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Diversified Segmentation And Classification Techniques On Brain Tumor : A Survey

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Abstract - *Brain tumor is the anomalous or uncontrolled growth of the brain cells. Different kinds of tumors give off an impression of being more basic to specific ages, however in general, the best frequency seems, by all accounts, to be in individuals 65 and above. The cases of brain tumor is increasing over these periods. Early discovery of brain tumor is vital for the essential treatment at the correct time. These can be discovered by taking MRI of brain. Magnetic Imaging Resonance (MRI) is imaging technique in medical field which is taken to discover the irregularities in human organs. There are several other imaging models like Computed Tomography(CT), Ultrasound, X-Ray etc. Manually annotating the images are hectic and devours heaps of time. Automatic system for analyzing the images may provide great elucidation about the inconsistencies and save the time of medical specialists. Therefore automatic systems for detection is developed. About twenty research papers are reviewed here which explores various brain tumor detecting techniques. The aim of this work is to consolidate various techniques so far implemented on recent timeline upon brain tumor image processing and furnish new research facts.*

***Key Words*: Brain tumor, Image processing, Image Segmentation, Detection, Classification, MRI**

1.INTRODUCTION

An irregular unusual structure of mass in brain is brain tumor, which grows in an uncontrolled manner. It may be cancerous or may not be cancerous. Cancerous tumors are very dangerous and are difficult to cure completely which may even grow back after surgery or therapy. Moreover, it advances to further segments of the body. But in the case of non-cancerous tumor, it remains within the boundaries of brain. Class of brain tumors frequently diagonised includes Acoustic Neuroma, Astrocytoma, Chordoma, CNS Lymphoma, meningioma, Pituitary tumors etc. Among children Brain Stem Glioma, Ependymoma, Medulloblastoma etc. are more common than in adults. Different types of tumors has different characteristics, identifying those characteristics can help doctors to diagonise what kind of tumor the patient is having. There are many advanced medical image monitoring tools and techniques. A powerful and versatile imaging modality is MRI. It is most preferred due to its peak resolution and quality. There are different MRI sequence images: T1 weighted, Proton Density weighted and , T2 weighted MRI. It uses robust magnetic field and frequency in radio to operate. Once diagonised the treatment has to be started as soon as possible. The treatment options include: surgery, therapies like Radiation, Chemo etc. Nowadays with numerous image processing techniques like segmentation and feature extraction, tumor can be detected by the help of automatic computerized system. The need for the automatic detection of tumor has become inevitable due to the limitation of manual annotation on MRI. Numerous processing techniques on image are applied on MRI for detection of tumor which includes segmentation, feature extraction, feature reduction, classification etc.

2. METHODS

Many methods and algorithms for brain tumor detection on various medical image modalities for detection, segmentation and classification have been introduced by various researchers. The most recent methodologies are reviewed here.

V Viswapriya and shobarani [1] proposed segmentation based on Contextual Clustering method for pre-processing of image and segmentation of tumor in brain MRI. In this they took MRI of brain tumor as input followed by preprocessing it, then the Contextual Clustering algorithm is applied to that pre-processed image for tumor segmentation. This work mainly involves of image pre-processing and tumor segmentation. In Image Pre-Processing session, Input MRI are enhanced by improved manipulated input datasets. Image pre-processing consists sub functions of Image resizing and gray scale conversion, noise removal by median filtering and Morphological opening operations. Tumor segmentation use standard normal distribution derived

Contextual Clustering . They could obtain improvement of the segmentation accuracy by reducing false segmentations.

Swapnil R. Telrandhe et el [2] proposed brain tumor detection adaptively by means of K-Means segmentation with pre-processing of image. SVM is employed in unsupervised method which is employed to generate and maintain the pattern in image pre-processing state. Image is transformed to gray scale, 3x3 median filter is used on brain image in order to eliminate the noise, the image obtained is then passed through a high pass filter to detect edges. Skull Masking is done. Detection of skull is used to control the boundaries of the object, which helps in finding region of interest. The classification and discovery of brain tumor is done by using the Support Vector Machine technique. They could find area of tumor and its type of tumor in addition to their aim of detecting brain tumor.

