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Segmentation of Liver CT Images

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Abstract – In this paper we propose a method for automated liver segmentation from CT images that is invariant in terms of size, shape and intensity values. The system consists of two stages. In the first stage of the computerized system, the CT liver image is acquired and pre-processing is done to remove the noise and to enhance the image. In the second stage, liver region is segmented from the liver CT image. Experimental results show that our propose technique segments the liver region with accuracy.
Keywords— Keywords: Liver CT, Automatic Segmentation, Pre-processing, enhancement.

I. INTRODUCTION

As a medical imaging technique, computed tomography(CT) is quite useful for doctors to analyze the pathological changes of the biological organs. In order to reduce deaths, the diseases must be detected accurately in the early stage. The main problem of liver segmentation from CT images is related to low contrast between liver and near by organs intensities. Liver sometimes presents in different dimensions and makes the detection and segmentation even more difficult.

II. PROPOSED ALGORITHM

After enhancing the liver CT image , the next step of our proposed technique is to segment the liver region from liver CT image. Segmentation is done to separate the image foreground from its background. Segmenting an image also saves the processing time for further operations which has to be applied to the image. We have used segmentation using a threshold in order to segment the liver CT image. Afterwards some morphological operations are applied on the image to obtain the final segmented liver region.

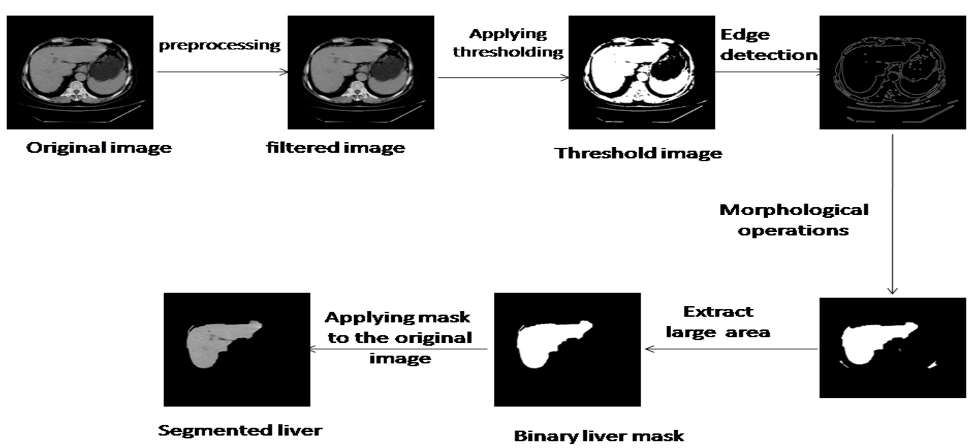

Figure 1: Flow diagram of Computerized System for Liver CT Segmentation

III. MATERIAL AND METHOD

The datasets were acquired from known scanning centre in MANSOURA city and these images are 512 by 512 pixel and these results are obtained using MATLAB R2014a

A. Read Medical Image

DICOM files contain metadata that provide information about the image data, such as the size, dimensions, bit depth, modality used to create the data, and equipment settings used to capture the image. To read metadata from a DICOM file, use the dicominfo function. dicominfo returns the information in a MATLAB structure where every field contains a specific piece of DICOM metadata. You can use the metadata structure returned by dicominfo to specify the DICOM file you want to read using dicomread [2].

B. Convert A Data Matrix To A Greyscale Image

A greyscale image (also called gray-scale, gray scale, or gray-level) is a data matrix whose values represent intensities within some range. MATLAB stores a greyscale image as an individual matrix, with each element of the matrix corresponding to one image pixel [2]. A grayscale imaging is sometimes called "black and white," but technically this is a misnomer. In true black and white, also known as halftone, the only possible shades are pure black and pure white. The illusion of gray shading in a halftone image is obtained by rendering the image as a grid of black dots on a white background (or vice versa), with the sizes of the individual dots determining the apparent lightness of the gray in their vicinity. The halftone technique is commonly used for printing photographs in newspapers [4].

