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US Breast Cancer Image Enhancement and Wavelet Based Denoising

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ABSTRACT

Breast cancer is the common form of cancer with 81% of cases occurring in women aged 50years and over. In medical image processing, image denoising has become a very essential exercise all through the diagnosis because Ultrasound (US)images are normally affected by speckle noise, and it is crucial to operate case to case. Here we proposed an image resolution enhancement and despeckling technique by using Discrete and Stationary wavelet transform for image enhancement and the median filters and average filters are reduce the speckle noise in the Ultrasound breast cancer images.
Key words: *Ultrasound, DWT, SWT,IWT,*

INTRODUCTION

Ultrasound breast cancer images are usually corrupted by different types of noises during the acquisition and transmission of biological signals. The main objective is to enhance the image and reduce the noise and the image should be clear and easy to visualize the cancer nodules in the image by the physician.

Noise in an Image

It is generally desirable for image brightness (or film density) to be uniform except where it changes to form an image. There are factors, however, that tend to produce variation in the brightness of a displayed image even when no image detail is present. This variation is usually random and has no particular pattern. In many cases, it reduces image quality and is especially significant when the objects being imaged are small and have relatively low contrast. This random variation in image brightness is designated as noise. This noise can be either image dependent or image independent. All the digital images contain some visual noise. The presence of noise gives an image a mottled, grainy, textured, or snowy appearance.

TYPES OF NOISES

1) Random Noise

Random noise revolves around an increase in intensity of the picture. It occurs through color discrepancies above and below where the intensity changes. It is random, because even if the same settings are used, the noise occurs randomly throughout the image. It is generally affected by exposure length. Random noise is the hardest to get rid of because we cannot predict where it will occur. The digital camera itself cannot account for it, and it has to be lessened in an image editing program.

2) Fixed pattern noise

Fixed pattern noise surrounds hot pixels. Hot pixels are pixel bits that are more intense than others surrounding it and are much brighter than random noise fluctuations. Long exposures and high temperatures cause fixed pattern noise to appear. If pictures are taken under the same settings, the hot pixels will occur in the same place and time. Fixed pattern noise is the easiest type to fix after the fact. Once a digital camera realizes the fixed pattern, it can be adjusted to lessen the affects on the image. However, it can be more dubious to the eye than random noise if not lessened.

3) Banding noise

Banding noise depends on the camera as not all digital cameras will create it. During the digital processing steps, the digital camera takes the data being produced from the sensor and creates the noise from that. High speeds, shadows and photo brightening will create banding noise. Gaussian noise, salt & pepper noise, passion noise, and speckle noise are some of the examples of noise.

4) Speckle Noise

Speckle noise is defined as multiplicative noise, having a granular pattern it is the inherent property of ultrasound image and SAR image. Another source of reverberations is that a small portion of the returning sound pulse may be reflected back into the tissues by the transducer surface itself, and generates a new echo at twice the depth. Speckle is the result of the diffuse scattering, which occurs when an ultrasound pulse randomly interferes with the small particles or objects on a scale comparable to the sound wavelength. The backscattered echoes from irresolvable random tissue in homogeneities in ultrasound imaging and from objects in Radar imaging undergo constructive and destructive interferences resulting in mottled b-scan image.

Speckle degrades the quality of US and SAR images and thereby reducing the ability of a human observer to discriminate the fine details of diagnostic examination. This artifact introduces fine-false structures whose apparent resolution is beyond the capabilities of imaging system, reducing image contrast and masking the real boundaries of the tissue leading to the decrease in the efficiency of further image processing such as edge detection, automatic segmentation, and registration techniques. Another problem in Ultrasound data is that the received data from the structures lying parallel to the radial direction can be very weak, where as structures lying normal to the radial direction give stronger echo.

SPECKLE NOISE IN ULTRASOUND IMAGES

These scans use high frequency sound waves which are emitted from a probe. The echoes that bounce back from structures in the body are shown on a screen. The structures can be much more clearly seen when moving the probe over the body and watching the image on the screen. The main problem in these scans is the presence of speckle noise which reduces the diagnosis ability. It provides live images, where the operator can select the most useful section for diagnosing thus facilitating quick diagnoses.

WAVELET TRANSFORM

The wavelet transform has become a useful computational tool for a variety of signal and image processing applications. For example, the wavelet transform is useful for the compression and enhance the digital image files

Wavelet transforms are classified into discrete wavelet transforms (DWTs) and continuous wavelet transforms (CWTs). Note that both DWT and CWT are continuous-time (analog) transforms. They can be used to represent continuous-time (analog) signals. CWTs operate over every possible scale and translation whereas DWTs use a specific subset of scale and translation values or representation grid.

