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Implementation and Comparison of Different Segmentation Techniques for MRI and CT images

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Abstract: Medical image segmentation offers rich information in clinical applications for accurate diagnosis. Numerous algorithms in image segmentation techniques have been proposed in the field of computed tomography (CT), magnetic resonance imaging (MRI) for brain tumor detection. The Medical practitioner faces the problem in decision-making and choosing the best segmentation method which will apply to determine the region of interest related to tumor lesion. In this paper segmentation of medical images has been investigated using k-means, level set and region growing techniques in brain tumor images. This study provides an accuracy that compare the strength of each method in order to develop necessary computational algorithms that enhance the analysis of biomedical image in diagnosis and analysis purposes.

Image parameters such as mean square error, peak signal-to-noise ratio, normalized cross correlation, average difference, structural content and the accuracy was assessed to compare across each technique. The accuracy of the k-means, level set and region growing is 92.4%, 86.7% and 88.3% respectively.

Keywords: Segmentation, K-means clustering, Level set, Region growing, Histogram, Median filter, Morphological operation.

I. INTRODUCTION

The medical image segmentation process can be considered as one of the basic, yet very important, steps in digital image processing and computer vision applications. The extraction of objects from the background of a digital image has been a challenging task in the field of digital image processing. With the increasing demand for complex image analysis and interpretation, the demand for accurate segmentation of images has also grown stronger and as a result many image segmentation methods and algorithms have been developed over the past few decades. Segmentation involves partitioning an image into a set of homogeneous and meaningful regions so that the pixels in each partitioned region possess an identical set of properties or attributes. Segmentation algorithms are based on different parameters of an image like gray-level, color, texture, depth or motion. In medical images, segmentation is mainly done based on the gray-level value of pixels, because the majority of medical images are gray-scale representations. Image segmentation algorithms based on gray-level values of pixels of an image can be divided into two categories: those based on similarity and those on discontinuity. The former method involves segmenting an image based on the similarity of intensity between pixels within a region, while the latter uses sudden changes in gray-level to indicate the discontinuity of a region [1]. Region Seed Growing this method requires a seed point that is selected by the user and removes all pixels connected to the Preliminary seed. It is a used for extracting an image region that is connected based on some predefined criterion. These conditions of selected it is can be based on intensity information or boundaries in the image [2]. The manual selected dealings to obtain the seed point is the great disadvantage for this region growing. The region that needs to be extracted, a seed must be planted but split-and-merge is an algorithm related to region growing, but it does not require a seed point [3,4].

K-means is one of the simplest unsupervised learning algorithms. This algorithm easy to solve the well-known clustering problem. The procedure follows an easy way to classify a given data set through a different number of clusters k clusters) fixed a priori. [5]. Many of the PDEs used in image processing are based on moving curves and surfaces with curvature-based velocities. In this area, the

level set method was very influential and useful. The basic idea is to represent the curves or surfaces as the zero level set of a higher dimensional hyper-surface. This technique not only provides more accurate numerical implementations but also handle topological change very easily [6].

II. Related work

In 2016 "Ibtihal D and his team proposed**,** Tumor segmentation from MRI image is important part of medical images experts. This is particularly a challenging task because of the high assorting appearance of tumor tissue among different patients. MRI images are advance of medical imaging because it is give richer information about human soft tissue. There are different segmentation techniques to detect MRI brain tumor. In this paper different procedure segmentation methods are used to segment brain tumors and compare the result of segmentations by using correlation and structural similarity index (SSIM) to analyses and see the best technique that could be applied to MRI image [7].

