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AN OVERVIEW OF BRAIN TUMOR SEGMENTATION ALGORITHMS

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ABSTRACT

Brain is the most important and vital organ of the human body. The control and coordination of all the other vital structures is carried out by the brain. The tumor is formed by the uncontrolled multiplication of cell division. Several techniques were developed to detect and segment the brain tumor using several segmentation algorithms such as 1) watershed algorithm, 2) k-means clustering, 3) Fuzzy c-means clustering is carried out. This is the effective algorithm where segmentation of tumor is carried out and its features such as centroid, perimeter and area are calculated from the segmented tumor. To identify the brain tumor, scanned MRI images are given as the input. The work involved here helps in medical field to detect tumor and its features helps in giving the treatment strategy to the patient.

KEYWORDS-Magnetic Resonance Image (MRI), Preprocessing and Segmentation (K-means, Fuzzy c-means, Watershed algorithm), Parameter analysis.

1) INTRODUCTION

CANCER is one of the most serious health difficulties in the world field. The death rate of lung cancer is the highest among all other types of cancer. Lung cancer is one of the most serious cancers in the world, with the smallest survival rate after the analysis, with a regular increase in the number of deaths every year. Survival from lung cancer is directly related to its progress at its detection time. The earlier the detection is, the higher the probabilities of successful treatment. An estimated 85% of lung Cancer cases in males and 75% in females are caused by cigarette smoking.

Brain, heart and lung etc. are the most main parts of the human body. And then, all parts of the body are controlled by the brain cells. Therefore, brain is a vital organ of the body. Currently, brain tumour is a very serious disease among children and adults. The most deadly and inflexible diseases are brain tumour. Brain tumour’s location and quickly spreading make a dangerous problem in treatment of tumour. Thus, image segmentation and detection are energetic method to solve the medical problem of the various diseases. Imaging of the brain tumour can be done by (CT) computed tomography scan, (MRI) magnetic resonance image scan, Ultrasound, etc. In this research, MRI scan is used to implement the system.The word tumor is a synonym for a word neoplasm which is formed by an abnormal growth of cells Tumor is something totally different from cancer.

Types of Tumor:

There are three common types of tumor: 1) Benign, 2) Pre-Malignant, 3) Malignant (cancer can only be malignant).

a) Benign Tumor:A benign tumor is a tumor that does not expand in an abrupt way; it doesn’t affect its neighboring healthy tissues and also does not expand to non-adjacent tissues. Moles are the common example of benign tumors.

b) Pre-Malignant Tumor: Premalignant Tumor is a precancerous stage, considered as a disease, if not properly treated it may lead to cancer.

c) Malignant Tumor: Malignancy (mal- = bad and -ignis = fire) is the type of tumor, that grows better with the passage of time and finally results in the death of a person. Malignant is basically a medical term that defines a severe progressing disease. Malignant tumor is a term which is typically used for the description of cancer.

2) TECHNIQUES AVAILABLE

2.1) K-MEAN CLUSTERING

2.1.1) K-Mean clustering give idea for automatic brain tumor segmentation. Normally the structure of the Brain can be viewed by the MRI scan or CT scan. The MRI scanned image is taken for the whole process. The MRI scan is easier than CT scan for diagnosis. It is not affect the human body. Because it doesn't use any radiation (emission). It is based on the magnetic field and radio waves. There are different types of algorithm were established for brain tumor recognition. But they may have some drawback in detection and extraction. There are two algorithms are used for segmentation. So it gives the perfect result for tumor segmentation. Tumor is due to the uncontrolled growth of the tissues in any part of the body. The tumor may be primary or secondary. If it is an origin, then it is known as primary. If the part of the tumor is spread to another place and grown-up as its own then it is known as secondary. Usually brain tumor affects CSF (Cerebral Spinal Fluid). It causes for strokes. The surgeon gives the treatment for the strokes rather than the treatment for tumor. So detection of tumor is important for that treatment. Normally tumor cells are of two types. They are Mass and Malignant. The detection of the malignant tumor is slightly difficult to mass tumor. For the accurate detection of the malignant tumor that needs a three dimensional representation of brain and 3-D analyzer tool. In this paper we focused on detection of mass tumor detection. [1]

2.1.2) Image segmentation may be defined as a technique, which divides a given image into a finite number of non-overlapping regions with respect to some appearances, such as gray value distribution, texture Distribution, etc. Segmentation of medical images is required for many medical diagnoses like radiation treatment, planning volume visualization of regions of interest (ROI) describing boundary of brain tumor.

