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Brain Portion Extraction Scheme using Region Growing and Morphological Operation from MRI of Human Head Scans

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***Abstract*—** In this paper, we propose a brain portion extraction method using single seeded region growing technique and morphological operations. Segmentation requires initial seed point selection, which increases computational cost and execution time. To overcome these problems a single seeded region growing method for image segmentation is proposed. Starts by selecting a seed point at center pixel within the image as the initial seed and grow regions to extract brain portion in Magnetic resonance image. Brain portion is iteratively grown by comparing all unallocated neighbouring pixels to the region. Finally Morphological operations erosion, dilation, and holes filling are performed to extract the fine brain. The performance of the method is estimated using the Jaccard and Dice similarity coefficients. Proposed method was tested with IBSR of brain images and had accurately segmented the brain regions which are better than the existing methods such as Brain Extraction Tool (BET), Brain Surface Extractor (BSE).

***Keywords*—** Brain Extraction,Image Segmentation,Single seeded region growing,Morphological operations.

I. INTRODUCTION

Medical image segmentation is best challenging problems in healthcare industry. Medical imaging modalities are X-ray, Computed Tomography (CT) and positron Emission Tomography. Magnetic resonance imaging (MRI) is a medical imaging technique and useful for the scanning soft organs such as the brain, heart, and eyes and providing information about the blood circulation. MRI Technique is used to study the brain structures and the brain related diseases. MRI reform the speed and accuracy of diagnosis and prognostic procedures in medical field in the applications. MRI (Magnetic Resonance Images) is often used in medical field. It is a non-invasive, non-destructive, flexible imaging tool. Several techniques have been developed for MRI brain image segmentation and methods are used in BET (Brain Extraction Tool), BSE (Brain Surface Extraction).The Magnetic resonance imaging include different tissue classes contains four regions, grey matter (GM),white matter (WM),cerebrospinal fluid (CSF) and background. Segmentation is the partitions image into different distinct regions meaningful and useful for image analysis and interpretation. It can be used for many applications in computer vision and digital image processing.

Region growing is a region-based image segmentation method also called pixel based image segmentation. We Propose a Region growing method select initial seed point in a corresponding the region grow by appending to each seed points those neighboring pixels. The proposed method gives better results than that of the two existing skull stripping methods BET, BSE [1].

II PROPOSED METHOD

A. Region Growing

Region growing method is used to partition an image into non overlapped regions in the image. Region growing method can correctly separate the region and provide good segmentation results. The region growing and mathematical morphological methods are the non-brain region and done by extraction of the brain region. The main aim of region growing images is to individual pixels are called seeds in an input image and Starts with initial seeds and grows with neighbouring pixels. The Seed may be pixel or region [10].

a) Region Growing Algorithm

- Each pixel and region with respect to the intensity, It is based on seed selection.
- Region growing is grown from initial seed and compared with 8-connected neighbourhood pixels and 4-connected neighbourhood pixels.

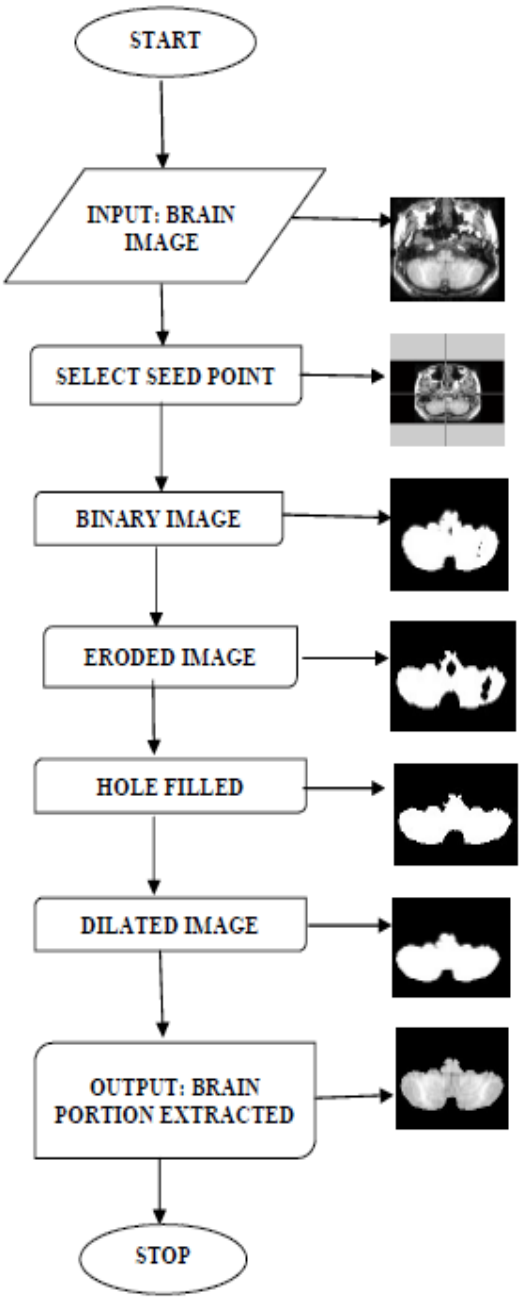


Figure 1: Flowchart of the proposed method

- First process (or) iteration, 8-neighbor pixels in the 3X3 neighbourhood pixels of the center pixel satisfying the condition. The most useful in region growing in Pixels are grouped together.

$$R = \cup_{k=1}^{A} Rk \quad (1)$$

- Rk is a connected region. The segmentation must be complete and every Pixel must be in the region.
- The region must be disjoint, $= \emptyset$ for all I=1,2,….n
- R represents the whole image region.

