International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Segmentation of Brain Tumor Using Bat Optimization to Distinguish WM, GM and CSF

Gagandeep Kaur[1], Naveen Kumari[2]

[1]Punjabi University Regional Centre for IT & Management, Mohali

[2]Assistant Professor, Punjabi University Regional Centre for IT & Management, Mohali

Abstract: ***To detect tumor and then segment brain magnetic resonance image with the help of segmentation into different parts is a very challenging task and it emerges to help specialists in diagnosing tumor. In this context and to become aware of that particular region or tumor, this paper is presenting different techniques which have been used in former period. In the proposed work one of optimization technique is used i.e. BAT optimization which is used to detect tumor, edema, white matter, gray matter and cerebrospinal fluid.***

Keywords: Brain tumor, BAT optimization,edema, white matter, gray matter, cerebrospinal fluid

1. Introduction

Brain is very essential part of human body. The brain is consisting of soft nervous tissues in the skull which helps the vertebrates to perform various functions. The tissues in brain are white matter (WM), grey matter (GM) and cerebrospinal fluid (CSF). But nowadays the diseases like brain tumor, cancer, and edema are very common and to diagnose these diseases properly the physicians should have to detect that particular region of brain or any other part of body. Brain tumor is growth of abnormal cells in brain and edema is excess of watery fluid in tissues of the body. To detect brain tumor or edema doctors take images of brain which are known as MRI. These images of brain help in detection of brain tumor or edema at particular region of brain. There are different types of tumor benign (cancerous) and malignant tumor (non-cancerous) [6]. The MR images are used because they have better contrast quality and display the detail more appropriately. The MR images are incorporated of different type more images that is T1-weighted (T1), T2-weighted (T2) and flair images which are used in the segmentation of different regions in MRI [8]. The first step for the detection of tumor on MR image is segmentation which also helps in calibrating the area, location and shape of the tumor [7]. Segmentation is basically used to divide the image into different parts which will help the physician in carrying out the treatment according to the detection or performing surgery of particular region. Earlier, the segmentation was done manually by doctors who consume lots of time and delay the diagnosis of disease. The segmentation of brain tissues was even more difficult in the case of edema and tumor. But, nowadays, for detecting the tumor in MR images different tools had been developed which segment tumor cells from other parts of brain in particular time period. Numerous amount of researches were done to make the diagnose and detection of tumor and edema facile which consume less amount of time. The segmentation of other parts in the brain like white matter (WM), gray matter (GM) and cerebrospinal fluid (CSF) are also feasible using different segmentation methods.

The main purpose of the proposed work is detection and segmentation of tumor and edema which are diseased tissues including white matter (WM), gray matter (GM) and cerebrospinal fluid (CSF) which are healthy tissues.

The further paper is organized as section 2 contains related work. The section 3 contains the purposed work. Section 4 and 5 consist of experimental result and conclusion respectively. The last has future scope.

2. Related Work

Fuzzy c-means algorithm: it is an unsupervised learning algorithm. The popularity of this algorithm is due to its simplicity, efficiency and self organizing capability [1]. It is basically a method of forming clusters which accredit membership grade to each data element, and each data element belongs to cluster.

Gaussian mixture model and decision tree classifier it is a parametric probability density function which is weighted sum of k Gaussian component densities. Whereas, decision tree was used for the performance evaluation of Gaussian mixture model (GMM) [2].

Hybrid segmentation: in this method hybridization of four different methods are done. That are threshold segmentation, watershed segmentation, edge detection and morphological operators. All of the methods are post processing methods. The threshold segmentation was used for scanning labeling the pixel and scanned each pixel individually. Watershed segmentation was used to group together all those pixels that have same intensity. Lastly, morphological operators were used in which image was converted into binary form and divided the tumor part. As it is known that tumor part has higher intensity so, that is why it was properly shown in the image [3].

There are various optimization techniques which are also used for segmentation to get the perfect results. Optimization is used to make something fully perfect and to perform lengthy calculations in short time. Artificial bee colony (ABC) optimization which is one of optimization technique. It is swarm intelligence algorithm which was

developed basically on the behavior of bee. How the bee reach to its food by using different possible solutions [4].

