Study of Different Brain Tumor MRI Image Segmentation Techniques

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Abstract-The method of brain tumor segmentation is nothing but the differentiation of different tumor area from Magnetic Resonance (MR) images. There are number of methods already presented for segmentation of brain tumor efficiently. However it's still critical to identify the brain tumor from MR images. The segmentation process is extraction of different tumor tissues such as active, tumor, necrosis, and edema from the normal brain tissues such as white matter (WM), gray matter (GM), as well cerebrospinal fluid (CSF). As per the survey study, the brain tumors most of time detected easily from brain MR image, but required level of accuracy, reproducible segmentation, abnormalities classification is not predictable and straightforward. The segmentation of brain tumor is composed of many stages. The manual process of doing the segmentation of brain MR images is very time consumption and tedious task, and hence it is associated with many challenges. Therefore, we need automated segmentation method for brain images. There are many techniques presented to investigate the performance of automated computerized brain tumor detection for the medical analysis purpose. In this review paper, our main goal is to present the review of different brain tumor segmentation methods using the MR images. The different methods for segmentation are studied with their advantages and disadvantages in this paper.

Index Terms- Brain Tumor, Classification, Disease Identification, Magnetic Resonance Imaging (MRI), Segmentation, Tumor Detection.

I. INTRODUCTION

In medical practices, the early detection and recognition of brain tumors accurately is very vital. In literature, there are many techniques has been proposed by different researchers for the accurate segmentation of brain tumor. Some discoveries such as X-rays, ultrasound, radioactivity, magnetic resonance imaging (MRI) or computed tomography and the development of tools that can generate medical images have facilitated the development of some of the most efficient exploration tools in medicine. Such tools are capable of exploring the structure, function and the diseases that affect the human brain, and deals with the cancer-affected region of the brain. The main goal for the medical researchers since from last few decades is the curing brain tumors, however the building of new methods for treatments requires more time as well as money.

Medical science yet needs to find all the main causes of different types of cancers and then develop the methods to cure them before brain tumors development starts.

Magnetic resonance imaging (MRI) is high-quality medical imaging, particularly for brain imaging. MRI inside the human body is helpful to see the level of detail. Doctors have major technical and economic importance of reliable and fast detection and classification of brain cancer, based on common practices. Most of the technicians are slow, less responsible, and that's hard to quantify possess a degree of subjectivity.

For the early detection of brain tumors there are many imaging methods for diagnostics purpose are presented. These imaging techniques are Positron Emission Tomography (PET), Magnetic Resonance Imaging (MRI), and Computed Tomography (CT). Among this all imaging techniques, MRI is most efficient for the research of brain tumor detection and classification as compared to other imaging techniques. This is because of high contrast of soft tissues, high spatial resolution as well as it does not produce any harmful radiation Reliable and fast detection and classification of brain cancer. Although MRI and the tumor about the size of being able to provide information, it is unable to classify tumor types, invasive techniques such as biopsy and spinal applications, which are painful and time consuming methods.

In this paper we are aiming to take review of different methods of brain tumor image segmentation. We are aiming to present the different MRI images segmentation methods.

II. REVIEW OF MRI BRAIN IMAGE SEGMENTATION METHODS

Objective of this review section is to present literature survey of image segmentation methods. The main goal is to highlight advantages and limitations of these methods. Key image processing techniques for brain MRI image segmentation is classified as thresholding, region-growing, clustering, soft computing, atlas-based, image/symmetry analysis, other methods etc.
A. Thresholding
Thresholding is one of the most generally used and oldest methods for image segmentation. In the process of thresholding, image is supposed to be composed of regions and these regions belong to different ranges of gray scale. Histogram of image is consists of peaks and valleys, where each peak represents one region. The valley between the peaks represents a threshold value. Histogram thresholding method is based on a concept that divides the image into two equal halves and histograms are compared to detect the tumor and cropping method is used to find a proper physical dimension of brain tumor. The threshold technique makes decision based on the local raw pixel information. It helps in extracting the basic shape of an image, overlooking the little unnecessary details.

B. Region-growing
In this technique the images are partitioned by organizing the nearest pixel of similar kind. It starts with a pixel (initial seed) that having similar properties. Accordingly the neighbouring pixels based on homogeneity criteria are appended progressively to the seed. In splitting process, region get divided into subregions that do not satisfy a given homogeneity criterion. Splitting and merging can be used together and its performance mostly depends on the selected homogeneity criterion. Without tuning homogeneity parameters, the seeded region growing technique is controlled by a number of initial seeds. If the number of regions was approximately known & used it to estimate the corresponding parameters of edge detection.

