Ultrasound Image Processing Techniques For Detection Of Anomalies

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Abstract

Ultrasound imaging system is right advantageous to television internal tissues, muscles, joints and blood vessels in non-invasive manner. The anomaly detection in US diagnosis system is very active compare to other imaging techniques. But, when sound waves pass through the gaseous medium it's very challenging to reflect the image to screen the patient's condition and due to some speckle noise arises during scanning may not give proficient image diagnosis. So, removal of such noisy conditions becomes an important task in image processing. Hence, by applying different de noising image processing algorithms will provides better visualization for anomaly detection, here we specified what are the different noise removal algorithms are required for ultrasound system.

Keywords: **Anomalies, De noising, Medical image Processing ultrasound (us).**

I. INTRODUCTION

Ultrasound imaging uses electrical -to- acoustical transducers to generate repetitive high frequency sound waves to examine the internal organs. It generates a frequency range of sound waves in between 20 kHz to more gigahertz.

US waves travels through different mediums like solid, liquid, and gas its speed varies with the density of medium. Faster the propagation of US waves when it travels through the denser medium like speed of US through bone is twice through muscle [8] [9].

DIFFERENT MODES OF US SCANS

A (amplitude) _ mode imaging:

It generates one dimensional wave form, and provides very detailed information about rapid or subtle motion like heart valve.

B (brightness) _mode imaging:

It represents the echoes as dots rather than vertical deflections and the brightness represents the strength of the reflected echo. It displays the two dimensional cross section view and it is of two ways to generate the scan like rotating and phased array transducer. The rotating transducer from side to side display the dots in geometrical way. And the second one phased array transducer has several piezoelectric transducers positioned in a line and each of them transmits and receives pulsed US waves and this type of scanning is faster than the rotating scan.

M (motion) _ mode imaging:

US pulses are used to analysis of moving organs. The boundaries of organ produces the relative reflections to the transducer move and it can be used to determine the velocity of specific organ structures.

Doppler Mode:

Used to study the blood flow through blood vessel, including the arteries and veins. Doppler US measures the direction and speed of blood cells as they move through vessels

Advantages:
Most common we use the US system for monitor the fetus growth and it is useful to detect the thyroid, heart and glands of body as it non-invasive method there is no need of needles and injections.

It is temporary scan. But, we can analyse it by saving the diagnosed images and it is cost effective compare to other imaging methods and it does not emit the radiation so, it is extremely safe and gives the clear picture image for soft tissues which does not given by x-ray scanning.

The spatial resolution techniques improves the quality of image and it provides good minimal invasive techniques like needle biopsies and needle aspiration.

Challenges faced by US [10]:

- Patients are more difficult to image by US because greater amount of tissues attenuates the US waves as they pass deeper into the body
- It has difficulty to penetrate from bone surface of a body we may see the outer surface not concentrate on inside except for infants.
- Problems in US image refers to mainly the quality of image. The resolution includes spatial resolution and temporal.
- The spatial is of two types like axial and lateral, depends upon the reflected position of beam like either side by side for axial and perpendicular to temporal effects the major of capability of imaging system to degrade the structure detail.
- The length of US like variations with amplitude, time, and distance which points out the axial resolution may have some defects.
- In pulse wave of US , the vibrations of piezo crystal which generates the US beam are effected by every short pulse and produces the artifacts in the image .and it may misdirect the practitioner towards false interpretation and the artifacts may occur due to the old and simpler model of equipment.
- Major artifacts may occur at multiple reflectors across tissue boundaries called reverberations of the image.
- Due to the poor physical condition of transducer or less than electrical isolation of crystal elements may lead to form the noise in image.
- The acoustic shadowing occurs beyond reflectors such as gas or heavy observer like bone. Leaving the inadequate beam energy for examination of structures sometimes causes the difficulties of interpretation.
- In a damaged transducer some crystals elements may have cracks, the vibrations may be poor and irregular or the damping mechanism may be faulty hence, these transducers generates strange difficulty to account signals in image.

By this we conclude that due to different conditions of US image causes noise to monitor the patient anomalies. So, by using different de noising algorithms we can improve the quality of image for better results.

II. DIFFERENT NOISE REMOVAL TECHNIQUES FOR ANOMALY DETECTION

US image segmentation based algorithms for noise reduction

Speckle reduction:

Reducing the speckle noise is of two types like processing and post processing.

Processing techniques have no change or motion of the objects when it's moving during the reception of observations. In this the images are obtained as usual.

Post processing method is appropriate for reduction of speckle noise which deals to enhance the signal to noise ratio while edge conserving lines in the image.

