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An Efficient Segmentation Approach for Brain Tumor Detection in MRI

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Abstract

Background: For effective tumor diagnosis, early brain tumor detection becomes an important procedure. Despite a huge number of tumor detection techniques available, brain tumor segmentation is still a challenging field because of the complex characteristic of the brain MR images. This work aims to achieve an efficient segmentation approach for tumor detection. **Methods:** The Contextual Clustering based segmentation methodology proposed here includes image pre- processing and tumor segmentation. Image pre-processing removes total noise in the image and corrects the boundaries. Tumor segmentation uses Contextual Clustering algorithm to segment the tumor part from the input MR images. **Findings:** An automatic method of tumor detection and localization in the brain MRI is proposed here which avoids false segmentation and improves accuracy. **Application:** This stated Contextual Clustering algorithm works efficiently in brain tumor segmentation for the MRI brain images and produces accurate results for the input datasets and used in medical fields.

Keywords: Brain Tumor Segmentation, Contextual Clustering, MRI (Magnetic Resonance Imaging), Medical Imaging, Tumor Detection

1. Introduction

Brain tumor is an abnormal and excessive growth in the brain. It can be categorized as benign and malignant. Benign tumor stays localized and does not spread elsewhere in the body and can be cured by surgical removal. The malignant tumors spread to other organs and tissues. Both the benign and malignant tumors are hazardous to the patients and may lead to death. Image creation of the human body (or parts thereof) for clinical application is referred as medical imaging. A medical imaging technique used primarily in radiology to image the anatomy and functioning of the body is known as MRI (Magnetic Resonance Imaging). Hence an efficient method for tumor segmentation should clearly use a reliable tool where the MRI scan can be used as an accurate technique for detecting tumor from human brain.

The objective here is to effectively identify and segment the tumor region from the brain MRI. Even though the existing method consists of contextual information of a voxel in the image leading to smoothness in the segmentation results, the complexity of the brain MRI images could be detrimental in discerning the brain tumor segmentation tasks using the patch feature. This proposed algorithm overcomes the drawbacks in the existing system and improves segmentation accuracy.

A.C. Prabhu et al.[1] [2016] presented an integrated hybrid segmentation approach to classify the MRI on the basis of local independent projections. The hybrid PAM is used to partition and to determine the cluster centers, along with enhanced fuzzy c-means approach. A. Shenbagarajan et al.[2] [2016] proposed MRI analysis makes use of the region based Active Contour Method to segment and Artificial Neural Network based Levenberg-Marquardt (LM) algorithm to classify the MR images into Normal

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and Tumourous. Moon. N et al.[3] [2002] presented an expansion of the Expectation Maximization (EM) segmentation algorithm. Using an individual's information on tumor location derived from subtraction of post and pre-contrast MRI, it proposes modification to a probabilistic brain atlas. This enhanced method can handle different types of mass tumors, pathology and infiltrating changes like edema.

Shobarani[4] [2014] presents the contextual clustering algorithm to extract the features from the mosaic texture images and K means with CC is used to segment the texture based on the features extracted from the Contextual Clustering. Shobarani and Purushothaman[5] [2011] present the contextual clustering and fuzzy logic to extract the features from the textile images. Vivek Singh et al.[6] [2003] presented a standard technique with which projection images of particles are identified automatically. This method is based upon Markov random field modelling of the projected image. S.M. Ali et al.[7] [2013] used four types of techniques in the extraction of the tumor region. They are Gray level stretching and Sobel edge detection, K-Means clustering technique based on location and intensity, Fuzzy C-Means clustering, and an Adapted K-Means clustering technique and Fuzzy C Means technique. T. Logeswari and M. Karnan[8] [2009] presented a work wherein image segmentation is done by using HSom. The Hsom is the extension of the self organizing map and is used in the classification of the image by analyzing every row. The computational speed is achieved by the HSom with vector quantization, in the lowest level of weight vector, having a greater value of tumor pixels.

Eero Salli et al.[9] [2001] presented an algorithm for Statistical Parametric Maps (SPM), that makes use of a contextual clustering procedure, which is calculated from three dimensional images that vary over time. The detection of the neural activations from functional MRI (fMRI) is performed by this algorithm. Meiyan Huang[10] [2014] presented a method to classify each voxel into different classes that segments the tumor in MRI images based on Local Independent Projection based Classification (LIPC) algorithm. Pabitra Roy et al.[11] [2013] has presented an automated method for detecting brain abnormalities and tumor edema segmentation from brain MRI. This algorithm uses thresholding technique that uses standard deviation average intensity to find the threshold intensity value which is near the intensity value of tumor border. Shubhangi S. Veer and P.M Patil[12] [2015] present global thresholding and watershed segmentation for tumor detection. Aqhsa Q. Syed and K. Narayanan[13] [2014] uses neural network for classification for tumor detection in MRI images. Minakshi Sharma and Sourabh Mukharjee[14] [2013] have used Grey Level Co-occurrence Matrix (GLCM) to perform feature extraction. An adaptive network called ANFIS which combines the advantages of both fuzzy and neural network is used to segment the tumor.

