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Segmentation of Brain Tumor Using K-Means Clustering Algorithm

[1]D. Vijaya Kumar and [2]V.V. Jaya Rama Krishniah
[1]Acharya Nagarjuna University, Tenali, Andhra Pradesh, India
[2]Department of CSE, ASN Women's Engineering College, Tenali, Andhra Pradesh, India

Abstract: Since, image segmentation is a classic inverse problem which consist of achieving a compact region based description of the image scene by decomposing it into meaningful or spatially regions sharing similar attributes. Tumor is nothing but uncontrolled growth of tissues in any part of the body. Tumors are of different types and they have different treatments. The k-means algorithm is an iterative technique that is used to partition an image into k clusters. In developed countries most research show that the number of people who have brain tumors were died due to inaccurate detection of tumor. CT scan or MRI is directed into intracranial cavity produces a complete image of brain and this image is visually examined for detection.

Key words: Magnetic Resonance Imaging (MRI), brain tumor, k-means, CT (Computerized Tomoghraphy) scan, thresholding, image segmentation

INTRODUCTION

Image segmentation is an important and perhaps, the most difficult task in image processing. Segmentation refers to the grouping of image elements that exhibit similar characteristics, i.e., subdividing an image into its constituent regions or objects.

Segmentation is a fundamental process in digital image processing which has found extensive applications in areas such as medical image processing, compression, diagnosis arthritis from joint image, automatic text hand writing analysis and remote sensing. The clustering methods can be used to segment any image into various clusters based on the similarity criteria like color or texture. k-means clustering algorithm divides the image into k clusters based on the similarity between the pixels in that cluster.

Brain tumor segmentation deals with the implementation of simple algorithm for detection of range and shape of tumor in brain MR image. Normally, the anatomy of the brain can be viewed by the MRI scan or CT scan for diagnosis. There are different types of algorithm were developed for brain tumor segmentation. But they may have some drawback in detection and extraction and result people who have brain tumor died. k-mean clustering algorithm is used for the accurate detection of the brain tumor. The tumor may be primary or secondary. The brain tumor is primary when it is an origin and the brain tumor is secondary when the part of the tumor is spread to another place and grown. Propensity (Zarandia *et al*., 2011; Chitade and Katiyar, 2010; Praveena and IlaVennila 2010). It can be used to predict iron shrinkage tendency and help the foundry to control scrap.

Literature review: The widely used algorithm in image segmentation system is k-mean clustering algorithm. There were several attempts made by researchers to improve the effectiveness and efficiency of the k-means algorithm. There are many researchers suggest initialized method of cancroids of k-means algorithm.

Stephen proposed a method for choosing k instances randomly from database as seeds. The drawback of this technique is the computational complexity, there are several iterations of the k-means algorithm are needed after that each instance is assigned which in a large database is extremely burdensome (Van De Ville *et al*., 2003).

Douglas and Michael suggested a method to select a good initial solution by partitioning dataset into blocks and applying k-means to each block. But the time complexity is slightly more. Though, the above algorithms can help finding good initial centers for some extent, they are quite complex and some use the k-means algorithm as part of their algorithms whichstill need to use the random method for cluster center initialization.

Haralick and Shapiro suggested that there is no full theory of clustering and therefore no full theory of image segmentation. They have established the following qualitative guideline for good image segmentation.

- Segmented regions should be unified and homogeneous with respect to some characteristic such as gray level or texture
- Region interiors should be simple and without many small holes

Corresponding Author: D. Vijaya Kumar, Acharya Nagarjuna University, Tenali, Andhra Pradesh, India

- Adjacent segmented regions should have significantly different values with respect to the characteristic on which they are considered unified
- Boundaries of each segment should be simple, not ragged and must be spatially accurate

That means the image segmentation techniques are generally ad hoc and differ on how they emphasize one or more of the desired properties. Therefore, the final implementation of each image segmentation algorithm depends very much on the end of the application. However, these differences usually center on the choices of parameters or methods of how to adapt certain parameters to the image (Ravichandran and Ananthi, 2009).