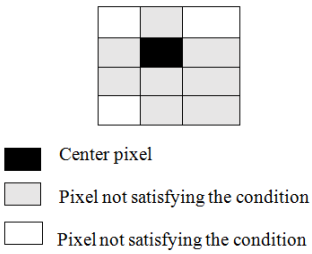
	(x,y+1)	
(x1,y)	(x, y)	(x+1,y)
	(x,y-1)	

4-Neighbour Pixels

(x1,y+1)	(x,y+1)	(x+1,y+1)
(x1,y)	(x, y)	(x+1,y)
(x-1,y-1)	(x,y-1)	(x+1,y-1)

8- Neighbour Pixels

b) Pixel map for Region growing



The region growing is the pixel at the center is the seed point for the region growing process. There are 8 pixels in the 3x3 neighbourhood of the center pixel satisfying the condition. All the pixels these pixels are grouped together in the region, which has now grown to a 3x3 size with a square shape.

Region based image segmentation in Region growing method to select the initial seed selection to choose neighbouring pixel.

The pixel value falls within growing criteria and satisfy the condition then to add the region otherwise any neighbouring pixels remain then not satisfying the condition then selected from region. Selected pixels from region [12].

The flowchart for region based segmentation method in region growing as shown as figure 2.

B. Morphological Operations

Morphological operation are methods for processing images based on the shape. The operations are used either to separate or join region in specified structuring element(SE).The Dilation and erosion are the basic morphological operations.

a) Erosion

Erosion operation is principally performed on binary images. Erosion helps to decoupling weakly disconnected object in a cluster of objects. Erosion removes pixels on the object boundaries and it is achieved by using SE (Structuring Element) in B. The eroded image is received as:

$$Y = X \ominus SE \quad (2)$$

Where, $\ominus$ represents erosion operation. Erosion detaches the weakly connected regions from the brain portion.

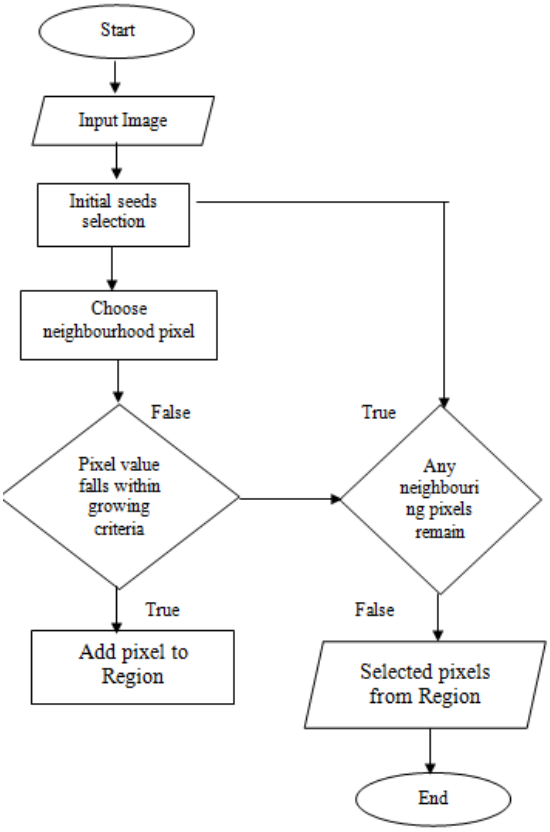


Figure 2: Flowchart for Region growing

(a) (b)

Figure 3: (a) Input Image (b) Eroded Image

b)Dilation

Dilation adds pixels to the object boundaries and it is achieved by using structuring element SE. The SE is placed at all pixel positions in the input image X and it is checked with the consistent neighbouring of pixels.

The erosion, lost by few brain pixels. The pixels are recovering the lost tissues by morphological operation in dilation by using structuring element (SE). The dilated image is received as:

$$Y = X \oplus SE \quad (3)$$

C. Performance Evaluation Metrics

The experiments by using the region growing method in MRI brain images collected from IBSR (Internet Brain Segmentation Repository) and gold standard images. System used in MATLAB R2013a for implementing the seeded region growing method.