2. Materials and Methods

2.1 Proposed Work

This proposed work is to detect and segment the tumor region in the brain MRI using Contextual Clustering algorithm and to show that its accuracy in the tumor segmentation is higher when compared to all other already used conventional methods. The processes in this proposed work are:

1.The MRI of brain is taken as the input image.
2. Then Image pre processing is carried out in that MRI of brain.
3. The Contextual Clustering algorithm is applied to that pre-processed image to segment the tumor region.

This work involves
1 Image Pre-Processing
2 Tumor Segmentation

2.1.1 Image Pre-Processing

- The visual appearance of input MRI images is enhanced.
- And the manipulation of input datasets is improved.

This Image pre-processing does three sub functions:

- Image resizing and gray scale conversion
- Total noise removal by median filtering
- Morphological opening operations

2.1.1.1 Image Resizing and Gray Scale Conversion

First resizing of the input MR image is carried out where the image gets enlarged. Then the gray scale conversion takes places.

2.1.1.2 Noise Removal By Median Filtering

An efficient image improvement technique that eliminates salt and pepper noise is median filtering. Since this filtering is less sensitive to high changes in pixel values than other linear techniques, this median filtering technique can remove entire salt and pepper noise from the image without any changes to the quality of an image. Hence here total noise from the input image is eliminated by using median filtering.

Median filtering:

- The entire image is scanned by 3x3 sub region.
- At each position the centre pixel got replaced with the median value.

2.1.1.3 Morphological Opening Operations

After removal of the total noise present in the image both morphological operations like the erosion and dilation is performed to correct the boundaries of the image.

2.1.2 Tumor Segmentation

After the pre processing process the tumor region segmentation takes place using the Contextual Clustering algorithm.

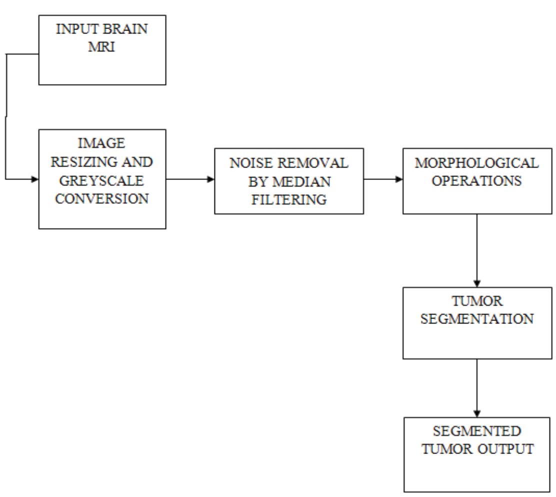


Figure 1. Process Of Proposed Methodology.

2.2 Contextual Clustering Based Segmentation

The Contextual Clustering algorithm is derived from standard normal distribution. It segments the data into group1 (ω0) and group 2 (ω1).

The steps for the implementation of the Contextual Clustering algorithm that segments the tumor part from the Brain MRI are

1. Describe decision parameter Tcc (+ve) and weight of neighborhood information β (+ve). Assign Nn to be the total data available in the neighborhood. Assign Zi to be the actual data, i.
2. Categorize data with zi>Tα to ω1 and data to ω0. Store the categorization to C0 and C1.
3. For every data i, calculate the number of data ui, that belongs to group ω1 in the neighborhood of data i. Assume that the data beyond the range belongs to the group ω0.
4. Categorize ω1 to data with

$$z_i + \frac{\beta}{T_{cc}}(u_i - \frac{N_n}{2}) > T_\alpha$$

and ω0 to other data. The classification is stored in variable C2
5. If C2 ≠C1 and C2 ≠ C0, copy C1 to C0, C2 to C1 and go to step 3, if not, halt and go to C2.

The following are the steps in the implementation of Contextual Clustering:

a. Analyze the entire Pattern (Brain MRI feature).
b. Arrange the values of the Pattern.
c. Locate the median Cm.
d. Identify the number of values higher than the median values, Um.
e. Compute CC using Cm + (beta/Tcc) * (Um – (bs/2)).
f. The segmented values are assigned to CC.

Here Matlab is used to implement this Contextual Clustering algorithm.

Figure 2 stated below reveals a gradual raise in the error when the beta value varies from 0.1 to 1.0. Therefore the CC estimation enhances when the beta value is lower. Figure 3 reveals a gradual decrease in the error when the threshold value varies from 10 to 100. Therefore, higher threshold value indicates enhanced CC estimation.

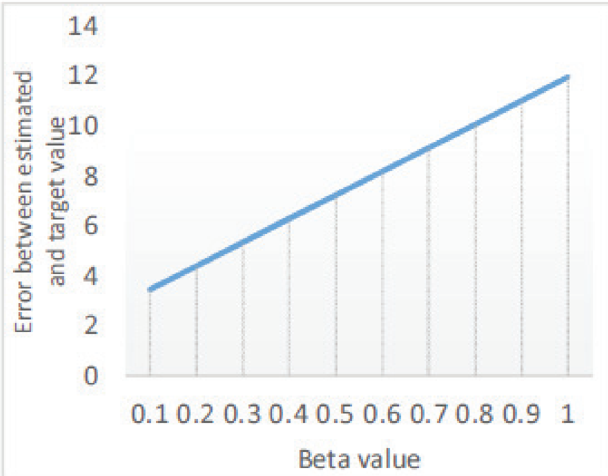


Figure 2. Beta Values Impact in CC Estimation.