Wavelet filter is useful for de noising operations. The process to exploit the wavelet operation is as follows [13].

Calculate the DWT of the image.
Calculate threshold wavelet coefficients and compute the IDWT.
The multi resolution and multi scale nature thresholding technique using dwt is very simple and useful. By using speckle reducing anisotropic diffusion is a non-linear smoothing filter prevents the edge sensitive and reduce the speckle noise by preserving the edges.
Disadvantage:
It have some constrains like reducing the resolution by using this transforms causes over smoothing.

Super Resolution Algorithm for Removal of Speckle Noise
Noise occur in the system due to improper contact between the probe and body may causes the problems in signal processing where information may lost or form a noise called speckle. The accuracy of the images is accomplished by the type of waves passed through the transducer.
Here de convolution algorithm is used for the analysis of input signal and impulse response. it is convolved into two types [24]winer filtering,clean
The super resolution algorithm is used for better details it works effectively when low level resolution images contain different perspective of the same object
Disadvantages:
It is useful only for the blurred images not of noise removal for diagnostic ones and the de convolution algorithm is used for only winer filter but, it is not much effective for clean and it tends to improve some optical methods and numerical calculations for effective results.

Graph based image segmentation
Improved segmentation for US images is based on graph diffusion and regularization model with the help of haralick texture features to obtain more efficient segmentation.
The process takes place using non local pixel characteristics and able to compare pixels that might not be the neighbours of the image. And we represent the image by graph which provides an efficient way to store a similarity measures of pixels [25].
And for more feature extraction of the image the hiralick based segmentation involves into a account of graph based method. The co-occurrence matrices are employed for efficient way of characterisation

Disadvantage:
But, it doesn't show the similarity information held by adjacent pixels of image.

Smoothing algorithm for foetal
Segmentation of US image for fetus using smoothing algorithm results good to detect the fetus femur it gives the better analysis for comparatively to the automatic segmentation .the segmentation of fetal femur faces very hard segmentation problem .because of strong changes within the object.

By using the smoothing algorithm to smoothen the elongated objects are presented around the femur bone. The US segmentation of biometric measurements of are performed by edge information extracted directly from the intensity values. And they have used the multilevel thersholding combined with edge detection and morphological approach. But, it fails because of elongated objects are present around the femur bone. Hence, these objects can be removed by smoothing algorithm [14].

III. IMAGE REGISTRATION BASED NOISE REMOVAL TECHNIQUES

Multi-modality registration methods are often used in medical imaging as images of frequently obtained from different scanners, like CT/MRI, or PET/CT images or US/MRI for anomaly localization.
And the medical image registration of same patient can be taken at different point of time. Image similarities are broadly used in medical imaging .the degree of similarity between intensity patterns of two images depends on modality of the images to be registered.

And it is of different types like manual, interactive, automatic, and semi-automatic. And the modality of different types like single and

multimodality is performed. Where single modality is dome by same scanner/sensor type

Where multi-modality is absorbed by images acquired by different scanner/sensor types.

In image registration the quality of the image is done by transformation mapping between the two images. The noise may creates in US images occurs due to the patient movements during scanning and exists of heart pulse rates while scanning other parts of body

The process of registration is as follows

- get the information
- apply the pre-processing technique to improve the quality of image.
- select the same characteristics of image and do the transformation mapping between the images
- reconstruct the image
- combine the reconstruction of image by overlapping them
- subtract the reconstruct image from original one.

Disadvantage: Image registration may require more time consuming in performing and increase the accuracy.

Segmentation driven image Registration for 4D moving ultrasonic baby

GFR estimation of us baby is an important parameter for the calculation of disease estimation.

First to analyse the registration method for correct voxel displacement to estimate the filtration rate of kidney then implement the automatic segmentation has an advantage of classification of tissue voxels which is based on actual response, then analyse the compartment modelling parameters for renal filtration rate. After proceed to simultaneous segmentation registration method. By this we can reduce the errors occur in one step instead of analysing each and every stage [26].

Disadvantage:

Here affine registration method is used but, it may not rectify the noise occurs due to the respiratory system.

IV. ENVIRONMENTAL NOISE REMOVAL ALGORITHM

HYPER SPECTRAL ANOMALY DETECTION

HS of a remote sensing applications is to monitor like environment, geological, agriculture etc. the output of the image occurs with low quality because of clutter in the image.

To remove the unknown clutter background we use REED-XI algorithm. Generally the anomalies are monitored in two ways like global or local anomaly. The global anomaly do the segmentation first with small HS cube and apply the cut off threshold value to detect the anomaly. The local detectors may need of spatial size of surrounding pixel are calculated [27].

