

FIRE FLY GENETIC APPROACH FOR BRAIN TUMOR SEGMENTATION IN MRI

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Abstract— : Brain tumor detection is challenging task due to complex structure of human brain. MRI images generated from MRI scanners using strong magnetic fields and radio waves to form images of the body which helps for medical diagnosis. This paper segment the MRI image of brain tumor into two class first is tumor area while other is non tumor one. Here by using Fire Fly algorithm segmentation of tumor region can be done without any prior training with high accuracy. Proposed algorithm utilize median filter as well for removing the noise part of the image. Experiment was done on real image dataset. Results are compared with existing methods on various evaluation parameters and it was found that proposed algorithm is better than others.

Keyword — Digital Image processing, Brain tumor, Genetic Algorithm, Segmentation.

I. INTRODUCTION

Medical image analysis [2] can be used as preliminary screening techniques to help doctors. Various aspects of segmentation features and algorithms have been extensively explored for many years in a host of publications. However, the problem remains challenging, with no general and unique solution, due to a large and constantly growing number of different objects of interest, large variations of their properties in images, different medical imaging modalities, and associated changes of signal homogeneity, variability, and noise for each object. Computed Tomography (CT) and Magnetic Resonance (MR) imaging are the most widely used radiographic techniques in diagnosis, clinical studies and treatment planning. The motive is to discuss the problems encountered in segmentation of CT and MR images, and the relative merits and limitations of methods currently available for segmentation of medical images. With increasing use of CT and MR imaging for diagnosis, treatment planning and clinical studies, it has become almost compulsory to use computers to assist radiological experts in clinical diagnosis, treatment planning. Reliable algorithms are required for the delineation of anatomical structures and other regions of interest. The techniques available for segmentation of medical images are specific to application, imaging modality and type of body part to be studied. Segmentation based on gray level techniques such as thresholding, and region based are the simplest techniques and find limited applications. However, their performance can be improved by integrating them with artificial intelligence techniques. Techniques based on textural

features have excellent results on medical image segmentation. The limitation is that under certain circumstances it becomes difficult to correctly select and label data; has difficulties in segmenting complex structure with variable shape, size, and properties. A variety of different neural network-based algorithms are also available for texture- based segmentation and classification having good accuracy. However, most of these neural network-based algorithms require extensive supervision and training and their performance depends upon the training method and data used in training. The use of medical image segmentation in a particular mode in which the medical image exist is also described along with the difficulties encountered in each mode. This survey mainly focuses on segmentation of Computed Tomography and Magnetic Resonance images. The research focuses on classification of brain tumor medical images. Brain tumor classification consist of three steps-Preprocessing, Feature Extraction and Classification. Based on the features, classifier discriminate the classes to which it belongs to.

II. LITERATURE SURVEY

Ketan Machhale et al. (2015) [7] proposed an intellectual classification system to recognize the normal and abnormal MRI brain images. At present, decision and the treatment of brain tumors is based on the symptoms and radiological appearance. Magnetic resonance imaging (MRI) is the very important controlled tool for anatomical judgment of the tumors in brain. Nowadays, various techniques were used for the classification of the brain cancer. Under these techniques used the modules like image preprocessing, image segmentation, image feature extraction and subsequent classification of brain cancer are performed. Support Vector Machine (SVM), K- Nearest Neighbor (KNN) and Hybrid Classifier (SVM-KNN) are the various machine learning techniques are used.

Trung Le et al. (2010) [10] proposed the new support vector machine technique for the two-class medical image classification. The main idea of the method is to construct an optimal hyper sphere such that both the interior margin between the surface of this sphere, the normal data, and the exterior margin between this surface and the abnormal data are as large as possible. The proposed method is implemented easily and can reduce both the false positive and also false negative error rates to obtain very good classification results. The Support Vector Machine (SVM)

classifier is a good classifier that works well on the wide range of classification problems, even problems in the high dimensions and the cases that are not linearly separable. Perhaps the biggest problem with the support vector approach is in choice of the kernel.

