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An Efficient Morphological Salt-and-Pepper Noise Detector

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ABSTRACT

An efficient two stage morphological impulse noise detector is proposed in this paper. The proposed method first identifies the noise pixels by comparing the current pixel with the brightest and the darkest pixels in its working window and then in second stage morphological operations based detector is used to improve the performance of impulse noise detector. Simulation results performed on different images shows better results in terms of the qualitative and quantitative measures of the images.

Keywords: - Mathematical morphology, salt-and-pepper noise, image filter.

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1. Introduction

In removing salt-and-pepper noise, median filter's performance is better than the linear filters, though traditional median (MED) filter modify both the corrupted pixels and good pixels in the noisy image and filtering performance is greatly influenced by the filtering window size [1]. In order to avoid distorting good pixels, the switching scheme has been proposed [2]-[9]. These filters perform better than the MED filter by identifying the corrupted pixels using noise detectors before filtering. However these proposed noise detectors will identify some corrupted pixels as the noise-free pixels or misclassify the uncorrupted pixels as the noisy pixels. Consequently, these proposed switching filters will damage some fine details in noisy image or retain some impulses in the filtered image at a high noise density.
In this paper, we present a two stage impulse noise detector to realize accurate noise detection for wide range of noise density.

2. Proposed algorithm

Here we propose a highly accurate noise detection algorithm for wide range of noise density [up to 90%]. This scheme makes possible a most perfect removal of impulse noise in a more efficient manner by keeping the fine details of the image intact leaving the uncorrupted pixel untouched.
Let $f(i,j)$ be the value of the noisy image at pixel location (i,j). for noise detection purpose first of all we will create a flag image b of image $f(i,j)$, and *b(i,j)* will give the flags value at (i,j) location. Initially all flags values of flag will be set '0' and then for noisy pixel flags will be modified to '1' .Steps of our proposed algorithm are as fallows.
Step1. Impose a 7x7 window, which is centered on the current pixel, and find out the maximum value S_{nax} and S_{min} under the window.
Step2. The following equation is used for the
1st stage noise detection

$$b(i,j) = \begin{cases} 1 & \text{if } f(i,j) = S_{\max} \text{ or } f(i,j) = S_{\min} \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

Step3. Use the following equation for the second stage noise detection and modify the 1st stage binary flag.

$$d(i,j) = \left| \frac{((f o g) \bullet g)(i,j) + ((f \bullet g) o g)(i,j)}{2} - f(i,j) \right| \quad (2)$$

Now, comparing *d(i,j)* with the predefined threshold T, the noise candidate *(i,j)* will be re-classified as the noise pixel or noise flag *b(i,j)* is modified in the following way,.

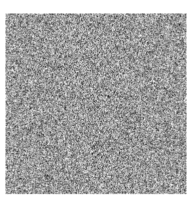
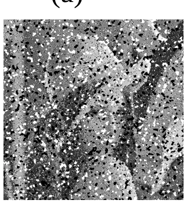
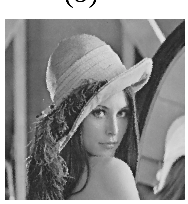
$$b(i,j) = \begin{cases} 1 & b(i,j) = 1 \text{ and } d(i,j) \geq T \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

Step4. Repeat step 2 and step 3 for the each pixel in the image and prepare the noise map b, where 1 denotes the current pixel is noisy and 0 denotes the current pixel is good.

From the equation (3) it can be seen that the corrupted pixels in the first-stage noise detection will be corrected as noise free pixels at the second stage if the condition ($d(i, j) < T$) is satisfied .Obviously, the threshold affects the performance of the proposed method.
By choosing the appropriate threshold value, the second stage noise detection can effectively reduce the number of misclassified noise-free pixels.

3. Simulation Results

In the simulation, the effectiveness of the proposed method is demonstrated by real processing results with gray scale image lena.png, (see table 1 & 2), with their dynamic range of values [0, 255]. In the part of image restoration, we use adaptive switching median filter [ASMF][6] algorithm. Here, four different methods (1) The Progressive switching median filter [PSM filter] [9], (2) Adaptive Switching Median Filter [ASM filter] [6], (3) Min-Max (with window 3×3) filter [7] and (4) proposed method are compared in terms of quantitative measurement (miss-detection [M], false-detection [F]and PSNR). For qualitative analysis, performance of the filters is tested at different levels of noise densities, and the results are shown in Fig 1. In the proposed method, the size of the structuring element g is chosen as 5×5, while T is predefined as 30. For other compared filters, relevant parameters are tuned to achieve the best restoration results. The PSNR values for the proposed method and the other compared filters are shown in table 2. From the Table 2, it can be seen that proposed method produces higher PSNR values than other filters.


(a)

(b)

(c)

(d)

(e)

(f)

Fig1. Simulation results of different filter (a) Original image (b) noisy image with 80% impulse noise (c) output for PSM filter (d) output of ASM filter (e) output for min-max filter (f) output for proposed algorithm

4. Conclusion

The proposed impulse noise detector realises accurate noise detection by means of morphological operations. The experiment results demonstrate that our method achieves excellent performance in terms of missed-detection, false-detection and PSNR.

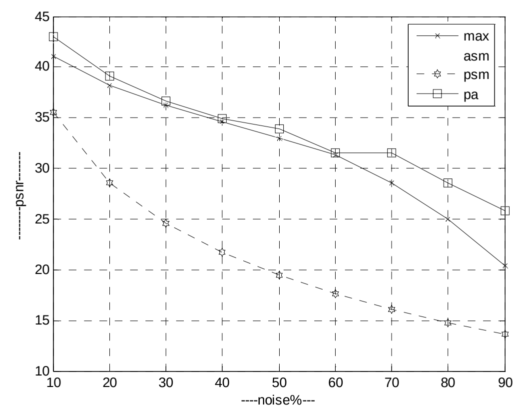


Fig 2 Noise density versus PSNR

Table 1 Noise detection results of switching filters for Lena image

Filters	Results	Noise density			
		20	40	60	80
PSM	M	118	390	446	17083
	F	1792	2118	5020	14153
ASM	M	0	0	0	0
	F	6487	4854	3237	1612
Min-Max	M	3	0	8	146
	F	12593	6183	2138	626
PA	M	0	0	0	0
	F	41	3	0	0

Table2 Comparison of restoration performance in PSNR for various filters for Lena image.

Filter	Noise Density in percentage			
	20	40	60	80
PSM	28.62	21.71	17.64	14.75
ASM	38.93	34.60	31.00	28.11
Min-Max	38.15	34.58	31.32	24.97
PA	39.16	34.93	31.57	28.60

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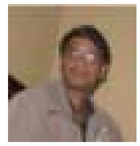
Authors Biography



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