A COMPARATIVE ANALYSIS OF WAVELET AND CURVELET TECHNIQUES FOR NOISE REMOVAL

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Abstract— This paper presents a comparative analysis of curvelet and wavelet transforms using thresholding technique to denoise an image corrupted with different kinds of noise. Usually, the process of transmission, receiving, and coding leads to noise. Firstly, we discuss the digital implementation of two recently developed multi-scale transform: wavelet and curvelet transform. Curvelet transform is a newly class of multi-scale transform as compared to wavelet transform. The main aim of this paper is to analysis the noise removal using wavelet and curvelet transforms. Here, we apply these two transforms to restore the image from the noisy image and compare the special effects of denoising on that image. The experimental results show that the denoising method by curvelet transform is better as compared to wavelet transform as it gives low mean square error (MSE) and high peak signal to noise ratio (PSNR).

Index Terms — Wavelets, curvelets, denoising, image.

I. INTRODUCTION

Digital image processing techniques also corrupt images with noise, leading to major reduction in quality of image. Usually, linear filters (wiener, mean and median filters) are used for removing noises from image, but it blurs information [1]. We know that wavelet transform is one of the best techniques of signal processing which can display the signals on in both frequency and time domain. Wavelet transform is one of the better approach to other frequency- time analysis tools because its time scaling width of window may be expanded to match the original data, especially in digital image processing [2, 3]. This makes it predominantly helpful for non-stationary signals analysis, such as transient and noise. For a discrete time signal, an important algorithm of discrete wavelet transforms (DWT) is the multi resolution analysis and it is a non-redundant decomposition. And one of the most accepted methods consists of thresholding of the wavelet coefficients using soft threshold or hard threshold as introduced by Zarmehi and Donoho. Elyasi proposed numerous techniques for noise removal from corrupted images with the Gaussian noise with the help adaptive wavelet transform [4, 5].

Main purpose of this work is to increase the PSNR in db and to reduce the mean square error (MSE) . To Design and implementation of a model for noise removal using wavelet and curvelet transforms with the help of multilevel decomposition techniques [6, 7]. Quantitative study would be perform by inspection attain Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) assessment of the denoised image. The random noise reduction is also the main decisive factor for determining the image superiority impartially.

II. WAVELET TRANSFORM

Wavelet transform can attain superior scarceness for spatially contained details, such as singularities and edges. In case of distinctive natural images, maximum coefficients of wavelet have very little magnitudes, apart from that big ones which have high frequency characteristic of that image like singularities and edges. DWT is indistinguishable to the hierarchical sub band systems [7]. The procedure for wavelet decomposition of an image is given as: In the 1st level of decomposition, the image is dividing into four subbands that are the LH, LL, HH and HL sub bands as shown in Fig 1. Figure shows that the HH sub band gives the detail of diagonal component of the image; and the HL sub band provides the horizontal charecterstics while the LH subband presents the vertical features [8, 9]. The LL subband is a low level resolution left behind consisting of low level frequency components and it is a subband which can be further divide into higher levels of decomposition [10].

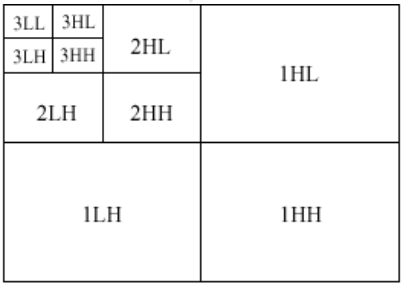

Figure.1 DWT based Wavelet Decomposition to various levels

The basic steps for all thresholding method are as follows:

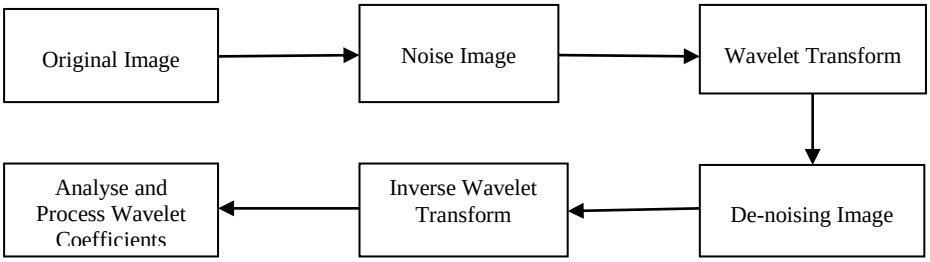

Figure 2: Process of image de-noising on wavelet transform

III. CURVELET TRANSFORM

Curvelet transform is a non-adaptive technique for the multi-scale object representation. Curvelet transform is an extension of the wavelet concepts. And the curvelet transform is becoming well-liked in related fields, namely in scientific computing and digital image processing. Curvelet transform is the multi-scale geometric wavelet transform that can represent curves singularities and edges much more efficiently than conventional wavelet transform. Curvelet transform combines the multi-scale analysis and the geometrical ideas to attain the best possible rate of convergence by the simple thresholding [11, 12]. The multi-scale decomposition finds the point discontinuities into linear structure. Curvelets with the variable length have a variable width and so a inconsistent anisotropy.

