A Review on Feature Extraction Techniques for Brian Tumor Detection and Segmentation

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Abstract— **Brain tumor detection and segmentation through the Magnetic Resonance Images (MRI) is a crucial task in tumor diagnostics. Screening of brain tumors is an essential to significant improvements in the diagnose and reduce the incidence of death and the accurate analysis of brain tumor images would reduce the diagnostic time and lead to better treatment planning for patients, it can only be as successful as the feature extraction techniques it relies on. Many of these techniques have been used, but it is still not exactly clear which of feature extraction techniques ought to be favoured. There are many feature extraction techniques proposed for tumor detection and segmentation. Extraction of useful features from MR images is a challenging task as the brain tumor varies in size, shape, and structure. This paper surveys the methods and techniques used for feature extraction, for the purpose of brain tumor detection and segmentation from MR images.**

Keywords— Brain Tumor, Magnetic Resonance Image (MRI), Feature Extraction techniques.

I. INTRODUCTION

The human brain is the central organ of the human nervous system. The brain consists of the cerebrum, the brainstem and the cerebellum. It controls the actions of the human body, integrating, and coordinating the information it receives from various sense organs, and making decisions on the instructions sent to the remaining part of the body [1]. Brain tumor is an irregular growth of cancerous or non-cancerous cells in the brain. The reason behind the brain tumor is not predictable. However, the reasons found for brain tumors are radiations and rare genetic condition. Another reason is, technology evolution. Cell phones are used at high rate is one reason for the incidence of brain tumors in young generation. Brain tumors are commonly detected by Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) [2]. The major tumors are: malignant (fast growing) and benign (slow growing) tumors. Primary brain tumors (malignant) affect the surrounding tissues. Secondary brain tumors spread to other parts of the body from brain. Brain tumors are classified according to the location and type of tissue. Around 120 types of tumors are identified and classified by World Health Organization [3].

Early detection of tumor can increase the life span of a person. In diagnosing brain tumors, imaging plays an important role [3]. Diagnosing the brain tumor is still a difficult problem. Finding the exact location of the tumor part is a big challenge in the medical imaging test [4].

The main objective of brain tumor segmentation is to separate tumor region from the normal brain tissues. Many researchers are contributing greatly towards brain tumor segmentation [2].

Diagnosing brain tumor is a very challenging job as tumors are largely diverse in shape and appearance. In earlier research works, many methods were proposed for the automatic diagnosis of brain tumor. In order to classify brain images into different classes various features are extracted from them.

The features are extracted from these images to minimize the usage of time, memory and data. Feature extracted from the image contains important information. This is used as inputs to the classifier for image classification and segmentation [5]. Classification of features extracted from an image is shown in Fig.1.

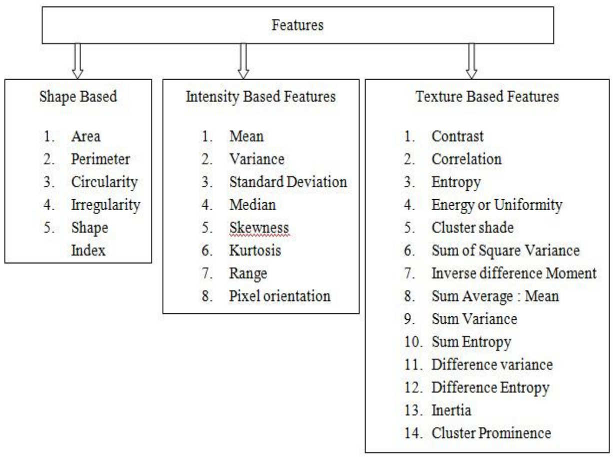

Fig.1. Extracted Features from MR images

This paper contains following Sections: different techniques of feature extraction are discussed in section II, followed by the conclusion in Section III.

II. LITERATURE SURVEY

A study on recent feature extraction techniques for brain tumor detection is given below.

Reema Mathew A et.al., proposed an efficient system for tumor detection and classification. Initially the input image is registered to a reference image. Then the skull and other unwanted details are removed from the input registered image. Ostu's thresholding and morphological operators are used for tumor boundary detection. Next step is the noise removal by an anisotropic diffusion filter. In 2D wavelet decomposition, the wavelet transforms can be applied again on the lowpass-lowpass (LL) version of the image, yielding seven sub images. Hence N level decomposition in 2D cases resulting in 3N+1 different frequency bands namely, LL, LH, HL and HH. Discrete wavelet transform decomposition is applied to the preprocessed image. Now the important features are extracted from the decomposed image. Then the extracted features are combined and normalized and are given as input to the SVM classifier. The output of SVM classifier was obtained as normal or benign or malignant [6].

Wei Chen et.al., proposed a novel method for brain tumor segmentation based on features of separated Local Square. For preprocessing, N4ITK algorithm is used for removing bias field then histogram algorithm is used to transform each image to a specified histogram to ensure that all the images have the similar gray level ranges. Next, the simple linear iterative clustering (SLIC) algorithm is applied to partition the image into perceptually meaningful atomic regions with approximately similar characteristics and size for superpixel segmentation. Then, gray statistical characteristics including mean, standard deviation, skewness are considered and kurtosis and gray level co-occurrence matrix (GLCM) and histogram of local binary patterns (LBP) are used to extract texture features from each superpixel. After feature extraction SVM classifier is designed to classify each superpixel as either tumor region or nontumor[2].

