AN ENHANCED MEDIAN FILTERING ALGORITHM TO REDUCE THE NOISES PRESENT IN THE IMAGE

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ABSTRACT

The restoration of image is a most significant branch of digital image processing in which noise, ambiguity and blurriness are detached from the corrupted images. A number of filters, liner as well as non-linear have been proposed to restore the digital image. Among those, median filter exhibits better noise reduction, but it involves time complexity. Hence, this work proposed an enhanced median filtering algorithm. The result analysis depicts that this proposed MF algorithm reduces the noise considerably and maintains the image. Thus the performances of the noise reduction has been effectively enriched.

Keywords: Impulse Noise, Enhanced median filtering algorithm, Image processing.

1. INTRODUCTION

Noises arise in the capturing of the image and transmission process. It leads to the corruption of real information in the image and affects the visual effects of the digital image. Hence, in order to reduce noise effects, filters like Weighted Median Filter (WMF) (Yin et al. 1996) and the Center-Weighted Median Filter (CWMF) (Sung-JeaKo & Yong Hoon Lee, 1991) were presented as a solution for developing the median filter that has extra weight in the window with selected pixels. Switching median filters (Wang & Zhang 1999, Pei-Eng Ng & Kai-Kuang Ma 2006, Shuqun Zhang et al. 2002) with prior to non-linear filtering, the proposed is displayed with the difference in corrupted and non-corrupted pixels. Restoring noisy pixels are applied with median value and its alternative but leaving non-corrupted pixels unaffected. Hwang & Haddad (1995) proposed an Adaptive Median Filter (AMF) excels with the minimum and medium noise density levels in noise. With the maximum in noise densities, the alternates ‘n’ corrupted pixel increasing considerably. The increase in window size gives the maximum removal performance in noise. The minimum correlation of the existed and restoring median pixel values respectively is identified. The result is the smearing edges of extension.

Chen & Wu (2001) presented an Adaptive Center Weighted Median Filter (ACWMF) which is utilized to eliminate impulse noise with high density. Progressive Switching Median Filter (PSMF) (Wang & Zhang 1999) executes proficiently, the difficulty in computation results in the complication with the hardware implementation. The decision based on median filters like a Decision Based Algorithm (DBA) (Srinivasan & Ebenezer 2007), Boundary Discriminative Noise Detector (BDND) (Pei-Eng Ng & Kai-Kuang Ma 2006), Modified Decision Based Unsymmetrical Trimmed Median Filter (MDBUTMF) (Esakkirajan et al. 2011) and Simple Adaptive Median Filter (SAMF) (Haidi Ibrahim et al. 2008) is presented in the literature for eliminating salt and pepper noise with high density in digital images. The Boundary Discriminative Noise Detector utilizes a huge window of size 21 X 21 for the noise pixels detection. Hence, it needs maximum time in computation and particulars obtain distorted with greater noise densities. From the study of conventional filters, it can be observed that the technique of 'n' non-linear filtering are suggested with the denoising of the corrupted images. The filters find its decreasing agent in the noise on preserving the edges and specification of images. The main aim of the schemes is to design a new topology in filter to overcome above discussed disadvantages. Hence, this work proposed a novel improved median filter for noise removal.

2. DESIGN OF ENHANCED MEDIAN FILTERING

This type of filter is a nonlinear signal processing technology depends on statistics. The digital image's noisy value or the replacement of sequence is the neighborhood (mask) median value. The mask pixels are sequential in their gray levels, and the median value of the group is stored for replacing the noisy value. The output of the median filtering is

$$p(a,b)\ med\{\ q(a\ \_\ i,\ b\_\ j),\ i,\ j\text{-}M\ \}\ ,$$

Here

$p(a, b)$, $q(a, b)$ are the output image and the real image respectively,

M is the two-dimensional mask,

The mask shape is square, cross, circular, linear and etc.; and the size of the mask is k x k (where k is odd) such as 3 x 3, 5 x 5, and etc.

