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IMPULSE NOISE REMOVAL IN IMAGES USING MORPHOLOGICAL SET NOTATION

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ABSTRACT: These papers propose a novel method for noise removal in the images. The impulsive noise takes gray level values from the image as minimum or maximum from the dynamic gray level range. In this paper Set notations are proposed to eliminate the noise pixels corrupted by low and high gray level values. The method also adopt median and is compared with obtained Set notation values from local neighborhood of the image to preserve important image features during filtering. The proposed method shows significant improvement with respect to SNR and PSNR with comparison to existing Optimal Morphological Filter (OMF) method.

Keywords: Impulse Noise, Edge Features, OMF, Median, SNR, PSNR

1. INTRODUCTION

Digital images are often corrupted by different types of noise, namely, additive white Gaussian noise, impulse noise and mixer of Gaussian and impulse noise. Images are often corrupted by impulse noise during acquisition and transmission; thus, an efficient noise suppression technique is required before subsequent image processing operations. Salt-and- pepper noise is one type of impulse noise which can corrupt the image, where the noisy pixels can take only the maximum and minimum values in the dynamic range. Hence, image smoothing is one of the most common and important image processing operations in image and video processing applications. Linear filter were used as the primary tools for many of the signal and image processing applications, because of the availability of systematic theory for design and analysis [1]. If images are corrupted by Additive White Gaussian Noise (AWGN) linear filters show very good performance [2]. Human vision is very sensitive to high-frequency information. Image edges and image details (e.g. Corners and lines) have high frequency content[2] and carry very important information for visual perception. Highly suitable filter ones that used for digital image filtering requires good edge and image details preservation properties. Most of the digital images require low-pass filtering. Low pass filtering tends to blur edges and destroy lines, edges, and other fine image details. These reasons have led researchers to the use of nonlinear filtering techniques for image processing applications. An important non linear filter that will preserve the edges and remove impulse noise is standard median filter [3] [4]. Median filter [5] is widely used in impulse noise removal methods due to its denoising capability and computational efficiency [6]. However, it is effective only for low noise densities. To overcome this drawback, many recent techniques [7]-[13] first detect the impulse locations and then filter the noisy pixels without processing the uncorrupted ones. Specialized median filters such as weighted median filter[14], center weighted median filter[15] and Recursive Weighted Median Filter (RWMF)[16] were proposed to improve the performance of the median filter by giving more weight to some selected pixel in the filtering window. When the noise level is over 50%, the edge details of the original image will not be preserved by the median filter[17]. Some of the decision based algorithms, such as Adaptive Median Filter [18], Signal Dependent Rank Ordered Mean Filter[19], a Difference Type Noise Detector [20], Detail Preserving Filter[21], and High Probability Noise Removal Filter[22] have been published in the literature. All these algorithms first detect the noisy pixels and remove it by applying either standard median filter or its variants. These filters are effective in removing low to medium density impulse noise. Recently, An Optimal Morphological Filtering (OMF)[23] technique has been proposed to remove salt and pepper noise, in which, the corrupted pixels are replaced by either the median value of the window or calculating minimum or maximum pixel value of neighbors, in contrast to other existing algorithms that use only median value for replacement of corrupted pixels. In this paper a new algorithm is presented which improves the performance of removing of impulse noise. SNR means a measurement of the quality of signals. The higher the ratio, the better the image is. PSNR refers to a unit of the measurement of image quality which is most commonly used as an objective valuation standard that measures generally the quality of the image.

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2. IMPULSE NOISE MODEL

The Salt and Pepper (SP) noise is also called as fixed valued impulse noise will take a gray level value either minimal (0) or maximal (255) (for 8-bit monochrome image) in the dynamic range (0-255). It is generated with the equal probability. In the case of salt and pepper noise, the image pixels are randomly corrupted by either 0 or 255. That is, for each image pixel at location (i, j) with intensity value $Z_{i,j}$, , the corresponding pixel of the noisy image will be $I_{i,j}$, in which the probability density function of $I_{i,j}$ is

$$p(x) = \begin{cases} P/2 & \text{for } x = 0 \\ 1 - p & \text{for } x = Z_{ij} \\ p & \text{for } x = 255 \end{cases}$$

where p is the noise density .

