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Survey on Brain Tumour Detection and Segmentation Techniques on MRI Images

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Abstract: At present, in medical image processing brain tumor detection and segmentation is a very fast growing and challenging task in the field of research due to its complex structure and shape. Tumor location is an important factor that affects the individual functioning. Segmentation plays a vital role in detecting the tumour region correctly there by helping the radiologist to analyse the tumour region. For the diagnosis of brain tumour region MRI (magnetic resonance imaging) is usually preferred due to its unchallenging advantages in the image quality. Existing literature suggests a robust method for extraction of brain tumor is yet to be developed.

Keywords: *Magnetic Resonance image, Segmentation, Detection, Fuzzy c mean, Level se.t*

I. INTRODUCTION

Image processing is a methodology which is capable of converting an image into digital form and it performs certain operations on image, so as to achieve an enhanced image or to extract some vital information from it for human interpretation. In image processing, input is an image (may be a video frame or a photograph in any format) and the output may be an image or the characteristics of the input image. Image processing system usually considers an image as a two dimensional signal, while processing. It is similar to digital signal processing. It is one among the emerging technologies, with its branches of application widespread into several domains of business. Researchers are in need of image processing; as it offers real time applications and the results derived from image processing techniques are also made available to the hands of its user.

A brain tumor occurs due to abnormal cells division within the human brain. There are two main types of brain tumors: malignant and benign tumors. Primary brain tumor is malignant, that affect the surrounding tissues and it's called cancerous tumor. The secondary brain tumor are benign, they spread to the brain from another parts in the body. Imaging plays an important role in the diagnosis of brain tumor. Scientist have classified brain tumor according to their location and type of tissue involved to detect whether it is cancerous and non-cancerous. World Health Organization classified 120 types of tumor and it is done based on the behaviour of the cell from less aggressive to more aggressive.

II. LITERATURE SURVEY

In brain MR images after appropriate segmentation of brain tumor, classification of tumor to malignant and benign is difficult task due to complexity and variation in tumor tissue characteristics like its shape, size, gray level intensities and location. Taking in to account the aforesaid challenges, this research is focussed towards highlighting the strength and limitations of earlier proposed classification techniques discussed in the contemporary literature. Besides summarizing the literature, the paper also provides a critical evaluation of the surveyed literature which reveals new facets of research.

1. Xiao et al [2013] proposed an approach to estimate features from the correlation between brain lateral ventricular (LaV) deformation and tumor and apply the extracted features for magnetic (MR) resonance image tumor segmentation. Proposed technique mainly consists of four stages: pre-processing, feature extraction, segmentation and classification. In the first stage, the issue of intensity non standardization, geometric non uniformity and redundant data in the image background and skull are addressed. Lateral ventricular deformation is used for feature extraction. In the segmentation part, the selected and unsupervised segmentation methods are used to evaluate the effect of LaV deformation feature on the brain tumor segmentation. In this paper the most frequently used K nearest neighbours (KNN) and conventional Fuzzy connected C-mean (FCM) method are used. The experimental results on feature extraction shows the relevancy between LaV deformation and location of tumor .Comparative experiments on tumor segmentation suggest that in most cases, tumor segmentation accuracy improves when the extracted features is applied. In the proposed system the Specificity and sensitivity obtained is 100%The proposed brain tissue segmentation steps has a disadvantage of wrongly assigning, a non CSF pixel to the cluster CSF. To remove this undesired pixel, a global mask is applied to remove the pixel area, there by leaving the region as extracted. Future scope of this paper is that, by incorporating the relevant LaV deformation as additional features in the feature set for pattern recognition segmentation method, brain tissue segmentation can be improved.

2. El-Dahshan et al [2010] in their paper presents a hybrid technique for the classification of Magnetic Resonance Images (MRI). The proposed hybrid technique consists of

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three stages: feature extraction, dimensionality reduction and classification. In the first stage feature extraction is done by Discrete Wavelet Transform (DWT). In the second stage, the feature of Magnetic Resonance Image has been reduced by using Principal Component Analysis (PCA). In the classification stage two classifiers have been developed. The first classifier is based on feed forward back propagation artificial neural network (FP-ANN) and the second classifiers have been used to classify subjects as normal or abnormal MRI human image. A classification of 97% and 98% has been obtained by FP-ANN and K-NN respectively. The results shows that the proposed technique is robust and effective compared with other recent work. The limitation of this work is that it requires fresh training each time when ever, there is a change in the image database. In future the work can be extended for the developed technique for processing the pathological brain tissue.

