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Using Median Filter Systems for Removal of High Density Noise From Images

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Abstract— An Efficient algorithm for median filter for removal or improvement of gray scale images that square measure highly corrupted salt and pepper noise is proposed during this paper. Noise in image square measure represent by the pixel value 0's and 255's that square measure shows that black and white dot in image. In proposed algorithm take an image and choose 3x3 size window and 5x5 size window and processing or center pixel value check if its value is 0's or 255's then image is corrupted otherwise noise free image. If image is noisy and processing pixels neighboring pixel value is between 0's and 255's then we tend to replace pixel value with the median value and if processing pixels neighboring pixel value is 0's or 255's then we tend to replace pixel value with the mean value. Further increased the window of size 5x5 and once more repeat given process until image is denoised. The proposed filter algorithm with 3x3 and 5x5 patch shows higher parametric values as compared to the standard median filter with 3x3 and 5x5 patch for Lena image. The simulation result shows higher and efficient performance of Peak signal to noise ratio and Mean Square Error and Image enhancement factor.

Keywords— Standard median filter, Salt and Pepper Noise, Unsymmetric trimmed median filter, Peak signal to noise ratio, Mean square error, Image enhancement factor.

I. Introduction

Images area unit corrupted by noise chiefly throughout image acquisition and/or transmission. Impulse noise is one amongst those noises, that is generated throughout imaging because of faulty shift wherever fast transients area unit gift. Impulse noise denoising is a critical issue in case of digital image processing [1]. The appearance of image is considerably affected even at density of impulse noise. There are 2 kinds of impulse noise, they're salt and pepper noise and random valued noise. Noise removal is achieved by using a number of existing linear filtering techniques which are mathematically simple. A significant category of linear filters minimizes the mean square error (MSE) criterion. These linear filtering techniques work well once noise is additive. These techniques fail when noise is non additive and are not effective in removing impulse noise. Non-linear filtering techniques area unit enforced wide as a result of their superior performance in removing salt and pepper noise and conjointly conserving fine details of image. There are many works on the restoration of images corrupted by salt and pepper noise. The median filter was once the foremost common non-linear filter for removing impulse noise, due to its smart denoising power and procedure potency. Median filters are known for their capability to remove impulse noise as well as preserve the edges.
Images are often corrupted by impulse noise Image noise is any degradation in an image signal while an image is being sent from one place to another place via satellite, wireless and network cable etc. error occurs in image signal while an image is being sent electronically from one place to another place, for example an image transmitted using a wireless network might be corrupted as a result of lighting or other atmospheric disturbance[2].Impulse noise are classified into two categories: fixed valued impulse noise and random valued impulse noise. Impulse noise the pixel value of a noisy pixel takes either maximum or minimum gray level [3]. Gray scale images are distinct from one –bit black and white images, which in the context of computer imaging are images with only the two colors, black and white (also known as binary images). Gray scale images have many shades of gray in between 0 and 255. In random value impulse noise, noisy pixel value is in the range of [0,255] for gray scale images. In this paper we focus only on removing fixed value impulse noise.

II. LITERATURE SURVEY

Removing impulse noise there are many linear and nonlinear filtering techniques.

In Median filter (MF) [4] is used to reducing noise. It is used to remove noise in image for only low noise density. This filter performance is poor. The Standard Median Filter (SMF) is used to remove only low noise densities but high noise densities its performance is poor and image is not cleared.

In Adaptive Median Filter (AMF) [5] [6] "Salt & Pepper Impulse Detection and Median based Regularization using Adaptive Median Filter". New Adaptive 2D spatial filter operators for the restoration of salt & pepper impulse noise are corrupted digital images. Its performance is better as compare to SMF but high noise densities the window size has to be increased, so images are blurring.

Weighted Median Filter (WMF) [7] is also used to removal salt and pepper noise and its performance is good for low density noise but high density noise images are not clear.