MATERIALS AND METHODS

System design: In order to overcome the difficulties of k-means clustering in existing method the following design is carried out. Figure 1 consist of mainly four modules, preprocessing, segmentation, feature extraction and approximate reasoning. Pre-processing is done by filtering. Segmentation is carried out by advanced kmeans and fuzzy C-means algorithms. Beevi and Sathik (2010) Feature extraction is by thresholding and finally, approximate reasoning method to recognize the tumor shape and position in MRI image using edge detection method (Ravichandran and Ananthi, 2009). The proposed method is a combination of two algorithms.

Pre-processing: It performs filtering of noise and other artifacts in the image and sharpening the edges in the image. In pre-processing RGB to grey conversion and reshaping takes place. The main aim of this study is to detect and segment the tumor cells. But for the complete system it needs the process of noise removal. For better understanding the function of median filter, we added the salt and pepper noise artificially and removing it using median filter. 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.

k-means segmentation

k-means clustering: Clustering is one of the major data analysis methods widely used in many practical applications of emerging areas. Clustering is the process of finding groups of objects such that the objects in a group will be similar to one another and different from the objects in other groups. High quality clusters with high intra-cluster similarity and low inter-cluster similarity this is a good clustering method. In the k-means algorithm initially we have to define the number of clusters k. Then k-cluster center are chosen randomly. The distance

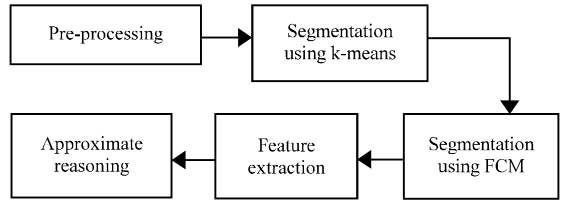

Fig. 1: Block diagram of proposed method

between the each pixel to each cluster centers are calculated (Sahu and Parvathi, 2013; Alsabti *et al*., 1997). The distance may be of simple Euclidean function. Single pixel is compared to all cluster centers using the distance formula.

Algorithm 1; k-mean clustering:
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

Mathematical representation: For a given image, compute the cluster means m:

$$M = \frac{\sum_{nc\,(i) = k} X_i}{N_c},\ k = 1, ..., K \tag{1}$$

Calculate the distance between the cluster center to each pixel:

$$D_{(i)} = \arg\min \|X_i\text{-}Mk\|^2,\ i = 1, ..., N \tag{2}$$

Repeat the above two steps until mean value convergence.

Flowchart of k-means algorithm: The diagrammatic representation of the k-means algorithm and its flow (Fig. 2).

Screen shot or pre-processing and k-means: Screen shot or pre-processing and k-means is shown in Eq. 3 (Fig. 3):

$$Y_m = \sum_{i=1}^{N}\sum_{j=1}^{C} M_{ij}\|X_i\text{-}C_j\| \tag{3}$$

Where:

m = Any real number >1

M_{ij} = Degree of membership of X in the cluster j

x = Data measured in d-dimensional

R_j = D-dimension center of the cluster where

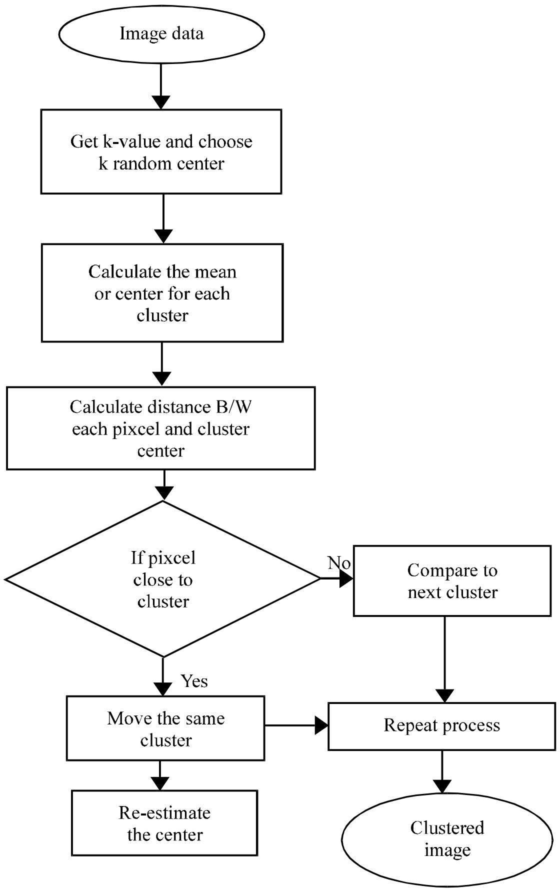

Fig. 2: Flowchart of k-means algorithm

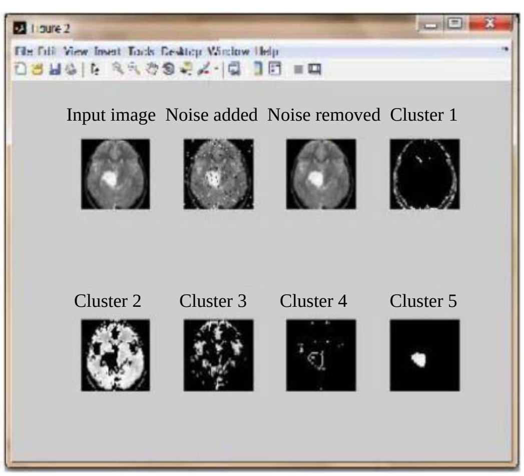

Fig. 3: Output pre-processing and k-means for k = 5

$$M_{ij} = \frac{1}{\sum_{i=1}^{C}\left(\frac{|X_i - C_j|}{|X_i - C_j|}\right)^{\frac{2}{m-1}}} \quad (4)$$

$$RR_j = \frac{\sum_{i=1}^{N} x_i, M_{ij}^m}{\sum_{i=1}^{N} M_{ij}^m} \quad (5)$$

The above process ends when:

$$\max_{ij}\left\{\left|M_{ij}^{(k+1)} - M_{ij}^{(k)}\right|\right\} < \delta \quad (6)$$

Where:
K = No. of iteration steps
C = The fuzzy C-means algorithm

RESULTS AND DISCUSSION

Feature extraction: In feature extraction image of tumor extracting the cluster which shows the predicted tumor area at FCM output. What ever the extracted tumor giving to the thresholding process. That entire image applies the binary mask value then the dark pixel becomes dark and and white pixel becomes brighter.

Approximate reasoning: In the approximate reasoning binarization method is used to calculate tumor area. In binarization method image consist of two values either black or white. Black value assigned 0 and white value assigned to 1:

$$\text{Image, } I = \sum_{w=0}^{255}\sum_{h=0}^{255}[f(0)+f(1)] \quad (7)$$

Where:
Pixels = Width (W)X
Height (H) = The 256×256
f (0) = White pixel (digit 0)
f (1) = Black pixel (digit 1)

Segmentation using fuzzy c-means: In fuzzy logic 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 0-1. Member of one fuzzy set can also be member of other fuzzy sets in the same image:

- P = Number of white pixels (width×height)
- 1 pixel = 0.264 mm
- The area calculation formula is size of tumor, $S = [(\sqrt{P})\times 0.264]\ mm^2$
- P = No. of white pixels
- W = Width
- H = Height

CONCLUSION

There are different types of tumors are available. They may be as mass in brain or malignant over the brain. Suppose if it is a mass then k- means algorithm is enough to extract it from the brain cells. 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 a input to the k-means and tumor is extracted from the MRI image. For accurate segmentation of brain tumor k-means clustering algorithm is more efficient.

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