ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering
SITES
Smart And Innovative Technologies In Engineering And Sciences
Gyan Ganga College of Technology
Vol. 5, Special Issue 3, November 2016

An Automated System for Tumor Detection Using Details MRI Image

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Abstract: Brain tumor in human occur when abnormal cells collect within the brain. This paper proposed an appearance based method for Tumor detection using MRI. In this appearance based method wavelet is followed by the PCA. The wavelet is embedded with the PCA (Principal Component Analysis) to overcome the limitations of PCA and improve the tumor recognition rate. DWT is applied on image to extract the important information (Detail image) and to remove the irrelevant information of the MRI. Then PCA is applied on the detail MRI image to find the uncorrelated feature vector. After extracting features from the MRI, classification is done by k-nearest neighbor (KNN). The Classification rates for the proposed feature extraction techniques are analyzed with different classifier pairs. To compare these feature extraction techniques for correct tumor recognition, an experiment is conducted on datasets which is collect from Anant hospital Jabalpur. The experimental result shows the acceptable rate for detection of tumor.

Keywords: Wavelet; MRI; Detail MRI; Principal Component Analysis; k-nearest neighbor

I. INTRODUCTION

Brain tumor cause major problem in the human body that affect the body in very critical manner. Sometime it is difficult to find reason behind tumor so that the risk factor increases. In many cases the tumor affected person died, there is a few percentage that the people safe there life. The fact under the main reason of dying people is because they are not get proper treatment for the problem and they don't know how to proceed. Magnetic resonance imaging (MRI) and computed tomography (CT) plays an important role in brain tumor diagonisation in human brain.

Out of so many diseases, brain tumor is the key most problem that occurs in human body. Presently, risk factors of tumor detection cannot be avoided and the survival rate of the patient is only related to early detection. Based on the above challenges the objective of this work is to develop a computer based diagnosis system to recognize the Tumor from MRI image. The objective of this paper is:

- Pre-processing of MRI images.
- Extracting efficient features from MRI images for detection of tumor.

In this paper Details MRI images (DMI) is embedded with the PCA to overcome the limitations of PCA and improve the speed of the system. Wavelet decomposition is applied on MRI image to get the Details MRI images (DMI) and to remove the irrelevant information of the MRI. Then PCA is applied on the Details MRI images (DMI) to find the uncorrelated feature vector and KNN is used as classifier for classifying the MRI images.

The rest of this paper is organized as follow: Related work is discussed in section 2; over view of system is mentioned in section 3; in section 4, an Experimental result has been illustrated; Final section deals with conclusion.

II. RELATED WORK

Several studies are reported in literature for an automatic system for tumor detection. The work is as follows:
Mtthew C. Clark et al.[1] proposed work on Automatic Tumor Segmentation Using Knowledge Based Techniques. In this paper author used MRI images for the segmentation. Starting with slices of interest for the study, in which the whole brain divided in to slices from the top of the brain to find the abnormal cells or tissues where the white and gray mater tissues occur.

Then knowledge based system, in which feature space is extracted based on the previous knowledge and based on the shape and size of the tumor.

In year 2009 Evangelia et al. [2] The objective of this paper is to investigate the use of pattern classification methods for distinguishing different types of brain tumors.

Bandyopadhyay [3] proposed Detection of Brain Tumor-A Proposed Method. In this review paper author has also described the types of brain tumor, its anatomy and its symptoms. And various classification techniques are discussed. For detection of tumor in brain, author has used

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Computer Aided Diagnosis technique, and for classification of tumor various methods like Artificial Neural Networks, Support Vector Machines etc. are discussed.

Mustaqeem et al. proposed an Efficient Brain Tumor Detection Algorithm Using Watershed & Threshold Based Segmentation. In this paper an efficient algorithm is prepare with the help of segmentation and morphological operation to extract the tumor area.

Selvakumar et al. [4] proposed Brain Tumor Segmentation and calculate its area in brain using K-Mean Clustering and Fuzzy C-Mean Algorithm. In this paper author has also described thresholding method to convert the given image into the gray scale form. The author covert the whole process into four module, in first module they used filtering in the preprocessing , Segmentation is carried out by advanced K-means and Fuzzy C-means algorithms, Feature extraction is by threshold and finally, Approximate reasoning method is used to recognize the tumor shape and the position in MRI image is calculated by edge detection method.

Elavarasi and Jayanthy [5] proposed a Soft sensor based brain tumor detection using CT-MRI. In this paper author has applied various image processing techniques and various morphological operations on CT and MRI images of brain and output result from of both images set are compared.

Kumari [6] proposed SVM Classification an Approach on Detecting Abnormality in Brain MRI images. In this paper author has described classification technique to classify the brain tumor .The proposed method applied by author consist of two stages-to extract the feature and its Classification. In this SVM classifier types and their performance are discussed.

