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Comparison of Bat Optimization with Wavelets and Neural Network for Brain Tumor Segmentation

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Abstract—Brain tumor is the most severe disease segmentation is used to extract tumor from image. The segmentation is also widely used for brain tumor detection and extraction from MR images. The detection of brain tumor in MRI is difficult task. In this paper we compared two different techniques for segmentation of brain tumor. The bat optimization is compared with neural network for the segmentation accuracy.

Keywords— MRI, Brain Tumor, Bat Optimization, white matter, gray matter, cerebrospinal fluid, neural network

I. INTRODUCTION

The cell is the fundamental unit of living organisms. Human body contains trillions of cells and all of them performing their own function. In the evolution of health services, medical imaging play very important role to detect and diagnose it in short period of time. The use of computer is widespread in the field of medical, such as cancer research, brain tumor, and heart disease. The cells has to divide and form the new cells whereas when the division of cells is performed out of order which cannot be controlled it give rise to unwanted tissues called as tumor [4]. The tissues of brain which are not affected by any disease are known as healthy tissues. On the other hand, the brain tissues which are affected by any type of disease are known as diseased tissues. The healthy tissues of brain consist of different parts in brain that are white matter (WM), gray matter (GM) and cerebrospinal fluid (CSF). The white matter (WM) tissues transfer different information in brain to other tissues. It is white in color because of myelin name substance present in it. The gray matter (GM) performs different sensory functions using its tissues like seeing, taking decisions and many more. The cerebrospinal fluid (CSF) is a clear transparent fluid which provides protection to brain inside the skull. Although, brain tumor and edema are the diseased tissues of brain. Brain tumor is a cluster of diseased tissues and edema is swelling around the tumor which is in excess of watery fluid around the tumor. The brain tumor is the abnormal growth of tissues in the brain or in central spine that disturb the function of brain. The abnormal growth of brain tissues give rise to either cancerous (malignant) of noncancerous (benign) tumor. The tumor is of two type malignant (cancerous) and benign (not). The malignant tumors are cancerous which are made up of cell. The malignant tumor can spread into the other parts of the body whereas benign tumors are not cancerous and the cells present in it do not spread to the other parts of the body. Magnetic resonance images are examined by radiologist to identify the presence of abnormal tissue through visual interpretation. There are different coalition of sequences of MRI techniques which are used to diagnose tumor. These sequences are T1 weighted, contrast-enhanced T1 weighted, T2 weighted and FLAIR images [6]. Medical image segmentation is the process of automatic or semi-automatic detection of boundaries within 2D or 3D image. Image segmentation separates the image into segments known as classes or subsets. The segmentation of image into classes or subset is performed until the problem is solved [5]. The segmentation helps to get more accurate results and to detect the particular location of tumor. The segmentation of brain MR images is a very hectic task. Earlier, the segmentation was performed manually by the physician who took long time to segment the particular part of brain. This manual segmentation results in delay of diagnosis which was deteriorating the health of patient day by day. When the manual segmentation is performed on the brain MRI it makes the process prolonged and enervate. But nowadays, there are more advanced techniques and software which take less of time and provide the more efficient results. With the help of computerized segmentation algorithms the physicians can conveniently diagnose the disease of brain by scrutinizing the tissues and structure in perceptible demeanor [3]. Although, still there are many computerized techniques which are not segmenting the tumor efficiently and leave some of its part undetected which later affect the health of patient. There different advancements which have been done on this technique. There are different problems which can be detected even after using the advanced technique like the technique do not segment the tumor properly or it left some of tumor undetected. To remove these types of problems various advanced techniques are developed which help in dealing with such problems. These new techniques reduce the work of physicians as well as improved the efficiency of obtained results. The different optimization techniques are emerging area in this field. As many real-world optimization problem become more complex better optimization algorithm were needed. One of them was used in this research work.

