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A Comparative Analysis of K-Means and Fuzzy C-Means Clustering Algorithms Based on CT Liver Image

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***Abstract*—**Image processing techniques are broadly used in different areas of medical imaging to detect different types of abnormalities. The clustering algorithm is used in image processing for image segmentation. Image processing technique can help to detect the tumor and also it helps to identify the affected parts of the organs. This paper describes two clustering algorithm K-Means and Fuzzy C-Means clustering to compare their performance based on CT liver image. The segmentation result of K-Means is compared to the segmentation result of Fuzzy C-Means clustering. Experiments were conducted to evaluate their performance based on some criteria such as computational time, energy, homogeneity, PSNR etc.

Keywords*-CT images;; Image Segmentation; Clustering; K-Means; Fuzzy C-Means*

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I. INTRODUCTION

In the basis of recent statistics, liver tumor is one of the most dangerous diseases in all over the world. Liver tumor affects a large number of human beings and their prevalence is expected to increase in the near future. So far, proper detection and treatment of liver tumor in which that prevents a large number of patients. In medical science, if the doctors find out any abnormal behavior in human being, then they suggest for different kinds of diagnosis tests for confirmation of any disease.

For detection of human liver tumor Computed Tomography are mostly used. Generally, every doctor asks for CT scan for detection of the tumor in the liver. There are various medical imaging systems like as surface texture, object boundary extraction, tumor detection and many others that can be used to improve their diagnosis. In this case, it is important to select an effective image analysis. Thus far, many segmentation methods have been used in medical imaging but most of them do not perform well to detection of liver boundary from a CT image. The benefits of CT images are that it is good in image quality, it is good in desirable image illumination, and it has high contrast and high visibility. Image segmentation is mainly used due to the fact that there are several organs close to the liver that makes the segmentation more difficult. The doctor goes for manual technique and looks into the CT images manually and takes decision about the affected liver, the liver tumor position and how much affect the liver by tumor.

Many clustering algorithm have been developed for image segmentation in digital image processing. Most commonly used algorithm are K-Means clustering and Fuzzy C-Means clustering. After clustering, the segmented image are analyzed to detect the problem of liver. In medical image the detection process is more effective than the conventional process. However, there are still remaining a number of problems that must be overcome in order to develop fully reliable automated image processing systems. One of these problems is the need to guarantee that the image processing technique reduce the problem for detecting tumor in human liver. This is a real problem for detecting tumor from CT images, we need a computationally efficient algorithm to reduce the problem with very good performance as compared to the conventional method.

II. SYSTEM ALGORITHM

The system algorithm is as follows:

Step 1: Input CT image
Step 2: Convert original image into grayscale image
Step 3: Resize the image
Step 4: Segment image using clustering method (K-Means and Fuzzy C-Means)
Step 5: Segmented image classification into two parts: Normal and Abnormal part.
Step 6: Output the Comparison of clustering algorithm using image properties.

Fig. 1shows the flowchart of the system.

III. EXPERIMENTAL METHODS

A. Input Image

We use CT image as input. We have collected CT image from internet. The input image is shown in Fig. 2.

B. Grayscale image

We convert the original imageinto grayscale image. The grayscale image is a black and white image and each pixel has only one value which is the intensity of the pixel. The value may range from 0 to 255. Grayscale images are composed exclusively of shades of gray, varying from black at the

weakest intensity to white at the strongest intensity. Grayscale image is shown in Fig. 3.

C. Masked Image

Image masking is a technique to separate an image from its background to place the image over another background. Mask creation is often used to create the binary mask which contains the value 0 or 1. Masking process is performed by polygonal region of interest in MATLAB. To create masked image first create binary image then the binary image is multiply with the original image. The masked image is shown in Fig. 4.

D. Image Segmentation using K-Means Clustering

We take two different case of liver image for segmentation. We use K-Means clustering algorithm which is an unsupervised clustering of image. This algorithm helps us to classify the liver into two parts, such as normal parts and abnormal parts. The segmentation is shown in Fig. 5.