Disadvantage:

It does not detect the targets of known specific objects in the image.

V .ITERATION BASED SEGMENTATION

The US waves will detect the internal organs of fetal like head, placenta, femur etc. and it is also used to provide best diagnostic approach for patients who suffers from abdominal problems. the noise generates from the US waves due to various abnormal conditions the visualization of organ becomes very difficult to radiologist, hence the proposal work is to use different noise removal algorithm techniques in image processing and to improve the quality of image in abdomen which is easy to analyse the anomalies, for which we tried iterative based segmentation for bowel gas detection.

Iterative method is one of our proposed work which is already exists and gives best results for segmentation of microscopic modules and for noise removal techniques[28] and it divides an image's histogram iteratively into three classes.by applying an Otsu's method on the first iteration then threshold value of the second to be determined and it is compare to third class which is tbd method.by the detection of histogram levels[28].

First we have to apply otsu's method for segmentation process.

In general vision and image processing, Otsu's method is used to spontaneously perform clustering-based image thresholding, or, the reduction of a grey level image to a binary image. The system dons that the image contains two classes of pixels following bi-modal histogram (foreground pixels and background pixels), it then computes the finest threshold splitting the two classes so that their combined spread (intra-class variance) is minimal. The extension of the original method to multi-level thresholding is referred to as the Multi_Otsu_method. In Otsu's method we exhaustively search for the threshold that minimizes the intra-class variance (the variance within the class), defined as a weighted sum of variances of the two classes:

$$\sigma_w^2(t) = w_1(t)\sigma_i^2(t) + w_2\sigma_i^2(t)$$

Weights $\omega_i$are the probabilities of the two classes separated by a threshold $t$and $\sigma_i^2(t)$variances of these classes. Otsu shows that minimizing the intra-class variance is the same as maximizing inter-class variance:

$$\sigma_w^2(t) = w_1(t)w_2(t)[\mu_1(t) - \mu_2(t)]^2$$

which is expressed in terms of class probabilities $w_1$and class means μ_1.The class probability $w_1(t)$is computed from the histogram as t:

$$w_1(t) = \sum_0^t P(i)$$

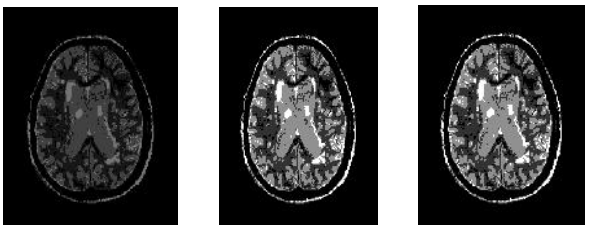
While the class mean $\mu_1(t)$is:

$$\mu_1(t) = \left[\sum_0^t P(i)\,x(i)\right] / w_1$$

Where $x(i)$is the value at the center of the i_{th} histogram bin. Similarly, you can compute $w_2(t)$and $\mu_2(t)$on the right-hand side of the histogram for bins greater than the class probabilities and class means can be computed iteratively. This idea yields an effective algorithm.

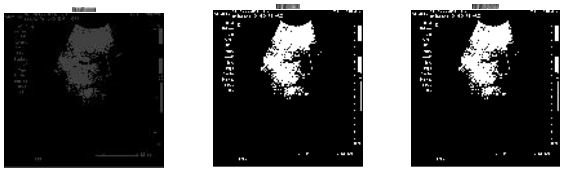
Image segmentation by using threshold method is quite simple but very powerful approach for segmenting images based on characteristics of the image.

Tri class segmentation on brain tumor detection



Iteration one iteration two iteration three

Tri class segmentation on bowel gas



Iteration one iteration two iteration three

By comparing two iteration model based segmentation gives better results for brain tumor detection than bowel gas

So, edge detection in bowel gas is very difficult and noise removal other than speckle method is very important to consider in ultrasound images.

VI. CONCLUSION

In this paper we present what are the advantages and challenges faced by the ultrasound imaging system and different noise removal techniques used in ultrasound system and their disadvantages. Out of which speckle reduction techniques are useful for noise removal in US diagnosis method and we have tried for iterative method of segmentation for detection of noise removal which is already exists.it gives better results for brain tumor detection and other microscopic analysis But, it does not useful for the bowel gas detection method. And edge detection is also very difficult during segmentation. Hence, we conclude that clutter based segmentation methods will provide effective de noising algorithms and anomaly detection in abdomen.

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