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APPRAISAL AND ANALOGY OF MODIFIED DE-NOISING AND LOCAL ADAPTIVE WAVELET IMAGE DE-NOISING METHODS

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Abstract— **Removal of noise is a determining track in the image rebuilding process, but denoising of image remains a claiming problem in upcoming analysis accomplice along image processing. Denoising is utilized to expel the noise from corrupted image, where as we need to maintain the edges and other detailed characteristics almost accessible. This noise gets imported during accretion, transmitting & receiving and storage & retrieval techniques. In this paper, to discover out denoised image the modified denoising technique and the local adaptive wavelet image denoising technique can be obtained. The input (noisy image) is denoised with the help of modified denoising technique which is form on wavelet domain as well as spatial domain along with the local adaptive wavelet image denoising technique which is form on wavelet domain. In this paper, I have appraised and analyzed achievements of modified denoising technique and the local adaptive wavelet image denoising technique. The above procedures are contemplated with other based on PSNR between input image and noisy image and SNR between input image and denoised image. Simulation and experimental outgrowth for an image reflects as the mean square error of the local adaptive wavelet image denoising procedure is less efficient as compare to modified denoising procedure including the signal to noise ratio of the local adaptive wavelet image denoising technique is effective than other approach. Therefore, the image after denoising has a superior visual effect. In this paper, these two techniques are materialized with the help of MATLAB for denoising of image.**
Keywords— ***Adaptive wiener filter; noise removal method (denoising); PSNR; Wavelet transform.***

I. INTRODUCTION

Digital images consist a vital role both in daily life utilization such as satellite, tomography along with areas of research and technology such as information about geographical systems and astrograph. In actuality, an image is combined along assured quantity of noise which reduces visual class of image. Henceforth, taking away of noise in an image is an extremely ordinary complication in current study in image processing. An image achieve perverted with noise throughout accretion or on transmission due to channel erratum or else in storing the media due to faulty hardware. Eliminating noise out of the noisy image is yet a demanding difficulty for researchers.

Noise can be categorised as impulsive noise (example: salt and pepper noise, random valued impulse noise, etc.), additive noise (example: additive white gaussian noise) and multiplicative noise (example: speckle noise). On the other hand, in this project the analysis has been confined to additive white gaussian noise. In common, the intention of noise eliminating scheme is to abolish noise and also to conserve information and edges of image as much as feasible.

Elimination of noise is essential in the image processing. Fig. 1 represents the necessary model for denoising of image. In the application of these techniques, initially the noisy image is decayed with the help of wavelet transform. Hereafter, by utilising thresholding shrink decayed images and assign adaptive wiener filter to decayed images. Ultimately denoised image is achieved by use of inverse wavelet transform as revealed in fig.1.

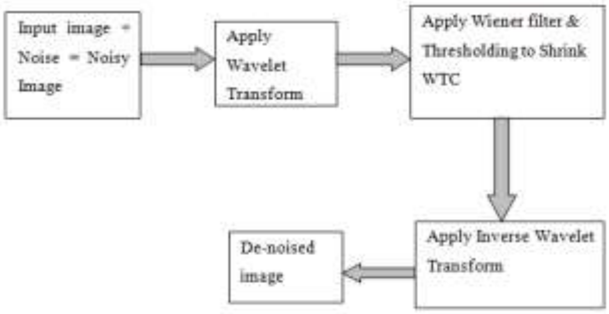


Fig.1 Basic model for de-noising of image.

In the current year most of the denoising methods in wavelet domain rely upon threshold range and shrinking of wavelet transform coefficients used for image denoising. Wavelet decays the image and aparts noisy signal as of from original signal on suitable base as in [1]. Adaptive wiener filtering is individual of filtering techniques to eliminate the noise out of noisy images. Due to its ease and efficiency, additional concentration is given on wavelet based adaptive wiener denoising as per in [3]. Modified wiener filter is projected by C. M. Leung as well as W. S. Lu which is put on display that how can the conventional wiener filters can be enriched for the rebuilding of blurred images in [4]. Later on a variety of wavelet base wiener filtering and thresholding techniques have been projected in [5], [6], [7], [8], [9], [10], [11], [12] and [14]. On the other hand, in this paper, I have measured two different approaches to denoise the image. In these approaches, the adaptive wiener filter is working to reduce additive noise i.e. AWGN in noisy image.

