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# Comparative Analysis of Classification Techniques for Magnetic Resonance Image

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***Abstract :*** Classification of Brain MRIs are very important research area now a days. MR Images are very useful to identify the brain tumor in early stage so, that treatment should be given at right time. Brain tumors are abnormal growth of tissue in the brain. In this work texture analysis is done to classify the normal and abnormal brain MR Images. Features are extracted with the help of sym2, sym4 and sym6, 26 features are extracted by three wavelets from 380 MR images. 285 images are used as training images and 95 are used as testing images. Features are reduced with the help of PCA (Principle Component Analysis). Classification is done with the help of SVM and PNN. Comparison of SVM and PNN has been proposed with the different symlet wavelets and also their processing time.

***Keywords :*** Symlet wavelet, texture analysis, Classification, MRI.

## 1. INTRODUCTION

In medical image processing, Magnetic resonance images has great importance. Many researchers has been focused on MR Images. For the diagnosis of brain tumor MR Images are used at large scale. In 2014, an estimated 128,000 new cases of cancer were diagnosed in Australia[17]. If diagnosis is not done correctly, treatment is also not possible. In texture analysis the homogeneous regions are identified presents in image. Texture analysis extracts information from image [1]. Normally GLCM is used to do texture analysis [2]. Discrete wavelet transform (DWT) [3] is also very useful in texture analysis. A lot of research has been done by several researchers, T2-weighted MR images were used to extract features with the help of space–frequency analysis by [4]. An automated tumour detection from CT images using wavelets has been proposed in paper [5]. In [6] various strategies and important points to be considered for MRI texture analysis are explained. A review is done in [7] to show the recent published techniques and state-of-the-art neuroimaging techniques. The texture of MRIs has also been very vital to determine the type of tumour [8].

Extending the GLCM to the wavelet domain provides the better results than the standard approach based on traditional GLCM. Therefore, in this paper DWT is used upto 4-level of decomposition, three wavelets db4, bior5.5 and sym4 [15] are used one by one. Classification is done by two SVMs (linear Kernel), sym4 showing the best performance in terms of accuracy and processing time.

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## 2. TEXTURE ANALYSIS

Image texture is the spatial variations present in the pixel intensities (gray values), it is useful for various applications and has been a latest topic of research. Image processing and pattern recognition is one of the application areas of texture analysis. Texture [11] identifies the homogeneous regions present in an image. Generally, the extraction of features from image is done then classification of these features are done to differentiate the abnormal and normal tissue or images. There are various features and it is very difficult to extract all the features from an image, so identification of the most informative features is also important issue.

The wavelet transform is very efficient technique to do texture analysis for almost every type of images. It is a multiresolution technique, Wavelet transforms are classified as: continuous, discrete and multiresolution[14]. The Discrete Wavelet Transform (DWT) divides image into sub band using low pass and high pass filters as shown in figure 1. The four parts are approximation (AN), horizontal (HN), vertical (VN), and diagonal (DN). Where for getting approximation image low pass filter is used and for three detailed images are produced with the help of high pass filter, these three detail images are showing the changes in brightness of the input image. This is one level decomposition of the image we can further decomposition till the required level is achieved[16]. A 4-level decomposition is done for feature extraction in this paper. Three different wavelets (sym2, sym4, sym6) are used to apply DWT on the MRI data set.

## 3. FEATURE EXTRACTION

Feature extraction is the main step to do texture analysis of any medical image. Features are extracted from the sub-bands of images. Two features mean and standard deviation are used for texture analysis. In this work total of 26 features are extracted with the help of 4-level DWT[15] and their covariance matrix and correlation matrix at each level of decomposition for vertical (VX), diagonal (Dx) and horizontal (Hx). The 26 features are mean and standard deviation of approximation matrix of level 4 dwt decomposition and 12 features based on mean and standard deviation from each level from correlation matrix for Vertical, diagonal and horizontal. The mean is calculated by dividing the sum of a set of the feature values by the number of features in the set. Width of filter matrix can be identified with the help of standard deviation. The features extracted are: mean_aprox, mean_RD1, mean_RD2, mean_RD3, mean_RD4, mean_RH1, mean_RH2, mean_RH3, mean_RH4, mean_RV1, mean_RV1, mean_RV1, mean_RV1, std_approx, std_D1, std_D2, std_D3, std_D4, std_H1, std_H2, std_H3, std_H4, std_V1, std_V2, std_V3, std_V4.

