Indian J.Sci.Res. 17(2): 514-519, 2018 ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

A SURVEY ON VARIOUS METHODS FOR SEGMENTATION OF BRAIN TUMOR

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Abstract-Magnetic resonance (MR) images are a very useful tool to detect the tumor growth in brain. Segmentation of brain tumor from MRI images in an efficient way becomes an important role in medical image processing. One of the challenging task is to segment the tumor in an automatic manner. In this paper, we are highlighting different methods and technology used to segment the tumor. The advantages and disadvantages of several methods and technology will be discussed.

Keywords-MRI, Thresholdingbased segmentation, Region based method, K-Means clustering, Watershed segmentation.

I. Introduction

Image processing becomes one of the important role in the field of Medical Imaging. Magnetic resonance image (MRI) becomes an important tool for most of the researcher. It produce high quantized image giving minute details regarding delegate structure within human body. The results obtained from analysis are used to guide for the treatment.

Here a tumor may be defined as a swelling part of a body caused due to abnormal growth of tissue or cell. Studies have found that brain tumor is caused due to exposure to ionizing radiation such as radiation therapy where the machine is aim to the head and even caused due to family history. So it becomes important to detect tumor in early stage so as to give early treatment.

Brain tumor can be of two types: malignant or cancerous tumors and benign tumors. The cause of brain tumor is unknown but some of the risk factors include exposure to the industrial chemical and even as neurofibromatosis. While concern has been raised about mobile phone use, the evidence is not clear. The most common types of primary tumors in adults are: meningioma's (usually benign), and astrocytoma's such as glioblastomas. In children, the most common type is a malignant medulloblastoma.

The signs and symptom of brain tumor mainly depends on size and location of the tumor. The symptom onset – in the timeline of the development of the tumor – depends in many cases on the nature of the tumor (as to it being benign or malignant). In most of the cases it is also related to the change in the nature of the neoplasm, from

slow-growing, late-symptom-onset *benign* to faster-growing, early-symptom-onset malignant.

It has been estimated that the number of new brain cancer cases in USA, 2015 is 22,850 (12,900 males and 9,950 female) and death due to brain cancer in USA, 2015 is 15,320 (8,940 males and 6,380 female). It is found that California has the maximum number of death cases (1690 death cases) as compared to other states in USA. It is also found that the death is due to the radiation to the head (for example mobile phone), cigarette smoking and environmental toxins (for example, chemicals used in oil refineries, embalming chemicals, and rubber industry chemicals) [13].

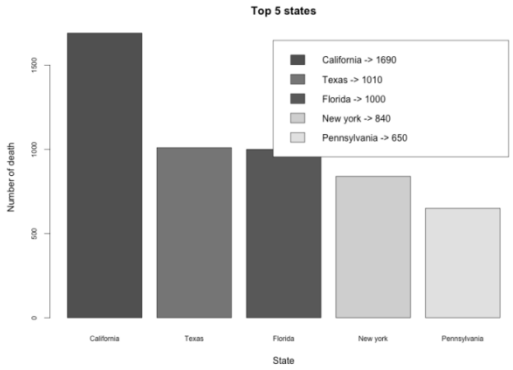

Fig 1: Graph that shows the top 5 states in which the death rate due to brain cancer is maximum in USA, 2015.

Getting segmented brain tumor from MRIs becomes very important for neurosurgeon, oncologist and radiotherapy to measure tumor responses for treatment. Segmentation can be done manually but it takes considerable time and is prone to error. So automatic detection and segmentation is highly desirable. However automatic segmentation and detection is highly challenging task. For example, tumor can vary in size, shape and location.

II. Literature Overview

C. Senthil Singh et al.[1]have proposed a computer aided system for brain MR image segmentation for detection of tumor location using K-means clustering algorithm followed by morphological filtering. They found that this method having more advantage as it avoids the misclustered regions that can inevitably be formed after segmentation of the brain MRI image for detection of tumor location. Using this method, they were able to

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segment tumor from different brain MRI images. The main disadvantage of the above said method is that it produces different result for different number of clusters.

RiriesRulaningtyaset al. [2]proposed on edge detection for brain tumor using histogram equalization and edge detection process. Three methods are suggested for edge detection. They are Robert, Prewitt, and Sobel. From these three methods of edge detection, Robert, Prewitt, and Sobel, Sobel method is more suitable for edge detection of brain tumor because it has a little mean and standard deviation value. Moreover it also gives good performance image, with edge line between brain tissues and tumor tissues are sharper than other three methods edge detection.