C. Medical Image De-Noising

Medical images are subject to a wide variety of distortions, during acquisition, processing, compression, storage, transmission and re-production, any of which may result in a degradation of visual quality. Images such as magnetic resonance imaging, computed tomography, ultrasound, X-ray images are collected by different types of sensors and they are contaminated by different types of noises. Noises include speckle noise, Gaussian noise, salt and pepper noise etc.

Normally, low quality images are not effective and very difficult to measure. Therefore, there is a fundamental need of noise reduction form medical images. Generally speckle noise; Gaussian noise mostly occurred in the MRI, CT scan and ultrasound images. In medical image processing many methods are used for noise reduction. Each method can effectively working any one of the noise only not for all types of noises. Noise removal filters can produce the best results depends upon its parameter [5].

1) Median Filter: The median filter is a popular nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because under certain conditions, it preserves edges while removing noise [6].

D. Thresholding

Thresholding is an important technique in image segmentation applications. The basic idea of thresholding is to select an optimal gray-level threshold value for separating objects of interest in an image from the background based on their gray-level distribution. While humans can easily differentiable an object from complex background and image thresholding is a difficult task to separate them. The gray-level histogram of an image is usually considered as efficient tools for development of image thresholding algorithms. Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one [3]. Otsu method was proposed by Scholar Otsu in 1979. Otsu method is global thresholding selection method, which is widely used because it is simple and effective. Otsu algorithm can obtain satisfactory segmentation results when it is applied to the noisy image [3].

E. Edge Detection

The most powerful edge-detection method that edge provides is the Canny method. The Canny method differs from the other edge-detection methods in that it uses two different thresholds (to detect strong and weak edges), and includes the weak edges in the output only if they are connected to strong edges. This method is therefore less likely than the others to be fooled by noise, and more likely to detect true weak edges [1].

F. Morphological Operations

The morphological operators are based on set theoretic approach and are suitable for extracting shape information with the help of a structuring element, which may be viewed as a probe .Most elementary binary morphological operations are dilation, erosion, opening and closing.

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It can be expressed as:

$$\text{Erosion: } A \ominus B = \{a \mid B_a \subset A\}$$
$$\text{Dilation: } A \oplus B = \{a+b \mid a \in A, b \in B\} = \cup_{a \in A} B_a$$
$$\text{Opening: } A \circ B = (A \ominus B) \oplus B$$
$$\text{Closing: } A . B = (A \oplus B) \ominus B$$

Eqauations(1): morphological operations equations.

1) *Erosion*

is one of the two fundamental morphological operators and is a process used to shrink the area of an object in the image. When the structuring element B has a center (e.g., B is a disk or a square), and this center is located on the origin of E, then the erosion of A by B can be understood as the locus of points reached by the center of B when B moves inside A. For example, the erosion of a square of side 10, centered at the origin, by a disc of radius 2, also centered at the origin, is a square of side 6 centered at the origin.

2) *Dilation*

is the complementary process to erosion. It is used to expand the images. If B has a center on the origin, as before, then the dilation of A by B can be understood as the locus of the points covered by B when the center of B moves inside A. In the above example, the dilation of the square of side 10 by the disk of radius 2 is a square of side 14, with rounded corners, centered at the origin. The radius of the rounded corners is 2.

3) *Opening*

is the process that includes erosion followed by dilation of the resulting image after the erosion process.

4) *Closing*

is the process that involves dilation followed by erosion of the resulting image after the dilation effect.