In Center Weighted Median Filter (CWMF) [8] weights are assigned to selected pixels in the filtering window in order to control the filtering behavior but at high noise density filters fails to reproduce the original image with edge details. Centre weighted median filter and Recursive Weighted Median Filter (RWMF) are used to improve the performance of the median filter. It also give more weight to some selected pixel in window and exhibits blurring of filtered images [9].To overcome this problem in Adaptive Center Weighted Median Filter (ACWMF) but in this filter we need some threshold values [4].

To remove the threshold problem in Tri-State Median Filter (TSMF) [10].In this filter images noise detection by an impulse detector, this takes the outputs from the SMF and CWMF and compare with the center pixel value and origin value in order to make a tri-state decision. The switching logic is controlled by a threshold T and the output of TSM filter.

Directional Weighted Median Filter (DWMF), are used to remove impulse noise and this filter is also used to identify noisy pixel using all four directional information of the selected pixel to calculate the median. In this method, two major steps: Detect noisy pixel using new impulse detector and Utilize weighted directional calculate the median for removing impulse noise and preserve details [11].

Decision Based Algorithm (DBA) is also known as Switching Median Filter (SMF) [11]. In this filter is used to minimize the undesired alteration of uncorrupted pixels by the filter. Overcome this problem, switching median filter checks each input pixel whether it has been corrupted by impulse noise or not. Then it will be change only the intensity of noisy pixel candidates, while left the other pixels unchanged the decision is based on a threshold value. This filter repeated replacement of neighboring pixel produces streaking effect [12].

In Decision Based Unsymmetrical Trimmed Median Filter (DBUTMF) is used to overcome streaking effect problems, but the trimmed median of the 3x3 window will not provide the best result for the noisy pixel [13].

In Modified Decision Based Unsymmetrical Trimmed Filter (MDBUTMF) is used to remove image details such as thin lines and corners while problem of DBUTMF, But in this filter performance is not best [14].

In Decision-based Average or Median filter (DAM) [15] Combine the advantages of the [16] and adaptive median filter in order to achieve better result. DAM has a good trade-off between quantitative and qualitative properties of the recovered image and computation time. And this method noisy pixel values are replaced by average and median of the neighbor's value.

Modified Non-Linear Filter (MNLF) is also used to remove impulse noise. In this method the noisy pixel are replaced by trimmed median value when other pixel are not all 0's or 255's. But if the all the pixel value are 0 or 255 then this method increases the window size and then trimmed median value is calculated and noisy pixel is replaced [17].

All this filters fail at low and high noise density. The proposed filter achieves best performance value of Peak Signal to noise ratio (PSNR) and MSE values.

III. PROPOSED FILTER

The proposed algorithm is divided into two parts first is addition of noise and second is filtering operation. The projected Median filter can be a easy and powerful non-linear filter. Median filter is employed for reducing the number of intensity change between one pixel and therefore the other different pixel. During this filter, if image is noisy and processing pixels surrounding pixel value is lies between 0's and 255's then we tend to exchange pixel value with the median of it. The median of selected window from given pixel value is calculated by arranging all the pixel values into increasing order and then replace the pixel being calculated with the processing pixel value. And if processing pixels neighboring pixels value in the selected window contains all 0's or 255's then we tend to replace pixel value with the mean value which can be calculated by arranging all the pixel values into increasing order and then replace the pixel which is calculated with the processing pixel value. Further Increased the window of size 5x5 and once more repeat the given process until image is Denoised.

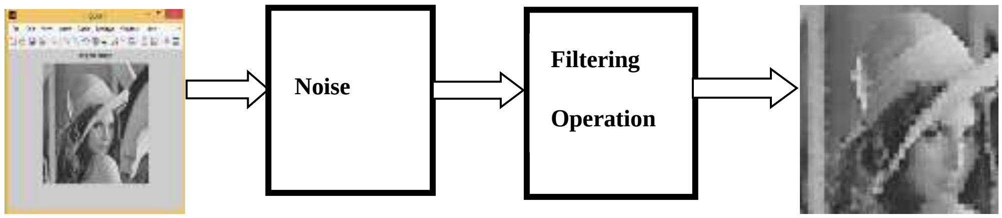

Figure 1: Block diagram of proposed system

IV. Proposed Filter Algorithm-

Step 1): Initially Read Noisy Image.