The cross mask or square mask k x k is identified in the filtering mask. 'k' is treated as odd. The retaining image details is possible with the smaller mask. The noise reduction performance becomes weak with the larger mask. The work introduces a new filtering algorithm for salving the issue.

The improved method is made for reducing noise but retaining the particulars of the image. The correlation in neighboring pixels is identified for the natural image. The contamination of pixel is possible with the availability of the same. The process of noise reducing in each pixel is checked sequentially, if the average value is less than the value of a pixel in the mask, then the conclusion is that the pixel is contaminated by the noise with replacement of the median value of the mask; on retaining the existed value. The image details are possible by reducing the computation time and retaining the same. The replacement of the real value in the pixel by median value leads to the computation process with the average value. It reduces time complexity but improving the effect of noise reducing. This creates an iterative process; it both improves the effect of noise-reducing better, and decreases the time complexity.

3. RESULTS AND DISCUSSION

In digital images, the proposed methodology's performance is comparing with some other state-art-filtering methods for the reduction of the salt and pepper noise. On carrying the test, the recognized test images are pepper, eight, lena, boat and baboon respectively. Measures of the objective quantitative utilized for the evaluation of MSE and the PSNR are among the real and restored images is existed and the images that is restored by explaining in the following quotations.

$$MSE(F,F') = \frac{1}{MN}\sum_{a=1}^{M}\sum_{b=1}^{N}[F(a,b)-F'(a,b)]^2 ,$$

$$PSNR(F,F') = 10\log_{10}\frac{[255]^2}{MSE(F,F')}$$

Here $F(a,b)$ is the real image and $F'(a,b)$ is the image which is restored of size MN.

3.1 Numerical Results

Impulse noise is included to the recognized testing images. The corrupted images are tested at different stages of impulse noise density begins from 10% (minimum noise ratio) to 70% (maximum noise ratio). Initially, the numerical results and visual performance of the standard median filter is compared for various test images. The numerical results are displayed in tables 1 and 2. The proposed methodology performs well for pepper, eight, lena, boat and baboon test images that are corrupted at different noise ratios.

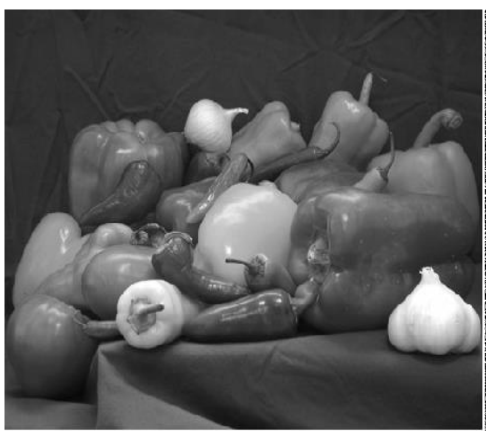
Table 1. Performance of the proposed MF filter with MSE values for various test images

Test Image	Filtering Method	Density of Noise (%)						
		70%	60%	50%	40%	30%	20%	10%
Pepper	MF	1437	1227	1020	835.6026	612.9912	426.0354	215.4830
Eight	MF	1787	1532	1244	986.7137	743.4851	519.3139	303.9563
Lena	MF	1294	1137	951.0365	780.1149	591.5251	405.8789	241.1651
Boat	MF	1421	1277	1091	896.8403	688.6893	487.8071	284.6255
Baboon	MF	1390	1213	1034	875.3365	726.2194	543.7314	376.1161

Table 2. Performance of the proposed SMF filter with PSNR values for various test images

Test Image	Filtering Method	Density of Noise (%)						
		70%	60%	50%	40%	30%	20%	10%
Pepper	MF	16.5562	17.2395	18.0410	18.9108	20.2563	21.8363	24.7967
Eight	MF	15.6089	16.2781	17.1814	18.1889	19.411	20.9765	23.3027
Lena	MF	17.0091	17.5734	18.3488	19.2092	20.4111	22.0469	24.3077
Boat	MF	16.6042	17.0689	17.7501	18.6037	19.7506	21.2483	23.5881
Baboon	MF	16.6991	17.2888	17.9854	18.7091	19.5201	20.770	22.3776