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II. RELATED STUDY

Ayse Demirhan et al In this study, we present a new tissue segmentation algorithm that segments brain MR images into tumor, edema, white matter (WM), gray matter (GM), and cerebrospinal fluid (CSF). The segmentation is performed using selforganizing map (SOM) that is trained with unsupervised learning algorithm and fine-tuned with learning vector quantization (LVQ). Input feature vector is constructed with the features obtained from stationary wavelet transform (SWT) coefficients.

Kailash Sinha et al This paper presents a comparative study of three segmentation methods implemented for tumor detection. The methods include k-means clustering with watershed segmentation algorithm, optimized k-means clustering with genetic algorithm and optimized c- means clustering with genetic algorithm. Traditional k-means algorithm was sensitive to the initial cluster centers. Genetic c-means and k-means clustering techniques were used to detect tumor in MRI of brain images. At the end of process the tumor was extracted from the MR image and its exact position and the shape are determined.

V. Zeljkovic et al In this paper, an automated algorithm for brain tumor detection and medical doctors assistance in facilitated and accelerated diagnosis procedure was developed and initially tested on images obtained from the patients with diagnosed tumors and healthy subjects.

Ahmad Chaddad et al This paper concerns a new features type of Glioblastoma (GEM) detection based on the Gaussian Mixture Model (GMM) An abnormal area was detected using the multi-thresholding segmentation with morphological operations of MR images, while discarding those that are either redundant or confusing, thereby improved the performance of the feature-based scheme to detect the brain tumor.

R.Preetha et al Image Segmentation is essential and challenging to visualize the tissue of human for analyzing the MR images. Deformable models and Region based methods were extensively used for medical image segmentation. Clustering of brain tumor images was done by using Fuzzy C means for tumor localization. The Fuzzy C means clustering with the extension of Feature extraction and classification was used for the brain tumor detection.

Neha Tirpude et al In this paper they proposed a technique was used to extract the tumor portion, successfully demarcated the tumor boundary, locate the tumor with a bounding circle and to diagnose whether the tumor is present or absent. A fuzzy clustering-based technique was proposed which helps to study & analyze the intricate structure of the brain.

Emrah Hancer et al In this paper, a new image segmentation methodology based on artificial bee colony algorithm (ABC) was proposed to extract brain tumor from magnetic reasoning imaging (MRI). The proposed methodology comprised of three phases: enhancement of the original MRI image (preprocessing), segmentation with the ABC based image clustering method (processing), and extraction of brain tumors (post-processing).

III. PROPOSED METHOD

TRAINING: the training was used to train the system. The training will help in learn the the system that how it can perform different methods on Image. The training of the system was done by choosing some of images from dataset and train those images by applying different methods, technique on them to obtain the desired results out it so that we can extract different features from it.

pre-segmentation: the pre-segmentation remove the outer skull from the image which is not region of interest. The removal of skull was done by using different methods. We are using Gaussian function to remove skull. After, the Gaussian filter we prepare a mask for image in which there is no skull and our image can easily fit into that mask. The next operation applied on the image was morphological operation. The basic function of morphological operation is to reduce the gap between boundaries of image and fill the holes in image.

quantization process: this process was used for dividing the image into different parts. The quantization process can properly identify that which part of brain is of diseased tissue and which are healthy tissues. It can help in identifying the tumor region more precisely. For the quantization we had used superpixel. The superpixel will divide the image into different small areas which will be further helpful in identifying the percentage of tumor in each particular area.

Feature extraction: in this part we extract different features from the MR image and all the extracted features were stored in FVT (feature vector table). The FVT is in a form of matrix in which different feature can be stored in table. To extract the features from image we mark each object in image. Every object in image was separated from other object by giving different colors to each object.

BAT optimization: this is our proposed technique which is a soft computing technique the bat optimization is a metaheuristic method in which bats use echolocations for finding the prey during night. Basically bat optimization adopted the behavior of bats, the way in which bats uses different frequencies to find prey and differentiate between various insects at night [1]. There are different types of bats and each of them uses different range of frequencies to locate the prey. Basically echolocation is a type of sonar which is used by microbats to find, locate and keep away from hindrance. The bats can sense the distance between food by using its different frequencies.

