Volume 5, Issue 10, October-2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Hybrid Technique for Detection and Segmentation of Tumor in Liver Ultrasound Images

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Abstract- Image enhancement is to process an image so that result is more suitable than original image for specific image. and segmentation method The simulation tests have been carried out using images with different organs, noise levels, and transducer frequency. Discrete wavelet transform use the technique of debauchees wavelet has been applied to remove speckle noise in the image, After that Contrast-limited adaptive histogram equalization has been applied for contrast adjustment. Then circular Hough transform has been used to get the circular blob in the infected tumor region. In the end Chan-Vese contour segmentation has been applied using circular blob location to segment out infected region in the image. This paper presents a review on various ways of Image enhancement and segmentation along with a proposed techniques such as wavelet transform , CLAHE ,contour segmentation.

Keywords— Enhancement, Wavelet transform, CLAHE, 2-D Gaussian Filter, Contour Segmentation, Circular Hough Transform.

I. INTRODUCTION

In this era of technology, every medical discipline attached himself to ultrasound or other medical instruments and benefits itself from this relatively inexpensive method that provides a view of the inner organs of the human body without exposing the patient to any radiations [1].Due to the presence of noisy dots in them, the enhancement of ultrasound images is extremely difficult, especially in case of liver or kidney images whose essential structures are too small to be resolved by large wavelength ultrasound. This type of noise significantly increases the difficulty in discriminating fine details in images during diagnostic analyses. This also complicates further image processing, such as image segmentation and edge detection [2].

1.1 Digital Image Processing

Digital Image Processing (DIP) involves the modification of digital data for improving the image qualities with the support of computer. The processing helps in maximizing clarity, sharpness and details of features of interest towards information extraction and further analysis. This form of remote sensing actually began in 1960s with a limited number of researchers analyzing airborne multispectral scanner data and digitized aerial photographs. However, it was not until the launch of Landsat-1, in 1972, that digital image data became widely available for land remote sensing applications.

1.2 Biomedical Image Processing

Medical imaging is the technique and process used to create images of the human body for clinical purposes or medical science. In the last few years, huge parts of research have been carried out on the biomedical image Processing and analysis such as ultrasonography, computed tomography (CT), magnetic resonance image (MRI), and nuclear medicine which can be used to assist doctors in diagnosis, treatment, and research. It is estimated that liver diseases are among the top ten killer diseases in India, causing lakhs of deaths every year. Since liver cancer is the sixth most common malignant tumor in the world and the third most common cause of cancer-related deaths worldwide. Hence, it is very important to produce a common standard tool, which is able to perform diagnosis with same ground criteria uniformly everywhere. Enhancement techniques which are commonly used for image analysis and interpretation includes the Spatial filtering , Shock filtering , Contrast Limited Adaptive Histogram Equalization (CLAHE) , Contrast Stretching, Histogram Equalization , frequency domain filtering, histogram processing, morphological filtering, and wavelet-based filtering.

1.3 Wavelet transform

An image is a two-dimensional function f(x,y), where x and y are the spatial (plane) coordinates, and the amplitude of at any pair of coordinates (x,y) is called the intensity or gray level of the image at that point [3].Images are often corrupted with noise during image acquisition and transmission. For example during the image acquisition, the performance of imaging sensors is affected by a variety of factors, such as environmental conditions and by the quality of the sensing elements themselves. The noise degrades the quality of an image and loss the useful information details. The noisy image is visually unpleasant and it is difficult to perform various further analyses like segmentation, recognition and compression. Therefore, it is very important to reconstruct an original image from the corrupted observations.

1.3.1 Applications of wavelets:

Wavelet analysis is an exciting new method for solving difficult problems in mathematics, physics, and engineering, with modern applications as diverse as wave propagation, data compression, signal processing, image processing, pattern recognition, computer graphics, the detection of aircraft and submarines and other medical image technology.

