Brain Tumor Detection using Hybrid Clustering with Estimate Arguing

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ABSTRACT
Detection of tissues from MR brain images is quite difficult task in medical field applications. Segmentation is utilized to detect the tissues accurately. Many algorithms have been presented to detect the tissues from the MR brain images. Most of them were remained failure due to their inaccurate results. To resolve this problem, an analysis of tissues detection in MR images using hybridclustering with estimate arguing (HC-EA) is proposed. Our proposed methodology consists of pre-processing, tissues detection and calculating the estimated area of clustered tissues. Extensive simulated analysis shown that the effectiveness of proposed hybrid clustering approach. Our main concentration is on detection of multi-tissues with an enhanced accuracy over conventional clustering algorithms like fuzzy c- means (FCM), K-means and manual segmentation.
Key words: magnetic resonance imaging, brain tumor, thresholding, fuzzy c means, K-means and estimate arguing

I. INTRODUCTION

Basically, magnetic resonance imaging (MRI) [1] is utilized to investigate the processes of human body and organisms functioning. It influencesthe treatment and diagnosis in several specialties although the effect on enhanced health outcomes is uncertain. These sorts of imaging are desirable over the computed tomography (CT) since it does not utilize any ionizing radiation, when either modality could yield the same information. Brain tissue is an uncontrolled growth in any part, which causes serious death to the human. Detecting these tissues in an early stage is a vital and quite difficult task to the medical diagnosis persons. Detection of tissues in MR images can be done by segmenting the images. Grouping of similar elements is known as segmentation. Clustering is a process to do the segmentation, which clusters the number of elements into few clusters based on the similarity of intensity valuesor pixel values and gray intensities of an image. Outcome of clustering consists of number of segmented objects in which it has extracted information of input image.Because of the information extraction in any images, the segmentation has been utilized in many application fieldslike image enhancement, detection of objects, compression, processing of medical images and retrieval systems [2]. Over past decades there have been many algorithms implemented for segmenting images. FCM is a well-known approach among those and it's a very popular clustering technology, that can segment source image into number of objects by utilizing the membership functions [4] and [5]. However, these sort of algorithm suffering from higher complexity due to the membership values assignment. Later years, to reduce the computational complexity a simple and effective clustering algorithm was proposed. It has been utilized widely due to its capability of clustering meta data very faster [4] and [7-9]. Then after segmentation of images was done by utilizing hierarchical clustering [12-14] and Gaussian Mixture Model with its variant Expectation Maximization[17-18].However, the algorithms presented in the literature have been suffering from inaccuracy in finding the exact tissue, higher computational complexity and lack of stability. To overcome these problems, HC-EA algorithm for detecting single and multi-tissues in MR brain images and calculating the estimated area using number of white pixels in a segmented MR image with an enhanced performance over conventional clusteringalgorithmslike fuzzy c means (FCM), K-means and even that of manual segmentation.

II. RELATED WORK

Author in [3] presented a segmentation algorithm that was based on improved watershed approach. This approach provided some better enhancements over manual segmentation algorithms, but it was suffering from few restrictions like over segmentation and sensitive to false edges. In [4], a fuzzy implementation has been presented by the author named fazel.Fuzzy is a set of rules and regulations, in which the segmentation depends on the membership values. However, fuzzy wasn't without drawbacks, it suffers from the computational complexity due to its dependency on membership function.Later, many researchers tried to implement hybrid combos with the integration of FCM algorithm. Author in [5] presented an effective segmentation of tissue in brain images by utilizing the combo of spatial information and FCM, this resolved the issue found in [4], but it was also taking more computational time to segment an image and also suffer from false edges. To overcome the limitations of above mentioned segmentation algorithms, the author in [6] proposed an efficient segmentation algorithm which utilized k-means clustering for segmenting MR brain image. This approach was an extended version for the watershed, manual segmentation and FCM based algorithms. Segmented output of k-means is quite better over those algorithms and this takes very less time to compute the segmented images. From then many researchers tried to implement the integrated algorithms with the combination of k-means clustering to get the enhanced performances in [7-10]. However, this K-means depends on the selected centroids initially. It needs new centroids to be updated by calculating the mean of obtained clustered points in the first iteration.The mean of these values provides the floating values which were not favourable for replacing as a new centroid.

