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Brain Tumor Segmentation Methods: A Review and Challenges

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ABSTRACT

The objective of the paper is to throw the light on the existing procedures of Brain Tumor segmentation methods. The uncontrolled growth of cells forms the tumor. If such tumor is formed in the brain region, then it is termed as "brain tumor". The paper also focuses on the preface to Brain Tumor, conventional Brain Tumor segmentation process, and few existing methods. Finally, as the concluding remarks, the challenges and issues faced during the tumor segmentation process are discussed in detail. Authors would like to extend their future work in developing the efficient method to localize and segment the brain tumor using the bounding box method and Support Vector Machine, respectively.

Keywords: Bounding Box Method, Brain Tumor, Brain Tumor Types, Computed Tomography, Magnetic Resonance Imaging, Tumor Grades, Tumor Segmentation.

I. INTRODUCTION

In general, the "tumor" is defined as the abnormal growth or out of control growth of the cells. If such tumors are formed in the brain cells, then it is termed as brain tumors. The tumors are categorized into two major divisions, based on the initial location of the cell from which the tumors are initiated. The categories are (1) primary tumor and (2) the second tumor. The tumor initiated in the brain tissues are referred as the primary tumor. The tumor cells initiated elsewhere in the body parts and spreads to brain tissues are referred as secondary tumors. The secondary brain tumors are also called as "Metastatic" brain tumors. The categorization of tumors is carried out on the following basis:

(1) The location of the tumor.

(2) The types of cells where the tumor is invoked.

(3) The tumor growth rate, that is, the severity of the tumor and the nearby affected tissues/cells.

Further, the primary brain tumor is divided into two categories based on the growth rate, tumor boundaries, and the spreading nature. The types of primary brain tumors are (1) Benign, and (2) Malignant tumors [1]

The features of benign tumors are (1) slow growth, (2) clear tumor boundaries, (3) rarely spreading nature. Even though the benign tumor does not have serious side effects, their location determines the vital role in threatening life.

The features of malignant tumors are (1) Rapid growth, (2) capricious boundaries, and (3) rapidly affecting the nearby cells with the spreading nature. These tumors remain World Health Organizations (WHO) has laid the foundation for classifying the brain tumors using standard communication, planning the treatments and predicting the outcomes [2]. The classification of tumors was based on the type of the cell where the tumor originates, and grading was based on its aggressive nature. Table 1 summarizes the features of tumor grades ranging from I to IV.

Table 1 Tumor grades

Grade I	Grade II	Grade III	Grade IV
Slow growth rate	Relatively slow growth rate	Actively produces abnormal cells	Rapid growth of abnormal cells
Practically appears to be normal	Marginally seems to have abnormal appearance	Abnormal in nature	Authentic abnormal in nature
Minimum malignant	Possibilities of invading the adjacent tissues	Penetrate into normal tissues	(Mostly) contains the dead cells in the center region.
Long-term survival	Possibilities of recurring into higher grades	Likely to transform into higher categories	Recursive growth by forming new blood vessels

II. CAUSES OF BRAIN TUMORS

Even though there are advancements in the medical field to save the humans, still the mystery behind the origins of brain tumor is unrevealed. The following section shows the general causes of brain tumors summarized from [2].

(1) Presence of cancer cells elsewhere in the other parts of the body.

(2) Continued exposure to chemicals, pesticides and poisonous solvents, and

(3) Inherited diseases.

There are three ways to confirm the presence of tumor in the brain tissues. They are;

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(1) Computed Tomography (CT): The CT scan is a safe and noninvasive testing procedure that uses X-ray beam to build two-dimensional brain images. The brain structure can be viewed and analyzed in a layer-by-layer approach, which is used to explore more about the abnormalities in the brain tissues.

(2) Magnetic Resonance Imaging (MRI): The MRI, another noninvasive test, uses radio frequency waves and magnetic field to create the meticulous view/image of the brain tissues.

(3) Biopsy: When the diagnosis of CT and MRI scan is not precise, then the biopsy is the only choice to determine the status of the brain tumors. It is the best method followed by a pathologist to remove the tiny tumors present in the brain region(s) using a microscope. It is carried out either as a part of open surgery or as a needle biopsy. Types of biopsy include (1) Needle biopsy (where a hollow needle is passed through a narrow hole in the skull to remove the affected tissues) and (2) Stereotactic biopsy is used to handle the rooted tumors in the complex locations.

