

Review on Automatic Brain Tumor Detection Technique

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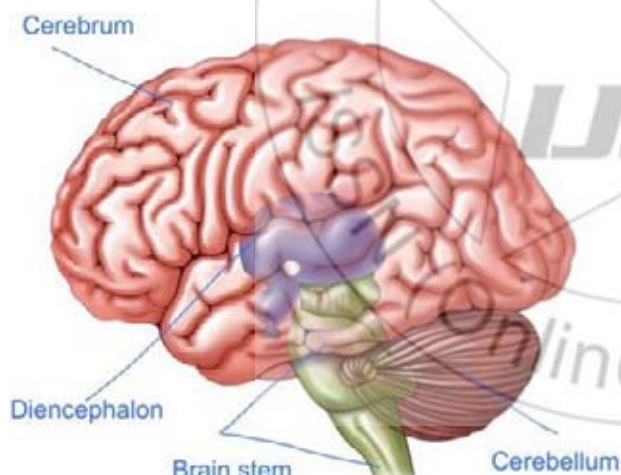
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Abstract: Brain tumor is abnormal growth of cells within brain which may be cancerous or non-cancerous. MRI is the preferred technology out of various available technologies for the diagnosis and evaluation of brain tumor. The current work presents various segmentation techniques that are employed to detect brain tumor. The algorithm based on segmentation using clustering technique deals with steps such as preprocessing, segmentation, feature extraction and classification of MR images. The integration of K-means and Fuzzy C-means (KFCM) clustering algorithm is used, that reduces the problem of gray level selection and noise sensitivity to FCM. K-means algorithm is used for initial segmentation. On the basis of updated membership and automatic cluster selection, a sharp segmented image is obtained from modified FCM technique. This technique is used to select the small deviation for gray level in tumor region for proper segmentation of brain tumor from MRI image.

Keywords: Threshold, Classifier, clustering, K-mean, Fuzzy C-mean, KFCM, Membership Function, Covariance

1. Introduction

Brain is kernel part of the body and it has very complex structure. The brain consists of gray matter (GM) and white matter (WM) contained within the skull. The brain has the three main parts: the cerebrum, the cerebellum and the brain stem. When brain is damaged, it can affect many different things, including memory sensation and personality.



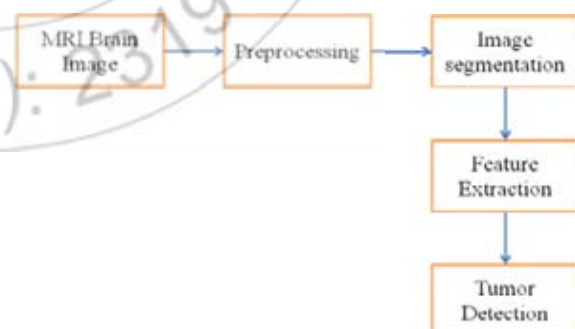
Brain tumor is an abnormal growth of cells inside the skull. Normally the tumor will grow from the cells of the brain, blood vessels, nerves that emerge from the brain. There are two types of tumor which are benign (non-cancerous) and malignant (cancerous) tumors. The main types of treatment for brain tumors are surgery, chemotherapy, and radiation therapy. Radiologists perform the diagnosis of brain tumor manually on MRI images but it being time consuming. The techniques like MRI (Magnetic Resonance Imaging), FMRI (Functional Magnetic Resonance Imaging), MRT (Magnetic Resonance Tomography) and CT (Computed Tomography).^[4,6]

MRI strongly depends on computer technology to generate or display digital images. Detecting brain tumors from MR

Images is a complex medical process and cannot be done without image processing techniques. Structures like tumor, brain tissue and skull cannot be identified without image segmentation. The algorithm based design for segmentation is used for detection of brain tumor with the study of the physical and mental condition of patient. This also used to calculate the exact location and area of tumor which helps in providing proper treatment to patient and in surgical and radiological operations.