In modified denoising technique which is form on wavelet domain as well as spatial domain, wavelet transform is utilized for decay of image other than this wavelet domain adaptive wiener filtering has a few limitations. To overwhelm on these limitations, we need a modified denoising technique for image denoising which is formed on grouping of wavelet and spatial domain adaptive wiener filtering and outputs of this modified denoising technique which can enlarge by the use of local adaptive wavelet image denoising technique in which 1-D window is obtained in wiener filter design.

In this paper, the two approaches performances are analoged using Matlab. At last the comparisons of the outputs are achieved by denoising methods.

II. LOCAL ADAPTIVE WIENER FILTERING

In the year 1994 Norbert Wiener posed the approach of optimal filter known as wiener filter [2] which is capable of obtaining sufficient outcomes for image denoising. Due to its integrity and efficiency, we apply adaptive wiener filter in modified denoising technique and the local adaptive wavelet image denoising technique.

Believe an image is contaminated with additive Gaussian white noise. The noisy image can be represented as:

$$o(i,j) = a(i,j) + n(i,j) \quad \textbf{(1)}$$

Where o(i,j) is the noisy image, x(i,j) is the original image and n(i,j) is additive gaussian white noise. The ambition in the Image denoising is to repress noise as of noisy image by means of bare minimum mean square error. At this time, the wiener filter decreases the mean square error among the estimated image a^(i,j) and the original image a(i,j). This fault can be computed as:

$$e^2 = E[(a(i,j) – ax^{\wedge}(i,j)^2] \quad \textbf{(2)}$$

Wiener filters the image or the input with the help of pixel-wise adaptive wiener filtering, with the use of neighbourhoods of size M-by-N to approximate the local image mean and standard deviation of the image. At this point it takes into consideration that the noise is immobile by means of zero mean and variance not correlated along the real one. Rooted in these assumptions wiener filter finds local mean and variance around each pixel using (3) and (4) as shown below:

$$\mu = \frac{1}{NM}\sum_{i,j\in k} o(i,j) \quad \textbf{(3)}$$

$$\sigma^2 = \frac{1}{NM}\sum_{i,j\in k} o^2(i,j) - \mu^2 \quad \textbf{(4)}$$

Where (3) is considered as local mean and (4) is considered as local variance.

If noise variance is not given, wiener filter utilises common of all local evaluated variances. The simple form wiener was acknowledged in [13].

III. MODIFIED DENOISING TECHNIQUE

Wavelet transform (WT) has been a dominant as well as extensively used implement in image denoising due to its energy condensation and multi-resolution effects. It overwhelms many boundaries of Fourier transform along with its capability to symbolize a function concurrently in frequency and even in time domain. In WT, DWT (Discrete wavelet transform) i.e. significantly sampled appearance of WT gives most condensed form of demonstration. Consequently, in this paper the DWT is used to the image for parting of horizontal, vertical and diagonal information of the image. We relate the DWT based on the Haar wavelet.

Thus previously we continue, we provide a small opening to the Haar wavelet. The Haar wavelet is the first and foremost well known wavelet and was projected by Alfred Haar in 1909. This wavelet is the easy out of all wavelets and its process is effortless to recognize. Haar wavelets contain their boundaries also. They are piecewise constant so for this reason it makes irregular, blocky alikeness. There are quite a lot of other wavelets obtainable like the Daubechies wavelet, Donoho's wavelet, Meyer wavelet, etc. On the other hand these wavelets are not that easy to understand and are also calculation part is concentrated.

As the wavelet coefficients are intended by a wavelet transform. Afterwards it is probable to filter out the noise out of wavelet coefficients by the help of wiener filter.

Wavelet transform disintegrate image into sub images and build simple to remove the noise the image. Usually, the reason of denoising is to take away the noise at the same time as retain the edges and all other detailed characteristics as much as probable. However while we utilize wavelet domain adaptive wiener filtering to get rid of noise, the outputs are not pleasing since image suffers on or after more ripples such as artefacts i.e. ringing effects of image along edges and it gives lower peak signal to noise ratio (PSNR). Fig. 2 represents a case of image with the ringing effect and with no ringing effect. This reduces the visual value of denoised image.

(a) (b)

Fig. 2 a) Image with ringing effect and b) Image without ringing effect

This will have an effect on our final objective which is to decrease noise as of noisy image and to protect particulars and edges of image as greatly as probable. One of the behaviour is to explain this crisis is to utilize a modified denoising technique which is based on grouping of together wavelet domain adaptive wiener filtering as well as the spatial domain adaptive wiener filtering.

