Segmentation of Brain Tumor Using Different Clustering Algorithms

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Abstract- This paper presents a robust segmentation method which is the integration of K-means and Fuzzy C-means clustering algorithm. Current system presents the implementation of different algorithms for detection of range and shape of tumor in brain MR images and identifies stage of tumor from the given area of tumor. Tumor is an uncontrolled growth of tissues in any part of the body. After researching a lot statistical analysis which is based on those people whose are affected in brain tumor some general risk factors and symptoms have been discovered. The development of technology in science day night tries to develop new methods of treatment. This image is visually examined by the physician for detection & diagnosis of brain tumor. However, this method accurate determines the accurate of stage & size of tumor and identifies stage of tumor from the area of tumor. This work uses segmentation of brain tumor based on the k-means and fuzzy c-means algorithms. This method allows the segmentation of tumor tissue with accuracy and reproducibility comparable to manual segmentation. In addition, it also reduces the time for analysis and identifies stage of tumor from the given area of tumor.
Keywords: Magnetic Resonance Imaging (MRI), Brain tumor, Pre-processing, K-means, fuzzy c-means, Thresholding.
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I. INTRODUCTION

Normally the anatomy of the Brain can be viewed by the MRI scan or CT scan. In this paper the MRI scanned image is taken for the entire process. The MRI scan is more comfortable than CT scan for diagnosis. It does not affect the human body. It is based on the magnetic field and radio waves. There are different types of algorithm were developed for brain tumor detection. But they may have some drawback in detection and extraction.

In this work, two algorithms are used for segmentation. K-means clustering algorithm and Fuzzy C mean algorithm. It gives the accurate result for tumor segmentation. Tumor is formed due to the uncontrolled growth of the tissues in any part of the body. The tumor may be primary or secondary. If it is an origin, then it is known as primary. If the part of the tumor is spread to another place and grown as its own, then it is known as secondary. Normally brain tumor affects CSF (Cerebral Spinal Fluid). It causes for strokes. The physician gives the treatment for the strokes rather than the treatment for tumor. So, detection of tumor is important for that treatment. The lifetime of the person who affected by the brain tumor will increase if it is detected at current stage. That will increase the lifetime about 1 to 2 years. Normally tumor cells are of two types. They are Mass and Malignant. The detection of the malignant tumor is somewhat difficult to mass tumor. In this paper we focused on detection of brain tumor with the help of Brain MRI images and identify stage of tumor from the given area of tumor. Treatment for brain tumor depends on the type and stage of the tumor, the size and place of the tumor, and your general health and medical history. In most cases, the goal of treatment is to remove or destroy the tumor completely. Most brain tumor can be cured if found and treated early.

A person who was affected by any kind of tumor has an increased risk of developing another brain tumor of any type. A person who has two or more close relatives (mother, father, sister, brother, or child) who are responsible for developing brain tumor has a risk factor of developing brain tumor for his own. Rarely, members of a family will have an inherited disorder that makes the brain more sensitive and increases the risk of brain tumor. About 5% of brain tumors may be linked to hereditary (genetic) factors or conditions. The

objective of this work is to contract such a tool which can tell people about his/her approximate condition about brain tumor, that is he or she in risk or not and how much?. The developing platform for the detection is java. At the end, we are providing systems that detect the tumor and its shape and identify stage of tumor from the given area of tumor.

II. RELATED WORK

Presented system of image registration and data fusion theory adapted for the segmentation of MR images. Propose a system of image registration and data fusion theory adapted for the segmentation of MR images. This system provides an efficient and fast way for diagnosis of the brain tumor. This system provides an efficient and fast way for diagnosis of the brain tumor called K-means algorithm [1].

Meena and Raja presented an approach of Spatial Fuzzy C means (PET-SFCM) clustering algorithm on Positron Emission Tomography (PET) scan image datasets. Proposed algorithm is incorporated the spatial neighborhood information with traditional FCM and updating the objective function of each cluster. This algorithm is implemented and tested on huge data collection of patients with brain neuro degenerative disorder such as Alzheimer's disease. It has demonstrated its effectiveness by testing it for real world patient data sets. [2].

Presented system look at three algorithms namely K Means clustering, Expectation Maximization and the Normalized cuts and compare them for image segmentation. This project addresses the problem of segmenting an image into different regions. We analyze two unsupervised learning algorithms namely the K-means and EM and compare it with a graph-based algorithm, the Normalized Cut algorithm. The K-means and EM are clustering algorithms, which partition a data set into clusters according to some defines distance measure [3].

