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Improving MRI Segmentation by Fuzzy C Mean Clustering Algorithm Using BBHE Techniques

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Abstract- Magnetic resonance imaging (MRI) is a medical imaging technique used to investigate the anatomy and physiology of the body is widely used in hospitals for medical diagnosis and staging of diseases. The research efforts have been devoted to processing and analyzing medical images to extract meaningful information to detect abnormalities. MRI segmentation aims at extraction of object boundary features which plays a fundamental role in understanding image content. A challenging problem is to segment regions are boundary insufficiencies, blur edges, lack of texture contrast between regions of interest and background. To address this problem two categories of approaches are used on medical image segmentation: (i) enhancement technique i.e. histogram equalizer technique is implemented on selected image to enhance the contrast of image. Brightness preserving Bi Histogram Equalization (BBHE) technique is used for enhancing the image because previous technique perverse contrast but only BBHE consider Brightness of an image. (ii) Apply fuzzy-C mean (FCM) clustering segmentation algorithm on enhanced image. Fuzzy C mean algorithm helps to compute clusters from the image and calculate the centers of clusters. Examples of medical data segmentation and general conclusions from the methods are described and we give future directions for solving challenging and open problems in medical image segmentation.

Keywords— Fuzzy-C Means Clustering; Magnetic Resonance Imaging; Histogram Equalization Technique; Segmentation

I. INTRODUCTION

Magnetic resonance imaging (MRI) for treatment, diagnosis, planning and clinical studies has become almost necessary for radiological experts to make clinical diagnosis and treatment planning by using computers. To extract the required useful information from image the image segmentation is used. Segmentation based on fuzzy c mean clustering algorithm every point has a degree of belonging to clusters as in fuzzy logics rather than belonging completely to just one cluster thus points on edge of a cluster may be in the cluster to a lesser degree than the points in the centers of cluster. The medical images tend to suffer much more noise than realistic images. This of course poses great challenges to any image segmentation technique. Hence before fuzzy c mean clustering segmentation, image enhancement is required. Histogram based techniques is one of the important digital image processing techniques which can be used for image enhancement and advantages of histogram based techniques are simplicity of implementation of the algorithm. The Histogram Equalization (HE) method has two main disadvantages which affect efficiency of this method. For solving the above problems some techniques have proposed for example using Bi Histogram Equalization (BHE) algorithm instead of Histogram Equalization (HE). It should be mentioned that Bi Histogram Equalization (BHE) is one of the best proposed algorithm. Brightness preserving Bi Histogram Equalization is an emerging new technology. Preserving bi-histogram equalization (BBHE) is proposed to overcome the problems of the typical Histogram Equalization. Goal of the proposed algorithm is to preserve the mean brightness of a given image while the contrast is enhanced. Image segmentation is one of the most widespread means to classify correctly the pixels of an image in a decision oriented applications. Image segmentation is a technique that partitions an image into uniform and non-overlapping regions based on some likeness measure. Clustering is one of the most popular classification methods and has found many applications in image segmentation. Clustering, the unsupervised classification of patterns into groups is one of the most important tasks in exploratory data analysis [3]. The different acquisition modalities, the different image manipulations and variability of organs all contribute to a large verity of medical images. It can be safely said that there is no single image segmentation method that suits all possible images [2]. Before segmentation image enhancement techniques is used to de blur the edges of for segmentation. The most effective method of image enhancement based on histograms equalization, brightness-preserving bi-histogram equalization, contrast-limited adaptive histogram equalization, end-in search, histogram matching, and exact histogram matching (EHM) [8].

The BBHE firstly decomposes an input Image into two sub images based on the mean of the Input Images. One of the sub image is the set of samples less than or equal to the mean whereas the other one is the set of samples greater than the mean. The BBHE equalizes the sub images independently based on their respective histograms with the constraint that the samples in the formal set are mapped into the range from the minimum gray level to the input mean and the samples in the latter set are mapped into the range from the mean to the maximum gray level. The BBHE is a novel extension of a typical histogram equalization, which utilizes independent histogram equalizations over two sub images obtained by decomposing the input image based on its mean [5]. Paper [10] Introduced a neighborhood averaging additive term into the objective function of FCM. Zanaty and Aljahdali [17] introduced a new local similarity measure by combining spatial and gray level distances. They used their method as an alternative pre-filtering to an enhanced fuzzy c-means algorithm (EnFCM) [18]. Paper [19] proposed a spatial homogeneity-based FCM (SHFCM). Paper [20] incorporated both the local spatial context and the non-local information into the standard FCM cluster algorithm. The PCM-based algorithms suffer from the coincident cluster problem that makes them too sensitive to initialization [22].