Dr J. Jayakumariet al. [3] have developed a brain tumor segmentation method using Watershed Segmentation and validated using MRI Data. This method can segment a tumor provided that the desired parameters are set properly. The results show that Watershed Segmentation is the best method to segment a tumor in MATLAB environment, provided the parameters are set properly.

J.Selvakumaret al. [10]have used computer aided method for segmentation (detection) of brain tumor based on the combination of two algorithms i.e. K-Mean Clustering and Fuzzy C-Mean. The noise free image is given as an input to the k-means and the tumor is extracted. Then segmentation is done using Fuzzy C means for accurate shape which helps in identifying types of tumor and calculation of area. Experimental result is compared with other and found that their method gives more accurate.

Meiyan Huang el.al[4] have proposed a novel automatic brain tumor segmentation method for MRI images. In this method, tumor segmentation is treated as a classified problem. The proposed method is LIPC (local independent projection-based classification). This method used local independent projection into the classical classification model, and a novel classification framework was derived. The proposed method was evaluated using both synthetic data and public available brain tumor image data. In both problems, their method outperformed competing methods.

Hui Tang, Huangxiang Lu et al. [5] proposed an automatic method for whole brain gliomas detection from T2W scout scan which consist of three steps. They are normalizing the pixel intensity, pixel- wise classification using a random forest classification method and finally excluding false positives in a morphological way. Themethod is evaluated using leave-one-out method and achieve an accuracy of 83.0% for HG gliomas and 78.8% for low grade gliomas in dice similarity coefficient. Theresult shows the potential possibility of roughly extracting brain gliomas in a single T2w MRI.

R.Helenel al. [6]develop a Computer Aided Diagnostics (CAD) scheme for Brain Tumour detection from Magnetic Resonance Image (MRI) using active contour models and to investigate with several approaches for improving CAD performances. For segmentation, snake models, DRLSE and FCMLSM are applied. Among the three, FCMLSM is found to be the best. For classification, Random Forest and AD Tree classifiers are adopted and give sensitivity of 97% and with minimum classification error.

Parveenet al. [7] proposed a technique for brain tumor classification based on the support vector machine (SVM) and fuzzy c-means. The porposed algorithm is a combination of support vector machine (SVM) and fuzzy c- means, a hybrid technique for prediction of brain tumor. The image is enhanced using contrash improvement and mid-range stretch. The skull is stripped using double thresholding and morphological opeartions. The Fuzzy C means is used for segmentation to detect the tumor. Finally Grey level run length matrix (GLRLM) is employed for feature extraction, after which SVM is used to classified the tumor. The hybrid methodology of combining support vector machine and fuzzy c-means clustering for classification gives accurate result for identifying the brain tumor.

Tao Wang et al.[9] proposed an automatic brain tumor detection and segmentation based on a Normalized Gaussian Bayesian classification and a new 3D Fluid Vector Flow algorithm. The algorithm that is proposed by the above said authors has two major contributions. The first contribution is that Normalized Gaussian Mixture Model is used to model a healthy brain tissue. The second contribution is that they extended 2D Fluid Vector Flow to 3D space and then used it for tumor segmentation.

RanaBanilet al. [8] proposed a method that utilizes the intensity difference immaculately by using Frequency Emphasis in Homomorphic Filtering. Noise is removed by using Gaussian filter. By thresholding, segmentation and morphological operation, the tumor regions are extracted and mapped in edge detected image of brain.

III. Methods for Tumor Segmentation

A.Thresholding based segmentation

Thresholding based image segmentation aims to partition an input image into pixels of two or more values through comparison of pixel values with the predefined threshold value T individually[12]. Failure to find the most suitable algorithm to determine the threshold value(s) T the result might be one or all of the following:

1) The segmented region might be smaller or larger than the actual
2) The edges of the segmented region might not be connected
3) Over or under-segmentation of the image (arising of pseudo edges or missing edges)

B. Region based segmentation

The main goal of segmentation is to partition an image into regions. Some segmentation methods such as"Thresholding" achieve this goal by looking for the boundaries between regions based on discontinuities in gray levels or color properties. Region-based segmentation is a technique for determining the region directly.

Basic concept of seed points: **Region growing** is a simple region-based image segmentation method. It is also classified as a pixel-b. The first step in region growing is to select a set of seed points. Seed point selection is based on some user criterion (for example, pixels in a certain grayscale range, pixels evenly spaced on a grid, etc.). The initial region begins as the exact location of these seeds. The regions are then grown from these seed points to adjacent points depending on a region membership criterion. The criterion could be, for example, pixel intensity, grayscaletexture, or color based image segmentation method since it involves the selection of initial seed points. Since the regions are grown on the basis of the criterion, the image information itself is important. For example, if the criterion were a pixel intensity threshold value, knowledge of the histogram of the image would be of use, as one could use it to determine a suitable threshold value for the region membership criterion[11]. Advantages of using Region based segmentation is given below

1) Region growing methods can correctly separate the regions that have the same properties we define.
2) Region growing methods can provide the original images which have clear edges the good segmentation results.

