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Wavelet based Image Denoising using Weighted Highpass Filtering Coefficient and Exposure based Sub-Image Histogram Equalization Enhancement Technique

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ABSTRACT

Image processing (IP) is an approach to convert an image into digital shape and carry out a few operations on it to attain some beneficial statistics from it. The main intention of image processing is to visualization, Image polishing and healing, and picture retrieval, dimension of sample, picture popularity. In Digital Image Processing (DIP), the images are more prone to noise due to image capture and transmission. Digital images (DI) are contaminated via numerous varieties of noises which include Gaussian, Speckle and Impulse noise. There are numerous technique of denoise image. The most necessary property of ID model is that it should completely reduce noise as much as possible and edge preservation. This paper gives an insight view of some major work in the field of ID. This study affords a robust-discrete wavelet transform (DWT)-Discrete cosine Transform (DCT) based approach that denoises the image by adding weighted high pass filtering coefficients in wavelet domain. Thereafter denoised algorithm further enhanced by Exposure based Sub-Image Histogram Equalization (ESIHE) that is the novelty of the proposed work. Experimental results show that proposed algorithm enhances the denoising performance measured in terms of performance parameter and gives better visual quality. Mean Square Error (MSE), Root Mean Square Error (RMSE) and Peak Signal to Noise Ratio (PSNR) used as a performance parameters which degree the feature of an picture.

Keywords— Discrete Cosine Transform (DCT); Discrete wavelet Transform (DWT); Weighted High pass Filtering Coefficients (WHFC); Exposure based Sub-Image Histogram Equalization (EISHE); PSNR; MSE; RMSE.

I .INTRODUCTION

Digital image (DI) performs an essential position in our each day lifestyles and inside the region of studies and technology. When the DI is transmitted from one location to some other vicinity, for the duration of the transmission noise is introduced into the photograph. Any shape of sign processing having picture as an enter and output is known as IP. Due to the imperfection of the devices used within the IP, noise can be generated .The interference for the duration of the transmission degrades the statistics. Noise also can be generated via the transmission errors and compression. Different styles of noises are added with the aid of distinct noise resources like darkish cutting-edge noise is due to the thermally generated electrons at sensor sites. Noise degrades the photo best that’s why there's a want to denoise the picture to repair the excellent of picture. There are diverse methods which are help to do away with the noise from the digital picture. But choosing the correct technique is performs essential position in getting the preferred picture. The techniques used to denoise the satellite picture

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and clinical picture are exceptional, Therefore the ID approach used for satellite tv for pc photograph isn't always appropriate for denoising the medical image.[1]

Noise that arises inside the image are impulse noise (Salt and pepper noise (SPN)), additive noise (Gaussian noise (GN)), and multiplicative noise (Speckle noise (SN)). Different noises have their very own traits which make them distinguishable from others.

Image denoising is an important pre-processing step for image analysis. Researchers still continue to focus on it to obtained better quality of visual assurance because denoising removes noise but introduces artifacts and also causes blurring. In this paper, a brand new set of rules based totally on wavelet transform is proposed on the way to take away the noise from the noisy photo by way of adding ESIHE. Thereafter still resultant image is visually blurred. This blurriness would be minimized by adaptive wiener filter which gives better visual appearance. [2]

The structure of the paper is prepared as follows, in section II, the evaluation of using noise and filter and strategies. Section III describes the literature survey. IV describes the proposed set of rules. V. Experimental consequences to illustrate the overall performance of the proposed set of rules are given in segment VI. And eventually segment concludes this paper. [3]

II NOISE TYPE , FILTERS AND METHODS

1) Salt-And-Pepper Noise (SPN)

SPN additionally referred to as impulsive noise or spike noise. In this sort of noise, the picture is debased by white and dark spots on it, having dim pixels in brilliant districts and splendid pixels in dull locales. Highly contrasting dab in the picture have some noise esteem i.e. 0 and 1 separately. This noise is created because of simple to-advanced converter mistakes and bit blunders. Dead pixels deliver a comparable however non-arbitrary show in a LCD screen.