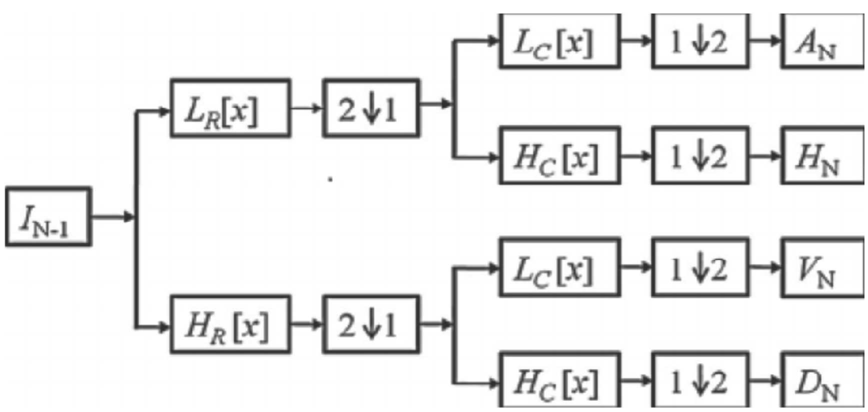



**Fig. 1. Decomposition of an image by 2-D DWT.**

## 4. FEATURE REDUCTION

In this work principal component analysis technique has been implemented to reduce feature set [12] and to get the appropriate feature from each vector feature. In PCA dimensions of Multidimensional data is reduced according to the number Components required. Original dimensions having higest variance are combined linearly to get the principal component and for nth principal component highest variance has been combined, Basic concept of PCA is shown in figure2. In Figure2 dark lines shows original basis; doted lines shows the PCA basis. Where points are considered at regular spaced positions when straight line is rotated at 300, where in the right side graph shows the reconstruction of the data in one dimension with the help of first principal component only. If the data is 2 dimensional, second principal component is also identified isolated with the orthogonality constraints. If only y two variables are measured, such as Blood Pressure and sugar in a specific number of patients, It's not a complex task to plot it and also easy to visually assess the correlation between them. So, it becomes a complex task to visualize the relationship between a multi-dimensional matrix.

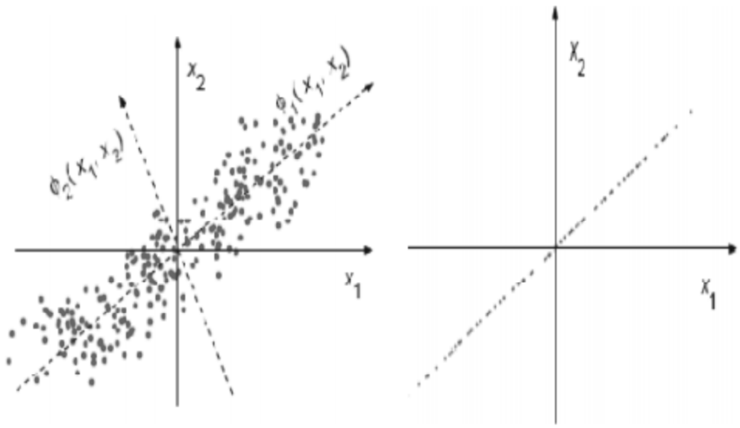
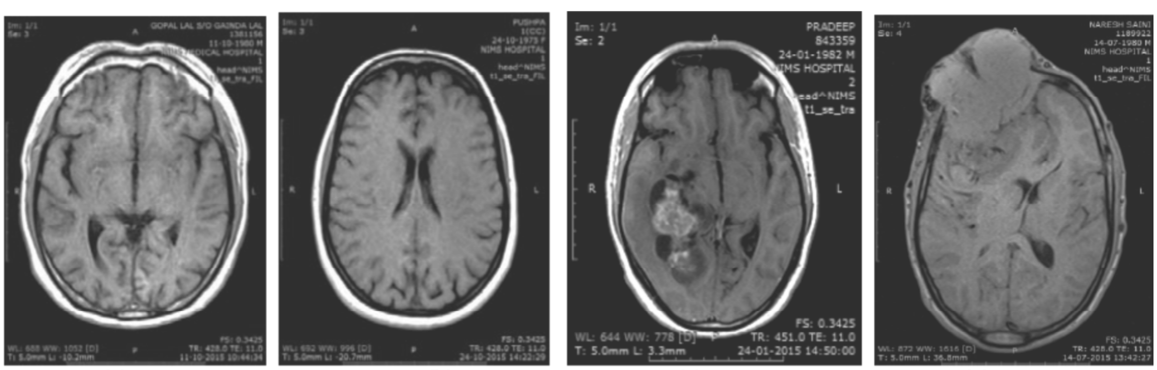


