Abstract

Medical practitioners are increasingly using digital images during disease diagnosis. Several state-of-the-art medical equipments are producing images of different organs, which are used during various stages of analysis. Examples of such devices include MRI, CT, ultrasound and X-Ray. In medical image processing, image denoising has become a very essential exercise all through the diagnose because Ultrasound images are normally affected by speckle noise. The noise in the image has two disadvantages, the first being the degradation of the image quality and the second, more important, obscures important information required for accurate diagnosis. Arbitration between the perpetuation of useful diagnostic information and noise suppression must be treasured in medical images. In general we rely on the intervention of a proficient to control the quality of processed images. In certain cases, for instance in Ultrasound images, the noise can restrain information which is valuable for the general practitioner. Consequently medical images are very inconsistent, and it is crucial to operate case to case. This paper presents a wavelet-based thresholding scheme for noise suppression in Ultrasound images and provides the knowledge about adaptive and anisotropic diffusion techniques for speckle noise removal from different types of images like Ultrasound.

One of the inherent properties of coherent imaging is the presence of speckle noise. This noise impacts valuable properties and important information of the image and it is difficult to remove or efficiently reduce it. The tradeoff between noise reducing and holding image information should be such that image recognition process would be done properly. For this purpose, many methods have been presented. The most appropriate of which are the wavelet transform and directional contourlet transform. In this paper, a suitable algorithm based on contourlet transform, with logarithmic threshold is presented. The obtained results by applying the proposed method on real image are better than those of using other algorithms. We use the signal to noise ratio as a measure of visual quality of resulted images Ultrasound method is one of the best.
imaging methods for soft tissues of body, because it is portable, no ionic radiation is used and it is relatively cheap, but the main disadvantage of images taken by this method is the low quality of images that is in turn due to the presence of a multiplicative noise.

**Keywords** - Speckle Noise, Ultrasound Images, Noise Filters, MATLAB.

**Introduction**

Context-based adaptive wavelet thresholding [2] method introduced a simple context-based method for the selection of adaptive threshold. Coherent filtering [3], is a speckle noise reduction technique of the ultrasound images. This technique is based on Coherent Anisotropic Diffusion for real time adaptive ultrasound Speckle noise reduction. Speckle much present in images of kidney and liver which have small structures with high wavelengths [1]. Since speckle reduces image quality, so it is undesired and speckle filtering is a preprocessing action taken typically for analyzing and extending the properties and identification of medical measurements. Present methods for removing the speckle noise such as using wavelets transform [2], despite of their various advantages; have shortcomings that enforce researchers to develop new methods. One of methods for noise reduction presented recently is based on contourlet transform in which different thresholds are used. Fast development of medical imaging technology has led to the development of new image processing methods including noise filtering techniques, optimization, classification and segmentation. However the speckle noise reduction remains still a challenge. In [1], it has been used. Medical images are usually corrupted by noise in its acquisition and Transmission. The main objective of Image denoising techniques is necessary to remove such noises while retaining as much as possible the important signal features. Introductory section offer brief idea about different available noises and denoising schemes.

**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.

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 effects 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 homogeneousities 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. Inspired by the painting scenario and studies
related to the human visual system and natural image statistics, we identify a “wish list” for new
image representations:

1) **Multiresolution**: The representation should allow images to be successively approximated,
from coarse to fine resolutions.

2) **Localization**: The basic elements in the representation should be localized in both the spatial
and the frequency domains.

3) **Critical sampling**: For some applications (e.g., compression), the representation should form
a basis, or a frame with small redundancy.

4) **Directionality**: The representation should contain basis elements oriented at a variety of
directions, much more than the few directions that are offered by separable wavelets.

5) **Anisotropy**: To capture smooth contours in images, the representation should contain basis
elements using a variety of elongated shapes with different aspect ratios. Among these
desiderata, the first three are successfully provided by separable wavelets, while the last two
require new constructions.

**Literature Review**

Arve Kjoelen et.al, studied the rapid growth in the field of diagnostic imaging has produced
several new class of digital images, resulting from computerized tomography, magnetic
resonance imaging, and other imaging modalities. In addition, well-established imaging
modalities such as X-rays and ultrasound will increasingly be processed and stored in a digital
format. It has been estimated that a 600-bed hospital would need almost 2 terabytes (2,000
gigabytes) of storage per year if all images produced at the hospital were to be stored in a digital
format. The need for high performance compression algorithms to reduce storage and
transmission costs is evident. The compression techniques described herein were likely to be
effective for a far wider range of images than the skin tumor images employed in this research [1].

Wael Badawy et.al, found that with the recent explosion of the Internet, the implementation of technologies such as telemedicine, video conferencing, and wireless data communication have been constrained due to the Internet’s finite bandwidth. With the limited technology at hand, techniques were needed to compress a large amount of data into a feasible size before transmission. Data compression had even a greater importance in many applications that involved storage of large data sets, such as magnetic resonance imaging, digital television, and seismic data collection. There were number proposed compression techniques in the literature, but none had unique properties of sub band coding algorithms. One such technique presented here was the discrete wavelet transform (DWT), which was one of the most efficient compression algorithms because of its perfect reconstruction property and lack of blocking artifacts [2].