II. ARCHITECTURAL DESIGN

A. Main Techniques

Histogram equalization (HE) has been a simple yet effective image enhancement technique. However, it tends to change the brightness of an image significantly, causing annoying artifacts and unnatural contrast enhancement. Brightness preserving bi-histogram equalization (BBHE)

The fuzzy c mean clustering (FCM) introducing a spatial penalty for enabling the iterative algorithm to estimate spatially smooth membership functions. This technique combines FCM segmentation and BBHE with some modification in its membership function for removal of noise from the MRI brain images.

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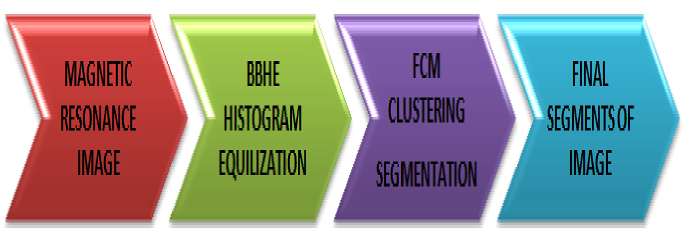

Fig.1 shows the steps of techniques used in algorithm

B. Design methodology involves

Select the medical image for image processing, if a medical image is RGB (Color Image) convert into grayscale. Apply enhancement technique i.e. histogram equalizer technique which can enhances the contrast of image. BBHE histogram equalization technique for enhancing the image will be used because previous techniques perverse contrast only BBHE consider Brightness of an image. Then apply fuzzy-C mean clustering algorithm on enhanced image. FCM algorithm computes cluster from the image and calculate the centers of cluster for segmentation. Now with the help of cluster center make the segment of image. Finally we obtain the segmented image with the help of BBHE and fuzzy c-mean clustering segmentation algorithm.

III. FUZZY C MEAN CLUSTERING ALGORITHM DESIGN

Theory based segmentation is type of image segmentation algorithm include derivatives from different fields and are very important for segmentation approach. They include wavelet based algorithms, genetic algorithms, fuzzy based algorithms, and neural network based algorithms, clustering based algorithms and so on. Clustering is an unsupervised learning task where one needs to identify a finite set of categories known as clusters to classify pixels. Similarity criteria is defined between the pixels and then similar pixels are grouped together to form clusters. These criteria include attribute of an image such as color, texture and size etc. cluster depends on both the quality of similarity criteria used and how it is implemented. Clustering methods are classified as k-means clustering, hard clustering and fuzzy clustering.

A. Fuzzy C mean clustering

Fuzzy clustering can be used in situations when there are no defined boundaries between different objects in an image. This clustering divides the input pixels into clusters or groups on the basis of some similarity criterion. The similarity criterion can be connectivity, intensity, distance, etc. Fuzzy Clustering Mean algorithm is most accepted since it can preserve much more information than other approaches. In this technique a data set is grouped into N clusters with every data point in the dataset belonging to every cluster to a certain degree.

B. The Proposed Fuzzy C-Means Algorithm

Fuzzy C-means (FCM) clustering is a data clustering algorithm in which each data point belongs to a cluster to determine a degree specified by its grade of membership. FCM partitions a collection of N vector x_i, i=1,….N into C fuzzy groups and finds a cluster centre in each group such that an objective function of a dissimilarity measure is minimized. Difference between FCM and k means is that FCM employs fuzzy partitioning such that a given data point can belong to several groups with the degree of belongingness specified by membership grades between 0 and 1. FCM, the membership matrix U is allowed to have not only 0 and 1 but also the elements with any values between 0 and 1. This matrix satisfies the constraints:

$$\sum_{i=1}^{c} U_{ij} = 1, \qquad \forall_j = 1, \dots, N \tag{1}$$

The objective function of FCM can be formulated as follows:

$$p(u, v_1, \dots, v_c) = \sum_{i=1}^{c} \sum_{j=1}^{N} u_{ij}^{m} \left\| x_j - c_i \right\|^2 \quad (2)$$

$$c_i = \frac{\sum_{j=1}^{N} u_{ij}^{m} x_j}{\sum_{j=1}^{N} u_{ij}^{m}} \quad (3)$$

Where UI_J is between 0 and 1, C_i is the cluster centre of fuzzy group i , and the parameter m is a weighting exponent on each fuzzy membership. Fuzzy partitioning is carried out through an iterative optimization of the objective function shown above, updating of membership uij and the cluster centers C_j by:

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\left\| x_j - c_i \right\|}{\left\| x_j - c_k \right\|} \right)^{\frac{2}{(m-1)}}} \quad (4)$$

The intra-cluster distance measure, which is simply the median distance between a point and its cluster centre as shown in equation 4. The proposed algorithm is described as follows:

a) Select a subset from the dataset.

