Image Analysis for Brain Tumor Detection : A Survey

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***Abstract*— Nowadays Diagnosis of diseases using medical image is became cherished tool in medical science. Brain tumor pathologies are the utmost conjoint loss in the existing situation of health care society. Henceforth, precise recognition of the type of the brain irregularity is extremely indispensable for treatment planning which can minimalize the incurable results. Medical imaging technology simplifies the doctors to see the interior portions of the body for easy diagnosis. It also assisted doctors to make aperture surgeries for reaching the internal parts without actually opening too much of the body. In this paper we have discussed different techniques of brain tumor detection and did emphasis on different phases involved in detection.**

***Keywords*— MRI,RGB,PCA,MLP**

I. INTRODUCTION

Brain tumor is an unusual and unreasonable development in the cerebrum. It can be ordered as benevolent and dangerous. Benign tumor remains restricted and does not spread somewhere else in the body and can be cured by surgical expulsion. The harmful tumors spread to different organs and tissues. Both the considerate and harmful tumors are dangerous to the patients and may prompt passing. Picture production of the human body (or parts thereof) for clinical application is alluded as restorative imaging. A restorative imaging procedure utilized essentially in radiology to picture the life systems and working of the body is known as MRI (Magnetic Resonance Imaging). Thus an efficient technique for tumor identification ought to plainly utilize a dependable device where the MRI output can be utilized as an exact method for recognizing tumor from human brain.

The objective here is to eff ectively distinguish and fragment the tumor area from the cerebrum MRI image. Despite the fact that the current technique comprises of relevant data of a voxel in the picture prompting smoothness in the division comes about, the many-sided quality of the mind MRI pictures could be impeding in perceiving the mind tumor division errands utilizing the fix include. MRI exploits the phenomenon of nuclear magnetic resonance (NMR) to produce high quality structural images of the internal organs and other tissues. When undergoing a structural MRI scan, the patient is placed in a powerful static magnetic field, with which the spins of hydrogen atoms in their body align. Applications of MRI segmentation include the diagnosis of brain trauma where a signature of brain injury, white matter lesions may be identified in moderate and mild cases. MRI segmentation methods are also useful in diagnosing multiple sclerosis, including the detection of lesions and the quantization of lesion volume using multispectral methods.

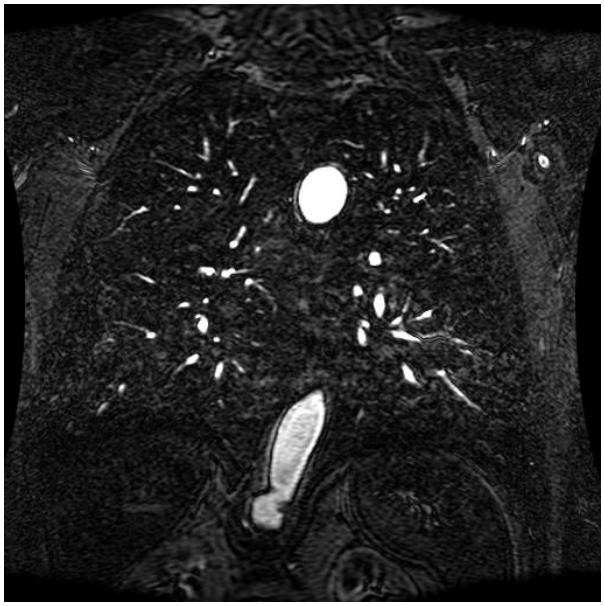

Fig.-1 MRI Image

Automatic brain tumor identification from MRI image involve following steps:
1. Image Acquisition
2. Feature Extraction
3. Classification

Image Acquisition: In this step input MRI image is converted from RGB to Gray image. Input image contains noise, which affect the accuracy of brain tumor detection, henceforth need to reduce or removal of noise is required. Another problem of input image is high dimensionality of input image. There are different methods for dimension reduction eg. PCA (Principle component analysis).

Feature Extraction: The features are of image characterized by their chromaticity values, which prompt colors hue and saturation, evading the luminance constituent. The chromaticity is attained by normalizing the RGB components of the image, named the R, G and, B components.