Thresholding and morphological operation are used for segmentation and detection of tumor. The thresholding is an image processing technique which is mostly used for the image segmentation. It converts the grey scale image into binary image [10]. The morphological operations use binary images and perform different set operations on image to obtain the desired output [10].

3. Our Method

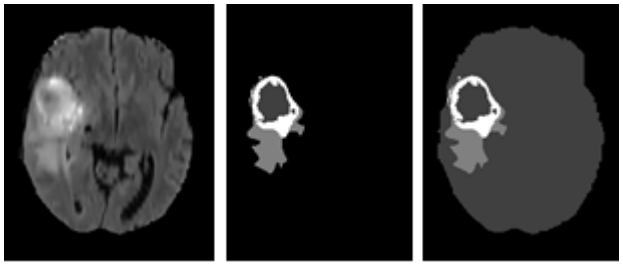
This part will give brief view of different methods used to detect tumor, edema, gray matter, white matter and cerebrospinal fluid in the MR images.

A) Preprocessing

Training: The system is trained to detect tumor in MR images using different techniques.

1) Pre segmentation: it is used to remove the skull from image. For skull removal firstly, we apply Gaussian filter which will blur the image and remove different noises from image. After the Gaussian filter one morphological operator is used that is erosion operator. The erosion operator is used to remove the gap. Basically in this part we are preparing skull mask for the brain.
2) Quantization process: in this process we are using super pixel to quantize the image. It divides the image into different number of small regions which is helpful in calculating the tumour region and the area used by tumour.
3) Feature extraction: The different feature of image has been extracted from the image. The different objects of image have been separated from each other to get the features from image. The different features of image are stored in the FVT (feature vector table) like area, diagonal distance, and mean intensity of image. The dct features are also used for calculating the frequency of image. The image which was manually segmented by physician was used to determinate that which region of ground truth belongs to which part of brain.
4) BAT optimization: this is particle swarm optimization algorithm. It is metaheuristic method in which echolocation of bats are used. Basically it is based on behaviour of bats that how bats differentiate between different insects and how they can find prey by using their echolocation [5]

Following are the images obtained when the system is fully trained:



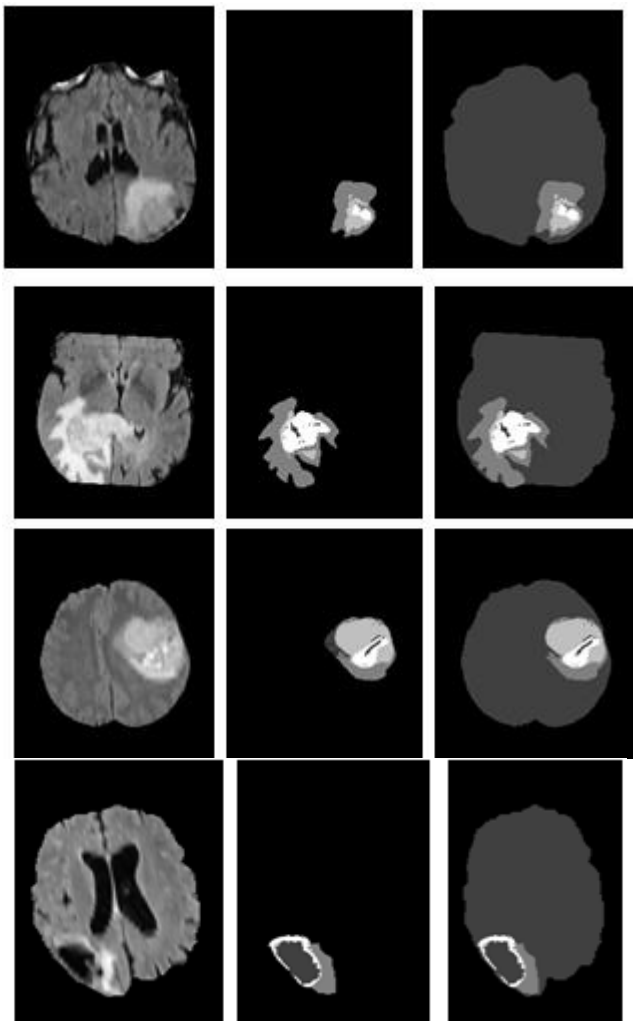
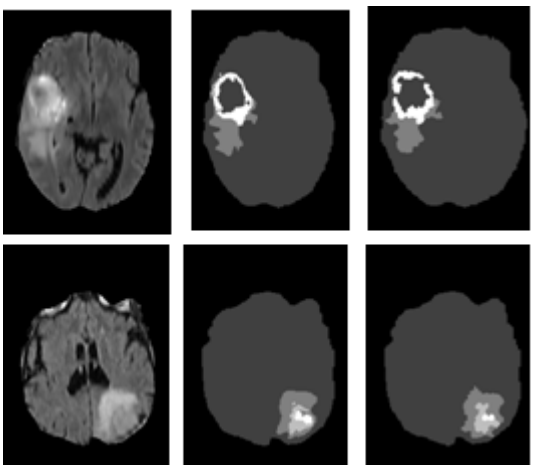


