AUTOMATIC LIVER SEGMENTATION WITH FILTERING AND MORPHOLOGICAL METHODS

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Abstract

The main contribution of this paper is automatic liver segmentation which is the important step of liver benign or malignant classification. Morphological based automatic liver segmentation algorithm is proposed to get better classification results. Two popular image enhancing methods such as image filtering and morphological methods are used. It is required to remove texts in images by enhancing with image filtering method which extracts all connected liver components. In this research, automatic liver segmentation has been conducted to enhance liver image by image filtering and morphological operations such as image opening, dilation and filling holes. Liver region is segmented from the(512× 512) pixels abdominal CT liver images. This accuracy result is acceptable for liver segmentation.

Keywords: Computed Tomography (CT), Morphology, Segmentation.

Introduction

Imaging technology has seen a great development in spatial resolution and scan time, resulting in growing data volumes that the medical practitioner has to analyze. The internal structures hidden by the skin and bones can be sought in medical imaging. In medical images, liver detection and segmentation has been reported using Computed tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound (US) and Positron Emission Tomography (PET). By using these techniques reports are very reliable decisions for diagnosis. Computed Tomography(CT) is an invaluable tool for diagnosis and treatment planning in Medical imaging. This technique and process of creating visual representations of the interior of a body for clinical analysis of some organs or tissues (physiology). CT image modality can be widely used in liver diagnosis. Computed tomography (CT) is an imaging procedure that use of computer processed combinations of many x-rays measurements taken from different angles to produce cross-sectional (tomographic) images of specific areas of a scanned object, creating a series of detailed pictures, or scans, of areas inside the body without cutting. Image

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segmentation is a technique for extraction and delineation of regions of interests (ROI) in images, are particularly interesting. The main goal of segmentation is to represent an image to be more meaningful and easier to analyze. Segmentation can be used diagnosis and study of anatomical structures or localization of pathologies such as cancer tumors. In many clinical applications, segmentation of the whole liver region from abdominal computed tomography (CT) image is the essential first step in the computer-aided diagnosis and process of partitioning an image. Although image segmentation is a well-studied area of image analysis, numerous problems have still in its application to medical images. It can be provided a more accurate anatomical information about the visualized structures. In this paper, liver region is segmented from the abdominal CT liver.

Related Works

Liver segmentation methods are generally divided into two main classes, semi-automatic and fully automatic methods, under each of these two categories, several methods, approaches, related issues and problems will be defined and explained. Many automatic liver segmentation methods have been proposed. They are intensity based approaches: The most common procedure is to apply threshold operators to discard regions with intensity outside the liver range, or to apply multi-model threshold. But the thresholds affect the result directly and hard to determine. Prior knowledge based approaches: The topological, distance and orientation relations are the most common used priori knowledge, used to exclude neighboring organs beside liver. They are always combined with other approaches. Statistical based approaches: A statistical model discrimination of the liver is established from quantities of data sets. And it is used to pre-process the images and obtained liver likelihood images for further process. Nevertheless, the model generation is time consuming and could not respond sensitively among different patients. In this study, the step of the algorithm adaptive morphological operations are performed including largest connected component selection, hole filling and morphological opening. Finally, morphological dilation is used to refine the segmentation results.

Materials and Methods

Image Acquisition

All CT liver images are collected from No (2) Military Hospital (500 Bedded), and Bahosi Hospital, Yangon (Myanmar). These are stored in database of images in JPEG formats and displayed as a gray scale images.

Image Enhancing

A gray scale image is a data matrix whose values represent intensities within some range. MATLAB stores a gray scale image as an individual matrix, with each element of the matrix corresponding to one image pixel. The basic segmentation, binarization is the process of converting a gray scale image to a binary image. Normally, low quality images are not effective and very difficult to measure. Therefore, there is a fundamental need of noise reduction from medical 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.

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 and opening. Dilation and erosion are often used in combination for specific image preprocessing applications, such as filling holes or removing small objects. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The methods of mathematical morphology make possible a large number of very powerful image analysis techniques and therefore morphological operators can be used to develop other image processing techniques. After image binarilization morphological operations were performed to remove the unwanted regions.