K-means clustering is a key technique in pixel based methods. In which pixel based methods based on K-means clustering are simple and the computational complication is relatively low compared with other region based or edge based methods, the application is more practical. It is an unsupervised clustering algorithm that classifies the input data points into multiple classes based on their natural distance from each other. K-means clustering suggests automatic method to find the characteristics of Tumor cells using Morphological technique. Morphological operations are applied on the segmented image for smoothening the brain tumor part. [2]

2.1.3) In medical image segmentation of images plays a dynamic role in stages which occur before applying object recognition. Image segmentation helps in automaticanalysis of brain diseases and helps in qualitative and measureable analysis of images such as measuring accurate size and volume of detected portion. Exact measurements in brain diagnosis are somewhat difficult because of diverse shapes, sizes and presences of tumors. Tumors can grow sharply causing defects in neighboring tissues also, which gives an overall abnormal structure for healthy tissues also. In this paper, we will improve a technique of segmentation of a brain tumor by using segmentation in combination with different MATLAB techniques.

K-means clustering is a method of vector quantization, originally from signal processing, that is popular for cluster analysis in data mining. K-means clustering purposes to partition n observations into ‘k’ clusters in which each observation belongs to the cluster with the nearest mean, serving as a sample of the cluster. This results in a partitioning of the data space into Coronoid cells. The problem is computationally difficult however, there are efficient experiential algorithms that are commonly employed and converge quickly to a local optimum. These are usually similar to the expectation-maximization algorithm for mixtures of Gaussian distributions through an iterative modification approach employed by both algorithms. Additionally, they both use cluster centers to model the data; however, k-means clustering tends to find clusters of comparable spatial level, while the expectation-maximization mechanism allows clusters to have different shapes. [3]

2.1.4) K- means Clustering- A cluster is a group of objects which are similar between them and are different to the objects going to otherclusters. Clustering is an unsupervised learning method which deals with finding a structure in a collection ofunlabeled data. A movable description of clustering could be the process of establishing objects into groups whosemembers are similar in some way. K-means clustering is an algorithm to group objects based on features into k number of groups where k is a positive integer. The grouping or clusteringis done by minimizing distance between the data and thecorresponding cluster centroid. Thus the function of k-means clustering is to cluster the data. [4]

2.2) C-MEAN CLUSTERING

2.2.1) A Fuzzy C-MEAN Clustering- The fuzzy logic is a method to processing the data by giving the partial membership value to each pixel in the image. The membership value of the fuzzy set is ranges from 0 to 1. Fuzzy clustering is basically a multi valued logic that allows intermediate values i.e., member of one fuzzy set can also be member of other fuzzy sets in the same image. There is no unexpected transition between full membership and non-membership. The membership function states that the fuzziness of an image and also to define the information enclosed in the image. These are three main basic features involved in characterized by membership function. They are support, Boundary. The core is a fully member of the fuzzy set. The sustenance is non membership value of the set and boundary is the Intermediate or partial membership with value between 0 and 1. [1]

2.2.2) The fuzzy logic is a method of processing the data by giving the partial membership value to each pixel in the image. The membership value of the fuzzy set is ranges from 0 to 1. Fuzzy clustering is basically a multi valued logic that allows intermediate values member of one fuzzy set can also be members of other fuzzy sets in the same image. There is no sudden transition between full membership and non-membership. The membership task defines the fuzziness of an image and also to define the information checked in the image. These are three basic features involved in describing by membership function. They are sustained Boundary. The core is a complete member of the fuzzy set. The support is a non-membership value of the set and boundary is the intermediate or partial membership with value between 0 and 1. [4]

2.2.3) In the year 1973 Dunn developed the Fuzzy C Means algorithm and later in 1981 it was improved by Bezdek. However the Fuzzy logic was planned in 1965 by Lofti A Zadak a professor of Computer Science at University of California, Berkeley. Fuzzy logic is a form of many-valued logic or probabilistic logic. Its definition only means approximate values rather than fixed and particular. In compare with traditional logic they can have changing values, where binary sets have two-valued logic, true or false, fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between fully true and fully false. [5]