2.1. PROPOSED MORPHOLOGICAL FILTER

The proposed morphological filter first detects impulse noise in the image. The corrupted and uncorrupted pixels in the image are detected by checking the pixel value against the maximum and minimum values in the mask selected. Let I denote noise image and for each pixel I[x, y] denoted as $I_{x,y}$. A sliding window of size (2L + 1) X (2L + 1) centered at $I_{x,y}$ is defined as shown in Fig. 1.

$I_{i-1,j-1}$	$I_{i-1,j}$	$I_{i-1,j+1}$
$I_{i,j-1}$	$I_{i,j}$	$I_{i,j+1}$
$I_{i+1,j-1}$	$I_{i+1,j}$	$I_{i+1,j+1}$

Figure: 1 3 X 3 Mask

the pixels corrupted by low and high gray values are eliminated using the following set based optimal notations.

$$PE = \left\{ \overset{3}{\underset{i=1}{\forall}} \; \overset{3}{\underset{j=1}{\forall}} \; \text{Max}(I_{ij} \cup I_{j,i}) \right\} \quad (1)$$

$$SE = \text{Max}\left\{ \overset{3}{\underset{i=1}{\forall}} \; \overset{3}{\underset{j=1}{\forall}} \; \text{Min}(I_{ij} \cup I_{j,i}) \right\} \quad (2)$$

The Optimal equation (1) computes the minimums of all row and column, which eliminates the pixels corrupted by low intensity (pepper noise). The optimal equation (2) computes maximums of all row and column. This eliminates the pixels corrupted by high intensity value (white noise). The algorithm also adopted median to check whether PE and SE are corresponding image pixel or not.

2.2. Proposed Algorithm

The below Algorithm describes entire procedure.

1. Read the image I.
2. Read the pixels from the sliding window and store in M.
3. Compute the PE and SE using optimal equations (1 & 2).
4. Check the PE and SE with the Central pixel

   If (PE > = $I_{i,j}$ > = SE)

   res(i,j) = $I_{i,j}$;

   elseif (PE < = $I_{i,j}$ < = SE)

   res(i, j) = M;

   else

   res(i,j) = abs(PE + SE)/2)

   end if
5. Repeat the steps 2 to 4 on entire image.
6. Display the resultant Image
7. Stop
3. Result

The proposed algorithm has been applied on standard noisy images (Lena, Cameraman, and Mandrill).Our proposed algorithm is compared with existing OMF method [4] which is shown in Table 1

Table 1
Comparison of OMF and Proposed Method

Image Name	SNR		PSNR	
	OMF	PROPOSED	OMF	PROPOSED
Lena	2.4538	2.4578	70.3283	71.6263
Cameraman	1.8365	1.8413	68.8555	70.5179
Mandrill	3.3010	3.3102	71.1717	72.2076

Visual Comparison are shown in Fig. 2

a b c

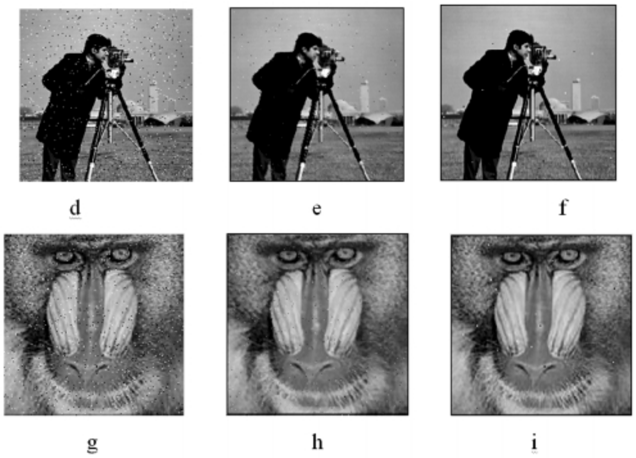

Figure 2: a, d and g are Original Noisy Images. The Results Obtained using OMF Method are Shown in b, e and h. The Results Obtained using Proposed Method are Shown in c, f and i

4. CONCLUSION

Our proposed method is sufficient to remove impulse noise significantly with compared to OMF method. This method performs well on gray scale noisy images .The experimental results shows that the proposed filtering technique restores the fine details, such as lines and corners efficiently and shows better results when compared with other standard noise filters. The proposed algorithm's performance can be further improved by using improved noise detecting techniques.

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