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Image Denoising using Mean Filter

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ABSTRACT: The first step in any image processing process is to remove noise from an image, and this is the aim of every de-noising technique. The noise removal technique should be used carefully to avoid introducing artifacts that could cause the image to become blurry. In this paper, five levels of Gaussian noise and Salat & Peppers are applied to original images to add noise (σ=5, σ=10, σ=15, σ=20, σ=25 σ=50) and also combination Gaussian and Salt & peepers are used with noise level 25. Removing noising is filtered in mean filter. Performance evaluation of the mean filter with three methods of noise is provided. After testing all the approaches with Gaussian noise σ =15, the results revealed that Lena's image was superior to the others. The other photos, however, performed better for the Gaussian levels 20 and 25 than the Lena image. With all types of noise, the mean filter produced good results.

Keywords: Image Denoising, Mean Filter, Gaussian Noise, salt & peppers, PSNR

1. INTRODUCTION

The practice of applying algorithms to digital images is known as "digital image processing." It belongs to the category of digital signal processing. It may have the following benefits: During processing, a variety of techniques are used to reduce noise and signal distortion in the input data.

A variety of approaches are used for image processing. These methods, which were established in the 1960s, were applied mainly to character recognition, medical image analysis, and wire photo applications. However, the high expense of these methods made them disadvantageous. Then, in the 1970s, more affordable methods such as computers and specialized hardware became accessible. The only restriction found was the conversion of television standards after real-time image processing. Finally, In the 2000s, digital image processing primarily became the most extensively utilized method of image processing due to the advent of faster computer generations and processing units. Since it is the most economical approach as well as the most multilateral [2][3]. Later, further techniques were developed. One example is the employment of wavelets in [4]'s new phase congruency calculation approach. Phase congruency in 2D images can be calculated by extending a 1D signal. For varied scales of images, high pass filters are utilized. On the other hand, the brand-new Bayesian picture de-noising technique with two complementary discontinuity measures was introduced in [5]. His study's results demonstrate that noisy pictures may be created with a clear, high peak signal to noise ratio (PSNR), and that the noise can be successfully decreased while keeping edge components. For feature preservation, the spatial-gradient and another metric that looks at continuity detects contextual discontinuities. The most of solutions up to now have had the drawbacks of being expensive, complicated, and blurring out features in the image. This paper suggests an image de-noising method in the spatial and wavelet domain to get beyond these restrictions. De-noising images in the wavelet and spatial domains tend to use local mean filters, mean filters, and wavelet thresholds to eliminate noise. Section 2 includes Literature Review. Addition noise model in section 3, section 4 explains spatial domain filtering, section 5 mean filter, the parameters in 6, 7 methodology, the results in 8, and section 9 includes conclusion

2. LITERATURE REVIEW

A novel non-local means algorithm and grey theory GNLM were introduced in[1] in order to retain the image's most important details. In reality, the approaches produce good results, but they also lengthen the computation time. In a uniform region, the non-local means method produces a very excellent result. PSNR and MSE are used as the quality of image metrices. For the elimination of high-density impulse noise from color pictures, both at low density and high density impulse noise, a combination of weighted mean filter and adaptive vector median filter (VMF) is presented in

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[2]. Several state-of-the-art filters, most likely MDBUTMF, ACWVM,2-NCLPVMF, MHFC, HFC, DBCWMF, MSVMAF, AIFF, have been compared to the measurements PSNR, MSE, SSIM, and FSI. For color picture denoising, an improved non-local means (INLM) filter is proposed in [3]. The technique employs the advantages of the BILF and the NLM to eliminate impulse noise, Gaussian noise, and noise that is both impulse and Gaussian while still maintaining excellent picture detail at various noise ratios. The measuring the pixel similarity, the spatial similarity, and the mean of differences. In comparison to numerous existing filters, including the BILF , the FDNLM , the GNLMKIM , the MSMF , and the NLM , the suggested technique has better denoising performance.

