ISSN(Online) : 2319-8753
ISSN (Print) : 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

A Survey on Brain Tumor Segmentation Methods with the Remedial Approach

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ABSTRACT: The objective of the proposed method is to put forth a novel and hybrid method to localize the tumor(s) in the brain images. The proposed method has four phases namely; (1) Preprocessing, (2) Feature Extraction, (3) Classification and (4) Diagnosis phase. The steps and procedures in the preprocessing step such as Smoothing, Skull Stripping, and Filtering processes are incorporated to localize the exact tumor boundary. Later part deals with the Feature Extraction and Classification phase to classify the tumor region from the brain tissues. Finally, the Diagnosis phase provides the detailed tumor information such as its location, size, and details about the nearby affected tissues and so on. Even though there exists numerous brain tumor techniques and algorithms, they suffer from the limitations. Henceforth, the proposed method tries to overcome the pitfalls in the existing process and localizes the brain tumor in an optimized manner.

KEYWORDS: Brain tumor, Tumor grades, Enhancement, Segmentation, Feature Extraction, Classification.

I. INTRODUCTION

In general, the tumor is defined as tissue cluster formed due to the aggregation of abnormal cells in the body. Typically, at an appropriate time, the old cells are being replaced by new ones. Due to the advent of a cancerous tumor(s), this cycle is disrupted. The tumor cells grow exponentially and don't perish, unlike healthy cells. Two types of brain tumors are a primary tumor and secondary or metastatic tumor [1]. Usually, the primary brain tumor outsets in the brain and tends to stay during its growth tenure. Whereas, the secondary brain tumor commences elsewhere as cancer in the body and later spreads to the brain region. Further, the primary brain tumor has two sub-division namely, (i) Benign tumor and (ii) Malignant tumor. Table 1 shows the traits of benign and malignant tumors compiled from [1] and [14]. Figure 1 shows the MRI brain images without and with tumors.

Table 1. Features of Tumors

Benign Tumor	Malignant Tumor
Distinct borders	Invasive borders
Slow Growth	Rapid Growth
Rarely spreads	Often spreads
Less harm	Life- threatening

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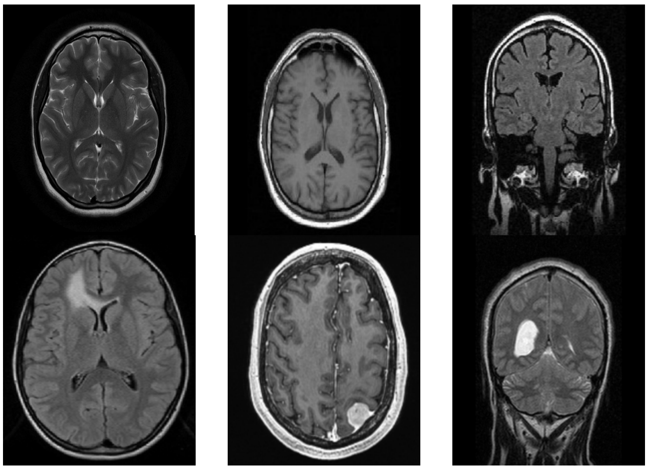

(a)

(b)

Figure 1. MRI brain images (a) Typical MRI brain images (b) MRI brain images with the tumor.

"Glioma" is the small primary brain tumor, and its types include; (1) Astrocytoma, (2) Brainstem Glioma, (3) Ependymoma, (4) Oligo Dendro Glioma, and (5) Optic nerve glioma. Some other types of a primary brain tumor include (1) Primitive Neuroectodermal Tumor (PNET), (2) Pineal gland, (3) Pituitary tumor, (4) Craniopharyngioma, (5) Schwannoma, (6) Meningioma, and (7) Primary Central Nervous System lymphoma. A common type of Secondary brain tumor compiled from [2] includes, (1) Lung cancer, (2) Colon cancer, (3) Breast cancer, (4) Melanoma, and (5) Kidney cancer. World Health Organization (WHO) has graded tumors [1] into four types based on the following criteria; (i) Growth rate, (ii) Similarities when compared to healthy cells, (iii) Uncontrolled growth, (iv) Blood supply, (v) Invasive potential and (vi) Tumor with dead cells in its center region. Table 2 shows the salient features of four grades of tumors.