METHODOLOGY

The proposed technique uses DWT to decompose a low resolution image Fig.1.into different sub-bands, namely low-low (LL), low high (LH), high-low (HL), and high-high (HH).Then the three high frequency sub-band images have been interpolated using bi-cubic interpolation. Three high frequency sub-bands (LH, HL, and HH) contain the high frequency components of the input image. Down sampling in each of the DWT sub-bands causes information loss in the respective sub-bands. That is why SWT is employed to minimize this loss.

The high frequency sub-bands obtained by SWT of the input image are being incremented into the interpolated high frequency sub-bands in order to correct the estimated coefficients. In parallel, the input image is also interpolated separately. Finally, corrected interpolated high frequency sub-bands and interpolated input image are combined by using inverse DWT (IDWT) to achieve a high resolution output image.

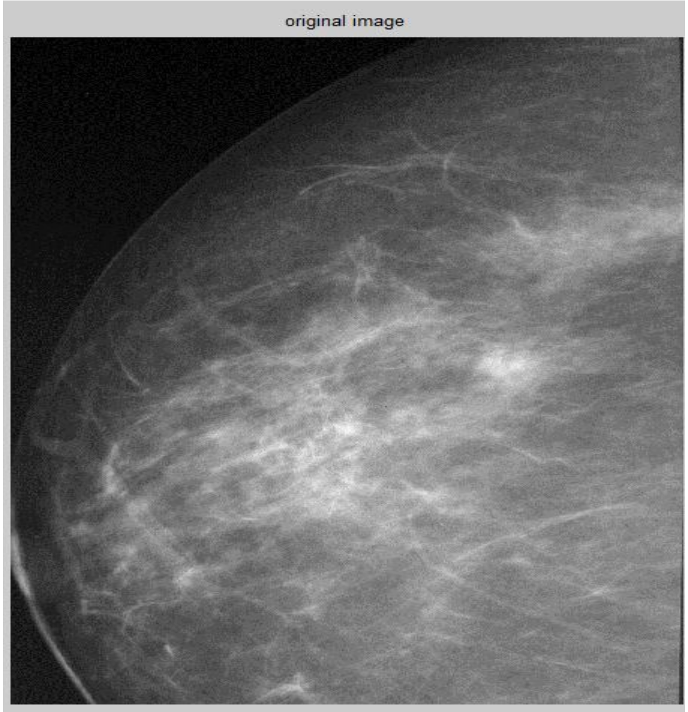
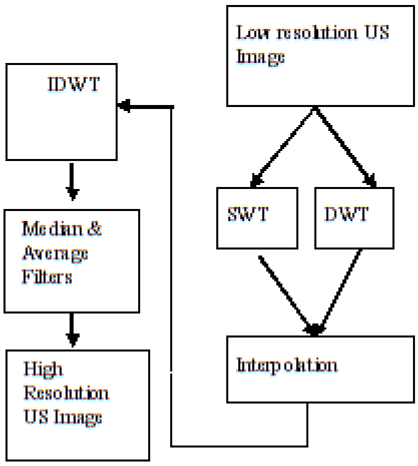


Fig.1.Original image



1.Block diagram.

The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries.

Median filtering is one kind of smoothing technique, as is linear Gaussian filtering. All smoothing techniques are effective at removing noise in smooth patches or smooth regions of a signal, but adversely affect edges. Often though, at the same time as reducing the noise in a signal, it is important to preserve the edges. Edges are of critical importance to the visual appearance of images, for example. For small to moderate levels of (Gaussian) noise, the median filter is demonstrably better than Gaussian blur at removing noise whilst preserving edges for a given, fixed window size.

The Average (mean) filter smoothes image data, thus eliminating noise. This filter performs spatial filtering on each individual pixel in an image using the grey level values in a square or rectangular window surrounding each pixel.

