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PERFORMANCE COMPARISON OF CONTOURLET AND WAVELET TRANSFORM IN DENOISING OF ULTRASOUND IMAGE

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ABSTRACT

Pictures are simple way of representing information. At the time of applying operations like segmentation, feature extraction, feature analysis image should be noise free. The purpose of image de-noising process is to eliminate the without affecting actual quality of image. Introduction of noise is due to disgraceful securing, transmission and gathering and capacity and recovery forms. As noise gets introduced in image, there is degradation in visual quality of image. There are many types of noises present into image such as Speckle noise, Additive noise. Impulse noise is a most ordinarily show in every single medicinal picture including ultrasound pictures. To extract useful information from image it is to be restored in the original form so, for restoration of image transformations are to use. DWT (Discrete wavelet transform) and contourlet transform are the new methods for image restoration. In this paper comparative analysis of various de-noising techniques based on contourlet and wavelet transform is presented. Examination of Haar DWT and Symlet DWT with wiener and median filtering systems and contourlet change is finished. Result analysis is done in terms of Peak Signal to Noise Ratio, Mean squared Error and computational time.

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INTRODUCTION

The essential objective of de-noising systems are to decrease the impact of noise with holding critical Features of image. There are numerous image De-noising strategies available. Presently a day's wavelets families are exceptionally proficient for upgrade of De-noising picture. Picture de-noising is a rebuilding procedure, where endeavours are made to recoup a picture that has been debased by utilizing earlier learning of the corruption procedure. It is outstanding that while getting the information picture a few variations get presented alongside it and consequently a loud picture is left with for future preparing. The picture de-noising normally debased by clamor is an established issue in the field of flag or picture handling. Ultrasound imaging is exceptionally well known due its different focal points: it is sheltered, non-obtrusive, compact, moderately cheap, and give a constant picture arrangement.

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Be that as it may, ultrasound pictures are less quality, essentially caused by multiplicative nature of the spot noise. Exist in and bring down the nature of ultrasound pictures Speckle noise impacts the conclusion and human translation. Different changes are connected so as to de-noise the picture yet wavelet change is more favourable to utilize on the grounds that it has variable window estimate. Different separating methods are utilized to enhance PSNR to lessen MSE. Ultrasound picture de-noising ought to stifle dot commotion without the loss of picture edges and structure data. There are various standard spot de-noising systems, for instance, averaging filters, linear filters, median filters, Adaptive filters and so on. For the most part single scale channel utilize, but it may be inadequate to procure adequate de-noising for ultrasound pictures. Starting late, multi-assurance development was familiar with de-noising ultrasound pictures. By specifying large window size for region where data content is more and small window size where data content is low by this principle wavelet change can be checked. Another rule favoured stance of using discrete wavelet change is that after change it won't simply give repeat and abundancy information of banner yet furthermore gives

momentary information while in various changes transient information yet in another change is lost. Focus channel is utilized to anchor edges of the photograph and to check changes in neighbourhood and for performing smoothing operation wiener channel to be utilized. An electronic copy can be downloaded from the social affair website. For request on paper controls, you should contact the social event dispersions leading body of trustees as showed on the gathering site. Information about clear paper convenience is available from the get-together site.

Literature Survey

Discrete wavelet transform with Symlet and other filters based ultrasound image denoising algorithm given in [01] by A. K. Yadav *et al*. Strategies for expulsion of dot commotion from medicinal pictures in light of Multiresolution wavelet investigation and separating procedures has been proposed. In their investigation different de-noising strategies in view of PSNR, MSE and calculations handling time are analyzed. Qibin Fan *et al.* (2015), proposed a multi parameter regularization demonstrate for picture rebuilding in light of aggregate variation (TV) and wavelet outline. The distinction be-tween their calculation and different plans is that, the basic picture is initially isolated into two sections, at that point authorize two regularization things to the staying two sections while their calculation does not have to separate the picture, rather than which, add up to variety and framelets are specifically following up all in all picture in TV outline. Numerically, they receive the elective bearing strategy for multiplier (ADMM) to build up a quick and stable calculation and set up its meeting examination.

Zouhair Mbarki *et al*. (2016), in their paper proposed two phase calculation. The initial phase is to apply regularized de-convolution which takes place in Fourier domain by the statistical wiener filter. Reason for doing this to balance the degree of PSF and lessen corruptions. The later stage comprises in decay of coming about picture, which yet contains a noise part, into wavelet transform and reproduce it after setting the threshold level to the coefficients.