3 Kalbhani et al in their paper, they proposed a method for the classification of MRI in to normal or one of seven different diseases. At the first two level, two dimensional discrete wavelet transform (2D DWT) of the input image is calculated. In this the wavelet coefficients of details sub band can be modelled by Generalized Auto Regressive Conditional Hetroscedasticity (GARCH) statistical model. After feature vector normalization, principal component analysis (PCA) and linear discriminant analysis (LDA) are used to extract the proper feature and remove the redundancy from the primary feature vector. Finally the extracted feature are applied to the K nearest neighbour (KNN) and support vector machine (SVM) classifier separately to determine the normal image or disease type. Experimental results indicate that the proposed algorithm achieve high classification rate and the new introduction method needs only less number of features for classification. In the first scenario the classification accuracy achieved for KNN and SVM classifier are about 97.62% and 98.21% respectively and in the second scenario both classifier achieve about 100% accuracy

4 Sindhumol at al, proposed a method to improve the brain tumor classification from Magnetic Resonance Image based on spectral angle based feature extraction method and spectral clustering independent component analysis (SC-ICA). First the input spectral MRI is divided in to different clusters by spectral distance based clustering. Independent component analysis (ICA) is done on the clustered data in conjunction with support vector machine (SVM). Here T1 weighted, T2 weighted and proton density fluid inversion recovery images were used to evaluate the performance. Comparative analysis with ICA based SVM and other conventional classifiers established the stability and efficiency of SC-ICA based classification. The accuracy achieved by the analysis of ICA based SVM results in 98% and 96.1% for reproduced lesion. However in future the proposed method can be refined with an adaptive threshold selection scheme and the expansion of multi spectral data with more informative MRI sequence, can be used for the analysis of several brain tissues. The experimental results indicate that the classification performance varies on selected threshold values. Low threshold values can improve the classification of local features but it may lead to over clustering, which adversely affect the normal tissue analysis. Feature extraction cost due to clustering in SC-ICA is another issue

5 Nantha gopal and sukanesh [2012] in their paper presented a computer software system designed for segmentation and classification of benign and malignant tumor. In this, the author presents a method to select both dominant run length and co-occurrence texture feature of wavelet approximation tumor region by a support vector machine. 2 D discrete wavelet decomposition is performed on the tumor region the noise. Seventeen features are extracted and six features are selected using students t-test. The selected Features are then fed to the classifiers, SVM and probabilistic neural network and the classification accuracy is evaluated using fold cross validation method. In this the classification accuracy obtained is about 96.4%.The experimental results show that the proposed SVM classifier is able to achieve high segmentation and classification accuracy. However the paper has its own limitation of having a new training set whenever there is change in the data set and this method is applied only to CT images. More over the work can be extended to other type of imaging such as liver CT images, MRI imaging and ultra sound imaging. This paper has its own limitations of having a new training set whenever there is change in data set and this method is applied

6 Georgiadis et al [2008] employed a software system for discrimination between metastatic and primary brain tumor on MRI. The study employed a Modified Probabilistic Neural Network classifier (PNN) and incorporating a nonlinear least square feature transformation(LSFT) in to the PNN classifier in this six features are extracted from the T1 weighted image .in this they ac cured a good classification accuracy of 95.24% for discriminating between metastatic and primary tumor and 93.48% for distinguishing gliomas from meningiomas in the first level and in the second level classification accuracy is 100%.selecting the ROI across the pixel. In the first level gliomas and menigiomas were grouped in to primary brain tumor with the help of third degree LSFT PNN classifier and in the next level the primary brain tumor is again classified in to gliomas and meningiomas with the help of second degree LSFT PNN. The added advantage of this method is the improved performance, increased class separability and the dimensionality reduction. Limitation of this work is that, external cross validation method is used to avoid over fitting condition and it has very less discriminant accuracy

7. Zarandi et al [2011], in their paper presented a type II fuzzy expert system for diagnosing human brain tumor using T1 weighted MR images. The proposed system consists of four modules: pre-processing, segmentation, feature extraction and approximate reasoning. A fuzzy rule base by aggregating the existing filtering method is used for pre-processing step; segmentation is done by extending the probabilistic c mean (PCM) method by using the type II fuzzy concepts, mahalanobis distance and kwon validity

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index. Feature extraction is done by thresholding method and finally a type II approximate reasoning method is developed to recognize the tumor grade in brain MRI. Experimental result shows that the proposed system is superior in recognizing the brain tumor and its grade than type I fuzzy expert system. Its future works include, using parametric operator instead of standard ones makes the system more adaptive.

8. Navarro et al , in their paper presented a new method for feature selection of dimensionality reduction and several off the shelf classifiers on various HMRS modalities ie, long and short echo times and an adhoc combination of both. In feature selection they are having entropy selection algorithm, which is a fast method to generate a relevant subset of spectral frequency. Feature selection is done in the classifier in an independent way in the boot strap samples. Then a set of classifier is developed on the boot strap samples using previously selected set of features and the outcome is the selection of a specific classifier for each data type. A final model is obtained using boot strap sample using iterative procedure. The accuracy obtained for the proposed system is 95%.Therefore the feature research extends the use of the proposed methodology to other brain tumor classification problems involving different pathologies and pathological grouping.