2.3) WATERSHED

2.3.1) In geography, a watershed is the point that divides areas drained by different river system. The watershed transform is a morphological gradient-based segmentation technique. The gradient map of the image is considered as a relief map in which different gradient values correspond to different elevations. If we stroke a hole in each local minimum and immerse the whole map in water, the water level will rise over the bowls. When two different body of water meet, a dam is made between them. The progress continues until all the points in the map are immersed. Finally the whole image is segmented by the dams which are then called watersheds and the segmented regions are referred to as catchment bowls. A catchment bowl is the geographical area draining into a river or tank. The watershed algorithm applies these ideas to gray-scale image processing in a way that can be used to solve a variety of image segmentation problem. Watershed algorithm, a segmentation method in mathematics morphology, was firstly introduced to the image division area by Beucher and Meyer. [3]

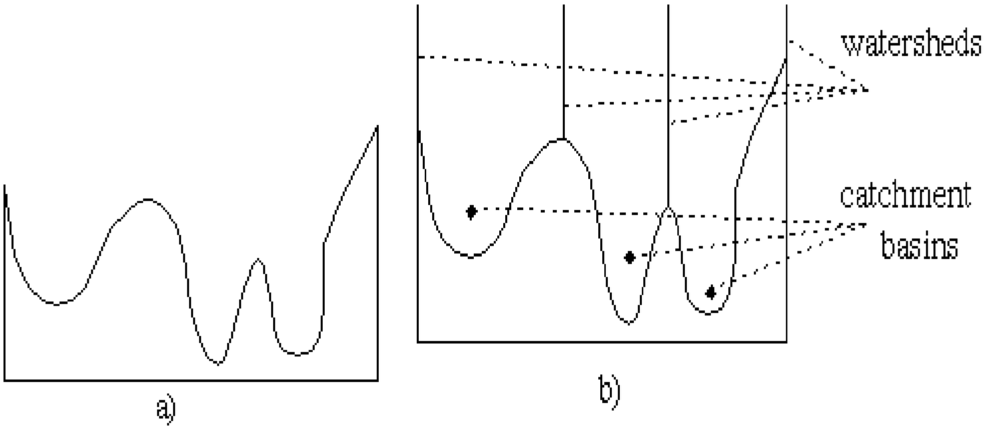

Figure a) gray level profile of data
b) Watershed segmentation

2.3.2) Marker-Controlled Watershed Segmentation

In Marker-based watershed segmentation markers are used. A marker is a connected element belonging to an image. The markers contain the internal markers, associated with objects of interest, and the external markers, related with the background. Sorting out touching objects in an image is one of the more difficult image processing operations. The watershed transform is often applied to this problem. The marker based watershed segmentation can segment exclusive boundaries from an image. The strength of watershed segmentation is that it produces a unique solution for a specific image. The over-segmentation problem is also removed by marker watershed segmentation. Generally, the watershed transform is calculated on the gradient of the specific image. It provides the number of advantages.It is a simple, spontaneous method, it is fast and it can produces a complete partition of the image in divided regions even if the contrast is poor. An important task was to classify what features must be taken into consideration of an image for successfully noticing the lung cancer. [6]

2.4) THRESHOLDING

2.4.1) Thresholding is one of the frequently used method for image segmentation. This method is effective for images with altered intensities. By using this method, the image is divided directly into different regions based on the intensity values.

Global thresholding

Global thresholding method selects only one threshold value for the whole image. Global thresholding is used for images. It is simple and faster in addition time only if the image has homogeneous intensity and extraordinary contrast between foreground and background.

Otsu's thresholding

Wang Hongzhi (2007) developed improved threshold image segmentation algorithm based on the Otsu method. This method confirms that both the modification of the object and the modification of the background keep away from the variance of the whole image. The improved method produces suitable results for both the image with histogram of bimodal and unimodal distributions. [7]

2.4.2) Threshloding is one of simple image segmentation method. It is process of separating pixels in different classes liable on their pixels gray levels. A thresholding method defines an intensity value, called the threshold, which separate the desired classes. The segmentation is achieved by taking threshold value. Based on threshold value and pixels are combination with intensity batter than the threshold into one class and remain pixels grouping into another class. The important disadvantage are that, in the simplest form only two classes are generated and it cannot be applied to multichannel images. In thresholding technique, image having only two values white or black. MR image contains 0 to 255 grey values. So, thresholding of MR images overlooks the tumor cells. [8]