Statistical Moments: The following statistical features were computed:
1) Mean value, 2) Median value, 3) Standard Deviation, 4) Skewness.
Texture Features: Adaptive Dynamic Range Coding (ADRC) are effective to extract texture features(Feature Vector) .Given an image I(x, y) with size P × Q.

$$\begin{cases} r=R/(R+G+B) \\ g=G/(R+G+B) \\ b=B/(R+G+B) \end{cases} \quad (1)$$

Feature Vector: ADRC (Feature Vector) is Defined as:-
Adaptive Dynamic Range Coding (ADRC):

$$ADRC(x) = \begin{cases} 0, & \text{if } x < x_{av} \\ 1, & \text{otherwise} \end{cases}$$

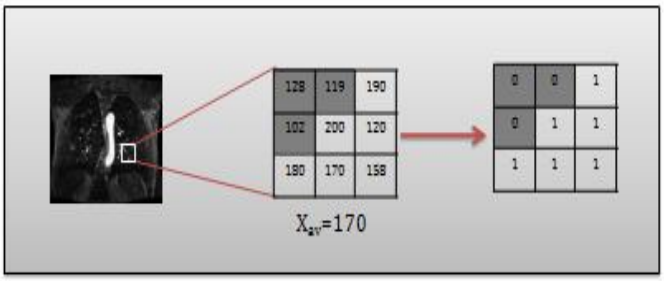

Fig.-2 Calculation of feature vector

Classification: There are several methods meant for image classification. For example neural network, K-means classifier, Self-organizing map (SOM), Support Vector machine etc.

Further in this paper in section-II we will elaborate different literature statement. In section-III we will explain how we have motivated towards this survey. In section-IV we will provide a tabular comparison among different literature. At last section we will conclude our survey.

II. LITERATURE SURVEY

Abdullah Al Jumah et. al. said that the problem of estimating an image corrupted by additive white Gaussian noise has been of interest for practical reasons. Non-linear denoising methods based on wavelets, have become popular but Multiwavelets outperform wavelets in image denoising. Multiwavelets are wavelets with several scaling and wavelet functions, offer simultaneously Orthogonality, Symmetry, Short support and Vanishing moments, which is not possible with ordinary (scalar) wavelets. These properties make Multiwavelets promising for image processing applications, such as image denoising. The aim of this paper is to apply various non-linear thresholding techniques such as hard, soft, universal, modified universal, fixed and multivariate thresholding in Multiwavelet transform domain such as Discrete Multiwavelet Transform, Symmetric Asymmetric (SA4), Chui Lian (CL), and Bi-Hermite (Bih52S) for different Multiwavelets at different levels, to denoise an image and determine the best one out of it. The performance of denoising algorithms and various thresholding are measured using quantitative performance measures such as, Mean Square Error (MSE), and Root Mean Square Error (RMSE), Signal-to-Noise Ratio (SNR), Peak Signal-to-Noise Ratio (PSNR). It is found that CL Multiwavelet transform in combination with modified universal thresholding has given best results [SciRes 2013].

Yudong Zhang et. al. said that work aims at developing a novel pathological brain detection system (PBDS) to assist neuroradiologists to interpret magnetic resonance (MR) brain images. We simplify this problem as recognizing pathological brains from healthy brains. First, 12 fractional Fourier entropy (FRFE) features were extracted from each brain image. Next, we submit those features to a multi-layer perceptron (MLP) classifier. Two improvements were proposed for MLP. One improvement is the pruning technique that determines the optimal hidden neuron number. We compared three pruning techniques: dynamic pruning (DP), Bayesian detection boundaries (BDB), and Kappa coefficient (KC). The other improvement is to use the adaptive real-coded biogeography-based optimization (ARCBBO) to train the biases and weights of MLP. The experiments showed that the proposed FRFE+ KC-MLP + ARCBBO achieved an average accuracy of 99.53 % based on 10 repetitions of K-fold cross validation, which was better than 11 recent PBDS methods [Springer 2016].