Table 2. Tumor Grades and its Salient Features

Grade I tumor	Grade II tumor	Grade III tumor	Grade IV tumor
Slow growth	Relatively slow growth	Active growth	Abnormal growth
Almost appears to be normal	Slightly seems to be abnormal	Appears to be abnormal	Seems to be very normal
Least preferred malignant	Possibly invade adjacent tissues	Penetrate to adjacent tissues	Maintains rapid growth
Less Harm	Possibilities of recurring as higher-grade tumors	Chances to recur as higher-grade tumor	Extremely harmful

Mostly, Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) methods are used to analyze the tissues and tumors present in the brain. Digital image processing techniques play a vital role in the medical field to investigate the medical reports. Further, Machine Learning Technology has already solved numerous problems in the medical history. Some of the techniques to detect and locate the presence of tumor in the MRI brain images are as follows: (i) Edge-based detection method, (ii) Shape-based detection method, (iii) Feature-based detection method, and so on. Out of these methods, the proposed method adopts edge-based and feature-based methods to localize and segment the tumor in the MRI brain image.

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The organization of the paper is as follows: Section 2 deals with the existing methods of brain tumor detection methods. Section 3 deals with the summary and discussions about the current methods. Based on the pitfalls in the existing methods, a contemporary method is proposed in Section 4. Finally, Section 5 draws the conclusion.

II. EXISTING METHODS

The following section deals with the existing methods of brain tumor detection methods from the MRI brain images. Parveen and Amritpal Singh [3] proposed a hybrid technique to detect brain tumor using Support Vector Machine (SVM) and Fuzzy C-Means Clustering (FCM). A real dataset of 120 patients' MRI images experimented. The MRI images were converted to two-dimensional matrices (using MATLAB) for image enhancement. Before segmenting the MRI images by using Fuzzy C-Means, the enhanced images are skull striped by Double Thresholding, Erosion, and Region Filling methods. The segmented images are feature extracted by Gray Level Run Length Matrix (GLRLM) for better understating. Further, training the SVM classifier on 96 brain images, the remaining 24 brain images were used for testing to identify the tumor present in brain images. The tabulated performance of SVM Classifier revealed that the accuracy of linear Kernel function is about 91.66%. However, the author concluded that hybrid SVM algorithm might be implemented to improve the accuracy rate by reducing the error rate.

Karthik, Menaka and Chellamuthu's method [4] the detected brain tumor from MRI images efficiently by combining the Curvelet and Gray Level Co-occurrence Method (GLCM) features using Support Vector Machine (SVM) classifier. Irrespective of the technique, pre-processing of MRI images becomes mandatory for the extraction of the brain from MRI images. Skull-stripping was used to pre-process the MRI image. The pre-processed image was segmented by Watershed Transform method to extract Region of Interest. Spatial and frequency domain based statistical features and texture features from the MRI images were stored as feature vectors. Those vectors were used to train the SVM Classifier. The algorithm was evaluated on Brainweb and IBSR datasets. The study compared various classifiers based on the accuracy level. The comparison of efficiency level and RoC plot for different classifiers revealed that the combination of SVM with curvelet and GLCM outperformed other methods in tumor detection. The authors claim to extend the study for classification of images for different pathological conditions, types, and diseases.

Dina, Samy, and Selim proposed a modified Probabilistic Neural Network (PNN) model based on Learning Vector Quantization (LVQ) to carry out an automatic brain tumor classification [5]. The performance of the proposed modified PNN model was measured regarding training performance, classification accuracies and computational time. The model was tested on a database of 64 MRI scan Gray scale image with each image size of 220 X 220 pixels. Among the 64 images, a group of 18 random MRI images was used as test set while the rest were used as training dataset. Simulation results showed that the proposed system successfully classified the MRI images 100% accurately. The modified PNN method reduced 79% of the processing time when compared with earlier systems [6]. The method needs further study in a network structure to tune the performance.

Vishnukumar, Syed and Suthar proposed an automated scheme for contrast enhancement in mammograms [7]. The detection process involved a series of steps like soothing, edge detection, histogram modifications and color mixing. Noise elimination and edge enhancement were carried out using Gabor Algorithm and Fast Fourier Transform, whereas the segmentation was performed using the Marker-Controlled Watershed Algorithm (MCWA) method. The method was tested on breast X-ray mammograms. The simulated results showed enhanced visibility to identify valuable information about the determination of breast cancer. Even though this method has resulted in improved visibility of tumor region, failed to validate with the standard datasets.

