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Impulse Noise Removal using Enhanced Leading Diagonal Sorting Algorithm

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Abstract

Objective: The Impulse or salt and pepper noise corrupt the image data and quality of the image. There are several strategies in the existing algorithms to eliminate the noise but also have drawbacks. We identify the drawbacks of the standard algorithms in consider with apply in the proposed algorithm to achieve the prefect noise removal. Enhance the Leading Diagonal Algorithm with different approaches to improve and identify the betterment of the proposed algorithm and prove with the parameter analysis of standard filters. **Materials and Methods:** Images are corrupted by the high density level of impulse noise. Retrieving the images by the proposed algorithm to make the images in better quality and preserving the edges. The Proposed algorithm based on the 5th pixel is called the pixel of processing and consider the diagonal matrix elements of the finding window to effectively to eliminate the high density noise. The Lena, The baboon and the lady-image are taken as the sample images to mix with the percentage of noises. The restoration of the sample images with the comparison of standard or recommended filtering algorithm. With the help of PSNR and MSE parameter to prove the improved algorithm is better than the available filtering algorithms. **Findings:** The noise density from 10% to 50% is added to the sample images in the increment of every 10% of noise density. Based on the parameter analysis (PSNR and MSE) with the standard filters to dedicate the new algorithm is for the betterment of more than the available filtering algorithm. The new algorithm is improving the quality and preserving the edges. **Conclusion:** To get the higher PSNR value and reducing value of MSE to prove the new approach is for the enhancement of the quality and retrieval of the images from the high density corrupted noise.

Keywords: Diagonal Sorting Method, Impulse Detection, Median Filter, Mean Square Error, Peak Signalto Noise Ratio

1. Introduction

Images are taken by the digital cameras. The digital images are corrupted by the different noises induce by the harsh environment. The most induced type of noise is the impulse noise. It is called salt and pepper and another one is the random noise[1,2]. "0", "255" are the minimum and maximum value of impulse noise to corrupt the captured the images. They are different approaches to reduce the impulse noises[3-5].

Median Filter (MF) is a type of non-linear filter. It effetely removes the low density noise and insufficient performance of high density noise to preserve the edges. It deals with the salt and pepper noise suppression[6,7].

Leading Diagonal Sorting algorithm (LDS)[8] is proposed for the removal of the salt and pepper noise in the gray images. LDS is sufficient for the removal of noise suppression but it has drawbacks of noise suppression in the high density level. LDS is considered for the leading diagonal pixel, it check the left most leading pixel is noise or noise-free pixel. It LDS pixel are corrupted by the noise pixels, then the noise pixel is removed by their neighbor pixels.In gray images, the performance of Leading Diagonal Sorting algorithm (LDS)[8] effectively to removes the impulse noise from the low density level and insufficient to deal with the high density noise. The LDS to find the processing pixel is whether noise or noise free. If noise is identified, then the noisy pixel is replaced by the new algorithm by the neighbor pixel.

Trimmed Median Filter (TMF) is a 2-stage filter in the decision based Unsymmetric filter[9]. It identifies the noise pixel and restores the original pixel. It replaces the noisy

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pixel with the median or mean values of the algorithms based on the proposed condition. It effectively removes the noise and also demerit the blurred effects on the images.

Different methods for eliminating of the Salt and pepper noises are enhanced by the Multistage Eight Directional Median Filter[10], Adaptive Weighted Median Filter[11], Partial Trimmed Global Midpoint and Unsymmetric Trimmed Median Filter[12], Standard Median Filter[13], FPGA Based Impulse Noise identification and original image restoration Techniques[14].

The new approach deals with the target to eliminate the high density noise and preserving edges. It compared with the existing methods of noise removal in the range of 10% to 50% and it increased from every 10% noise density.

The organization of paper describes the different sections. The section 2 discusses the materials and methods. Illustration of ELDS algorithm is explained in section 3. Section 4 explains the experimental results with the help of the tables and the figures. The concluding discussions are presented in section 5.

2. Materials and Methods

The proposed Enhanced Leading Diagonal Sorting algorithm reduce the noise in the given imgae. Figure 1 shows the flowchart for proposed framework

The detailed explanation of prospoed algorithm is given below:

STEP 1: Select the sliding window as a size of 3 x 3. In this window is assumed as a processing pixel.