1. Image Denoising
2. Speech Recognition
3. Fingerprint Verification

1.4 Discrete wavelet transforms (DWT)

The Discrete Wavelet Transform (DWT) is used in a variety of signal processing applications, such as video compression [5], Internet communications compression [6], object recognition [7], and numerical analysis. It can efficiently represent some signals, especially ones that have localized changes. The wavelet transform with the four-coefficient called Daubechies wavelet [4] will be discussed in the thesis report. The Daubechies wavelets are a generalization of the Haar transform, and sometimes the Haar transform is referred to as a 2-coefficient Daubechies wavelet.

II. LITERATURE SURVEY

This section involve literature survey of various enhancement and Segmentation Techniques used for liver cancer and ultrasound imaging which is the most effective tool for diagnostics & treatment planning. It is used for imaging soft tissues in organs like liver, kidney, spleen, uterus, heart, brain etc.

Zhong et al. [8] describes wavelet thresholding for image denoising under the framework provided by Statistical Learning Theory aka Vapnik-Chervonenkis (VC) theory. Under the framework of VC-theory, wavelet thresholding amounts to ordering of wavelet coefficients according to their relevance to accurate function estimation, followed by discarding insignificant coefficients. Existing wavelet thresholding methods specify an ordering based on the coefficient magnitude, and use threshold(s) derived under gaussian noise assumption and asymptotic settings. In contrast, the proposed approach uses orderings better reflecting statistical properties of natural images, and VC-based thresholding developed for finite sample settings under very general noise assumptions. A tree structure is proposed to order the wavelet coefficients based on its magnitude, scale and spatial location. The choice of a threshold is based on the general VC method for model complexity control. Empirical results show that the proposed method outperforms Donoho's level dependent thresholding techniques and the advantages become more significant under finite sample and non-gaussian noise settings.

Yisong et al.[9] presented a novel adaptive denoising method based on wavelet tluesholding method. At first, it presented a new thresholding function that has a continuous derivative while the derivative of standard thresholding function is not continuous. The new thresholding function makes it possible to constrnct an adaptive algorithm based on wavelet thresholding method. Second. by using the new thresholding function. they presented an adaptive method based on SURE Risk. At last, several examples' nuinerical analyses are given; the results show that the proposed method is very effective in finding the optimal solution in mean square error (MSE) sense. It also indicates that their method gives better MSE ,performance than other wavelet thresholding methods.

Yoon et al.[10] proposed a new thresholding scheme that can considerably improve the performance of the well-known waveletbased denoising algorithms. The custom thresholding function can be adapted to the characteristics of the given signal, resulting in a smaller estimation error. It was shown that the custom thresholding proposed in this paper outperforms the traditional soft and hard-thresholding schemes

Yi et al. [14] discussed the Shannon entropy and local entropy. Give the algorithm for the local entropy computing and mathematical morphology method. Proposed a new local entropy based image segmentation for liver CT image. They use several figures to show how it works. This segmentation method not only can do liver CT image segmentation, but also can get the cancer image from the liver CT image. Results show that local entropy is an effective method on CT image segmentation, and can help the diagnosis of liver cancer. This is a very significant work worthy of further study.

Manavalan et al. [15] proposed a novel segmentation procedure for the TRUS medical image of prostate. The ultrasound images are very difficult to segment because of poor image contrast, speckle noise, and missing or diffuse boundaries in the transrectal ultrasound (TRUS). So the significant application is the segmentation of the prostate in transrectal ultrasound image. Generally there is no common approach for prostate image segmentation. The extraction of the prostate region from the original TRUS medical image is still a challenging research. Their work consists of four main stages. In the first stage, aM3-Filter is used to generate a despeckled image, since the speckle noise is commonly found in the ultrasound medical images. And the despeckled image is enhanced by top-hot filter. In the second stage, this enhanced image is used to compute thresholded image by local adaptive threshold method and Morphological operators are applied to extract an area containing the prostate (or large portions of it). In the third stage, The DBSCAN algorithm is applied to identify the core pixels, border pixels and noise pixels. The Clusters are formed by considering the density relations of the points. The clusters of core pixels and border pixels are used to automatically characterize the prostate region. The performance of the proposed algorithm is compared with manual segmentation using statistical parameters such as Rand Index (RI), Global Consistency Error (GCE), Variations of Information (VOI) and Boundary Displacement Error (BDE).