The image presentation of the proposed MF filter for various standard test images like pepper, lena, boat in lake and baboon is demonstrated as follows:



(i)

(ii)

(iii)

Figure 1. Performance of the proposed MF filter for pepper test image

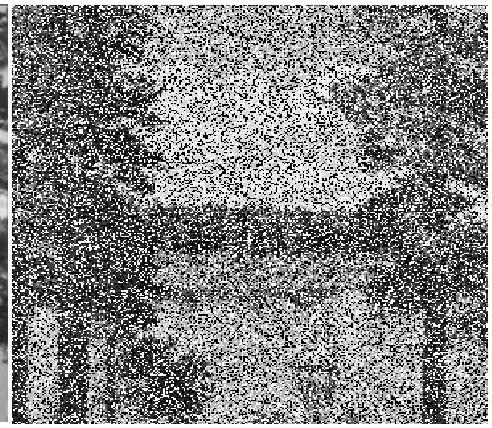
The above figure demonstrates the image presentation of the proposed MF filter for pepper test image. Figure 1(i) and (ii) demonstrate an enlarged part of the existed image that is degraded to 50% impulse noise respectively. Figure 1(iii) shows the noise suppression with the proposed MF filter. The presented technique achieved better visual outcomes than MF while suppressing the impulse noise.

(i) **(ii)**

(iii)

Figure 2. Performance of the proposed MF filter for Lena test image

The above figure demonstrates the image presentation of the proposed MF Filter for Lena test image. Figure 2(i) and (ii) demonstrate an enlarged part of the existed image that is degraded to 50% impulse noise respectively. Figure 2 (iii) displays the noise suppression with the proposed MF filter. The proposed technique achieved better visual outcomes while suppressing the impulse noise.

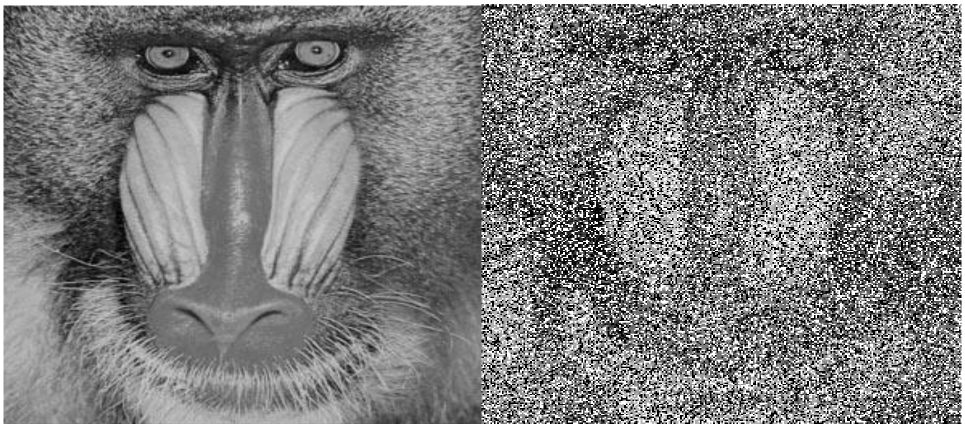



(i) **(ii)**

(iii)

Figure 3.Performance of the proposed MF for Boat in Lake test image

The above figure demonstrates the image presentation of the proposed SMF filter for boat in Lake Test image. Figure 3(i) and (ii) demonstrate an enlarged part of the existed image that is degraded to 50% impulse noise respectively. Figure 3(iii) shows and the noise suppression with the proposed MF filter. The proposed method achieved better visual outcomes while suppressing the impulse noise.

