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Performance Analysis of Image Clustering Algorithm Applied to Brain MRI

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Abstract: Exact measurements in brain diagnosis are difficult because of various shapes, sizes and appearances of tumors. Tumor is an abnormal growth of body tissue; it can be cancerous or non-cancerous. There is a strong demand for automate the tumor detection and segmentation process. Thus, we required computer aided diagnosis of brain tumor from MRI images to control the difficult problems in the manual segmentation. There are several methods available in literature for medical image segmentation. In this paper, we introduced new segmentation method for detection of bias field image and classification of white matter and gray matter .From experimental results, BCFCM required less time than FCM algorithm.

Keywords: Magnetic Resonance Image (MRI), Brain Tumor Segmentation, Bias-Corrected Fuzzy C Means Algorithm (BCFCM).

I. INTRODUCTION

Brain is most important organ in the human body. Exact measurement in brain diagnosis is difficult because of presence of complex tissue, shape and size .Brain tumour is an abnormal growth of cell. For detection of brain function, pathology and anatomy widely used MRI images. Thus, we required computer aided diagnosis of brain tumor and segmentation from MRI image to control the difficult problems in the manual segmentation. The aim of Image segmentation is the image partitioning into important region that have powerful correlation with objects or areas of the real world contained in the image. In medical field it is used for detection of brain tumour and other different application. In MRI images, intensity in homogeneity which are caused by magnetic setting, patient position and radio –frequency coil. At present, most clinicians segment a specific area of brain MRI by manual segmentation method. It is not only time consuming, but also differences between different observers. Therefore, it's necessary of an accurate brain MRI segmentation algorithm. Clinical brain tissue MR images usually contain noise, bias field (BF), which causes intensity non-uniformity (INU), Partial Volume Effect (PVE). One of the major difficulties faced by brain MR image segmentation is the bias field in MR images, which arises from the fallibility in the radio-frequency coils or problems associated with the acquisition sequences. Bias field correction refers to a procedure to detect the bias field from the measured image so that its effect can be eliminated.

In this paper, we introduced new BCFCM segmentation method for detection of bias field image and classification of white matter and gray matter. BCFCM is very useful for noise and intensity in homogeneity image segmentation. It has the low-pass filter to guarantee the smooth bias field estimation. But it does not consider the global intensity information, so the segmentation results will lose lots of edge information. We introduce the global intensity information into BCFCM to estimate accurately the pixels on the boundary. Then, the segmentation result will have a smooth bias field guaranteed by the BCFCM and an accurate segmentation with edge information guaranteed by the global intensity. Also compare with fuzzy c mean clustering which required more time that of bias- corrected FCM. The remaining paper is organized as follows: The Previous works and the limitation are described in Section II. Section III gives us the details of Standard fuzzy C means Clustering algorithm. PSO Algorithm is described in section IV.

II. LITERATURE SURVEY

Bhagwat et al (2013) presented a paper showing comparison of K-means, Fuzzy C-means and Hierarchical clustering algorithms for detection of brain tumor. Testing of these three algorithms was done on MRI brain image in non medical format (.jpg, .png, .bmp etc) as well as on DICOM (.dcm) images. From all the clustering techniques fuzzy C-means are mostly used. By comparing with the other K-means algorithm produces more accurate results. Difference steps such as image pre-processing feature extraction, segmentation and classification are used for tumor detection of brain.

In A. Sivaramakrishnan and Dr. M. Karnan (2013) proposed implement the tumor of brain diagnosis region from image which considered the cerebral tissues where image was completed by using FCM clustering method technique and histogram. For the calculation part the value of intensity of the gray level images. By using principal component analysis the images will be decomposed which will be used to decrease the wavelet dimensionality of the co-efficient. The result will show that the tumor part of the MRI brain is successfully detecting the tumor.

Charbel Fares et al (2011), regularly measure and assess the segmentation of an image algorithms. It will perform the segmentation algorithms and differentiate which is based on most important factors: exactness, image will be choices depend on stability, and parameter will be chosen depend on the stability.

