# Review of Image Segmentation techniques to detect brain tumor from MR Images

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*Abstract*—**Image Processing is no longer aloof from the world of medical. Medical image processing is challenging and important field now a day. Processing of MRI is one of the part of this field. Medical diagnostics can easily provide image in digital formats. However precise identification of brain tumor growth from medical images is still a critical and complicated task. Manual brain tumor detection may prone to human error. Hence researchers are now trying to automate the diagnostics. In this paper various techniques of automatic tumor Segmentation and detection has been discussed. Also describes our proposed strategy to detect & extract brain tumor from patient's MRI scan images using wavelet transform. These methods incorporate with some noise removal processes, segmentation and morphological operations which are the basic concepts of image processing.**

***Index Terms***— **Image Segmentation, Magnetic Resonance Images, Brain Tumor, Wavelet Transform.**

## I. INTRODUCTION

Segmentation of image plays very important role in the area of image processing. Basically Image segmentation is the process of partitioning the digital image into various set of pixels to change or convert that image into something which is easier to analyze and much useful. This is typically used to locate objects and boundaries (lines, curves, etc.) in images. Particularly, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The goal of image segmentation is a domain independent decomposition of an image into different regions such as brightness , color, textures, intensity etc. An important step in segmentation is to extract the region of area in which we are interested. We can called it (ROI) Region of interest.

In our case image segmentation is needed in a very accurate manner in MR Imaging for finding the unusual growth in tissues of the body part like brain. i.e abnormal growth of tissues of brain is detected using segmentation of MR images.

Fig.1 shows different stages in brain tumor detection. Pre-processing of MRI images is the first step in image analysis which perform image enhancement and noise reduction techniques which are used to improve the quality of images, then morphological operations are applied to detect the tumor in the image. Image Segmentation group pixels into regions and hence defines the object regions. It uses features of ROI like object area,intensity etc. Classification is the last step in the process of brain tumor detection used to classify whether the image is normal or abnormal and can be classify that abnormality type is benign or malignant. The morphological operations are basically applied on some assumptions about the size and shape of the tumor and in the end the tumor is converted into the original gray scale image with 255 intensity to make visible the tumor in the image.

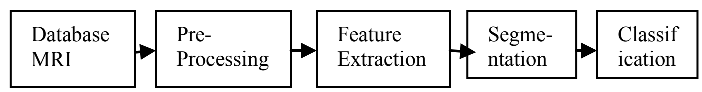


Fig.1 Stages in Brain Tumor Detection

*Brain MRI*

MRI is rapidly growing medical imaging technique and capture high resolution images of soft tissues [1]. It is a noninvasive technique for classifying cells composed of tissues in human body [2].MR imaging uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of various soft tissues, bones and virtually all other internal body structures. It does not use ionizing radiation and provides detailed pictures of brain and nerve tissues in multiple planes without obstruction by overlying bones. In general, the MRI images do not possess any structural information regarding the ROI that need to be extracted. Therefore, the cross-sectional shape of each anatomical feature must be extracted through image segmentation. The problems of MRI include mainly Noise, Intensity inhomogeneity,Shading artifact, Partial volume etc. There are still some challenges such as correct and reproducible characterization and segmentation of abnormalities using intelligent algorithms due to the variety of shapes, locations and image intensities of different brain tumors of MRI[2].

*Tumor/lesions*

Brain tumor is a group of abnormal cells that grows inside of the brain or around the brain without any control. It is very hazardous disease to human beings due to which death may occur. There are three general types of Tumor;Benign, Pre-malignant and Malignant.

*Benign Tumor* is a tumor which does not spread out in an abrupt way; it doesn't affect its neighbouring healthy tissues and also does not spread to non-adjacent tissues.

*Pre-Malignant Tumor* is aprecancerous stage. It is considered as a disease, it may lead to cancer if not treated properly.

*Malignant Tumor* is the type of tumor, which grows worst with the passage of time and at last results in the death of a person. The term malignant tumor is typically used for the description of cancer [3].

## II. REVIEW OF SEGMENTATION METHODS AND THEIR DEPLOYMENT

Automated detection systems help to overcome the time taking process of manual segmentation of large datasets. It also ensures reproducibility which is normally affected by inter and intra observer variability. However, automated systems are not without problems to achieve these objectives. For example, some of the major problems are pixel intensities violate the independent and identically distributed assumptions of images due to vary nature of the brain MR images, presence of a considerable amount of artifacts and intensity inhomogeneity in MR images [4, 5]. There is a need that automated method must consider these problems in order to achieve the reproducible segmentation results and to develop clinically accepted automated methods.
There are diverse motivations for the development of methods for automatic medical image segmentation. Every year, new brain MRI automatic segmentation algorithms are published. Though there are different classifications of medical image segmentation techniques yet no standard classifications of these techniques. A common classification of these methods is thresholding ,edge detection, clustering, region growing, active contours and statistical ,fuzzy ,neural network techniques etc. Researchers have been developing many schemes according to their intended application by combining various segmentation and/or methods like feature extraction, classification etc. In this section, we review some of the primary techniques available in literature for medical image segmentation along with its deployment in automated schemes.

