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Segmentation and Classification of Brain Tumor MRI Images Using Support Vector Machine

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Abstract— This paper proposes a set of algorithms which work for the better detection and classification of Brain Tumor. The MRI image based Brain Tumor analysis would efficiently deal with classification process for Brain Tumor analysis. There are three stages namely Feature Extraction, Feature Reduction and Classification. Feature Extraction and Feature Reduction using for two algorithms. There are Discrete Wavelet Transform (DWT) and Principle Component Analysis (PCA). The Features Extracted are Mean, Standard deviation, Kurtosis, Skewness, Entropy, Contrast, Variance, Smoothness, Correlation and Energy. The result is then given to Support Vector Machine (SVM) for tumor classification as Benign or Malignant.

Keywords— Brain Tumor, Discrete Wavelet Transform (DWT), Principal Component Analysis (PCA), Support Vector Machine (SVM), Magnetic Resonance image (MRI).

I. Introduction

The Brain is one of the most vital and complex structure in a human body. Brain can be affected from problem which cause change in its normal structure and its normal behavior. This problem is known as brain tumor. Different image techniques like Magnetic Resonance Imaging (MRI) are used by inner structure of the brain and diagnose the tumor. A tumor is an any mass cause abnormal and uncontrolled growth of cell. There are two type of Brain tumors have been classified. 1. Benign Tumors 2.Malignant Tumors.

Benign tumor is having their boundaries or the edges. They do not spread over the other parts of the body. Malignant tumor is considered to be the most serious one and they develop rapidly. They affect the various necessary organs which even lead to the death.

Brain Tumor is includes Computed Tomography (CT) scan, Magnetic Resonance Imaging (MRI) scan. Classification is the process in which the brain image is classified as Benign or Malignant. In this process, different features are extracted. The classification process is very important. The segmentation process is to perform to the system to detect accurate tumor in image.

Segmentation is used to dividing the image to its parts sharing identical properties like color, texture, contrast and boundaries. Analysis of segmentation of a large set of images and comparisons of these segmentations between relevant subgroups of images. Thresholding is implemented for segmentation.

The proposed system suggests using three stages namely Feature Extraction, Feature Reduction and Classification. This approach extracts features using Discrete Wavelet Transform and Feature Reduction is done using Principal Component Analysis (PCA). The result is used in Support Vector Machine (SVM) for tumor classification as Benign or Malignant. Wavelet transform is an executive tool for feature extraction from MR brain images. The following step as follows:

Step 1: Input of MRI Image.
Step 2: Generate Preprocessing image.
Step 3: Segmentation is locate the object and pixel image.
Step 4: Feature extraction through DWT
Step 5: Feature reduction through PCA.
Step 6: Finally SVM classifier is used to classification from MR Image. It is shown in Fig.1.

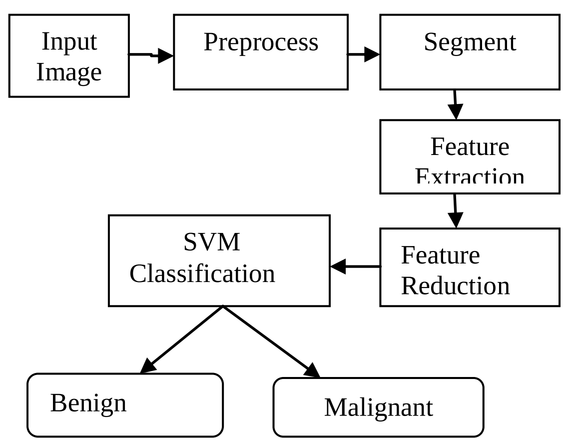

Fig1: Block Diagram of Proposed System

II.LITERATURE SURVEY

N. Varuna Shree T. N. R. Kumar. et.al [1] The identification, segmentation and detection of infecting area in brain tumor MRI images are a radius and the task of consuming. The different structure of the human body. It visualized the image processing concepts. The results nearly 100% accuracy in identify the benign and malignant detect from brain MR images demonstrating the effective of the proposed technique.