Fig. 1 shows the typical MRI scan images of the brain with benign and malignant tumors, respectively.

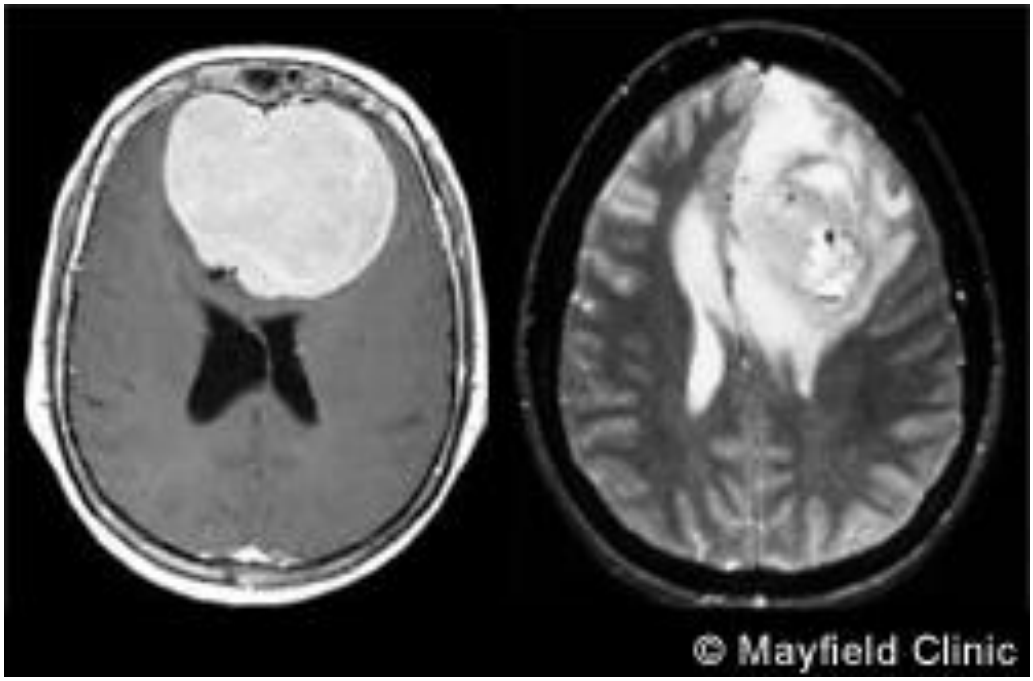

Fig. 1 (a) Benign tumor (b) Malignant tumor (Courtesy: Source [2])

The following section deals with the procedure followed in the existing methods to segment the tumors in the brain tissues with its performance measures.

III. CONVENTIONAL BRAIN TUMOR SEGMENTATION METHOD

Fig. 2 shows the typical method for detecting the tumors in the MRI brain images. There is some sequential preprocessing of input MRI brain images to classify and confirm the presence of tumor in the input image. The

first step in the brain tumor segmentation process is to resize the input image to a standard size image (for example 256 x 256 pixels), so that, further processing becomes easier to handle the usual image size. The second step is to enhance the image features using the conventional techniques. The benefits of enhancement process include the enhancement of (1) image quality, (2) visual appearance of the image components, (3) clarity, and (4) to provide the transformation procedures in the subsequent image processing steps. The third step is to normalize the intensity to the uniform level throughout the image. The purpose of normalizing the intensity level not only eliminates the noise in the image but also provides significant improvement during the tumor classification process [3].

The fourth step, background segmentation process, also known as "background subtraction", deals with separating or isolating the background features from the image. Henceforth, foreground image features are apparently visible and legible for further processing [4]. In the fifth step, the detection of midsagittal brain plain takes place to identify the initial level dissimilarities in the brain tissues. The subsequent process proceeds with the feature extraction and classification processes with the help of few trained data. The resultant of this phase concludes and confirms the presence of tumor in the input brain image. If the input image has a tumor, its location is identified and subsequently segmented, and then diagnosis result(s) are provided with the features of tumor in the input MRI brain image.

IV. EXISTING METHODS

The following section deals with the existing brain tumor segmentation methods along with its performance issues.

