

Removal of Random Valued Impulse Noise by Directional Mean Filter Using Statistical Noise based Detection

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ABSTRACT

Digital image processing and video processing are mainly used for the noise removal technique is a highly demanded research field. The main objective of this paper work is to detect and de-noise the image using a novel two stage algorithm for the removal of random valued impulse noise from the images is presented. In this paper, the first stage does the noise pixels are detected using the average deviations and threshold value. In the second stage, the directional differences between the four main directions are calculated. The median values of the pixels which lie in the direction of minimum difference are calculated and the noisy pixel values are replaced with the median value. This method identifies the noisy pixels in the corrupted images. So the two stage algorithm for image denoising random valued impulse noise is used. Experimental results show that proposed method is superior to the conventional methods in Peak Signal Noise Ratio (PSNR) values of the image performs, with and without noise compared. Comparison of PSNR values of the proposed method and the existing techniques show that the proposed method perform better than the existing one.

Index terms

Impulse noise, random valued impulse noise, noise detection, Image De-noising, Nonlinear Filters.

1. INTRODUCTION

Noise removal and suppression from images is one of the most important techniques concerns in digital image processing. The impulse noise is one of the most important noise, which comes from during transmission time errors in analog to digital conversion processing time. An important characteristic of this type of noise is that only a part of the pixels are corrupted and the remaining part noise-free. Fixed valued impulse noise takes the values 0 and 255 where as the random valued impulse noise takes the values in the dynamic range of [0,255]. Various methods have been proposed in the literature for the removal of random value impulse noise.

One of the important most efficient methods is the median filter method. This method is mainly used to suppress noise with high computational efficiency. However, since using the technique, average of the every pixel in the image is replaced by the median value in its consider for the neighborhood value. The median filter often removes desirable details in the noise image and blurs image it too. The weighted median filter and the center-weighted median filter were proposed as to improve the median filter by giving more weight to some selected pixels in the filtering window. Although these two filters can preserve more details than the median filter, they are still implemented uniformly across the image without considering whether the current pixel is noise-free or not. ROAD mechanism provides a measure of how very close

to a pixel value to its four most similar neighbors. Consider the noise level is high it introduces that time introduces blurring in the image. The methods which filters all the pixels irrespective of the corruption noise to blur the image, hence the techniques which follow the two stage process of detection of noise pixels and filtering of noise pixels are employed to achieve better performance in terms of peak signal to noise ratio. In order to overcome the difficulties in this paper, a two stage algorithm removal of impulse noise is proposed. The proposed method is simple and outperforms the existing methods in terms of the peak signal to noise ratio.

2. TWO STAGE ALGORITHM FOR REMOVAL OF IMPULSE NOISE

Consider X to be a random valued noise corrupted image of size $M \times N$ and $X(i,j)$ denote the grey level at the pixel location (i,j) . The pixels in the detection window 'P' of size 3×3 is denoted as

$$P = [X_{i-1,j+1}, X_{i,j+1}, X_{i+1,j+1}, X_{i-1,j}, X_{i,j}, X_{i+1,j}, X_{i-1,j-1}, X_{i,j-1}, X_{i+1,j-1}] \quad (I)$$

In the first stage the noise corrupted pixels are detected using the absolute deviation between the mean value and the centre pixel value and by comparing with threshold value. In the second stage, the detected noise pixels are replaced with the median value of the pixels lying in the direction of the minimum difference.

2.1 Noise detection

Step 1: A 5×5 sliding window (p) was chosen from the noise corrupted image, and it runs from the top most left corner to the bottom most right corner, covering the entire size of the image. The centre pixel of the 5×5 window was treated as the test pixel.

Step 2: Usually the pixels located in the neighbourhood of a test pixel are correlated to each other and they process almost similar characteristics if the test pixel under consideration is noise free. The absolute difference between the mean value and the centre pixel value in the chosen 5×5 window is calculated.

Step 3: Calculation of mean value.

$$\bar{X} = \frac{1}{m \times n} \sum_{i=1}^m \sum_{j=1}^n X_{i,j} \quad (1)$$

where $m \times n$ is the size of the chosen window.

Step 4: Calculation of the absolute deviation between the mean value and the centre pixel value.

$$d = |X_{i,j} - \bar{X}| \quad (2)$$

Where $X_{i,j}$ is the the centre pixel value in the 5x5 window under consideration.