Swarnalatha et al. (2013) [9] proposed a concept based on the novel fuzzy approach with bit plane FCMBP approach. The bit plane filtering method is used to slice the presented image for classification to find out destroyed region of the presented image. The sliced image must be normalized with old techniques and then compared with fuzzy technique for the better classification and the cluster of the spoiled portion. Thereby control points are extracted that are further needed for reconstruction of the images. The performance of the fuzzy approach with bit plane technique is evaluated with the help of simulation and it is found that our approach yields better results when compared to other accessible methods. Its disadvantage is only efficient for most significant bit-planes (MSB).

Zehra Karhan et al. (2015) [3] proposed a method that is used for determining whether the medical image belongs to that class or not, using textural features of the medical images. The study was conducted on the images in the IRMA (Image Retrieval in Medical Applications), in the international database. After performing the preprocess on medical images, discrete wavelet transform (DWT) was applied and then the discrete cosine transform (DCT) was applied to the each band components. After extracting the features, using of 1%, 3%, 5% and 7% of the obtained data were classified. K-Nearest neighbor algorithm was used in classification phase. The classification performance was around the 87 percentage. One of the main highlight of the wavelets is that they offer a simultaneous localization in time and the frequency domain.

Parveen et al. (2015) [4] proposed a new hybrid technique based on support vector machine (SVM) and the fuzzy c-means for brain tumor classification. This algorithm is a combination of support vector machine (SVM) and fuzzy c-means, a hybrid technique for prediction of the brain tumor. In this algorithm image is enhanced with the help of techniques such as contrast improvement, and mid-range stretch. Double thresholding and the morphological operations are used for the skull stripping. The Fuzzy c-means (FCM) clustering is used for the segmentation of image to detect suspicious region in the brain MRI image. Grey level run length matrix (GLRLM) is used for the extraction of the feature from the brain MRI image, after which the SVM method is used to classify brain MRI images, which provide accurate and more effective results for the classification of brain MRI images.

III. Proposed Model

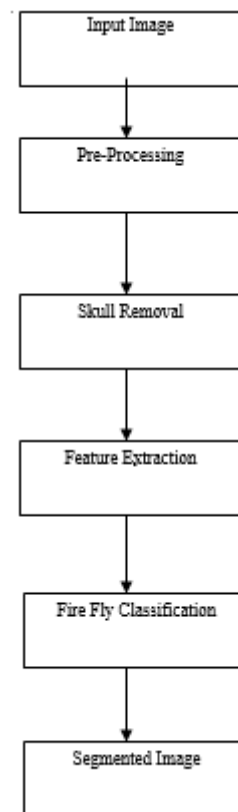


Fig. proposed work block diagram.

A. Visual Pre-Processing

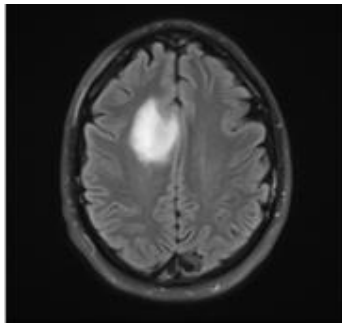
In this step image is resize in fix dimension. As different image have different dimension. So conversion of each is done in this step. One more work is to convert all images in gray format. AS different image has RGB, HSV, etc. format so working on single format is required.

Median Filter: The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal.

B. Skull Removal

Convert the gray scale image into binary image by Thresholding. The output binary image F has values of 1 (white) for all pixels in the input image with pixel value greater than threshold and 0 (black) for all other pixels. Binarized image consist 1 for brain tissues and 0 for non brain tissues. The binary image can be reconstructed image E is defined

$E = 1$ if $F > T$ or $E = 0$ if $F \leq T$ Where T is the threshold value



(a)



(b)



(c)

Fig. (a) Image before skull removal. (b) Image after binary segmentation. (C) Image after skull removal in binary format.