III. METHODOLOGY

The implementation of the segmentation method, which are k-means, level set and region growing method was done and also the comparison between them. The implementation applied using MATLAB program. The following block diagram as shown in figure1 illustrate the proposed method for applying the segmentation methods on different medical images:

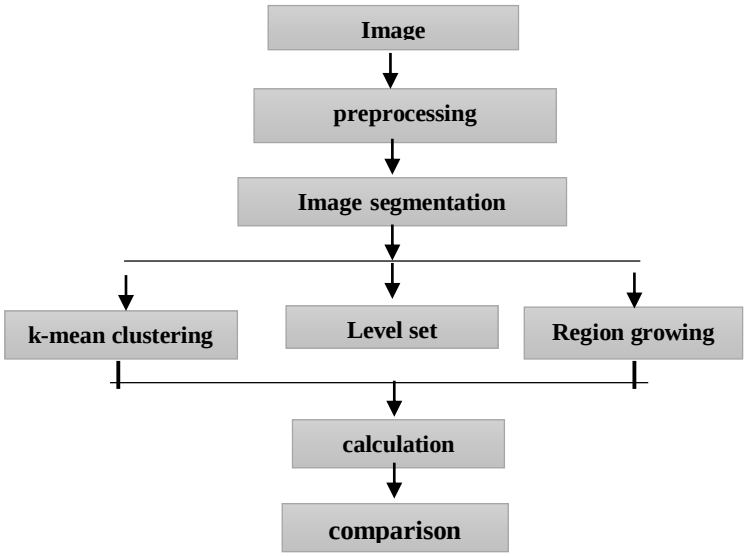

Figure 1 Proposed system block diagram

a. Image Loading

This is the first step of the process. In this step, the MATLAB system will load the images (which are MRI and CT brain tumor images) from the file selected by the user. The input images can be from "jpg" and "png", image formats and the images are loaded from TCIA website [8].

b. Image Preprocessing

The preprocessing steps start with Converted the image from RGB to gray, then the histogram of the image was Computed. After that the noise was removal from the image using median filter. The median filter applied with size of 3x3. Finally, the morphological operation applied to remove unwanted information and to enhance the contrast of the image. Morphological operation such as dilation and erosion applied.

C. Image Segmentation

Image segmentation is used to separate the foreground (tumor segment) from background (remaining image). Three image segmentation techniques was implemented on different types of images and the comparison between each one. These techniques were K-Mean clustering, level set and region growing image segmentation.

IV. Results

The proposed system for the implementation and comparison of different segmentation techniques on medical images has been done and gave the result shown below:

A. Image preprocessing

The input images from CT and MRI brain tumor was shown in figure 2 (a and b). First the CT and MRI brain tumor images is converted to gray images as shown in figure 2 (c and d). Second the histogram was computed for CT and MRI brain tumor images and this process shown in figure 3 and 4.

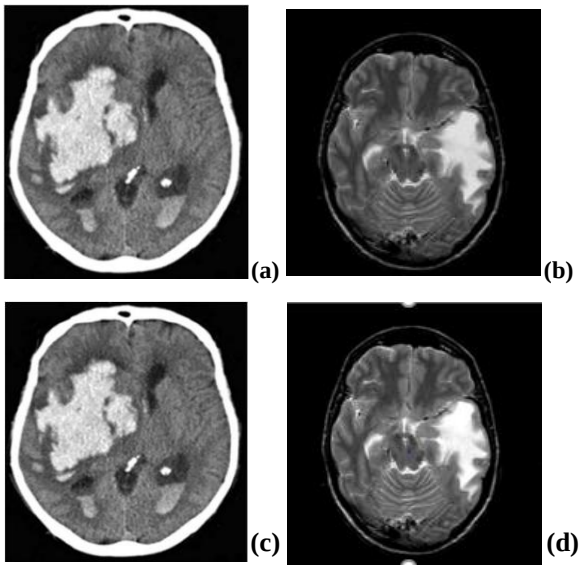

Figure 2: (a) CT brain tumor image and **(b)** MRI brain tumor image **(c)** CT brain image converted to gray image. **(d)** MRI brain image converted to gray image.