2.4.3)Thresholding is useful in discriminating foreground from the background. By selecting a suitable threshold value called as T, then the gray level image can be converted to binary image. The binary image should contain all of the primary information about the position and shape of the objects (foreground). The advantage of obtaining binary image is that it reduces the complexity of the data and simplifies the process of recognition and classification. The most common method to convert a gray-level image to a binary image is to choice a single threshold value (T). Then all the gray level values below this T will be classified as black, and those above T will be white. Otsu's method using (gray thresh) function Computes global image thresholding. Otsu's method is based on threshold selection by statistical principles. Otsu suggested minimizing the weighted sum of within-class differences of the object and background pixels to establish an optimum thresholding. Remember that minimization of within-class variances is equivalent to maximization of between-class variance. This technique gives satisfactory results for bimodal histogram images. [6]

2.5) HIERARCHICAL CLUSTERING

2.5.1) Hierarchical clustering technique works by grouping data objects into a tree of clusters. Hierarchical clustering does not requires specifying the number of clusters. There are two types of Hierarchical clustering.

1. Agglomerative clustering, 2. Divisive Clustering

The basic process of hierarchical clustering for a given set of N items to be clustered and NxN distance matrix is given as,

Step 1: Start by allocating each item to a cluster i.e., N items will have N clusters. Let the distance between the Clusters be the same as the distance between the items they contain.

Step 2: Find the similar pair of clusters and merge them into a single cluster to reduce the number of clusters.

Step 3: Compute the distance between the new cluster and each of the old cluster.

Step 4: Repeat steps 2 and 3 until all items are clustered into a single cluster of size N. [7]

2.5.2) A Hierarchical clustering method works by grouping data objects into a tree of clusters. There are two types of clustering 1.Agglomerative 2.Divisive.

Agglomerative clustering varies in the similarity measures which employ single link, complete link, group average, centroid similarity. Hierarchical clustering does not require toidentifying the number of clusters. In agglomerative clustering each element is treated as a singleton cluster and then merged.Until all points merge into a single cluster, which results in dendograms formation. [5]

2.6) MORPHOLOGICAL FILTERING

2.6.1) Morphological processing is constructed with operations on sets of pixels. Binary morphology uses only set membership and is indifferent to the value, such as gray level or color, of a pixel. It relies on the ordering of pixels in an image and many times is applied to binary and gray scale images. Through processes such as erosion, dilation, opening and closing, Binary images can be modified to the user's specifications. Binary images are images whose pixels have only two possible intensity values. They are normally displayed as black and white. Numerically, the two values are often 0 for black, and either 1 or 255 for white. Binary images are often produced by thresholding a gray scale or color image in order to separate an object in the image from the background. The color of the object (usually white) is referred to as the foreground color. The rest (usually black) is referred to as the background color.[9]

2.6.2) The morphological operations involve filtering a label map such that the boundary of a labeled region either grows or contracts. Sequences of morphological operations can extend manual segmentation by filling in small holes or breaking connections between regions. Thresholding is another filtering method that is used to label pixels whose grayscale values are in a desired range. Morphological processing is constructed with operations on sets of pixels. Binary morphology uses only set membership and is indifferent to the value, such as gray level or color, of a pixel. Morphological image processing relies on the ordering of pixels in an image and many times is applied to binary and grayscale images. Binary images are images whose pixels have only two possible intensity values. They are normally shown as black and white. Mathematically, the two values are often 0 for black, and either 1 or 255 for white.Morphological Segmentation details the segmentation for identifying the tumor in the brain. The morphological operations are applied to the grayscale images to segment the abnormal regions. Erosion and dilation are the two elementary operations in Mathematical Morphology. A combination of these two represents the rest of the processes. [10]

2.6.3) Morphology is the study of shapes and structures from precise image. Morphological filters are formed from the basic morphology operations. An organizing element is mainly required for any morphological operation. Morphological operations operates on two images, organizing element and input image. Corresponding image that elements are small images that are used to probe an input image for properties of interest. Origin of a structuring element is defined by the center pixel of the structuring element. In morphology, the structuring element defined will pass over a section of the input image where this section is defined by the neighborhood window of the structuring element and the structuring element either fits represents the input image's structure is got and suppression of the geometric features of the input image that doesn't fit the structuring element's neighborhood takes place. Two main morphology operations are erosion and dilation where erosion results in the thinning of the objects in the image considered and dilation results in thickening of the objects in the image. Dilation uses the highest of all the pixels in the value of all the pixels in the neighborhood of the input image defined by the structuring element and erosion uses the lowest value neighborhood of the input image. [11]