**Thresholding method** is frequently used for image segmentation. 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. A major weakness of this segmentation mode is that: it generates only two classes. Therefore, this method fails to deal with multichannel images. Besides, it also ignores the spatial characteristics due to which an image becomes noise sensitive and undergoes intensity in-homogeneity problem, which are expected to be found in MRI. Both these features create the possibility for corrupting the histogram of the image. For overcoming these problems various versions of thresholding technique have been introduced that segments medical images by using the information based on local intensities and connectivity. Though this is a simple technique, still there are some factors that can complicate the thresholding operation, for example, non stationary and correlated noise, ambient illumination, busyness of gray levels within the object and its background, inadequate contrast, and object size not commensurate with the scene [6][7].

A. Usman have designed an automated computer aided system which segment and detect the brain tumor. With the help of this system, brain tumor can be extracted using pre-processing, global thresholding and post processing .It can include morphological operations (erosion, dilation, masking etc) and windowing technique [8]. This technique of brain tumor detection is very simple and useful for some particular kind of MR images. This algorithms does not work properly for all type MRI of brain image, because of the intensity variation within the image This technique used the global thresholding in order to segment an image. Due to this false result may get while detecting the tumor, since all whitish part of the brain MR image is not always tumor.

**Region Growing** For image segmentation region growing method is a well developed technique. Based on some predefined criteria this method extracts image region. This is based on intensity information or edges in the image. An operator manually selects a seed point and extracts all pixels that are connected to the initial seed based on some predefined criteria. The main disadvantage of this technique is, it is very time consuming process because it require user interface for selection of seed points [9]. An algorithm called as split-and-merge which is related to region growing algorithm, but it does not require a seed point[10]. Region growing can also be sensitive to noise, causing extracted regions to have holes or even become disconnected. These problems can be removed using a homotopic region-growing algorithm[11].

**Edge Detection** Edge is nothing but boundary between two images. So for detection of these edges edge based segmentation is used. The edge detection technique is used for the identification and locating sharp discontinuities in the image. This method divides an image on the basis of boundaries [12]. The basic edge detection operator shows a matri area gradient operation which determines the level of varience between different pixels of image. Based on Gradient (derivative) function number of edge detection operators are available like sobel edge detection operator, prewitt edge detection operator, Cannny edge detection operator, Laplacian of Gaussian edge detection operator[13].

**Clustering Method** Clustering is a set of data with similar characteristics [4]. Clustering is suitable in biomedical image segmentation when the number of cluster is known for particular clustering of human structure. In exclusive clustering, one pixel belongs to only one cluster and it does not belong to another cluster. The example of exclusive clustering is K- mean clustering. In overlapping clustering one pixel belong to two or more clusters. The example of overlapping clustering is fuzzy C-mean clustering.
***K-mean Clustering*** It is one of the most popular and widely used clustering algorithms. It performs pixel based segmentation of multiband images. An image stack is considered as a set of bands corresponding to the same image [14]. The procedure for k-mean clustering is simple and easy to segment an image using basic knowledge of cluster value. Initially define the number of clusters and arbitrarily select centre for each cluster. Secondly calculate distance between each pixel to chosen cluster centroid. Compare each pixel with

k clusters cenroids and find distance using distance formula. If the pixel has shortest distance among all pixels, then it is moved to particular cluster. Repeat this procedure until all pixels compared to cluster centroids. This procedure continues until some convergence criteria are met[8]. The main advantages of this algorithm are to its simplicity and minimum computational price. The main disadvantage of this algorithm is, it does not give same result each time the algorithm is executed[14]. This is simple to implement, fast and efficient but demerit is its Output depends on the number of partitions used in the segmentation