STEP 2: If $0<P_{ij}<255$ is the condition to determine the noise free pixel and its value undisturbed.

STEP 3: First check the 5th pixel of the sliding window, if $0=P_{ij}=255$, then P_{ij} is a considerd as a affected pixel. Find the median value to the given sliding window and replace P_{ij} with the median value.

STEP 4: The left most leading diagonal elements of the given slinding window are taken. The diagonal values are checked for salt and pepper noise. when the values are corrupted by noise pixels then affected pixels are replaced by the median value of the diagonal elements.

STEP 5: The right most leading diagonal elements of the 3 x 3 matrix are taken. The diagonal values are checked for salt and pepper noise. If the values are corrupted by noise pixels and they will replaced by the median value of the diagonal elements.

STEP 6: Step 3 to 5 is repeated until complete image.

3. Illustration of ELDS Algorithm

Case 1): 5th pixel of the processing window is consists of salt and pepper noise, then replace the processing pixel by the median value.

$$\begin{bmatrix} 45 & 122 & 34 \\ 0 & \langle 255 \rangle & 12 \\ 0 & 12 & 0 \end{bmatrix}$$

The noise value of 255 is replaced by the median value of 12. The processing pixel is "255".

$$\begin{bmatrix} 45 & 122 & 34 \\ 0 & \langle 12 \rangle & 12 \\ 0 & 12 & 0 \end{bmatrix}$$

Case 2): If the most left diagonal element in the selected window are 45, 12, 0. Where '0' is considered as affected pixel.

$$\begin{bmatrix} \langle 45 \rangle & 122 & 34 \\ 0 & \langle 12 \rangle & 12 \\ 0 & 12 & \langle 12 \rangle \end{bmatrix}$$

The Median value for 45, 21 and 0 is 12. Then the value '0' is changed in to '12'.

$$\begin{bmatrix} 45 & 122 & \langle 34 \rangle \\ 0 & \langle 12 \rangle & 12 \\ \langle 0 \rangle & 12 & 12 \end{bmatrix}$$

Case 3): If the rightmost diagonal elements in the selected window contain noise as a processing pixel.

$$\begin{bmatrix} 45 & 122 & \langle 34 \rangle \\ 0 & \langle 12 \rangle & 12 \\ \langle 12 \rangle & 12 & 12 \end{bmatrix}$$

The Median value of 34, 12,0 is 12. Where '0' is considered as affected pixel is take place by 12.