Curvelet transforms are the special members of the multiscale geometric transforms [13, 14]. Essentially, the Curvelet transform expands the ridgelet transform to the multiple scale analysis. The digital curvelet transform can be implemented by the fast discrete curvelets transforms [15, 16]. The curvelet and image are malformed into the frequency domain, and then convolve curvelets with images in the spatial province becomes the artifact in frequency domain. Lastly the coefficients of curvelet are calculated by using the inverse fouier transform on their spectral products. Figure 3 shows the basic procedure of image denoising using curvelet transform [4, 17].

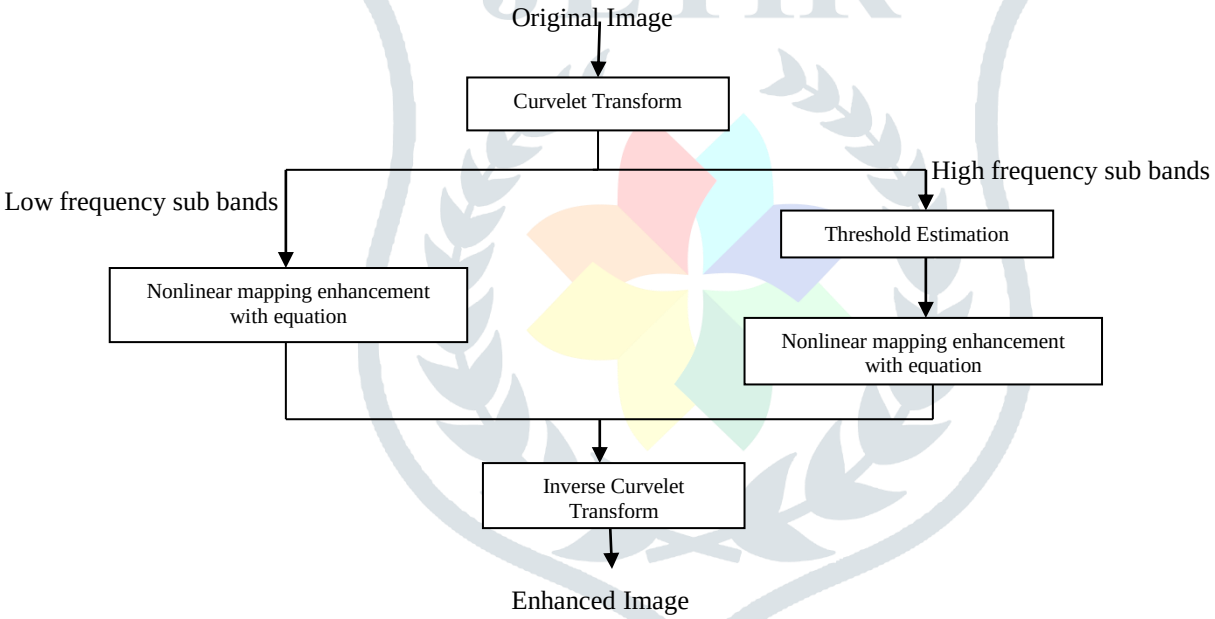

Figure 3: Process of image de-noising on curvelet transform

IV. PROPOSED WORK

In proposed work, we explain primary concept at image denoising which is based on a newly introduced class of transforms- Wavelet and Curvelet transform. Here, we show the comparison between the curvelet transform and wavelet transform and which transform is superior for noise removal. Our main aim is to increase the peak signal to noise ratio (PSNR) in db and to reduce a mean square error (MSE) by introducing a white noise like Poisson noise, Gaussian noise, and Speckle noise. Thresholding is a simple method for image segmentation. We can create binary images from a greyscale image using thresholding technique. It is also a simplest non-linear technique that can operate on single wavelet coefficient at a particular time. Each coefficient can be threshold by comparing against the threshold. If coefficient is lesser than threshold then set to zero, else it is set aside or personalized by replacing the little noise coefficients with zero. In both cases (Hard thresholding and Soft thresholding) the coefficients which are lower than a certain threshold are locate to zero.

V. EXPERIMENTAL RESULTS

In this paper, we have considered a image of a deer. In this image we used a different kinds of additive noises like Speckle noise, Gaussian noise and Poisson noise with different variance levels σ=0.1, 0.2, 0.3, 0.4 etc. And before introducing a noise the means value is always be zero.

Table.1: Comparison of PSNR (In db) using Wavelet and Curvelet with Different Noise

Noise	Noisy Images	Wavelet (Haar)	Curvelet
Speckle	30.3175	27.5320	34.6481

Gaussian	24.9821	26.3177	32.5695
Poisson	27.7774	27.0979	34.0178

Table 1. shows a comparative analysis of curvelet and wavelet with different noises and we calculate the peak signal to noise ratio (in Db).

Table.2: Comparison Of MSE using Wavelet And Curvelet With Different Noise

Noise	**Noisy Images MSE**	**Wavelet(Haar) MSE**	**Curvelet MSE**
Speckle	60.4406	114.7811	22.2981
Gaussian	206.4762	151.8122	35.9851
Poisson	108.5620	126.8472	25.7805

Table 2. shows a comparative analysis of curvelet and wavelet with different noises. We calculates the mean square error(MSE). Figure 4 and figure 5 show the de-noising using wavelet and curvelet transform respectively.