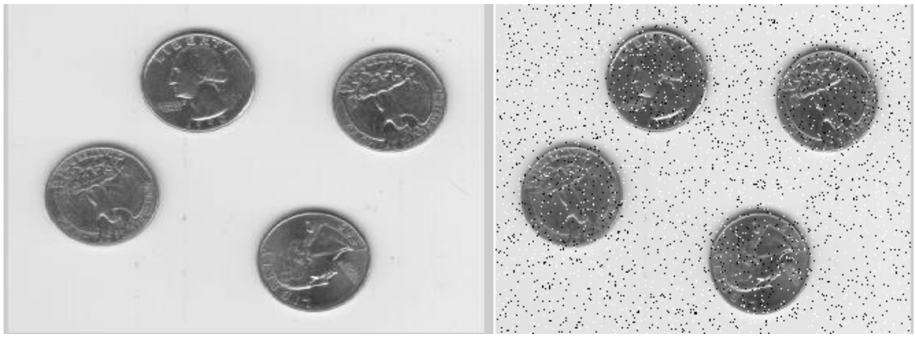


(i) **(ii)**

(iii)

Figure 4. Performance of the proposed SMF filter for baboon test image

The above figure explains the visual presentation of the proposed MF filter for the test image baboon. Figure 4(i) and (ii) demonstrate an enlarged part of the existed image that is degraded to 50% impulse noise respectively. Figure 4(iii) the noise suppression with the proposed MF filter. The proposed method achieved excellent visual outcomes while suppressing the impulse noise.



(i) **(ii)**

(iii)

Figure 5. Performance of the proposed MF filter for Eight test image

The above figure explains the visual presentation of the proposed SMF filter for the eight test image. Figure 5(i) and (ii) demonstrate an enlarged part of the existed image that is degraded to 50% impulse noise respectively. Figure 5(iii) the noise suppression with the proposed MF filter. The proposed method achieved excellent visual outcomes while suppressing the impulse noise. Tables 3 to 7 are the comparative tables on PSNR values of the proposed filter for various test images at various densities of noise.

Table 3. Comparative table on PSNR values of the proposed filter for the pepper test image

Method	**Noise density (%)**						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	6.8	7.5	8.3	9.3	10.5	12.3	15.3
Proposed Filter	16.5562	17.2395	18.0410	18.9108	20.2563	21.8363	24.7967

Table 4. Comparative table on PSNR values of the proposed filter for the lena test image

Method	**Noise density (%)**						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	7.0	7.7	8.5	9.5	10.6	12.4	15.5
Proposed Filter	17.0091	17.5734	18.3488	19.2092	20.4111	22.0469	24.3077

Table 5. Comparative table on PSNR values of the proposed filter for the baboon test image

Method	**Noise density (%)**						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	7.1	7.8	8.6	9.5	10.8	12.6	15.6
Proposed Filter	16.6991	17.2888	17.9854	18.7091	19.5201	20.770	22.3776

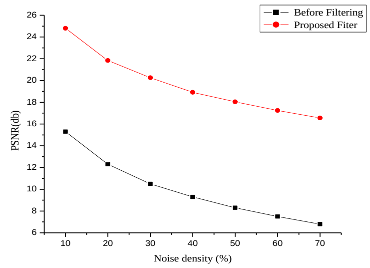
Table 6. Comparative table on PSNR values of the proposed filter for the Eight test image

Method	**Noise density (%)**						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	7.0	7.7	8.5	9.5	10.6	12.4	15.5
Proposed Filter	15.6089	16.2781	17.1814	18.1889	19.411	20.9765	23.3027

Table 7. Comparative table on PSNR values of the proposed filter for the boat in lake test image