Devi et al. [12] proposed a spatially adaptive and multi scale products wavelet thresholding image de noising framework, which integrating both bilateral filtering and wavelet thresholding using multi scale products. The major factor in the performance of the proposed method is the application of BF and multi scale product based thresholding which helps in eliminating the blur effect in digital images. In addition to this, it also helps in preserving the edges. This method multiplies the adjacent wavelet sub bands to strengthen the significant features in the image and then applies the thresholding to the multi scale products for the better differentiation of edge details in the image.

Rashidi et al. [11] proposed a new thresholding function for wavelet thresholding. This function is continues and has higher order derivation. Therefore it is suitable for gradient decent learning methods such as thresholding neural network (TNN). This function is used by the TNN and threshold values for wavelet sub-bands are estimated according to least mean square (LMS) algorithm. The experimental results show improvement in noise reduction from images based on visual assessments and PSNR comparing with well-known thresholding functions.

Ting et al. [13] proposed an improved edge detection operator for the ultrasound images of cardiac ventricular wall with strong noises and fuzzy edges detected in the motion of their rotation. Ultrasound imaging technology is an effective means of medical diagnosis without wound. The function of viscera is estimated through its locomotor track. To the technology of computer assistant processing and analysis for ultrasound images, the key step is segmenting the edges of tissues accurately. The algorithm modified the combination of morphological operations, so that the unclear edges of images are avoided. Furthermore, multi-structure elements were also introduced which can reserve integrated edges from different directions of the images. Experiments demonstrate that this edge detector has a better performance on the edge detection of ventricular wall. It can not only keep the edges more accurate than traditional edge detectors, but also satisfy the request of coherent

III. PROPOSED WORK

We proposed a hybrid method for segmentation of defected region in liver US based on the combination of the wavelets, circular Hough transform, contour segmentation etc. wavelet transforms can be used in tasks ranging from edge detection to image smoothing, Because they provide significant insight into both an image's spatial and frequency characteristics, wavelets can also be used in applications in which Fourier methods are not well suited, like progressive image reconstruction.

The basic approach [16] to wavelet based image processing is to

1. Compute the two-dimensional wavelet transform of an image.
2. Alter the transform coefficients.
3. Compute the inverse transform.

In detail above three terms can be understand as following;

Assume the observed data vector X=[m, x, x2, ...:X N]. Our denoising objective is to decrease high frequency unwanted components and increase the visual perception of low frequency components like edges in the image. The wavelet denoising pass through following steps to attain the results.

1. Apply the discrete wavelet transform (DWT) to the vector x and obtain the empirical wavelet coefficients c_detail at scale j, where j=l, 2> ..., J. Note that c_approx represent the scaling coefficients and will not be shrunk in the next step.
2. Apply the thresholding function to the empirical wavelet coefficients at each scale j, j=1, 2 ... J. Then the estimate coefficients at each scale are obtained based on the selected threshold value t= [t_1, t_2……….t_j] Note that t_j is the threshold for wavelet coefficients at scale j
3. Use the IDWT on thresholded wavelet coefficients and obtain the estimation values of the signal.

We divided our work into various sections, each of them are explained below.

(A) Wavelet Transform
(B) Evaluating Threshold
(C) Wavelet Denoising
  (a) Rigr-sure
  (b) Neigh-Shrink[18]
  (c) Visu-Shrink[17]
(D) Contrast-limited adaptive histogram equalization (CLAHE)
(E) Implementation of 2-D Gaussian filter for smoothing
(F) Circular Hough transforms
(G) Region Based Active Contour Segmentation using seed point from circle detected.