(a) (b)

Figure 4: (a) Input Image (b) Dilated Image

a) Hole Filling

A hole is an area of dark pixels in region surrounded by a connected border of foreground pixels in binary image and the use of dilation, Complementation and intersection [13].

$$X_k = (x_k - 1 \oplus B) \cap A^c \quad (4)$$

Finally, all the holes are filled in

$$X_k \, , X_k = X_k - 1 \quad (5)$$

(a) (b)

Figure 5: (a) Input Image (b) Hole filled

The MRI brain images, Not extracted for the brain portion in the upper slices, bottom slices and the same problem has been reported in BET and BSE also. For Calculating the performance of the proposed method and computed the similarity indices and Jaccard given by,

$$J(A, B) = \frac{|A \cap B|}{|A \cup B|} \quad (6)$$

The Dice coefficient (D) is given by:

$$D(A, B) = \frac{2|A \cap B|}{|A| + |B|} \quad (7)$$

Where A represents the aggregate pixels of the image received by the proposed method and B represents the aggregate pixels in the image received from ground truth data (gold standard) [14].

The segmentation errors false positive rate (FPR) and false negative rate (FNR) are false negative rate (FNR) is used to measure the misclassification done by the proposed segmentation method.

FPR is the ratio of the number of pixels incorrectly classified as brain region to number of pixels non-brain region and false positive pixels.FNR is the ratio of the number of pixels

incorrectly classified as non-brain region to number of brain region and false negative pixels The FPR represents the degree of over segmentation. The FPR and FNR are computed as:

$$FPR = \frac{|FP|}{|TN|+|FP|} \quad (8)$$

$$FNR = \frac{|FN|}{|TP|+|FP|} \quad (9)$$

True positive (TP) and False positive (FP) are defined as the number of voxels correctly and wrongly classified as brain tissue by the region growing method. True Negative (TN) and False Negative (FN) are defined as the number of voxels correctly and wrongly classified as non-brain tissue by the region growing method [16].

D. Materials

We have used volumes of MRI axial datasets to assess the performance of the proposed method. The images are received from IBSR (Internet Brain Segmentation Repository). Each image consists with dimensions of 256 × 128 pixels.

III. RESULTS

The experiments are carried out by applying the proposed method on the selected MRI axial brain images and performed quantitative and qualitative analysis. For quantitative analysis, the Jaccard (J) and Dice (D) were calculated for the sample selected images of IBSR datasets. The values of J and D computed by using the skull stripping methods BET and BSE for the selected images. The FPR and FNR were also calculated for the images.

TABLE 1: Computed Values of Mean for the parameters J, D, FPR, and FNR by BET, BSE and Proposed Methods for the Images

Methods	J	D	FPR	FNR
BET	0.928	0.962	4.7	**5.95**
BSE	0.937	0.966	1.96	1.12
Proposed	**0.908**	**0.951**	**2.19**	**1.96**

III. CONCLUSION

The Region growing method is best result for Segmentation in MRI (Magnetic resonance Images) brain portion extraction scheme using and morphological operations are used for MRI of human head scans. The results shows that region growing method worked well on normal Brain datasets. Initial seed point at center pixel Within the image and the grow regions to extract MRI brain image portion in Magnetic resonance image (MRI) using Single seeded region growing method. Better results can be received by omitting erosion, dilation, and hole filling. The BET and BSE methods have produced better results than the existing BET, BSE .Thus the SRG method is a suitable method to segment the brain from MRI brain images.

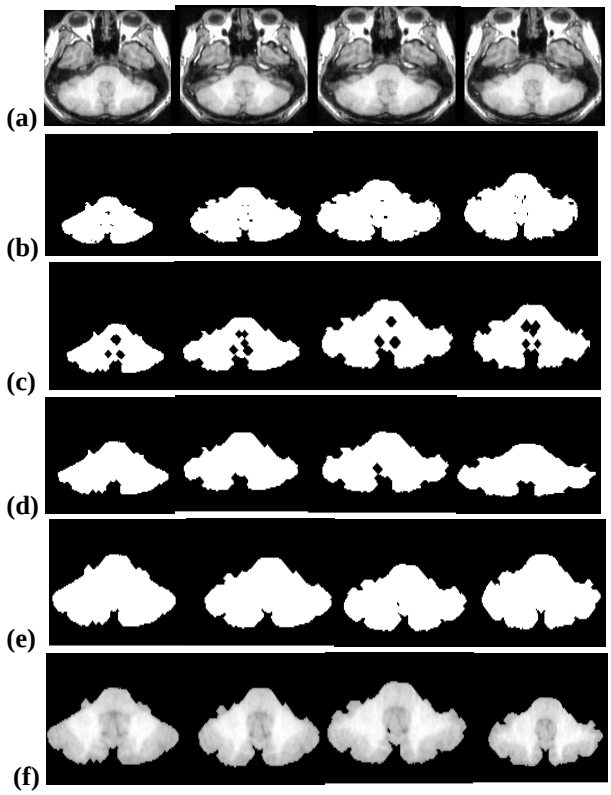


Figure 6: (a) Input Image (b) Segmented Image (c) Eroded Image (d) Hole Filled (e) Dilated Image (f) Extracted Image

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