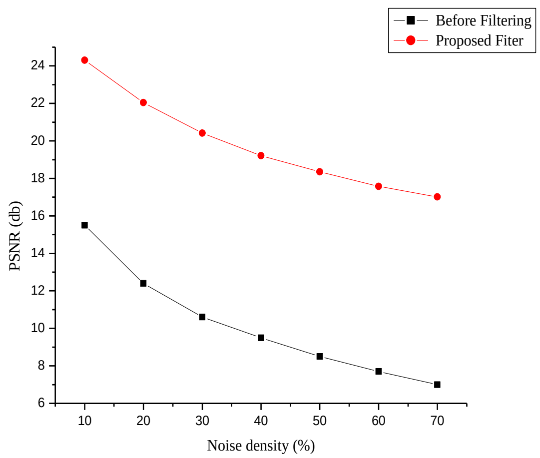
Method	**Noise density (%)**						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	7.0	7.7	8.5	9.5	10.6	12.4	15.5
Proposed Filter	16.6042	17.0689	17.7501	18.6037	19.7506	21.2483	23.5881

Pepper



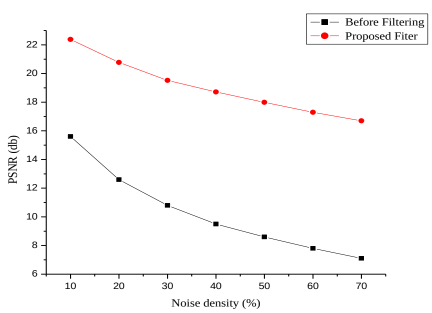
(i)

Lena



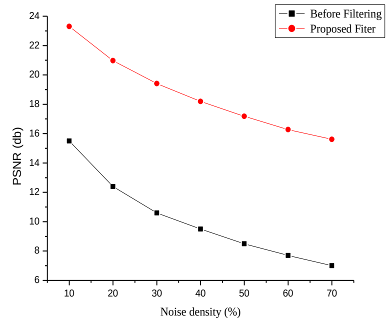
(ii)

Baboon



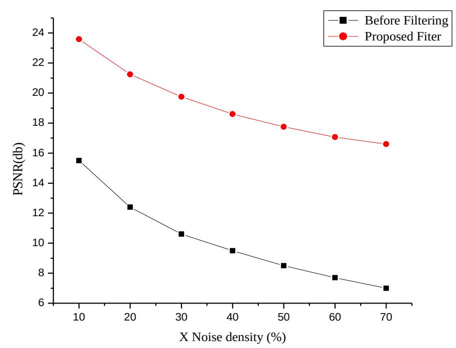
(iii)

Eight



(iv)

Boat



(v)

Figure 6. Comparative Graphical representation on PSNR values of the proposed filter at various densities of noise for the test images (i) pepper image (ii) lena image (iii) baboon image (iv) eight image (v) Boat in lake image

The proposed technique is proficient to eliminate the impulse noise as conserving more fine details. Tables 8 to 12 are the comparative tables on MSE values of the proposed filter for various test images at various densities of noise.

Table 8, Comparative table on MSE values of existing filter with proposed filter for the pepper test image

Method	Noise density (%)						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	12952.8	11087.9	9207.3	7356.94	5546.76	3704.26	1836.26
Proposed Filter	1437	1227	1020	835.6026	612.9912	426.0354	215.4830

Table 9. Comparative table on MSE values of existing filter with proposed filter for the boat in lake test image

Method	Noise density (%)						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	12952.8	11087.9	9207.3	7356.94	5376.78	3504.23	1636.26
Proposed Filter	1421	1277	1091	896.8403	688.6893	487.8071	284.6255

Table 10. Comparative table on MSE values of existing filter with proposed filter for the Eight test image

Method	Noise density (%)						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	12952.8	11087.9	9207.3	7356.94	5376.78	3504.23	1636.26
Proposed Filter	1787	1532	1244	986.7137	743.4851	519.3139	303.9563

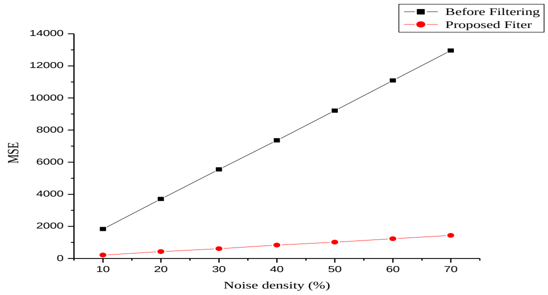
Table 11. Comparative table on MSE values of existing filter with proposed filter for the Lena test image