Lie wang *et al* (Wang, 2009) proposed wiener filter based image denoising algorithm. It considers the distinctive bearing block of image data in consideration of comparing rule by auto-adjusted wiener channel of wavelet, it also enhance picture by collateral form. By estimating the of the model parameters, consolidating auto-adaptive wiener filter of wavelet to de-noise corresponding coefficient of scale and its coefficient of wavelet, by using wavelet reconstruction the enhanced image is obtained. The experimental analysis shows that the algorithm retains the key characteristics of image while removing the noise. It achieves better enhancement of CT images. For ultrasound speckle noise suppression H. Rabbani *et al*., (2008), proposed nonlinear thresholding techniques with multiple scales. The combination of noise free component and noise represents the coefficients of wavelet for logarithm of image. Accepting some local mixture distribution is present in noise free component, and type of noise is either Gaussian noise or Rayleigh noise, minimum mean squared error is determined by them and averaged minimum is found for reduction of noise. To characterize the heavy tailed property of noise free wavelet coefficient Gaussian and Laplacian filters are used by authors.

Nasser Eslahi *et al*. (2016), suggested block based compressive sensing image restoration technique based on recursive curvelet thresholding, which considers regularization term and discrete curvelet transform as sparsifying transform. To overcome disadvantages like non adaptive and sensitive to noise nature of linear decay thresholding, an adaptive curvelet thresholding proposed. Another primary favourable position of utilizing discrete wavelet change is that after change it won't just give recurrence and sufficiency data of flag yet in addition gives fleeting data though in different changes transient data is lost (Kumar, 2012). Separating systems are utilized to enhance top flag to clamour proportion and to decrease mean square blunder subterranean insect to improve the edges and lines of the picture. There are numerous customary spot denoising strategies, for example, fleeting averaging (Yadav, 2015 and Qibin Fan, 2015), middle channel (Karaman, 1995) homomorphic Wiener channel, (Jain, 1989), and so on. The majority of them utilize a solitary scale channel. Be that as it may, single scale examination is deficient to get ideal denoising for ultrasound pictures. As of late, multi-determination innovation was acquainted with de-commotion ultrasound pictures. The contourlet change is a prevalent multi-scale portrayal for picture examination (Do, 2002). The important features of the contourlet change are the quick execution. This method is appropriate for denoising of ultrasound images (Huang, Mao-Yu, 2018). As specific smoothing process anisotropic diffusion is used. In the even area this smoothing system isn't constrained, yet transversely finished most remote point zone, it is kept.

Wavelet Families

Discrete Wavelet Transform: A discrete wavelet transform is type of transform in which wavelets are sampled discretely. Samples which is collected discretely is representation of complete waveform. DWT decomposes the signal into orthogonal set of wavelets. DWT has variable window size so that scaling can be possible and it requires less time for computation. The two dimensional wavelet transform is applied by using two one dimensional DWT one along the rows and another along the columns. This task divides the entire image in to four disintegrated sub-bands as Low sub-band, Low High channel, high low channel and high represented as LL, LH, HL and HH respectively. For multi-level decomposition the low sub-band is further decomposed into four levels, where L, H speaks to low and High recurrence groups separately. 1, 2 and 3 are the levels of decomposition.

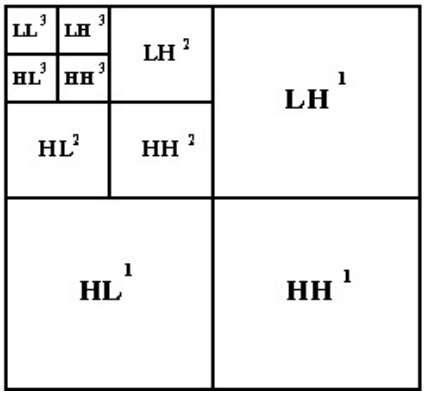

Fig. 1. 2-D DWT with three level decomposition

Haar Wavelet: Mathematically the Haar transform is a series of rescaled squared wave known as wavelet family or basis function. The Haar wavelet first introduced in 1909 by by Alfred Haar. Haar wavelet is simple in nature and it is easy to understand the operation on it. The Haar succession is currently perceived as the primary known wavelet premise it is quick and memory effective. It overcomes the problem associated with other transform as it is exactly reversible without affecting edge information.