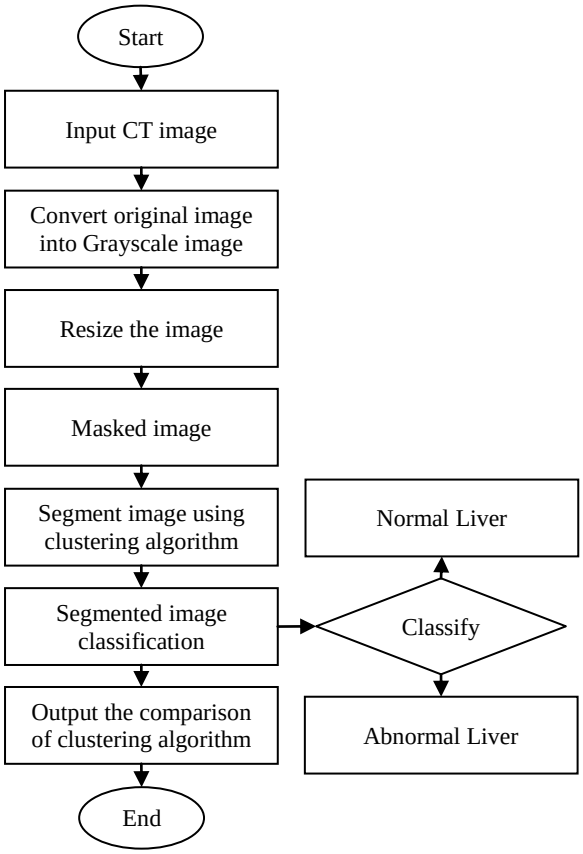


Figure 1. System flowchart for segmentation and classification

Figure 2. Input Image

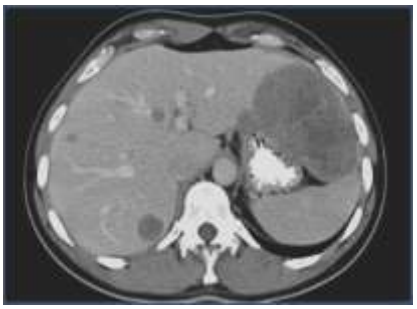
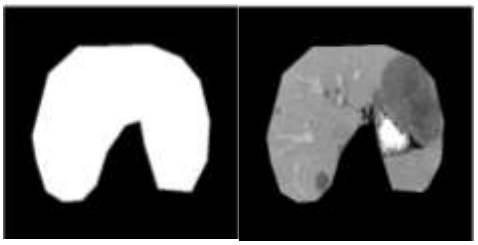


Figure 3. Grayscale Image



(a) Mask (b) Masked Image

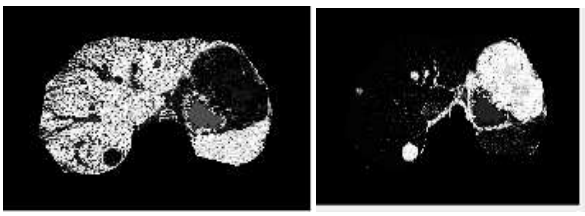
Figure 4. Mask and Masked Image

(a) Normal (b) Abnormal

Figure 5. Image Segmentation using K-Means Clustering

E. Image Segmentation using Fuzzy C-Means Clustering

We use another unsupervised clustering algorithm Fuzzy C-Means to cluster and classify the liver into two parts, such as normal parts and abnormal parts.The segmentation is shown in Fig.6.



(a) Normal (b) Abnormal

Figure 6. Image Segmentation using Fuzzy C-Means Clustering

IV. Result Comparison

We took CT image as input and apply clustering algorithm for image segmentation. The parameters for comparison are as follows:

A. *Image Contrast*

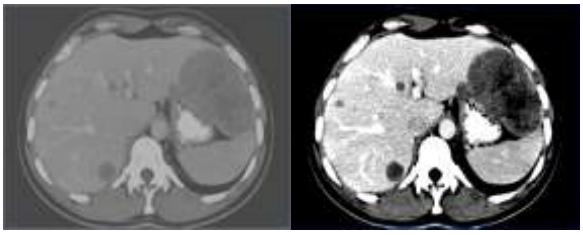
Contrast refers to the difference between maximum and minimum pixel intensity in an image. Returns a measure of intensity contrast between pixels.

Formula: $\sum_{i,j} |i-j|^2 \, p(i,j)$, where p is a $m \times n$ matrix and i, j is neighbor pixel. Fig. 7 represents the different contrasted images.

B. *Correlation*

Digital image correlation is an optical method that employs image registration techniques for accurate 2D and 3D measurements of changes in image. Image correlation is commonly used in such areas as automotive, aerospace, biological, industrial, research and education, and many others.

Formula: $\sum \frac{(i-\mu_i)(j-\mu_j)\,p(i,j)}{\sigma_i \sigma_j}$



(a) Deduced contrast image (b) Increased contrast image

Where range = [-1 1].

Figure 7. Images with different contrast

C. *Energy*

Energy is a relative term in digital image processing. Energy refers to some values that are trying to minimize or maximize or optimize. Energy is widely used in typical object detection or image segmentation tasks where it is posed as a energy minimizing problem.

Formula: $\sum_{i,j} p(i,j)^2$

Where range = [0 1].

D. *Peak signal-to-noise ratio (PSNR)*

Peak signal-to-noise ratio (PSNR) is an engineering term for the ratio between the maximum possible powers of a image and the power of corrupting noise that effects the fidelity of its representation.

Formula:

$$PSNR = 10\log_{10}\left(\frac{I^2{}_{\max}}{MSE}\right)$$ Where *MSE* is mean square error and I_{max} is maximum intensity value.

The result of clustering comparison is shown in Table I.

TABLE I. COMPARATIVE RESULT OF K-MEANS AND FUZZY C-MEANS CLUSTERING ALGORITHM

Comparison Properties	K-Means Clustering	Fuzzy C-Means Clustering
Time Complexity	Low	High
Image Contrast	0.0187	0.0297
Correlation	0.9768	0.9875
Energy	0.9550	0.9235
Homogeneity	0.9941	0.9971

V. CONCLUSION

We have analyzed many parameters to compare the clustering algorithm. From the summary result shown in Table I, we have seen that K-Means clustering is faster than Fuzzy C-Means clustering algorithm. On the other hand, the PSNR value is higher in Fuzzy C-Means than in K-Means. Other parameters'value such as image contrast, correlation are high in Fuzzy C-Means clustering but lowin K-Means clustering algorithm. Energy is low in Fuzzy C-Means but high in K-Means. So we saw that Fuzzy C-Means clustering algorithm is better than K-Means clustering algorithm by our comparative analysis.

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