Ivana Despotovi (2013) introduced FCM-based clustering techniques majorly for noise robust and spatially coherent image segmentation types. The information of the local image is mingle into both the sameness evaluate and the function of membership is to repay for the result of noisy. Neighbourhood, based on the features which are a phase congruency was established to allow extra reliable image smoothing without segmentation. The results will be segmented, method will be demonstrate efficiently protect the regions of homogeneity and is extra noise to robust than comparable to FCM-based methods.

Maoguo Gong (2013), by introducing a kernel metric for segmentation of an image upgrade fuzzy C-means clustering algorithm and fuzzy factor will be a weighted. The factor of fuzzy which is depends on the distance space of all neighboring pixels and the difference in the gray-level at the same time. It will determine the parameter of the modern algorithm adaptively by using selection rule which will be a fast bandwidth selection for all data points in the collection of group. The results of original images show that the algorithm is powerful and well planned for any type of noise.

From literature survey we come to know that segmentation of brain tumor is very tedious job from MRI images. As brain consists of various tissues, which are also represented in MRI images, it is difficult to correctly detect the tumor part. Thus, computer based system are requires for segmentation of MRI brain images. There are various methods present for segmentation of MRI brain images. Out of those bias corrected fuzzy C means clustering is most suitable segmentation method for MRI brain tumor diagnosis.

III. METHODS

Fuzzy C Means algorithm:

It is a type of many-valued sense basically called as probabilistic logic. By the definition you can clears that it believes estimated values quite than set of fixed and correct. With traditional logic in contrast which is having binary values as 0 or 1 i.e. true or false. Fuzzy logic having a variable truth value degree ranges between 0 and 1. Fuzzy logic is used for handle the concept of limited part of truth, where the truth value will be ranges between completely true and completely false value.

Let X is a sample points of space, with the common elements of X are denoted by x. Thus, X=$\{x\}$. A set of fuzzy A in X is characterized by the function of membership *A(x)* which is related to the each point in X and each point is a real number in the interval range [0,1]. The value *A(x)* at x shows the membership grade of x in A. Therefore, more rapidly the value of (x) to unity then higher is the membership grade of x in A. In the hard process of clustering, each and every data point sample is assigned to only single cluster and remaining all the clusters are regarded as displace collection of the set of data. There are many cases in practice, in which they are not completely disjoint cluster and the data will be belonging to single cluster as well as to another also.

By assigning membership to each data point this algorithm works corresponding to each centre cluster on the origin of distance between the centre of cluster and the data point. Clearly, summation of each data point membership function should be equal to one. After each iteration, the up-gradation of the membership and cluster centre is done.

Main objective of FCM is to minimize:

$$j(uv) = \sum_{i=1}^{n} \sum_{j=1}^{c} (u_{ij})^m \left|\left|x_i - v_j\right|\right|^2 \quad \text{..} (1)$$

Where, $\left|\left|x_i - v_j\right|\right|$ is the Euclidean distance between h data and h cluster centre.

Biased corrected fuzzy c means clustering algorithm:

The observed MRI signal modelled in term of gain field. The gain field is defined as a product of the true signal generated by the underlying anatomy and a spatially varying factor.

$$Y_k = X_k G_k \qquad \forall\, k \in \{1, 2, \ldots, N\} \qquad (2)$$

where X_k and Y_k are the true and observed intensities at the kth voxel, respectively, G_k is the gain field at the kth voxel, and N is the total number of voxels in the MRI volume. If the gain field is known, then it is easily find the tissue class by applying a conventional intensity-based segmenter to the corrected data. Similarly, if the tissue classes are known, then we can estimate the gain field .We will show that by using an iterative algorithm based on fuzzy logic, we can estimate both.