M.Rama Krishna1 | Fahmeeda [2] Brain tumor image of segmentation is important clinical research. It is growth of normal and abnormal cells, includes various types of benign, malignant. Detection is necessary to prevent complications of loss of vision and speech. The segmentation is defined to the difficult task. MRI images are visually and demand high diversity in tumor area. Hence, the segmentation is done using the SVM. It reduces the classification error rate and they provide better accuracy.

1P. Kumar and 2B. Vijayakumar [3] In this paper, we have fostered a new transpire for automatic dissection of brain neoplasm in MR images. The propositioned method entails of four stages using for this preprocessing, dissection, feature extraction, feature reduction and classification. The espoused tentative are gauged using the metric Similarity Index (SI), Overlap Fraction (OF) and extra fraction (EF). For comparison, of the proposition technique has colons extracted the brain tumor divulging with other neural network classifier.

Sreeja R, Radhakrishnan B. et. al [4] In this paper using for maximum variance standardization for brain tumor Detection in this work. The proposed method uses threshold based segmentation best for Brain tumor detection. As accuracy values of Threshold are taken, the performance of the proposed detection system is high.

Vaishnavi S. Mehekare1, Dr.S.R.Ganorkar. et. al[5] Brain tumor detection is an important application of recent days. In this paper, the concepts of image segmentation, basics of MRI, and clinical applications of MRI. Introduction about brain tumor, various types of brain tumors and their characteristics are detected. The research work further presented using for a novel algorithm for segmentation and classification of brain tumors.

III.METHODOLOGY

A. Brain Tumor Detection

There are four steps of Brain Tumor Detection:

a) Segmentation,
b) Feature Extraction By Using DWT,
c) Feature Reduction By Using PCA,
d) Tumor detection and classification.

a) Threshold segmentation

Image segmentation is typically used to locate objects and boundaries such as lines, curves, etc., in images. Each of the pixels in a region is have some similar characteristic or computed property, such as color, intensity, or texture.

Thresholding technique segments the MR images by a binary partitioning of the image intensity. The segmentation is based on thresholds. Usually MRI images have non-isotropic vowel sizes in order to get isotropic image, compute the threshold of different tissues gray levels and the image histogram as a probability density function of the Image. Threshold is define as Eqn (1),

$$P(i) = {n_i}/{N} \quad (1)$$

Where ni = Number of voxels with gray level

i = $\{0,1,2,3 \ldots \ldots W-1\}$

N = Number of voxels in image,

P = Probability for a voxel to get intensities.

b) Feature extraction by using discrete wavelet transform (dwt)

The Discrete Wavelet Transform (DWT) became a very versatile signal processing tool proposed the multi-resolution representation of signals based on wavelet decomposition. Feature Extraction is used to extract the wavelet coefficient from MR images. DWT is a technique used to extract features of each image from brain MRI, which extracts maximum highlighting pixels present in images to progress results. The main advantage of wavelets is that they provide localized frequency information of classification. In this various statistical features are calculated. There are 1) Mean, 2) Standard Deviation, 3) Entropy.

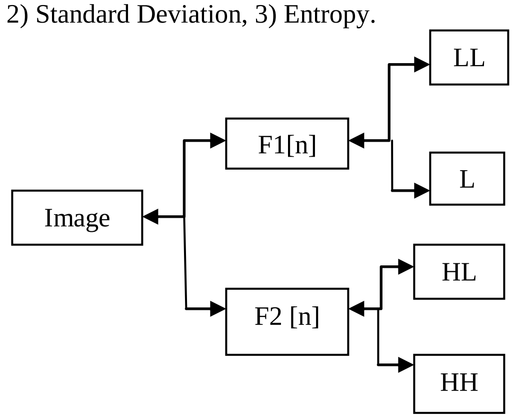

Fig 2: DWT schematically

It is shown in Fig. 2. The input image is process by F1 [n] and F2 [n] filters which is the row representation of the original image. A result of this transform there are 4 sub band (LL, LH, HH, HL) images at each scale.

c) Feature reduction by using principal component analysis (pca)

The Principal Component Analysis well- accredited tools for transmuting the presented input features into a new lower dimensional feature space. In proposed method is extract features from brain MR images using PCA. It is commonly used forms of dimensional reduction. The main purpose of using PCA approach is to reduce the dimensionality of the wavelet coefficients.