Laszlo Lefkovits et el [3] proposed a discriminative model for tumor detection from multimodal MR images, using random forest classifier. The standard image database used for segmentation of brain tumor is the BRATS. Pre-processing consists of noise filtering and standardization of luminosity and contrast. In feature extraction stage, they have used first order operators, higher order operators, texture features, spatial context features. They propose their feature selection algorithm, presented in detail in [21].Classification by RF classifiers.It then performs post processing for enhancing the performance of classification. By feature selection algorithm, can find the best feature set for the proposed task. Disadvantages are the database used has considerable limitation in segmentation performance, very time-consuming image annotation process for experts, uniform pre-processing of images, necessity of post-processing.

Saddam Hussain et el [4] proposed algorithm on automated brain tumor segmentation by means of deep convolutional neural network. The proposed methodology is composed of pre-processing, Convolutional Neural Network, and post-processing. In pre-processing state N4ITK bias field correction is used. A CNN is composed of many layers such as pooling, convolution, dense, fully convoluted layer etc.in which convolution layers are the principal building block. Each convolution layer takes feature maps as an input from its previous layer. Convolution layer generate numerous feature maps as result. Simple morphological operators are employed for improving the segmentation results in the post-processing part. Tests are accomplished on BRATS 2013 and 2015 datasets. The models are trained using a two-phase training method. The proposed network performed satisfactorily on both the datasets which produced pretty good results for core and enhancing areas.

N Varuna Shree and T N R Kumar [5] presented a method to Identify and classify brain tumor MRI with feature extraction by means of Discrete Wavelet Transform and probabilistic neural network. Pre-processing of the image done to enhance the visual appearance by removing the noises. Region growing based segmentation is used. Feature extraction using discrete wavelet transform and graylevel co-occurrence matrix for wavelet coeffiecients and statistical feature extraction respectively. The features extracted trained dataset were trained by means of PNN for the purpose of classification. Proposed methodology to achieve accuracy of nearly 100% was achieved for trained dataset and 95% was achieved for tested dataset.

Hao Dong et el[6] proposed a fully automatic technique for segmentation of brain tumor by means of deep convolutional networks with U-Net. The described technique was done on BRATS 2015 datasets. Data augmentation was applied to improve the network performance by producing more training data from the original one. The described architecture on network is established on the U-Net comprised of upsampling and downsampling path. The evaluation was completed by means of a cross-validation method of five fold. Proposed method could provide both efficient and robust segmentation of tumor.

Najeebullah Shah et el[7] presented a fully automated technique for segmentation and classification of brain tumor using cascaded Random Decision Forest (RDF) model. In pre-processing step, the voxel intensities of sequences are normalized using histogram matching technique. More than 200 features are extracted from neighborhood, intensity, texture, and context information. Only 58 features are selected out of these 200 candidates by feature reduction using a novel appraoch. Models are trained and tested using RDF. They used BRATS 2013 dataset for the experiment. The proposed work achieved great results regarding accuracy and efficiency. The future work can be done by searching for more discriminating features and further improving normalization techniques.

Hwan-ho Cho and Hyunjin Park[8] described process of classifying HGG and LGG of brain tumor using radiomics. They used three types of radiomics features, histogram based features, shape descriptors, and GLCM and texture features were calculated. Feature values calculated are

converted to z-scores. LASSO regularization is performed the radiomics score is calculated as the linear weighted sum of feature values. Result shows grade of Glioma can be forecasted using radiomics approach. This could yield better results with additional clinical parameters.