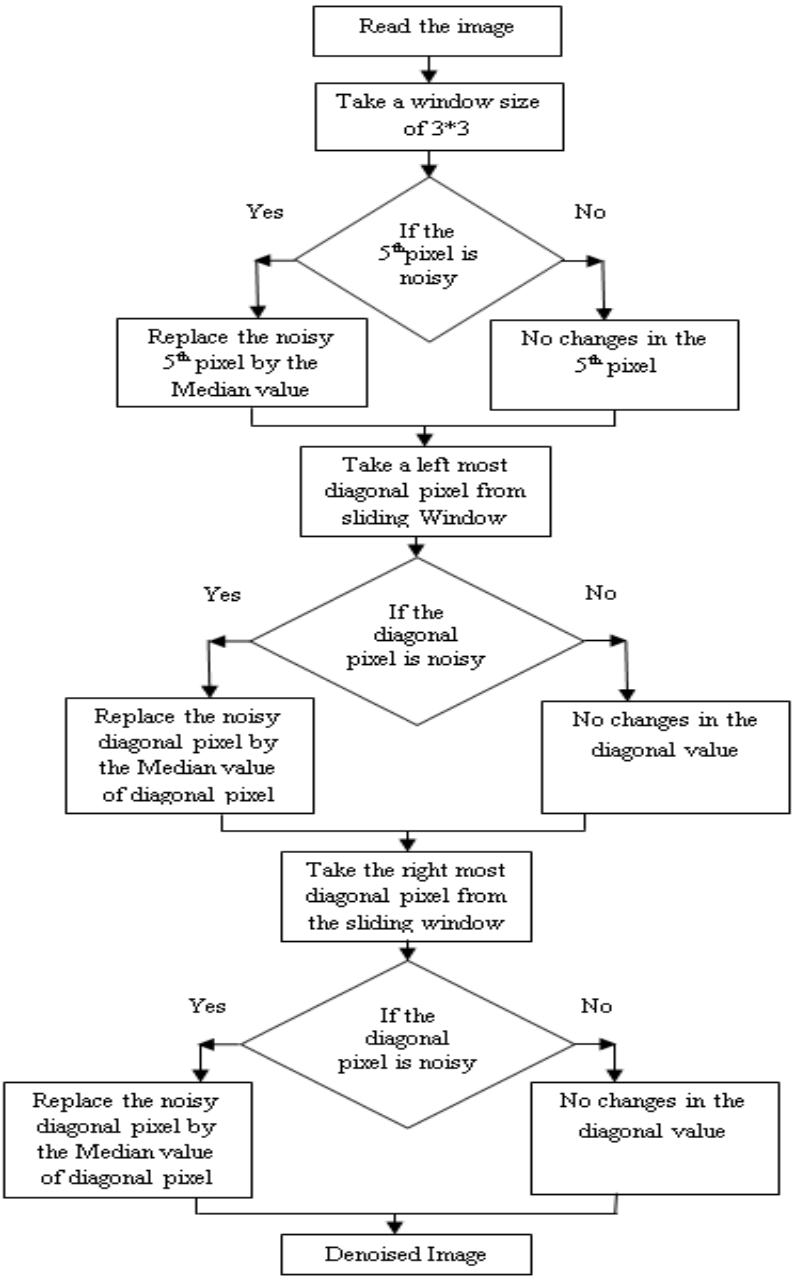

Figure 1. Flowchart of Proposed algorithm.

4. Experimental Results

The sampled grey images of Lena, Babbon and Lady Images in the size of 256 X 256 is considered for evaluation. The sample images are corrupted by the percentage of different noise density. The noise density level is varied from 10% to 50%.

The restoration results of the sampled images are quantitatively measured by Peak Signal-to-Noise Ratio (PSNR) and Mean Square Error (MSE).

$$PSNR = 10 \times \log_{10} \frac{255^2}{MSE} \quad (1)$$

$$MSE = \frac{1}{xy} \sum_{i=0}^{x-1} \sum_{i=0}^{y-1} \left(I_{ij} - R_{ij} \right)^2 \quad (2)$$

The equation (1) and (2), assumes the original image pixel I, the restoration image of pixel R, x and y assumes the image height and width.

Table 1. Comparison of PSNR and MSE values between Existing and Proposed Algorithm for Lena Image

Noise density	LDS algorithm (Existing)		TMF algorithm (Existing)		ELDS algorithm (Proposed)	
	PSNR	MSE	PSNR	MSE	PSNR	MSE
10% noise	15.3337	1.9750e+003	14.6355	2.2539e+003	16.1167	1.6568e+003
20% noise	11.9491	3.9652e+003	11.9400	4.1926e+003	13.2998	3.1361e+003
30% noise	9.9331	5.9374e+003	10.2696	6.1591e+003	11.8004	4.5130e+003
40 % noise	8.3858	8.2784e+003	9.1485	7.9731e+003	10.7881	5.5943e+003
50% noise	7.1387	1.1241e+004	8.1612	1.0008e+004	10.1051	6.6882e+003

Table 2. Comparison of PSNR and MSE values between Existing and Proposed Algorithm for Baboon Image

Noise density	LDS algorithm (Existing)		TMF algorithm (Existing)		ELDS algorithm (Proposed)	
	PSNR	MSE	PSNR	MSE	PSNR	MSE
10% noise	15.2869	1.9399e+003	14.7753	2.1825e+003	16.4582	1.4814e+003
20% noise	11.9955	4.1393e+003	12.1650	3.9808e+003	13.7394	2.7704e+003
30% noise	9.9727	6.5949e+003	10.5454	5.7802e+003	12.1442	4.0000e+003
40 % noise	8.3897	9.4954e+003	9.3648	7.5857e+003	11.1342	5.0473e+003
50% noise	7.1693	1.2576e+004	8.4998	9.2576e+003	10.3327	6.0703e+003

Table 3. Comparison of PSNR and MSE values between Existing and Proposed Algorithm for Lady Image