Figure 1: each row contains original image, ground truth of image and proposed segmented image

Testing: the testing of system is performed and obtains results from it. Firstly different regions are predicted and the best weight for each was predicted. Each region was predicted from manually segmented image and more clear segmentation was obtained on proposed segmented image.

The following images show original image its ground truth image and proposed segmented image. The proposed segmented image was obtained after applying BAT optimization during training period. In this section testing was done on the training part using MR images.



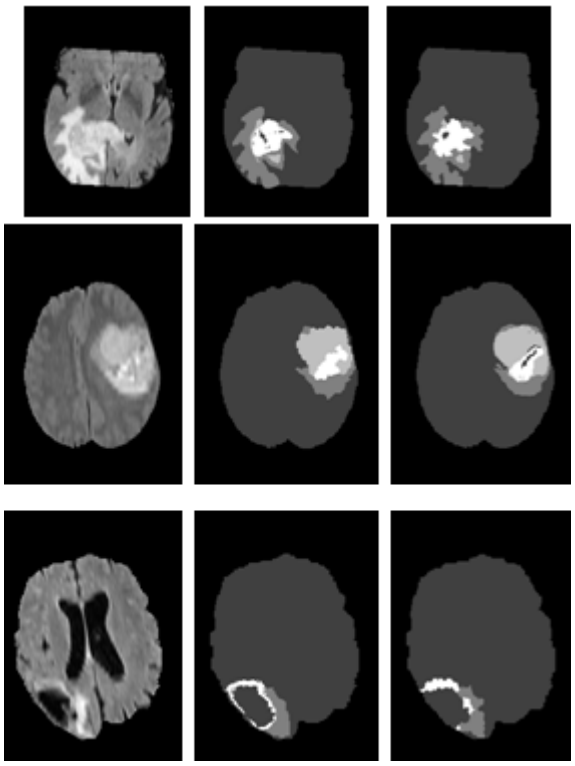


Figure 2: Segmentation results obtained after applying technique

4. Experimental Result

In this section qualitative and quantitative experimental results are obtained. The various experiments are performed using MATLAB R2014a.The proposed method was applied on BRATS (brain tumor segmentation) 2012 dataset [10]. The dataset had varied variety of MR images. There are two tasks which are to be performed on dataset that are training and testing. For training part, real brain images are provided along with their ground truths.

The performance is calculated by using dice similarity index, specificity and sensitivity. There are few terms which are used to calculate these performance measures that are TP(true positive), TN(true negative), FP(false positive) and FN(false negative).

The dice similarity index is coefficient which is region bound and it calculates overlay and segmentation results [9]
(2*TP)/ (2*TP) + FP + FN)

The sensitivity and specificity both are used to classify the results.
Sensitivity: TP/ (TP + FN)
Specificity: TN/ (FN + TN)