Jes´us L´azaro et. al. describes a clustering technique using Self Organizing Maps and a two-dimensional histogram of the image. The two-dimensional histogram is found using the pixel value and the mean in the neighborhood. This histogram is fed to a self-organizing map that divides the histogram into regions. Carefully selecting the number of regions, a scheme that allows an optimum optical recognition of texts can be found. The algorithm is especially suited for optical recognition application where a very high degree of confidence is needed. As an example application, the algorithm has been tested in a voting application, where a high degree of precision is required. Furthermore, the algorithm can be extended to any other thresholding or clustering applications [Elsevier 2006].

Samir Kumar Bandyopadhyay said that For the past decade, many image segmentation techniques have been proposed. These segmentation techniques can be categorized into three classes, (1) characteristic feature thresholding or clustering, (2) edge detection, and (3) region extraction. This survey summarizes some of these techniques. In the area of biomedical image segmentation, most proposed techniques fall into the categories of characteristic feature thresholding or clustering and edge detection. We present current segmentation approaches are reviewed with an emphasis placed on revealing the advantages and disadvantages of these methods for medical imaging applications [IGRCS 2011].

V.P.Gladis Pushpa Rathi et. al. said that Feature extraction is a method of capturing visual content of an image. The feature extraction is the process to represent raw image in its reduced form to facilitate decision making such as pattern classification. We have tried to address the problem of classification MRI brain images by creating a robust and more accurate classifier which can act as an expert assistant to medical practitioners. The objective of this paper is to present a novel method of feature selection and extraction. This approach combines the Intensity, Texture, shape based features and classifies the tumor as white matter, Gray matter, CSF, abnormal and normal area. The experiment is performed on 140 tumor contained brain MR images from the Internet Brain Segmentation Repository. The proposed technique has been carried out over a larger database as compare to any previous work and is more robust and effective. PCA and Linear Discriminant Analysis (LDA) were applied on the training sets. The Support Vector Machine (SVM) classifier served as a comparison of nonlinear techniques Vs linear ones. PCA and LDA methods are used to reduce the number of features used. The feature selection using the proposed technique is more beneficial as it analyses the data according to grouping class variable and gives reduced feature set with high classification accuracy [arxiv 2012].

Mohammad Havaei et. al. present a fully automatic brain tumor segmentation method based on Deep Neural Networks (DNNs). The proposed networks are tailored to glioblastomas (both low and high grade) pictured in MR images. By their very nature, these tumors can appear anywhere in the brain and have almost any kind of shape, size, and contrast. These reasons motivate our exploration of a machine learning solution that exploits a flexible, high capacity DNN while being extremely efficient. Here, we give a description of different model choices that we've found to be necessary for obtaining competitive performance. We explore in particular different architectures based on Convolutional Neural Networks (CNN), i.e. DNNs specifically adapted to image data. We present a novel CNN architecture which differs from those traditionally used in computer vision. Our CNN exploits both local features as well as more global contextual features simultaneously. Also, different from most traditional uses of CNNs, our networks use a final layer that is a convolutional implementation of a fully connected layer which allows a 40 fold speed up. We also describe a 2-phase training procedure that allows us to tackle difficulties related to the imbalance of tumor labels. Finally, we explore a cascade architecture in which the output of a basic CNN is treated as an additional source of information for a subsequent CNN. Results reported on the 2013 BRATS test dataset reveal that our architecture improves over the currently published state-of-the-art while being over 30 times faster [arxiv 2015].

V. Viswa Priya* and Shobarani proposed work detects tumor using a new segmentation method and localisation in brain MR images. T e main aim of presenting this Contextual Clustering based segmentation technique is the improvement of the segmentation accuracy by the reduction of false segmentations. In this work the brain MRI is taken as the input image and the segmented tumor region is got as the output which uses this ef cient Contextual Clustering algorithm which takes less time to segment with least computations in segmentation and hence by improves the segmentation accuracy compared with all other already used conventional methods. Modif cations of the values of the variables used in the proposed algorithm can be tried as the future work for the further improvement in the segmentation [IJST 2016].