Funmilola et al presented the Fuzzy K-C-means method, which carries more of Fuzzy C-means properties than that of K-means. This work has mainly focused attention on Clustering methods, specifically k-means and fuzzy c-means clustering algorithms. These algorithms were combined to come up with another method called fuzzy k-c-means clustering algorithm, which has a better

result in terms of time utilization. The algorithms have been implemented and tested with Magnetic Resonance Image (MRI) images of Human brain. Results have been analyzed and recorded [4].

Wilson and Dhas used K-means and Fuzzy C-means respectively to detect the iron in brain using SWI technique. An accurate assessment of iron accumulation is required for diagnosis and therapy of iron overload in various neurodegenerative diseases. Susceptibility Weighted Imaging (SWI) offers information about any tissue that has a different susceptibility than its surrounding structures. [5].

Presented deep study of brain tumor describes different type of diagnosis approaches. This paper presents a systematic Type-II fuzzy expert system for diagnosing the human brain tumors (Astrocytoma tumors) using T1-weighted Magnetic Resonance Images with contrast. The proposed Type-II fuzzy image processing method has four distinct modules: Pre-processing, Segmentation, Feature Extraction, and Approximate Reasoning. [6].

In the field of pattern recognition due to the fundamental involvement of human perception and inadequacy of standard Mathematics to deal with its complex and ambiguously defined system, different fuzzy techniques have been applied as an appropriate alternative [7].

Presented work has suggested a synergistic and an effective algorithm for the detection of brain tumors based on Median filtering, K Means Segmentation, FCM Segmentation, and finally, threshold segmentation. In this proposed approach we enhance the quality of the tumor images acquired by the aid of MRI and then to detect the size of the tumors, approximate, reasoning is applied. [8].

Presented work, the author gives a study of the various algorithms that are available for color images, text and gray scale images. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture [9].

In this work presented k-means and C-mean clustering techniques to extract the features from the brain images and detect the tumor [10].

III. PROPOSED SYSTEM

The proposed work is a combination of two clustering algorithms. The presented system has mainly four modules: preprocessing, segmentation, feature extraction, approximate reasoning. Pre-processing step is done by image filtering using median filter. After that Image Segmentation is carried out by K-means and Fuzzy C-means algorithms. Feature extraction is by image thresholding and finally, approximate reasoning step to recognize the tumor area and position in MRI image and identify stage of tumor from result area of brain tumor. I.e., finally implement a system to identify stage of tumor which is easier, cost reducible and time savable.
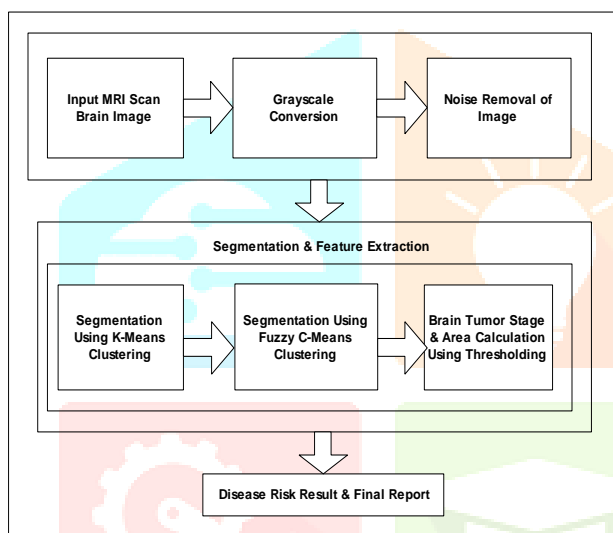

Figure: Proposed System Architecture

Pre-processing

In this step, firstly we removed the noise of an image using median filter also other artifacts in the image and sharpening the edges in the image. RGB to gray conversion and Reshaping also takes place here. It includes median filter for noise removal. The possibilities of arrival of noise in modern MRI scan are very less. It may arrive due to the thermal effect. The main aim of this work is to detect and segment the tumor cells. But for the complete system it needs the process of noise removal.

Segmentation using K-means

Steps:
1. Give the no of cluster value as k.
2. Randomly choose the k cluster centers
3. Calculate mean or center of the cluster

4. Calculate the distance b/w each pixel to each cluster center
5. If the distance is near to the center then move to that cluster.
6. Otherwise move to next cluster.
7. Re-estimate the center.
8. Repeat the process until the center doesn't move.

Segmentation using Fuzzy C means

The fuzzy logic is a way to processing the data by giving the partial membership value to each pixel in the image.