Step 5: The threshold value ‘T’ is determined from each 5x5 window, to identify the pixels corrupted by the noise. An adaptive threshold value was calculated from each 3x3 window using the following equation to obtain the precise result.

$$T = 0.78 * \sigma \quad (3)$$

Where ‘ σ ’ is the standard deviation for the 5x5 window under consideration

Step 6: Calculation of standard deviation.

$$\sigma = \sqrt{\frac{1}{m \times n} \sum_{i=1}^m \sum_{j=1}^n (X_{i,j} - \mu)^2} \quad (4)$$

Step 7: The pixel under consideration is treated as noisy pixel if the absolute deviation is greater than the threshold value otherwise the pixel is treated as noise free.

Step 8: Steps 3 to 7 are repeated until entire pixels in the noisy image ‘X’ are covered.

Step 9: Binary noise mask ‘N’ is created on the basis of step 8.

$$N(i,j) = \begin{cases} 1, & \text{if } d < T \\ 0, & \text{otherwise} \end{cases} \quad (5)$$

Step 10: Noise free pixels are sited directly to output image and Noisy pixels are subjected to filtering process.

2.2 Filtering stage

In this stage the “noise pixels” marked with $N(i,j) = 0$ is replaced by an estimated correction term.

Step 1: Consider a 3x3 window, starting from the top-most left corner of the impulse noise corrupted image X.

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

Fig 1: A 3x3 window of noisy image

Step 2: The absolute differences between the current pixel and its neighbors in the four main directions (i.e.) horizontal, vertical and direction along two diagonals are calculated.

$$D_k(i,j) = |X(i+u, j+v) - X(i-u, j-v)| \quad (6)$$

where, $(k, u, v) = \{(1, 1, 1), (2, 0, 1), (3, -1, 1), (4, -1, 0)\}$

Step 3: The direction along which the pixels giving the minimum difference value is calculated (i.e.) $\text{Min} \{D_1, D_2, D_3, D_4\}$.

Step 4: The median value of the pixels in the step 3 was calculated.

Step 5: Finally, the correction term to restore a detected “noise pixel” was obtained from the step 4 is replaced with the noise pixel value. The above steps 1 to 5 are repeated for all the pixels in the image.

The flow chart shows the flow in which the image is processed. Get the image as input. Using border handling technique, find the pixel value. Repeating it for most, take it as a noise value. This value is checked against random valued impulse. If it is yes, then the value is processed with proposed algorithm. If it is no, then it is replaced with the previous value. Then the neighbours are checked for noise. If the neighbours are noisy then it replaced with the previously processed value. If the neighbours are non-noisy values, then it replaced with the same. This is repeated for all pixels and finally the output is arrived.

