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Quantitative and Qualitative Measurement of K-Means and Fuzzy C Means, the Detection and Extraction of MRI Cerebellum lesions.

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Abstract: Clustering is an unaided examination with two totally various procedures: hard clustering and soft clustering. K-Means might be a hard clustering procedure and FCM might be a soft clustering procedure. In this paper, a performance live is administrated on these two algorithms to search out the higher one for detection and extraction of cerebellum lesion in MRI. Each subjective and objective evaluations are administrated. Varied applied mathematical measures like MSE, PSNR, ROI, NROI, Compression ratio, accuracy are utilized for target investigation of the consequences of the near examination of the two calculations. Abstract investigation is administrated by subject specialists. From this examination, it is discovered that FCM is delivering higher quality segmentation results than K-Means regarding accuracy and ROI segregation. Then again, K-Means is overpowering the relatively lesser measure of time for image segmentation than FCM. In this way, on the off chance that accuracy is given parcel of need than time complexness, at that point FCM should be an essential inclination.

Keywords: Cerebellum lesion, K means clustering, Fuzzy C Means, Performance measurements.

I. INTRODUCTION

In medical image process, Segmentation of brain MR image is incredibly difficult and difficult task, as a result of MR images are related to artifacts. Applicable and correct segmentation strategy is important in preceding tumor detection and classification. Segmentation in image process is alluded because the method of confining an image into reciprocally elite regions. It is applied so as to find objects and boundaries in images. These artifacts darken or mimic the pathology. Image segmentation methods are upheld one among the two essential properties of image intensity esteems: separation and similitude. The past methodology relies on changes in intensity, like edges and corners. The last relies on partitioning an image into regions that are similar because of collection of predefined criteria. Segmentation facilitates to demark between the objects, characterization and visualization of regions of interest. There are few algorithms and methods that are created and enforced for image segmentation like histogram based strategies, edge-based strategies, artificial neural network based strategies, physical model based methodologies, region-based strategies (region splitting, growing, and merging), and clustering strategies (Fuzzy C-means clustering, K-means clustering, Mean Shift and Expectation Maximization) [1]-[5], however still there needs to build up an efficient, speedy strategy of medical image segmentation as a result of all these techniques have their own benefits and limitations in terms of quality, relevancy, execution and procedure time. The troublesome downside in segmentation method is that the choice of correct technique for a selected quite image database. There is no typically acknowledged Procedure for image segmentation. In this paper, Image segmentation techniques are enforced and their performance is evaluated. Performance of those approaches has been assessed as far as Mean square error, Peak Signal to noise quantitative relation, time period, and accuracy and in terms of compression quantitative relation as well as area is computed.

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II. METHODOLOGY

A. Segmentation by K-means clustering

K-means clustering algorithmic program solves clustering downside and it is the only unsupervised learning algorithmic program. The procedure followed by K-means clustering to classify a given set of information through a particular variety of clusters is incredible easy. In K- means 'K' centroids are outlined, one for every cluster. These clusters should be placed far away from one another. The ensuing step is to require some extent of having a place with a given information set and partner it to the closest focal point of mass. At the point when no reason for existing is incomplete, the essential advance is finished and an early gathering is done. At now we liked to recalculate k new centroids of the groups following from the past advance. Once having k new centroids, another coupling should be done between comparable data set focuses and furthermore the closest new focal point of mass. A circle has been produced. As an aftereffects of this circle, the k centroids correction their area bit by bit till no extra changes are finished. Finally, this algorithmic program targets at limiting an objective function called squared error function given by.

$$J(V) = \sum_{i=1}^{k} \sum_{j=1}^{k_i} \left\| x_i - v_j \right\|^2$$

(1)

Where $\|X_i - V_j\|$ is the Euclidean distance between the two points.

'K_i' is the data points in i[th] cluster

'K' is the number of cluster centres.

Algorithm for K-means clustering

Step 1: First choose variety of centroids haphazardly that depends on number of clusters.
Step 2: Now, partition the objects inside every cluster.
Step 3: It finds partitions specified pixels inside every cluster are as on the subject of one another as doable, and as isolated from the objects in different clusters as doable.
Step 4: The objects are within the cluster or not are going to be calculated by measurement the gap between the cluster pixels. Once the calculated Euclidean distance has smallest value then the pixels are going to be clustered with the corresponding cluster.
Step 5: Do the above method for remaining clusters additionally. Then, get three clusters with their similar pixels.
Step 6: Then, calculate the mean of every cluster and replace the mean values with the centroids.
Step 7: Repeat the equivalent method with these new centroids by giving the amount of iterations till unless the convergence prevalence i.e., the mean value of clusters = cluster center of mass value.