2) Gaussian Noise

Gaussian noise is otherwise called enhancer noise or electronic noise as it produces from speaker or finder. It utilizes Gaussian conveyance i.e. Standard conveyance. It is brought substance in nature, every pixel is loose and flag force of each pixel is also self sufficient. [4].

A. Discrete Wavelet Transform (DWT)

DWT is a way for analyzing multi-stage signal it can analyze the signal at distinct frequency bands with unique resolutions with the aid of decomposing it into approximation and special intonations. The precept of the set of rules is to divide the picture into four at each iteration, three blocks at the details of the picture (LH, HL, HH), and the fourth (LL) corresponds to the most important facts for the eye (low frequencies), which serves basis for the following iteration. To decompose this picture into sub photo we use: excessive and low pass filters (LPF). The DWT can be expressed as follows:[5]

$$X_f(a_2 b) = \int_{-\infty}^{+\infty} f(t).\frac{1}{\sqrt{a}}' \qquad (1)$$

B. Discrete cosine transforms (DCT)

First of all image is segmented into non overlapping blocks of 8x8. Then every of those blocks ahead DCT is implemented. After that some block selection criteria is applied and then coefficient selection criteria is applied.

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$$y(j,k) = \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\alpha_j\alpha_k\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\{x(m,n) * \cos\frac{(2m+1)j\pi}{2M}\cos\frac{(2n+1)k\pi}{2N}\}$$

$$\alpha_j = \begin{cases}\frac{1}{\sqrt{2}} & j = 0 \; or \; j = 1,2, \\ 1\end{cases} \qquad (2)$$

$$\alpha_k = \begin{cases}\frac{1}{\sqrt{2}} & k = 0 \; or \; k = 1,2,. \\ 1\end{cases} \qquad (3)$$

1. Weiner Filter (WF):

WF approach requires the facts approximately the spectra of noise and authentic signal and it works well best if the underlying signal is clean. Weiner technique implements the spatial smoothing and its version complexity manage correspond to the deciding on the window length. WF supposes noise and electricity spectra of factor a priori. The purpose of the WF is to clear out the noise that has corrupted a signal. This filter out is based totally on a statistical approach. WF addresses the filtering of a picture from a different view. The aim of WF is reduced the suggest rectangular mistakes as an awful lot as possible. This filter out is able to reducing the noise and degrading function. We used the Linear Time Invariant filter which offers output similar as to the unique signal as plenty feasible [3].

2. Mean Filter:

The mean filter is a simple spatial filter. It is a sliding-window filter that replaces the center value in the window. It replaces with the common mean of all the pixel values in the kernel or window. The window is normally rectangular however it could be of any shape. It does now not maintain info of picture. Some information are removes of picture with the use of the suggest clear out.

3. Median Filter (MF):

Median [3] Filter is an easy and effective non-linear filter that is based order statistics. It is straightforward to implement method of smoothing picture. MF is used for reducing the amount of depth variation between one pixel and the opposite pixel. In this filter, we do not replace the pixel fee of image with the mean of all neighboring pixel values, we replaces it with the median price. Then the median is calculated by means of first sorting all of the pixel values into ascending order and then update the pixel being calculated with the middle pixel value. If the neighboring pixel of picture that's to be taken into consideration consists of a good numbers of pixels, than the average of the two middle pixel values is used to update. The MF offers nice result whilst the impulse noise percent is much less than .1 %. When the amount of impulse noise is multiplied the MF no longer gives first-class end result.

III .EXPOSURE BASED SUB-IMAGE HISTOGRAM EQUALIZATION (ESIHE)

It is technique used for contrast enhancement of low contrast grey scale picture. Exposure thresholds are computed to divide the original image into sub-pictures of various depth stages. The histogram is likewise clipped using a threshold price as an average wide variety of gray degree occurrences to manipulate enhancement fee. The character histogram of sub images is equalized independently and ultimately all sub pix are included into one entire picture for analysis.