It allow the labeling of a pixel to be affected by the labels in its immediate neighbourhood by using modified equation (1) . The neighbourhood effect acts as a regularizer and biases the solution toward piecewise-homogeneous labeling. Such a method is useful in segmenting scans corrupted by salt and pepper noise. The modified objective function is given by

$$j_m = \sum_{i=1}^{c}\sum_{k=1}^{N} u_{ik}^{p} ||x_r - v_r||^2$$

$$+ \frac{\propto}{N_R}\sum_{i=1}^{c}\sum_{k=1}^{N} u_{ik}^{p} \left(\sum_{x_r \in N_k} ||x_r - v_i||^2\right) \qquad (3)$$

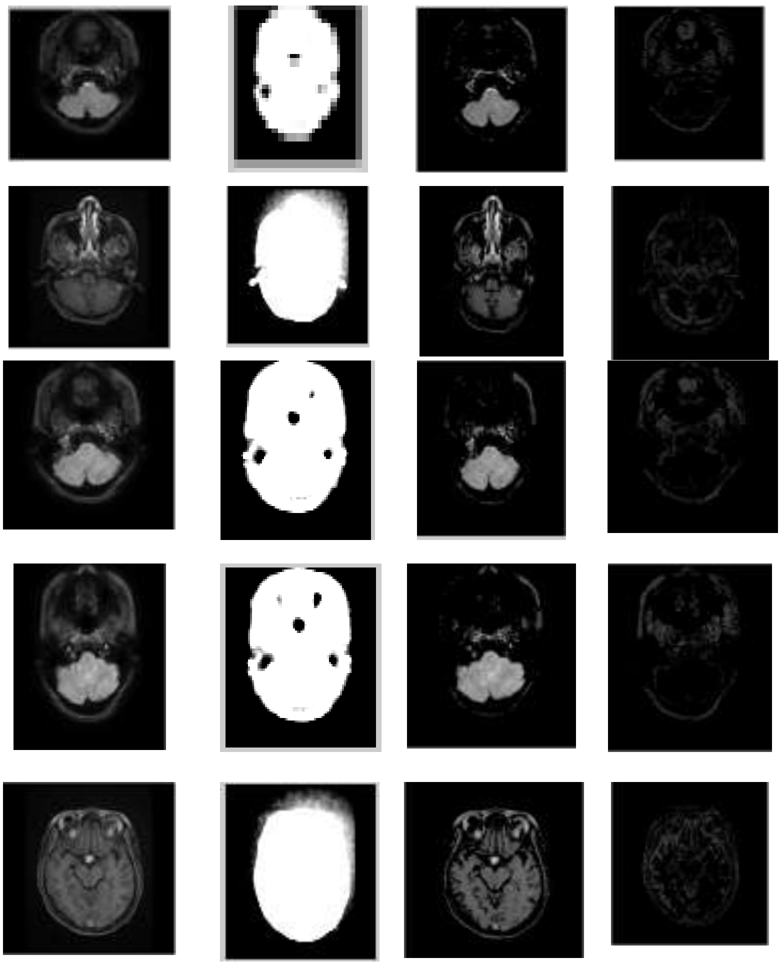
Formally, the optimization problem comes in the form