Opening

Opening is the process that includes erosion followed by dilation of the resulting image after the erosion process. Opening is defined by the following equation

$$A \circ B = (A \Theta B) \oplus B \text{ -} \quad (1)$$

Opening operators are generally used as filters that remove dots characteristic of pepper noise and to smooth the surface of shapes in images. These operators are generally applied in succession and the number of times they are depends on the structural element size and image structure.

Filling

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

$$f(x,y) = \begin{cases} 1 - I(x,y) \quad if \quad f(x,y) \quad on \quad the \quad border \quad of \quad i \\ 0 \quad otherwise \end{cases} \quad (2)$$

This equation is filling operation where I =binary image, f = marker image

Erosion (Reduction)

Erosion is one of the fundamental morphological operators and is a process used to shrink the area of an object in the image. An erosion of A(image) by B(structuring element)is defined by

$$A \Theta B = \{a \mid B_a \subset A\} \quad (3)$$

Dilation (Increase)

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.

$$A \oplus B = \{a + b \mid a \in A, b \in B\} \quad (4)$$

Image Segmentation Procedure

This section presents two main parts: image enhancing and liver segmentation as shown in Figure1. Firstly, input CT scanned image is acquired by CT scanner and then this original CT image is converted to grayscale. The binarization process is the conversion from the grayscale image to binary image with level 0.4256 which level value is getting better binary images for all test data. The purpose of first part is to remove patient record text from the binary image by binary image filtering method which is to enhance liver portion. The binary image filtering method is used as a kind of cleanup or preprocessing operation to remove small "noise-like" patient record text according to the size of object having smaller objects. The next step of image enhancing is morphological opening process which eliminates some of the foreground bright pixels from the edges of regions of foreground pixels. Since opening process is an erosion followed by a dilation using the same structuring element (SE) for both operations, 5X5 SE whose all elements have one is used in this research. This process is separated the liver and other organs such as stomach, spleen, pancreas, etc. that support to obtain better result in the automatic segmentation process. The second part is the liver segmentation which includes image filtering, hole filling, morphological dilation and image masking. The image filtering process two times in both image enhancing and liver segmentation. The next step is hole filling process detects the boundary of a cell and want to obtain an object which is filled and covers the cell. And then the hole filled image is dilated with same SE of opening process. Actually, this dilated binary image is liver segmented image that is needed to convert grayscale image. Thus, the segmented binary image is processed by image masking which separates the binary liver image from its background, either to cause the liver grayscale image to stand out on its own or to place the grayscale image over another background. The main contributions of automatic liver segmentation has image enhancing with filtering methods and morphological operations such as opening, dilation with same SE whose all elements have value one 5X5 matrix.