Disadvantages are

1) The computation is timeconsuming, no matter the time or power.
2) Noise or variation of intensity mayresult in holes or over segmentation.
3) The method may not distinguish the shading of the real image

C. K-Means Clustering

1) K-Means is a least-squares partitioning method that divide a collection of Define k centroid, one for each singe cluster. This centroid must be put in any location on the image. The best strategy is to put each centroid as far as possible.
2) Compute the distance of each point from each cluster by computing its distance from the corresponding cluster mean. Assign each point to the cluster it is nearest to.
3) Iterate over the above two steps till the centroid does not move.

Advantages of K-Means clustering are given below:

1) Fast: K-Means and associated groundtruth can be precomputed and stored, and assigned to new data sets
2) Simple to use: Extensive hand-labeling of images by experts to generate training data is not necessary.
3) Probabilistic framework allows to approximate the actual edge probabilities for optimal segmentation

The main disadvantages of K-Means clustering is that Detection of edges still not robust enough; a single hole in objects into K groups[10]. The algorithm is given below:

a cell border can cause spillover of the watershed algorithm.

D. Watershed Segmentation

The watershed transformation considers the gradient magnitude of an image as a topographic surface. Pixels having the highest gradient magnitude intensities (GMIs) correspond to watershed lines, which represent the region boundaries. Water placed on any pixel enclosed by a common watershed line flows downhill to a common local intensity minimum (LIM). Pixels draining to a common minimum form a catch basin, which represents a segment [3].

The algorithm of watershed segmentation is worked as follows:

- Suppose a hole is punched at each regional local minimum and the entire topography is flooded from below by letting the water rise through the holes at a uniform rate
- Pixels below the water level at a given time are marked as flooded.
- When we raise the water level incrementally, the flooded regions will grow in size. Eventually, the water will raise to a level where two flooded regions from separated catchment basins will merge.
- When this occurs, the algorithm constructs a one-pixel thick dam that separates the two regions.
- The flooded continues until the entire image is segmented into separate catchment basins divided by watershed ridge lines.

Advantages

1. The resulting boundaries form closed and connected regions

2. The boundaries of the resulting regions always correspond to contours which appear in the image as obvious contours of objects.
3. The union of all the regions forms the entire image region

The main disadvantage of the Watershed Transform is that for most natural images it produces excessive over segmentation.

Year	Author	Methodologies	Pros	Cons
2014	C. Senthilet al. [1]	K-means clustering	Fast and simple to use	Produce different results for different input cluster number
2014	RiriesRulaningtyaset al.[2]	Edge detection using histogram equalization	Sobel operator gives good performance image, with edge line between brain tissues and tumor tissues are sharper than other three methods edge detection.	
2014	Meiyan Huang el al. [4]	Local independent projection-based classification	Evaluated the proposed method using both synthetic data and public available brain tumor image data. In both problems, the method outperformed competing methods.	
2014	R.Helenel al. [6]	Computer Aided Diagnostics (CAD) scheme for Brain Tumor detection using	This method gives accuracy of 97% and with minimum classification error. The time	

		active contour models	taken to detect Tumor is approximately 2 mins for an examination (30 slices).	
2013	Hui Tang et al. [5]	Random forest classification followed by a post-processing step to remove false positives and to smooth the segmentation.	Successfully detects out tumors in 28 out of 30 dataset (successful rate = 93.3 %).	
2012	J.Selvakumaret al. [10]	K-Mean Clustering and Fuzzy C-Mean	Allows thesegmentation of tumor tissue with accuracy and reproducibility comparable to manual segmentation. In addition, it also reduces the time for analysis.	Over segmentation leads to error in results.
2011	Dr J. Jayakumari et al. [3]	Watershed Segmentation and validated using MRI Data	If the intensity level difference between the cancerous and non-cancerous regions is higher than the performance of Watershed Segmentation algorithm is	Produces excessive over segmentation.

			better	

IV. Conclusion

In this paper, we have presented various image segmentation techniques for brain tumor. Different tumor segmentation methods were explored and their drawbacks and advantages are presented. As per the survey, K-Means clustering is limited to only initial number of k-cluster. Wrongly selected clusters lead to erroneous result. Also for different input cluster number, different results will be given.Thereforein future, watershed segmentation is suggested which will overcome the problem of K-Means clustering.

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