

## A Survey of Brain Tumour Segmentation Methods: A Review

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**Abstract-** Brain tumor segmentation aims to separate the different tumor tissues such as active cells, necrotic core, and edema from normal brain tissues of White Matter (WM), Gray Matter (GM), and Cerebrospinal Fluid (CSF). MRI based brain tumor segmentation studies are attracting more and more attention in recent years due to non-invasive imaging and good soft tissue contrast of Magnetic Resonance Imaging (MRI) images. With the development of almost two decades, the innovative approaches applying computer-aided techniques for segmenting brain tumor are becoming more and more mature and coming closer to routine clinical applications. The purpose of this paper is to provide a comprehensive overview of MRI-based brain tumor segmentation methods.

**Keywords -** Brain Tumour, Magnetic Resonance Imaging (MRI), Segmentation.

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### I. INTRODUCTION

There are a lot of segmentation techniques for brain tumor detections. Thresholding Method: The most popular and commonly used method for image segmentation is Thresholding methods. In this method, image pixels are divided with the help of intensity level of an image. This method is mainly used to distinguish the foreground objects from background images. Edge Based Segmentation method is a connected pixel that is found on the boundary of the region is called an edge. So these pixels on an edge are known as edge points [3]. Edge can be calculated by finding the derivative of an image function. Some edges are very easy to find. These are: Ramp edge, Step edge, Roof edge, Spike edge.

**Region Based Segmentation Method:** This method is based on segmented an image on the basis of similar characteristics of the pixels. Region Based segmentation method is further divided into two categories, one is Region Growing and the second is Split and Merge

**Clustering Based Segmentation Method:** The clustering based techniques are the techniques, which segment the image into clusters having pixels with similar characteristics. Data clustering is the method that divides the data elements into clusters such that elements in same cluster are more similar to each other than others.

**Watershed Based Method:** The watershed based method uses the concept of topological interpretation. In this the intensity represents the basins having hole in its minima from where the water spills. When water reaches the border of basin

the adjacent basins are merged together. To maintain separation between basins dams are required and are the borders of region of segmentation. These dams are constructed using dilation. The watershed methods consider the gradient of image as topographic surface. Partial Differential Equation Based

**Segmentation Method:** The partial differential equation based methods are the fast methods of segmentation. These are appropriate for time critical applications. There are basic two PDE methods: non-linear isotropic diffusion filter (used to enhance the edges) and convex non-quadratic variation restoration (used to remove noise).

**Artificial Neural Network Based Segmentation Method:** A neural network is an artificial representation of human brain that tries to simulate its learning process. An artificial neural network is often called a neural network or simply neural net.

**Brain Tumor:** A brain tumor is characterized by the unusual development of cells inside the mind or focal spinal waterway. A few tumors can be destructive along these lines they should be distinguished and cured in time. The correct reason for mind tumors is not clear nor is a correct arrangement of manifestations characterized, in this way, individuals might be experiencing it without understanding the peril. Essential mind tumors can be either dangerous (contain disease cells) or amiable (don't contain growth cells) [9].

Brain tumor happened when the cells were separating and developing anomalous. It seems, by all

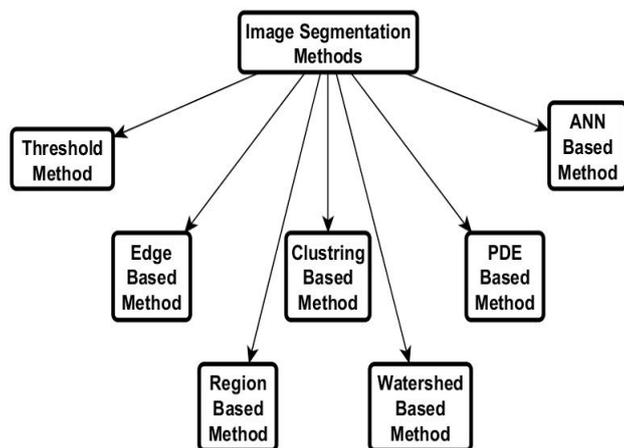


Figure 1: Segmentation methods

accounts, to be a strong mass when it determined to have symptomatic medicinal imaging strategies. There are two sorts of mind tumor which are an essential cerebrum tumor and metastatic mind tumor. An essential cerebrum tumor is a condition when the tumor is shaped in the mind and tended to remain there while the metastatic mind tumor is the tumor that is framed somewhere else in the body and spread to the mind [10].

