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A Literature Study on Detecting Gall Bladder's Wall Thickness for Finding Early Abnormalities using Ultrasonic Images

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ABSTRACT

This paper is regarding the literature study that has been conducted for the purpose of analyzing the ultrasonic images of gall bladder of the patients having abnormalities. In general most of the paper it has been found that in order to find abnormalities in gall bladder they consider the accumulation of stones. The study has been made clear that the densities, thickness of the stones, shape of the gall bladder are detected in most of the paper. Biological characteristics are given much importance than physical characteristics. A new approach is developed in this paper, that is gall bladder wall has to be considered in order to find the abnormality depending upon the thickness of the wall. Hence the Region of Interest is considered as wall of the gall bladder. The normal thickness of the wall of the gall bladder is less than 3mm. The pathogenesis in gall bladder is observed by the walls of the gall bladder as it gets enlarged in case if there is any abnormalities like presence of stones in the form of solid, liquid, or semi solid. Later on this physical characteristic like reflection coefficient, acoustic impedance and dynamic modulus are considered rather than biological characteristics and its mapped with the Region of Interest to find the changes and to analyse whether any intervention can be done in it.

Keywords: *Ultrasonic Image,Region of Interest(ROI), Thickness*

Introduction

In present scenario the most common biliary disease is the gall bladder problems. There are two types of Gallstones in gall bladder, the first one is the Cholesterol stone, the stone is said to be cholesterol stone if the content of cholesterol is more than 70%. The second is the Pigment stone, the stone is said to be pigment stone if the cholesterol content is less than 70%.The common problems in Gallstones are gallbladder inflammation, biliary pain, bile duct obstruction, and pancreatitis.

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There is a marked geographic variation in gallstone prevalence (Figure 1). In developed countries, more than 85% of gallstones are cholesterol stones. About 20 million people in the USA (15% of the population) have gallstones ·An extraordinarily high prevalence was found in American Indians.In Europe, ultrasound studies revealed a prevalence of 9 - 21% and an incidence of 0.63/100 persons/year.

Literature Survey

The below given description is the literature study made on different papers related to the gall bladder problem. These papers have followed different methodologies and have compared all those methodology. Most of the approach describes the study of gall stones rather than gall bladder walls. Few of the papers of gall bladder are covered under literature survey and are described below:

Shivi Agnihotri et al [3] in 2009 used automated gallstones segmentation techniques for the purpose

of automatic detection of gall stones. In ultrasound images a noise called speckle noise is present; in order to suppress the noise a technique called anisotropic diffusion technique has been employed. The image is segmented by NCUT technique. Finally the segmented image of gallstones with the gall bladder is obtained using closed form matting technique.

Bertan Karhoda el at [4] in 2009 method plays a vital role in biomedical analysis edge detection. Initially to improve the quality of gall bladder image two methods were proposed. The main function of histogram equalization is it performs a transform function on the ultrasonic image in order to scatter the gray scale values. The second method is used which is considered as digital filtering method which results in approximate coefficients, diagonal, horizontal and vertical coefficients. The histogram equalization methods shows better CPU time performance

J Zang el at [5] in 2010 a new method was developed for the gall bladder modeling for laparoscopic cholecystectomy simulation. In this the gall bladder image is segmented from clinical CT images.A multilayer model has been constructed for this purpose. This model have produced satisfactory results in both perception and time performance

Marcin Ciecholewski el at [6] in 2010 two active contour models was proposed for extracting the shape of the image. The methods are Edge based and Region based models which make use of morphological methods for the purpose of extraction of Gall bladder shapes. This contour model was applied to ultrasonic images without lesions and also specific disease units like turns of gall bladder, polyps and gallstones. The Edge based model as produced a precise result of extraction of the shape of gall bladder rather than the morphological model which has also put an advantage.

Ravi K Smalal el at [9] in 2011 image a semi-automatic method is used. A technique for computing feature images in ultrasound that is based on the hessian computed within a multi-scale framework is used. Active contouring method is done followed by the gradient vector flow energy.The main advantage of the method is it is robust which is able to handle the challenges like speckle noise, missing of boundaries, presence of gallstones.

W Huang el at [10] in 2011 have constructed a deformable gall bladder. In this multi layer mass spring method is used. The inner layer of this method is constructed based on the surface mesh of the gall bladder. The parameters of the springs were configured based on the biological properties.

Weiying Xie el at [11] in 2013 a validation is done to detect the gall stones present in the gall bladder. The reason for the inducing the validation is due to the presence of speckle noise, luminous in-homogeneity and low contrast which fail to detect the gall stones. Hence for the purpose of segmentation to obtain precise result Level set method is used.

Weiying Xie el at [12] in 2014 used a method for validation for proper identification of gall stones. This identification is done using level set method. This method is robust to extract gall stones from the ultrasound images. This method is helpful to the clinicians as a decision support tool.

Neha Mehta el at [14] in 2015 a new method was developed for segmenting 3D gallbladder from CT images, which is nothing but a semi automatic method. To extract the gall bladder region a classifier called support vector machine is used. For the purpose of segmentation active contour and level set methods are employed for precise results. The main drawback in this method is it failed to extract the gall bladder region containing stones and inflammation with high density.