In this kind, denoising or removal of image has been accepted out initially on the base of adaptive wiener filtering in the wavelet domain and after that on the source of an adaptive wiener filter in the spatial domain. In the execution of this technique, initial a pre-denoised image is acquired by means of the thresholding in the wavelet domain.

After that an adaptive wiener filtering in spatial domain is functional to the rebuilt image to get better precision. At this point, the spatial wiener filtering is one among the classical linear filtering method in the spatial domain, although the wavelet domain wiener filtering is one of a new signal evaluation process. To figure a modified denoising technique, we can unite the techniques of the image denoising in spatial domain and the one of them in wavelet domain.

In this technique, to denoise or to remove noise from the image following steps has to be followed:

- Primarily select or consider an image, ensure, whether its gray image or color image? If it’s a color image then convert this image into gray image. Then utilize it as an input image.
- The next action will be to employ wavelet transform (DWT) to decay the noisy image therefore it’s divided into 4 sub images: LL, HL, LH, and HH. Following

this take on wiener filter for LL sub image and employ thresholding to rest of the sub images.

- Then rebuilt image with the help wavelet inverse transform, and get the denoised image.
- Wiener filter as well adopt to obtain denoised image by spatial domain adaptive wiener filtering and even we obtain denoised image with the help of Wavelet.
- To obtain the result of modified denoising technique once again apply wiener filter to it.
- At last, calculate PSNR among original image and noisy image and PSNR among the denoised image and original image, to make sure a match among wavelet domain adaptive wiener filtering and spatial domain adaptive wiener filtering.

SDWF diminish the mean square error among denoised image and original image and evaluation of denoised image is recognized in [13].

The major advantage of this technique is that it decreases ripples similar to artefacts just around image edges. Henceforth the denoised image has an improved visual result. Fig.3 represents the denoised images that have denoised by modified denoising technique, denoising or removal of noise of image in spatial domain, by wavelet and denoising of image in both domains. It can be seen that the visual superiority of denoised image which is been obtained by modified denoising technique is improved than other techniques.

IV. THE LOCAL ADAPTIVE WAVELET DENOISING TECHNIQUE

Local adaptive wiener filter in the wavelet domain can be utilised to get better the signal to noise ratio of the image. We can improvise the PSNR outcome of modified denoising method with the help of local adaptive filters in this technique. Local adaptive filters will be able to obtain from several 1-D windows which is been constructed on the direction character of the sub image within the wiener filter. We can utilize 1-D windows for the LH, HL as well as HH sub images as given in fig. 5 as of from left to right.

Variety of 1-D window structure must be utilized to calculate approximately the mean and variance of sub-image. Fig. 4 represents the shape of the 1-D window [15].

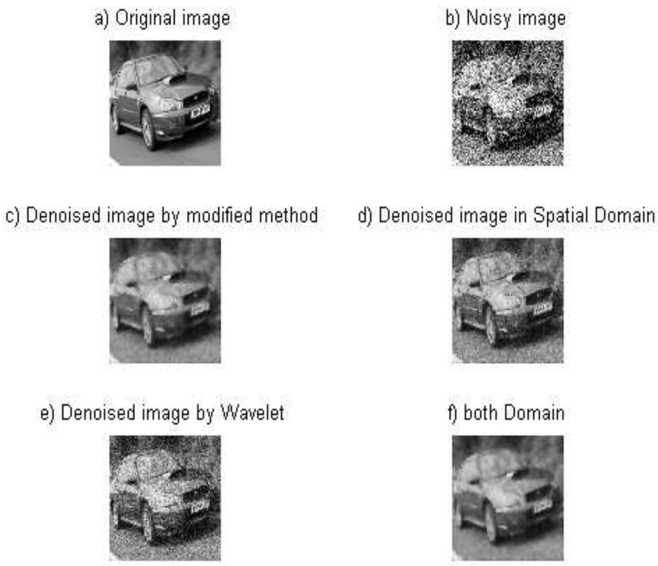
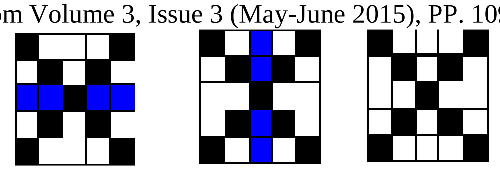


Fig.3 Image denoised by modified denoising technique.



(a) (b) (c)

Fig.4 1-D window structures: from left to right:
a) 1-D windows for LH,
b) 1-D windows for HL
c) 1-D windows for HH.