JIŘÍ BLAHUTA et. al. hows how to classify the medical ultrasound intracranial images by using PCA method. The main goal is a classification of ROI substantia nigra in midbrain. The classification of images is useful to detection Parkinson´s disease (PD). Work is based on image processing and is realized with the help of artificial neural networks which has been simulated in NeuroSolutions 6 software environment. We have selected a PCA method for processing. This method is well applicable in NeuroSolutions. Author also concluded that principles of modeling neural network for image processing based on PCA method. Detailed description of PCA and all results are available in full paper. The future work will be based on ANN too, maybe with different method or approach. We have checked this simulation in Matlab software with appropriate Neural Network Toolbox [IEEE 2011].

Neha Rani et. al. said that Brain is an organ that controls activities of all the parts of the body. Recognition of automated brain tumor in Magnetic resonance imaging (MRI) is a difficult task due to complexity of size and location variability. This automatic method detects all the type of cancer present in the body. Previous methods for tumor are time consuming and less accurate. In the present work, statistical analysis morphological and thresholding techniques are used to process the images obtained by MRI. Feed-forward backprop neural network is used to classify the performance of tumors part of the image. This method results high accuracy and less iterations detection which further reduces the consumption time [IJCA 2016].

Sudipta Roy et. al. said that Tumor segmentation from magnetic resonance imaging (MRI) data is an important but time consuming manual task performed by medical experts. Automating this process is a challenging task because of the high diversity in the appearance of tumor tissues among different patients and in many cases similarity with the normal tissues. MRI is an advanced medical imaging technique providing rich information about the human soft-tissue anatomy. There are different brain tumor detection and segmentation methods to detect and segment a brain tumor from MRI images. These detection and segmentation approaches are reviewed with an importance placed on enlightening the advantages and drawbacks of these methods for brain tumor detection and segmentation. The use of MRI image detection and segmentation in different procedures are also described. Here a brief review of different segmentation for detection of brain tumor from MRI of brain has been discussed.[arxiv 2013]

III. MOTIVATION

The computerized brain tumor classification is as yet a testing undertaking. One of the reason is tumor's capricious properties, for example, size, shape and area unless the tumor improvement in time is explored and pictures from past examining are accessible. Considering just the free filtering, the greater part of the said properties are obscure. Along these lines normal design acknowledgment procedures depending on such properties and broadly utilized for protest identification what's more, extraction in both therapeutic and true pictures can't be utilized.

Motivation towards this survey is there are several implementation for detection of brain tumor detection but the accuracy of existing are not up to the mark. In introduction section we have discussed that brain tumor identification involves different steps, image preprocessing, Feature extraction and image classification, if we use better techniques in this steps then [illegible] the accuracy of brain tumor detection.