Anant and Siddu [8] proposed a method to classify medical images without human inspection. The proposed technique used Principal Component Analysis (PCA) to extract the features and applied Adaptive Neuro-Fuzzy Inference System (ANFIS) tool for training. The ANFIS classifier detected the tumors with the accuracy of 90%. The statistical results showed that ANFIS method outperformed PNN method by more than 90% for the same set of data. However, there is no clarity on the dataset used to evaluate the proposed method.

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Vol. 6, Issue 6, June 2017

Vishal Paramane, Lalita Admuthe, Vinayak Sutar proposed an approach [9] to detect a brain tumor and classify them from MRI brain images using Computer Aided Detection (CAD) scheme. The CAD system includes series of steps to classify tumor, namely, (i) MRI image pre-processing (ii) Determination of ROI (iii) Edge Detection of brain skull (iv) Tumor Segmentation and (v) Classification of tumor stage. To classify the brain tumor, feature extraction was done through localized segmentation method and Back Propagation Neural (BPN) Network with Levenberg-Marquardt(LM) algorithm. Though this approach was not tested on any unique dataset, randomly six images were used for the study. As the binary mask was applied on original image for 100 iterations, the results are accurate with the regression value R=0.99. The best validation performance was obtained at 23rd epoch. Apart from identifying and segmenting the brain tumor, CAD method determined the growth rate of tumor too.

Nithyapriya and Sasikumar [10] proposed a modified AdaBoost Support Vector Machine (AdaBoost SVM) to detect and segment the brain tumor from MRI images. The MRI tumor images are classified into sub-images or blocks. The features are extracted from the sub-images through multi-fractional Brownian motion (mBm) method. On application of AdaBoost SVM algorithm, the features are analyzed in detail to detect the tumor area(s). Even though, the algorithm was able to detect the presence of tumor in MRI brain images.

The hybrid approach implemented by Dipali and Patil [11] was a combination of Support Vector Machine (SVM) and Fuzzy C-Means to predict brain tumor efficiently. The images were pre-processed for denoising and skull stripping. To detect Region of Interest (RoI) from brain MRI images, Fuzzy C-Means Clustering was used. Feature extraction enabled to identify the tumor and the non-tumor area from ROI. The method was tested on tumor images collected from Brain Segmentation Repository and live images from diagnostic centers. To classify the feature extracted images accurately and more efficiently SVM technique was applied. The author used only tumor images for the study, so the efficiency of the proposal method does not deal with non-tumor images.

Santhoshkrishnan, Sivanarulselvan and Betty's study [12] concentrated on brain tumor detection and classification through image processing techniques. The tumor images from MRI and CT scans are used for the survey. The images from scan center are preprocessed initially for noise removal, and by Gray Level Co-occurrence Matrix (GLCM) method the features are extracted. Further, an integrated approach of both Artificial Neural Network (ANN) and Fuzzy C-Means Segmentation technique was used for segmenting the tumor area from the original image; thereby the limitations in both the methods were eliminated. Finally, ANFIS method classifies as either normal or abnormal image. In the case of abnormality, the type of defect was also specified. The technique was evaluated based on accuracy, specificity, sensitivity. The results revealed that the proposed method is superior to the existing one, but the comparison or its values were not mentioned.

Mariam and Zaid's work [13] concentrated on fully automated brain tumor brain tumor detection on brain tumor images. The proposed image processing involves four steps for tumor detection namely; (1) Pre-processing by Anisotropic diffusion filter for denoising MRI images, (2) The denoised images are masked based on symmetry, (3) SVM classifier detects the brain tumor from the masked images, and (4) The segmentation process was evaluated based on Dice-coefficient (DC) where a DC > 0.7 is ideal segmentation. When this algorithm was evaluated with 40 MRI brain images, brain tumor detection accuracy was found to be 95.5%. However, authors failed to specify the performance of the algorithm with standard datasets.