The membership value of the fuzzy set is ranges from 0 to 1.

Fuzzy clustering is basically a multi valued logic that allows intermediate values i.e., member of one fuzzy set can also be member of other fuzzy sets in the same image. There is no abrupt transition between full membership and non-membership.

The membership function defines the fuzziness of an image and also to define the information contained in the image.

Approximate reasoning

In the approximate reasoning step the tumor area is calculated using the binarization method. That is the image having only two values either black or white (0 or 1). And then classify the stage of tumor from the given area of tumor

IV. MATHEMATICAL MODEL

Mathematical equation in K-means clustering

1. $M = \frac{\sum_{i:c(i)=k} Xi}{Nk}$, k=1, 2,…, K.

2. $D(i) = \arg \min \|X_i - M_k\|^2$, i=1, 2,.., N.

Mathematical equation in Fuzzy-C means clustering

$Y_m = \sum_{i=1}^{N} \sum_{j=1}^{C} M_{ij}{}^m \|X_i - C_j\|^2$

Where,

m= any real number greater than 1,
M_{ij}= degree of membership of X; in the cluster j,
X_i= data measured in d-dimensional,
R_j= d-dimension center of the cluster,

The update of membership Mij and the cluster centers R are given by:

$$M_{ij} = \frac{1}{\sum_{K=1}^{C} \left(\frac{\|Xi-Cj\|}{\|Xi-Cj\|}\right)^{\frac{2}{m-1}}}$$

$$R_j = \frac{\sum_{i=1}^{N} Xi.Mijm}{\sum_{i=1}^{N} Mijm}$$

V. ALGORITHMS

K-means clustering

Steps:
1. Give the value to k for no of cluster.
2. Randomly choose the k cluster centers
3. Calculate mean or center of the cluster
4. Calculate the distance b/w each pixel to each cluster center
5. If the distance is near to the center then move to that cluster.
6. Otherwise move to next cluster.
7. Re-estimate the center.
8. Repeat the process until the center doesn't move.

Fuzzy C-Means Algorithm

The fuzzy logic is a method to processing the data by giving the partial membership value to each pixel in the image.

The membership value of the fuzzy set is ranges from 0 to 1.

Fuzzy clustering technique is basically a multi valued logic that let on middle values i.e., participants of one fuzzy set can also be member of other fuzzy sets in the same image. There is no direct transition between full membership and non-membership.

The membership function denotes the fuzziness of an image and to define the information contained in the image.

VI. RESULT

Let us consider the brain tumor image procured from MRI, containing the tumor in figure 1. Median filtering is implemented on the acquired images to get rid of the unwanted noises. The outcomes are displayed in the figure 2.
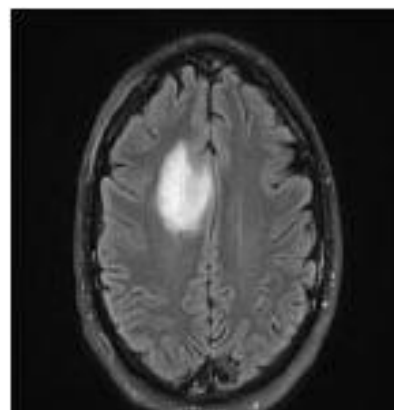

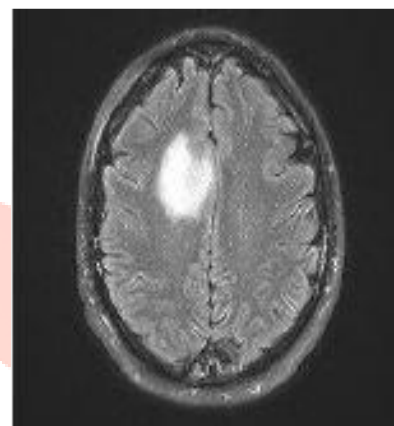**Fig. 1 Brain Tumor Image**

Fig. 2 Median Filtering Outcome

K means algorithm is implemented on such noise filtered images containing brain tumors. In figure 4, a white spot is seen, which is outcome of threshold segmentation on the input image. This region is the area having higher intensity values compared to the defined threshold. Areas with higher intensity values mostly contains ulcer. The outcomes of thresholding segmentation are shown below in figure 3.
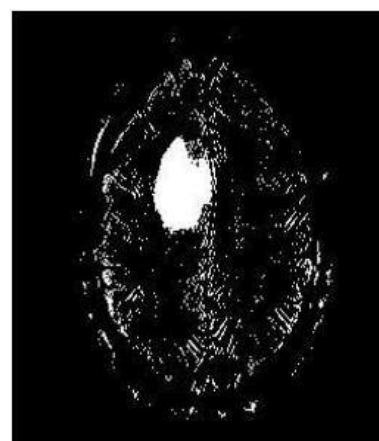