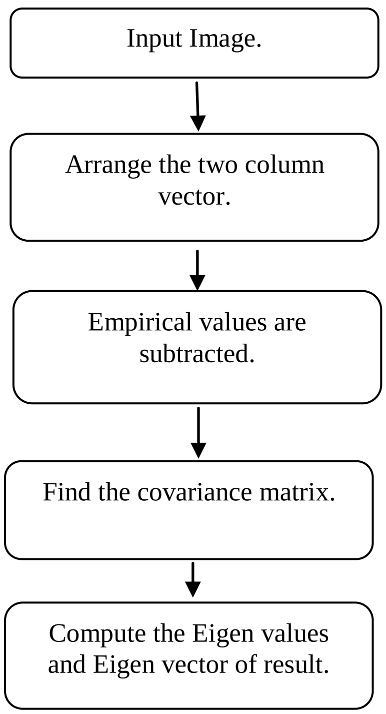

Fig. 3

Algorithm
Step1: Input Image I [x, y].
Step2: Arrange in two column vector.
Step3: Calculate Empirical means values are subtracted.
Step4: Find the covariance Matrix.
Step5: Compute Eigen vector and Eigen values of result vector.

d) *Classification using support vector machine (svm)*

SVM is a supervised machine learning algorithm. It can be used for classification and regression. It is mostly used in classification problems. It is state of the art pattern recognition technique grown up from statistical learning theory.

The basic idea of applying SVM for solving classification problems: a) through a non-linear mapping function to transform the input space to higher dimension feature space. b) The separating hyper plane with maximum distance from the closest points of the training set will be constructed. Using a SVM classifier to accurately classify features of every image in dataset.

The last step for diagnosis and which is specifically used for classification of tumors. There are two important commands svmtrain and svmclassify used for this process. In Kernel space the training data to map by using Kernel function svmtrain. The kernel function can be following the function: linear, quadratic, polynomial. SVMStruct is used to classify each row of the data in sample, a matrix of data and using the information, created using the svmtrain function. Finally the result is shown on Fig. 3 and Fig. 4. This way used detect the malignant and benign tumors are classified.

B. Performance metrics

Mean (M): The total number of pixels in an image is divide the all the pixel values of an image to add the calculated mean value of an image. Mean in Eqn (2),

$$M=\left(\frac{1}{mXn}\right)\sum_{x=0}^{m-1}\sum_{y=0}^{n-1} f(x,y) \quad (2)$$

Standard Deviation (SD): It is the second central moment. Eqn(3), it describing the probability distribution of an observed population. It can serve a measure of in homogeneity. The better intensity level and high contrast of edges of an image indicated a higher value.

$$SD(\sigma)=\sqrt{\left(\frac{1}{m\times n}\right)\sum_{n-1}^{m-1}\sum_{y=0}^{n-1}(f(x-1)-M)^2} \quad (3)$$

Kurtosis (S_K): Kurtosis is called a parameter to describe a probability distribution of a random variable's in a shape. X is the random variable, Kurt(X) is the Kurtosis and it defined as Eqn (4),

$$K_{urt}(x) =\left(\frac{1}{M\times N}\right)\frac{\Sigma(f(x,y)-M)^4}{SD^4} \quad (4)$$

Skewness (S_K): Measure of symmetry or the lack of symmetry is called skewness. The skewness of a random variable *X* is a random variable of skewness and is denoted as $S_K(X)$ and it defined as Eqn (5),

$$S_{k(X)}=\left(\frac{1}{M\times N}\right)\frac{\Sigma(f(x,y)-M^3)}{SD^3} \quad (5)$$