2. Brain MRI Image Processing

Brain MRI image is complicated to examine and hence required to process using different image processing technique. The processing steps are Brain MRI scan image, preprocessing, image segmentation, feature extraction and segmented image, which having flow as given below,



A. Preprocessing

Pre-processing mainly involves those operations that are necessarily to extract the desired information and geometric corrections of the original image. These improvements include correcting the data for unwanted noise and removal of non-brain element in the original image. Image filtering is pre-processing stage, used for reducing image noise, highlighting important portions. After this stage the medical image is converted into standard image without noise and skull which image part other than brain.

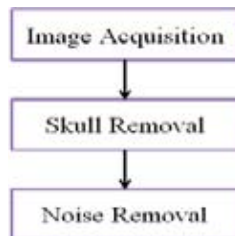
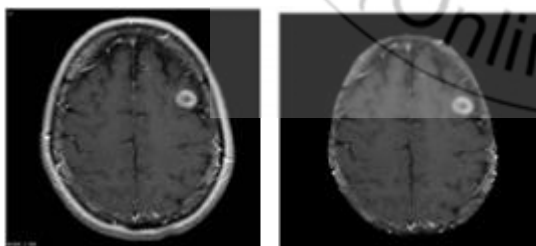


Image Acquisition

Scan is being widely used to get the images for processing to detect the tumor. The techniques like MRI (Magnetic Resonance Imaging), NMRI (Nuclear Magnetic Resonance Imaging), MRT (Magnetic Resonance Tomography) and CT (Computed Tomography) are used for scanning of the brain. Out of which MRI scan is widely used as it provides much greater contrast between the different soft tissues of the body compared to CT scan. MRI strongly depends on computer technology to generate or display digital images. MRI brain images can be obtained from intra-operative magnetic resonance scanner which creates the brain MRI scan image. There are many such systems available to obtain Brain image by MRI scan. This is read and stored image as 2-D array of pixels and display in size of 256 x 256 pixels. MRI scans are stored in JPEG image format. [2]

Skull Removal

The technique that is to be used to remove skull, must be effective, efficient, reliable and fully automated. In Brain MRI there is a particular intensity of the back-ground that appears before brain image. Unfortunately in brain MRI, the same intensity is appeared as a part of the brain. And this appearance is a false background. The morphological techniques are effective and fully automated but inefficient way of skull removal. Morphological image opening i.e. erosion followed by dilation is performed on film artifacts removed MR image. Erosion is a technique which uses background and the foreground for the processing. Erosion detects the small gap between skull and brain and removes the skull from brain region. [2] The skull removed image is shown as below,

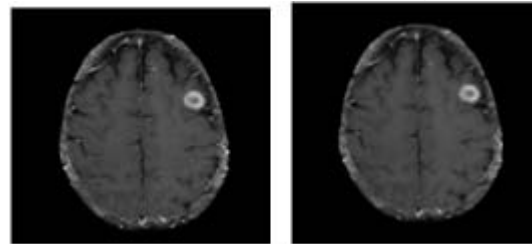


Noise Removal

Filtering technique is used for noise removal. Noise reduces the accuracy of segmentation and hence it is required to remove using filtering techniques. Median Filter, Low pass Filter, Prewitt edge-finding filter, Nonlinear Filter and other filter with contrast Enhanced filter are used for noise removal technique. Median Filter removes the noise with high frequency components from MRI without disturbing the edges and it is used to reduce 'salt and pepper' noise. This technique calculates the median values of the surrounding pixels to determine the new value of the pixel to de-noise it. A median is calculated by sorting all pixel values by their size, then selecting the median value as the new value for the

pixel. Hence, the removal of high frequency components using median filtering technique is used. It gives high resolution MRI compared to other filtering technique. [4]