Segmentation of brain MRI images for clinical analysis is a challenging task. Ching, Chen and Lin proposed FCM based Automatic Thresholding Algorithm for segmenting the MRI brain images [6]. Initially, the Otsu's threshold method was applied to compute initial threshold (separated image from the background) and then using FCM Cerebrospinal Fluid (CSF), Gray matter (GM) and White matter (WM) in the cerebrum region of the brain are determined. The cerebrum area was masked and compared with that of the original image and Region of Interest (RoI) was further segmented. The proposed method was compared and verified with the K-Mean method based on the uniformity measure of the region R. If R is close to 1, then the image is well segmented and if it is close to 0 then it a worst case. Authors experimented the algorithm on images obtained from Taiwan Medical center. The uniformity measure of WM, GM, and CSF were 0.99, 0.99, and 0.98, respectively. Further, the images were visually inspected using the contour. However, the number of images used for the experimentation was left unmentioned.

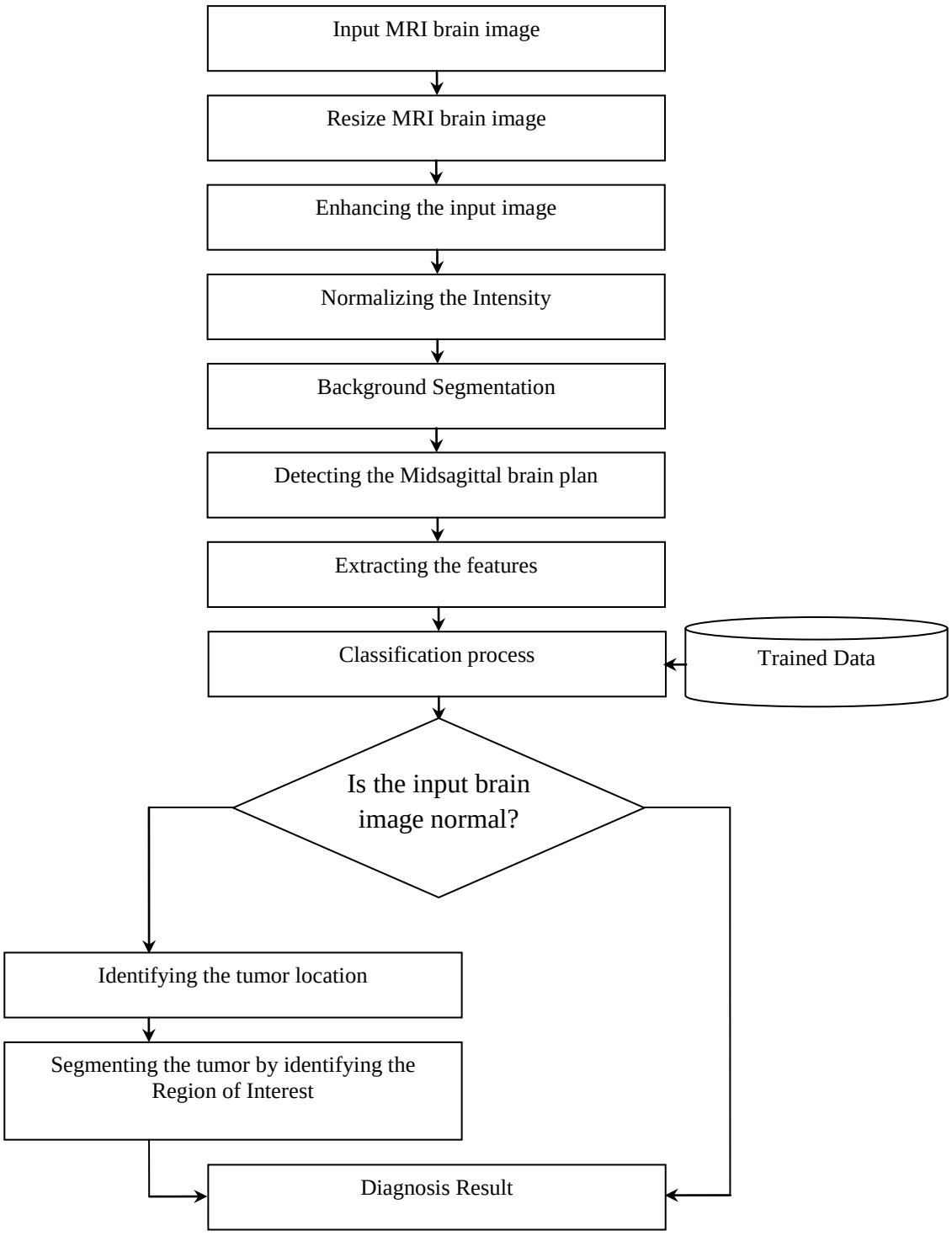

Fig .2 Conventional Brain Tumor Segmentation Method

Dai and Yan reviewed several image segmentation algorithms to propose an improved Fast Level set Matching Algorithm (FM) for detecting and segmenting the Region of Interest specifically the brain tumor [7]. The traditional Fast Matching Algorithm caused edge-leakage in the low-level gray region which was eliminated in

the improved FM Method. The formulae of velocity function were different from that of the traditional method. The efficiency of the proposed improved FM method was validated using Visual C++ environment. However, the improved FM method did not experiment on any standard dataset and failed to provide the accuracy and efficiency rates.

The authors proposed a hybridized Brain Segmentation method using Fuzzy Logic and Artificial Neural Networks (ANN) [8]. The proposed segmentation method has various steps such as;

- Preprocessing the MR images through image masking and applying Canny Edge Detection and morphological operators.
- Extracting the candidate areas by identifying common properties such as gray color surface, texture and color.
- Labeling the candidate points.
- Extracting the common properties such as brightness, shape, texture of the labeled candidate points
- Finally, the images are classified and segmented by Neural Network and Fuzzy Clustering Method.

The proposed method was compared with existing methods and validated regarding Sensitivity (0.94) and Specificity (0.93) respectively. Fuzzy C-Means and Fluid Vector Flow combined with Support Vector Machine (SVM) methods were used for comparison. Even though the comparative study shows the positive rate and not the error rates, there is no clear distinction in the number of images used for evaluation.

Shantha Kumar and Ganesh Kumar proposed an automated approach for tumor detection from MRI images [9]. This method adopted various techniques for feature extraction namely,