9. Saritha et al [2013] in their paper proposes approach by integrating wavelet entropy based spider web plots and probabilistic neural network for the classification of Brain MRI. The proposed technique uses two steps for classification ie wavelet entropy based spider web plot for feature extraction and probabilistic neural network for classification. The obtained brain MRI, the feature extraction is done by wavelet transform and its entropy value is calculated and spider web plot area calculation is done. With the help of entropy value classification using probabilistic neural network is computed. This probabilistic neural network provides a general solution to the pattern classification problem and its classification accuracy is about 100%. The limitation of this technique is that whenever there is an increase in image database fresh training is required.

10. Zhang et al [2011] in their paper they presented a neural network based method to classify a given MR brain image as normal or abnormal. This method first employs wavelet transform to extract feature from image and then the technique of principal component analysis (PCA) to reduce the dimensions of features. The reduced features send back to back propagation neural network, with which scaled conjugate radiant (SCG) is adopted to find the optimal weight of neural network. The classification accuracy of both training and test image are 100%. In future the proposed method can be employed for MR images with other contrast mechanisms such as T1W, proton density weighted.

11. Lin et al [2005] in their paper they presented a method for precise accurate and efficient quantification of brain tumor via MRI. The purpose of this work is to build a computerised system to evaluate its effectiveness for routine clinical work. In this the image (FLAIR,T1 and T2) are processed independently. The steps involved are (a). MRI image are first standardised for each protocol and subsequent operation is done on the standardised image. The segmentation is done through fuzzy connectedness algorithm. (b). the FLAIR images are segmented to compute the volume of edema. (c). T1 and T1E images are registered and a different image is obtained. (d). the difference image is segmented. (e). all segmented region volumes are computed. However the limitations in this method that it runs automatically except for the choice of a volume of interest and seed point. A user verification step must be added to ensure the quality.

12. Kharrat et al [2010] in their paper they proposed a hybrid approach for the classification of brain tissue in magnetic resonance image (MRI) based on genetic algorithm and support vector machine (SVM). The proposed method has 3 steps:-feature extraction, feature selection and classification. In this a wavelet based texture feature is derived and optimal texture features are extracted from normal and tumor region by using spatial gray level dependence method (SGLDM) and these features are given as input to SVM classifier. The optimal features are used to classify the brain tissue into normal, benign and malignant tumor and their performance is evaluated .the accuracy of the proposed system varies from 96.37% to 98.99%. This paper is having the limitations of having fresh training set whenever there is change in image database.

13. Jayachandran and Dhanasekharan [2013] proposed a paper based on hybrid algorithm for detection of brain tumor in magnetic resonance imaging using statistical and support vector machine classifier. The proposed technique consists of 4 namely noise reduction, feature extraction, feature reduction and classification. In the first stage anisotropic filter is applied for noise reduction and to make the image suitable for extracting features. In the second stage texture features are extracted using gray level concurrence matrix. In the third stage feature is reduced using principal component analysis (PCA). In the last stage the FSVM classifier is used to classify the subject as normal or abnormal image. The classification accuracy is about 95.80%.

14. Sapra et al [2013] in their paper they proposed 2 approaches for brain tumor detection, identification and classification. The first approach is based on integrated set of image processing algorithm that is canny detection algorithm, while the other is based on modified and improved probabilistic artificial neural network structure and the modification is done on the basis of specified region of interest within the tumor area. From each ROI, set of features are extracted and their intensity characteristics are extracted and normalized. Each region of interest is given a weight to estimate the probability density function of each brain and they are given as input to the classifier for classification. Experimental results show that they have

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classification accuracy of about 100%. However the main drawback of this approach is that its classification accuracy is different for different data sets.

15. Lashkari [2010] this paper introduces a novel automatic brain tumor detection method that uses T1, T2 weighted and PD, MR images to determine any abnormality in the brain tissue. The proposed technique mainly consists of 4 stages- pre-processing, feature extraction, feature selection, classification. In pre-processing stage the increase in contrast between normal and abnormal brain tissue is done and DFT of the image is computed. In the next stage, feature extraction is done. Here non-statistical feature extraction namely Gabour wavelet is used and the feature selection is done by means of kernel-F score method. These selected features are then sent to the multilayer perception neural network for further classification. However the system is having the limitation of using all the 3 modalities such as T1, T2 weighted and PD MR Images. Its future works include the integration of features derived from fractural analysis which describes the local texture or ruggedness in terms of an estimated value called Hurst Coefficient.