Final Output By setting the threshold condition with binarized image and input brain image, wherever the binarized image consist 1 place intensity level of input image and wherever the binarized image consist 0 place 0. The output image consists only the brain tissues. The final output image defined as G, binarized image as F and input image as A

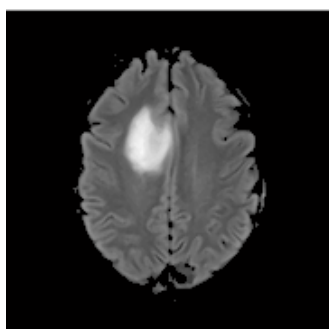


Fig. Image after skull removing process.

C. Feature Extraction

Color Feature is extract from the image obtained after skull removal. Here gray format image is utilized for features. As values of gray scale is range from 0-255. So each value act as the population in the genetic algorithm. In the case of greyscale image pixel values represented by the intensity values ranges from 0 to 255.

D. Fire Fly algorithm

Generate Population: Here assume some cluster set that are the combination of different pixel values. This is generate by the random function which select fix number of pixel values for the centroid. This can be understand as let the number of centroid be C_n and number of pixel values are N then one of the possible solution is $\{C_1, C_2, \dots, C_n\}$. In the similar fashion other possible solutions are prepared which can be utilize for creating initial population represent by ST matrix.

$ST[x] \leftarrow \text{Random}(N, C_n)$

Intensity: Fire fly 0 utilize the Euclidean distance formula between two fire fly X and Y is calculated by

$$r = \sqrt{\text{sum}((X - Y)^2)}$$

Now find the intensity of the fire fly by

$$I = I_0 e^{-\gamma \times r^2}$$

Where I is intensity of the fire fly for the selected centroid fire fly.

I_0 is intensity of the fire fly for the minimum value r .

γ is absorption coefficient.

R is distance between the fire fly (pixels).

Objective of this fire fly is to segment the pixels of the image as per the chromosome or population set. Here cluster center which give minimum distance from the cluster is consider as the best solution of the current iteration.

E. Segmented Image

Fire Fly algorithm provide the cluster centers in the image as image is broadly segment into three region first is skull part second is brain part and third is tumor part. So, three cluster centers were obtained by the fire fly algorithm. Now as per the distance from the cluster center pixels are segment and give single color value for the group.

F. Proposed Algorithm

Input: MI (MRI Image)

Output: SI (Segmented Image)

1. $I \leftarrow \text{Pre-processing}(MI)$
2. $I \leftarrow \text{Median_filter}(I)$
3. $WSI \leftarrow \text{Skull_removal}(I)$ // without skull Image
// Firefly algorithm

4. $ST \leftarrow \text{Generate_population}(WSI)$ // set of chromosome
5. While (!MaxGeneration)
6. For $i = 1: n$ // n number of all fireflies in single chromosome
7. For $j = 1: d$ // d number of all fireflies in space
8. If ($I_j > I_i$)
9. Move firefly I towards j in d-dimension
10. End if
11. Get attractiveness, which differs with distance r.
12. End for j
13. End for i
14. $B \leftarrow \text{best_chromosome}(ST)$
15. End while
16. $SI \leftarrow \text{Segment_image}(WSI, B)$

IV. Experiment and results

The tests were performed on an 2.27 GHz Intel Core i3 machine, equipped with 4 GB of RAM, and running under Windows 7 Professional. MATLAB 2012a is the tool use for the implementation of this work. It is used because of its rich library which have many inbuilt function that can be directly use in this work for different purpose. Out of different function few are intersection, comparing of the string, etc.