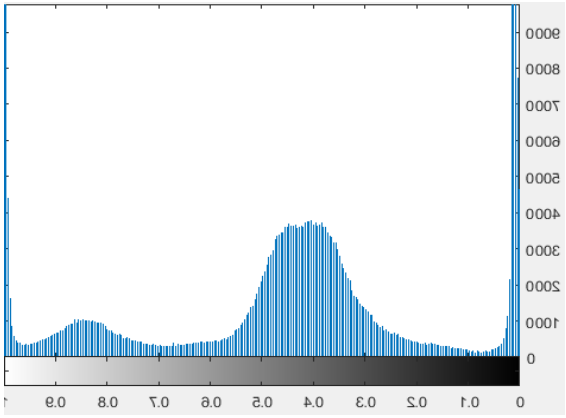

Figure 3: Histogram of CT brain image

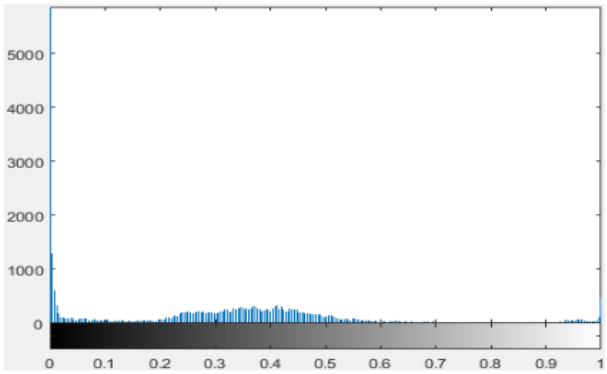

Figure 4: histogram for MRI brain image.

Median filter was applied on CT and MRI brain tumor images, as shown in figure 5 (a) and (b). Finally, the morphological operation was applied on median filtered image, as shown in figure 5(C) and (d).

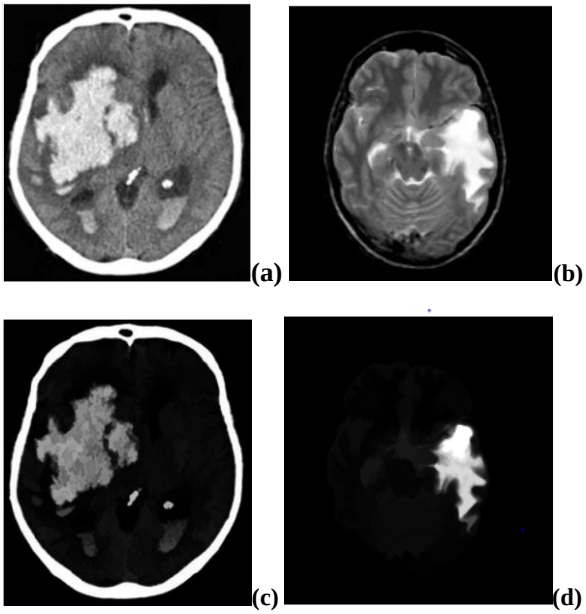

Figure 5 (a) Median filter applied on CT image, **(b)** median filter applied on MRI image. **(c)** Morphological erosion and dilation applied CT brain image and **(d)** morphological erosion and dilation applied on MRI brain image.

B. Image segmentation

The result after **applied the k-means** on CT and MRI brain tumor images with cluster k=3 shown in figure 6.

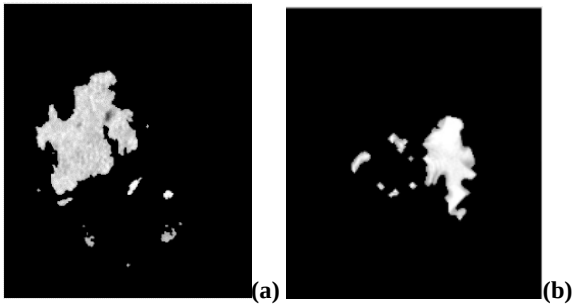

Figure 6 (a) The result from k-means clustering that applied on CT image and **(b)** the result from k-means clustering that applied on MRI image.

-The results **of level set** and **region seed** growing methods on CT and MRI brain images shown in figure 7.

