Liver segmentation by region properties

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ABSTRACT

These days the most challenging and emerging field in engineering is image processing. In this field, the segmentation of liver using computed tomography (CT) scan has extended a lot of significance. In this paper, we have implemented a simple CAD system for segmentation of liver using CT image. It is observed that by this algorithm the segmentation of liver works well with a normal proportion of liver images but not with those of fatty liver images as this category of abnormal liver reached the rib portion and segmentation becomes difficult.

Keywords – **CAD system, computed tomography, fatty liver, tumoured liver, segmentation.**

I. INTRODUCTION

The biggest organ in the human body is the liver whichweighs approximately 1500 g and is located in the upper right corner of the abdomen. The liver is closely associated with the small intestine. The liver carries out over 500 metabolic functions, resulting in the production of products that are released into the blood stream or that are excreted to the intestinal tract (bile). The portal vein delivers venous blood under low-pressure conditions to the liver. The hepatic artery delivers high-pressure arterial blood [1]. Segmentation of the liver plays a vital role in the study of liver function and can contribute to the diagnosis of liver ailments such as steatosis, fibrosis, etc. Liver segmentation is an important criterion for the planning of surgical involvements like liver tumour resections. For clinical applicability, the segmentation approach must be able to handle with the high variation in shape and gray-value appearance of the liver. Today, the medical image segmentation draws more attention and interest. It provides, automatically, to restrict the internal structures of the patient, these structures can be structural (organs) but also pathological (lesions). Segmentation of lesions in a large image databank has a clear interest: it allows the radiologist to help in diagnosis and also to speed up the process of analysis. When the liver is affected by a tumoural pathology, it is possible to operate it by cutting the vile part. But this cut has to respect rules of volumetric and very specific vascularization. The medical imaging is then used to identify and visualize the internal structures. These structures do not appear in a single image but requires several procurements which will, therefore, be compared. The objective of the current research works is to achieve the segmentation to obtain the volume of the liver and its internal structures [2].

Recently, liver segmentation in CT images has made a vast significance in the field of medical image processing. It is the first and the essential step for finding liver diseases, liver volume measurements and 3D liver volume rendering. To extract the liver anatomical information, a great quantity of collected data demands a manual method and visual inspection, which are a mental work and a huge time-consuming procedure. Machine learning practices and image processing theories provide a lot of methods of liver segmentation. However, the liver segmentation in CT images is a difficult task due to the low level of contrast and blurry edges which characterize the CT images. These characteristics are caused by the partial volume effects due to the patient movement, spatial averaging, reconstruction artifacts and beam hardening. Furthermore, neighbour organs like spleen, liver and stomach might share similar gray levels .Meanwhile; the same organ may not show the same gray intensities in the similar subject, all of these facts and in addition to the difficulty and extensive variability of liver shapes increase the complexity of the liver segmentation task.

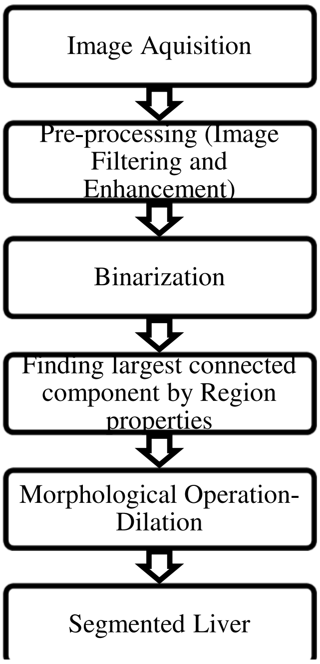
Liu et al. identified the liver peak in the histogram of the whole volume and determined two threshold values at each side of the peak. A liver binary volume is created by using the threshold values, after that, attached neighbour organs are deleted by a set morphological operations. Pilet al. proposed a method for extracting liver in CT images and employed it in computer aided liver diagnosis system. The liver distribution is measured and used to select the region of interesting (ROI) by using an existential probability of liver's value in a window. Fully automatic liver segmentation method has been developed by Campadelli et al. described a method of low computational cost gray-level based technique where no data samples are needed.OussemaZayane et al. [3] developed an automated

CAD system for liver segmentation based on shape and location of the liver.Tarek M. Hassan et al. [4] proposed a system to classify the framework for the diagnosis of liver disorders using multi-support vector machine (multi-SVM). Gehad Ismail Sayed et al. [5] presented a paper on several measurements that evaluate different segmentation methods. Chunhua Dong et al. [6] Comparing our method with conservative RW and the state-of-the-art interactive segmentation methods, our results show an improvement in the accuracy of liver segmentation. NegarFarzaneh et al. [7] proposed a hierarchical method based on probabilistic models of position and intensity of voxels for segmentation of liver that achieves the Dice similarity coefficient of higher than 89%. TuğbaPalabaş et al. [8] determined an automate system to remove the ribs and soft tissue from an image. M.Jayanthi et al. [9] proposed method discusses the comparative study of different methods and how those algorithms are used to detect the liver.