III. SUMMARY OF EXISTING METHODS

Table 2 shows the overview of existing methods discussed in Section 2. Some of the important factors to be considered for localizing, segmenting and classifying the brain tumor in the MRI brain images are as follows:

1. Smoothing and Enhancing process has significantly affected the tumor detection accuracy
2. Denoising and Skull stripping process augments the tumor detection process to the next level.
3. Precise tumor segmentation is required to explore the characteristics of tumors in the brain.
4. An acceptable classifier is needed to classify and grade the tumors as primary or secondary tumors.
5. Either the standard datasets or the live images should be used for evaluation purpose.

IJIRSET

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Vol. 6, Issue 6, June 2017

Table 3. Summary of existing brain tumor segmentation methods

Ref.	Year	Adopted Methods				Database	Segmentation Accuracy (%)	Remarks
		Enhancement	Pre-processing	Segmentation	Classifier			
[3]	2015	Mid-range Stretch	Skull stripping	Fuzzy C-Means	SVM	120 images from WWW	91.66%	Accuracy can be improved by reducing error rate
[4]	2015	-	Skull stripping	Watershed Algorithm	SVM, GLCM	Brainweb and IBSR dataset	90%	May extended to detect other tumors
[5]	2012	Smoothing by Gaussian filter	-	-	LVQ based PNN	64 images	100% in classification.	Determination of network structure needs refinement
[7]	2012	Gabor and Fast Fourier Algorithm	-	MCWA	-	Breast X-ray mammograms	Enhanced visibility of image to identify more information	Visibility rate is missing. Standard dataset not applied.
[8]	2013	-	-	-	ANFIS	-	More than 90%	Not evaluated with Standard datasets
[9]	2013	-	Median filter	Active Contour	ANN	6 Random images	Regression value =0.99	Standard dataset not used.
[10]	2014	-	Standard methods	Multifractional Brownian Method	Ada Boost SVM	-	Not mentioned	Standard dataset not used.
[11]	2016	-	Skull stripping	Fuzzy C-Means	SVM	Internet Brain Segmentation Repository	Not mentioned	Non-tumor images are not considered for the study
[12]	2016	-	Median filter	Fuzzy C-Means	Fuzzy Logic and NN	-	Accuracy Rate, specificity and sensitivity not mentioned	Type of abnormality (if any) is identified
[13]	2017	Anisotropic Diffusion Filter	-	Dice co-efficient method	SVM	40 MR images	95.5% in tumor detection	Standard dataset not used

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By considering all these factors, the proposed method collaborates four phase to localize, segment, classify and diagnose the tumors in the MRI brain images.

The following section illustrates the various processes in the proposed method.

IV. PROPOSED METHOD

Figure 2 shows the phases of the proposed method; (i) Preprocessing, (ii) Feature Extraction, (iii) Classification, and (iv) Diagnoses Result. The aim of the proposed method is to detect and localize the brain tumor in the MRI brain images. The first phase, Pre-processing step, has further sub-divided into the following phases namely, (i) Smoothing, (ii) Skull stripping, (iii) Filtering, (iv) Enhancement using Contrast Limited Adaptive Histogram Equalization (CLAHE) method, (v) Segmentation using Fuzzy C-Means Clustering (FCM) method and defining the Region of Interest (RoI). As a result, the output of the first phase is the localization of tumor in the input image. The tumor detected image is subjected to the second phase, feature extraction phase using Gray Level Co-occurrence Matrix (GLCM) and Gray Level Run Length Matrix (GLRLM) method, where the most dominating features are extracted from the RoI. Later, these features are analyzed and classified in the third phase, Classification phase, using Support Vector Machine (SVM) classifier. Finally, the fourth phase, diagnosis phase, provides the specification details about the tumor (if any).

V. CONCLUSION

Nowadays, the development techniques in the medical field using DIP to detect the brain tumor is inevitable. Henceforth, the proposed method figure outs the possibilities of pitfalls in the existing brain tumor methodologies and proposes a novel hybrid method for localizing the tumor from the MRI brain images. The proposed method has four phases namely, Preprocessing, Feature Extraction, Classification and Diagnosis phase. As a part of research work and future work, authors are planning to evaluate the proposed method with the live images apart from standard datasets.