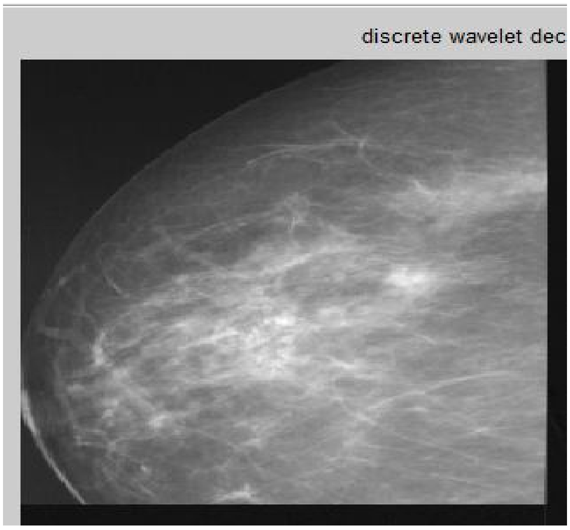


Fig.2.DWT-based enhanced image

In image resolution enhancement by using interpolation the main loss is on its high frequency components (i.e., edges), which is due to the smoothing caused by interpolation. In order to increase the quality of the super resolved image, preserving the edges is essential. In this work, DWT has been employed in order to preserve the high frequency components of the image. The redundancy and shift invariance of the DWT mean that DWT coefficients are inherently interpolable. In this correspondence, one level DWT (with Daubechies 9/7 as wavelet function) is used to decompose an input image into different sub band images. Three high frequency sub bands (LH, HL, and HH) contain the high frequency components of the input image. In the proposed technique, bi cubic interpolation with enlargement factor of 2 is applied to high frequency sub band images. Down sampling in each of the DWT sub bands causes information loss in the respective sub bands. That is why SWT is employed to minimize this loss.

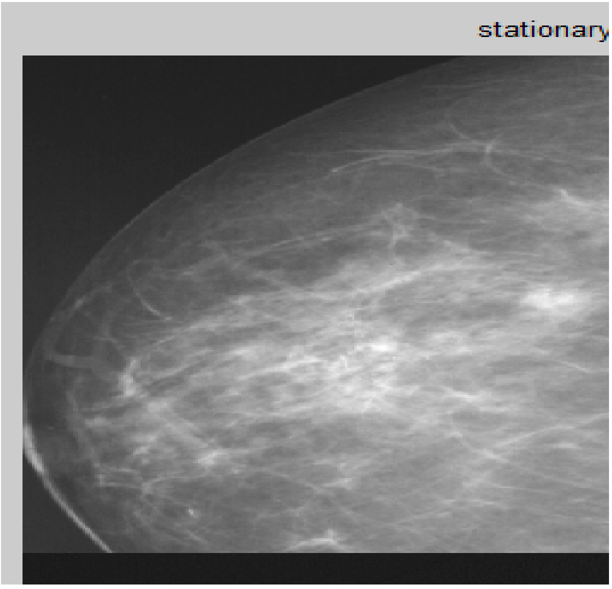


Fig.3.SWT based enhanced image

The interpolated high frequency sub bands and the SWT high frequency sub bands have the same size which means they can be added with each other. The new corrected high frequency sub bands can be interpolated further for higher enlargement. Also it is known that in the wavelet domain, the low resolution image is obtained by low pass filtering of the high resolution image. In other words, low frequency sub band is the low resolution of the original image. Therefore, instead of using low frequency sub band, which contains less information than the original high resolution image, here the input image was used for the interpolation of low frequency sub band image.

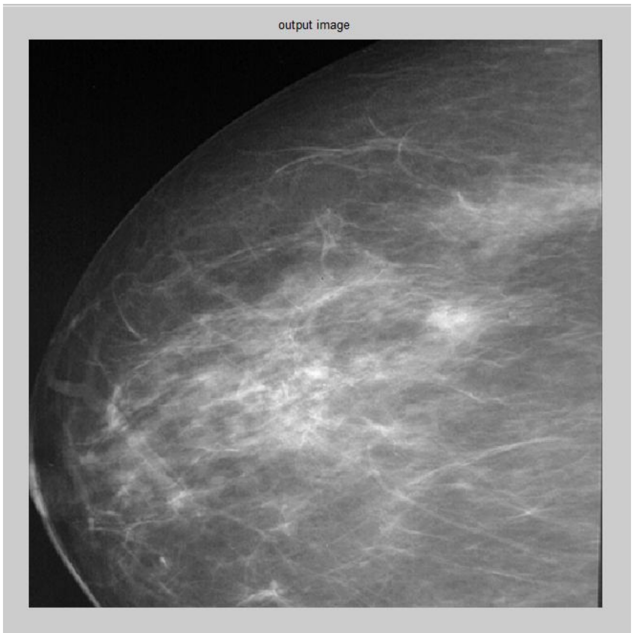


Fig.4.Output Image (despeckled and enhanced)

Using input image instead of low frequency Subband increases the quality of the super resolved image. After interpolating input image and high frequency sub bands and then applying IDWT, the output image will contain sharper edges than the interpolated image obtained by interpolation of the input image directly. This is due to the fact that, the interpolation of isolated high frequency components in high frequency sub bands and using the corrections obtained by adding high frequency sub bands of SWT of the input image, will preserve more high frequency components after the interpolation than interpolating input image directly. Further speckle noise of the image is removed using median and average filters which shown in Fig.4

CONCLUSION

Thus we have enhanced and denoised the ultrasound breast cancer image using wavelet transforms and median and average filters, and experimental results shows that this technique is accurate and effective in low resolution ultrasound images.

In future, more wavelet transform techniques can be used for enhancement and denoising of ultrasound breast cancer image which increases the resolution of image and helps the physician to diagnose the image clearly.

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