3) RECENT DEVELOPMENTS

JIE WEI AND GUANG LI are the student from Department of Computer Science, City College of New York presented paper on Automated Lung Segmentation and Image Quality Assessment for Clinical 3-D/4-D-Computed Tomography in 8 January 2015. And there index terms are biomedical image processing, image analysis, classification algorithms, morphological operations, machine learning algorithms, data visualization, computed tomography. To achieve personalized cancer treatment planning, the spatial and temporal data within the 4-dimensional computed tomography (4DCT) images serve as the foundation to retrieve crucial geometric, topologic and dynamic knowledge. The algorithms generates these results faster in time by at least one order of magnitudes, in 4DCT lung segmentation. [12]

Ashima Anand Student, ECE Department, Chandigarh University, Gharuan, India presented paper on Survey on Segmentation of Brain Tumor: A Review of Literature also in January 2016 they use Techniques such as Threshold-based, Region-based, Artificial Neural Networks, FCM. The future work regarding brain tumor segmentation should focus on improving the accuracy by using additional features such as prior knowledge, shape and models. To achieve better prediction rate, gradient with HPF (high pass filtering) can be used as it prominently give us edges with higher accuracy. [13]

Bjoern H. Menze, Koen Van Leemput, Danial Lashkari and there coordinators are published paper on A Generative Probabilistic Model and Discriminative Extensions for Brain Lesion Segmentation With Application to Tumor and Stroke in APRIL 2016 The tumor grows fast and patients often have survival times of two years or less, calling for immediate treatment after diagnosis. The slower growing "low-grade" disease comes with a life expectancy of five years or more, allowing the aggressive treatment to be delayed. Extensive neuroimaging protocols are used before and after treatment, mapping different tissue contrasts to evaluate the progression of the disease or the success of a chosen treatment strategy. As evaluations are often repeated every few months, large longitudinal datasets with multiple modalities are generated for these patients even in routine clinical practice. In spite of the need for accurate information to guide decision making process for a treatment. these image series are primarily evaluated using qualitative criteria indicating, for example, the presence of characteristic hyper-intense intensity changes in contrast-enhanced T1 MRI or relying on quantitative measures that are as basic as calculating the largest tumor diameter that can be recorded in a set of axial images. While an automated and reproducible quantification of tumor structures in multimodal 3D and 4D volumes is highly desirable, it remains difficult. Glioma is an infiltrative growing tumor with diffuse boundaries and lesion areas are only defined through intensity changes *relative* to surrounding normal tissues. As a consequence, the outlines of tumor structures cannot be easily delineated even manual segmentations by expert raters show a significant variability and common MR intensity normalization strategies fail in the presence of extended lesions. Tumor structures show a significant amount of variation in size, shape, and localization, precluding the use of related mathematical priors. [14]

4) APPLICATIONS

1. Many image segmentation techniques have been developed in the past. But still it remains a challenging task. A segmentation method may perform well for one MRI brain image but not for the other images. Thus it is very hard to achieve a generic segmentation method that can be frequently used for all MRI brain images. BPN classifier gives fast and accurate classification that can be effectively used for segmenting MRI brain images with high level of accuracy.

2. Image processing plays energetic role in today's world. Now a day the applications of image processing can be found in areas like electronics, remote sensing, bio-medical and so on. If we focus bio-medical applications, image processing is widely used for

diagnosis of different tissues purpose. By use of appropriate image segmentation method and use of accurate input image is very important.

3. Techniques used here are clustering techniques in gray images and color images. We can assume that unsupervised clustering is better than supervised clustering algorithms which need less training. The proposed system is more efficient and is less error sensitive. The system can be used in treatments of the tumor using radiation and chemotherapy [15]

5) CONCLUSION

Image processing plays dynamic role in today's world. Now a day the applications of image processing can be found in areas like electronics, remote sensing, bio-medical and so on. If we focus bio-medical applications, image processing is widely used for diagnosis of different tissues purpose. By use of appropriate image segmentation method and use of accurate input image is very important. In this paper various existing segmentation techniques for brain (MRI) Magnetic resonance imaging have been discussed. Image segmentation has a promising future as the universal segmentation algorithm. As the result, image segmentation is affected by lots of factors, such as similarity of images, spatial characteristics of the image continuity, texture and image content. In this work, various techniques of image segmentation has been discussed, an overview of some related image segmentation techniques has been presented. The main image segmentation algorithms and classification of image segmentation are discussed. In this study, the overview of various segmentation methodologies applied for digital image processing is explain briefly.

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