Fig. 3 K Means Clustering

Once the K Means Clustering gets over, Fuzzy C-Means segmentation is eventually implemented on the resulted image procured from K Means segmentation. The region affected by ulcer is highlighted in this process. The outcome of the watershed segmentation is shown below in figure 4.
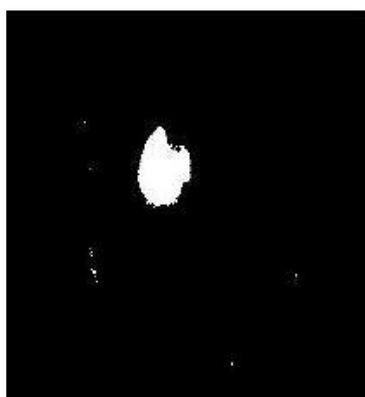

Fig. 4 FCM Segmentation

Eventually, the thresholding segmentation is implemented, once the FCM segmentation is completed. The outcomes are spectacular and intended approach is efficacious in nature to an extent. Figure 5 shows the resultant image procured after the implementation of thresholding segmentation.
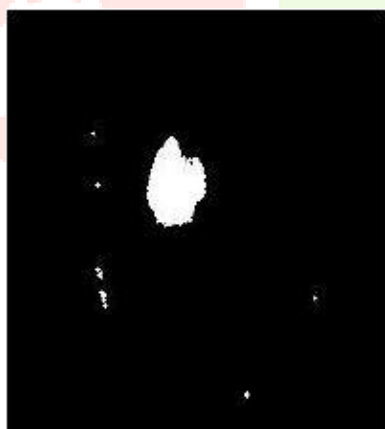

Fig. 5 Thresholding Segmentation

Fig. 6 Output Images of Tumor Area Estimation

The output is displayed above in figure 6.

The proposed system is also very sensitive to the errors, because the small error will take the situation in ambiguous state which is not good for diagnosis of tumor. Again same FCM mean and k means algorithms are use to compare individual performance with the proposed method and the result of all are compare and we find that the proposed system having less errors in the system.

Also, we compared the existing and proposed result and shows graphically. Let see the following graph and table shows the segmentation accuracy result of both clustering techniques mainly k-means clustering technique and fuzzy c means clustering respectively. The overall existing segmentation accuracy of k means technique and fuzzy c means clustering are 90% and 94% resp. So our proposed system segmentation accuracy is 94% and 96% respectively.

So this works gives better segmentation result compare to existing method.
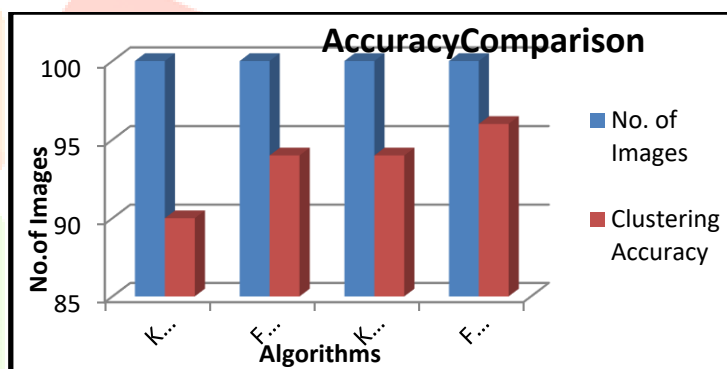

Fig. 7 Brain Image Clustering Accuracy Graph

Table: Brain Image Clustering Accuracy

Algorithm	No. of Images	Clustering Accuracy (Exis.)	Clustering Accuracy (Prop.)
K-Means Clustering	100	90%	94%
Fuzzy C Means Clustering	100	94%	96%

CONCLUSION

Brain Tumor segmentation is carried out in this presented work. Firstly, image pre-processing is done using median filter technique. If there is any noise are present in the MR image it is removed before the K-means process. The noise free image is given as an input to the k-means and tumor is extracted from the MRI image. And then segmentation using Fuzzy C means for accurate tumor shape extraction of malignant tumor and thresholding of output in feature extraction. Finally approximate reasoning step for calculating tumor area and position calculation and finally to identify stage of tumor from resultant area of tumor i.e. identifies stage of tumor which is easier, cost reducible and time savable.

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