Entropy (E): It is calculated to randomness of the textural image and is defined as Eqn (6)

$$E = -\sum_{X=0}^{M-1}\sum_{x=0}^{n-1} f(x,y)\log_2 f(x,y) \quad (6)$$

Contrast (c_{on}): Contrast is a measure of intensity pixel and neighbor over the image. It can be defined as Eqn (7),

$$C_{on}=\sum_{x=0}^{m-1}\sum_{y=0}^{n-1}(x-y)^2 f(x,y) \quad (7)$$

Variance (σ^2): It is defined as sum of the squared distances of each term in the distribution from the mean (μ) and it is divided by the number of terms in the distribution (N). To subtract the square of the mean (μ^2). It can be defined as Eqn (8),

$$\sigma^2=\frac{\sum(x-\mu)^2}{N} \quad (8)$$

Smoothness: It is used to smoothing an Image. It is used to reduce noise within an image or to produce a less pixel image. Low pass filters are used in many smoothing methods. It is also based on a single value representing an image. For this, average value of the image or the middle (median) value.

Correlation (C_{orr}): The spatial dependencies between the pixels are described by correlation and it is defined as Eqn (9),

$$C_{orr}=\frac{\sum_{x=0}^{m-1}\sum_{y=0}^{n-1}(x,y)\, f(x,y)-M_x M_y}{\sigma_x\sigma_y} \quad (9)$$

Where Mx and My are the mean and σx and σy is the standard deviation in the horizontal spatial.

Energy (En): It defined as the quantifiable amount of the extent of pixel pair repetitions. The energy referred to angular second moment and it defined as Eqn (10),

$$En=\sqrt{\sum_{x=0}^{m-1}\sum_{y=0}^{n-1} f^2(x,y)} \quad (10)$$

Peak signal-to-noise ratio (PSNR): It is used to evaluate the characteristic of reconstructed image from processed image. It defined as:

$$PSNR=20\log_{10}\frac{2m-1}{MSE} \quad (11)$$

Eqn (11) the better signal-to-noise ratio indicates the lower value of mean square error and higher value of peak signal-to-noise ratio.

Mean Square Error (MSE): It is used to measure of signal or image. MSE is used to compare two images and it produce the quantitative or similarity scores. Mean in Eqn (12),