A. Evaluation Parameter

As various techniques evolve different steps of working for segmenting image into appropriate category. So it is highly required that proposed techniques or existing work need to be compare on same dataset. But cluster which are obtained as output is need to be evaluate on the function or formula. So following are some of the evaluation formula which help to judge the clustering techniques ranking.

$$\text{Precision} = \frac{\text{True_Positive}}{\text{True_Positive} + \text{False_Positive}}$$

$$\text{Recall} = \frac{\text{True_Positive}}{\text{True_Positive} + \text{False_Negative}}$$

$$F_Score = \frac{2 * \text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}}$$

$$\text{Accuracy} = \frac{\text{Correct_Classification}}{\text{Correct_Classification} + \text{Incorrect_Classification}}$$

In above true positive value is obtained by the system when the classified pixel is same as in actual case or ground truth pixel. While in case of false positive value it is obtain by the system when the classified pixel is not of same case as in actual case or ground truth pixel.

B. Results

Dataset Percent	Precision Value Comparison	
	Previous	Proposed
D1	0.9406	0.9946
D2	0.9953	1
D3	0.9951	0.9955

Table 1. Precision value comparison from proposed genetic approach.

Table 1 shows that proposed work has achieved a high precision value as the testing files are increasing. It has shown in table that firefly genetic algorithm segmentation is more accurate as compare to self organizing mapping.

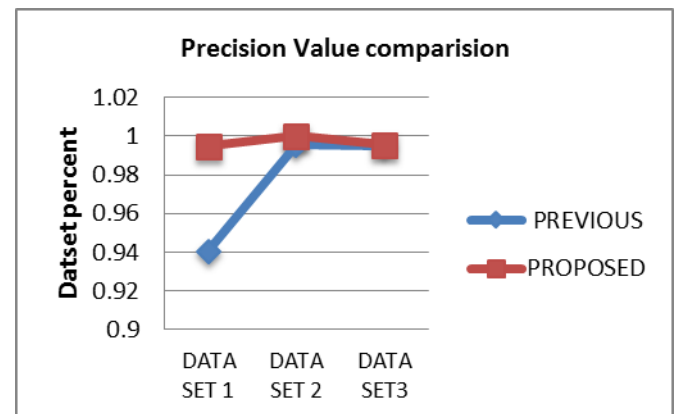


Fig1: Comparison of precision value from proposed genetic approach

Dataset Percent	Recall Value Comparison	
	Previous	Proposed
D1	0.9979	0.9990
D2	0.995	1
D3	0.9998	1

Table 2. Recall value comparison from proposed genetic Approach.

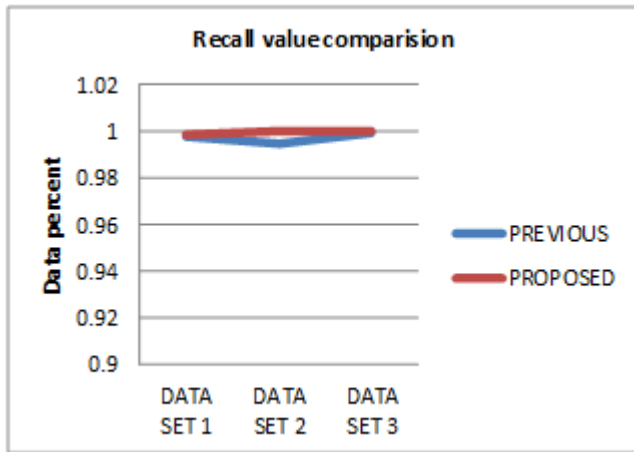


Fig2: Comparison of recall value from proposed genetic approach

	F-Measure Value Comparison	
	Previous	Proposed
D1	0.9684	0.9968
D2	0.9975	1
D3	0.9972	0.9977

Table 3. F-Measure value comparison from proposed genetic approach.

Table 3 shows that proposed work has achieved a high F-measure value as the testing files are increasing. It has shown in table that firefly genetic algorithm segmentation is more accurate as compare to self organizing mapping.