In this current paper, to get better signal to noise ratio of image by local adaptive wavelet image denoising technique following steps has to be followed:

- Primarily we use wavelet transform (DWT) i.e. Daubechie4 wavelet to decay the noisy image therefore it’s divided into 4 sub images: LL, HL, LH and HH.
- The next move will be to construct local adaptive filters with the help of more 1-D windows on the direction facts enclosed in each sub image.
- Following this pertain wiener filter for LL sub image and use equally local adaptive filters and thresholding to left over sub images.
- After that rebuild image by wavelet inverse transform and we will get the denoised image as output.
- At last, to compute PSNR among original image and noisy image and PSNR among the denoised image and original image.

Out of Fig. 5 it is obvious that the local adaptive wavelet image denoising technique with the direction characteristic enclosed in the sub images might suppress additive gaussian white noise and also preserves the edge of image.

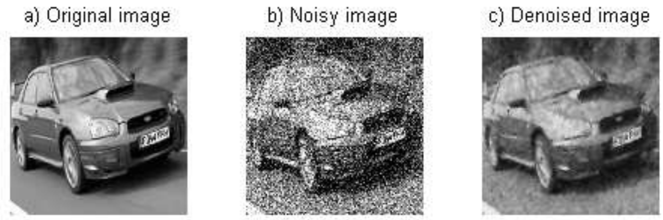


Fig.5 Image denoised by the local adaptive wavelet image denoising technique

V. RESULT

The accomplishment of both the technique for denoising of image were evaluated on the basis of greyscale images as Lena image, 106-subaru-impraza (car), Red flower, Beach, Beach2 and so on at noise variance 0.05. At this point, in this paper for the accomplishment valuation we will take into consideration that the car image is with the resolution of 256×256.

The visual quality of an image is been evaluated by purpose assessment as well as subjective assessment. For subjective assessment, the image must be experimented by a human professional. Although the human visual system (HVS) is so complex and it will not give the precise visual quality of image.

There are different number of metrics utilised for the aim of assessment of an image. A number of them are mean square error (MSE) and also peak signal to noise ratio (PSNR). Mean square error (MSE) is been represented in the equation (2) and one more significant parameter is peak signal to noise ratio (PSNR). Peak signal to noise ratio (PSNR) is measured for assessing the visual quality of the denoised image. It’s been expressed in logarithmic scale whose unit is dB. PSNR is a ratio of peak signal power to noise power.

$$PSNR = 10\log 10 \frac{M.N.255^2}{\sum_{i=0}^{M-1} \sum_{j=0}^{N-1}(a(i,j) - a^\wedge(i,j)^2}$$

Where a(i,j) is the original noise-free image, y(i,j)is the noisy image, and the filtered image be illustrated as a^(i,j). Here, I and j illustrate the discrete spatial coordinates of the digital images. And the size of images is M×N pixels, i.e. i=1,2,3,…,M, and j=1,2,3,…,N.

Table 1 and Table 2 demonstrate the outcome of Lena image, 106- subaru-impraza (car), Red flower, Beach, Beach2 and Peppers images by modified denoising technique and the local adaptive wavelet image denoising technique at noise variance 0.05, correspondingly.

TABLE I. PSNR RESULTS OF MODIFIED DENOISING METHOD FOR 106-SUBARU-IMPRAZA(CAR), LENA, RED FLOWER, BEACH, BEACH2 AND PEPPERS IMAGES AT NOISE VARIANCE 0.05.

Images	Noisy Image	Modified Method	Spatial Domain	Wavelet	In Both Domain
106subaru-impraza (car)	13.8489	22.4287	21.7254	19.1450	22.2101
Lena	13.6494	23.4258	22.1679	19.1308	23.3198
Red flower	13.5685	25.6633	22.7976	19.3975	25.8451
Beach	13.6629	26.4078	22.8705	19.5483	26.8683
Beach2	13.7278	26.1827	22.7218	19.5011	26.5645
Peppers	13.9997	21.3503	21.3890	19.1428	20.8398

From table no. 2 it can be observed that local adaptive wavelet image denoising technique gives higher PSNR among denoised image and original image than the modified denoising technique. We can say display effects of denoised image will exclusively depend on the PSNR values. However as we increase variance level, the peak signal to noise ratio (PSNR) decreases.

