IMPULSIVE NOISE SUPPRESSION USING MODIFIED TRISTATE MEDIAN FILTER AND ADAPTIVE SWITCHING MEDIAN FILTER

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Abstract - Noise is undesired information that contaminates an image.. To recover the image from its noise there exits many filtering techniques which are application oriented. For the existing filtering technique one pixel is taken at a time and a sub window is considered around that pixel. Then mean is calculated using the pixel values of that sub window. The First algorithm is called Modified Tri State Median Filter (MTSM). It is based on the test for the presence of noise in the Sliding Window (W) pixels. It computes Median (M1) for neighborhood pixels and CWM in the Sliding Window. Then it calculates d1 and d2 and sets a threshold (T) value. The decision making of replacement of central pixel depends on the T. The second algorithm is called Adaptive Switching Median Filter(ASM) using Neighborhood pixels. It enumerates d2 and d3 and SM. It also finds the difference between d2 and d3. The decision for replacing the central pixel is rest with T. Here, the quality of MTSM and ASM filters was ascertained using the quality metric PSNR and its result evidentially proves that the proposed filter ASM are much effective and can be used as an alternate approach for noise removal.

***Key Words*: Tristate, Sliding Window, Median, Neighborhood pixels.**

1. INTRODUCTION

A digital image is an image f(x,y) that has been discretized both in spatial coordinates and brightness. Interest in digital image processing methods stems from two principal applications areas, improvement of pictorial information for human interpretation and processing of image data for data storage, transmission. Noise is defined as a process which affects the acquired image and is not part of the scene. Noise is any undesired information that contaminates an image. Noise appears in an image from a variety of sources. The Salt and Pepper type noise is typically caused by malfunctioning of the pixel elements in the camera sensors, faulty memory locations, or timing errors in the digitization process. For the images corrupted by Salt and Pepper noise the noisy pixels can take only the maximum and the minimum values in the dynamic range. To recover the image from its noise there exits many filtering techniques which are application oriented. The working procedure of the existing mean filtering technique is very simple. For the existing filtering technique one pixel is taken at a time and a sub window is considered around that pixel. Then mean is calculated using the pixel values of that sub window. In this paper, we propose an efficient adaptive method for the removal of salt and pepper noise. In the proposed method, first a 3X3 window is taken where the central pixel is recognized as the processing pixel. Then if the processing pixel is found 0 or 255 then it is a noisy pixel, and the window size is increased depending upon the other elements of the current window. Lastly the processing pixel is replaced by either the mean, median or trimmed value of the elements in the current window according to the conditions given in the algorithm. The proposed algorithm is tested against various standard images and the experimental result shows that our proposed algorithm has better restoration image quality with better PSNR value as compare to other existing algorithms. The outline of this paper is as follows. The proposed algorithms are presented in section II and section III. Experimental and comparison result are given in section IV. Finally we conclude our work in section VII.

2. MODIFIED TRISTATE MEDIAN FILTER

A large number of techniques have proposed to remove impulse noise from corrupted images. Median(M1) and Centered Weighted Median (CWM) have been widely applied in impulse noise reduction. Since Median(M1) and Centered Weighted Median (CWM) filter applied to an entire image without a prior detection of the corrupted pixels. So, to improve performance, many existing methods use an impulse detector to determine whether a pixel should be modified. Then, the filtering process is applied only to the identified noisy pixels.

The First algorithm is called Modified Tri

State Median Filter (MTSM). It is based on the test for the presence of noise in the Sliding Window (W) pixels. There are three state assigned for restoring the image.

State 1: If T ≥ d2, then Cp(i,j)=Cp(i,j)

State 2: Elseif d2>T≥d1 Cp(i,j)=CWM

State 3:ElseCp(i,j)=M1

This algorithm computes the Median (M1) for neighborhood pixels N_4 (C) of the Cp(i,j) and CWM in the Sliding Window (W). Compute d1 between the CWM and Cp(i,j) similarly compute d2 between central pixel Cp(i,j) and M1. Fix the threshold(T) between 10 to 25. The decision making of replacement of central pixel depends on the T.

2.1 Algorithm of Modified TriState Median Filter:

STEP 1: Read the corrupted image u'

STEP 2: Divide u' into sub images in the order of overlapping Sliding Window (W) of size n×n.

STEP 3: Set the threshold value T.