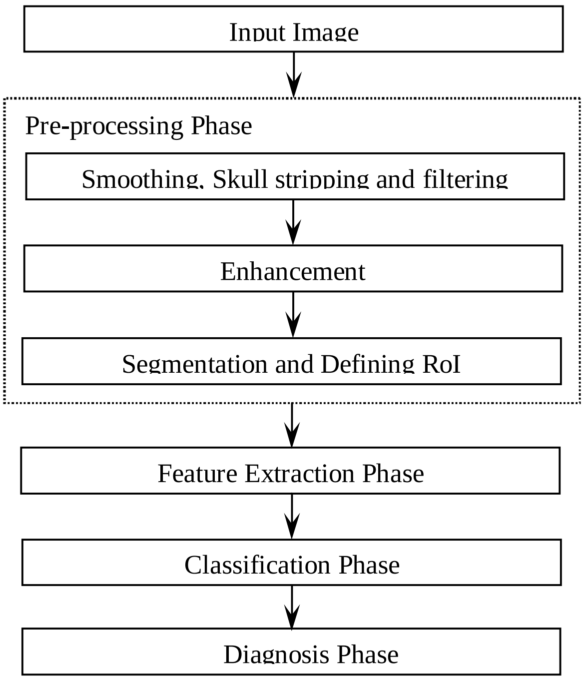

Figure 2. Proposed Method

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ISSN (Print) : 2347-6710

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Website: www.ijirset.com

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REFERENCES

[1] Brain Tumor Primer, A Comprehensive Introduction to Brain Tumors, American Brain Tumor Association, 9th Edition, https://neurosurgery.mgh.harvard.edu/abta/abta_braintum or_primer.pdf
[2] Brain Tumors: Introduction, https://www.saintlukeshealthsystem.org/health-library/brain-tumors-introduction
[3] Parveen and Amritpal Singh, "Detection of Brain tumor in MRI images, using Combination of Fuzzy C-Means and SVM", 2nd International Conference on Signal Processing and Integrated Networks, pp. 98-102, 2015.
[4] R. Karthik, R. Menaka, C. Chellamuthu, "A comprehensive framework for classification of brain tumor images using SVM and Curvelet transform", International Journal of Biomedical Engineering and Technology, Vol. 17, No. 2, pp. 168-177, 2015.
[5] Dina Aboul Dahab, Samy S. A. Ghoniemy, Gamal M. Selim, "Automated Brain Tumor Detection and Identification using Image Processing and Probabilistic Neural Network Techniques", IJIPVC, Vol. 1, No. 2, pp. 1-8, 2012.
[6] Mohd Fauzi Othman, Mohd Ariffanan and Mohd Basri, "Probabilistic Neural Network for Brain Tumor Classification", 2nd International Conference on Intelligent Systems, Modelling and Simulation, 2011
[7] Vishnukumar K. Patel, Syed Uvaid, Suthar, "Mammogram of Breast Cancer Detection based using Image Enhancement Algorithm", International Journal of Emerging Technology and Advanced Engineering, Vol. 2, No. 8, pp. 143-147, 2012.
[8] Anant Bharadwaj, Kapil Kumar Siddu, "An approach to Medical Image Classification using Neuro Fuzzy Logic and ANFIS classifier", IJCTT Vol. 4, No. 3, pp. 236-240, 2013.
[9] Vishal Paramane, Lalita Admuthe, Vinayak Sutar, "Brain Tumor Detection using method of Segmentation based on Soft Computing", International journal of Innovative Research in Science, Engineering and Technology, Vol. 2, No. 8, pp. 3687-3696, 2013.
[10] G. Nithyapriya and C. Sasikumar, "Detection and Segmentation of Brain tumors using AdaBoost SVM", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 2, Special Issue 1, pp. 2323-2328, 2014.
[11] Dipali B.Bismale, S.N.Patil, "Brain Tumor MRI image segmentation using FCM and SVM techniques", International Journal of Engineering Science and Computing, Vol. 6, No. 12, pp. 3939-3942, 2016.
[12] G. Santhoshkrishnan, K. Sivanarulselvan, P. Betty, "Brain tumor Detection and Classification using Image Processing", International Journal on Application in Information and Communication Engineering, Vol. 2, No. 4, pp. 32-35, 2016.
[13] Mariam Saii, Zaid Kraitem, "Automatic Brain tumor detection in MRI using image processing techniques", Biomedical Statistics and Informatics, Vol. 2, No. 2, pp. 73-76, 2017.
[14] Brain Tumors (Benign and Malignant): Symptoms, Causes, Treatment: www.webmd.com/ cancer/brain-cancer/brain-tumors-in-adults#1