Noise density	LDS algorithm (Existing)		TMF algorithm (Existing)		ELDS algorithm (Proposed)	
	PSNR	MSE	PSNR	MSE	PSNR	MSE
10% noise	15.1158	2.0179e+003	14.9867	2.0788e+003	15.9370	1.6702e+003
20% noise	11.7650	4.3650e+003	12.1408	4.0032e+003	13.1876	3.1457e+003
30% noise	9.7465	6.9476e+003	10.4073	5.9669e+003	11.6212	4.5119e+003
40 % noise	8.2740	9.7518e+003	9.2302	7.8245e+003	10.6571	5.6334e+003
50% noise	7.0771	1.2846e+004	8.3495	9.5836e+003	9.9110	6.6893e+003

The PSNR and MSE are evaluated for simulation and comparison of performance of TMF, Existing LDS algorithm and proposed ELDS algorithm which is presented in Table 1-3. From the table it is clear that the ELDS method provides better result in terms of PSNR and MSE. The ELDS provides better achievenment than TMF and Existing LDS algorithm for noise density from 10 to 50 %.

Figure2-4 shows the restoration output of noise images using TMF, existing LDS and proposed ELDS algorithm for the image "Lena" "Baboon" "Lady" are affected by '0' and '255' noise level by 10%, 20%, 30%, 40%, and 50%. Observed from figure 2-4, that proposed ELDS suppresses the impulses and also preserves the edges than the existing LDS algorithm. TMF algorithm suppresses the impulse noise, but it produced blur effect. The proposed ELDS algorithm achieves better PSNR value compared to TMF and Exisiting LDS algorithm and preserve the image quality for 10%- 50%.

Fig 5-7 illustrates the comparison of PSNR value for Lena, Baboon and Lady image. From the graph observed the that proposed ELDS algorithm provides better PSNR value in image quality than TMF and existing LDS algorithm. Experimental results shows ELDS algorithm provides better visual quality.

Figure 2. Image Restoration Results of the Lena Image.