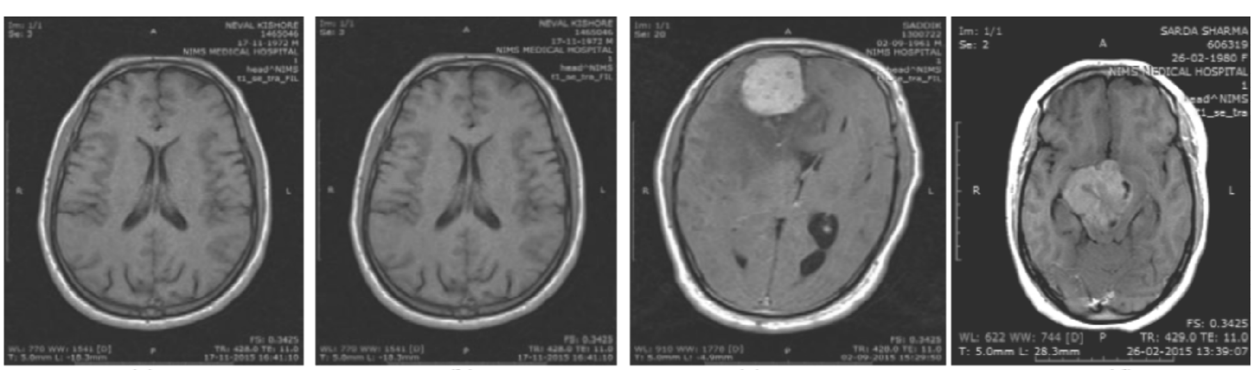
**Fig. 2. The Basic concept of PCA.**

As we know that covariance is calculated between the two variables. If the variables are more than two, covariance is measured between the adjacent variables like X and Y; Y and Z and Z and X. PCA becomes useful in these kind of sytems. PCA has been implemented to reduce the features, 95% of information is attained by only 13 features reduced by PCA out of 26 features extracted by Different wavelets. Training set is generated with these 13 features.



(a) (b) (c) (c)

**Fig. 3. Brain MR images from training set (*a*) and (*b*) are the Normal MR images and (*c*) & (*d*) are the Abnormal MR images.**



(a) (b) (c) (d)

**Fig. 4. Brain MR images from testing set (*a*) and (*b*) are the Normal MR images and (*c*) & (*d*) are the Abnormal MR images.**

## 5. CLASSIFICATION

In this work classification is done with the help of two different Techniques (i) Support Vector Machine (ii) Probabilistic Neural Network and comparison has been presented among these two. As we know that classification is the system in which a test data is considered as a class depending on the basis information gained by the classifier during training time.

(a) **Support Vector Machine (SVM) :** It is useful for a class as well as n-class classification problems. In SVM non-linear dividing problem is converted into a linear with the help of different kernel function available in this technique. There are lots of reasons to use SVM [13] in this work: 1) limited samples are required to obtain optimum solution a problem; 2) Global optimum solution can be identified. 3) SVM having minimum computational complexity. 4) Kernel function helps to solve the complexity. Also with the help of specific kernel function, time of training can also be reduced. In this work Radial basis function kernel has been used.

(*b*) **Probabilistic Neural Network (PNN) :** It is also used for classification in this work, it is a Radial Basis Function (RBF) network. Basic architecture of NN has number of layers (*i*) Input Weights Layer (*ii*) Rule Layer (*iii*) Output Layer. Where the output layer is known as exhibiting layer and Rule layer also called as Pattern Layer.

(*c*) **Classification Performance :** A lots of statistical methods are available for evaluating and estimating the classifier accuracy. Round robin (10-fold cross-validation) is the one of best method for this. The classification accuracy of the system is identified by this method. It is achieved by partitioned the data into a training data set, validation data set and testing data set. Validation set identifies where the training should be stopped. Testing data is used after training to identify the classification performance independently. Where the classification accuracy is calculate according to the error rate.

## 6. PROPOSED WORK

Medical Images (MRI of brains) for the proposed work are taken from NIMS medical college & hospital, Jaipur, Rajasthan, India. All the images are of various patients age from 18 to 76 in DICOM format. First of all we convert these in JPEG format for matlab compatibility, then pre-processing is done to improve the quality of images with the help of median filter. 380 brain images are used in two groups for training 285 images are used and 95 images are used for testing purpose, each group having both the normal and abnormal images in equal ratio. Two normal and two abnormal images from training set are shown in figure 3, also four images from testing set are shown in figure 4. The proposed technique is elaborated in figure 5.

After pre-processing by median filter, 4-level DWT is applied with the help three different wavelet filters sym2, sym4, sym6 one by one to calculate 26 features from training images. After this PCA is applied to reduce the features, 95% of information is attained by 13 features produced by PCA. Training set is generated with these 13 features. Now testing images are processed in a same way to extract features. After this with the help of SVM and PNN classification is done with all the three wavelets and comparison is shown in terms of classification accuracy % and processing time to find the best combination. Testing images are also gone through the same steps except PCA, according to the result of PCA, index value is calculated that is equal to number of features left after PCA. With the help of index value we just matched only 13 features of testing images are matched with 13 features of training images and we have calculate the classification accuracy with the help of 10- fold cross- validation for all three wavelets and their processing time shown in table I for the comparison purpose.