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Poor evaluation photos do not occupy complete dynamic range. Images having histogram boxes concentrated toward a lower part or the darker gray stages possess low depth publicity whereas picture having histogram containers concentrated closer to a better element or the brighter component own excessive intensity exposure. Images may be extensively labeled as below uncovered and over exposed based at the intensity exposure. In this section, the algorithm of ESIHE is supplied. The algorithm consists of 3 steps, namely Exposure threshold calculation, histogram clipping and Histogram Sub Division and Equalization.

3.1 Algorithm of ESIH

Step 1: Compute the histogram h(k) of image.

Step 2: Compute the value of exposure and threshold parameter Xa.

$$exposure = \frac{1}{L}\frac{\sum_{k=1}^{L} h(k)k}{\sum_{k=1}^{L} h(k)} \tag{4}$$

Where h(k) is histogram of image and L is total number of gray levels.

$$X_a = L(1 - exposure) \tag{5}$$

Step 3: Compute the clipping threshold Tc and clip the histogram hc(k).

$$T_c = \frac{1}{L}\sum_{k=1}^{L} h(k)$$

$$h_c(k) = T_c \quad \text{for } h(k) \geqslant T_c \tag{6}$$

Step 4: Divide the clipped histogram into two sub histograms

Using the threshold parameter Xa.

Step 5: Apply the HE on individual sub

Histograms.

Step 6: Combine the sub images into one image for analysis.

IV .PROPOSED WORK

In this paper, we proposed an efficient image denoising algorithm which combines WHFC in wavelet domain and ESIHE. Let us start our proposed algorithm as given below.

The motive of image denoising is to remove the noise from the contaminated image with low MSE, RMSE and also high PSNR. Consider a real image S(x,y) that's corrupted by way of noise N(x,y). The corrupted picture may be written as:

$$X(x,y)= S(x,y) + N(x,y)$$

Where, noise may be GN, average noise or motion noise. DWT is applied to the corrupted image X(x,y) that decomposed it into four sub pieces which are labeled as LL1, LH1, HL1 and HH1. The LL piece is known as approximation coefficient. And the remaining parts are called detailed component. Now keeping the approximation part constant and apply WHFC to the detailed parts. These coefficients increase the intensity of pixels. After that convolved WHFC with detailed coefficients of wavelet. Then reconstruct the image by

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applying inverse wavelet transform to get the denoised image. Next we apply various ESIHE techniques which minimize the blurriness of the resultant image and gives better visual appearance, also a higher PSNR.

Following Steps are used to denoise an image in the proposed method:

1. First select an image, it should be gray image. If it is color image then convert it into gray image. Now this image is our input image S(x,y).
2. Add various noise (average, motion and Gaussian noise) on original image. Remember at a time apply only one noise

$$X(x,y) = S(x,y) + N(x,y)$$

3. Apply DCT and DWT to the noisy image. DWT decompose the image into 4 sub elements LL, HL, LH and HH

$$Y = W(x)$$

Y=(approximation coefficient and detailed1, detailed2, detailed3 coefficients)

4. Keeping approximation part constant,Apply WHFC to the detailed coefficient

$$WHFC = \frac{1}{9}\begin{matrix} -1 & -1 & -1 \\ -1 & +8 & -1 \\ -1 & -1 & -1 \end{matrix}$$

5. Now convolve WHFC with previously overall detailed coefficient.
6. Then reconstruct the image by applying inverse wavelet transform and inverse DCT to get the resultant image.
7. Apply ESIHE technique to the resultant image.
8. lastly, Calculate PSNR, MSE and RMSE value of the denoised image.

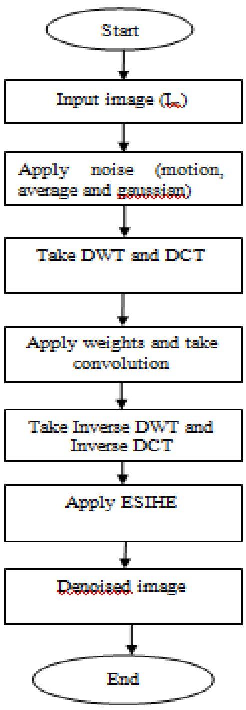

Fig.1. Flow chart of Proposed work

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V.RESULT ANALYSIS

The performance of proposed algorithm is comparing the usage of best size parameter and in terms of visible nice of the picture. The excellent measurement parameters are MSE, PSNR and RMSE.