Symlete Wavelet: Symlet wavelets are nothing but the Daubechies wavelets with increased symmetry. They both poses the same properties. Symlet wavelets are having 7 different functions from sym2 to sym8. In symN, N represents the order of Symlet. Symmetrical wavelets arranged in such way that they have least asymmetry and maximum number of vanishing moments.

Contourlet Transform: The contourlet transform is designed by combining laplacian pyramid and directional filter bank results in multi directional and multi scale filter (Po, 2006). The basic principle of applying multi scale decomposition after directional filter bank is key feature of contourlet transform. To catch the edge segregated breakpoints laplacian pyramid is used as first step. By at that point, by using two Directional filter bank the breakpoint a near way is blended into a line, which forms fundamental frame. In reality, the contourlet change can be viewed as the other execution procedure for the curvelet change. The curvelet has a superior than normal measure to the turned idiosyncrasy. As the curvelet is depicted in the relentless area, there are several issues when it is changed into the discrete space. In any case, the curvelet is a square based change. Along these lines the foreseen picture by the curvelet will make blocking and covering impact. The accentuation will expand in this way. Second, the curvelet is depicted in polar ways. It is hard to play out an instigate change for the picture in a rectangular oversee structure. A numerical game plan to see the curvelet as the stockpiling of wavelet coefficients has been exhibited (Jean-Luc Starck, 2002). That is, the edge data is seen by a most far off point like a wavelet work. The parts of the structures are seen by adjoining directional change.

Laplacian Pyramid

To realize the image multiresolution analysis laplacian pyramid is an effective way of decomposition. Each level of the Laplace decomposition generates down sampling part b which is low pass of image and qualification picture a. This system recursively decompose the low pass image part into another part b and a, results in n layer low pass images and n purposes of intrigue territory, these zones make up the pyramid picture breaking down.

Directional Filter Banks

To incorporate particular focuses an indistinguishable way from a coefficients directional examination is performed by directional channel bank. The directional sub-bands of DFB is distribution of band pass components of LP decomposition. Binary tree decomposition 1 layer is utilize to effectively implement directional filters in DFB. Binary tree decomposition generates 2l wedge shape frequency sub-bands. 2l parallel filter banks can be designed using DFB of 1l tree structure. The simplified DFB includes two stages. Beginning, a two-channel bank fragments the two-dimensional range into even level and vertical level, at that point a shearing administrator is utilized that just reorders the examples.

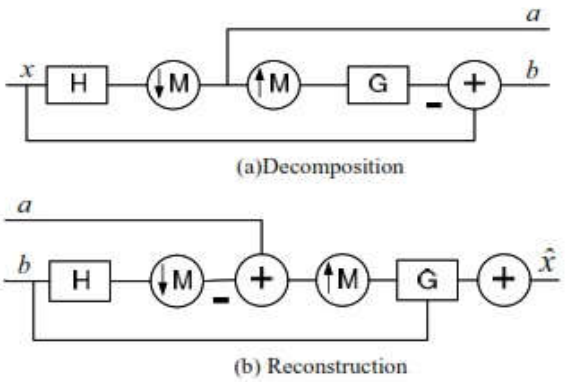

Fig. 2. LP decomposition and reconstruction

Image De-Noising Technique

Median Filter: Which is used to clear Speckle commotion, motivation clamor or spike commotion from the photo, Median filter is a special smoothening filter is used to improve the later outcome by removing noise from signal and preserves the edges. The median filter assumes essential part in picture process and representation. The middle channel execution comprises of ascertaining the middle of the dim level qualities among the square or rectangular channel window encompassing each pixel. Furthermore, organizes all the dark level qualities inside the rising request and chooses the center esteem and replaces the center pixel of that set.

Wiener Filter: Wiener channel is a direct channel. It alters nearby change Wiener channel performs little smoothing for high fluctuation. For low difference perform parcel of smoothing. It requires a considerable measure of calculation time. Image deformation in contourlet transform is two step process: First, laplacian pyramid filter is used to divide image into low recurrence sub-band and high recurrence sub-band. Through the process of two dimensional low pass shifting by interleaving and isolated segment examining low recurrence sub band is obtained. The low recurrence sub band is up sampled and low pass separated is used to keep the actual size of image. By subtracting low recurrence part from the underlying image the high recurrence part is obtained.

