An Overview on Automated Brain Tumor Segmentation Techniques

Arati Kothari,
Govt. Degree College,
Kalaburagi- 585105,
India

Dr. B. Indira,
Kasturba Gandhi Degree & PG College for Women,
Secunderabad, 500026,
India

Research and Development Centre, Bharathiar University, Coimbatore – 641 046

Abstract:
Segmentation of brain tumor is a very important and crucial step in the initial detection of tumor in the Medical Image Analysis. Though various methods are present for brain tumor segmentation, but detection of tumor still is a challenging task since for researchers as tumor possesses complex characteristics in appearance and boundaries. Brain tumor segmentation must be done with precision in the clinical practices. The objective of this review paper is to presents a comprehensive overview for MRI brain tumor segmentation methods. In this paper, various segmentation techniques have been discussed. Comparative analysis among these various segmentation conventions has been discussed in brief.

Keywords: Brain tumor, Image Segmentation, Medical Image Analysis, MRI.

1. Introduction:

A brain tumor is usually an abnormal mass of tissue in which some cells grow and multiply uncontrollably, apparently unregulated by the mechanism that control normal cells. The growth of a tumor occupies space within the skull and interferes with normal brain activity. A tumor can cause damage by shifting the brain or pushing against the skull, by increasing pressure in the brain, and by invading and damaging nerves and healthy brain tissues. Brain tumors are classified based on the type of tissues involved in the brain, the positioning of the tumor in the brain, whether it is benign tumor or malignant tumor and other different considerations. Brains tumors are the solid portion that spread throughout the surrounding tissues or distort the surrounding structures.

Image segmentation is one of most important task in image processing. It is used to analyze images in different fields; such as medical, science, agriculture and industry fields. The main objective of the image segmentation is to partition an image into mutually exclusive and exhausted regions such that each region of interest is spatially contiguous and the pixels within the region are homogeneous with respect to a predefined criterion. Widely used homogeneity criteria include values of intensity, texture, color, range, surface normal and surface curvatures.

In recent years, medical imaging and soft computing have made significant advancements in the field of brain tumor segmentation. This paper shows a review of various segmentation techniques for brain tumor detection using MRI image segmentation.

2. Literature Survey on MR Brain Image Segmentation:

During the past many researchers in the field of medical Segments the tumor from the brain is an important for to visualization the situation before do the surgery to achieve the desire result, it is important to raise the medical field to achieve the best result by using all the new techniques and by utilization all the computer features to enhance the segmentation purpose. Also it is used the computer to speed up the procedure got doing the segmentation. In recent literatures on medical image segmentation, several common approaches have been arrived. The available segmentation methods in literature for MR brain images can be broadly classified into 8 categories shown in fig 1.

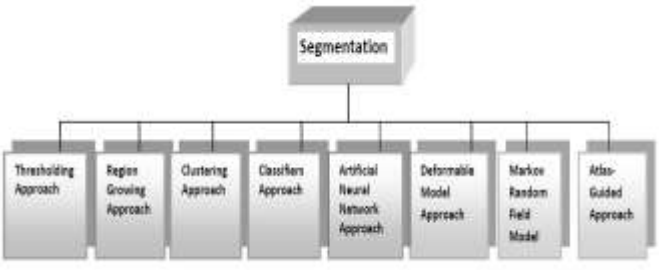

Fig 1: Classification of Brain Tumors

3. Segmentation Methods:

3.1 Fast Marching Method: It can be used as a fast initialization algorithm for image segmentation. Despite the fact that it requires low computational cost, in particular that the speed in this method is always positive or

always negative. Automatic detection of the crossing of the interesting edges is difficult to implement.

3.2 GA with Deformable contour Method [1]: This report use genetic algorithm (GA) as a searching method applied with deformable contour to segment brain MR images. Multiscale approach has been used in order to help accelerating brain area identification at coarse scales and localizing more accurate brain contours at finer scales.

3.3 The maximum likelihood Approach [2]: This approach segment the pathological tissue from the normal tissues .The drawback of this approach is that the proposed system is dependent class probabilities and threshold values.

3.4 Hidden Markov random field-Expectation Maximization [3]: HMRF model is a stochastic process generated by a MRF whose state sequence cannot be observed directly but can be indirectly estimated through observations. HMRF-EM framework, an accurate and robust segmentation can be achieved.

3.5 Modified Expectation Maximization (EM) algorithm [4]: This approach differentiates the healthy and the tumorous tissues. A set of tumor characteristics are presented in this paper which is highly essential for accurate segmentation. But the drawback of this work is the lack of quantitative analysis on the extracted tumor region.

3.6 Thresholding method [5]: This is simple and effective segmentation method for images with different intensities. The technique basically attempts for finding a threshold value, which enables the classification of pixels into different categories.

3.7 Radial basis function neural network (RBF) and contour model [6]: A combined radial basis function neural network and contour model based MR image segmentation technique is dealt in this paper. The contour model is used as a pre-segmentation step by developing the clear boundaries between the different tissues. RBF neural network is then used to segment the various brain tissues into different groups.

3.8 Atlas-based segmentation [7]: The atlas-based approach is able to segment several structures simultaneously, while preserving the anatomy topology. The method, provides a good trade-off between accuracy and robustness, and leads to reproducible segmentation and labeling.