Table 1: Measures of Segmented Tissue

No.	WM accuracy %			GM accuracy %			CSF accuracy %			Tumor accuracy %			Edema accuracy %		
	Sen.	Spec.	Dice	Sen.	Spec.	Dice	Sen.	Spec.	Dice	Sen.	Spec.	Dice	Sen.	Spec.	Dice
1.	85	80	90	98	99	99	98	99	99	71	72	99	1	1	99
2.	84	86	99	99	99	99	99	99	99	64	50	99	73	75	99
3.	84	84	99	98	98	98	98	98	98	85	87	99	52	38	99
4.	75	73	99	98	98	99	98	98	99	75	78	99	87	88	99
5.	80	82	99	99	99	99	99	99	99	59	60	99	4	2	99
6.	84	83	99	95	95	99	95	95	99	85	87	99	69	69	99
7.	82	84	99	97	97	98	97	97	98	84	79	99	0	0	100
8.	86	89	99	97	97	97	97	97	97	63	62	98	0	0	100
9.	92	93	99	97	97	98	97	97	98	79	79	99	54	51	99
10.	81	84	99	99	99	99	99	99	99	71	55	99	0	0	100
11.	87	85	99	97	97	99	97	97	99	56	61	99	65	57	99
12.	83	90	99	99	99	99	99	99	99	0	0	99	72	63	99
13.	77	72	99	99	99	99	99	99	99	77	82	99	0	0	100
14.	64	61	99	97	97	98	97	97	98	73	73	99	0	0	100
15.	88	89	99	97	97	98	97	97	98	92	94	99	0	0	100

The table 1 shows the performance of system which demarcates the boundaries of WM, GM, CSF, edema and tumor. The average result Show that 100% accuracy is obtained in edema whereas 99.9% in tumor. The gray matter (GM), white matter (WM) and cerebrospinal fluid (CSF) which are healthy tissues show 99.8%, 99.8% and 99.80% respectively.

5. Conclusion

In the proposed work we use a different technique to detect and segment the five different types of tissues in the brain that are WM, GM, CSF, tumor and edema. Whereas, tumor and edema are diseased tissues in brain. The technique was implemented on MR images such as T1, T2 and FLAIR. Firstly, the region which is not of our interest was removed; skull was striped using Gaussian and morphological operations. Then the system was trained to extract features from image and store them in feature vector table. This table was further, used as input in proposed technique that is BAT optimization. The BAT optimization optimizes the weight which is helpful in detecting the different regions of interest WM, GM, CSF, edema and tumor. All the experimental results were obtained by performing it on MATLAB R2014a. The performance of the technique was evaluated using dice similarity index, sensitivity and specificity. The results obtained are encouraging and the accuracy of detecting and segmenting different region is looking promising.

6. Future Work

The future work will be performing the same work using different technique which will improve more accuracy of system. Our work can be compared with other methods and can obtain more features from it.

References

[1] R.Preetha, G.R.Suresh. "*Performance Analysis of Fuzzy C Means Algorithm in Automated Detection of Brain Tumor*". 2014 World Congress on Computing and Communication Technologies. 2014 IEEE
[2] Ahmad Chaddad, Pascal O. Zinn, Rivka R. Colen "*Brain Tumor Identification Using Gaussian Mixture Model Features and Decision Trees Classifier*"IEEE. 2014 IEEE
[3] Kimmi Verma, Rituvijay, Shabana Urooj "*Effective evaluation of tumor region in brain MR images using hybrid segmentation*."IEEE. 2014 IEEE
[4] Emrah Hancer, Celal Ozturk and Dervis Karaboga, "*Extraction of brain tumors from MRI images with artificial bee colony based segmentation methodology*".IEEE.2012 IEEE
[5] Xin-She Yang *A new Metaheuristic Bat inspired Algorithm*
[6] Yamini Sharma, Yogesh K. Meghrajani, Member *Brain Tumor Extraction From MRI Image Using Mathematical Morphological Reconstruction*
[7] Mohammad Havaei1 Pierre-Marc Jodoin Hugo Larochelle *Efficient interactive brain tumor segmentation as within-brain kNN classification* 2014 22nd International Conference on Pattern Recognition
[8] Chaiyanan Sompong1 Sartra Wongthanavasu *A Novel Segmentation Method for Isointense MRI Brain Tumor* 2014 11th joint conference on computer science and software engineering(JCSSE)
[9] ayse demirhan, mustafa toru, inan guler *Segmentation of Tumor and Edema Along With Healthy Tissues of Brain Using Wavelets and Neural Networks* IEEE journal of biomedical and health informatics, vol. 19, no. 4 july 2015
[10] http://www.virtualskeleton.ch/ BRATS2012