TESTING: in this part testing was performed on different images and obtains the results from each image. The different regions from image are predicted. Then the results are obtained from each of it.

Firstly, we have to select any image from the dataset to easily perform different operations on it. When there is a selection of any particular image its ground truth from the dataset is to be selected for further processing. After selecting particular image and by default its ground truth the next step is to perform segmentation on that image. Image segmentation separates the image into segments known as classes or subsets. The segmentation of image into classes or subset is performed until the problem is solved [5]. The segmentation will predict different regions in the image. The

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segmentation will separate white matter(WM), gray matter(GM), cerebrospinal fluid(CSF), tumor and edema. The predicted regions gives information of region involved in the segmentation. Lastly, after performing all the segmentations the results are calculated. The results will show the accuracy of each region in a particular image.

IV. COMPARISON

In this section we compare the proposed technique with other technique and there qualitative and quantitative results. The proposed BAT optimization technique was compared with the existing method of neural network by Ayse demirhan et al [9]. The parameters used to compare the techniques were their accuracy. The accuracy measures used are sensitivity, specificity and dice coefficient. The database used in both techniques was BRATS2012.

Table I Comparison of Two Methods

Method	**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
Proposed method	92.9	93.5	99.8	99.5	99.6	99.8	99.5	99.6	99.8	92.3	94.4	99.9	87.7	88.0	100
Method proposed in [9]	96.0	95.4	90.8	85.9	97.2	87.4	99.3	97.7	96.1	53.5	95.3	60.92	73.3	95.7	77.2

The difference between proposed method and method used in [9] are pronounced and they deserve rigorous scrutiny. Although, they bear some minor similarities the difference between both the techniques are clear. It is clear from the table above that proposed technique was showing more promising results than method used in [9]. In the proposed method we used BAT optimization whereas in [9] they had used neural network. From the above table it is evident that for tumor and edema segmentation our technique was showing more accuracy. Adding to it, the WM, GM and CSF are also showing pronounced results. While some difference in both the techniques are noticeable the similarities are salient. Following graphs are showing the comparison of techniques.