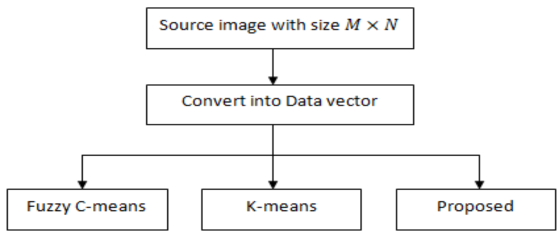


Fig1. Brain tissue segmentation flow diagram

Therefore, K-means must need to optimize for the integer or scalar centroid to be replaced with the existed centroid. In [11], the author has proposed a pillar- based approach to optimize the K-means clustering, in which the maximum value is selected instead of calculating the mean value to replace the initial centroid. Authors in [19-21] presented a hybrid algorithm for tumour detection and extraction from brain images, but they were failed to detect the tumor with higher accuracy. However, the above-mentioned algorithms have the drawbacks like less accuracy and inaccurate area estimation.

III. PROPOSED ALGORITHM

Here in the proposed clustering algorithm, we optimized the k-means clustering by applying fuzzy algorithm.

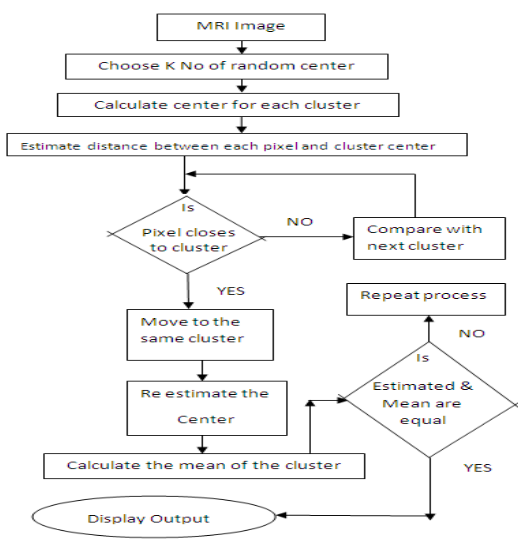


Fig. 2 Flow chart of K-means clustering

Algorithm1:

Step1: Select and read the source MR brain image 'I' which is to be segmented
Step2: Convert it into a data sets of column vectorfor grouping of similar elements.
Step3: Select the number clusters i.e. centroids.
Step4: Find the distancebetween each pixel to cluster point
Step5: Find number of data points those are near to the chosen clusters.
Step6:Choose the cluster with a minimal distance and then mover the data point to the relevant cluster centroid.
Step7:Now, re-estimate the new centroid by finding the mean of obtained data from step 6 and replace the initial centroid with the new one.
Step8: Repeat this process iteratively until the newand previous centroids are symmetrical.

Algorithm 2:

Input image = O

Output image = S

Step1: Read the output image 'O', which has been obtained from algorithm1

Step2: Apply fuzzy algorithm to the image 'O'

Step3: Display the segmented brain tissue image in which we had a tumour

Step4: Then calculate the area of the tumour using estimate arguing method, in which the area of the tumour will be calculated by considering the number of white pixels

Step5: And compute the CPU time in seconds for the comparison of proposed and existing techniques

A. HC-EA algorithm

Our proposed hybrid clustering is described in this section briefly. Figure 3 show that the block diagram of proposed HC-EA methodology. Algorithm 1 and 2 explained the complete procedure for obtaining the segmented tissues of brain images by utilizing the proposed approach. Median filter is utilized as a pre-processing step to eliminate the noise from input MR brain image.Obtained denoised MR brain image is converted into data vector then k-means clustering is applied to segment this vector into several clusters. Now, the segmented output is optimized by fuzzy algorithm to enhance the segmentation accuracy and perfect tissue detection. At last, estimate arguing is applied to estimate the area of obtained tissue image by utilizing the typography and digital imaging units [20].Here, we considered the images of size 256 x 256 and the pixels in the segmented image having only two values i.e., either black or white, where the pixel value 0 denotes the black and 1 denotes the white.Hence, we can represent the segmented output image as a summation of total number of white and black pixels.

$M = \sum_{x=1}^{L} \sum_{y=1}^{L} [f_{x,y}(0) + f_{x,y}(1)]$ (1)