The result of median filter is as shown below,



B. Image Segmentation

Segmentation subdivides an image into its constituent regions or objects and it should stop when the objects or regions of interest in an application have been detected. Segmentation is process of partitioning the image into different parts having similar features. The pre-processing stages needs to done on the image initially, and then segmentation and feature extraction is applied for the detection of the tumor which is the region of interest (ROI) from the entire image. The features are intensity based, area base, is the vital part of segmentation as the tumor must be isolated from the brain image. For brain image segmentation numerous image processing techniques have been proposed, for example- region growing, thresholding, classifiers and clustering. [3]

1. **Thresholding** approaches segment images by creating a binary partitioning of the image intensities. A thresholding procedure determines an intensity value, called the threshold, which separates the desired classes. The segmentation is then achieved by grouping all pixels with intensities greater than the threshold into one class and remaining pixels into another class. Thresholding typically does not take into account the spatial characteristics of an image and it causes to be sensitive to noise and intensity inhomogeneities of MRI image. For these reasons, variations on classical thresholding have been proposed for medical-image segmentation that incorporate information based on local intensities and connectivity. There are several threshold segmentation techniques such as Otsu method, Bernsen method, Sauvola method, Niblack method, Histogram Thresholding method, Kapur method and Th-mean method, from these methods Histogram Thresholding algorithm is given below. [4, 3]

Step 1: The MRI image of the brain is divided into two equal halves around its central axis to detect the infectious side from histogram of each part of the brain.

Step 2: The threshold points of the histograms is among the two histograms.

Step 3: Using the threshold point for both the halves, the image is segmented.

Step 4: The resultant image is cropped along its contour to find out the physical dimension of the tumor.

Step 5: Check the segmented images pixel value; and binaries it into two values to display tumor region.

Step 6: Segmented image is displayed. [11]

2. **Region growing** requires a seed point that is manually selected and selects all pixels connected to the preliminary seed based on some predefined condition. It

is a procedure for extracting an image region that is connected based on some predefined criterion. These conditions can be based on intensity information or boundaries in the image. The manual dealings to obtain the seed point is the great disadvantage for this region growing. Region growing has also been restriction to susceptible to noise; causing extracted regions to have holes or even become disjointed. These problems may overcome by using a hemitropic region-growing algorithm. The region growing method is a well-developed technique for image segmentation. The technique is not fully automatic and requires user interaction for the selection of a seed. Since this technique is noise sensitive, therefore, the extracted regions might have holes or even some discontinuities.^[3] Region growing techniques have various algorithm from these the working of region growing algorithm is given as follows;

Step 1: Selecting the input image and indicate the seed point for cross-section, at the spot where the tumor is present

Step 2: Displaying the next cross-sections and indicate the seed point, at the spot where the tumor is present

Step 3: With the selected seed points, the region grow until a boundary in the image is met for segmentation of tumor

Step 4: The pixels with similar intensity form the image are binaries with relative intensity

Step 5: Display image with segmented region.^[4]

3. **Classifier** methods are pattern recognition techniques that seek to partition a feature space derived from the image by using data with known labels. Classifiers are known as supervised methods because they require training data that are manually selected and then used as references for automatically segmenting new data. There are a number of ways in which training data can be applied in classifier methods. Because training data can be labeled, classifiers can transfer these labels to new data as long as the feature

space sufficiently distinguishes each label as well. Being non iterative, classifiers are relatively computationally efficient. A disadvantage of classifiers is that they generally do not perform any spatial modeling. Another disadvantage is the requirement of manual interaction to obtain training data.^[3] The Support vector machine and K-nearest Neighborhood algorithm are the methods used in classifier from these K-nearest Neighborhood algorithm is work as follow;

Step 1: Determine k value where k gives the number of nearest neighbors.

Step 2: Distance between query instance and all the training samples is calculated.

Step 3: On the basis of kth minimum distance, the distance is sorted.

Step 4: The majority class is assigned and class is determined.