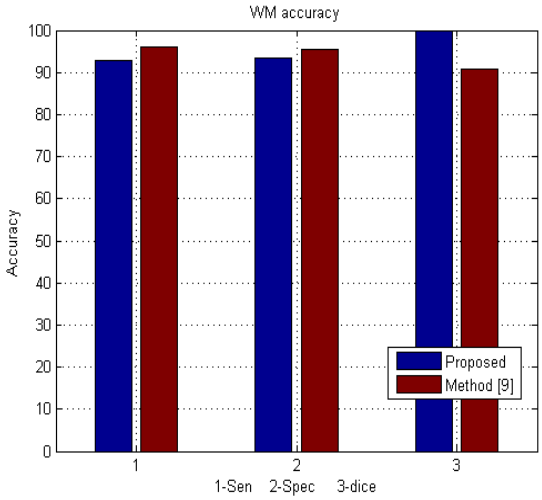

Fig. 1: WM accuracy comparison

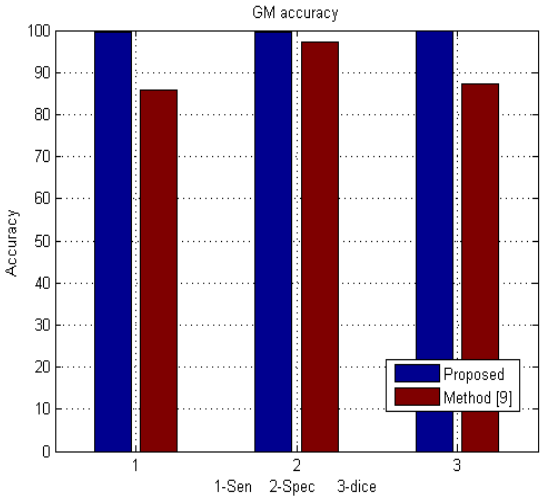

Fig. 2: GM accuracy comparison

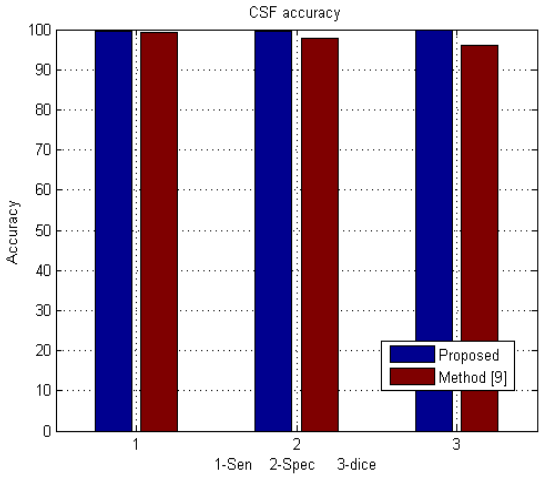

Fig. 3: CSF accuracy comparison

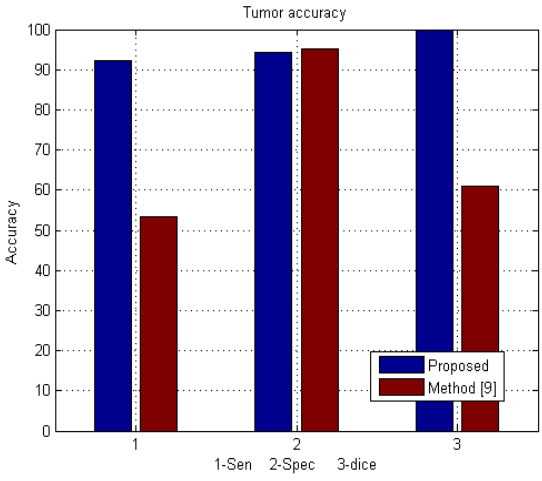

Fig. 4: Tumor accuracy comparison

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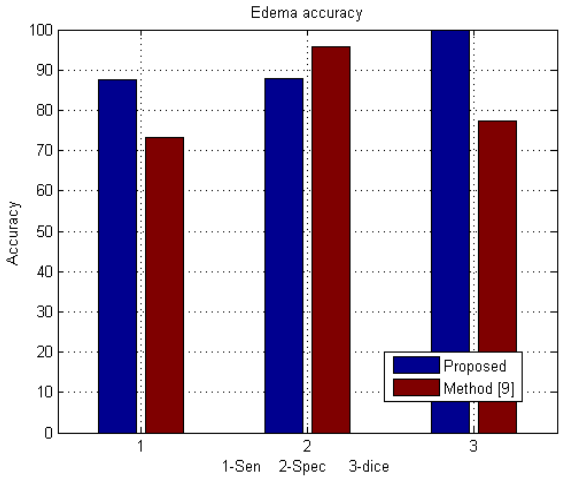

Fig. 5: Edema accuracy comparison

The figure 1 graph depict that proposed work has higher values than base paper in case when we had used dice parameter. The base paper had slightly higher value for both senstivity and specificity from proposed work. Figure 2 graph clearly depict that proposed work has higher values than base paper. The segmentation accuracy of GM is higher for the proposed work. The graph of figure 3 clearly depict that proposed work has higher values than base paper for all the three parameters. The segmentation accuracy of CSF is higher for the proposed work. Figure 4 graph give clear view for thesegmentation accuracy of tumor. It depict that proposed work has higher values than base paper. From figure 5 graph clearly depict that proposed work has higher values than base paper. The base paper had more accuracy only for specificity. Whereas, the proposed work is showing quite higher accuracy for both the senstivity and dice parameter. The segmentation accuracy of edema is higher for the proposed work

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V. 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. 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. the comparison of proposed work and base paper shows that the proposed work had better results for segmentation when comparing with base paper

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