Navpreet Kaur and Manvinder Sharma[9] used self adaptive k-means clustering for brain tumor detection. Median filtering and histogram equalization is used in pre-processing stage. The image obtained is clustered using self adaptive k-means clustering. Sobel edge detection is applied to clustered MRI. The proposed method reduces the thickness of boundary lines of regions and improves the accuracy. The introduced work recognizes the brain tumor growth in each slice of MRI. They could obtain the area and perimeter of detected tumor through their algorithm.

Manisha et el[10] proposed an automated method for detecting brain tumor by means of sobel edge detection method. Pre-processing done using median filter. Next thresholding is performed and then labeling on connected component is done. After segmentation morphological operations applied namely dilation and erosion. The sobel filter decides the edges of the image. Border of tumor area is detected. The proposed method finds the tumor region by thresholding. Unwanted objects are eliminated by setting predefined pixel area for obtaining tumor alone. The tumor border will be identified by sobel gradient finally.

F. P. Polly et el[11] proposed a method for detection and classification of high and low grade glioma from abnormal brain tumor MRI. In this work first the input MRI image is pre-processed by binarizing using Otsu binarization. K-means clustering is applied to the image and it is segemented. Feature extraction is accomplished by means of Discrete Wavelet Transform. PCA is used for feature reduction. After training the dataset it is classified by means of support vector machine into normal or abnormal. The abnormal set is further detected as low grade or high grade tumor. The proposed system could obtain 99 percent accuracy. Future work includes making it more reliable by adding more number of data and can be further applied to classify other brain diseases by adding more relevant features.

Hussna Elnoor Mohammed Abdalla and M. Y. Esmail[12] described the techniques utilized for discovery of brain tumor based on MRI by means of artificial neural networks techniques, with the help of CAD system. First phase the system is pre-processing of MRI images, which includes applying sharpening and smoothing filters. Second phase is post processing of images like segmentation using threshold method, morphological operations using erosion and dilation, feature extraction using Haralicks features method and calculating SGLD matrix. Final phase implements the feature of images for pattern recognition to detect the tumor. ANN is utilized to classify the MRI into normal or anomalous. Dataset is used from Whole Brain Atlas website. The presented algorithm has been successful and achieved the results with accuracy 99%

Bassma El-Sherbiny et el[13] proposed automated detection system for brain tumor, lung cancer and breast dense cancer(BLB). This system does the brain and lung cancer detection as well as segmentation and calculation of breast dense. Like any tumor detection system, first stage is the pre-processing of image where the noise present is removed using appropriate filters. Here Median and Guassian filters are applied. Feature extraction is done and extracted features are passed on to classifier for accurate classification. Image would be classified to normal and anomalous. The abnormal or tumor detected image is then pre-processed and segmented for accurate result, which helps doctor for perfect diagonosis. Segmentation is done using k-means with k=8,then it uses median filter again. Thresholding and Canny Edge Detection is also applied for segmentation process. In post processing, the calculation of maximum, minimum and the quantity of pixels which exceed 250 gray level is done to check the tumor type. Classification is done by means of SVM. This system could achieve good results with minimum time consumption, with 98% accuracy. They used BRATS 2015 AND BRATS 2017 datasets.

Garrepally Gopi Krishna et el[14] proposed a method for automatic classification of brain MRI. The system has three main stages. First is the feature extraction which is deployed by 2-D DWT, which would then generate feature extraction matrix. Normalization of matrix is done. Second is the dimensionality reduction by means of Probabilistic PCA. Final stage is classification using AdaBoost Random Forest algorithm. Random Forest prediction steps are described in their paper. Dataset 66 and Dataset 160 are used for this system. A 5x5 cross validation is applied to the system for optimizing the performance. The combination of AdaBoost algorithm with Random Forest classifier gives good results and performance. This work claims greatest accuracy as compared to existing methods. The future scope of this work is reducing the computational overhead by using Extreme Learning Machine for classification.