Step 2): Noise Detection Condition

If 0<P (i, j) < 255 / Noise free

Then, Send to de-noised or restore

Step 3): Choose window of size 3x3 with center element as processing pixel. Assume that the pixel being processed is P (i, j).Check the pixel value.

Step 4): If P(i,j) = 0 or P(i,j) = 255, then P(i,j) is a corrupted pixel.

Step 5): Apply Conditions

Case i): If target pixel P (i, j) neighboring all pixels are 0's or 255's then go to step 6 for Noise Removal

Case ii): if target pixel Y (i, j) neighboring all pixels are combinations of 0's and 255's then Go to step 7 for Removal of Noise.

Step 6): If all the elements in the selected window are 0"s and 255"s, then take all surrounding pixel P (i, j) after that arrange in increasing order and calculate the mean of the elements in the window. This mean value is replace by processing pixel P (i.j) and go to step 8.

Step 7): If processing pixel and neighboring pixel value contains some combination of 0's and 255's then eliminate 0's and 255's from the selected window and find the median value of the remaining elements. Replace P (i, j) with the median value and go to step 8.

Step 8): Image is restored.

Step 9: Repeat a process for every pixel for 5x5 window.

V. Methodology Of Proposed Work

In our proposed system we had implemented decision based filter and unsymmetric trimmed median filter, for every test image initially we had applied noise addition technique, then we had performed filtering algorithms using decision based filter and unsymmetric trimmed median filter and image is restored. This restored image we had compared with Peak signal to noise ratio, mean square error, image enhancement factor, our system has more efficient than other existing methods such as median filter. The proposed Median Filter Algorithm was processes to detect noise and remove 90% noise in given image as compare to previous algorithm.
Ex: - Case i): If target pixel P(i, j) value is maximum (i.e.255) gray level and its neighboring pixel are also maximum value or salt noise.

To remove the salt noise there are two phases

1) If we take median value it will be 255, which is again noisy pixel.

2) If we take mean value it will be 255, which is also noisy pixel again.

To solve this problem the target pixel is replace by the pepper noise mean value.

255	255	255
255	255	255
255	255	255

Case ii):- If target pixel P (i, j) value is minimum (i.e.0) gray level and its neighboring pixel are also minimum value or salt noise.

To remove the salt noise there are two phases

1) If we take median value it will be 0, which is again noisy pixel.

2) If we take mean value it will be 0, which is also noisy pixel again.

To solve this problem the target pixel is replace by the salt noise mean value.

0	0	0
0	0	0
0	0	0

Case iii):- if target pixel value in selected window is max/min gray level (0/255) and neighboring pixel contains all that adds 0 and 255 to the image.

To remove noise use following steps:

1) Take the selected window 3x3 all pixel value instead of target pixel in1-D array.

[255, 255, 255, 0, 255, 255, 0, 255]

2) Now this array element is sorting in ascending order.

[0, 0, 255, 255, 255, 255, 255, 255]

3) Now we find the mean value of this array is 159.

4) Hence replace the target pixel value by 159.