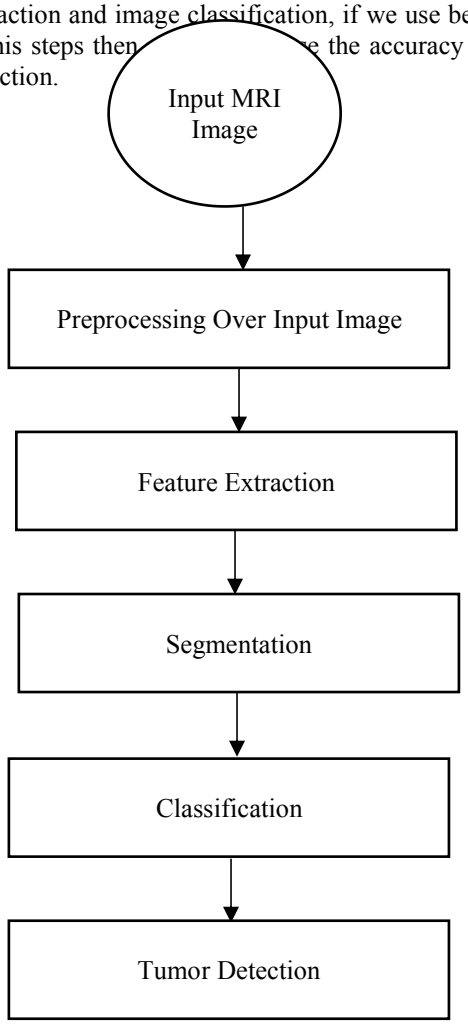

Fig.-3 Detection Process

IV. COMPARISOIN

S. No.	Author/Paper Title/Year of Publication	Method Used	Description
1.	Nilesh Bhaskarrao Bahadure et. al./ Image Analysis for MRI Based Brain Tumor Detection and Feature Extraction Using Biologically Inspired BWT and SVM/Hindavi 2017	Berkeley wavelet transformation (BWT) + SVM (Support Vector Machine)	The proposed method is suitable for integrating clinical decision support systems for primary screening and diagnosis by the radiologists or clinical experts. The experimental results achieved 96.51% accuracy demonstrating the effectiveness of the proposed technique for identifying normal and abnormal tissues from MR images.
2.	Yudong Zhang et. al./A Multilayer Perceptron Based Smart Pathological Brain Detection System by Fractional Fourier Entropy/Springer 2016	Multi-layer Perceptron	Author proposed a new PBDS of BFRFE + KC-MLP + ARCBBO. The experiments validated its effectiveness as achieved an average accuracy of 99.53 %. Author compared three different pruning techniques for MLP and showed KC is the most effective. Besides, we introduced the ARCBBO and proved it give better performance than BBO. Finally, the proposed PBDS is superior to 11 state-of-the-art PBDS methods. Proposed system takes input as medical brain images.
3.	V.P.Gladis Pushpa Rathi et. al./Brain Tumor Mri Image Classification With Feature Selection And Extraction Using Linear Discriminant Analysis/Researchgate 2013	PCA and LDA	In this paper PCA and LDA methods are used to reduce the number of features used. The feature selection using the proposed technique is more beneficial as it analyses the data according to grouping class variable and gives reduced feature set with high classification accuracy. The average correct rate by the method presented is 97.82% with FP of 1.0% and FN of 2.50%. All the features produce classification accuracy of 98.87% using LDA.

			The extracted four PCA components are classified using LDA and SVM classification and the accuracy achieved is 96%.
4.	Mohammad Havaei et. al./Brain Tumor Segmentation with Deep Neural Networks/arxiv 2015	Convolutional Neural Networks (CNN)	Presented an automatic brain tumor segmentation method based on deep convolutional neural networks. We considered different architectures and investigated their impact on the performance. Results from the BRATS 2013 online evaluation system confirms that with our best model.
5.	V. Viswa Priya* and Shobarani/An Efcient Segmentation Approach for Brain Tumor Detection in MRI/IJST 2016	Contextual Clustering algorithm	Proposed work detects tumor using a new segmentation method and localisation in brain MR images. T e main aim of presenting this Contextual Clustering based segmentation technique is the improvement of the segmentation accuracy by the reduction of false segmentations.
6.	Carlos A. Parra et. al./Automated brain data segmentation and pattern recognition using ANN/arXiv 2013	LVQ based ANN's (Artificial Neural Network)	Author implemented an artificial neural network (ANN) algorithm to perform the segmentation of brain MRI data. The multispectral characteristics of MR images with different modalities such as T1, T2 and PD are exploited to segment different brain tissues. The ANN algorithm used in this implementation is the Learning Vector Quantization (LVQ) network.
7.	Neha Rani et. al./Brain Tumor Detection and Classification with Feed Forward Back-Prop Neural Network/IJCA 2016	Feed-forward backprop neural network	This paper shows that combination of feature extraction and classification analysis. After analyzing the results it is concluded that this method is better than the other existing methods in terms of computation time. Specificity is 97.2%, Sensitivity is 97.2% and accuracy is 99.2%. Comparison results of proposed methodology with other authors results shows that this method gives more accurate results with the accuracy of 99.2%

V. CONCLUSION

Brain tumor detection using MRI image analysis is the prime impotent research area. Existing algorithms having accuracy is varying between 95%-98.5%, still medical system requires much more accuracy because medical system is meant for mankind where there is less chance of error, henceforth there necessity of efficient and accurate tumor detection. From our survey we saw that tumor detection from MRI image involved four essential steps as i. Image preprocessing ii. Feature extraction iii. Image segmentation iv. Image classification. Different algorithms used in each step, by the use of efficient algorithm in each step we can increase the accuracy of overall tumor detection.

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