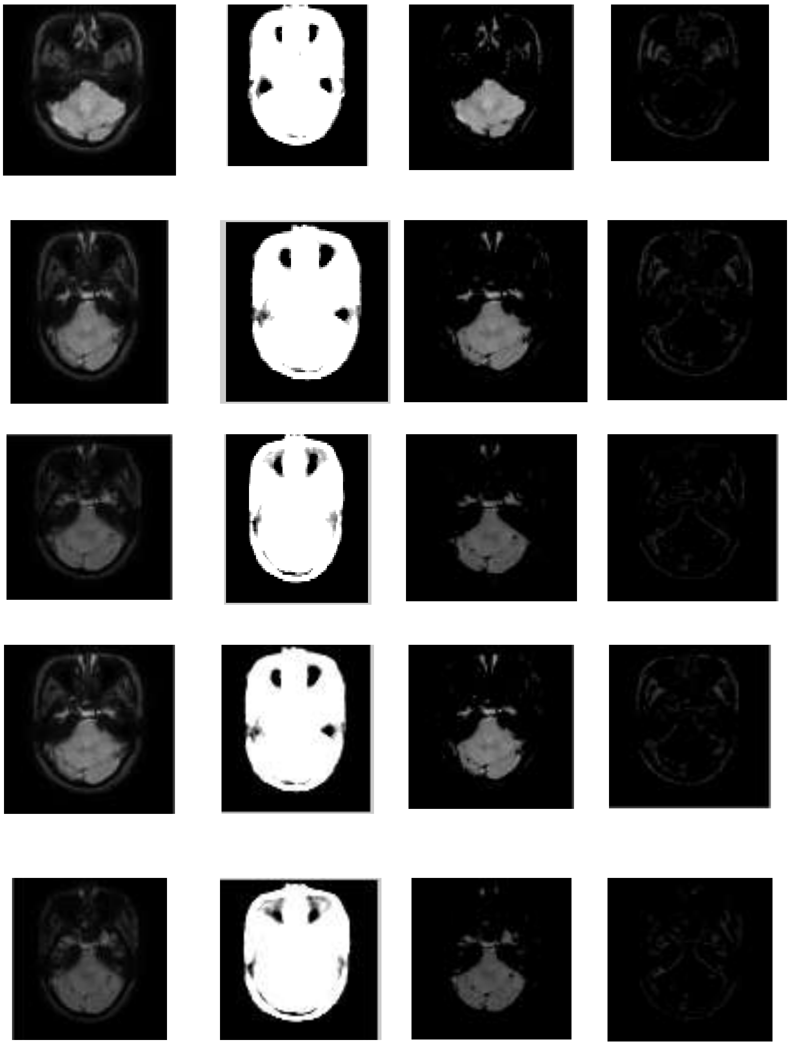
$$U, \{v_i\}_{i=1}^{c} {}^{min} \{\beta_k\}_{k=1}^{N} \qquad J_m \qquad \text{Subject to } \; U \,\epsilon\, u$$

IV. EXPERIMENTAL RESULTS

The segmentation is performed of brain tumor by using Matlab 13 and the outputs are obtained for each stage. The MRI data base of Brain Tumor has collected from Neuron hospital, Dhantoli, Nagpur and also from open data source. For the segmentation purpose 10 MRI brain images are considered. The image is with the default size 0f 512 x 512.

1) Output of BCFCM: (a) Original Image (b) Bias field Image (c) Segmented image using BCFCM :i) white matter ii) gray matter





(a) (b) (c) (i) (c) (ii)

Fig.4.1 Segmentation Results of BCFCM

2) Performance Analysis

Table 4.1: Comparison of BCFCM with FCM

SR NO.	Average Time in Sec		Accuracy in term of PSNR	
	BCFCM	FCM	FCM	BCFCM
1	2.6527	6.8382	93.3778	98.4894
2	3.0926	8.5186	88.3415	94.5436
3	3.2641	8.2656	92.7726	97.4042
4	3.0000	8.4375	94.3252	97.4584
5	3.3109	8.2656	91.5184	95.9831
6	3.0442	8.2500	91.7094	96.3078
7	2.8464	8.0165	92.4600	97.1831
8	2.9402	8.0622	93.8252	97.8810
9	2.7364	8.4326	94.3536	99.7718
10	2.7688	8.4800	93.4036	98.3021

CONCLUSION

We have demonstrated a new BCFCM algorithm for adaptive segmentation and intensity correction of MRI images .The algorithm was formulated by modifying objective function of standard FCM algorithm to compensate for in homogeneities. Using Stimulated MRI data estimate bias field without the need for manual intervention. We compared our results with traditional FCM segmentation and conclude that BCFCM required less time as well as more accurate than FCM. The results presented in this paper are preliminary and further clinical evaluation is required .The evaluation of the method for localized measurements, such as impact on tumor boundary or volume determinations also needs further work.

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