A R A Abdulraqeb et el[15] proposed an algorithm for segmentation of brain tumor MRI. The proposed algorithm is formed of two steps: automatic threshold finding and automatic tumor localization. The aim of automatic threshold finding is to eliminate the dependence of the result on the selection of threshold and to obtain segmentation threshold automatically. Therefore an algorithm is developed for that based on the brightness intensity in the histogram of MRI.In automatic tumor localization, they assume that tumor has vertically and horizontally maximum pixel count, finding row of maximum pixel count to determine the tumor location. Developed an algorithm for this also. They used 2 T1 weighted datasets for testing purpose. Sensitivity, Specificity, Dice coefficient, as well as Accuracy is computed. This work was also compared with thresholding and region grow based methods of segmentation. The proposed algorithm achieved good results for both the datasets.

Dr. shubhangi S. Veer and Dr. Anupama Deshpande[16] proposed algorithm for classifying brain tumor MRI using neural network framework. They used median filter for removing noises in the MRI. Segmentation is done using Watershed and Histogram Equalization technique. Classification uses Artificial Neural Network. Feature extraction is done using GLCM, extracted features includes contrast, homogeneity, correlation, energy and entropy. Neurosolution tool is used to select the neural network suitable for this work. Multilayer Perceptron Network, Jordan/Elman Network classifier and Radial Basis Function classifiers are implemented with the given dataset combinations. The results for each of the network is compared with respective datasets. From the obtained results multilayer perceptron network perform best.

G. S. Gopika et el[17] proposed method for detection and classification of tumor in brain by means of Artificial Bee Colony optimization with Fuzzy C Means(FCM). The MRI is input to the system. It is preprocessed to remove the noises, here Guassian filter is used. Segmentation of image is done. Hurst Index is used to find harshness of the area. Feature extracted includes intensity, Piecewise Triangular Prism Surface Area and multi-FD. FCM clustering is adopted and algorithm for the same is described in their paper. Artificial Bee Colony is used for optimization purpose. They applied multi-fractal analysis with surface estimation. Unbalanced data problem is eliminated by AdaBoost SVM algorithm. This system eliminates the need for manual annotations, joint division issues etc. They claim best results as compared to other existing systems.

Sanjay M Shelke and Sharad W Mohod[18] presented a method for semi-automatic segmentation of tumor in brain MRI using Convolutional Neural Network. In pre-processing stage mainly three things are performed first, denoising the image using Anisotropic Diffusion Filtering. Secondly, skull stripping is done. Finally, intensity normalization is done. MGH(Moment of Grey level Histogram) based feature extraction is applied, for the intensity distribution. GLCM is used for feature extraction. K-nearest neighbor algorithm is applied, CNN classifier is used for segmentation. GLCM and CNN is used for classification. CNN method takes less computational time.

Gunasekaran Manogaran et el[19] proposed an approach on Orthogonal Gamma Distribution using machine learning for detecting abnormality in brain MRI, for tumor detection. Coordinate matching is done using edge enhancement and orthogonal gamma distribution. This method automatically identifies region of interest. Guassian Distribution in Ls method and Chehads method and otss method have limitation, therefore Histogram is used. To identify edge coordination edge analysis is done with machine learning approach. For this fractional derivatives are analyzed and their method is applied to get edge details. An algorithm is proposed to enhance the image with black pixel reduction. To avoid data imbalance a heuristic approach is used for analyzing overall pixel distribution. Optimal threshold could be determined by this approach for removing the black pixels. Variance based threshold limit for machine learning approach is used for training orthogonal polynomials. An algorithm for reducing data imbalance is also proposed. Sensitivity and Specificity is calculated. Selecting single threshold value for the trained parameters produced desired results. Mean Square Error Rate and Peak SNR is calculated as well. Future scope of this work is to get a move on real time application using machine learning.