- Preprocessing by Anisotropic Diffusion Filter for noise removal.
- Using GLCM, gray level values are computed, further Local Binary Pattern (LBP) was applied followed by determination of Gray Level Features. Further, the Gray level Features are enhanced by multi-resolution images through Wavelet Transform

The multi-resolution images are segmented using Support Vector Machine Classifier. The proposed method was analyzed based on Sensitivity (99.4%), Specificity (99.6%), Positive Predictivity (97.03%) and Accuracy (99.5%) respectively. The segmented brain tumor images were compared with the ground truth images to prove its superiority or accuracy. Even though the authors claimed for higher tumor segmentation accuracy, they failed to specify the datasets used and the number of images used for evaluation.

Patil and Balachandra proposed an effective method for extracting tumor region from MRI brain images using MATLAB [10]. The algorithm was implemented in six steps. They are (1) conversion of input image into grayscale image, (2) initial denoising and sharpening of image took place by applying high pass filters, (3) median filter was employed to enhance the image quality (4) selection of threshold level for segmentation process (5) segmenting the region of interest using watershed segmentation method, and (6) finally, the morphological operations were applied to exclude the undesirable regions in the input MRI brain image, such that, the essential regions (tumor) are preserved with its original properties. The resultant of 6 steps yields in the localization of tumor region in the input image. However, data sets used for evaluation segmentation accuracies were unanswered queries in this approach.

Prajapati and Jadhav proposed a brain tumor segmentation approach using negative Matrix factorization method **[**11**]**. The proposed method consists serious of sub-processes namely, grayscale conversion, histogram equalization, sharpening the image features using high pass filters, denoising using median filters, thresholding followed by morphological processing operations. Finally, subtracting the resultant image with the original (input) brain image resulted in identifying the exact tumor location. Further, the tumor location is justified using region growing approach. Even though, the authors discuss the steps for in tumor segmentation in an elaborative manner, the data sets and segmentation accuracy of brain tumor from the input image where left unanswered.

Gavhande and Jadhav proposed a method to detect and extract brain Tumor from MRI scan images [12]. The MRI scan image was preprocessed and segmented to extract a tumor region. Routine procedures such as grayscale conversion, noise removal, and image enhancement were carried out during the pre-processing stage. The preprocessed images were submitted through watershed segmentation method. The morphological operation was applied to the resultant image get the final location of tumor region. The authors neither specified the database used for evaluation nor the details of experimental results.