TABLE II. PSNR RESULTS OF THE LOCAL ADAPTIVE DENOISING METHOD FOR 106-SUBARU-IMPRAZA(CAR), LENA, RED FLOWER, BEACH, BEACH2 AND PEPPERS IMAGES AT NOISE VARIANCE 0.05.

Images	Noisy image		The local adaptive wavelet image denoising method	
	RMSE	PSNR	RMSE	PSNR
106-subaru-impraza (car)	51.7370	13.8548	17.1159	23.4628
Lena	53.2291	13.6078	15.4871	24.3314
Red flower	53.0552	13.6363	13.1348	25.7624
Beach	52.8117	13.6762	12.9464	25.8878
Beach2	52.6835	13.6973	12.9861	25.8612
Peppers	51.1171	13.9595	19.4468	22.3538

VI. ANALOGY OF BOTH TECHNIQUES

The analogy of both techniques will be probable as the most of the steps are identical but change in methods. In this paper Haar wavelet transform as well as Daubechie4 wavelet are utilised for modified denoising technique and the local adaptive wavelet denoising technique, correspondingly.

Out of the table no.3 it can easily be implicit that RMSE of modified denoising technique is better as contrast to the local adaptive wavelet image denoising technique at different noise variance steps. But in different way we can utter that the PSNR of the local adaptive wavelet image denoising technique is high than modified denoising technique.

TABLE III. COMPARISON OF BOTH METHOD WITH PSNR BETWEEN ORIGINAL AND DENOISED IMAGE AT DIFFERENT NOISE VARIANCE LEVEL.

Noise Variance	PSNR in db		
	Noisy image	Modified denoising method	The local adaptive wavelet image denoising method
0.05	13.8489	22.4287	23.4628
0.1	11.5180	20.7711	21.2357
0.15	10.3545	19.6614	19.8178
0.2	9.6045	18.8588	18.9278
0.25	9.1220	18.2660	18.3018
0.3	8.7022	17.7009	17.7499
0.35	8.3902	17.2069	17.2419
0.4	8.1842	16.9228	17.0181

VII. CONCLUSION

The removal of noise from image is first move in image processing. The class of the denoised image is based on two major parts: wavelet transform for decay of image and adaptive wiener filtering which is in both wavelet domain as well as spatial domain. The appraisal of the local adaptive wavelet image denoising technique is good as that to modified denoising technique in terms of PSNR among denoised image and that of original image. Therefore, from these outcomes it can be finished that the local adaptive wavelet image denoising technique is more successful and efficient for repression of noisy image with AWGN compared to others. Therefore the image after removing noise have better visual effects and preserve the feature edges of image.

VIII. ACKNOWLEDGEMENT

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REFERENCES

[1] Donoho D L, "Denoising by soft-thresholding", IEEE Transactions on Information Theory, Vol. 41, No. 3, pp. 613-627, 1995.

[2] Gonzalez.R.C and. Wood R.E, "Digital Image Processing", 2nd edition, New Jersey Prentice Hall, 2002.

[3] Jin F,Fiegush, P,Winger L et al., "Adaptive Wiener filtering of noisy images and image sequences", Proceedings of the IEEE International Conference on Image Processing, ICIP,Vol.3, pp.349-352, 2003.

[4] Leung C.M., Lu W.S., "Modified Wiener filter for the restoration of blurred images", IEEE Pac Rim Conf Commun Comput Signal Process, pp. 166-169, 1993.

[5] Ick Hoon Jang and Nam Chul Kim, "Locally Adaptive Wiener Filtering In Wavelet Domain for Image Restoration", IEEE TENCON – Speech and Image Technologies for Computing and Telecommunications, pp.25-28, 1997.

[6] Huipin Zhang,Aria Nosratinia and R. 0.Wells, "Image Denoising Via Wavelet-Domain Spatially Adaptive FIR Wiener Filtering", IEEE Trans., pp.2179-2182, 2000.

[7] Marian Kazubek, "Wavelet Domain Image Denoising by Thresholding and Wiener Filtering", IEEE Signal Processing Letters, Vol.10, No.11, pp. 324-326, November 2003.

[8] Israr Hussain and Hujun Yin, "A Novel Wavelet Thresholding Method for Adaptive Image Denoising", IEEE, ISCCSP Malta, pp.1252-1256, 2008.

[9] 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, IJCSNS, Vol.8 No.1, pp.213-216, January 2008.

[10] Li Ke, Weiqi Yuan and Yang Xiao, "An Improved Wiener Filtering Method in Wavelet Domain", IEEE Trans., ICALIP, pp.1527-1531, August 2008.