Pratima P et.al., presented an automatic system which is able to detect slices which include tumor and features are extracted from that slice to delineate the tumor area using a single-spectral structural MR image. Image preprocessing which include noise removal, dividing the MRI into two equal half hemispheres. In order to find histogram asymmetry, histograms of each hemisphere is calculated. Then, using mutual information of their histograms, the half part likely to contain a portion of the tumor is determined. After detection of a right half part, which includes expected tumor tissue, it is fed into the feature extraction phase. To extract texture feature, Statistical feature methods such as Gray Level Gap Length Matrix and Gray Level Size Zone Matrix are applied to hemisphere containing tumor to locate the tumor area[7].

Manu Gupta et.al., presented a novel framework for brain tumor diagnosis and its grade classification based on higher order statistical texture features namely kurtosis and skewness along with selected morphological features. In order to improve the segmentation and feature detection process of input MRI brain volumes, bias correction is performed on MRI brain sequences by applying Hidden Markov Random Field Expectation Maximization (HMRF-EM) algorithm. The tumorous regions in the brain were located by using bilateral symmetry property of brain. The method involves dividing the brain in symmetric halves and then comparing them voxel-wise by applying subtraction operation. Output images have higher intensity for nonsymmetric regions, as their intensities will be different. To further differentiate the tumorous regions from remaining areas contrast stretching operation is applied. Lastly, to separate the exact tumor regions, region growing technique is applied with voxel having maximum intensity as seed point. After that, five morphological features are extracted from segmented tumor Major Axis Length Minor Axis Length Eccentricity EquivDiameter (D) Roundness/Circularity(C). The extracted feature set comprising of morphological and statistical features is used to classify the tumorous region using Support Vector Machines (SVM) as low grade or high grade [8].

Reema Mathew A et. al., proposed a technique to segment and classifies the brain tumor from MRI which helps doctors to plan further treatment or surgery. Initial preprocessing has been done with the help of median filter and Ostu's thresholding adopted for threshold determination. Then, in the preprocessed input MRI, the tumor is detected with the help of K-Means clustering. Features are extracted using Discrete wavelet transform (DWT), Gabour wavelet and GLCM. Since the feature vector obtained is a large vector, it is reduced withe help of PCA. Now the PCA output has been given as input to the SVM classifer. The classification of tumor into benign or malignant has performed using various kernels like RBF kernel, linear kernel and polynomial kernel [9].

Prof. Kailash and D. Kharat et.al., given a solution on the different problems of the arrangement of the Magnetic resonance imaging by making vigorous and more precise classifiers which will play the special role in the medical field to give the correct diagnosis on brain tumor like a specialist medical professional. A new technique for the catching of visual substance of an MRI Image is Focus on extraction. Principal Component Analysis (PCA), spatial gray level dependence matrix technique, SVM are the proposed strategies. These methods combine the intensity and the components of the shapes and the different orders with the textures of the tumor from the MRI images[10].

K.Selva Bhuvaneswari. and P.Geetha involved an idea of semantic feature layers (SFL) that relates feature classes based on features of lower levels and include additional knowledge. Vital features comprising of statistical information fed by Principal Component Analysis and semantic feature layer is used for classification. Semantic based image classification and segmentation is an important but inherently difficult problem in magnetic resonance (MR) medical images. Various image processing techniques are used to detect the abnormalities in the MRI images. Semantics, with respect to images, represents the association between low-level visual features and high-level concepts that can be described in words. An intelligent classification technique is essential to identify normal and abnormal slices of MRI brain images. This system had two stages: feature extraction and classification. In first stage PCA and SFL is used to achieve the feature extraction. In the next stage, extracted features are fed as input to PNN. It classifies the images as normal and abnormal. Performance measures such as sensitivity, specificity and accuracy are used to validate the system [11].

Nilesh B. Bahadure et.al., used feature extraction and optimization of the extracted features based on their relevance to detect brain tumor from the magnetic resonance images. By optimizing extracted features, only relevant features are retained for further analysis and so reduce the mathematical complexity of classification of the brain tumor and so detect the abnormalities at a fast rate with higher accuracy as compared to manual detection. Different brain magnetic resonance images obtained an average of 0.73 dice similarity index coefficient are compared, which indicates better overlap between the automated (machines) extracted tumor region with manually extracted tumor region by radiologists[12].

Hsin-Yi Tsai et.al., proposed a GPGPU (General-purpose computing on graphics processing units)-based parallel method to accelerate the extraction of a set of features based on the Gray-Level Co-Occurrence Matrix (GLCM) which is a second order statistic that characterizes textures. Performance evaluation of the proposed method implemented with CUDAC is carried out on various GPU devices by comparing to its serial counterpart. A series of experimental tests focused on Magnetic Resonance (MR) brain images demonstrate that the proposed method is very efficient and superior to the serial counterpart [13].

Anantha Padmanabha A G and S Y Pattar proposed a Textural Feature Extraction and Analysis for Brain Tumors using MRI to diagnosis of brain tumor. Median filter is used for Noise removal, Fuzzy C Means and Level Set Segmentation techniques used for segmentation. Textural feature extraction can be done by GLCM. Enhancement, segmentation, feature selection and Classification phase. The enhanced system is more accurate in classifying the tumor regions. Segmentation extracts the tumor[14].

III. CONCLUSION

The tumor detection and segmentation from MRI images is a time-consuming task. If we extract the relevant features needed for tumor detection and segmentation, then it is possible to have time efficient algorithm for tumor detection. In this paper, we studied various feature extraction techniques used for brain tumor detection and segmentation. It's a fact that the accuracy of the machine learning algorithm depends much upon the features to be used. Here the most widely used features are found to be texture-based feature and transform based features. These features are then given to any supervised and unsupervised machine learning technique for the tumor detection and segmentation purpose. Accurate analysis of brain tumor is a major issue in this world. Any further small contribution to this research area, might help the experts or doctors for diagnosis of the tumor.

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