II. METHODOLOGY

In the proposed method, a set of normal CT liver, tumoured CT liver and fatty CT liver images is taken for experimentation. The acquired CT image is pre-processed, which consists of-

1) Image filtering by Median filter.
2) Image enhancement by Adaptive Histogram Equalization.



Fig(i). Flow Diagram

After pre-processing, the enhanced image is converted to binary. From the obtained binary image, large connected component is identified using region properties. Inorder to smooth the liver boundaries and to retain the original liver shape, the morphological operation is performed on the identified component. By using for loop, segmented part is restored with original gray-level information. The segmented liver is obtained.

Step1- Image filtering by Median filter

In signal processing, it is often appropriate to be able to accomplish some kind of noise reduction on an image or signal. The median filter is a kind of non-linear digital filtering method, often used to remove noise. Such noise reduction is a usual Pre-processing step to mend the results of processing (For example, edge detection on an image). Median filtering is generally used in digital image processing because, under certain conditions, it preserves edges while removing noise.

Step 2- Adaptive Histogram Equalisation

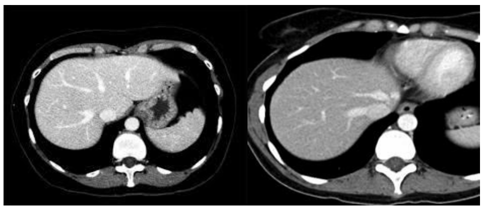
The contrast of the grayscale image is enhanced by transforming the values using Contrast Limited Adaptive Histogram Equalization (CLAHE). This works on minor regions in the image, called tiles, rather than complete image. Each tile's contrast is improved and the adjacent tiles are then combined using bilinear interpolation to eliminate artificially induced boundaries. The contrast, especially in uniform areas, can be restricted to avoid intensifying any noise that might be present in the image.

Step 3- Morphological Operations

Dilation and erosion are the most common morphological operations. Dilation means adding new pixels to the borders of an object in an image. Erosion means eliminating pixels from the borders of an object in an image.The number of pixels added or detached from the object in an image depends on the size and the shape of the structural elements used to process the image.

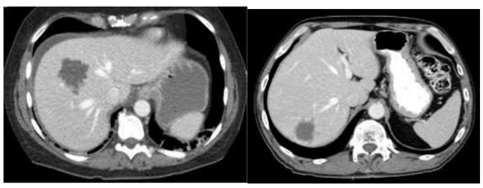
III. RESULTS

The following figures show the images as an output obtained using MATLAB software that is a grayscale image, filtered image, enhanced image, binary image and finally, segmentedliver from CT image. As Liver in CT image have more connected components than that of otherorgans surrounded. So it becomes very easy tosegment it from a CT image.



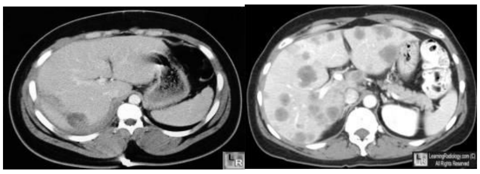
(a)Normal liver 1 (b) Normal liver 2

Fig(ii). Set of Normal CT Liver Images



(a)Tumour liver 1(b) Tumour liver 2

Fig(iii). Set of Tumour CT Liver Images

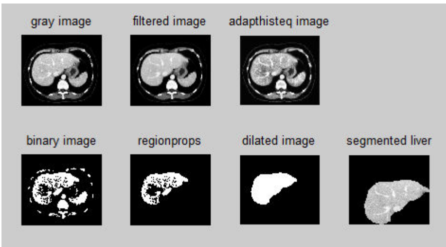


(a)Fatty liver 1(b) Fatty liver 2

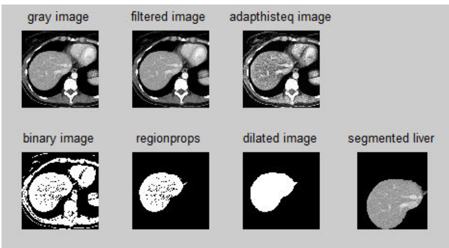
Fig(iv). Set of Fatty CT Liver Images

Table1: Results of segmentation for different types of liver

Sl.No	Type of Liver	Remarks
1	Normal liver 1	Segmented
	Normal liver 2	Segmented
2	Tumour liver 1	Segmented
	Tumour liver 2	Segmented
3	Fatty liver 1	Not Segmented
	Fatty liver 2	Not Segmented