P Mohamed Shakeel et el[20] proposed classification system of brain tumor by means of Machine Learning based Back Propagation Neural Network (MLBPNN) and analyzing it with infrared sensor technology. The input MRI preprocessed. Feature extraction uses Gray Level Covariance Matrix (GLCM) and Principal Component Analysis. The extracted feature includes contrast, dissimilarity, entropy, homogeneity, correlation and energy. Multi Fractal Measurement procedure is adopted for identification and classification. Fractal Dimension Algorithm is used for feature extraction. Adaboost algorithm is used for classification of input brain MRI. For this Adaboost and MLBPNN classifier is used. It feed forwards the training patterns.Then the image is trained by following steps:

clustering the input image, contour drawing, feature extraction, MLBPNN calculation, finally saving the class values. Then the image is tested by following steps: holes filling, erosion, declaring the class size and accuracy calculation. From the obtained results they conclude Back Propagating Neural Network is better than Adaboost classifier. This work is done using 2D images, in future scope this method can be extended to work on 3D medical images.

Table -1: Analysis of work done

Sl. no	AUTHOR	YEAR	METHOD	REMARKS
1	V.Viswapriya et el	2016	Contextual clustering based segmentation	Automatic tumor detection and localization in brain MRI avoiding false segmentation and improving accuracy
2	Swapnil. R.Telrandhe	2016	K-means segmentation SVM for classification	Obtained the type and area of the tumor
3	Laszlo Lefkovits et el	2016	Discriminative Model using Random Forest Classifier	Analysed noise and non standardness. Time consuming for annotation process
4	Saddam Hussain et el	2017	Deep Convolutional Neural Network	Improves the performance parameters
5	N Varuna Shree et el	2017	Discrete Wavelet Transform and PNN	100% accuracy, accurate and speedy detection of tumor
6	Hao Dong et el	2017	Unet based Fully Convolutional Network	Efficient and robust segmentation
7	Najeebullah Shah et el	2017	Cascaded Random Decision Forests	Accurate and efficient detection
8	Hwan-ho Cho et el	2017	Radiomics imaging features	By radiomics grade of gliomas can be well predicted
9	Navpreet Kaur et el	2017	Self Adaptive K-means clustering	Obtain the area and perimeter of detected tumor accurately
10	Manisha et el	2017	Sobel Edge Detection method	Tumor border is identified effectively
11	F. P. Polly et e	2018	K-means segmentation and Support Vector Machine for classification	Accurate detection and classification of gliomas
12	M.Y.Esmail et el	2018	Artificial Neural Network	Obtained 99% accuracy
13	Basma El-Sherbiny et el	2018	K-means for segmentation and Support Vector Machine for classification	Good results with 98% accuracy and minimum time consumption
14	Garrepally Gopi Krishna et el	2018	DWT for feature extraction, PPCA for dimensionality reduction and ABDRF for classification	Better performance and accuracy with promising results
15	A.R.A. Abdulraqeb et el	2018	Automatic threshold finding algorithm and automatic tumor localization algorithm	Obtained best results
16	Dr. shubhangi S. Veer et al	2018	Watershed and Histogram Equalization	Multilayer perceptron network perform best when compared to other

			for segmentation ,Artificial neural network for classificatio n	networks
17	G. S. Gopika et el	2018	Artificial Bee Colony optimization with Fuzzy C Means	Obtained best results
18	Sanjay M Shelke et el	2018	Segmentatio n using CNN ,feature extraction using GLCM	Takes less computational time
19	Gunaseka ran Manogar an et el	2019	Orthogonal Gamma Distribution based machine learning	Accuracy of 99.55% was obtained
20	P Mohame d Shakeel et el	2019	Machine Learning based Back Propagation Neural Network (MLBPNN)	Accurate result obtained using MLBPNN

3. CONCLUSIONS

Over these period of time there have been a lot of progresses in image processing techniques. We have succeeded in examining various segmentation and classification techniques for detection of brain tumor from MRI. Recent works on automatic brain tumor detection techniques are discussed. An analytic study is made on various algorithms along with its highlights. As there have been a lot of works on brain tumor image processing, this study may help the researchers to attempt for techniques not yet implemented for their future research works.

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