ZA Special Filter to Eliminate Salt and Pepper Noise from Gray and Color Images

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ABSTRACT

Color images are the most important and most common digital data circulating between people and institutions due to their use in various computer applications, which requires removing noise from them to become clear and comfortable to the eye and to facilitate the process of processing them. In this paper research we will introduce a special ZA filter, which can efficiently used to eliminate salt and pepper noise from both gray and color images. The proposed filter will be tested using various images with various noise ratios; the PSNR and MSE values between the clean and de-noised will be calculated. The obtained experimental results will be compared median and average filters results in order to raise some judgments.

Keywords

RGB color image, gray image, median filter, average filter, salt and pepper noise, noise ratio, PSNR, MSE.

1. INTRODUCTION

Digital images [1], [2], whether gray [3], [4] or color [5], [6], have recently spread and have been used in many vital computer applications [7], [8], [9], such as the person's face recognition applications [10] or fingerprint [11], [12], [13], to identify the person's identity. The images are also used in many security and protection systems [14], [15] and in medical applications and many other applications.

The clarity of the image and its freedom from noise is considered of great importance and the removal of noise, whether from the gray image or the color image, is one of the primary and primary processes for processing the digital image.

Noise reduces image quality resulting in loss of information and unsatisfactory visual effects. Salt and pepper noise is one of the most popular signals that affect image quality. In RGB color image, salt and pepper noise change how often colors overlap depending on the noise ratio. Several methods have been suggested to eliminate salt and pepper noise from the color image with minimal information loss. In this paper we will investigate the effects of adding salt and pepper noise to RGB color image, experimental noise ratio will be calculated and color combination will be calculated with the maximum and minimum presence in RGB color image. Additionally, this paper has proposed a methodology to eliminate salt and

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pepper noise for color images using an intermediate filter that provides image reconstruction in order to accept the result with minimal information loss. The proposed methodology will be applied and tested and experimental results will be analysed using the calculated values for MSE and PSNR [16], [17].

Salt-and-pepper noise is a form of noise sometimes seen on images. ... This noise can be caused by sharp and sudden disturbances in the image signal. It presents itself as sparsely occurring white and black pixels. An effective noise reduction method for this type of noise is a median filter or a morphological filter [18].

The negative effects of salt and pepper noise depend on the noise ratio, which the percent of effected pixel by the noise, the more noise ratio the more degradation on the image, figure 1 shows an image was affected by the noise with noise ratio equal 0.25.

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Figure 1: Salt and pepper noise with ratio =0.25

To measure the quality of any method of salt and pepper removal we have to calculate the peak-to-signal-noise-ratio (PSNR) between the clear image and the de-noised one, the higher the PSNR value, the more efficient the method, or to calculate the mean square error (MSE) between the clean image and the de-noised one, and here the lower the MSE value, the more efficient the method.

In this paper research we will compare the results of the proposed method with most popularly used method: median filter and average filter methods, and we will show how the proposed ZA filter increases the value of PSNR and decreases the value of MSE.

1- Proposed ZA filter

The proposed ZA filter can be used to reduce salt and pepper noise from gray and color images, the salt and pepper noise point can be treated as isolated point or as local minimums and local maximums [20], and here we follow the steps of edge detection to detect the noise points and then remove them from the noisy image.

- Applying ZA method for gray images
 - To remove the noise from a gray image we have to execute the following steps as shown in figure 2:
 - 1) Get the noisy image.

2) Select the following mask for isolated points detection and edge detection.



- 3) Apply correlation to get the image gradient.
- 4) Apply matlab function bwlabel to get the index matrix.
- 5) Subtract the index matrix from the noisy image matrix.



Figure 2: Applying ZA filter for gray images

Applying ZA method for color images

To remove the noise from a color image we have to execute the following steps as shown in figure 3:

- 1) Get the noisy image.
- 2) Extract each color matrix
- Select the following mask for isolated points detection and edge detection.

-1	-1	-1
-1	8	-1
-1	-1	-1

- 4) For each color matrix Apply correlation to get the image color gradient.
- 5) Apply matlab function bwlabel to get the index matrix for each color.
- 6) Subtract the index matrix from the noisy image matrix for each noisy color.
- Merge the color matrix to get the de-noised color image



Figure 3: Applying ZA filter for color images

2. IMPLEMENTATION AND EXPERIMENTAL RESULTS

The proposed ZA filter was implemented using gray images, the gray images were noised using salt and pepper noise, the noisy images then were filtered using ZA, median and average filters, figure 4 shows a gray image filtering example .

A pout.tif image was taken, and a salt and pepper noise was added to this image using different values of noise ratio, then the noisy image was treated using each of the three filters, table 1 shows the obtained experimental results.