Step 5: The tumor image is segmented.^[10]

4. **Clustering** algorithms are termed as unsupervised methods. To obtain training data, clustering methods iteratively alternate between segmenting the image and characterizing the properties of each class. In this way it trains it selves using the available data. Three commonly used clustering algorithms are the K-means algorithm, the fuzzy c-means algorithm, and the expectation-maximization algorithm. It iterates between computing the Euclidean distance for each pixel and computing maximum likelihood estimates of the means, covariances for each cluster until the same values are obtain as previous. Although clustering algorithms do not require training data, they do require an initial segmentation. Like classifier methods, clustering algorithms do not directly incorporate spatial modeling and can therefore be sensitive to noise. This lack of spatial modeling, however, can provide significant advantages for fast computation.^[3]

Algorithms used for Different Segmentation Techniques

Algorithm	Working	Results	Limitations
Thresholding Segmentation Method			
Ostu's Segmentation	Using weighted class variance it divides the image in 2 classes	Extracted image contain extra part with tumor and required to re process for proper output	Does no work properly with all type of MRI images Required to select weighted variance value
Histogram Segmentation	The band of multiple thresholding values is applied in between Tk and Tk-1, where Tk is lowest gray value and Tk-1 is highest gray value of extracted region	Extracted image contain tumor with some part of MRI image which can removed by required feature extraction	Required to apply correct threshold value to achieve proper result
Region Growing Segmentation Method			
Region Growing	The selected seed point for extracted region is applied with Hemitropic region growing algorithm on input image for segmentation of tumor	Extract the required region of interest from noise free input brain MRI region	Seed points are manually selected Noise create holes in extracted image or discontinuities in it
Classifier Segmentation Method			
K-Nearest Neighborhood	Depending on the training dada and value of k selected Euclidean distance is calculated and particular pixel is assign to particular class	Extract the proper region of tumor from MRI image	For large training set, poor run time performance Very sensitive to noise Dependence on the parameter K for training dada
Support Vector Machine	Depending on the learning feature, it train itself and form the classes of normal image and abnormal image for detection of tumor	It extract the accurate information from the input image	Training time is large and highly depend on the size of data
Clustering Segmentation Method			
K-Mean	Divides all pixels randomly in K clusters and	Its result is more accurate and	Need to understand K-values

algorithm	iteratively find the mean for each cluster center and repeat the same until it match with previous one	require less run time	Not works for global cluster More sensitive to noise
Fuzzy C-Mean Algorithm	Randomly select centroid and assign membership value to each pixel, pixels are assign to clusters based on membership value and distances from centroid	Its result is highly accurate and extract the exact edges of tumor in segmented image	Sensitive to noise and more time require to segment the image

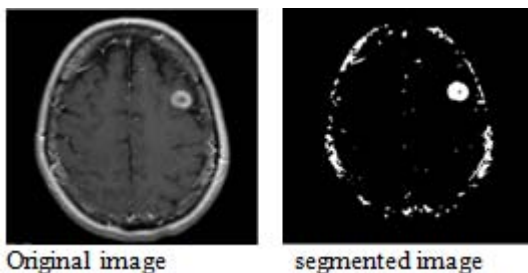
From these techniques, region growing, thresholding and classifiers requires the training data for the segmentation of region of interest and the clustering is self guided technique which do not required any training data for segmentation of image. The different methods for these segmentation techniques required to provide training data with some processing to calculate it, and also have less accuracy than clustering technique for segmentation. As brain image is complicated structure, the clustering technique is used for segmentation. The clustering techniques give a better accuracy than compared to other techniques whereas thresholding techniques have less computational time. The K mean algorithm requires less time than Fussy c mean algorithm but the accuracy of Fussy C mean is more than K mean and best work with medical images. Hence, accuracy is major concern then time requirement, algorithm designed using fuzzy-c-means and K mean are preferred for the segmentation of Brain MRI images. [5]

