Abstract

Objective: Normally MRI scan or CT helps to view the biology of brain. The segmentation methods are used to identify the tumor size and location. Methods/Analysis: Some of the segmentation methods are the Histogram-based segmentation and the Region-based segmentation (e.g.: Edge Detection method) which have the drawbacks in detection of size of the tumor and region. We are using the clustering based segmentation algorithms in this project. The run time and efficiency are the parameters used for comparison. Findings: These clustering algorithms like K-means, Fuzzy C and Pillar means are compared to each other for better performance by calculating the run time and efficiency of algorithms. This attempt improves the efficiency and computing time. Application/Improvements: It may help pathologists to identify the exact size and region easily.

Keywords: Fuzzy C, K-means, Pathologists, Pillar means, Segmentation

1. Introduction

Segmentation of medical image plays an instrumental role in the diagnosis. Segmentation has the properties like the least user interaction, minimum computational time, and accurate results. The segmentation method divides image into various number of sectors for precise and much simpler to analyze. Segmentation is mainly worn to locate the objects and boundaries of the images\(^1\).

Segmentation can be fully automated process; results can be obtained with its semi-automatic algorithms, i.e. it must need the involvement of human thinks. The semi-automatic means not completely auto-machine. This can be involved with its surroundings and also human involved with the proper algorithms then the data to produce the best results\(^2\). The basic case in which the need of the human amid the segmentation from the efficiency of the existing algorithms. Based on given input, the human should have to select the most apt algorithm, which cannot be done in an automated process. The human operator opinion is required.

The techniques for the image-processing include the treating image like a 2-D signal and implementing the primary signal-transformation techniques. Processing of the image commonly specify to image processing, the analog processing is also achievable. The acquiring of image is referred as the imaging. Image has a large number of finite elements which have a unique position and value. Each element in an image is represented by group of pixels. Processing of the image includes the altering quality of image to enhance its information for the humans or reconstruct it for an automatic approach\(^3\). The pixels will range between 1-256 and brightness changes between the same ranges. An image is the gathering of a large number of respective spots, each of which has a particular intensity to it.

There are mainly two types of tumors such as primary tumors and secondary tumors. The primary tumors are located at the origin of tissue. If the pieces of tumor rigidity to other area around the tumor and develops on its own, is a secondary. These tumors of brain causes...
patient has severe pain because that the tumor affects the Cerebral Spinal Fluid largely. The pathologist first gives the proper treatment for heavy pains before removal of tumor. So now a day the identification and detection of tumor is more important for the treatment. There are mainly two modalities used two scan the brain anatomy such as MRI scan or the CT scan. But as compared with CT, MRI is more comfortable than CT for the diagnosis purpose. The MRI scan can utilize low harmful radiation, so it doesn't affect the human body

2. Proposed Method

We are applying the clustering based segmentation algorithms like the K-means approach, Fuzzy C clustering and Pillar means in this project. Segmentation methods are co-related to each other for better performance by calculating the run time and the accuracy of each algorithm. The proposed method can be seen in the Figure 1 in the form of block diagram.

2.1 Pre-Processing Stage

In the first step of this method, digital image is enlarged in way that the rarer particulars are enhanced and the noise will be reduced from MRI image. Main goal of this stage is to separate the back ground from acquired image, remove noise and smooth the image components. Generally used enhancement and noise removal methods are reached so that the best possible outcomes are obtained. The enhancement process gives the more accurate edges and an efficient image. The noise will be removed by removing the blur effect from the digital image. Not only is the enhancement method, segmentation method also practiced. These noiseless and improvised images help to extracts the edge details and improve the true nature of the image. Then track the exact location of tumor by Edge detection method.

Image registration is additionally the piece of pre-preparing. It is an commanding use of advanced picture handling as it includes: carry a picture into arrangement with another picture, diagonal a picture as for another, overlay pictures, change shapes and size of pictures, match power, find coordinating between pictures, recover unique picture and some more.

In order to reduce the noise in the images Different varieties of filters are used. Linear filters such as Gaussian and averaging filters, these are used for this purpose. The average filters suppress the salt and pepper noise in the images. By utilizing the pixel's esteem is substituted with its neighborhood values. Median filter additionally decreases the noises like the salt and pepper. In this filter the pixel value is predicted by median of neighbouring pixels. So it was very accurate than others. Weighted average filter is a variety kind of filter that can be executed rapidly to give the great outcome.

2.2 Segmentation

The three variety types of the clustering algorithms are:

1. K - means algorithm,
2. Fuzzy C algorithm, and
3. Pillar K - means algorithm.

2.2.1 K-Means

This kind of technique is the one of the vital strategy to cluster the objects as per the characteristics of K number of classes here; K is taken as positive number. In order to obtain the clustering, reduce the Euclidean gap between the data points and the resultant cluster center/centroid.