16. Jafari and Shafaghi [2012]. In their paper presented a hybrid approach for the detection of brain tumor tissue in magnetic resonance image based on genetic algorithm and support vector machine. Proposed system consists of 4 stages. In the first stage –pre-processing: noise removal and contrast enhancing is done. The second stage is segmentation. Skull stripping is done with the help of morphological operations. The third stage is feature selection and extraction. Feature selection is done based on 4 categories- static features, Fourier and wavelet transforms histogram and the combination of prior set. Feature selection is done by means of genetic algorithm. In the fourth stage, the selected features are fed as input to the support vector machine classifier to detect normal and abnormal brain with an accuracy of 83.22%.The limitation of this work is that wavelet transform require large storage and its computational cost is high.

17. Selvaval et al. [] proposed an intelligent classification technique to identify normal and abnormal slices of brain MRI data. In this an advanced classification technique based on least square support vector machine (LS-SVM) are proposed and is applied to brain image slices. The classification of the feature is derived from slices. This classifier using linear as well as nonlinear radial basis function (RBF) kernels are compared with other classifiers like SVM with linear and nonlinear RBF kernels , RBF classifiers, multilayer perceptions(MLP) classifier and KNN classifier. The classification accuracy is about 98.64%.in future this could be further used for the classification of images with different pathological conditions, types and disease status.

18. Rathi and Palani [] in their paper they presented 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 support vector machine (SVM) classifier serves as a comparison of nonlinear technique with linear ones. PCA and LDA methods are used to reduce the number of features. The feature selection using the proposed technique is more beneficial as it analyses the data according to the grouping class variable and gives reduced feature set with high class accuracy. The classification accuracy obtained is 98.87%.

19. Sumitra and Saxena [2013]. In their paper they present a neural network technique for the classification of magnetic resonance human brain images. The proposed techniques consist of namely 3 stages: feature extraction, dimensionality reduction and classification. The feature extraction from MRI have been done using PCA essential features such as mean, median, variance, correlation values of maximum and minimum intensity. In the classification stage the classifier based on back propagation, neural network have been developed. This classifier classifies the subject as normal, benign and malignant brain tumor images. The result shows that the BPN classifier gives fast and accurate classification than other neural networks. The classification accuracy of testing data set of brain image is 73%. Its future works includes increasing the performance of the system by increasing the database.

20 Jain [2010] in this paper he proposed a method that classifies brain tumor based on artificial neural network. The proposed system consists of four stages: pre-processing, feature extraction, BPN classifier and classified image. In the pre-processing histogram equalization and morphological operations are done for enhancing and sharpening the binary image. Feature extraction is done by gray level co-occurrence matrix (GLCM). These extracted features are fed as input to the BPN classifier for classification. There the image is classified in to normal or abnormal image. Future work can be done by using an improved artificial neural network with improvement of feature function will help to achieve well separated data.

21 Deepa and Devi [2012] in their paper they proposed a automatic method that exploit the capability of back propagation and Radial Basis Function neural network function to classify brain image in to cancerous or non-cancerous one. The proposed system consists of multiple phases. First phase consist of texture feature extraction from brain MRI images using statistical features. In the second phase classification of brain images on the basis of these texture feature using BPN and RBFN classifier id done. After classification tumor region is extracted from those images which are classified as malignant using the segmentation process. The main disadvantage of this proposed system is in selecting the optimal features to distinguish between classes. This can be overcome by incorporating spatial auto correlation by fusing at different level reduces MSE in case of RBFN. In future work can be extended in improving RBF using spatial decomposition technique ie like shrinking and kernel catching. For better processing second level decomposition method for image wavelet can be implemented.

22 Mustara & Suchalatha [2012] in their paper they proposed a system for brain cancer detection and classification. The image processing technique like histogram equalization, image segmentation, image enhancement, morphological operation and feature extraction have been developed for the detection of brain MRI images. The extraction of texture feature in the detected tumor has been achieved by using gray level co-occurrence matrix (GLCM). These features are compared with the stored features in knowledge base. Finally a neuro fuzzy classifiers has been developed to recognize different type of brain cancer. The whole system has been tested in two phase firstly learning/training phase and secondly recognition/testing phase by using ANN classifiers

III. CONCLUSION

In this paper, partial survey of various techniques on brain tumor medical image segmentation has been discussed. Recent research in medical image segmentation techniques is presented. Image segmentation process will help to obtain enhanced result with higher efficiency, even though they provide satisfaction result, they failed to provide an accuracy of 100%.From the literature survey, and we can conclude that, no universal system can detect the tumor region more accurately regardless of its location, shape and intensity. Therefore, this topic further can further be explored, so that a better tumor detection system can be built which can help the doctors in evaluating MRI scans as the automated system will take lesser time than manual analysis and will provide more accurate results which will eventually be helpful in the treatment of patients suffering from brain tumor.

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