b) Then set C =2 the initial number of cluster, and max Cmax =the maximum number of cluster.

c) Initialize the membership matrix U with random values between 0 and 1 such that the constraints in "(1)" are satisfied.

d) Calculate fuzzy cluster centers Ci , i=1…….C.

e) Compute the objective function according to Equation. Go to step (g), if either it is below a certain tolerance value or its improvement over previous iteration is below a certain threshold.

f) Compute a new membership matrix U using Equation 8, then go to step 2.

g) Now obtain the center V1.

h) Apply step (c) on the subset with c number of cluster to obtain center V2.

i) Now use V2 to calculate the intra distance. Stop if intra is smaller than a prescribe value else set C =C+1, return to step (c), until C=Cmax.

IV. PROPOSED WORK

A. *Welcome screen*

This is the welcome screen. On clicking any button from fuzzy C mean and fuzzy C mean with BBHE, the results for selected technique will be displayed. On clicking the 'Select image' button, selection screen comes that helps to select the required image for segmentation. Clicking on 'Apply Fuzzy C mean', the results according to Fuzzy c mean clustering will be displayed. Clicking on 'Apply Fuzzy C mean with BBHE', the results according to Fuzzy c mean clustering with BBHE technique will be displayed. Histogram graphs of the original image and applied BBHE are shown in figure. If user wants to close the application at this time then he can click the 'EXIT' button.

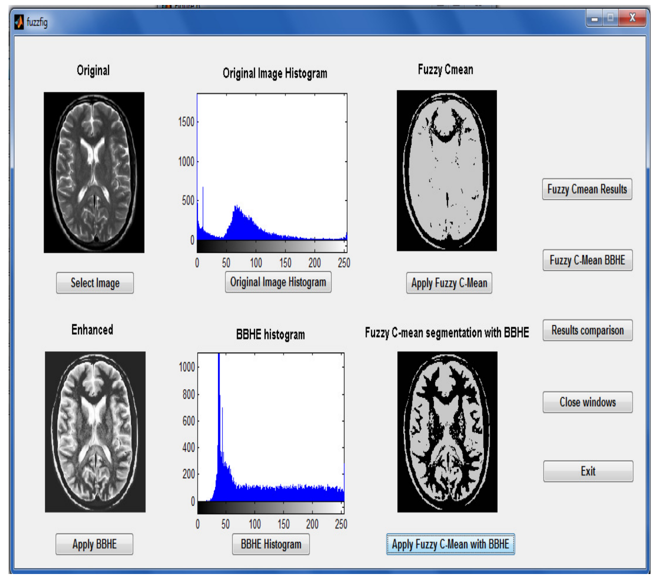

Fig.2 shows the graphical user interface of proposed work

V. EXPERIMENTAL AND COMPERATIVE RESULTS

A. *Comparisions of diferent parameters of image :-*

After Applying the Fuzzy c mean and Fuzzy c mean with BBHE, now click on the results button it will show the plot for the parameters peak signal to noise ratio (PSNR), mean square error (MSE) and bit error rate (BER).

a) PSNR comparison for Fuzzy C mean segmentation (previous) and Fuzzy C mean segmentation with BBHE (proposed).

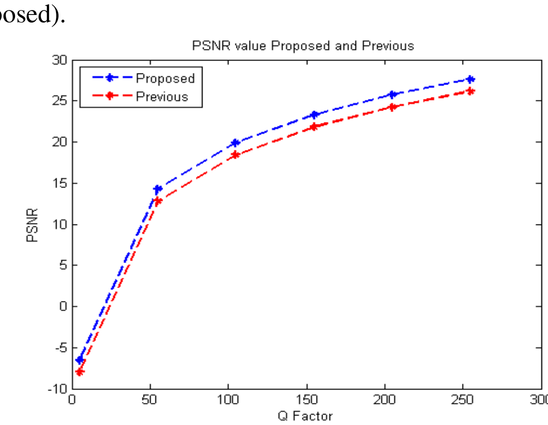

Fig.3 PSNR Value Proposed and Previous

b) BER comparison for Fuzzy C mean segmentation (previous algorithm) and Fuzzy C mean segmentation with BBHE (proposed algorithm).