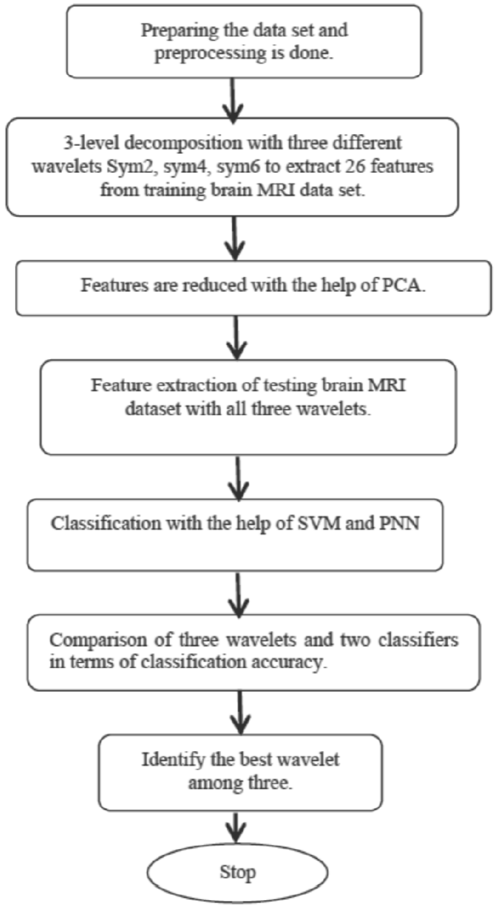



**Fig. 5. Flow chart of proposed work.**

## 7. SIMULATION RESULTS

All the medical images (MRI) are converted into jpeg format and divided into two sets, training set and testing set each having 285 and 95 images respectively. All the images are passed through median filter to reduce the noise present in it. The sym2 wavelet is used to extract the 26 features based on mean and standard deviation with the help of 4-level DWT. After this same features are calculated with the help of sym4 and sym6 simultaneously. As the feature has been extracted by all three wavelets, we have applied PCA to reduce the number of features, if number of features are less processing time of classification is also reduced. Once the features are reduced, out of 26 only 13 features are left as the result of PCA.

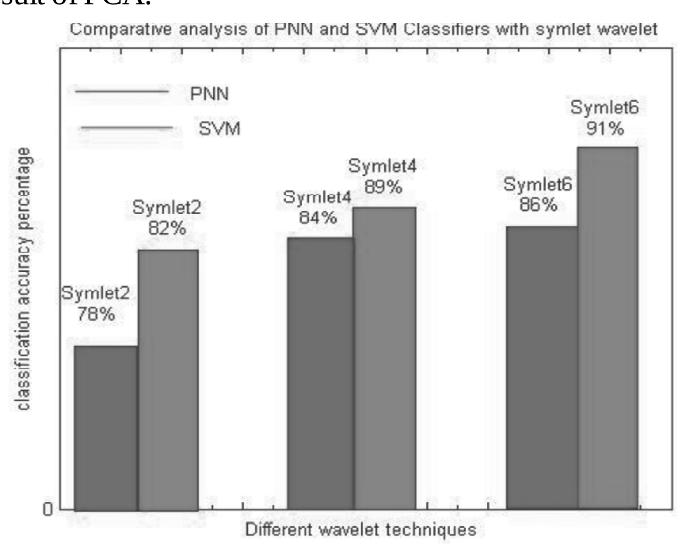



**Fig. 6. Comparative analysis of different classifier with different symlet wavelets.**

These 13 features are used to classification of brain MR images with the help of SVM and PNN and their comparison in terms of classification accuracy and processing time has been calculated. The comparative analysis of SVM and PNN is shown in table1 with different symlet wavelets and their graphical representation is also shown in figure 6. SVM shows the best classification accuracy with sym6 among all combination and also its processing time is less than others.

**Table 1. Comparison between three wavelets**

| *Wavelets* | *Sym2* | *Sym4* | *Sym6* |
|---|---|---|---|
| % Classification accuracy with SVM | 82% | 89% | 91% |
| % Classification accuracy with PNN | 78% | 84% | 86% |
| Processing Time with SVM | 30.135 s | 29.324 s | 27.513 s |
| Processing Time with SVM | 32.465 s | 30.926 s | 29.173 s |

## 8. CONCLUSION

The features are extracted from MR images by three different wavelets based on 4-level decomposition of DWT and classification has been done with the help of support vector machine and PNN. 380 real brain MR images are used to authenticate the work, these images are divided into two sets training set having 285 images and testing set having 95 images both the sets containing the equal no. of normal and abnormal images. Finally, the classification accuracy and processing time has been calculated for comparison. We found that sym6 has better capability for MRI classification than sym4 and sym2 with SVM. In terms of processing time also sym6 shows better results than sym4 and sym2 with SVM.

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