B. Segmentation by FCM

Fuzzy c-means (FCM) is a strategy of clustering which enables one bit of information to have a place with at least two groups. This technique is often time utilized in pattern recognition. It depends on minimization of the accompanying objective function:

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^m \left\|x_i - c_j\right\|^2 \quad , \quad 1 \le m < \infty \qquad (2)$$

where *m* is any genuine number more prominent than 1, *uij* is the level of enrollment of *xi* in the cluster *j*, *xi* is the *i*th of d-dimensional estimated data, *cj* is the d-measurement point of the cluster, and ||*|| is any standard communicating the comparability between any deliberate information and the center. Fuzzy partitioning is brought out through an iterative enhancement of the objective function appeared above, with the update of membership *uij* and the cluster centers *cj* by:

$$u_{ij} = \frac{1}{\sum_{k=1}^{C}\left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|}\right)^{\frac{2}{m-1}}}$$

$$c_j = \frac{\sum_{i=1}^{N} u_{ij}^m \cdot x_i}{\sum_{i=1}^{N} u_{ij}^m} \qquad (3)$$

The cycle will stop when

$$\max_{ij}\left\{\left|u_{ij}^{(k+1)} - u_{ij}^{(k)}\right|\right\} < \varepsilon$$

where ε is a end paradigm somewhere in the range of 0 and 1, whereas *k* are the emphasis steps. This system meets to a nearby least or a seat point of *Jm*.

The calculation is made out of accompanying advances:

1. Instate U=[uij] framework, U(0)
2. At k-step: calculate the centers vectors C(k)=[cj] with U(k)

$$c_j = \frac{\sum_{i=1}^{N} u_{ij}^m \cdot x_i}{\sum_{i=1}^{N} u_{ij}^m} \qquad (4)$$

3. Update U(k) , U(k+1)

$$u_{ij} = \frac{1}{\sum_{k=1}^{C}\left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|}\right)^{\frac{2}{m-1}}} \qquad (5)$$

4. on the off chance that || *U(k+1) - U(k)*||<ε then STOP; generally come back to stage 2

C. Performance parameters of Segmentation

C.1 Area:

Standardized area of the tumor is determined which is the region as for as region of the whole image. For ex; on the off chance that the tumor area is 0.005, at that point it demonstrates that the tumor area is 0.5 % of the area of the whole image. It is given by;

$$A = \frac{1}{h\,v} \sum_{(i,j)\in R} f(i,j) \qquad (6)$$

Where , h and v speak to the quality of the flat and vertical pixels of the input image individually, R speaks the region with label1, that is, the tumor locale, function 'f' relates to the estimation of pixels in the area R which is constantly '1'.

C.2 Number of pixels in tumor region:

The quantity of pixels that go under the removed tumor locale is given by;

N= h v A (7)

C.3 ROI (Region of interest)- Compression ratio:

Compression ratio = The Compression Ratio (CR) is a proportion of the last compacted record size to the first document size communicated in rate. Lower the CR, better is the compression.

$$CR\% = \frac{Final\ File}{Initial\ File\ Size} \times 100 \qquad (8)$$

All the data in a medical image is not similarly significant. ROI describes the affected part of an image and which is to be dissected.

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This region is compressed so that diminished size of an image can be accomplished with no data being lost. The ROI locale is packed using DWT (discrete wavelet transforms).

C.4 ROI (Region of interest)- bits per pixel:

The Bits-Per-Pixel proportion (BPP) is a ratio of number of bits required to store an image pixel. Lower the BPP, better is the compression. BPP is determined here concerning ROI.

C.5 NROI (Non region of interest) – Compression ratio:

During the time spent in compression, the non ROI locale is packed so that if there is any misfortune in data additionally it doesn't prompts any issue. Non ROI relates to the foundation information which is less significant. The non-region of interest region is packed utilizing discrete cosine transform (DCT)

C.6 NROI (Non region of interest) – bits per pixel:

The Bits-Per-Pixel proportion (BPP) is a ratio of number of bits required to store an image pixel. Lower the BPP, better is the compression. BPP is determined here concerning NROI.