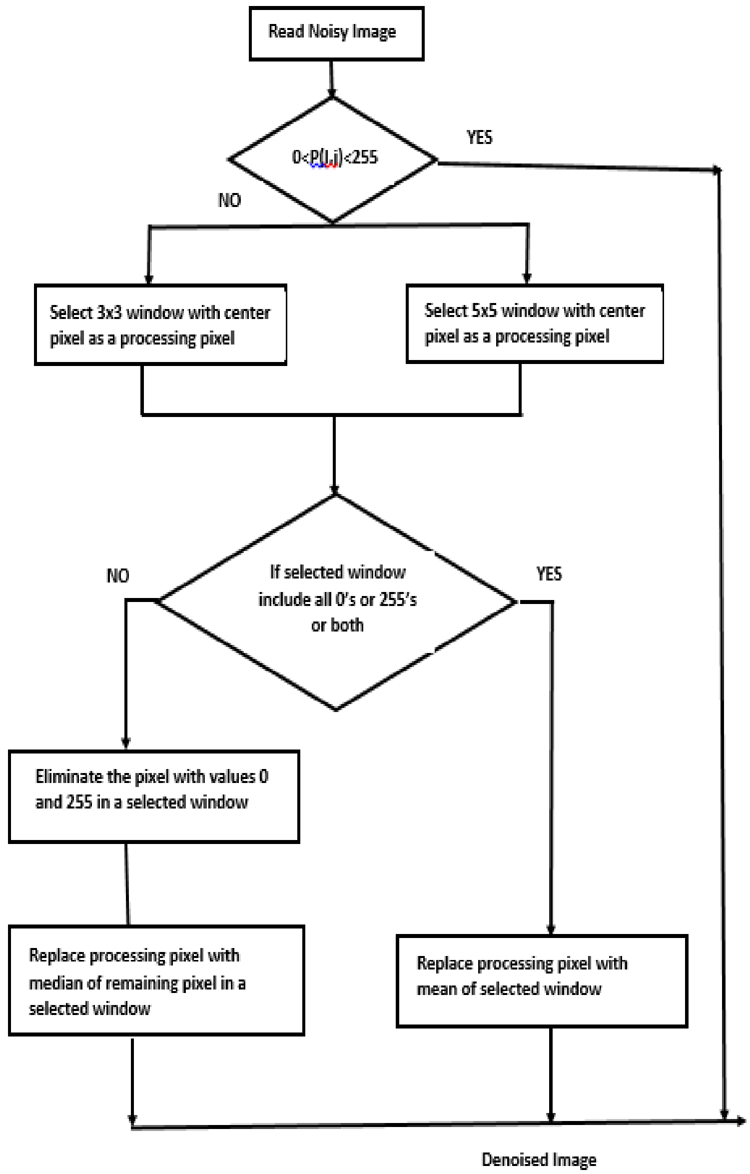

Figure 2: Flow Chart of Proposed System

Case iv):-If target pixel value is maximum (i.e.255) or minimum (i.e.0) gray level and its neighbor some pixel contains salt and pepper noise to the image.

In this case to remove noise use following steps:

1) Take the selected window 3x3 all pixel value instead of target pixel in1-D array.

[90, 80, 85, 40, 0, 255, 50, 255]

2) Now these array elements is sorting in ascending order and also remove salt and pepper value.

[40, 50, 80, 85, 90]

3) Now we find the median value of this array is 70.

4) Hence replace the target pixel value by 70.

70	80	85
40	255	0
255	50	255

Case v):-If the target pixel value in selected window is noise free value, so it does not require for processing.

50	70	90
10	80	40
60	30	20

VI. SIMULATION RESULT

The performance of the implemented algorithm for 3x3 and 5x5 window size is tested with lenna.jpg grayscale image. We have used Matlab R2010 as the simulation tool. The noise density (intensity) is varied from 10% to 90% and performances are quantitatively measured by the Peak-Signal-to-Noise Ratio (PSNR), Mean Square Error (MSE) and Image Enhancement Factor (IEF).

Performance parameter: - For comparing original image and filtered image, we calculate following parameters:

1) Peak-Signal-to-Noise-Ratio (PSNR): PSNR could be a mathematical term to estimate the standard of reconstructed image as compared to that of original image. It is outlined as magnitude relation between most maximum power of signal (original data) and power of corrupting noise (error in reconstruction). Peak signal to noise magnitude relation is often calculated in terms of index decibel scale. Higher PSNR shows that image reconstruction is of upper quality.

$$PSNR\ in\ db = 10\log_{10}\left(\frac{255^2}{MSE}\right) \quad \text{……..(1)}$$

2) Mean Square Error (MSE): The two major error metrics that are used to compare the various image compression methods are the PSNR (Peak Signal to Noise Ratio) and the MSE (Mean Square Error). MSE is the accumulative squared error between compressed image and original image.

$$MSE = \frac{\sum\sum(Y(x,y)-(\tilde{}Y\ (x,y))2}{MN} \quad \text{…… (2)}$$

Where MSE stands for mean square error, M x N, is size of the image, Y represents the original image and Ŷ denotes the Denoised image.