C. Clustering
The method of clustering organizes the objects into groups based on some feature, attribute and characteristic. Hence a cluster consists of groups of similar objects. There are two types of clustering, supervised and unsupervised. In supervised type clustering, cluster criteria are specified by the user. In unsupervised type, the cluster criteria are decided by the clustering system itself.

1) K-Means Clustering:
K-Means Clustering partition the observations into k clusters in which each pixel belongs to the clusters by minimizing an objective function in a way that the within cluster sum of squares is get minimized. It starts with initial K cluster centers and it reassigns the observations to clusters based on the similarity between the observations and cluster center. Automation of detection and segmentation of brain tumors in MRI images is a very challenging task due to occurrence of high degree of gray-level similarity in the image. T. U. Paul and S. K. Bandhyopadhyay [10] have presented a fully automated two-step segmentation process of brain MRI images. In the first step, skull stripping is performed by generating a skull mask from the MRI image and in the second step, an advanced K-means algorithm improvised by two-level granularity oriented grid based localization process based on standard local deviation is used to segment the image into gray matter, white matter and tumor region and then length and breadth of the tumor is assessed.

2) Fuzzy C-Means clustering:
Fuzzy C-means (FCM) clustering is a data clustering method in which each data point belongs to a cluster to a degree specified by a membership value. Fuzzy C-means divides a collection of n vectors into c fuzzy groups and finds a cluster center in each group such that a cost function of dissimilarity measure is minimized.

D. Soft-Computing
A self-organizing map (SOM) or self-organizing feature map is a type of artificial neural network for unsupervised learning. SOMs organize in training and mapping mode. Training process builds map using vector quantization process and mapping automatically classifies a new input vector. SOM map consists of neurons or nodes. Self-organizing maps each of which are neurons associated with a weight vector map data input vectors and position in the map space. The self-organizing maps a higher dimensional input space to a lower dimensional map space. Energy, entropy, contrast, mean, median, variance, correlation, maximum and minimum intensity values used to provide a clear description of the tumor.

E. Image/Symmetry Analysis
Image/Symmetry Analysis is an interactive segmentation method that in addition to area of the region and edge information uses prior information, also its symmetry analysis which is more consistent in pathological cases. A conceptually easy supervised block-based, shape, texture; content based technique has been used to analyze MRI brain images with relatively lower computational requirements. Classifying regions by means of their multi-parameter values does the study of the regions of physiological and pathological interest easier and more definable.

F Other Segmentation Methods
There are also others segmentation methods such as wavelet transform, edge detection method, watershed algorithm, deformable models with their own pros and cons. It is possible to combine different segmentation methods depends on application.

III. COMPARATIVE STUDY OF DIFFERENT SEGMENTATION TECHNIQUES
Comparative study of different segmentation techniques is summarized in compare table (Table1) with advantages and disadvantages. Most of the key features of methods are mentioned in Table1 with respective limitations and benefits that make our work unique.
### TABLE 1. COMPARE TABLE

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Proposed Technique</th>
<th>Algorithm Used</th>
<th>Benefits</th>
<th>Identified Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumar (2011)</td>
<td>A Texture based Tumor detection and automatic Segmentation using Seeded Region Growing Method[6]</td>
<td>Texture based Tumor detection and automatic segmentation</td>
<td>Seeded Region growing</td>
<td>This is region growing segmentation method for segmentation of brain tumor in MRI, in which it is possible to determine abnormality is present in the image or not.</td>
<td>It takes more time.</td>
</tr>
<tr>
<td>Roy (2012)</td>
<td>Detection and Quantification of Brain Tumor from MRI of Brain and it’s Symmetric Analysis[7]</td>
<td>Modular approach to solve MRI segmentation</td>
<td>Symmetry analysis</td>
<td>The proposed approach can be able to find the status of increase in the disease using quantitative analysis</td>
<td>Time consuming.</td>
</tr>
<tr>
<td>Meenakshi (2012)</td>
<td>Brain Tumor Identification in MRI with BPN Classifier and Orthonormal Operators[8]</td>
<td>Brain Tumor Identification in MRI with BPN Classifier and Orthonormal Operators</td>
<td>k-means clustering, BPN classifier</td>
<td>It combines clustering and classification algorithm.</td>
<td>Accuracy can be improved in less time</td>
</tr>
</tbody>
</table>

### IV. CONCLUSION

In this paper we have studied the different aspects of medical imaging especially for the application of diagnosis of brain tumor using MRI. We have presented the review of different brain image segmentation methods presented so far, as well their advantages and disadvantages are discussed as comparative analysis. In addition to this we are giving the information about different kinds of MRI images datasets which are frequently used for research studies as well as performance evaluation metrics. For the future work we suggest to present more accurate, efficient as well as faster method for early detection and classification of brain tumors.

### REFERENCES