$$MSE=\frac{1}{P\times Q}\sum\sum(f(i,j)_{f^R(i,j)})^2 \quad (12)$$

IV.RESULT ANALYSIS

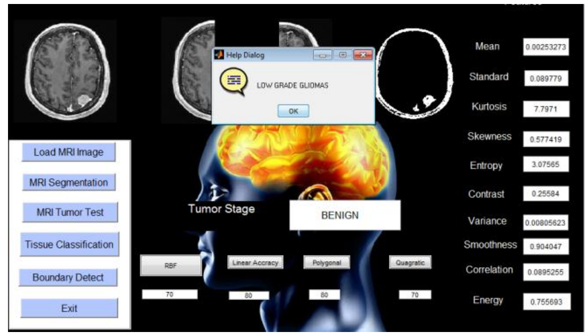

Fig 4: Result Obtained When Benign Tumor is detected

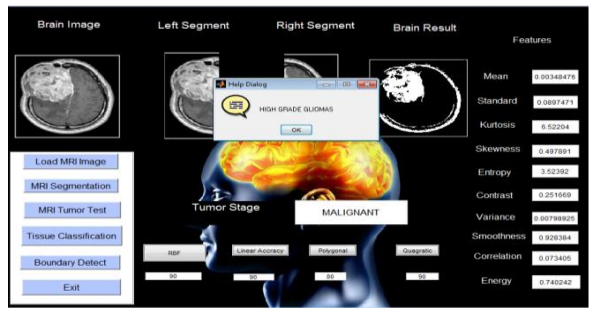

Fig 5: Result Obtained When Malignant Tumor is detected

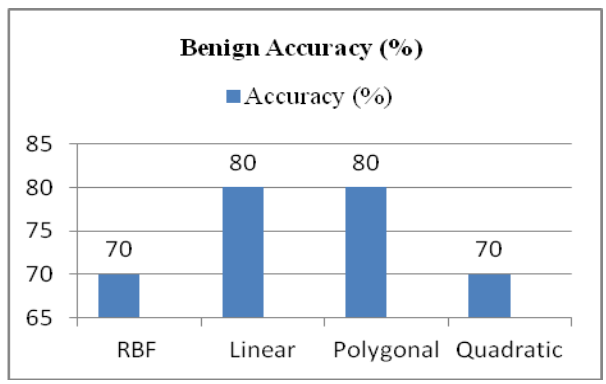

Fig 6: Benign Tumor Detection

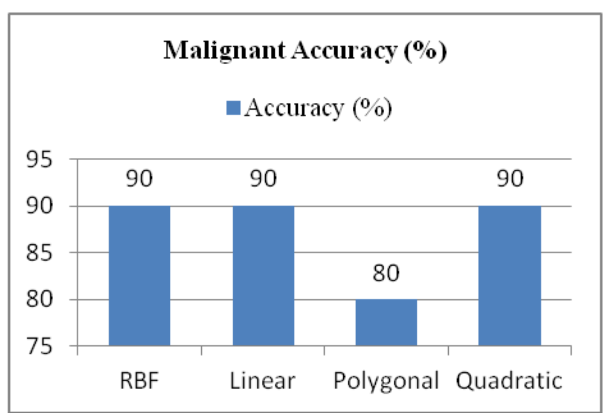

Fig 7: Malignant Tumor Detection

Table 1: Calculation of MSE, PSNR for Brain MRI image

	MSE		PSNR
Benign	Input image	0.8754	97.4180
	Output Image	0.0324	63.0254
Malignant	Input image	0.999	96.2703
	Output Image	0.1785	55.6132

In this result using this method is accurately detection from the classification of MRI image. Accuracy is shown in Fig. 5 and Fig. 6. Table 3 is using for differenciate from PSNR and MSE values of Benign and Malignant image. The Chart is shown in Fig. 7and Fig. 8.

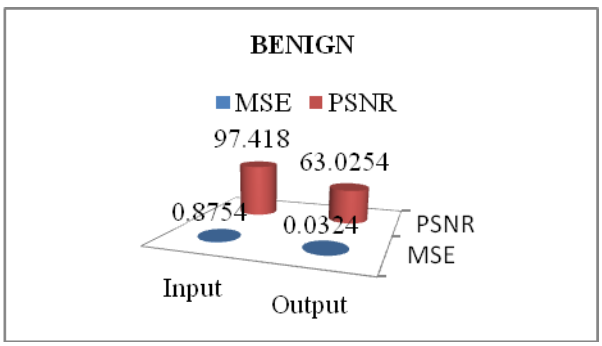

Fig 8: Benign with PSNR vs MSE

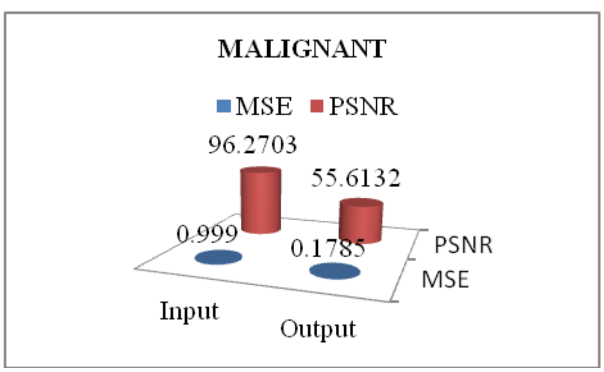

Fig 9: Malignant with PSNR vs MSE

V.CONCLUSION

In this paper, the concepts related to image segmentation and Classification of brain tumor detection is discussed. The thresholding approach is used for image segmentation which helps to recognize the portion of tumor in MRI image. Then using the approach of Discrete Wavelet Transform for Feature Extraction and Reduction of Principle Component Analysis, The Features Extracted are Mean, Standard deviation, Kurtosis, Skewness, Entropy, Contrast, Variance, Smoothness, Correlation and Energy. The accuracy of the brain tumor segmentation is also measured. Using this algorithm the brain tumors are accurately segmented and classification from an MR brain image. Then, Support Vector Machine is used to classify the tumors into benign and malignant.

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