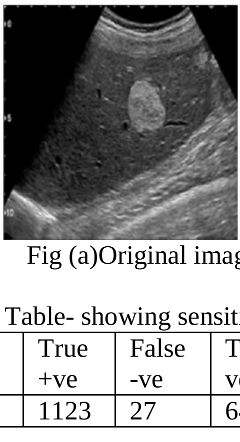
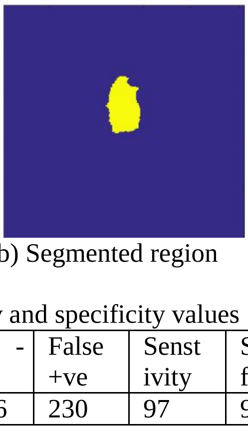



Fig (a)Original image (b) Segmented region

Table- showing sensitivity and specificity values

Image no	True +ve	False -ve	True -ve	False +ve	Senstivity	Specificity
1	1123	27	64156	230	97	99

2	1540	80	63782	134	95	99
3	2154	215	62927	240	90	99
4	2114	6	62538	878	99	98
5	1984	30	62584	980	98	98

IV. DIAGNOSTIC ACCURACY ASSESSMENT

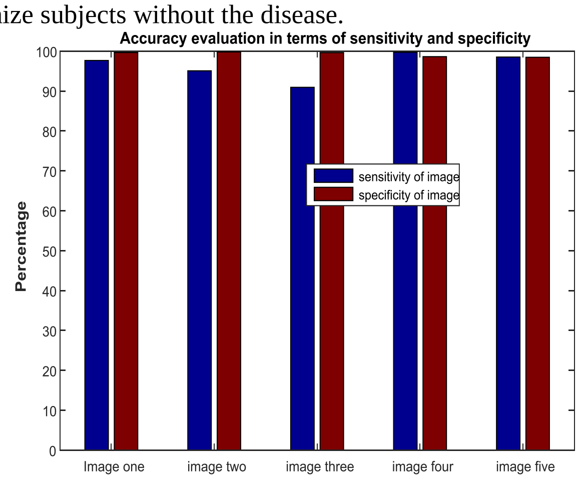
There are different methods to assess the diagnostic accuracy of CAD systems or algorithms. In our systematic review, we have used the following terms:

- **Sensitivity**

Sensitivity is a statistical measure that defines the proportion of true positive subjects with the disease in a total group of subjects with the disease (TP/TP+FN). It gives the probability of getting a positive test result in subjects having infected skin. Hence it relates to the potential of a test to recognize subjects with the disease .
Sensitivity evaluated for input image using the presented algorithm has been written below

- **Specificity**

This measure of accuracy of a diagnostic test is complementary to sensitivity. It is defined as the proportion of subjects without the infected pixels with negative test result to the total number of subjects without disease (TN/TN+FP). In other words, specificity represents the probability of a negative test result in a subject without the disease. Therefore, it describes the test ability to recognize subjects without the disease.



Bar graphs for sensitivity and specificity values

V. CONCLUSION

In this work, we propose an image enhancement and segmentation method using wavelet transforms, circular Hough transform and contour segmentation in order to provide a useful guideline for applying segmentation of infected region in medical field. The simulation tests have been carried out using images with different organs, noise levels, and transducer frequency. In this first of debauchees wavelet has been applied to remove speckle noise in the image, After that Contrast-limited adaptive histogram equalization has been applied for contrast adjustment. Then circular Hough transform has been used to get the circular blob in the infected tumor region. In the end Chan-Vese contour segmentation has been applied using circular blob location to segment out infected region in the image. Proposed method gives excellent on circular and elliptical tumors. In future work, same algorithm can be improved to get consider irregular shape tumors in Liver US images.

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