Performance Metric: The mean squared error speaks to the joined squared mistake between the compacted and the first picture. The lower the estimation of MSE means the less measure of blunder. Condition for computing MSE is given by:

$$MSE - \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M * N}$$

Where, I1 is the actual image, I2 is the compressed image to be assessed, m represents the number of rows, n represents no. of column. Peak Signal to Noise Ratio is the ratio between the most extreme conceivable intensity of info flag and the intensity of presented noise that influences the nature of portrayal. The formula for calculation of PSNR is given by:

$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right)$$

R is the greatest change in the info picture information compose. For instance, if the info picture has a twofold exactness drifting point information write, at that point R is 1. On the off chance that it has a 8-bit unsigned whole number information compose, R is 255, and so on dot commotion is decreased utilizing discrete wavelet change system. The higher the PSNR, the better the nature of the packed or recreated picture The PSNR square figures the pinnacle motion to-commotion proportion, in decibels, between two pictures.

EXPERIMENTAL RESULTS

As a methodology first speckle noise is added to the image and then filters are applied to reduce the effect of noise to some extent. Inverse discrete wavelet transform is used to obtain the original image back.

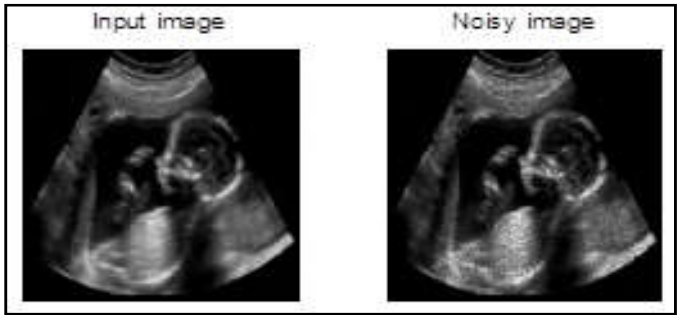

Fig. 3. Original Image and Noisy Image

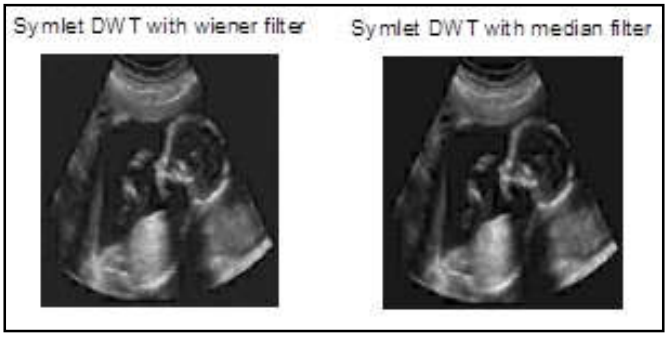

Fig. 4. Denoised Image using Symlet DWT with Wiener & Median filter

Fig. 5. Denoised image using Haar DWT with Wiener & Median filter

Performance of implemented methodology for denoising of ultrasound images is compared based on the different statistical parameters such as MSE, PSNR and computational time.

Table 1. Experimental result symlet and haar wavelet

Algorithm	MSE	PSNR	Computation time
Image with added speckle noise	22.9829	34.5167	0.1338
Symlet DWT with wiener filter	4.70491	41.4052	0.3593
Symlet DWT with median filter	0.0227	64.552	0.6694
Haar DWT with wiener filter	4.7281	41.3838	0.3576
Haar DWT with median filter	0.0234	64.4203	0.6629

Table 2. Experimental result symlet and haar wavelet

Input image	MSE		PSNR		Computation time	
	CT	CTAD	CT	CTAD	CT	CTAD
inp1.jpg	9.7479	4.7688	38.2416	41.3466	1.4990	1.9717
inp2.jpg	8.5828	4.2758	38.7944	41.8204	1.4645	1.8784
inp3.jpg	9.7809	5.1250	38.2270	41.0332	1.4292	1.7236

Conclusion

In one method performance of Haar and Symlet DWT with median and wiener filter is analysed. Ultrasound image is taken as input, known speckle noise is added to the input and output is obtained as noise free image. Symlet DWT with median filter gives best value of MSE & PSNR. In another method combination of Contourlet transform and anisotropic diffusion (CTAD) its gives better PSNR and MSE value but processing time is more than other Methods. The computational time for CTAD is more as compared to other methods. So for future scope the computational efficiency parameter can be consider for optimization.

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