A. Mean Square Error (MSE):

The MSE represents the cumulative squared error among the corrupted and the unique picture. A decrease cost of MSE defines lower errors. It is described by means of:

$$MSE = \frac{1}{mn}\sum_{m=0}^{m-1}\sum_{n=0}^{n-1}[f(i,j) - g(i,j)]^2 \qquad (7)$$

Here, *f(i,j)* is the original picture and *g(i,j)* is the corrupted picture. The dimensions of image is *m* x *n.*

B. Root Mean Square Error (RMSE):

RMSE represent the sample standard deviation of the differences between expected and observed value. The RMSE

Of an estimator T ˆ with recognize to a predicted parameter T is Defined as the square root of the MSE

$$RMSE(\hat{\theta}) = \sqrt{MSE(\hat{\theta})}$$

$$RMSE(\hat{\theta}) = \sqrt{E((\hat{\theta} - \theta)^2)} \qquad (8)$$

C. Peak Signal to Noise Ratio (PSNR):

PSNR is the ratio between most feasible strength of a sign and the power of the distorting noise. PSNR is used as first-rate measurement parameter between the original and compressed image. Higher the value of PSNR, better the best of compressed or reconstructed picture. It is defined by:

$$PSNR = 20\log_{10}\left(\frac{MAX_f}{\sqrt{MSE}}\right) \qquad (9)$$

Fig. shows one of the original picture, noisy image and resulting image of proposed method corrupted by GN.

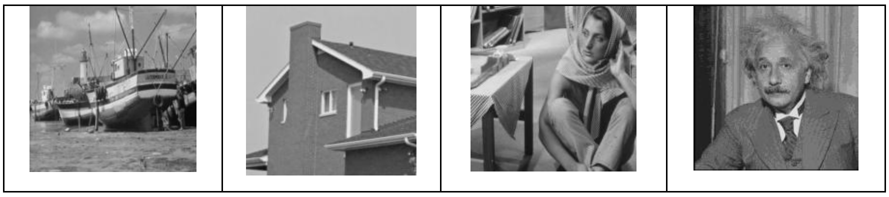

Fig.2 image dataset for analysis of proposed method

(a) Input image is taken

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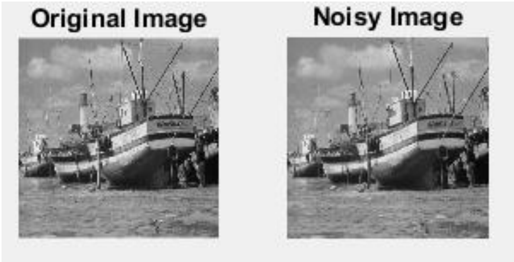
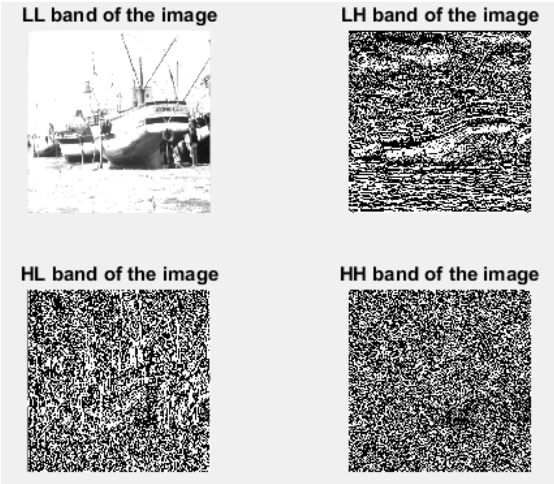
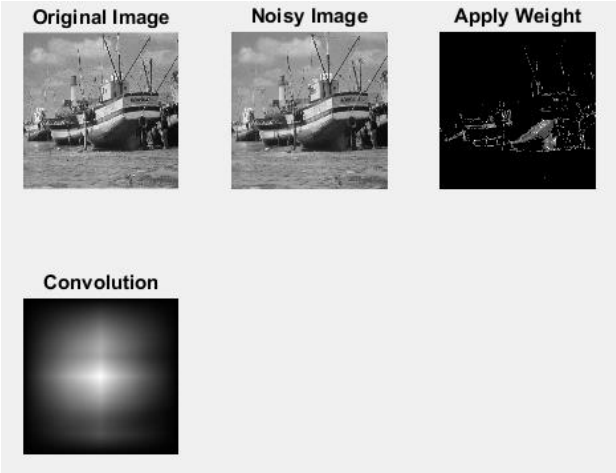