C.7 Perceptual quality measurement:

The nature of an image is determined with the assistance of the parameters for example mean square error [MSE], peak signal to noise ratio [PSNR], compression ratio. Mathematically these parameters are spoken to as

C.7.1 Mean square error (MSE)

Mean Square Error (MSE) between two images P and Pc with measurements M×N is characterized as

$$MSE = \frac{1}{M*N}\sum_{i=1}^{M}\sum_{j=1}^{N}(P[i,j] - Pc[i,j])2 \quad (9)$$

Lower the value of MSE, lower the error.

C.7.2 Peak signal to noise ratio (PSNR)

PSNR is the parameter for figuring the nature of a compacted image.

$$PSNR = 10\log[\frac{i2}{MSE}] \quad (10)$$

III. RESULT AND DISCUSSION

The method was implemented using MATLAB programming language on a computer. At first the basic K means algorithm and fuzzy C mean algorithm was implemented along with the subjective analysis. The parameters such as PSNR, computational time and segmentation accuracy are calculated for both algorithms. Table II and III shows tumor detection parameters for Fuzzy C means and K means clustering algorithms respectively. Table IV and Table V shows the comparison of basic K means and fuzzy C means algorithm. It is seen that the segmentation accuracy of both algorithms, comparative study shows that fuzzy C means has better accuracy than that of K means.

Table I Quantitative and qualitative analysis

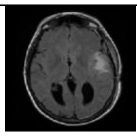
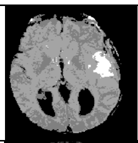
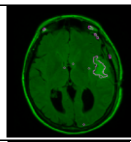
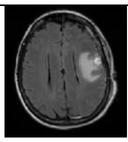
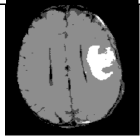
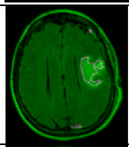
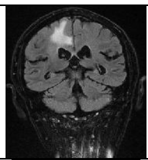
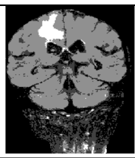
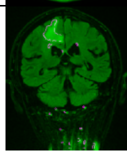
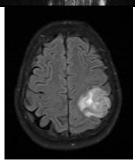
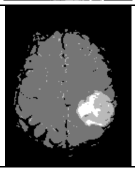
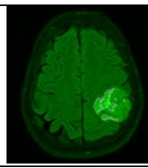
Original Image	K- Means	Fuzzy C Means	Subjective Analysis
			
			
			
			

Table II: Tumor region description using Fuzzy C means

Sl. no	No. Of Pixels in tumor area	Tumor area	ROI-CR	ROI-bits per pixel	NROI-CR	NROI-bits per pixel
1	659	0.0083	68.90	0.116	7.459	1.072
2	992	0.0125	50.87	0.157	8.745	0.914
3	1010	0.0122	49.38	0.162	4.881	1.638
4	1437	0.0071	79.51	0.100	12.27	0.651

Table III: Tumor region description using K- means clustering

Sl. no	No. of pixels in tumor area	Tumor area	ROI-CR	ROI- bits per pixel	NROI-CR	NROI-bits per pixel
1	849	0.0107	54.29	0.1474	8.186	0.977
2	1702	0.0214	29.01	0.2757	8.828	0.906
3	1529	0.0185	32.00	0.2499	5.248	1.524

4	6214	0.0306	20.48	0.3906	7.611	1.051

Table IV: Evaluation of FCM using MSE and other parameters

Image	Fuzzy C means			
	MSE	PSNR	Elapsed time	Accuracy %
1	0.086	59	7.25	95.7
2	0.096	66	4.74	97
3	0.2	61	4.70	93

Table V: Evaluation of K- means using MSE and other parameters

Image	K Means Clustering			
	MSE	PSNR	Elapsed time	Accuracy %
1	0.093	57.56	3.58	90.8
2	0.133	60	3.41	92.3
3	0.31	57	3.14	90

IV. CONCLUSION

The comparisons show the qualitative result parameters compared to Fuzzy C means and K-means clustering strategies. Once the PSNR values are high and MSE values are less, then the segmentation method offers sensible results. Elapsed time gives us what proportion of time it takes for a segmentation technique to get the output. Less elapsed time offers sensible result. It can be concluded that fuzzy c means yields higher lead to in terms of MSE, PSNR and other parameters as compared to K means clustering.

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