STEP 4: If the central pixel Cp(i,j) is corrupted

i) Compute M1 for N_4(C)
ii) Find the Centered Weighted median value for Sliding window pixels.

STEP 5: Compute the difference d1 and d2.

STEP 6: i) If T≥d2 then

Cp(i,j)=Cp(i,j)

ii)Else If the d1≤ T<d2 then

Cp(i,j)= CWM

iii) Else

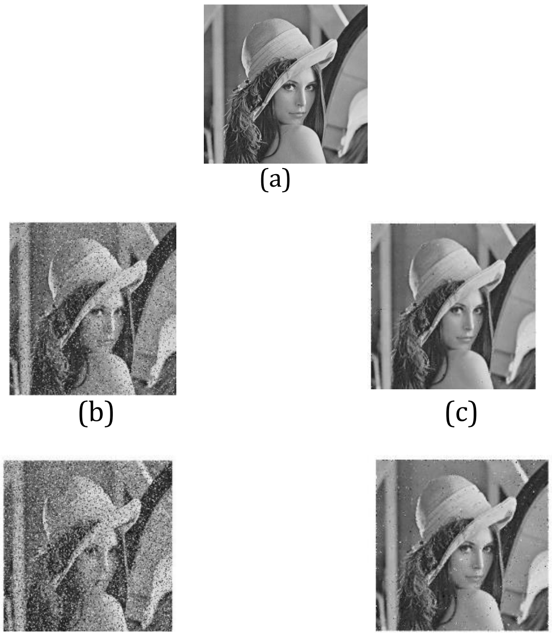
Cp(i,j)=M1

STEP 7: Repeat Step 4 for next central pixel until entire image is processed.

STEP 8: Stop

Table 1.1 Comparison of PSNR values for Lena Image with MTSM

METHOD	NOISE DENSITY (%)								
	10	20	30	40	50	60	70	80	90
MTSM	30.0	24.5	20.2	16.7	13.9	11.5	9.8	8.2	6.9



(a) (b) (c) (d) (e)

Fig. 1 (a) Lena Original Image.Corrupted Images of Lena with noise density.(b)10%d) 20%; (c),(e),are filtered images of (b),(d) respectively.

3. ADAPTIVE SWITCHING MEDIAN FILTER USING NEIGHBORHOOD PIXELS

The most common method used for impulse noise suppression for gray-scale and color images is the median filter (MF).

The second algorithm is called Adaptive Switching Median Filter(ASM) using Neighborhood pixels.

State 1: T≥d3 then, Cp (i,j)=Cp(i,j).

State 2: Else if d2≤T<d3 then Cp(i,j)=M1.

State 3: Else replace Cp(i,j)=M2

It computes the Median (M1) for N_4 (c) in the Sliding Window (W). Compute the difference (d2) between the M1 value and Cp (i,j), similarly it computes the difference(d3) between central pixel Cp(i,j) and M2. Fix the threshold value (T) between 10 to 25.

3.1 Algorithm for ASM for Neighborhood pixels:

STEP 1: Read the corrupted Image u'

STEP 2: Divide the corrupted Image u' into sub images by using overlapping sliding

Window (W) of size n×n.

STEP 3: Set the threshold value T.

STEP 4: If the central pixel Cp (i,j) is corrupted

(i) Compute SM for 4-connected pixels (M1)
(ii) Find the SM value for Corner pixels (M2)

STEP 5: Compute the difference d2 and d3.

STEP 6: i) If the threshold value T≥ d3 then

Cp(i,j)=Cp(i,j).

ii) Else If d2≤T<d3 then

Cp(i,j)=M1
iii) Else Cp(i,j)=M2

STEP 7: Repeat Step 4 for next central pixel until entire image is processed.

STEP 8: Stop

METHOD	NOISE DENSITY (%)								
	10	20	30	40	50	60	70	80	90
MTSM	31.0	25.1	20.4	17.1	14.2	12.3	10.3	8.8	7.7

Table 2 Comparison of PSNR values for Lena image for ASM.