Figure 4: Gray image filtering example

Table 1: (Gray in	nage filtering	g results
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Noise ratio	Z	ZA	Media	ın filter	Averag	e filter
	MSE	PSNR	MSE	PSNR	MSE	PSNR
0.002	0.9694	47.1397	0.9694	40.4978	4.4742	32.6573
0.005	0.9704	47.1352	4.4884	40.4841	33.3645	31.7721
0.01	0.9717	47.1295	4.6762	40.3060	42.6949	30.7012
0.02	0.9743	47.1180	5.3462	39.7245	62.0268	29.1947
0.03	0.9768	47.1067	4.9870	40.0265	80.3023	27.9577
0.04	0.9784	47.0999	6.9872	38.5619	99.2213	27.0389
0.05	0.9801	47.0922	6.3059	39.0075	118.8801	26.2926
0.09	0.9867	47.0632	12.1901	37.2707	198.8300	24.0201
0.1	0.9873	47.0605	12.7701	37.0688	219.5842	23.5890
0.2	0.9948	47.0275	56.9959	30.5724	421.5584	21.4277

From table 1 we can see that ZA filter provides the highest value for PSNR and the lowest values for MSE, thus ZA filter can be used to enhance the process of removing salt and

pepper noise from a gray level. From table 1 we can see that ZA filter keeps PSNR high and MSE low even if the noise ratio is high as you see in figure 5.

International Journal of Computer Applications (0975 – 8887) Volume 175– No. 11, August 2020



Figure 5: ZA filter features

The proposed ZA filter was also implemented using color images, the color images were noised using salt and pepper noise, the noisy images then were filtered using ZA, median and average filters, figure 5 shows a color image filtering example.

A peppers.png image was taken, and a salt and pepper noise was added to this image using different values of noise ratio, then the noisy image was treated using each of the three filters, table 2 shows the obtained experimental results.



Figure 6: Color image filtering example

International Journal of Computer Applications (0975 – 8887) Volume 175– No. 11, August 2020

Noise ratio	Z	A	Media	n filter	Averaş	ge filter
	MSE	PSNR	MSE	PSNR	MSE	PSNR
0.002	0.9503	111.3347	8.5810	89.3298	25.4913	89.3298
0.005	0.9524	111.3127	8.6606	89.2374	32.7254	75.9438
0.01	1.1646	109.3013	8.8385	89.0340	45.3483	72.6815
0.02	1.6583	105.7675	9.4642	88.3501	72.3158	68.0148
0.03	2.8777	100.2554	9.9144	87.8854	101.0541	64.6687
0.04	4.1855	96.5090	10.5040	87.3077	127.8458	62.3170
0.05	5.0805	94.5712	10.9936	86.8521	157.0595	60.2590
0.09	7.9401	90.1060	14.8847	83.8219	286.3645	54.2526
0.1	6.2330	92.5268	16.7230	82.6574	317.6584	53.2155
0.2	0.9756	111.0724	68.8024	68.5129	718.2172	45.0576
0.5	0.9803	111.0244	2251.1	33.6335	2556.6	32.3609

Table 2: Color image filtering results

ZA filter also was experimented using color images with various sizes by fixing the noise ratio to 0.5, figure 7 shows the result of filtering a color image of big size, while table 3

shows the results of treating various images using the three filters, and here we can see that ZA filter provides the best values for PSNR and MSE.



Figure 7: Filtering a big image

Table 5: various color image intering resul	or image intering results
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Image size(byte)	2	ZA	Median filter		Average filter	
	MSE	PSNR	MSE	PSNR	MSE	PSNR
151875	0.9503	110.8376	2145.9	34.1121	1861.4	35.5347
150738	0.9992	108.8561	1896.2	35.3490	1381.1	37.8004
151050	0.9849	110.9778	2638.0	32.0476	3026.9	30.6725
151008	0.9901	110.9252	3059.2	30.5662	2872.8	31.1948
151515	0.9870	110.9561	2380.1	33.0761	2006.0	34.7862
150849	0.9714	111.1151	3613.0	28.9024	3569.0	29.0249

5140800	0.9858	110.9683	2155.8	34.0660	2136.0	34.1584
6119256	0.9992	110.8336	1809.3	35.8185	1376.0	38.5560
2500608	0.9535	111.3018	3632.1	28.8496	3450.9	29.3613
			Average			
1629700	0.9802	110.7524	2592.2	32.5319	2408.9	33.4544

From table 3 we can see that ZA filter adds and enhancement to the process of removing salt and pepper noise, this enhancement can be calculated by dividing PSNR for ZA filter by PSNR of other filter, the enhancement is greater than one as shown in table 4, and from here we can strongly recommend ZA filter to remove salt and pepper noise from both gray image, regardless the image size and the noise ratio.

Method	ZA filter	Median filter	Average filter
ZA filter	1	3.4044	3.3105
Median filter	0.2937	1	0.9724
Average filter	0.3021	1.0284	1

3. CONCLUSION

A ZA filter of salt and pepper removing was proposed, implemented and tested. The experimental results showed that the proposed filter can be used for both gray and color images. The proposed filter was compared with median and average filters, and it was shown that ZA filter provides the best values for PSNR and MSE.

The proposed ZA filter add an enhancement to the process of filtering and it can by highly recommended for removing salt and pepper noise from gray and color images.

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