(b) add gaussian noise to the input image



(c) Take DWT of the noisy image



(d) apply weights and take convolution

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(e) Take Inverse DWT and Apply the ESIHE technique

TABLE I: COMPARISON OF PSNR OF DIFFERENT STATE OF ART DENOISING FILTER WITH PROPOSED TECHNIQUE

PSNR					
Image	**Types of Attack (noise)**	**Mean filter**	**Median filter**	**Weiner filter**	**Proposed (ESIHE) Technique**
Boat	Motion	21.3269	21.5451	21.5016	**36.4421**
	Average	27.1951	28.2140	27.0956	**35.8238**
	Gaussian	28.3687	30.7328	29.8378	**35.4499**
House	Motion	23.3624	23.8810	23.8015	**33.6124**
	Average	31.0358	33.5694	32.4337	**33.2031**
	Gaussian	32.9899	40.7553	36.9521	**33.1831**
Barbara	Motion	20.9564	21.1741	21.0881	**39.4242**
	Average	24.1117	24.5441	23.9315	**38.0241**
	Gaussian	24.7431	25.4092	26.5399	**36.2614**
Einstein	Motion	25.7210	25.7690	25.7389	**47.0773**
	Average	34.2766	36.4182	34.2725	**45.0179**
	Gaussian	36.3792	40.8556	36.5845	**45.4748**

GRAPH 1: COMPAIRING THE PSNR

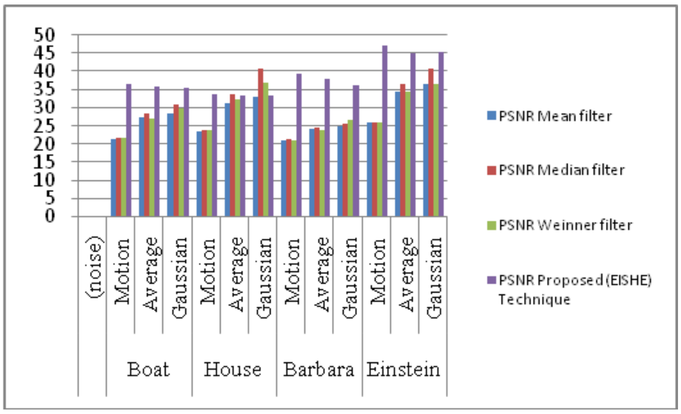

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TABLE II: COMPARISON OF RMSE OF DIFFERENT STATE OF ART DENOISING FILTER WITH PROPOSED TECHNIQUE

RMSE					
Image	**Types of Attack (Noise)**	**Mean filter**	**Median filter**	**Weiner filter**	**Proposed (ESIHE) Technique**
Boat	Motion	21.8875	21.3445	21.4517	3.8409
	Average	11.1375	9.9047	11.2658	4.1243
	Gaussian	9.7299	7.4114	8.2158	4.3057
House	Motion	17.3149	16.3113	16.4613	5.3201
	Average	7.1573	5.3465	6.0934	5.5768
	Gaussian	5.7154	2.3376	3.6219	5.5897
Barbara	Motion	22.8421	22.2758	22.4975	2.7248
	Average	15.8838	15.1125	16.2167	3.2014
	Gaussian	14.7701	25.4092	12.0101	3.9216
Einstein	Motion	13.1975	13.1247	13.1703	1.1290
	Average	4.9284	3.8515	4.9308	1.4310
	Gaussian	3.8688	2.3108	3.7784	1.3577