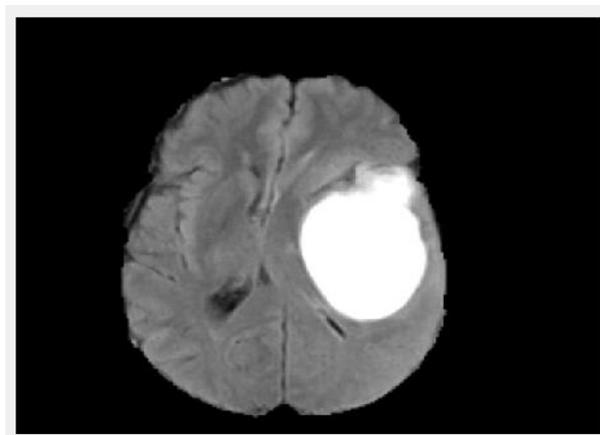


Fig. 1: Brain Tumor MRI Image

The side effect has a mind tumor relies upon the area, size, and sort of the tumor. It happens when the tumor compacting the encompassing cells and gives out the weight. Moreover, it additionally happens when the tumor obstructs the liquid that streams all through the cerebrum. The regular indications are having migraine, queasiness, and regurgitating, and having an issue with adjusting and strolling. A cerebrum tumor can be identified by the analytic imaging modalities, for example, CT sweep and MRI. Both of the modalities have favourable circumstances in identifying relying upon the area sort and the motivation behind examination required. In this paper, we want

to utilize the CT pictures since it is anything but difficult to inspect and gives out exact calcification and outside mass area [10].

The CT picture procured from the CT machine give two measurement cross-sectional of the cerebrum. In any case, the picture obtained did not remove the tumor from the picture. Accordingly, the picture preparing is expected to decide the seriousness of the tumor relies upon the size [10].

The explanations behind choosing CT pictures upon MRI pictures are as per the following:

1. CT is considerably quicker than MRI, settling on it the investigation of the decision in instances of injury and other intense neurological crises. CT can be gotten at impressively less cost than MRI.
2. CT can be gotten at impressively less cost than MRI.
3. CT is less delicate to understanding movement amid the examination.
4. The imaging can be performed considerably more quickly, so CT might be less demanding to perform in claustrophobic or overwhelming patients.
5. CT can be performed at no hazard to the patient with implantable therapeutic gadgets, for example, heart pacemakers, ferromagnetic vascular clasps, and nerve stimulators.

The concentration of this venture is CT cerebrum pictures' tumor extraction and its portrayal in a less difficult frame to such an extent that it is reasonable by everybody. People have a tendency to comprehend shaded pictures superior to anything highly contrasting pictures, in this manner, we are utilizing hues to make the portrayal less sufficiently difficult to be comprehended by the patient alongside the therapeutic staff. Shape plot and c-name of the tumor and its limit are customized to give 3D representation from the 2D picture utilizing distinctive hues for various levels of force. An easy to understand GUI is likewise made which causes therapeutic staff to accomplish the above target without getting into the code.

Benign tumors or Non Malignant tumors are often surrounded by a protective “sac” – a mechanism performed by your immune system – that segregates it from the rest of your body and enables it to be easily removed. This type of tumors can be serious if they are pressing a primary nerve, a main artery, or compresses brain matter.

Malignant tumors are formed from abnormal cells that are highly unstable and travel via the blood stream, circulatory system, and lymphatic system. Malignant cells do not have chemical adhesion molecules to anchor them to the original

growth site that benign tumors possess. These types of tumors are mainly responsible for the cause of cancer.

Segmentation of images into meaningful regions has been an important issue in diagnosis of medical images. Various Techniques used to detect tumors are:

- a. Image Transformation.
- b. Sharpening of Image.
- c. Image Segmentation using Otsu Thresholding Method.
- d. Labeling of Image.
- e. Morphological Operations.
- f. Edge Detection using Laplacian Mask.

## II. LITERATURE REVIEW

An automated brain tumor segmentation method was developed and validated by Michael R. Kaus against the manual segmentation with three-dimensional magnetic resonance images in 20 patients with meningiomas and low-grade gliomas. The automated method (operator time, 5–10 minutes) allowed rapid identification of brain and tumor tissue with an accuracy and reproducibility comparable to those of manual segmentation (operator time, 3–5 hours), making automated segmentation practical for low-grade gliomas and meningiomas [1]. Jin Liu provided a comprehensive overview of MRI-based brain tumor segmentation methods. Firstly, a brief introduction to brain tumors and imaging modalities of brain tumors is given.

Then, the preprocessing operations and the state of the art methods of MRI-based brain tumor segmentation are introduced. Moreover, the evaluation and validation of the results of MRI-based brain tumor segmentation are discussed. Finally, an objective assessment is presented and future developments and trends are addressed for MRI-based brain tumor segmentation methods [2]. Stefan Bauer provided a comprehensive overview by giving a brief introduction to brain tumors and imaging of brain tumors first. Then we review the state of the art in segmentation, registration, and modeling related to tumor-bearing brain images with a focus on gliomas.