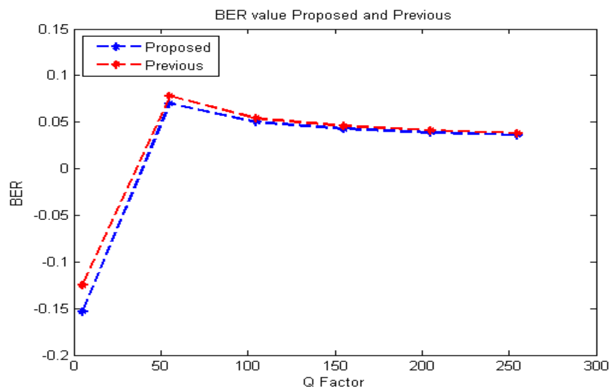

Fig.4 BER Value Proposed and Previous

c) MSE comparison for Fuzzy C mean segmentation (previous algorithm) and Fuzzy C mean segmentation with BBHE (proposed algorithm)

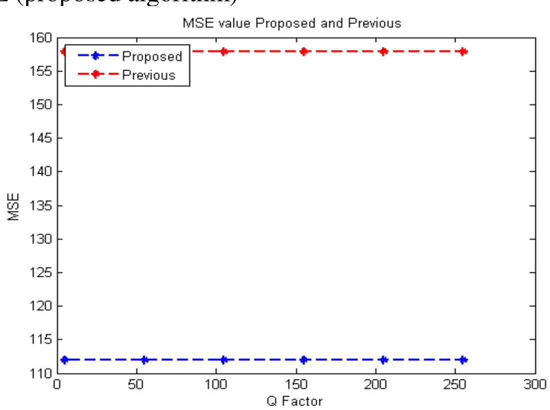

Fig.5 MSE Value Proposed and Previous

B. Based on following, results calculate:-

Lower values for MSE means lesser errors. A higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. The 'signal' is the original image, and the 'noise' is the error in reconstruction. So, having a lower MSE (and a high PSNR), it is a better one. BBHE (Brightness Preserving Bi-Histogram Equalization Technique) has the lowest MSE and highest PSNR. High PSNR means less noise in image and Low value of MSE indicates good contrast. Hence BBHE gives best result for grayscale image. Now if MSE approaches zero. The image should be in very good contrast. Table shows the comparison of basic factors of image for using previous and proposed algorithm.

Parameters	**PSNR**	**MSE**	**BER**
Quality Factor	255	255	255
FCM	26.1474	157.8835	0.0382
FCM with BBHE	27.6403	111.9579	0.0362

Table 1 comparison of quality factor of image

C. MRI examples

The experiment performed on original MRI shown in fig.6 (a). Fuzzy c mean segmentation is applied on it and the image is not giving enough information as shown in fig.6 (b).

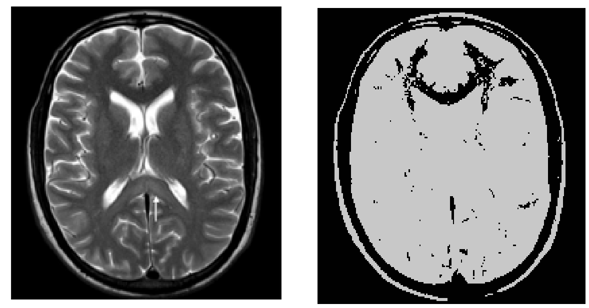

Fig.6 (a) original image (b) Fuzzy C-mean segmentation

To improve the efficiency of proposed algorithm using BBHE on MRI as shown in fig.7 (c) then applying FCM segmentation more effective and informative MRI is obtained as shown in fig.7 (d).

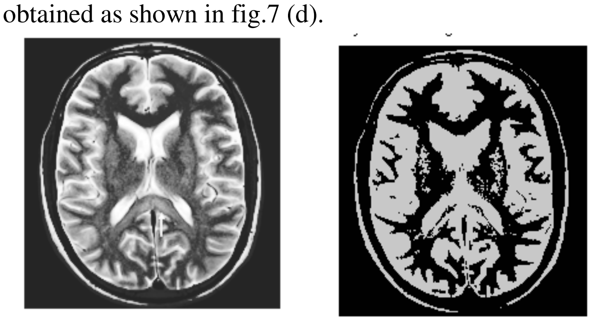

Fig.7 (a) enhanced image (b) Fuzzy C mean segmentation with BBHE

VI. CONCLUSION

This paper has presented a new approach which combines fuzzy c mean clustering Image segmentation and Brightness preserving Bi Histogram Equalization technique. These algorithms have a promising future ahead since they are the basis of image processing and have become the focus of contemporary research. In spite of several decades of research, there is no universally accepted image segmentation algorithm. Since image segmentation is affected by lots of factors such as type of image, color, intensity, level of noise, etc. Thus there is no single algorithm that is applicable on all types of images and nature of problem.

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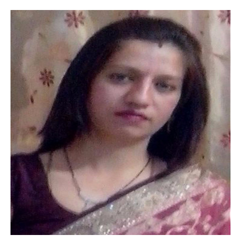

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