5) *Filling*

Filling is used to fill the gaps, holes present in the binary image. Filling is defined by the following equation:

$$F(x,y)= \begin{cases} 1 - I(x,y) & \text{if } f(x,y) \text{ onthe border of } I \\ 0 & \text{otherwise} \end{cases}$$

Equation(2):filling operation

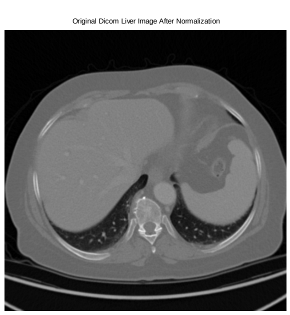
Where, I is a binary image F is a marker image.

G. Masking

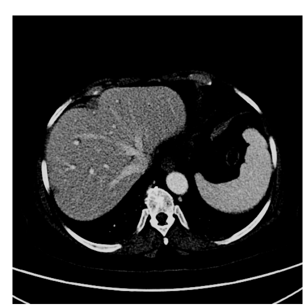
In computer graphics, the transparent areas can be specified through a binary mask, when an image is intended to be placed over a background. This technique has a wide application like is used in pointing device cursors, in typical 2-D video games, for GUI icons and other image mixing applications. In this method we use masking to region the segmented image consisting of only the liver [2].

H. Removing Small Objects: Removing small and unwanted area that are connected to the liver image

IV. SIMULATION AND RESULTS



(a) Original image



(b) Contrast stretched image

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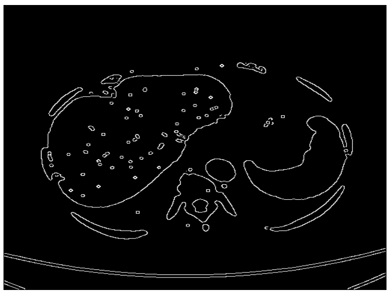
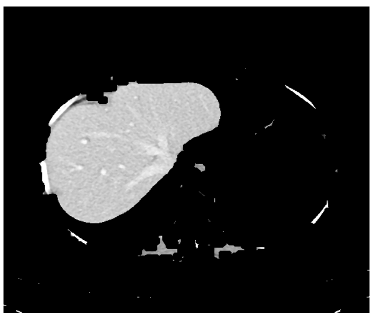
(c) Median filtered image

(d) Threshold image

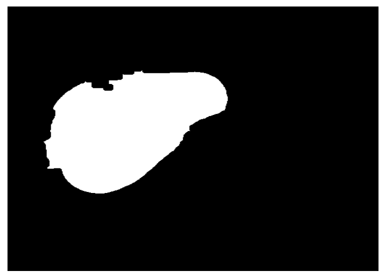


(e) Edge detection of the image

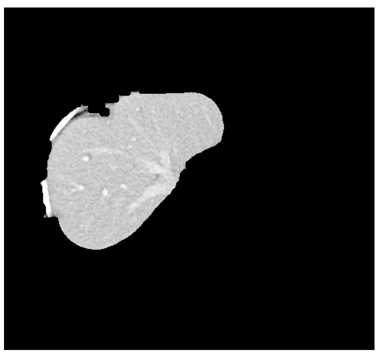
(f) Image after applying morphological operations



(g) Image after applying masking



(h) Image after removing small objects



i. Final segmented image

Figure2:the segmentation steps

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V. EXPERIMENTAL RESULTS

The tests of proposed technique are performed with respect to the liver region segmentation accuracy using 50 CT images of different patients. The images are of size 512x512 pixels. In order to check the accuracy of automated segmented liver region, liver region from all images is segmented manually by the hepatologist and oncologist.

parameter	value
Average Accuracy	92
Poorly Segmented	8%

VI. CONCLUSION

Segmentation of a liver from CT images is challenging due to the very low contrast between the liver and other organs. In this paper liver segmentation and enhancement is done using CT images.

The proposed method segments the liver using global threshold and then by identifying the largest area. Contrast of the liver region is improved . The proposed method is invariant in terms of size and shape of liver region. Experimental results show that our method performs well in enhancing, segmenting and extracting liver region from CT images.