***Fuzzy C-mean Clustering*** is the example of overlapping clustering technique. Here one pixel value depends on two or more clusters centers. In real time applications, one of the most difficult task in image analysis & computer vision is to classify the pixel in an image correctly [15], when there is no crisp boundaries between objects in an image thus in order to address this difficulty , fuzzy clustering techniques are used . One of the most widely used fuzzy clustering algorithms is the Fuzzy C-means (FCM) algorithm (Bezdek 1981). The FCM algorithm is partition of n element into a collection of c fuzzy clusters. it is a popular method for medical image Segmentation but it only considers image intensity and thus produce unacceptable results in noisy images. Lots of algorithms are planned to make FCM strong against noise and in homogeneity but it‘s still not perfect[8]. Fuzzy clustering technique classify pixel values with great extent of accuracy & it is basically suitable for decision oriented applications like tissue classification & tumor detection etc other Fuzzy clustering algorithms include GK (Gustafson-Kessel), GMD (Gaussian mixture decomposition), FCV (Fuzzy C varieties), AFC, FCS, FCSS, FCQS, FCRS algorithm and etc, among all The FCM is the most accepted method since it can preserve much more information than other approaches [15].

**Deformable model based segmentation scheme** used in concert with image pre-processing, can over-come many of the limitations of manual slice editing and traditional image processing techniques. These connected and continuous geometric models consider an object boundary as a whole and can make use of a priori knowledge of object shape to constrain the segmentation problem. The inherent continuity and smoothness of the models can compensate for noise, gaps and other irregularities in object boundaries. Furthermore, the parametric representations of the models provide a compact, analytical description of object shape[16]. Deformable models are the curves or surfaces de ne within an image domain. This can be moved under the influence of internal forces and external forces. The internal forces are designed to keep the model smooth during deformation. Similarly the external forces are de ne to move the model towards an object boundary or other desired feature within a image[17].There are two types of deformable models : a) Para-metric Deformable models : Represents curves and surfaces explicitly in their parametric form. This allows direct interaction with the model. b) Geometric Deformable: Provides a solution for primary limitation of parametric model. It is based on the curve evolution theory.this enable the contour to expand or contract over time, but Generates ill defined boundaries when applied to noisy images[18].

Automatic detection and segmentation of brain tumor using fuzzy classification and deformable models was introduced by W. Yang *et al*. The proposed method is fully automatic which is a combination of region based and contour based methods. It requires MR image of brain tumor which is applied to the improved kernel Fuzzy c-mean (IKFCM) method for rough detection of brain tumor. For precise tumor segmentation, this rough detection is used as the initial value of a deformable model. Classification can be done using IKFCM and Morphological operations. Improved kernel fuzzy c-means is a combination of Fuzzy c-means (FCM) and kernel method. For data classification point of view both membership and typicality are mandatory for data structure interpretation. It computes these two factors simultaneously. Noise sensitivity defect of FCM removed by IKFCM. For tumor detection and labeling histogram based IKFCM is used, since it is faster than classical FCM implementation. The extracted brain image can be classified into five classes, cerebrospinal fluid, white matter, tumor, gray matter and background. The mean of cerebrospinal fluid, white matter and gray matter are used as the centers of their classes. Zero value is used for background. Tumor has highest intensity among the five classes. Some morphological operations such as opening, erosion, largest component selection, etc are then applied to the tumor region in order to correct misclassification errors. Segmentation results were performed through a quantitative comparison with the results of fuzzy possibilistic c-means (FPCM). To evaluate the results two measures are used - ratio of correct detection (TP) and ratio of false detection (TF). The TP shows how much of the actual tumor has been correctly detected, while FP shows how much of the detected tumor is wrong [19].

In some of the researches, it was studied that brain tumor detection can be possible using colour converted k – means clustering segmentation. This approach first convert the input gray – level image into a color space image and operating the image labeled by cluster indeed. Clustering is a process in which date points with similar feature vectors can groups in a single cluster while data points with dissimilar feature vectors placed in different clusters. The data points that are nearly similar to the feature space are clustered together follows with further clustering of similarity feature space. Similarity of feature vectors can be represented by as Euclidean distance. The clustering is reckoned approach for partitioning d-dimensional data into k – clusters. K – means clustering algorithm places k – clusters for arbitrarily selected cluster centroids ‗*vi*' where $i$ = 1,2,---,k and modifies centroid for new cluster shape formation. Colour- converted segmentation test is the next step to segment an image. The colour converted segmentation is a method that converts colors into a single integer index where a specified color can be selected from a list of colours in a data collection. From final segmented image, the brain tumor is detected [20].

**Watershed Segmentation** is one of the best methods to group pixels of an image on the basis of their intensities. Pixels falling under similar intensities are grouped together. It is a good segmentation technique for dividing an image to separate a tumor from the image. Watershed is a mathematical

morphological operating tool. It considers the gradient magnitude of an image as a topographic surface. Pixels which have highest gradient magnitude intensities (GMIs) are considered as 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 of that image[21].
The main problem of watershed transform is its sensitivity to intensity variations, which results in over segmentation[18].