where L=1, 2, 3…256

$f_{x,y}(0) =$ black pixel having the value of zero,

$f_{x,y}(1)$= white pixels having the value of one

$$P = \sum_{i=1}^{L} \sum_{j=1}^{L} f_{x,y}(1)$$

Where,

P = number of white pixels

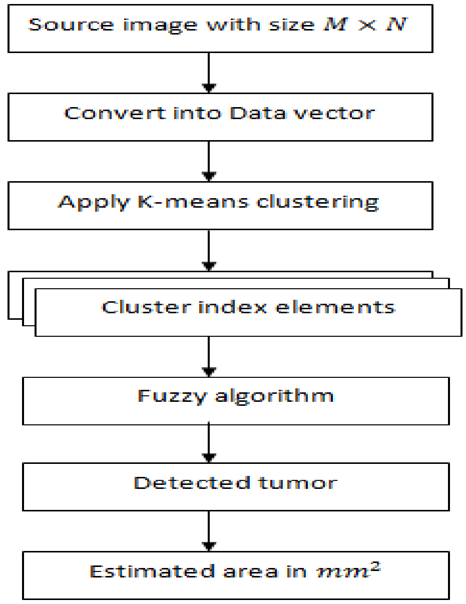


Fig. 3 Block diagram of proposed model

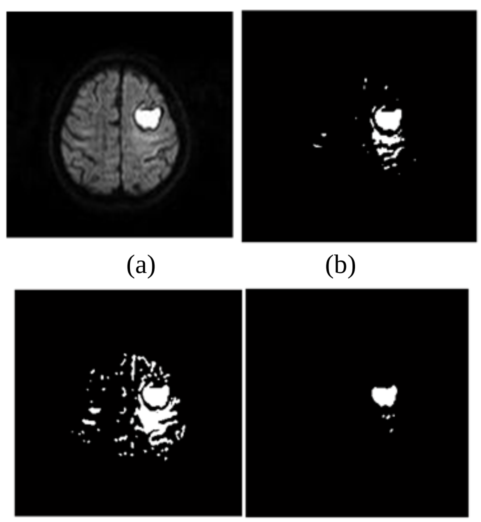
Now, by utilizingeq. (1), area of segmented tissue is calculated, where one pixel is equal to 0.264583 millimetres. i.e., 1 pixel = 0.264583 mm

Then the area of tissueis expressed as follows:

$$A_{Tumor} = (\sqrt{P}) \times 0.264mm^2$$

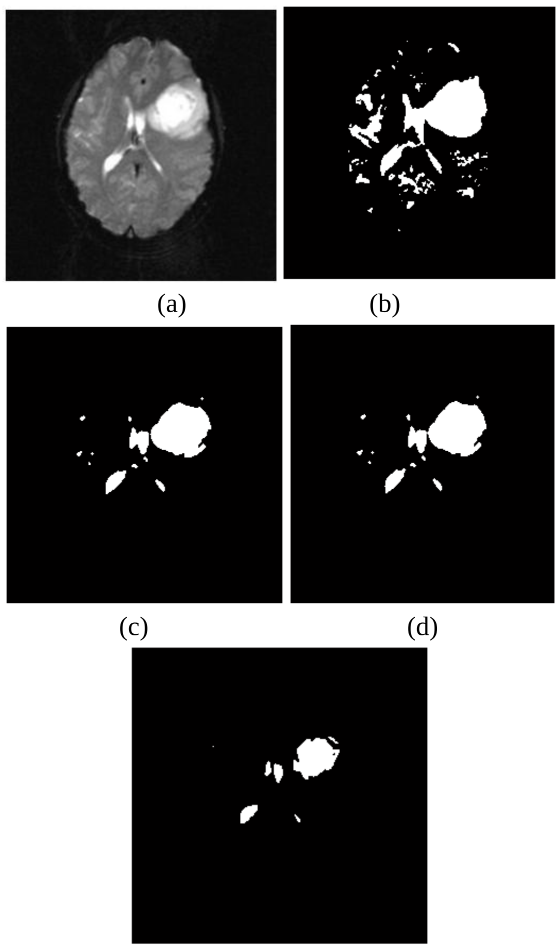
IV. EXPERIMENTAL RESULTS

This section describes the simulated analysis of proposed hybrid clustering with comparison to conventional clustering algorithms for detection of single and multi-tissues from the MR brain images. Various MR images have been utilized with different sizes and different stage of tissues for testing the effectiveness pf proposed clustering algorithm.


(a) (b)
(c) (d)

(e)

Fig. 4 (a) MR brain image and obtained segmented images with (b) manual segmentation (c) Fuzzy C Means and (d) K-means (e) proposed hybrid clustering



(a) (b)

(c) (d)

(e)

Fig. 5 (a) original image and obtained segmented images with (b) manual segmentation(c) fuzzy C means (d) K-means (e) proposed hybrid clustering

Then we evaluated the performance of conventional schemes Fuzzy c means, K-means and manually segmented algorithms with the proposed hybrid clustering algorithm for detection of single and multi-tissues in MR Brain images. The experimental results of MRI tumor detection using proposed hybrid algorithm and existing algorithms will be shown in below figures.