GRAPH 2: COMPAIRING THE RMSE

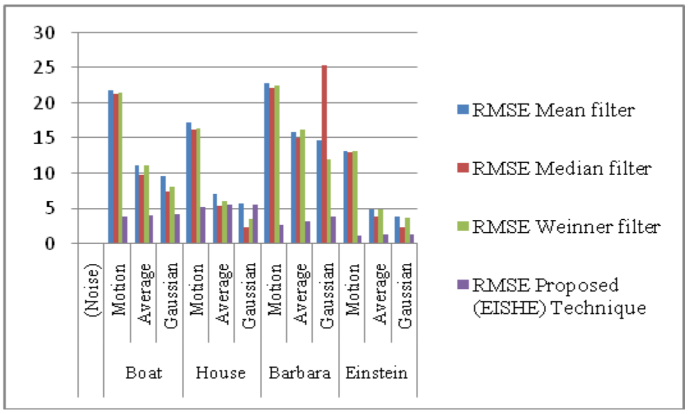

TABLE III: COMPARISON OF MSE OF DIFFERENT STATE OF ART DENOISING FILTER WITH PROPOSED TECHNIQUE

Data set image	**Types of Attack**	**Mean filter**	**Median filter**	**Weinner filter**	**Proposed technique**
Boat	Motion	479.0636	455.5861	460.1746	14.7526
	Average	124.0436	98.1027	126.9171	17.0099
	Gaussian	94.6703	54.9286	67.4995	18.5393
House	Motion	299.8048	266.0577	270.9749	28.3033
	Average	51.2273	28.2852	37.1290	31.1006
	Gaussian	32.6658	5.4645	13.1180	31.2445
Barbara	Motion	521.7178	496.2101	506.1375	7.4244
	Average	252.2960	228.3868	262.9825	10.2488
	Gaussian	218.1572	187.1354	144.2415	15.3793
Einstein	Motion	174.1733	172.2582	173.4574	1.2745
	Average	24.2894	14.8342	24.3126	2.0478
	Gaussian	14.9678	5.3397	14.2767	1.8433

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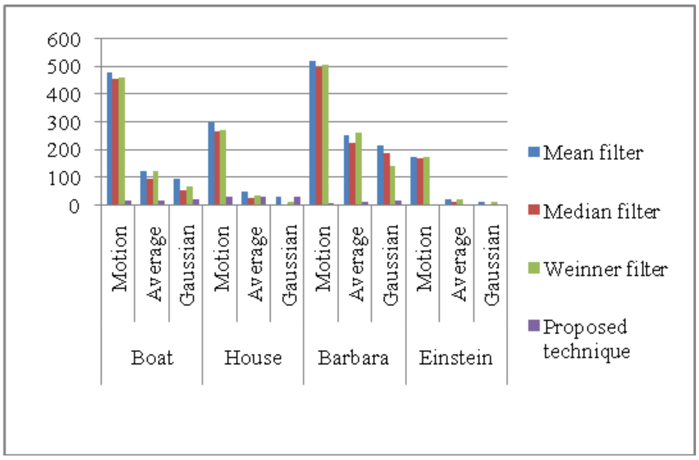
Graph 3: Compairing the Mse



VI .CONCLUSION

In this paper, an efficient picture denoising algorithm based on discrete wavelet transform is proposed to cope with the problem of picture recovery from its noisy counterpart. The major factor in the performance of proposed algorithm is the use of ESIHE which helps in improving the performance parameters of the denoised image. Experiments are conducted on different test images corrupted by various random noise levels in order to observe the performance of proposed algorithm. Result shows that this method is very good for noise reduction gives higher PSNR and low MSE and RMSE and better visual quality of image. Proposed algorithm can be extended in future to video framework and also in retrieving image more better, which may moreover further get better video denoising.

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