A mixed noise removal technique is suggested in [4] to remove pepper-and-salt noise based on the multidirectional picture information and retain edges and features. It combines an adaptive directional weighted mean filter with an enhanced adaptive anisotropic diffusion model. The techniques are evaluated using the Feature Similarity Index Measure (FSIM) and the Peak Signal-to-Noise Ratio (PSNR). The suggested algorithm is compared with various approaches for mixed noise removal as AMF, SBF, TF, and MNF, coupled with LRA, AMF coupled with WLRR, WLRA, and LRR. Also, a novel NLM utilizing the Shapiro-Wilk statistical test was introduced in [5] to enhance the obtained pictures' signal-to-noise ratio. De-noising is a crucial stage in the pre-processing process for a variety of image processing tasks, including image segmentation, feature extraction, image segmentation, and other quantitative measures. In various images, the suggested technique successfully reduces noise while preserving detail. The measures such as BC, mean SSIM, PSNR. NAMF is examined in [6] for SAP noise de-noising, which uses a nonlocal mean technique based on SAP noise. The experiments compare the NAMF outcomes to six state-of-the-art techniques: AWMF, AMF, NAFSMF, the suggested technique, DAMF, and BPDF. To eliminate the prepper and salt noise, the Adaptive Switching Weight Mean Filter (ASWMF) is presented in [7]. We contrast the de-noising outcomes of the ASWMF experiments with those of other comparable de-noising techniques. In accordance with intuition and error metrics like SSIM and PSNR. In order to remove various forms of noise, an examination of the relative impact of spatial domain filtering approaches in digital image processing is presented in [8]. Peak signal to noise ratio (PSNR), Mean Square Error (MSE), and other metrics are used to measure each filter's performance. An overview of image de-noising is provided in Table 1.

Table 1. - Review of Literature Summary

Reference	Technique or Method	PSNR &MSE values
[9]	Non-local means filters and its wavelet-based noise thresholding technique	PSNR =35.60
[10]	mean filter +WT	PSNR=26.6476
[11]	BF, WT, BFWT and GF	PSNR=34.76
[12]	DWT + MF	PSNR=26.5469
[2]	VMF+WMF	PSNR= 42.27
[3]	INLM	PSNR=28.4
[4]	ADWM	PSNR=32.10
[5]	NLM	PSNR=37.6
[13]	NAMF	--------
[7]	ASWF	PSNR=30.8

3. ADDITIVE NOISE MODEL

According to equation [6], an additive noise model combines the original signal plus noise to create a corrupted noisy signal:

$$W(x,y) = s(x,y) + n(x,y) \quad (1)$$

Where s(x,y) is the intensity of the original image and n(x,y) is noise, the result is the noisy signal w(x,y) at (x,y) pixel position [6] [7]. The example of Gaussian noise is shown in Figure 1[8].

FIGURE 1. - **a- actual image b- image with Gaussian noise**

4. FILITERING BY SPATIAL DOMAIN

This approach was presented as standard. The noise in digital images can be removed by employing spatial filters. Filters are divided into two groups: linear filters and nonlinear filters[9].

5. MEAN FILTER

In terms of mean square error, a mean filter is the best linear filter for Gaussian noise. Sharp edges, lines, and other tiny visual features are also susceptible to blurring by linear filters, which also suffer in the presence of signal-dependent noise [14].

6. PARAMETERS

Two parameters are employed in this investigation. MSE and PSNR[15]. To closely resemble the original image, PSNR should be high, according to the following equations[16] [17]:

A definition of the PSNR (in Db) is:

$$MSE = \frac{1}{M\,N}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}[F(i,j) - Org(i,j)]^2 \quad (2)$$

$$PSNR = 10\,.log\left[\frac{255^2}{MSE}\right] \quad (3)$$

Where: F(i,j) De-noising image, I(i,j) Original image, and M and N are the size of the original image.
Max: 255 is the highest possible pixel value for the grayscale image utilized in this work.