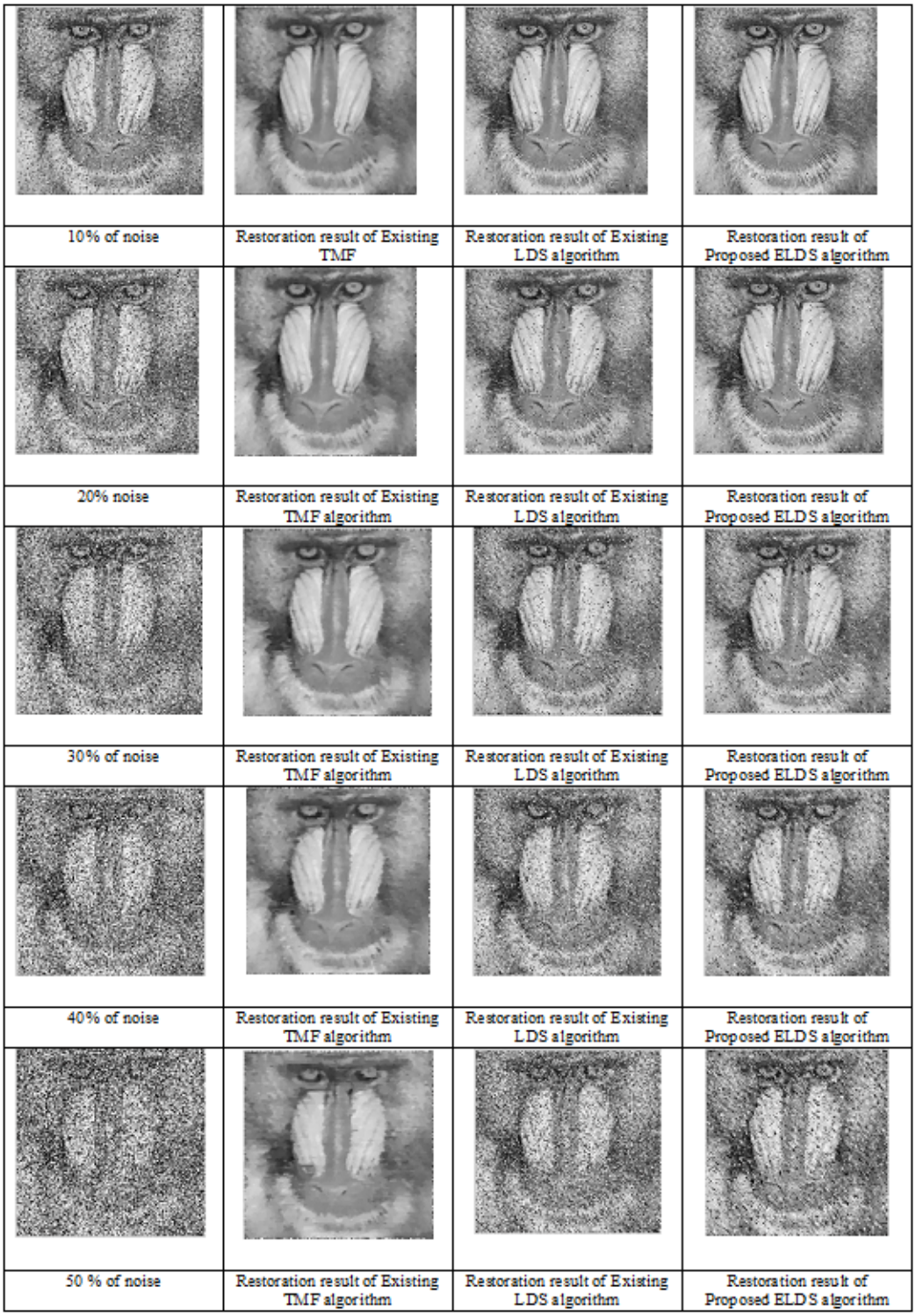

Figure 3. Image Restoration Results of the Boboon Image.

Figure 4. Image Restoration Results of the Lady Image.

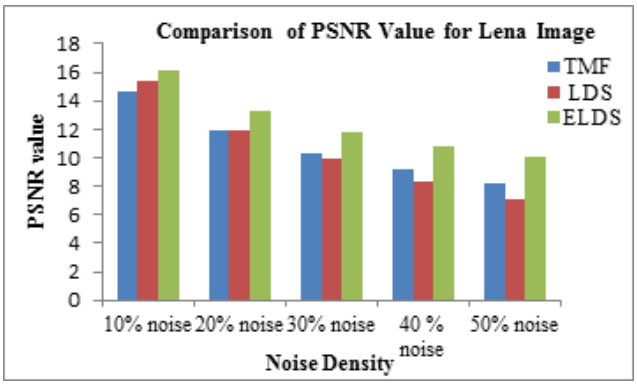

Figure 5. Comparison of PSNR Value for Lena Image.

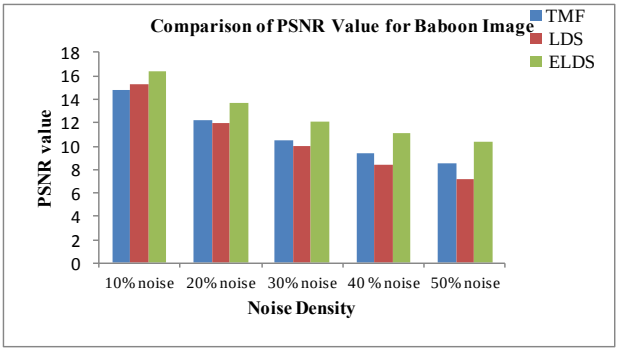

Figure 6. Comparison of PSNR Value for Lena Image.

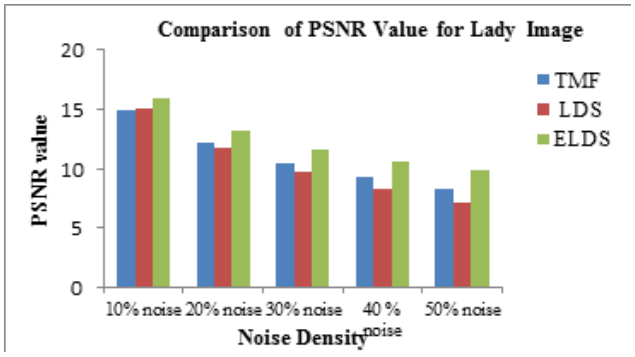

Figure 7. Comparison of PSNR Value for Lady Image.

5. Conclusion

An Enhanced Leading Diagonal Sorting (ELDS) algorithm is implement for the impulse noise detection and filtering process in this work. Simulation result illustrate that ELDS provides better quality based on PSNR and MSE value compared to TMF and LDS algorithms. From the result analysed that ELDS algorithm removes the 10%-50% of noise compared to TMF and exisintg LDS.

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