Feature preserved enhancement is of great interest in medical ultrasound images. Speckle is a main factor which affects the quality; contrast resolution and most important texture information present in ultrasound images and can make the post-processing difficult. This paper presents a new computationally efficient enhancement approach which is based on the rational-dilation wavelet transform (RADWT) and non-linear bilateral filter. RADWT, a new family of the discrete wavelet transform for which frequency resolution can be varied, is employed to provide effective representation of the noisy coefficient. Bilateral filter and different thresholding schemes are applied to the noisy RADWT coefficient to improve the denoising efficiency and preserve the edge features effectively with this consideration that blurring associated with speckle reduction should be less and fine details are enhanced properly for the visual enhancement of ultrasound images. The proposed approach helps also to improve the visual quality of the ultrasound images. Experimental results demonstrate the ability of proposed method for noise suppression, feature and edge preservation in terms of different performance measures [3]

The first part of this paper proposes an adaptive, data-driven threshold for image denoising via wavelet soft-thresholding. The threshold is derived in a Bayesian framework, and the prior used on the wavelet coefficients is the generalized Gaussian distribution (GGD) widely used in image processing applications. The proposed threshold is simple and closed-form, and it is adaptive
to each subband because it depends on data-driven estimates of the parameters. Experimental results show that the proposed method, called BayesShrink, is typically within 5% of the MSE of the best soft-thresholding benchmark with the image assumed known. It also outperforms Donoho and Johnstone’s SureShrink most of the time. The second part of the paper attempts to further validate recent claims that lossy compression can be used for denoising. The BayesShrink threshold can aid in the parameter selection of a coder designed with the intention of denoising, and thus achieving simultaneous denoising and compression. Specifically, the zero-zone in the quantization step of compression is analogous to the threshold value in the thresholding function. The remaining coder design parameters are chosen based on a criterion derived from Rissanen’s minimum description length (MDL) principle. Noise significantly, especially for large noise power. However, it introduces quantization noise and should be used only if bitrates were an additional concern to denoising. lossy compression has been proposed for denoising in several works. Concerns regarding the compression rate were explicitly addressed. This is important because any practical coder must assume a limited resource (such as bits) at its disposal for representing the data. The connection between compression and denoising, especially with nonlinear algorithms such as wavelet thresholding in a mathematical framework. However, these latter works were not concerned with quantization and bitrates: compression results from a reduced number of nonzero wavelet coefficients, and not from an explicit design of a coder [4].

**Problem Statement**

In a digital ultrasound image have an inherently grainy appearance due to random brightness variations that are most apparent in otherwise uniform areas of an image. The cause of this characteristic image noise, called speckle, can be traced to the nature of the ultrasound signal and its interactions with biological and medical objects.

An ultrasound imager emits pulses of energy with a single wavelength and frequency, which remain constant during subsequent interactions. The return signal that creates an image cell comes from a biological area large enough to contain numerous individual features. The speckle noise has property of multiplicative noise instead of additive noise. So removal of speckle noise and enhancement of image are necessary.

**Proposed Methodology for solving the problem and Software used:**

Steps for the speckle noise reduction in ultra sound images are carried out as below.

a. Construct Multiplicative noise model
b. Do the transformation of Multiplicative noise model
c. Do Wavelet transform of noisy image
d. Calculate variance of noise
e. Calculate weighted variance of signal
f. Calculate threshold value of all pixels and sub band coefficients
g. Take inverse DWT to do the despeckling of Ultrasound images.
h. Calculate PSNR (peak signal to noise ratio) for the evaluation of the algorithm

MATLAB
MATLAB (matrix laboratory) is a numerical computing environment and fourth generation programming language. Developed by MathWorks, MATLAB [7, 8, 9] allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

The 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. Filtering techniques are used as preface action before segmentation and classification. On the whole, Speckle noise affects all coherent imaging systems including medical ultrasound. Within each resolution cell a number of elementary scatterers reflect the incident wave towards the sensor. The backscattered coherent waves with different phases undergo a constructive or a destructive interference in a random manner. The acquired image is thus corrupted by a random granular pattern, called speckle that delays the interpretation of the image content. Ultra Sound images have linear relationship between the local variance and mean of the speckle as hence it can be modeled as signal dependent noise. This signal dependent noise model helps us to smooth the image in the homogenous regions where the signal can be assumed to be constant. Using the parameter, the local variance to mean ratio, it is possible to decide whether the processed pixel is within the homogenous region or not. Usually, if the local variance to the mean ratio is larger than the speckle, that corresponding pixel is considered as a resolvable object. Otherwise it is considered to be in homogenous region and
is to be subjected to smoothening. Wavelet denoising attempts to remove the noise present in the
signal while preserving the signal characteristics, regardless of its frequency content. As the
discrete wavelet transform (DWT) corresponds to basis decomposition, it provides a non
redundant and unique representation of the signal [10].

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