The objective of segmentation is outlining the tumor including its sub-compartments and surrounding tissues, while the main challenge in registration and modeling is the handling of morphological changes caused by the tumor. The qualities of different approaches are discussed with a focus on methods that can be applied to standard clinical imaging protocols. Finally, a critical assessment of the current state is performed and future developments and trends are addressed, giving special attention

to recent developments in radiological tumor assessment guidelines [3]. Sajid Iqbal proposed network uses BRATS segmentation challenge dataset which is composed of images obtained through four different modalities. Accordingly, we present an extended version of existing network to solve segmentation problem. The network architecture consists of multiple neural network layers connected in sequential order with the feeding of Convolutional feature maps at the peer level. Experimental results on BRATS 2015 benchmark data thus show the usability of the proposed approach and its superiority over the other approaches in this area of research [4].

Brain magnetic resonance image (MRI) segmentation is a complex problem in the field of medical imaging despite various presented method. MRI image of human brain can be divided into several sub-regions especially soft tissues such as grey matter, white matter and cerebrospinal fluid the combinatorial algorithm provide a solution to overcome the associated challenges of segmented brain MRI. Asymmetry analysis of brain has great importance because it is not only indicator for brain cancer but also predict future potential risk for the same. Nilesh. L. Shimpi concentrated to segment the anatomical region of the brain, divide the two halves of the brain and to detect each half for the presence of a tumor. Bilateral and mathematical analysis using Laplacian, gradient operator operates on real pictures, and the results show that the algorithm is flexible and convenient [5].

Munmun Saha reviewed various methods of segmentation and its application in medical image processing i.e. MRI image Ultrasound Image etc., we have focused on Brain Tumor MRI image. Recent medical imaging research faces the challenge of detecting brain tumor through MRI (Magnetic Resonance Image). There is a high diversity in the appearance of tumor tissue among different patients and in many cases similarity with the usual tissue.

They have used MRI because it provides accurate visualize the anatomical structure of the tissue. In this paper, a various method that has been used for segmentation of MRI for detecting brain tumor is reviewed [6]. Sahil J Prajapati proposed Nonnegative Matrix Factorization method which is mainly used as an uninterruptable decomposition approach for detection of tumor and to further classify into various types and also for feature extraction. NMF aims to find two non-negative matrices whose product closely approximates the original matrix. NMF contains all matrices to contain only non-negative elements and the NMF results show no cancellations, linear superposition only and considerable sparsity [7].

III. COMPARITIVE ANALYSIS

The following table describes various method of the segmentation that are used in the brain tumor detection.

	TECHNIQUE DESCRIPTION	ADVANTAGES	DISADVANTAGES
HISTIGRAM METHOD	This segmentation process mainly needs that the histogram of the picture has numerous peaks, where each relates to a specific region.	It normally doesn't require a previous information of the image. And it includes fewer calculation complexity.	1) Basically for an image without some noticeable peaks or the image with wide and even valleys, this technique does not works fine. 2) This technique does not reflect the facts, so it is not able to assure that partitioned regions are contiguous.
REGION BASED METHODS	Group Pixels into homogeneous regions. Includes region merging, region splitting, region growing or their combinations	It works best when the region homogeneity standard is quite simple to describe. This technique first removes noise and then detects the edges.	1) The biggest drawback is that this technique is quite costly both in memory management and time used in computations; 2)This technique has a characteristic dependency on the variety of seed region and the way in which regions and pixels are studied;
EDGE BASED METHODS	Based on the recognition of discontinuity, basically efforts to locate points with more or less abrupt changes in gray level.	Edge detection technique is the method in which human notices things and works well for images having fine difference between regions.	1)It does not work fine with images in which the edges are not properly-defined or there are many edges; 2) It is not a insignificant job to crop a closed curve or boundary; 3) Less resistant to noise than other techniques.
FUZZY METHODS	Apply fuzzy operators, mathematics, Properties and inference rules, provide a way to handle the uncertainty inherent in a diversity of problems due to ambiguity rather than randomness.	Fuzzy membership function can be used to represent the degree of some properties or linguistic phrase, and fuzzy IF-THAN rules can be used to perform approximate inference.	1)The determination of fuzzy membership is not a small job; 2) The computation involved in fuzzy approaches could be intensive.
NEURAL NETWORK METHODS	Using neural networks to perform classification or clustering	No need to write complicated programs. Can fully utilize the parallel nature of neural networks.	1) Training time is long; 2)Initialization may effect the result; 3)Overtraining should be avoided.

Table 1: Segmentation techniques

IV. CONCLUSION

Brain magnetic resonance image (MRI) segmentation is a complex problem in the field of medical imaging despite various presented method.MRI image of the human brain can be divided into several sub-regions especially soft tissues such as grey matter, white matter and cerebrospinal fluid the combinatorial algorithm provide a solution to overcome the

associated challenges of segmented brain MRI. In this paper, we have reviewed various methods of brain tumor segmentation. i.e. Histogram based, region based, edge based, fuzzy based and neural network based.

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