7. THE PROPOSED METHOD

The mean filter is used with different level of noise. Gaussian, and salt and pepper are used to test which one is the best. Classical datasets are used such as Lena, pepper, Barbara, and cameraman—from an original image input., salt, pepper, and Gaussian are added to make an image noisy. On the other hand, noise is removed using the wavelet threshold and mean filter by using the results of two equations for PSNR and MSE.

7.1 FLOW CHART

An input is provided by the image. A specified equation is used to introduce the Gaussian noise. The image is further translated into a different set of codes when the noise is added. As can be seen in figure 3.9, this produces a noisy image. To denoise an image, follow these two steps:

1. A noisy image is added as an input to a local mean filter, which processes the image to find the PSNR and MSE. This is shown using the equation that below, where the formula represents for a noise-producing image

$$W(x,y) = s(x,y) + n(x,y) \quad \textbf{(4)}$$

2-In order to locate the MSE and PSNR, the noisy image is added to the hard thresholding as an input. The equations below serve as a representation of the de-noising image.

$$MSE = \frac{1}{M\,N}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}[F(i,j) - Org(i,j)]^2 \quad (5)$$

$$PSNR = 10\ .log\left[\frac{255^2}{MSE}\right] \quad (6)$$

3- Between the first and second steps, the PSNR is compared. A high PSNR count implies successful outcomes even when the resulting image only approximately matches the source image.

Figure 2 offers the suggestion for image de-noising with mean filter after adding Peppers & salt noise and obtaining PSNR.