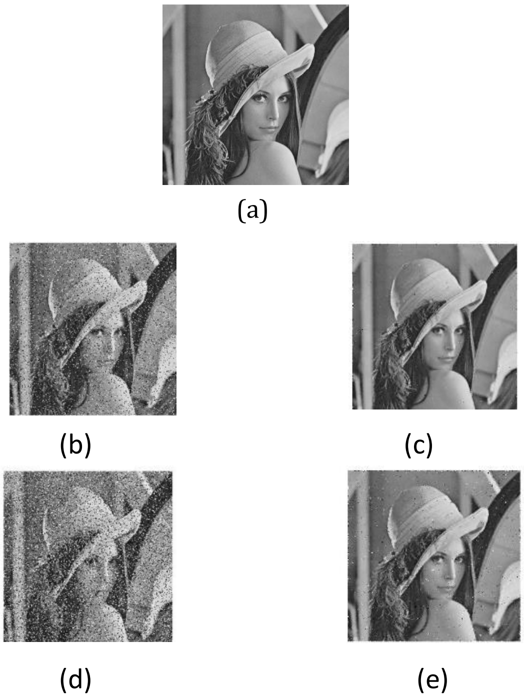


Fig 2 (a) Lena Original Image.Corrupted Images of Lena with noise density.

(b)10%d) 20%; (c),(e),are filtered images of (b),(d) respectively.

4. IMAGE QUALITY METRICS

The Peak Signal Noise Ratio (PSNR) is most commonly used as a measure of a quality of reconstruction in image compression. It is most easily defined via the mean square Error (MSE) which for two m × n monochrome images u and u' where one of the images is considered a noisy approximation of the other is defined as:

$$MSE=\frac{1}{m\times n}\sum_{i=1}^{m}\sum_{j=1}^{n}(u_{i,j}-u'_{i,j})^2 \quad (1)$$

The PSNR is defined as:

$$PSNR=10*log_{10}\left(\frac{255^2}{MSE}\right)(2)$$

Here, the definition of PSNR is the same except the MSE (Mean Square Error) is the sum over all squared value differences divided by image size and by three.

The Structural Similarity (SSIM) is a recently proposed image fidelity measure which has proved highly effective in measuring the fidelity of signals. The SSIM approach was originally motivated by the observation that natural images have highly structured signals with strong neighborhood dependencies. These dependencies carry useful information about the structures of the objects in the visual scene.

$$SSIM(x,y)=\frac{((2\mu_x 2\mu_y+C_1)+(2\sigma_{xy}+C_2))}{((\mu_x^2+\mu_y^2+C_1)(\sigma_x^2+\sigma_y^2+C_2))} \quad (3)$$

where μ_x and μ_y are average of x,y respectively, μ_x^2 and μ_y^2 are variance of x,y respectively, σ_{xy} is the covariance of x and y, $C1=(k_1L)^2$, $C2=(k_2L)^2$ are two variables to stabilize the division with weak denominator, L the dynamic range of the pixel-values (typically this is $2^{\#bits\ per\ pixel}-1$)and k_1=0.01 and k_3=0.03 by default.

The SSIM measures distortions as a combination of three factors: loss of correlation, luminance distortion and contrast distortion.

5. COMPARATIVE ANALYSIS OF OF MTSM AND ASM

Chart 1 gives a comparative analysis of the performance of proposed filters MTSM and ASM for Lena image with noise probabilities varying from 10% to 90%.The PSNR value obtained for Lena image from 10% to 90% noise density.

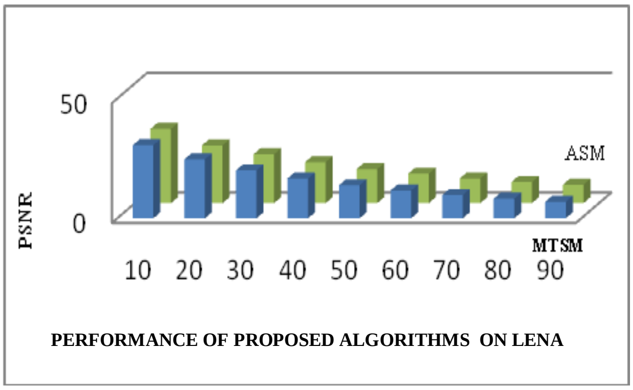


Chart 1- Performance of proposed filters for Lena Image

6. CONCLUSIONS

In this paper two new non-linear filters namely, Modified Tri State Median Filter has been developed and Adaptive Switched Median Filter were developed. The quality of these filters was ascertained using the quality metric PSNR. It is clearly shown from the comparison tables of two proposed filters that for standard images Lena, the PSNR values were found to be significantly higher on ASM filter with PSNR value of MTSM filter. Hence, from the results, it is evident that the proposed filter ASM are much effective and can be used as an alternate approach for noise removal.

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