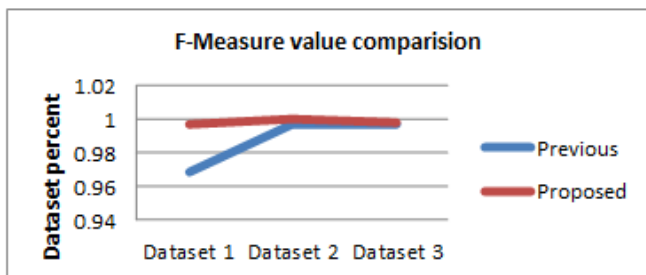


Fig3: Comparison. F-Measure of value from proposed genetic approach

Dataset Percent	Accuracy Value Comparison	
	Previous	Proposed
D1	93.9686	99.4052
D2	99.4960	99.9967
D3	99.560	99.5619

Table 4. Accuracy value comparison from proposed genetic approach.

Table 4 shows that proposed work has achieved a high accuracy value as the testing files are increasing. It has shown in table that firefly genetic algorithm segmentation is more accurate as compare to self organizing mapping.

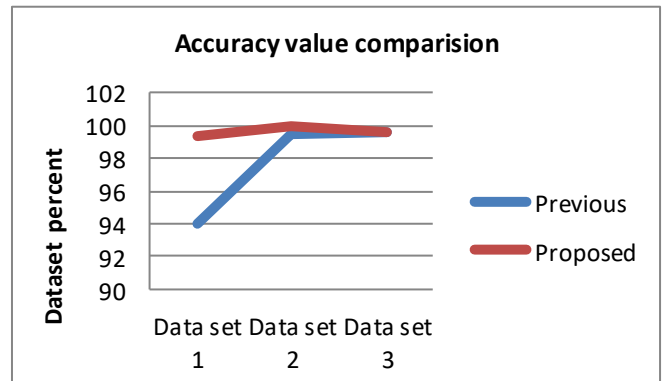


Fig4: comparison of Accuracy value from proposed genetic approach

Dataset Percent	Execution Time (second) Value Comparison	
	Previous	Proposed
D1	112.12	58.1233
D2	111.6525	39.3439
D3	108.564	51.5869

Table 5. Execution time value comparison from proposed genetic approach.

Table 5 shows that proposed work has achieved a low execution time value as compare to previous work. It has shown in table that firefly genetic algorithm segmentation is more accurate as compare to self organizing mapping.

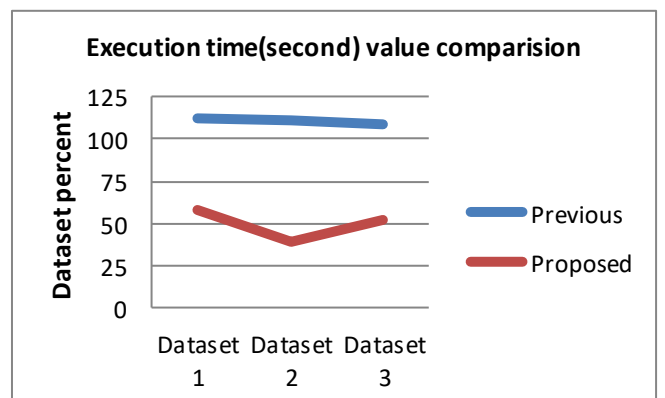


Fig5: Execution time (second) value comparison from proposed genetic approach.

CONCLUSION

As the tumor segmentation plays important role in brain tumor treatment. So, the proposed method utilizes the genetic approach to segment the MRI image of brain tumor into tumor and non tumor region. Here algorithms not need

any kind of prior training for classification. It is obtained that proposed algorithm uses fire fly genetic algorithm which segments the image with high accuracy. This work has increased the accuracy of the segmentation so the medical diagnosis gets easy and fast. Here overall precision and recall values are also good from segmentation view. In future one can adopt different genetic approach for segmenting of user MRI image as well.

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