3.9 Modified suppressed fuzzy c-means (MS-FCM) segmentation [8]: MS-FCM performs clustering and parameter selection, for the suppressed fuzzy c means algorithm simultaneously. It can easily select the parameter in Suppressed-FCM with a prototype-driven learning and also this algorithm seems to be simple in its computation. The parameter selection is on the basis of exponential separation strength among clusters.

3.10 High speed parallel fuzzy C means algorithm [9]: The high speed parallel fuzzy C means algorithm is more advantageous both in the sequential FCM and parallel FCM which employs the clustering process in the segmentation techniques. When the image size is so large, the proposed algorithm works very fast and it requires minimum execution time.

3.11 Back propagation neural network [10]: In this paper comparative analysis is done with the Inverse Laplace Transform based technique. The report concluded that BPN is superior in terms of processing time and accuracy over the conventional algorithm.

3.12 Fast neural network [11]: An iterative-free training approach is followed in this network using the Huang's neural network. The convergence time period is considerably reduced since the weights are determined analytically rather than through conventional weight adjustment procedure.

3.13 Watershed transform and level set method [12]: It combines the watershed transform and region-based level set method. The watershed transform is first used to presegment the image. The region-based level set method is then applied for extracting the boundaries of objects on the basis of the presegmentation. The consumed time does not depend on the size of the image but the number of presegmented regions. This method is computationally efficient.

3.14 Bayes-based region growing algorithm [13]: Bayes-based region growing algorithm that estimates parameters by studying characteristics in local regions and constructs the bayes factor as a classifying criterion. The technique is not fully automatic and this method fails in producing acceptable results in a natural image. It only works inhomogeneous areas. Since this technique is noise sensitive, therefore, the extracted regions might have holes or even some discontinuities.

3.15 Marker controlled watershed Segmentation [14]: This method is quite versatile, fast and simple to use. This can be applied to all type of 2D MR images representing all tumors irrespective of their location in human body and their size.

3.16 Deformable models [15]: The Segmentation efficiencies reported in this approach is very low and the report also concluded that the proposed approach is a failure in case of

symmetrical tumor across the mid-sagittal plane.

3.17 Color based segmentation method [16]: This paper proposes a color-based segmentation method that uses the K-means clustering technique to track tumor objects in magnetic resonance (MR) brain images. Experiments demonstrate that the method can successfully achieve segmentation for MR brain images to help pathologists distinguish exactly lesion size and region.

3.18 LVQ neural network [17]: The concept of GA is incorporated in this technique to improve the performance of conventional LVQ. An analysis in terms of segmentation efficiency and convergence time.

3.19 Support Vector machine[18] : Support vector machine is a promising technique in image segmentation because of its good generalization performance, especially when the number of training samples is very small and the dimension of feature space is very high

3.20 A fuzzy kohonen neural network [19] : This technique is completely dependent on the input features which are the drawback of this system. The qualitative and quantitative analysis results are inadequate when compared with the other techniques.

3.21 Marker controlled watershed Segmentation [20]: This method is quite versatile, fast and simple to use. This can be applied to all type of 2D MR images representing all tumors irrespective of their location in human body and their size.

3.22 Modified-FCM segmentation [21]: An improved segmentation technique has been proposed in this paper on the basis of FCM clustering algorithm. The neighbor pixels of targets are varied by applying the Sigma filter principle. The proposed algorithm **is** compared with FCM algorithm in visual evaluation and quantitative evaluation thereby the efficacy of the proposed method was demonstrated.

3.23 The improved FCM algorithm [22]: It is based on the concept of data compression where the dimensionality of the input is highly reduced. Since the modified FCM algorithm uses a reduced dataset, the convergence rate is highly improved when compared with the conventional FCM.

3.24 Vector quantization [23]: This paper presents a vector quantization segmentation method to detect cancerous mass from MRI images. It is a very effective model for image segmentation process. Vector quantization is a classical quantization technique from signal processing which allows the modeling of probability density functions by the distribution of prototype vectors.

3.25 Gaussian smoothing based FCM algorithm [24]: This approach has incorporated a feature selection algorithm for improved accuracy. Experimental analysis has revealed the suitability of this approach for noisy MR images. But the computational complexity of this approach is significantly high due to the bootstrap based feature selection techniques

3.26 Spatial Information with Fuzzy C-Means Clustering [25]: This approach utilizes histogram based Fuzzy C-Means clustering algorithm for the segmentation of medical images. The spatial probability of the neighboring pixels is incorporated in the objective function of FCM to increase the robustness against noise.

3.27 Hierarchical Self Organizing Map with FCM [26]: This paper, proposed a hybrid technique combining the advantages of Hierarchical self organizing map with FCM. This paper is used to give more information about brain tumor detection and segmentation of HSOM with FCM is the performance of the MRI image in terms of weight vector, execution time and tumor pixels are detected. The hybrid approach is accurately identifying the principal tissue structures in the image volumes.

Conclusion:

In this paper, the various automated techniques for brain tumor segmentation are analyzed in detail for the detection of brain tumor. This paper is used to give more information about brain tumor segmentation techniques using MR images.

The most challenging and active research area in the field of image processing for the last few decades is image segmentation. In spite of the availability of a large variety of methods for MRI brain tumor segmentation, but still, MRI brain tumor segmentation is a challenging task and there is a need and huge scope for future research to improve the speed, accuracy and precision of segmentation methods.

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