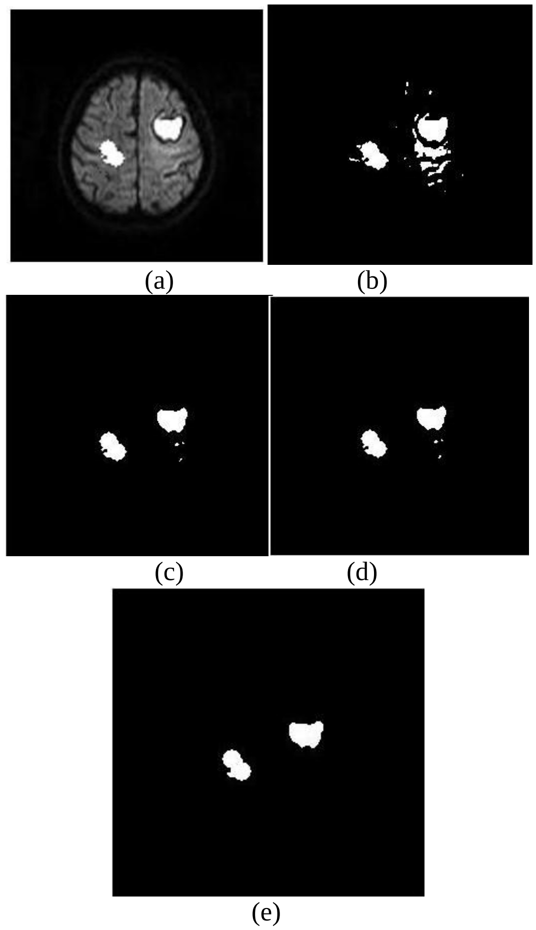


Fig. 6 Segmented multi tissues obtained (a) original image (b) manual segmentation (c) FCM clustering (d) K-means clustering and (e) proposed hybrid clustering

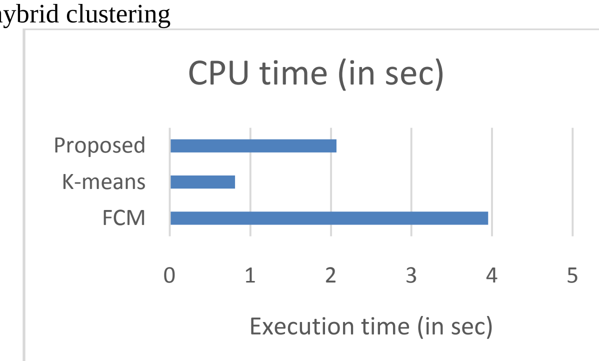


Fig. 7 Performance evaluation with CPU running time for multi tissues detection

By comparing the results our proposed approach is more effective and accurate. Fig4 and 5 shows that the segmented outputs of single tissue of MR brain images with manual segmentation, FCM clustering, K-means clustering and proposed hybrid clustering algorithms.From the obtained outputs, we can observe that the proposed hybrid clustering algorithm has detected the tumour more effectively with higher accuracy. Although, our proposed algorithm running time will be quite bit of more than the k-means clustering but however the accuracy of segmented output will be more i.e., tumour area will be estimated more precisely to diagnosis further.

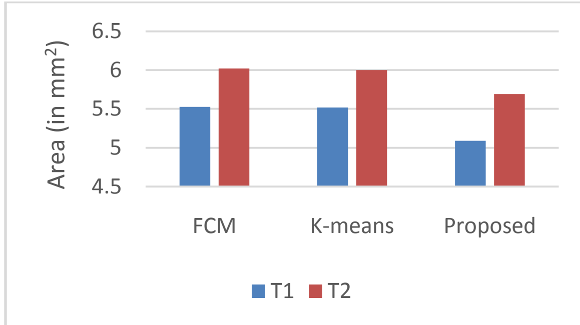


Fig. 8 Estimated area of segmented tissues T1 = tissue 1 and T2 = tissue 2

Above figures demonstrates that the performance evaluation of proposed hybrid clustering algorithm with comparison to the conventional clustering algorithms presented in the literature. We calculated execution time in seconds and tissues area in mm^2

V. CONCLUSION

The implementation of detecting single and multi-tissues in MR brain images and to estimate the area of the tissue has done with an improved accuracy and reduced computational time. Utilization of hybrid clustering and estimation of the area in terms of mm^2 based on the typography and digital imaging units has done successfully. We also compared the simulation results with the existing algorithms. Furthermore, this can be extended to 3D multi modal medical image segmentation with more effective and accurate clustering algorithms.

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