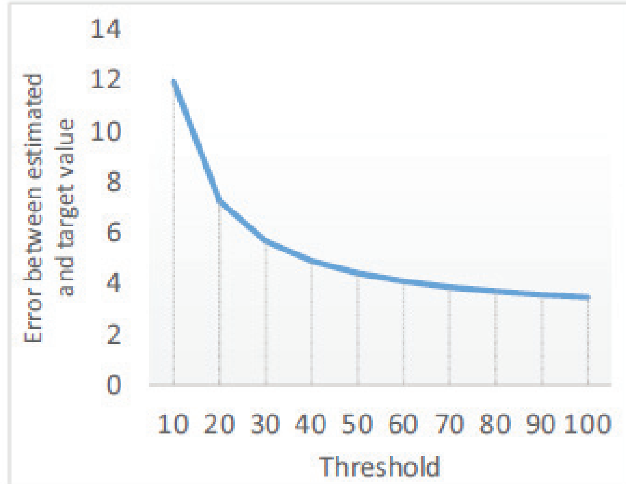
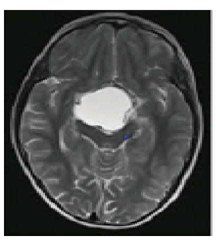
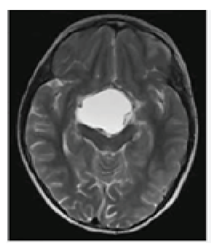
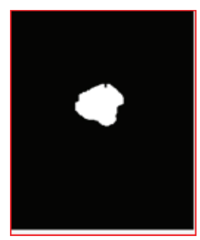
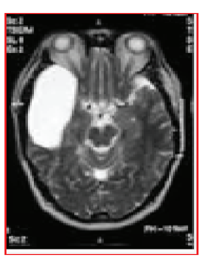
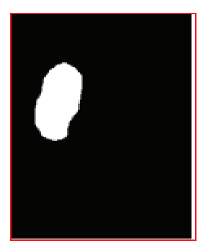
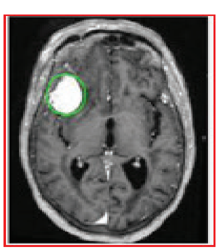
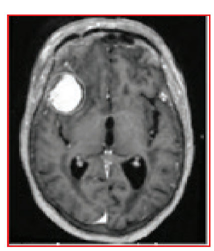
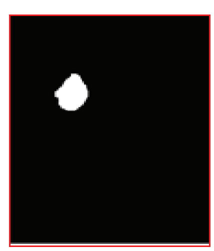


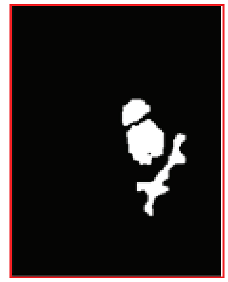
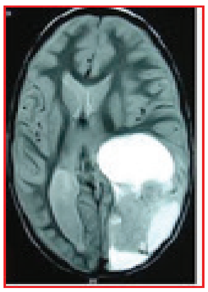
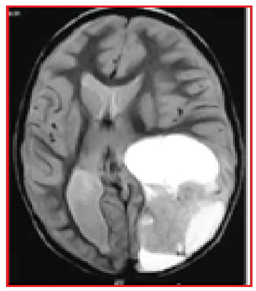
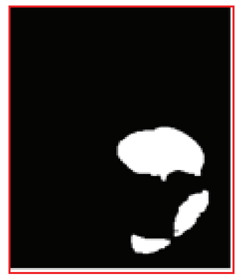
Figure 3. Threshold Values Impact in CC Estimation.

3. Experimental Results

Large number of brain input MRI datasets have been taken as samples and tried with this proposed algorithm. Different brain MRI input images, its median filtered output and the CC segmented tumor region have been presented in Table 1.

Table 1. Results after Segmentation of Various MRI Datasets of Brain

S. No	Input MRI of Brain	Image after Median Filtering	Segmented Tumor
1			
2			
3			

4			
5			

4. Conclusion

This proposed work detects tumor using a new segmentation method and localisation in brain MR images. The main aim of presenting this Contextual Clustering based segmentation technique is the improvement of the segmentation accuracy by the reduction of false segmentations. In this work the brain MRI is taken as the input image and the segmented tumor region is got as the output which uses this efficient Contextual Clustering algorithm which takes less time to segment with least computations in segmentation and hence by improves the segmentation accuracy compared with all other already used conventional methods.

Modifications of the values of the variables used in the proposed algorithm can be tried as the future work for the further improvement in the segmentation.

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