3. Clustering Algorithms

K-Means is the one of the unsupervised learning algorithm for clusters. In k-means algorithm initially required to define the number of clusters k. Then k-cluster center are chosen randomly. The distance between the each pixel to each cluster centers are calculated. The distance may be of simple Euclidean function. Single pixel is compared to all cluster centers using the distance formula. The pixel is moved to particular cluster which has shortest distance among all. Then the centroid is re-estimated. Again each pixel is compared to all centroids. The process continuous until the center converges. The K-means clustering algorithm clusters data by iteratively computing a mean intensity for each class and segmenting the image by classifying each pixel in the class with the closest mean [7]

Algorithm for K means Clustering:

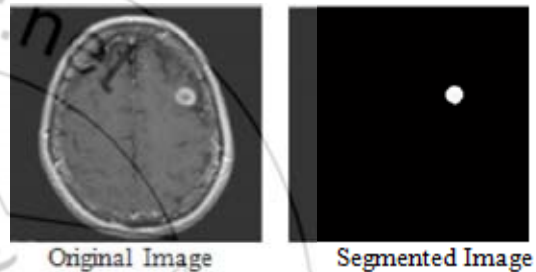
- Step 1:** Compute the intensity distribution
- Step 2:** Initialize the centers with k random values
- Step 3:** Cluster the pixels based on distance of their intensities from the center
- Step 4:** Compute the new center for each of the clusters
- Step 5:** Repeat the following steps until the cluster center of the image does not change anymore [11]



Fuzzy C-Mean clustering algorithm introduced by Bezdek is an improvement of earlier clustering methods. It is based on minimizing an objective function, with respect to fuzzy

membership, and set of cluster centroids. The FCM algorithm iteratively optimizes with the continuous update of fuzzy membership and set of cluster centroid. The drawback of FCM for image segmentation is the objective function of FCM does not take into consideration any spatial dependence among. [8]

- Step 1:** Randomly select c cluster centers.
- Step 2:** Calculate the fuzzy membership function and center for each cluster
- Step 3:** Compute the new membership value and update fussy membership degree
- Step 4:** Repeat previous Step until the membership value is less than or equal to previous one. [11]



The EM algorithm applies the same clustering principles with the underlying assumption that the data follow a Gaussian mixture model. The EM algorithm has demonstrated greater sensitivity to initialization than the K-means or fuzzy c-means algorithm.

A different technique for tumor detection from brain MRI image, based on the combination of K-means and FCM (KFCM) is used. It will reduce the problem of gray level selection and noise sensitivity accustomed to FCM. Very little bit of pixel intensity is not avoided and is selected based on the number of gray level to be used and the coarse image. By choosing right membership input & output variables along with adjusted number of feature and cluster the detection of tumor is completed. It is done by preparing train and target data for the relevant image through the network with feed forward back-propagation algorithm. [1]

4. Summary and Conclusions

Here several existing brain tumor segmentation and detection methodology has been discussed for MRI of brain image. All the steps for detecting brain tumor have been discussed including pre-processing steps. Pre-processing involves several operations like acquisition, skull removal and noise removal has been discussed. Quality enhancement and filtering are important because edge sharpening, enhancement, noise removal and undesirable background removal are improved the image quality as well as the detection procedure. Among the different filtering technique, median filter suppressed the noise without blurring the edges and it is better outlier without reducing sharpness of the

images. After the several image quality improvement and noise reduction discussion here, some possible segmentation methodology like intensity based thresholding segmentation, Region based, classification based and clustered based segmentation has been described above with short description, advantage and disadvantage to detect or segment a brain tumor from MRI of brain image. Clustered based segmentation performs very simple, fast and produce good results for non-noise image but for noise images it leads to serious inaccuracy in the segmentation. In spite of several disadvantage, an automatization of brain tumor segmentation using combination of K mean and modified fuzzy C mean algorithm for clustering method may overcome the problems and gives effective and accurate results for brain tumor detection.

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