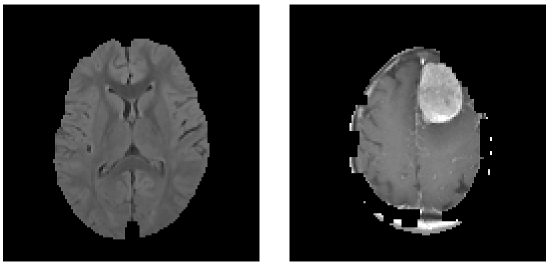

Figure 4: (a) Skull masking Non-tumor image (b) Skull masking Tumor image

3. Segmentation By Fuzzy C-Means

A clustering algorithm based on a similarity criterion organises items into groups. The Fuzzy c-Means is a clustering algorithm in which each item may belong to one or more than one group (hence the word `fuzzy' is used), where the degree of membership of each item is given as a probability distribution over the clusters. It does not decide about the complete membership of a data point to a particular cluster in place of this it calculates the likelihood.The technique for separating an image into multiple slices and object region is called segmentation. The skull stripped images are now used in image segmentation. This gives good result in tumor segmentation. Fuzzy c-means algorithm is used in this work for MRI image segmentation. To find out the suspicious region from brain MRI image, Fuzzy C-Means (FCM) algorithm is used. The fuzzy c-means clustering method gives good segmentation result.

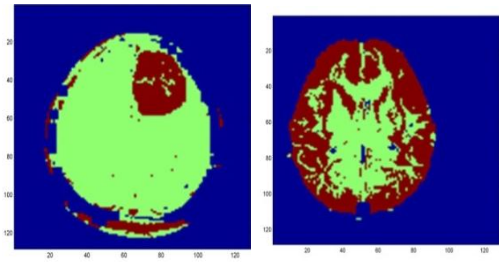

Figure 5: fuzzy c-mean algorithm

4. Feature Extraction Using GLRLM

Feature extraction is a method which is used in searching the related features from picture, and is used to understand the picture with ease. This input data group picture, transformed into compressed form is called feature extraction. It reduces the work for processing further such as for picture classification. In this method the GLRLM feature extraction method is used which is used after the fuzzy c-means algorithm. GLRLM is a matrix used for the extraction of the higher order statistical features in the image. Run implies the set of pixels with same intensity and are lying consecutively, collinearly in a given direction. Run length number means the number of pixels constituting each run and is obtained through counting the number of times the corresponding run occurs in the image. The matrix is represented as (u, v, |θ). It means that pixels with gray value of ‘u’ occurs collinearly ‘v’ times adjacent to each other in the direction θ. Gray-LevelRun Length Matrix (GLRLM), Wavelet transform were used for the extraction of statistical texture features from Region of Interest (ROI).Derive the gray level run length matrix (GLRLM) for second level maximum frequency sub bands of the discrete wavelet decomposed picture with 1one for distance and 0, 45, 90 and 135 degrees [8]. Here feature extraction isolates the related features, leading to understand the brain MRI images well [11].

5. Support Vector Machine (SVM)

Support vector machines (SVMs, also support vector networks are supervised learning models with learning algorithms associated to it, that analyze data used for classification and regression analysis. SVM is a supervised learning technique. This technique is a better tool used for data analysis and classification. SVM classifier has a fast learning speed even in huge data. SVM is used in two or more class classification issue. Support Vector Machine is depends on the conception of decision planes. A decision plane is one which differentiates a set of items having different class

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memberships**.** By using the Support Vector Machine technique, the classification and detection of brain tumor is completed. Classification is completed for identifying the tumor class present in the image. The use of SVM which involves two basic steps of training and testing.
In the SVM the classes are assumed to be identified as +-1, and the decision boundary is estimate as y=0. So, using the equation (3) :

$$y = \sum_{i=1}^{N} w_i x_i + b = x_i w + b \qquad (3)$$

Where xi is the input patterns, w is the weight vector, b the offset. Since the classes are defined as +-1 the equation for the line dividing the classes will be:

$$x_i w + b \geq 1 \text{ when } y = +1 \qquad (4)$$
$$x_i w + b \geq 1 \text{ when } y = -1$$

The distance from the hyper-plan (x_i w + b = 0) to the origin is $\frac{-b}{||w||}$, where || w || is the norm of w. The distance from the hyper-plane to the origin is: $M = \frac{2}{||W||}$
Where M is the margin. So, the maximum margin is obtained by minimizing||W||.
Classification is the process in which a given test sample is assigned a class by the classifier during training. We have used the SVM classifier [9].

6. Performance measures
Classification, the sensitivity, specificity and accuracy were calculated using below formulas:
• True Positive (TP): Abnormal brain is identified as abnormal correctly.
• True Negative (TN): Normal brain is identified as normal correctly.
• False Positive (FP): Normal brain is identified as abnormal incorrectly
• False Negative (FN): Abnormal brain is identified as normal incorrectly.
1) Sensitivity = TP/ (TP+FN) *100%
2) Specificity = TN/ (TN+FP) * 100%
3) Accuracy = (TP+ TN)/ (TP+ TN+FP+FN) * 100 %
Classifiers performance is based on these three parameters.

IV. RESULT AND DISCUSSION

In this paper, we are again and again emphasizing the point that SVM technique with fuzzy c-means i.e. hybrid SVM technique is used for segmentation and classification of brain MRI images. Real data set of 120 patients MRI brain images have been used for detecting 'tumor' and 'non-tumor' MRI images. The soft tissues in brain MRI images are segmented with Double Thresholding, Morphological operations and fuzzy c-means algorithm for clustering and gray level run length matrix for feature extraction. The SVM classifier is trained by 96 brain MRI images, after that the remaining 24 brain MRI images are used for testing the trained SVM. First SVM is trained by using 96 MRI brain image training set. Once it is trained, the classification accuracy is validated by using the testing set. The result for classification is accurate for large data sets.

TABLE I. CLASSIFICATION PERFORMANCES OF THE SVM CLASSIFIER FOR 120 IMAGES

Sr. no.	**SVM Kernel Function**	**Accuracy**
1	**Linear(Hybrid)**	**91.77%**
2	**Linear**	**74%**
3	**Polynomial**	**76%**
4	**Quadratic**	**84%**

Table 1 shows the Accuracy rate of the Hybrid SVM classifier using fuzzy c-means and GLRLM techniques.

V. CONCLUSION

In this proposed algorithm, brain MRI images are proved to be a significant way to detect the brain tumor. The hybrid technique of combining support vector machine and fuzzy c-means clustering in classification gives more accurate result for identifying the brain tumor. Future work is to get better accuracy rate and less error rate by using any other

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hybrid SVM algorithm which is to be proposed. In future work, different data mining techniques are to be used for training, different kernel functions for improving the performance of the classifiers and the data sets can also be increased.

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