Sivaramakrishnan and Karnan [7] performed a work, An Approach for Extraction of Brain Tumor in MRI Images Using Soft Computing Techniques. In this paper, for detection of brain tumor, author used Fuzzy C-means clustering and histogram techniques and for its classification into normal and abnormal type, K-nearest neighbor method is used.

In year 2013, Nagori and Madhuri [8] proposed an Algorithms for Extracting Values from MRS Graph for Brain Tumor Detection. In this paper, the authors propose three different approaches for extracting metabolite values from MRS graph. They used Value Extraction from most Visible Peak Point on which they extract the values of metabolite from MRS graph by using value extracting algorithm. They then apply experimental method on that they collect data manually from each patient and compare with the values came from visible peak method. Another one was use of standard template, Standard template directly provide values of NAAstd ,Crstd , Chostd and All the metabolic ratios of normal person. Graph scanning used to extract the peak point. Sharmal and Mukherjee [9] proposed a Fuzzy C-Means and Snake Model for Segmenting Astrocytoma. They work on tumor detection method by using segmentation method. They work on Astrocytoma tumor that is a type of tumor.

They work to extract the tumor area by using clustering method. they propose the work by using gray scale level Co-occurrence Matrix(GLCM) that use for texture feature extraction from the MRI images, ANFIS(Adaptive Network Fuzzy inference System) plus Genetic Algorithm for feature selection to find the feature that contain tumor in the image and FCM(Fuzzy C-Means) for segmentation.

El[10] proposed a new algorithm for Computer aided diagnosis of human brain tumor through MRI. They develop a CAD system with a low computational cost.

They proposed four main processes in their work, (i)image acquisition and preprocessing in that they used CT scan to generate digital images and used median filter and high pass filter for preprocessing, (ii) segmentation of ROI they used PCNN method, (iii) feature extraction and selection, they obtain using discrete wavelet transform, and (iv) classification of the selected ROI and performance Evaluation done using ANN.

Patel and Doshi [11] gives a study of segmentation methods for detection of tumor in brain MRI. In this paper segmentation method used to find the tumor in the brain and author used three segmentation method that are Threshold, Region growing, and Mean shift clustering method for tumor extraction. Sinha and Sinha [12] proposed an efficient segmentation methods for tumor detection in MRI Images.

In this paper author presents three important methods of Image segmentation for extraction of tumor in the MRI images. In that methods include k-means clustering with watershed segmentation algorithm, optimized k-means clustering with genetic algorithm and optimized c- means clustering with genetic algorithm.

Ain [13] proposed a multi-stage system for brain tumor extraction and detection. In this paper, first noise removal is performed and then texture features are extracted from these brain MRI. After extracting the features, the proposed system used ensemble based SVM and achieve more than 99 %accuracy in tumor classification.

In this paper tumor region is extract from tumor images using multi-step segmentation. This proposed work has been tested against the datasets of different patients received from Holy Family hospital and Abrar MRI & CT Scan center Rawalpindi.

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III. PROPOSED SYSTEM

The work flow of the proposed Tumor recognition (detection) system using Wavelet and PCA method is depicted in Fig. 1.

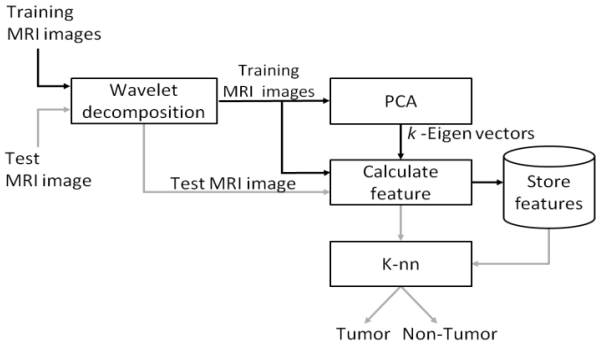

Figure 1. Automated Tumor Detection

The system includes, feature extraction, and classification as the main modules. PCA as feature extraction technique are applied on the details MRI image (DMI) obtained at the second level of wavelet decomposition instead of original MRI image for finding the uncorrelated features of the Tumor and Non Tumor images for classification. The details of each module are given in the following subsections.

A. Details MRI Images

Details MRI images (DMI) are generated by applying wavelet decomposition on the MRI image. The wavelet decomposition is a kind of time frequency signal analysis method. By using it, the MRI image can be decomposed into many sub band images with different spatial resolution frequency characteristic and directional features [14]. In this work multilevel wavelet decomposition has been used.

The MRI image is decomposed up to two levels, and the approximation and details coefficients is calculated. Instead of considering all the coefficients, only details coefficients are taken for further procedure. Detail coefficients give good time resolution and poor frequency resolution while approximation coefficient give good frequency resolution and poor time resolution. By applying wavelet decomposition on MRI, the size of DMI is reduced as compared to original MRI images in the ration of 1:16. This help to speed up the process of system.