V. CHALLENGES IN THE BRAIN TUMOR SEGMENTATION PROCESS

The following section depicts the issues and problems in localizing the tumor region(s) and the region of interest in the MRI brain images. Some of the challenging issues are summarized in [5] are as follows:

(1) The noise in the input MRI brain image.

(2) Heterogeneous intensity levels in the input brain image.

(3) Contrast level of the input MRI brain image.

(4) Difficulty in identifying the tumors in the early stages due to the absence of clear distinction between the healthy brain tissues and the tumor regions.

(5) If the tumor size is minimal, then localization of such tiny tumors becomes a tedious process, or sometimes there are possibilities of misinterpretation (by human experts) as healthy brain tissues.

(6) To classify the brain tumor correctly and categories its nature, numerous MRI sequence brain images has to be captured and analyzed.

(7) The tumor identification is a laborious effort and time-consuming process, and

(8) Further, feasibilities of human errors due to inter and intra-variations of brain tissues are considered as tumors and vice-versa.

VI. CONCLUSION

Medical Image Processing plays a vital role in diagnosing the abnormalities in the humans using MRI and CT scan methods. Among the different types of processes, MRI is the noninvasive and effective procedure to diagnose the brain tumor region(s). In this paper, authors had presented the overview of typical Brain Tumor segmentation procedure along with the few existing methods. By considering the merits and demerits of the

general Brain Tumor segmentation methods, authors would like to propose an efficient brain tumor localization and segmentation methods using bounding box method.

REFERENCES

[1] http://www.cancerresearchuk.org/about-cancer/brain-tumours/grades

[2] https://www.mayfieldclinic.com/PE-BrainTumor.htm

[3] A. Brahim, J.M. Gorriz, J. Ramirez, L. Khedher, "Linear intensity normalization of DaTSCAN images using Mean Square Error and a model-based clustering approach," *Studies in Health Technology and Informatics, 207, 2014, 251-260.*

[4] K. Karunakara, "*Some contributions to the study of pattern recognition*", Ph. D., Thesis, Kuvempu University, 2012. Available online: http://shodhganga.inflibnet.ac.in/handle/ 10603/ 25143

[5] Konstantinos Kamnitsas, Enzo Ferrante, Sarah Parisot, Christian Ledig, Aditya Nori, Antonio Criminisi, Daniel Rueckert, and Ben Glocker, "DeepMedic for Brain Tumor Segmentation", https://www.microsoft.com/en-us/research/wp-content/uploads/2017/02/ kamnitsas2016brats.pdf

[6] Ching-Hsue Cheng, You-Shyang Chen, Tzu-Cheng Lin, "FCM based Automatic Thresholding Algorithm to segment the Brain MR image", *Proceedings of the Sixth International Conference on Machine Learning and Cybernetics, 2007, 1371-1376.*

[7] Dai Junfeng and Yan Yunyang, "The Fast Medical Image Segmentation of Target Region Based on Improved FM Algorithm", *Procedia Engineering, International Workshop on Information and Electronics Engineering, 29, 2012, 48-52.*

[8] Dr. Mohammad, V Malakooti, Seyed Ali Mousavi and Dr. Navid Hashemi Taba, "MRI Brain Image Segmentation using Combined Fuzzy logic and Neural Networks for Tumor Detection", *Journal of Academic and Applied Studies, 3(5), 2013, 1-15.*

[9] P. Shantha Kumar and P. Ganesh Kumar, "Performance Analysis of Brain Tumor Diagnosis Based on Soft Computing Techniques", *American Journal of Applied Sciences 11(2), 2014, 329-336.*

[10] Rajesh C. Patil and A. S. Bhalchandra, "Brain Tumor extraction from MRI images using MATLAB", *International Journal of Electronics, Communication & Soft Computing Science and Engineering, 2(1), 2012, 1-4.*

[11] Sahil J Prajapati and Kalpesh R Jadhav, "Brain tumor detection by various image segmentation techniques with introduction to nonnegative matrix factorization", *International Journal of Advanced Research in Computer and Communication Engineering, 4(3), 2015, 599-603.*

[12] Sonam S. Gavhande and S. B. Jadhav, "Image Segmentation and identification tumor from MRI image", *International Research Journal of Engineering and Technology, 2(2), 2015, 167-170.*