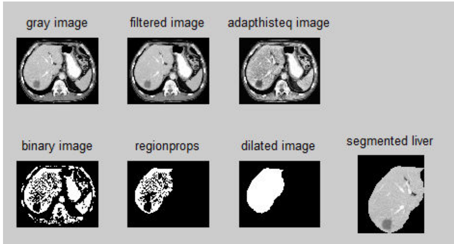


Fig(v). Stages of Liver Segmentation for Normal liver 1

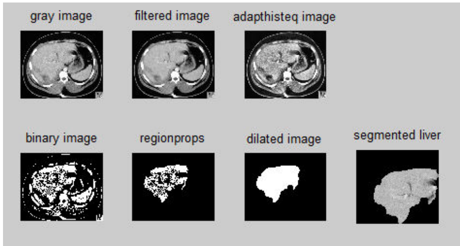


Fig(vi). Stages of Liver Segmentation for Normal liver 2

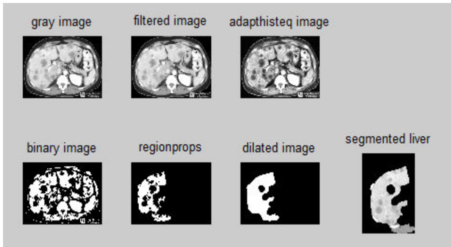
Fig(vii). Stages of Liver Segmentation for Tumour liver 1



Fig(viii). Stages of Liver Segmentation for Tumour liver 2



Fig(ix). Stages of Liver Segmentation for Fatty liver 1



Fig(x). Stages of Liver Segmentation for Fatty liver 2

IV. DISCUSSION

A set of six CT liver images are taken among which two of each category are normal liver, tumoured liver and fatty CT liver are considered for this experimentation. In order to classify the liver images are segmented using region propertieswhich worked easilyfor a set of both normal and tumoured liver images; whereas for set of fatty liver this method resulted in a incomplete segmentation as the fatty liver touches the ribs of the subject and hence complete segmentation of fatty liver could not be achieved.

V. CONCLUSION

The proposed method works well for normal liver, but not with the fatty liver as its size varies with severity. Severe fatty livers touch the ribs of the subject and hence complete segmentation of that abnormality cannot beeasily achieved. Further to overcome the drawback of this algorithm an adaptive segmentation algorithm can be implemented to improve the segmentation results for fatty liver.

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REFERENCES

[1] G. Pennazza; M. Santonico; C. Vernile; R. AntonelliIncalzi; A. De Vincentis; A. Picardi*AISEM Annual Conference, 2015 XVIII**Year: 2015 Pages: 1 - 3*, DOI: 10.1109/AISEM.2015.7066849

[2] Ahmed M. Mharib, Abdul RahmanRamli,SyamsiahMashohor andRoziBintiMahmood, "Survey on liver CT image segmentation methods" *Published online: 26 April 2011 © Springer Science + Business Media B.V. 2011.*

[3] Oussema Zayane1, Besma Jouini1 andMohamed Ali Mahjoub21, "Automatic liver segmentation method in CT images" *published in Canadian Journal on Image Processing & Computer Vision Vol. 2, No. 8, December 2011.*

[4] Tarek M. Hassan; Mohammed Elmogy; ElsayedSallam: *Computer Engineering & Systems (ICCES), 2015 Tenth International Conference on**Year: 2015 Pages: 395 - 401*, DOI: 10.1109/ICCES.2015.7393083

[5] Gehad Ismail Sayed; Mona Abdelbaset Ali; TarekGaber; Aboul Ella Hassanien;VaclavSnasel*2015 11th International Computer Engineering Conference (ICENCO)Year: 2015Pages: 144 - 149,* DOI: 10.1109/ICENCO.2015.7416339

[6] Chunhua Dong; Yen-Wei Chen; Tomoko Tateyama; Xian-hua Han; LanfenLin;Hongjie Hu; ChongwuJin; Huajun Yu*Fuzzy Systems and Knowledge Discovery (FSKD), 2015 12th International Conference onYear: 2015Pages: 1731 - 1736,* DOI: 10.1109/FSKD.2015.7382208

[7] NegarFarzaneh; ShadrokhSamavi; S. M. Reza Soroushmehr; HirenkumarPatel;SamuelHabbo-Gavin; David Paul Fessell; Kevin R. Ward; *KayvanNajarian2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)Year: 2016Pages: 6453 - 6456,* DOI: 10.1109/EMBC.2016.7592206

[8] TuğbaPalabaş; Onur Osman; TuncerErgin; UygarTeomete; ÖzgürDandin;Niza mettinAydın*2016 Electric Electronics, Computer Science, Biomedical Engineerings' Meeting (EBBT)Year: 2016 Pages: 1 - 4,* DOI: 10.1109/EBBT.2016.7483685

[9] M. Jayanthi*2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)Year: 2016Pages: 1462 - 1465,* DOI: 10.1109/WiSPNET.2016.7566379