The popular and widely used algorithm is to serrate the input data points in Euclidian region in K-means. It is the non-hierarchical method which follows simple method to classify the given input data through the definite no. of classes known as priori. The K-means was made using an iterative scheme where elements of data are interchanged between the clusters in order to satisfy the criteria of reducing the constant change among each cluster and increasing the variation between the clusters. When no elements are interchanged between the clusters, process is stopped. The 4 steps of k-means are described below:

1. Initially calculate the intensity of data set of points,
2. Initiate the centroids arbitrarily,
3. 1 and 2 steps are calculated again till the digital image cluster labels doesn't change any longer,
4. Calculate the cluster as per the distance of their intensities from the center intensities, and 
   \[ c(i) = \arg \min ||x(i) - j||^2 \]

5. Calculate the newly generated centroid for each cluster.
   \[ \mu_i = \frac{\sum_{i=1}^{m} 1[c(i) = j]x(i)}{\sum_{i=1}^{m} 1[c(i) = j]} \]

2.2.2 Fuzzy C-Means

In this method, the process of clustering occurs, includes the each input data point belonging to more than two numbers of clusters. This type of method is also known as constant clustering method it can produce the optimal c division by reducing the weight within the group sum function.

\[ Y_m = \sum_{i=1}^{N} \sum_{j=1}^{C} \mu_{ij} ||D_j - C_j||^2 \]

Where,
- \( D = \{d_1, d_2, \ldots, d_n\} \subseteq \mathbb{R}^p \) is the input data set of an image
- \( n \) = no. of data set points
- \( c \) = no. of classes
- \( q \) = weighted exponent

Steps in Fuzzy c algorithm: Let us consider \( D = \{d_1, d_2, \ldots, d_n\} \) is the image data points and \( C = \{c_1, c_2, \ldots, c_c\} \) is the image centers set.

1) Select arbitrarily the \( c \) cluster centers,
2) Calculate the fuzzy membership,
   \[ U_{ij} = \frac{1}{\sum_{k=1}^{c} \left( \frac{||D_i - c_j||}{||D_i - c_k||} \right)^q} \]
3) Calculate the centers \( 'c_j' \) using the below formula:
   \[ C_j = \frac{\sum_{i=1}^{N} \mu_{ij}^q \cdot D_i}{\sum_{i=1}^{N} \mu_{ij}^q} \]
4) Recap the steps 2 and 3 till the value of \( 'J' \) is maximized, or \( ||U^{[k+1]} - U^{[k]}|| < \beta \).

Here,
- \( k \) = iteration step.
- \( \beta \) = completion criterion ranging in \( [0, 1] \).
- \( U = (\mu_{ij})_{n \times c} \) is the fuzzy membership.
- \( 'J' \) = function.

2.2.3 Pillar Means

This is a technique of assigning the centroids initially where each of the centroid has the farthest Euclidian distance between the clusters\(^5\). The pillars in the algorithm should be placed as far as feasible from each other in a way to withstand the pressure distributed by the roof. Therefore, our approach in this paper gives the places of the centroids initially in the farthest Euclidean distance among the different clusters in the data points.

Figure 2 defines the location of 2, 3, and 4 pillars, in a way to take the pressure distributed by the several roof arrangement made of discrete points. The farthest is possible from each other in the distribution of the roof by spreading the pillars, in such a way pillars could be accept the roof’s weight and secure the structure. This involves that these pillars can be placed as farther as available from each other to take the whole of the roof’s pressure distribution. Therefore, the exact places of the centroids initially, in the farthest Euclidean distance among the different clusters in the spreading of the data.

2.3 Post-Processing Stage

The post-processing involves extraction of the image. Separating the cluster indicates the forecasted tumor at the segmentation stage output. This cluster is now given as input to threshold technique. In this process a binary mask is applied across the complete digital image. Then, area of the tumor calculated by using binarization technique in the roughly estimated step. This method involves the dark pixel becoming further dark and the whiter pixel becomes brighter\(^10\). We took the values from each coefficient of transform is compared with the threshold value given in the coding. If the value of pixel is below...
the threshold level, then it is 0, otherwise it will be taken as one.

The thresholding methodology is adaptation methodology wherever solely those coefficients whose magnitudes measure on top of a threshold measure preserved at intervals every block. Consider the digital image 'i' which has the k gray level, threshold t is an integer, that lies within the gray scale vary of k. The cutoff point could be a matched one where every point of image value in 'i' is compared to t. Supported on which, the result is made. The output binary image value represents the original worth of actual pixel value.

\[ e(n) = \begin{cases} 0 & \text{if } i(n) \geq t \\ 1 & \text{if } i(n) < t \end{cases} \]

3. Results

The clustering methods are employed in the detection and the segmenting results are shown in Figures 3-6.

4. Comparative Study

Computation time for all the clustering algorithms for different no. of clusters (k) is shown in the Table 1 and 2.

We observed that in the K-means and the Pillar means algorithms as the clusters increased the computational time decreased. But whereas Fuzzy C the run time increased as the clusters increased.

Figure 3. MR Image.

Figure 4. K – means.

Figure 5. Fuzzy C.

Efficiency of the algorithm is compared for all the clustering algorithms for different no. of clusters (k) is shown below in the Table 3 and 4. The efficiency is in terms of the variance among data points in the same clusters (\( V_w \)) and among the various clusters (\( V_b \)).

In clustering there should be less internal homogeneity (\( V_w \)) and more external homogeneity (\( V_b \)). We observed that in the Fuzzy C the internal homogeneity is less than that of K means and Pillar means. The external homogeneity in Pillar means is more than the Fuzzy
C and K means. Therefore Pillar means is more effective than Fuzzy c which is effective than k means.

5. Conclusion

Segmentation has an important aspect in medical images. In the medical diagnosis field, a large variety of image techniques are available currently, like CT and MRI scan. MRI is the more effective image model used for diagnostic image examination for the brain tumor. As compared with CT scan in all aspects, the MRI scan is easier for the identification tissues. K-means is faster than Fuzzy C, but the Fuzzy C locates the tumor cells very accurately. A novel approach that optimized the K-means method which is known as Pillar means algorithm to detect brain tumor more accurately and with a minimal run time was developed. We compared all the three clustering algorithms with each other in terms of the time and the accuracy or efficiency.

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7. References

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