B. Principal Component Analysis (PCA)

Principal Component Analysis is an unsupervised approach to find the right features from the training data. It seeks a direction that best represents the data in a least square sense. These directions are determined by the Eigen vector of the covariance matrix corresponding to the largest Eigen values [15]. The steps are:

- Consider M DMI in the database of size N*N.
- Represent those images in size of (N2 *1).
- Calculate the mean of the all DMI.
- Then subtract this mean from all the training DMI
- Calculate covariance matrix, Cov, as

$$Cov = AA^T \quad (1)$$

where A^T is transpose of A.

- Calculate the Eigen vector and Eigen values of the covariance matrix. Now arrange the Eigen values from the highest value to the lowest value and choose the first k-Eigen vectors which are having the highest Eigen value. This k Eigen vector is the principal component of the data set.
- Now calculate the feature vector for each DMI in a training set as :

$$P = M^T \times k\text{-Eigenvectors} \quad (2)$$

- The feature vectors P thus obtained are stored in the database for further processing. After calculating the feature vectors, the feature vectors will be store in the database for classification. The following procedure will be followed for the test image of size (N*N).
- Represent the test detail MRI image(DMI) is size of (N2 *1).
- Project the test image in the Eigen space and calculate the feature vector for the test image as:

$$W = T^T \times k - \text{Eigenvectors} \quad (3)$$

- To compare the feature W of test image with stored training feature vector for classification, KNN is used in this work.
-

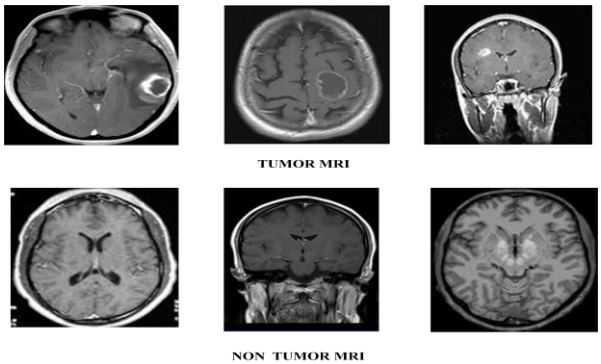

Figure 2. Non-Tumors Image; Tumor Image

C. K- nearest neighbors (KNN)

The k-nearest neighbors (KNN) is a method for classifying test samples based on nearby training examples in the feature space. In KNN, the training examples are vectors in a multidimensional feature space, each with a class label. The training phase of the algorithm consists only of storing the feature vectors and class labels of the training samples. In the classification phase, k is a user defined

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constant, and an unlabelled vector (a query or test point) is classified by assigning the label which is most frequent among the k training samples nearest to that query point. Usually Euclidean distance is used as the distance metric for calculating the distance.

IV. EXPERIMENTS AND RESULTS

Performance of the proposed approaches is evaluated on datasets which is collect from Anant hospital Jabalpur. The databases having sufficient amount of tumor and non tumor MRI images as shown in fig. 2.

Table 1-CLASSIFICATION RATE (CR) OBTAINED WITH DMI + PCA FOR DIFFERENT DB FILTERS ON FERET

Filters	Approximation MRI+PCA	Detail MRI+PCA
db1	61.5	84.2
db2	61.5	84.2
db3	**69.3**	**98.6%**
db4	53.8	84.5
db5	61.5	84.5
db12	61.5	61.2

All results are obtained with 2- fold cross validation. The system is trained with 50% images of database and tested on the remaining 50% images. MRI images of different persons are used for training and testing. The performance is measured by classification rate (CR).

The classification rate is the percentage of correctly classified images with the total number of MRI images in the testing set.

The CR of a system can be defined by: CR = N/T *100 where N denotes the number of correct classified MRI images, and T is the total number of MRI images in the testing set. To generate Details MRI Image (DMI), an efficient wavelet filter is identified by applying different types of Daubechies filter on these databases.

Table 1 illustrates the classification rate (CR) of the proposed feature extraction approaches on database with different Daubechies filter. The db3 filter achieves highest classification rate. Similar results were observed for other databases also. Due to empirical evidences and inherent properties like symmetry, compact support and use of overlapping window [16], db3 filter is chosen for rest of the experiments.

Table 1 shows that PCA on details MRI (Detail MRI + PCA) gives the higher classification rate than PCA on Approximation MRI (Approximation MRI+PCA) for the Databases.

V. CONCLUSION

This paper proposes and experimentally evaluates appearance based method for tumor detection. First the Bi level Wavelet is combined with PCA is applied on MRI for tumor detection. The experimental results show that the Details MRI image +PCA image achieves the highest detection rate than approximation MRI image + PCA. The proposed system improves the accuracy of diagnosis and achieves the approximately 98% classification rate.

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