VII. FUTURE WORK

In the future we will develop an algorithm for liver tumour extraction and liver tumour analysis and propose an algorithm for classification for the type of tumour

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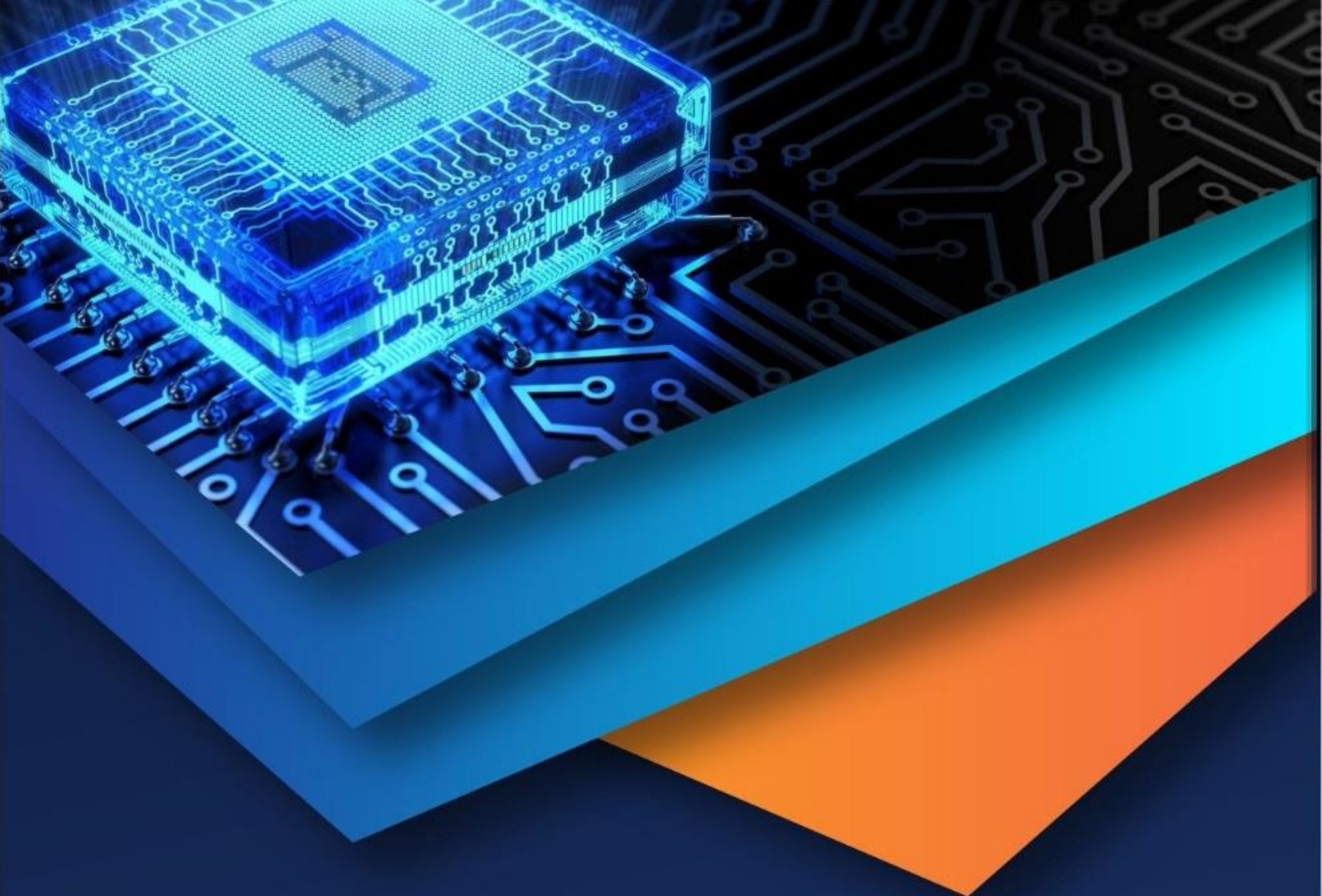

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