Wang Hong-yan el at [15] in 2015 used a lore based algorithm for the gall stone segmentation from the CT images. This method overcomes the drawback of the FCM algorithm. In this a penalty term is used to enlarge the range of specified class and achieve higher segmentation. This method is more efficient than the FCM algorithm.

Jing Lian el at [16] in 2017 uses a novel method to segment the gall bladder and gall stones in ultrasound images. In this different algorithms are used. Otsu algorithm is used to reduce the speckle noise and also enhance the image contrast. Second, global morphology filtering is used for acquiring a fine gall bladder region. PA-PCNN is employed to obtain high intensity regions. This method is potential to assist physicians for diagnosing the gall bladder disease rapidly and effectively

These are the various papers that have been studied for making a new intervention in early detection of gallbladder. Comparing all the above papers it's clearly identified that gall bladder wall thickness is not considered to study the abnormality. Hence an algorithm is proposed for the purpose of identifying the abnormality in wall of gall bladder.

G.R.Jothilakshmi et al [18] in 2018 discussed a novel method to calculate the size of microcalcification, the physical characteristics were calculated, and 3D projection of the binned image was obtained and the preferred bin was expressed in its size and using the 3D projection the size of microcalcification was calculated. G.R.Jothilakshmi et al [17] in 2018 proposed a technique to segment the RoI in sonomammogram image, the peaks of 3D binned images were calculated in order to identify microcalcifications

Proposed Work

The developed smart cane with receiver band is tested in Real time. The subject is artificially made blind and deaf and asked to notify the object direction by using the smart cane.

This paper proposes design for smart walking cane that supports the people with blind as well as deaf people which detects any kind of obstacles including water, fire. Since ultrasound sensor detects 270 degree obstacles from any direction can be detected by the subject. The objective is to provide an aid to visually impaired and deaf people which will assist them everywhere they go. This system is more reliable and efficient than other proposed system.

A real time ultra sonic image of gall bladder is considered. These images are obtained by passing ultra sound signal through abdominal area. Ultrasounds are sound waves with higher frequencies which are higher than the upper audible limit of human hearing. Below show is the flowchart for the proposed work

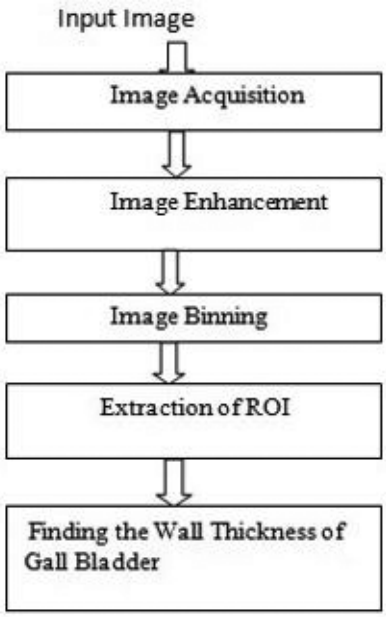

Fig. 1: Flow chart of the proposed work

Image Acquisition: Ultrasonic image is obtained from database. It contains normal and abnormal images. Each image is of varying pixel ranges. The images which are collected is of either defect or normal. The place where abnormalities are indentified is known as the Region of Interest (ROI). Hence the image is of varying pixel it is necessary to standardize the pixel value, thus we resize the image to 500*500.

Image Enhancement: Raw ultrasonic image are complex to understand hence, the image are subjected to enhancement. So Order statistic filtering is used to eliminate the blurring effect and speckle noise.

Image Binning: The whole image is binned initially with x rows and y columns. Each bin represents its own matrix. The bin which contains the RoI is identified and again subjected to further binning with x1 rows and y1 columns. Each bin has its own matrix. In our work we have binned the image with each block of 100*100 and hence there is 25 blocks of 5 rows and 5 columns

Finding ROI using Reflection Coefficient: From the proposed work we consider the gall bladder wall as the Region of interest as it is necessary to find the wall thickness. Hence the Region of Interest is considered as the gall bladder wall region. The region of interest will be identified using the calculation of reflection coefficient. Any image can be formed based on multiplication of illumination and reflectance components. So based on the equation (1), the reflection coefficient matrix could be obtained for the required bin. By fixing range of reflection coefficient, ROI is segmented out.

$$f(x,y) = i(x,y)\, r(x,y)$$

i(x,y) = illumination component, r(x,y)= reflectance components

Finding the Thickness

Thickness can be determined by using the below formula

$$\text{Thickness} = 2*\text{mean}(d) \qquad (1)$$

Where d is the Euclidean distance which is computed automatically using a Matlab function.

Conclusion

From the above papers it is common that the shape of the gallbladder is extracted by segmenting using

various contouring and morphological methods. Most of the paper they have focused on retaining the biological characteristics to study any abnormalities in gall bladder Hence a new approach has to be developed for finding the early abnormality in gall bladder. This is done by considering the gall bladder wall as region of interest to find any abnormalities basis on the wall thickening. Based on the wall thickening images abnormalities can be classified.

Ethical Clearance: The Study is based on the Digital Image Processing and does not require Ethical Clearance.

Source of Funding: Self funded.

Conflict of Interest: Nil

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