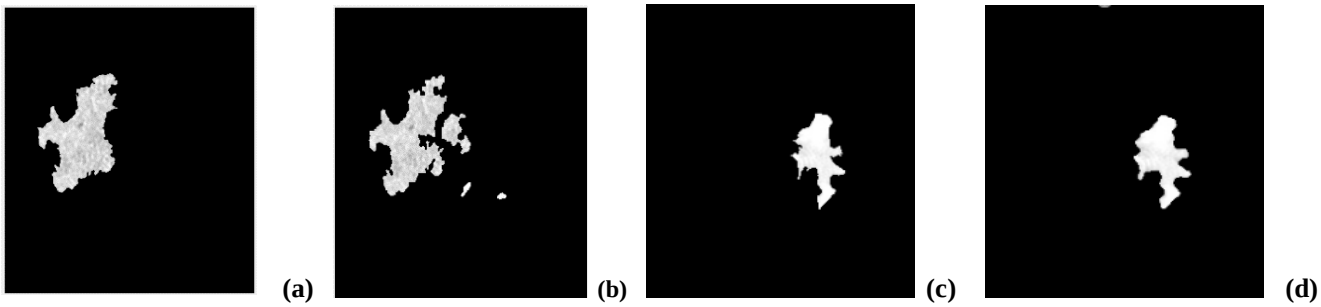

Figure 7 (a) The result from level set method applied on CT image and **(b)** The result from level set method applied on MRI image.**(c)** The result from region seed growing applied on CT image and **(d)** The result from region seed growing applied on MRI image

C. Parameter measurement

The evaluation of the images is an important concept were done using the Mean Square error, Peak Signal to noise ratio, Normalized Cross-Correlation, Average Difference, Structural Content and dice accuracy as shown in tables below:

parameters	k-means clustering	Level set method	Region seed growing
MSE	0.0893	0.1305	0.1258
PSNR	69.1166	65.8212	66.1377
N-cross-corr	0.9470	0.9805	1
AD	-0.0024	-0.0213	-0.0219
SC	0.9844	0.7742	0.7621
Dice accuracy	0.9071	0.8028	0.8195

Table 1 The results showed the comparison between segmentation methods that applied in CT brain tumor image

parameters	k-means clustering	Level set method	Region seed growing
MSE	0.0795	0.0791	0.0811
PSNR	70.1191	70.1716	69.952
N-cross-corr	0.8526	1	1
AD	0.0043	-0.0087	-0.0092
SC	1.1259	0.7965	0.7859
Dice accuracy	0.8499	0.8091	0.7982

Table 2 The results showed the comparison between segmentation methods that applied in MRI brain tumor image.

V. Discussion

The original CT and MRI brain tumor images shown are of 512x512 pixel size entered in preprocessing step, first the images were converted to gray images, then the histogram was computed for each one and showed that the image was low contrast, after that the median filter has been applied, so that the noise and film artifact were removed from the images, then the morphological operation were applied on images, so the surface of images was cleaned up and unwanted information were removed, after that the images were segmented using k-means clustering method**,** and the results showed that when the tumor is very close to bone, K-means segment the tumor region and a part of the bone as a single, then the images were segmented using the level set method, and it gives good result, finally the images were segmented using the region seed growing method and also the result was good.

The overall accuracy of the k-means, the level set and region seed growing segmentation method are 92.4%, 86.7% and 88.3% respectively.

VI. Conclusion

This study compares between k-means clustering, level set and region growing segmentation methods to identify the most suitable method for the segmentation of a brain tumor from magnetic resonance image and CT. The images were converted to gray images, then the histogram was computed for each one and showed that the image was low contrast, after that the median filter has been applied, so that the noise and film artifact

were removed from the images, then the morphological operation were applied on images, so the surface of images was cleaned up and unwanted information were removed, after that the images were segmented using three segmentation technique. The overall accuracy of the k-means level set and region seed growing is 92.4%, 86.7% and 89.3% respectively.

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