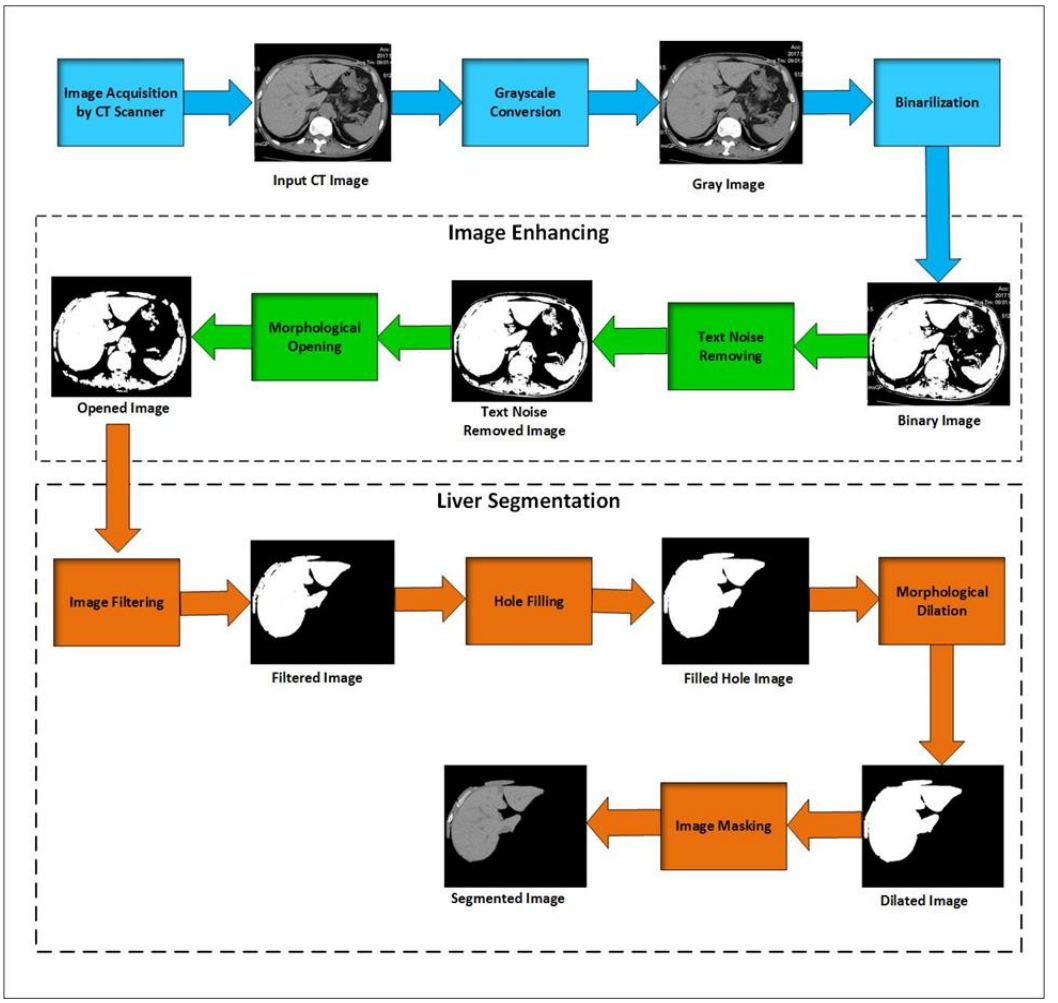

Figure 1: System design for Liver Segmentation

Results and Discussion

The tests of proposed technique are performed with respect to the liver region segmentation accuracy using 51Liver CT images of 30 different patients from the No (2) Military Hospital (500 Bedded), and Bahosi Hospital, Yangon (Myanmar). The images are of size 512×512 pixels. This paper describes the segmentation methods of CT liver images by using MATLAB R2018b. In order to check the accuracy of automated segmented from all liver

region images is segmented manually by the radiologist and oncologist. Automatic liver segmentation is difficult because of the wide range of human variations in the shapes of the liver. The intensities of liver and near organs are same. So, the main problem of liver segmentation from CT images is related to low contrast between liver and nearby organs intensities.

Conclusion and Future Work

Medical image segmentation is difficult and challenging problem due to poor, contrast, complex nature of medical images and image segmentation methods. However, fully automatic methods are challenging tasks for several stages of development in a liver medical diagnosis. As good liver surface segmentation is the first important step to liver treatment planning. The results of this work are acceptable. In the future we will develop an algorithm for liver tumor extraction and liver tumor analysis and propose an algorithm for classification for the type of tumor.

Acknowledgement

I would like to express my gratitude to my Supervisor Professor Dr Khin Khin Win, Head of Department of Physics, University of Yangon for her kind permission to carry out this work, then for her supervision, helpful advice and valuable suggestion.

I wish to show my sincere thanks to my Co-supervisor Professor Dr Aye Aye Thant, Department of Physics, University of Yangon, for her discussion and suggestion in this work.

I would like to thank all the people who encourage and support me during the undertaking of this work.

References

M.A.A lagdar, M. E. Morsy and M. M. Elzalabany (2015), "Segmentation of Liver CT Images", Monsoura University, Egypt

N. H. Abdel-massieh, M. M. Hadhoud, K. A. Moustafa (2010), " A Fully Automatic and Efficient Technique for Liver Segmentation from Abdominal CT Images", Menoufia University.

R. C. Gonzalez and R. E. Woods, (2002), "Digital Image Processing",2nd Edi, Upper Saddle River, NJ: Prentice-Hall

S. Senthilraja, Dr. P. Suresh, Dr. M. Suganthi (March-2014),"Noise Reduction in Computed Tomography", International Journal of Scientific & Engineering Research, Vol-5, Issue 3.

V. Thomasson, (2011), "Liver Tumor Segmentation Using Level Sets and Region Growing", Sweden.