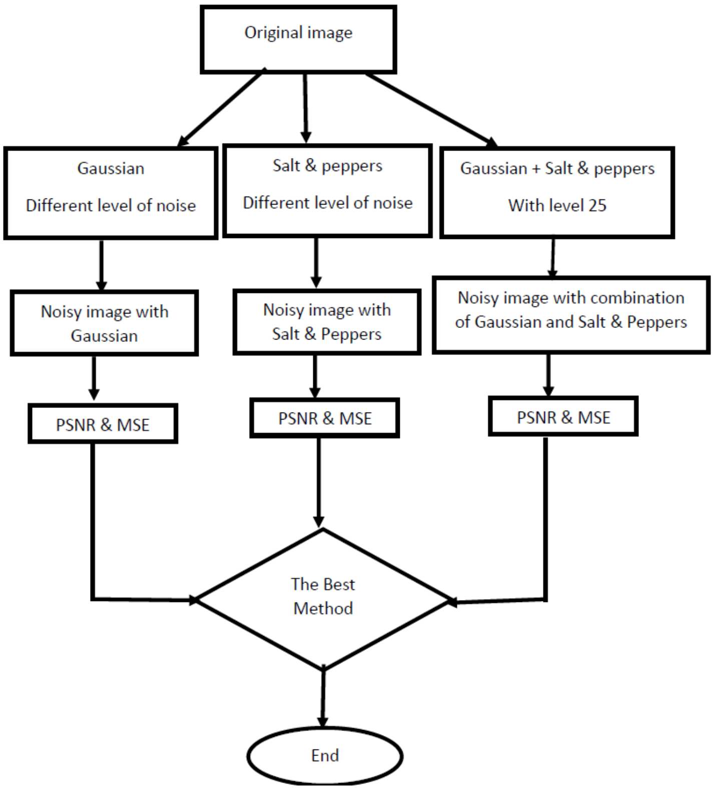

FIGURE 2. - Flow chart of Image Denoising Mean Filter

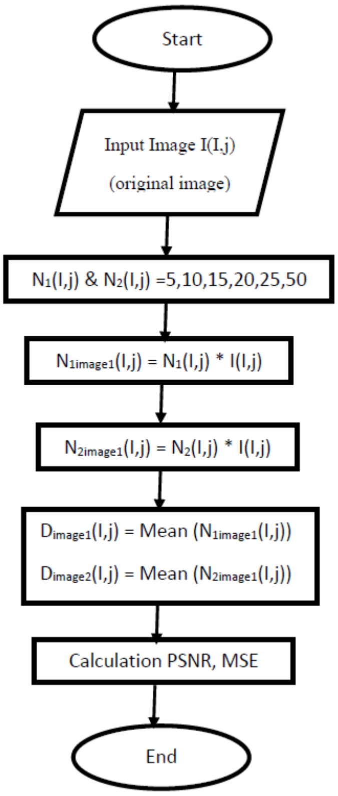

FIGURE 3. - flowchart of proposed work with Gaussian or Salt & peppers

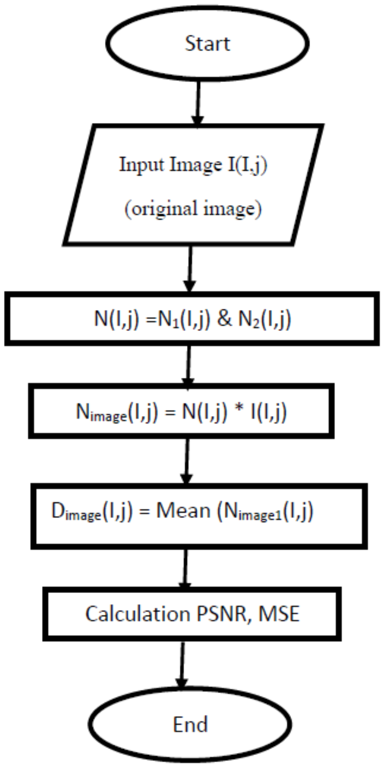

FIGURE 4. - flowchart of proposed work with combination of Gaussian and Salt & peppers

8. RESULTS

In this section, image denoising using mean is used. Where, PSNR in mean filter using three methods of noise has been evaluated. Gaussian, Sal &Pepper and combination Gaussian and Salt &Peppers noise have been used. To decrease noisy images, three 256×256 pixel grayscale images (Lena, Camera, and Pepper) were employed, as illustrated in figure 5. Also, the impact of noise with various Sigma values is used. Three values σ = 10, σ =50, and σ =100 for the noise that is additive Gaussian noise (AGN). Also, three additional levels of noise are utilized σ = 15, σ =20, and σ =25 to compare with[12] employing Mean filter.

FIGURE 5. - Three original pictures[12][11]

8.1 IMAGE DENOISING

Mean filtering is used in this section on various noise levels and image types. The original image and the Gaussian noisy image for three levels of noise (σ =10, σ = 50, and σ = 100) are shown in Figure 5.

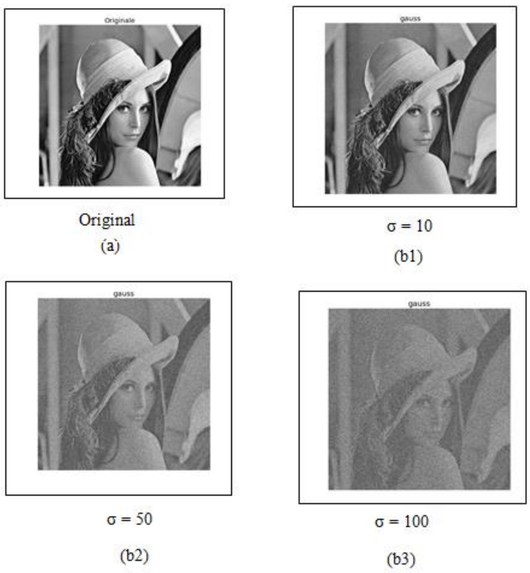

FIGURE 6. - Difference between the original picture (a) and the three-level Gaussian noise image (b1, b2, b3) (σ=10, σ=50, σ=100)

Table 2 shows the image denoising in mean filter for different levels of noise using three methods of noise. These methods are Gaussian, Salt &Peppers, combination Gaussian and Salt &Peppers noise. The results illustrate that the PSNR is 50.42389 down to 36.65222 with Gaussian noise level 5, 10,15,20, 25, 50, and 100 for the Lena's image. When Salt & pepper noise is used with different levels, the PSNR was 51.61022 down to 37.29752. the PSNR using combination Gaussian and Salt &Peppers is approximate of only Gaussian noise. The best results were for Lena in Salt & Peppers with different level.

