MRI Brain Image Segmentation Using Fuzzy C-means Clustering

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Abstract— The brain is a highly specialized organ. It serves as the control center for functions of the body. Words, actions, thoughts and feelings are centered in the brain. Each part of the brain has a specific important function and each part contributes to the healthy functioning of our body. The location of tumors in the brain is one of the factors that determine how a brain tumor affects an individual’s functioning and what symptoms the tumor causes. In this paper the Fuzzy C-means clustering algorithm is used for image segmentation and detecting the tumor objects that are found in the MRI brain image.

Keywords— Magnetic Resonance Imaging (MRI), Fuzzy logic, C-means algorithm, clustering, Segmentation

I. INTRODUCTION

Image diagnosis is a major component for treatment planning, research activities and more. Currently, the algorithm computation is playing an important role due to the increasing size and number of medical images. The selection of methods mainly depends on imaging modalities, its specific application and other factors. For an example the brain tissue has different requirements from other organ. Medical image segmentation automates the specific radiological function and other regions of interest. The goal of segmentation is to analyze the representation of an image into meaningful and easier. It refers to partition a digital image into multiple segments which are basically constructs with sets of pixels. Each pixel in the region of interest consists of some basic characteristics and computed property, known as intensity, texture and color. Nuclear imaging is the selective image modality for analyzing brain related neurological disorders. The major neurological alteration is accurate on shape, volume and tissue distribution in brain anatomy. MRI scan images are exclusively used to identify the cause of brain neurological disorder. Imaging is an essential aspect of medical science to visualize the anatomical structure of the human body. Several new complex multidimensional digital images of physiological structures can be processed and manipulated to help visualize hidden diagnostic features that are otherwise difficult or impossible to identify using planar imaging methods. Segmentation is an important process in most medical image analysis and classification for radiological evaluation or computer aided diagnosis. Segmentation methods can be classified into three categories. (i) Edge based methods (ii) Region based methods (iii) Pixel based methods.

II. CLUSTERING

“Grouping of similar patterns together “It is the most important unsupervised learning algorithm. It deals with finding a structure in a collection of unlabelled data. A cluster is a collection of objects which are similar
between them and are dissimilar to the objects belonging to other clusters. The clustering has divided as two types which are a. Hard clustering (K-means clustering) b. Soft clustering (Fuzzy C-means clustering)

Hard clustering is the method in which the data are grouped in an exclusive way, so that if a certain datum belongs to a definite cluster then it could not be included in another cluster. (i.e.) it belongs to only one cluster. Soft clustering uses fuzzy sets to cluster the data. So it is also called as Fuzzy clustering. In this clustering each data may belongs to two or more clusters with different degrees of membership function

III. ALGORITHMIC APPROACH

In this section the algorithmic approaches are discussed and proposed for the applications.

K-MEANS CLUSTERING

K-means clustering is one of the algorithms which is used to group the objects based on attributes or features into K number of groups where K is the positive integer. The grouping is done by minimizing the Euclidean distance between data and the corresponding cluster centroid. Thus the purpose of K-means clustering is to cluster the data. It is one of the simplest partitions clustering method. It is one of the unsupervised learning algorithms for clusters. Clustering the image is grouping the pixels according to the some characteristics. In this algorithm initially we have to define the number of clusters K, then K cluster centre are chosen randomly. The distance between each point to the cluster centers are calculated. The distance may be of simple Euclidean function. Single pixel is compared to all clusters centers using the distance formula. The pixel is moved to particular cluster which has shortest distance among all. Then the centroid is re-estimated. Again each pixel is compared to all centroids. The process continued until the center converges. The Equation.1 is used to obtain the distance between pixels and centroid.

\[
J(V) = \text{Eqn (1)}
\]

where, ‘\( \|x_i - v_j\| \)’ is the Euclidean distance between \( x_i \) and \( v_j \).

‘\( c_i \)’ is the number of data points in ith cluster.

‘\( c \)’ is the number of cluster centers.

The given Figure 1 shows the flowchart of K means algorithm. The flow chart gives clear idea and concept for understanding and designing
The following specified steps are used to write the coding and identifying the cluster: 1. Give the no. of cluster value as K.

2. Randomly choose the K cluster values.

3. Calculate the mean or center of the cluster.

4. Calculate the distance between each pixel to the each cluster center.

5. If the distance is near to the center then move the pixel to that cluster.

6. Otherwise move to the next cluster.

7. Re-estimate the center.

C-MEANS CLUSTERING: Fuzzy C-means clustering is a clustering algorithm in which each data point belongs to cluster to a degree specified by a membership grade. In this, object is grouped into C fuzzy groups. Cluster center is calculated for each group and the Euclidean distance is measured between the pixel and each centroid of clusters. Then the pixel is grouped with the cluster which has shortest distance to the centroid. FCM is a method of clustering which allows one pixel to belong to two or more clusters. The FCM algorithm attempts to partition a finite collection of pixels into a collection of C fuzzy clusters with respect to some given criterion. Depending on the data and the application, different types of similarity measures may be used to identify classes. Some examples of values that can be used as similarity measures include distance, connectivity and intensity. The Equation 2 is used to obtain the distance between pixels and centroid, equation 3 is used to obtain the cluster centre. Equation 4 is used to find the membership function.

\[ C_j = \] 

Eqn 2

\[ Cj = \] 

Eqn 3
The following specified steps are used to write the coding and identifying the cluster: 1. Initialize C cluster centroids.

2. Associate each pixel with the centroid closest to it.

3. Re-compute the cluster centroids based on the mapped pixels.

4. Repeat steps (ii) and (iii) until the locations of centroid do not change.

**IV EXPERIMENTAL RESULT**

After introducing the clustering algorithm and their basic mathematical foundations, now it is the time to discuss the result on the basis of experimental approach. This approach involves the implementation of the FCM algorithm and testing its performance on the basis of its quality of clustering Fuzzy c-means algorithm is implemented in MATLAB environment. The primary reason for the selection of MATLAB is significant amount of data available in that format and due to the increasing popularity of this language there is an extensive quantity of applications available. The experimental results of MR brain tumor images are shown as in the following figures.

![Fig. 3 Input image of brain](image)

![Fig. 4 Analysis of Brain tumor using Fuzzy C means clustering algorithm](image)

**V CONCLUSION**

Generally, the runtime of the algorithm depends upon the number of input data points and the number of clusters specified. Different approaches yield different type of results for cluster analysis. 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. And then segmentation using Fuzzy C-means for accurate tumor shape extraction of malignant tumor. The proposed method gives more accurate result.

REFERENCES


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