3) Image Enhancement Factors (IEF): The image enhancement factor is the statistical approach used to measure the effectiveness of the process used in the restoration of images. The higher the value of IEF better the process of conversion.

$$IEF = \frac{\sum\sum(\in(x,y)-(Y\ (x,y))2}{\sum\sum\left(Y(x,y)-\widetilde{Y}(x,y)\right)2} \quad \text{…….. (3)}$$

The simulation results for PSNR (Peak Signal to Noise Ratio) are show in table 1 for standard median filter and implemented algorithm with 3x3 and 5x5 patch for high (95%) level noise density for Lena image.

PSNR (db)				
% of Noise	Median filter		Proposed Filter	
	3x3	5x5	3x3	5x5
50	15.081	20.975	27.568	25.675
60	12.343	17.805	25.848	24.858
70	10.027	13.901	23.345	23.965
75	8.893	11.733	21.326	23.412
80	8.159	10.271	18.629	23.105
85	7.379	8.844	17.805	22.239
90	6.655	7.500	15.837	20.507
95	6.007	6.355	13.878	17.667

Table 1: Comparison result for PSNR value with different Noise Densities for Lena image.

The simulation results for MSE (Mean square error) are show in table 2 for standard median filter and implemented algorithm with 3x3 and 5x5 patch for high (95%) level noise density for Lena image.

MSE				
% of Noise	Median filter		Proposed filter	
	3x3	5x5	3x3	5x5
50	2018.13	519.41	118.82	176.02
60	3791.21	1077.80	169.13	212.41
70	6462.09	2647.90	301.01	260.95
75	8389.94	4362.99	479.06	296.33
80	9934.63	6108.67	708.21	318.07
85	11888.8	8484.54	1077.80	388.27
90	14046.7	11562.7	1695.54	578.50
95	16303.7	15049.5	2661.9	1112.4

Table2: Comparison result for MSE value with different Noise Densities for Lena image.

The simulation results for IEF (Image enhancement factor) are show in table 3 for standard median filter and implemented algorithm with 3x3 and 5x5 patch for high (95%) level noise density for Lena image.

IEF				
% of Noise	Median filter		Proposed Filter	
	3x3	5x5	3x3	5x5
50	4.57	17.77	81.12	52.46
60	2.91	10.25	65.34	52.02
70	2.00	4.88	42.94	49.53
75	1.66	3.20	29.16	47.14
80	1.48	2.41	20.81	46.33
85	1.31	1.84	14.51	40.28
90	1.18	1.43	9.80	20.75
95	1.07	1.16	6.60	15.80

Table 3: Comparison result for IEF value with different Noise Densities for Lena image.

The comparison chart of PSNR value of standard median filter and implemented algorithm with 3x3 and 5x5 patch for different noise density with Lena image are shown in figure 3.