J. Jayakumari*et al*. had proposed method for automatic detection of brain tumor based on magnetic resonance image using computer aided diagnosis system with watershed segmentation. Here watershed segmentation technique is used to segregates any image as different intensity portions and tumor cells consist of cerebrospinal fluid which has very high intensity. A watershed is a basin like structure defined by highpoints and ridgelines .The major idea of watershed segmentation is based on topographic representation of image intensity. Watershed segmentation can segregate tumors and high intensity tissues of the brain [22].

## III. PROPOSED SYSTEM -SEGMENTATION OF MR IMAGES USING WAVELET TRANSFORM

In various studies it was observed that Decimated and undecimated wavelet transform are beneficial in automatic detection of the brain tumor. It decomposes data into different frequency components, due to which each component can be studied with a resolution matched to its scale. Hence wavelet transform is best tool for image feature extraction. Basically DWT convert the data into the appropriate low and high frequency components at each level. The resultants have the same length as the original sequence. By modifying the filter at each level multiresolution can be achieved.
The Gabor Wavelet provide multi-channel filtering approach of texture analysis. The Gabor filters are basically a bandpass filters. Such bandpass filters efficiently captured the characteristics of tumor tissue[44]. Our proposed algorithm uses decimated wavelet transform and Gabor filter for obtaining multiscale behavior. These are used for preprocessing input image gives enhancement in the initial input. After applying some morphological operations image is converted into binary image, texture features are computed from resulting output. The features like area and location are detected through location finding algorithm and then segmentation of brain tumor tissues can obtained. Proposed work flow is shown in fig.2.

Currently available methods for MR image segmentation can be classified into classical, statistical, fuzzy, and neural network techniques. Since classical methods do not employ a priori information, the final segmentations are sensitive to noise and usually result is not found in continuous regions. Fuzzy segmentation techniques have not been applied for single channel image segmentation although they have shown assurance in segmentation of multichannel images. Although neural network techniques have been offered for MR image segmentation, they have been applied to only a small number of images .
Because of the large number of MR scans in a single brain scan the segmentation technique should be automated and should be done in a reasonable amount of time. Instead of employing lowpass and homomorphic filtering techniques that may corrupt the edges and other high-frequency details of the image, we employ Wavelet Transforms to reduce the effect of noise as well as to preserve the edges[23].

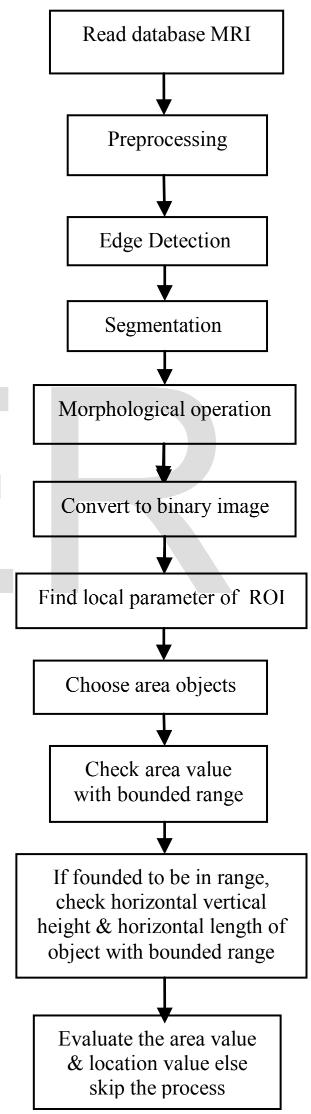


Fig.2 Proposed work flow of automatic brain tumor detection from MR images

## IV. CONCLUSION

Image segmentation plays vital role for the extraction of specified region from medical images. For detection of tumor from Brain MRI images, image segmentation is used. The accurate segmentation is crucial otherwise the wrong identification of disease can lead. Thus image segmentation remains a challenging problem in image processing. In spite of several years of research up to now to the knowledge of authors, there is no universally accepted method for image segmentation. Depending on the application, technique varies. Thus there is no single method which can be considered good for all type of images. Some of these Methods and Techniques for automatic brain tumor detection for MRI that have appeared in the recent literature have been discussed in this paper. It is upto the developer to choose a suitable segmentation technique based on their application .We described our proposed method for segmenting MR images showing tumor, both mass-effect and infiltrating structures. It uses wavelet transform and produces appreciative results even in the presence of noise.

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