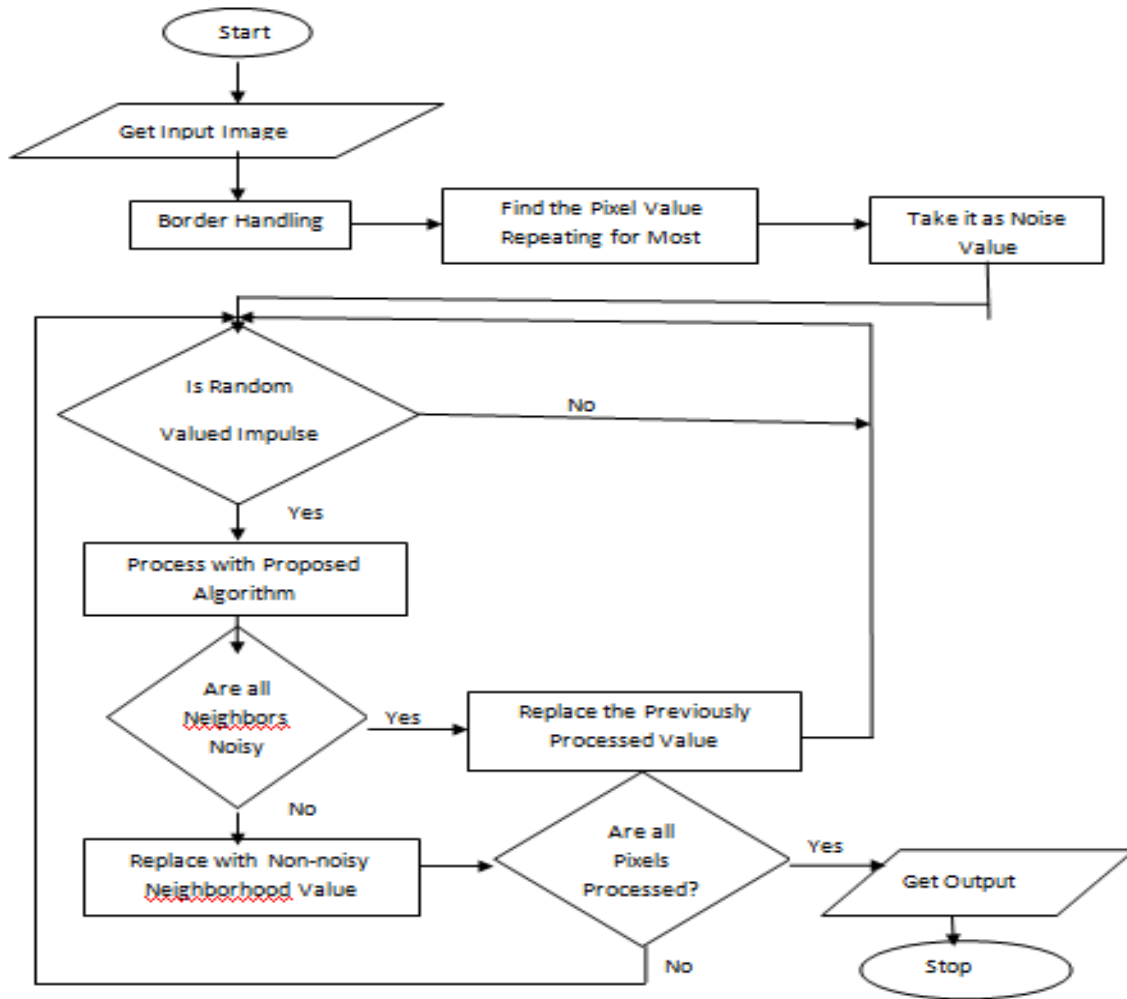


Fig 2: Flowchart of Noise removal method

3. RESULTS AND DISCUSSION

In this section, the feasibility of the proposed algorithm is compared to the other filters based on the quantitative measures. The PSNR (dB) evaluation scheme is used to access the strength of the filtered image, taken into consideration as to measure the computational efficiency of the filter implemented. In order to validate the proposed algorithm, Lena 512 × 512 png, 8-bit image is used in the analysis of the proposed algorithm which has been implemented on the MATLAB platform. This standard test image contains various characteristics suitable to test the performance of the filter being implemented.

Table 1 : Comparative PSNR Values of Various Filters on Noisy Lena Image.

Image /ND	10%	20%	30%	40%	50%	60%
Lena	36.07	35.17	32.71	31.26	28.68	24.77
peppers	37.13	36.91	35.44	34.15	31.71	27.92
barbara	24.06	23.75	23.05	22.80	22.38	21.68
boat	27.02	26.47	25.83	25.08	24.36	22.23



(a)

(b)



(c)

(d)



(e)

(f)



Fig 3: (a) original image (b) corrupted image (RVIN 40%) Restored image using (c) median filter (d) ROAD (e) CWMF (f) PWMAD (g) proposed algorithm.

Restoration results are quantitatively measured by peak signal-to noise ratio (PSNR), Table1 shows the PSNR values of the best results obtained by the proposed algorithm for the different 512 x 512 images corrupted with different noise densities. Table 2 shows the comparison of PSNR values of proposed technique with existing techniques for 512x512 Lena image. It can be seen that our proposed filter provides the best results in PSNR. In particular, when the noise ratio is larger than 30%, the proposed algorithm produces PSNR values that are onedecibel higher than the closest competing

Table 2:Comparative PSNR Values of Various Noise Filters on Noisy Lena Image.

Noise density	Median	ROAD	CWMF	PWMAD	PA
10	31.56	34.45	34.73	31.23	36.07
20	30.23	32.09	33.07	30.09	35.17
30	28.05	31.01	32.56	26.45	32.71
40	24.61	28.94	28.79	22.65	31.26
50	21.53	26.64	25.19	20.08	28.68

filters. By experimental results, the performance of the proposed algorithm is better than the competing filters in terms of the peak signal to noise ratio. It also removes most of the noise while preserving the edge details very well, and even thin lines.

4. CONCLUSION

The proposed algorithm deals with the removal of random valued impulsive Noise. Impulsive noise being contaminated in some pixels based on probability densities. The detector utilises a threshold value to compare with a predefined parameter. Fixed threshold is not suitable and do not work well under different noise conditions as well as for different images. In this algorithm, adaptive threshold determination strategy based on given noisy image statistics is proposed. Various statistical parameters i.e. (μ, σ^2) are also used to predict the threshold value. The proposed filter is an impulsive noise removal scheme using the directional pixel wise difference method, replacing the corrupted pixel with the median value of pixels lying in the direction of minimum directional difference. The restored image, by this scheme exhibits the desirable properties of edge and detail preservation. Extensive simulations and comparisons are done with competent schemes. It is observed, in general, that the proposed schemes are better in terms of peak signal to noise ratio suppressing impulsive noise at different noise densities than their counterparts.

5. REFERENCES

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