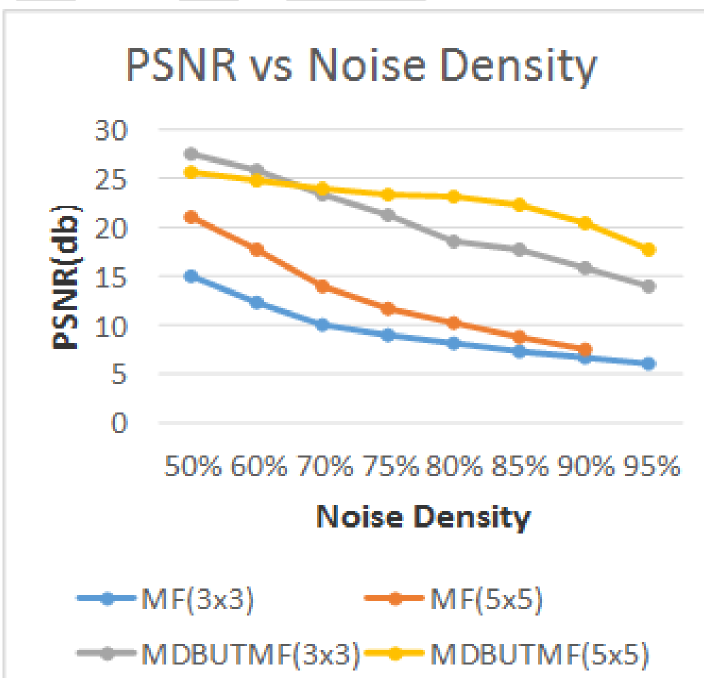

Figure 3: Comparison chart of PSNR and Noise density

The comparison chart of MSE value of standard median filter and implemented algorithm with 3x3 and 5x5 patch for different noise density with Lena image are shown in figure 4.

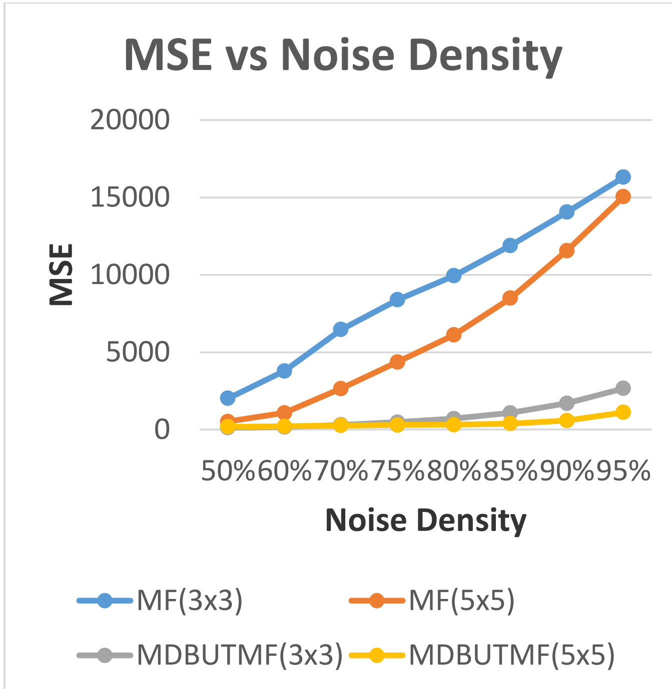

Figure 4: Comparison chart of MSE and Noise density

The comparison chart of IEF value of standard median filter and implemented algorithm with 3x3 and 5x5 patch for different noise density with Lena image are shown in figure 5.

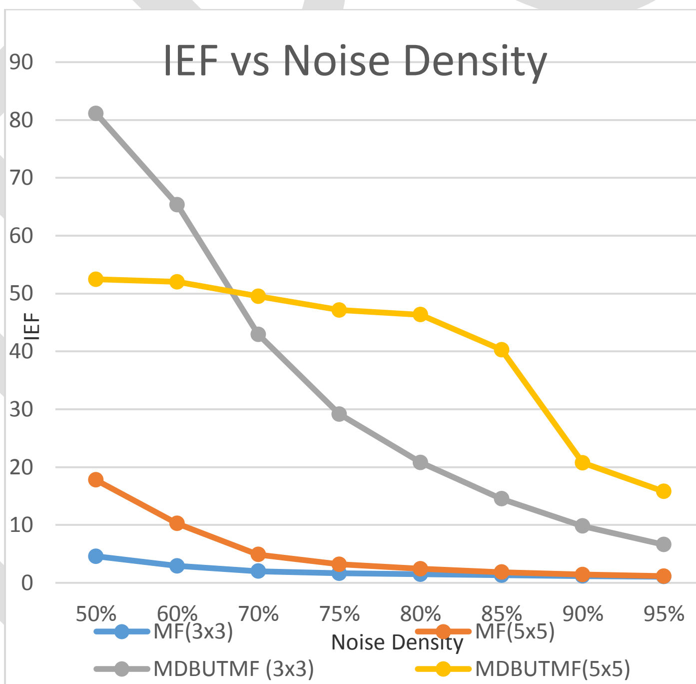

Figure 5: Comparison chart of IEF and Noise density

The performance of restored results of standard median filter and implemented algorithm with 3x3 and 5x5 patch for Lena image which is corrupted by 75% and 80% noise density as show in figure 7:

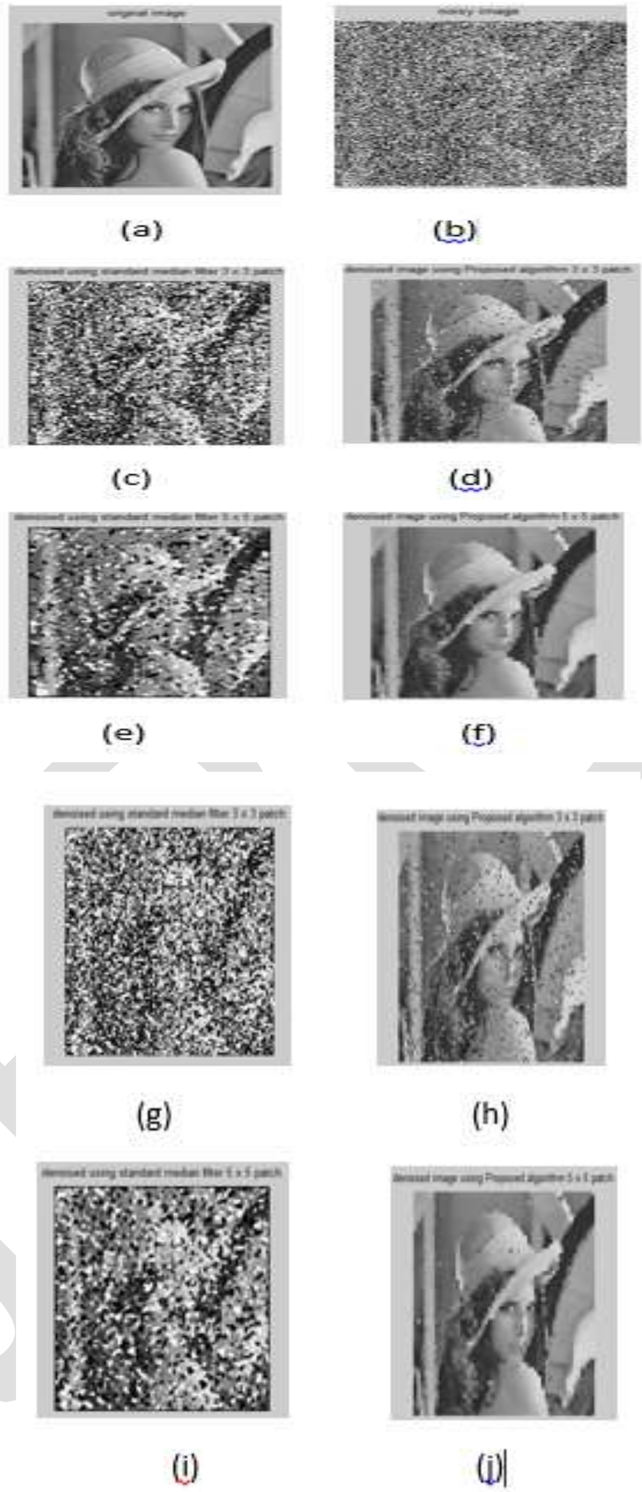

Figure 7: Result of the proposed filter and median filter for Lena image at 75% and 80% noise density. Column (a) original image (b) Corrupted image and (c) restored image using the standard median filter and implemented algorithm

CONCLUSION

In this paper we implemented new algorithm using median filter for removal of high density salt and pepper noise for gray scale image. The implemented filter algorithm with 3x3 and 5x5 patch shows higher parametric values as compared to the standard median filter with 3x3 and 5x5 patch for Lena image. The simulation result shows higher and efficient performance of Peak signal to noise ratio and Mean Square Error and Image enhancement factor.

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