Method	Noise density (%)						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	12952.8	11087.9	9207.3	7356.94	5376.78	3504.23	1636.26
Proposed Filter	1294	1137	951.0365	780.1149	591.5251	405.8789	241.1651

Table 12. Comparative table on MSE values of existing filter with proposed filter for the Baboon test image

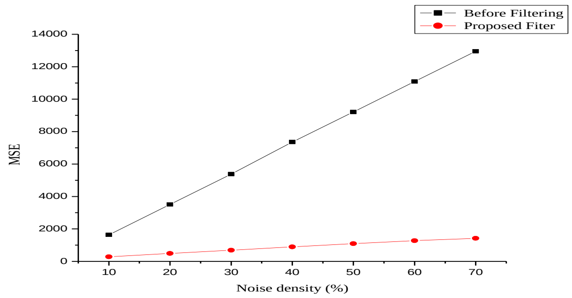
Method	Noise density (%)						
	70%	60%	50%	40%	30%	20%	10%
Before Filtering	12952.8	11087.9	9207.3	7356.94	5376.78	3504.23	1636.26
Proposed Filter	1390	1213	1034	875.3365	726.2194	543.7314	376.1161

Pepper



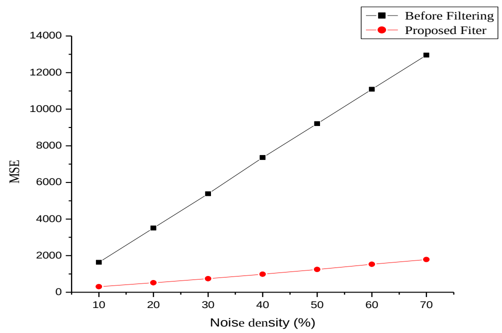
(i)

Boat in lake



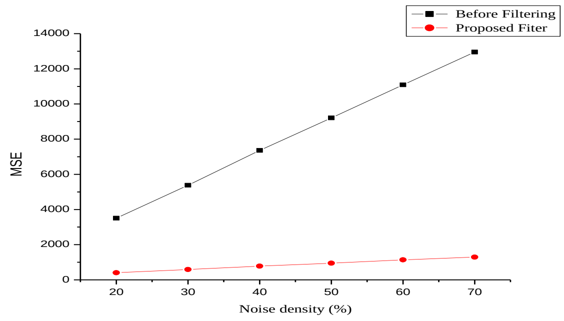
(ii)

Eight



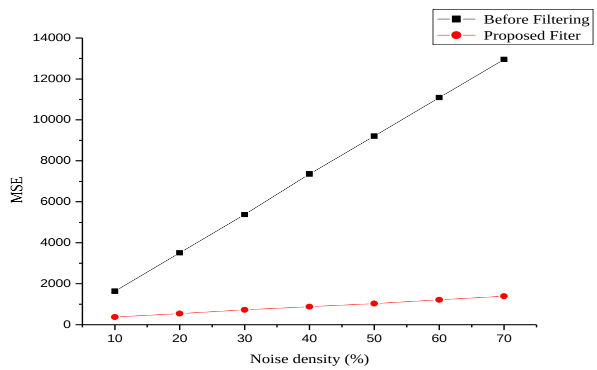
(iii)

Lena



(iv)

Baboon



(v)

Figure 7. Comparative Graphical representation on MSE values of the proposed filter at various densities of noise for the test images (i) a pepper image (ii) boat in lake test image (iii) eight image (iv) lena image (v) Baboon image

The proposed filter is competent to eliminate the impulse noise as conserving more fine details.

4. CONCLUSIONS AND SUMMARY

This work deals with execution of the enhanced median filter on eliminating impulse noise from the image. After considering various test images, the proposed method is being tested for removing noise. The proposed method is superior to corruption of image based on the measures PSNR and MSE for removal of noise.

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