Table 2. - PSNR values of mean filter for different noise levels with three methods of noise

Image	Gaussian Noise ration	PSNR in (dB)	Salt & Peppers noise	PSNR in (dB)	Combination Gaussian and Salt &		PSNR in (dB)
		Mean Filter		Mean Filter			Mean Filter
Lena	5	50.42389	5	51.61022	5		50.707233
	10	49.03591	10	51.03152	10		49.010091
	15	49.01121	15	50.01331	15		48.93422
	20	48.56688	20	48.87888	20		48.01244
	25	48.33222	25	48.57965	25		47.53212
	50	42.00233	50	44.32110	50		41.01223
	100	36.65222	100	37.29752	100		36.45322
Camera	5	50.21109	5	50.87232	5		49.21233
	10	48.08732	10	50.03987	10		49.30211
	15	49.00998	15	50.56130	15		49.93349
	25	48.26688	20	49.01223	20		48.01944
	25	47.04211	25	48.23064	25		47.00122
	50	43.019032	50	44.59802	50		43.01023
	100	35.32902	100	37.21092	100		35.14532
Pepper	5	50.00123	5	50.87232	5		50.00010
	10	48.50887	10	50.03987	10		48.30201
	15	49.11038	15	50.39510	15		49.05249
	20	49.00268	20	49.51083	20		48.91944
	25	47.529870	25	48.33332	25		47.031001
	50	44.497032	50	45.252302	50		44.399923
	100	34.548002	100	35.876610	100		34.444032

Figure 7: illustrates the different level of noise and three methods such as Gaussian, Salt &Peppers, Combination Gaussian and Salt & Peppers. The high PSNR is > 37 with salt and pepper for noise level 100.

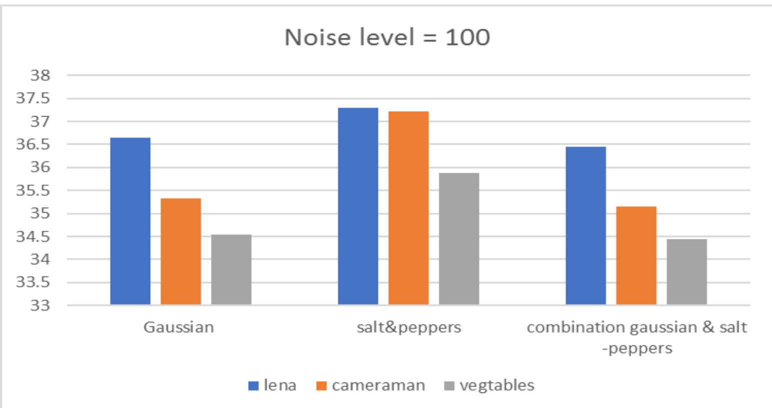

FIGURE 7. - different level of three types of noise

9. CONCLUSION

In this work, reducing noise in mean filter is used with classical images. Three methods of noise are used with different levels of noise. The methods are Gaussian, Salt &Peppers, combination Gaussian and Salt &Peppers noise. The results illustrate that the PSNR is 50.42389 down to 36.65222 with Gaussian noise level 5, 10,15,20, 25, 50, and 100 for the Lena's image. When Salt & pepper noise is used with different levels, the PSNR was 51.61022 down to 37.29752. the PSNR using combination Gaussian and Salt &Peppers is approximate of only Gaussian noise. The best results was for Lena in Salt & Peppers with different level

In feature work, we can apply Artificial inelegance in mean filter for denoising image with high level of noise and other types of noise to test which the best.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest

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