Figure 4: Image de-noising using wavelet transform

Figure 5: Image de-noising using curvelet transform

VI. CONCLUSION

A comparative analysis of de-noising using wavelet and curvelet transform is presented in this paper. The results show that the curvelet technique of denoising gives the superior results as compared to wavelet technique. The main objective of the de-noising is to eliminate the noise without losing important details contained in a particular image. To get this aim, we use some mathematical functions which are known as wavelet transform and curvelet transform. The major advantage of the curvelet transform & wavelet transform is that the image reliability after restoration is visually lossless. After analysis, the results show that the image denoising by curvelet technique is better as compared to wavelet transform as it gives low mean square error (MSE) and high peak signal to noise ratio (PSNR).

REFERENCES

[1] Shallu, Ekta Aggarwal, Rajesh Mehra: A Study on Adaptive Wavelet Technique for Speckle Noise Removal, Communication and Computing Systems,(2017).

[2] A. Achim, P. Tsakalides: SAR image de-noising via Bayesian wavelet shrinkage based on heavy-tailed modelling. IEEE Transaction on International Geo-science and Remote Sensing, (2012).

[3] A. Ben Hamza, Hamid Krim: Image De-noising: A Nonlinear Robust Statistical Approach. IEEE Transaction on Signal Processing, Vol.49, No. 12, (2013).

[4] Buddhi Prakash Sharma , Rajesh Rana , Rajesh Mehra: Face Recognition Using Gabor Wavelet for Image Processing Applications, Proc. of Int. Conf. on Emerging Trends in Engineering and Technology,(2013).

[5] Aleksandra Pizurica, Wilfried Philips, Ignace Lemahieu, Marc Acheroy: A Versatile Wavelet Domain Noise Filtration Technique for Medical Imaging. IEEE Transaction on Medical Imaging, Vol. 22, No. 3, (2006).

[6] Tanuj Yadav, Rajesh Mehra: Denoising and SNR Improvement of ECG Signals Using Wavelet Based Techniques, 2016 2nd International Conference on Next Generation Computing Technologies (NGCT-2016) Dehradun, India 14-16 October 2016.

[7] Ashish kumar Dass, Rabindra kumar Shial, Bhabani Sankar Gouda: Improvising MSN and PSNR for Finger-Print Image noised by Gaussian and Salt & Pepper. The International Journal of Multimedia & Its Applications (IJMA) Vol.4, No.4, (2012).

[8] Sugreev Kaur, Rajesh Mehra: High Speed and Area Efficient 2D DWT Processor based Image Compression, Signal & Image Processing, 2010.

[9] Shallu, Yogendra Narayan, Pankaj Nanglia,"A Comparative Analysis for Haar Wavelet Efficiency to Remove Gaussian and Speckle Noise from Image" in IEEE International conference 'INDIACom-2016' on 'Computing for Sustainable Global Development', pp. 2361-2365. (Electronic ISBN: 978-9-3805-4421-2, DVD ISBN: 978-9-3805-4420-5, Print on Demand(PoD) ISBN: 978-1-4673-9417-8).

[10] Levent Sendur, Ivan W. Selesnick: Bivariate Shrinkage Functions for Wavelet-Based De-noising Exploiting Inter scale Dependency. IEEE Transaction on Signal Processing, Vol. 50, No. 11, (2011).

[11] M. Antonini, M. Barlaud, P. Mathieu, I. Daubechies: Image coding using wavelet transform. IEEE Transaction on Image Processing, Vol. 1, No. 2, (2007).

[12] Mahalakshmi B.V and Anand M.J: Adaptive Wavelet Packet Decomposition for Efficient Image De noising By Using Neigh Sure Shrink Method. The International Journal of Computer Science and Information Technologies, Vol. 5 (4), 2014.

[13] R. C. Gonzalez, R.E. Woods Steven L. Eddins: Digital Image Processing using MATLAB. Published by Gatesmark, (2009).

[14] Shweta Gupta, Sumit Kumar, "Variational Level Set Formulation and Filtering Techniques on CT Images" in International Journal of Engineering Science & Technology (IJEST) ISSN: 0975-5462, vol.4 no.7, (3509-3513) Jul 12.

[15] S. Kother Mohideen, Dr. S. Arumuga Perumal, Dr. M.Mohamed Sathik: Image De-noising using Discrete Wavelet Transform. International Journal of Computer Science and Network Security, Vol. 8, No.1, (2008).

[16] Shallu, Sumit Kumar, Ekta Aggarwal"A study on Adaptive Wavelet Technique for Speckle Noise Removal" in Taylor & Francis International conference on 'Communication and Computing Systems', pp. 131-136,(ISBN-9781138029521).

[17] Zhaohui Zeng, Ian Cumming: Bayesian Speckle Noise Reduction Using the Discrete Wavelet Transform. International Geo-science and Remote Sensing Symposium, (IGARSS-98), Seattle (2009).