An IDBUTM Filter for the Removal of High Density Impulse Noise

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ABSTRACT
Improved decision based unsymmetric trimmed median filter is one of the valuable methods that are capable to restore of gray scale images which have been enormously corrupted by Salt-and-Pepper noise. An Improved decision based unsymmetric trimmed median filter is proposed to enhance decision based unsymmetric trimmed median filter in term of its noise filtering ability as the images are highly degraded. In the case of high density noise, the presentation of the standard methods is very poor in terms of noise restraint and detail preservation. This filter has proved its supremacy in preserving edges and fine details over the other well-known filters. This algorithm shows better results than the Median Filter (MF), Progressive Switched Median Filter (PSMF), Adaptive Median Filter (AMF) and Modified Decision Based Unsymmetric Trimmed median filter (MDBUTMF) at high Impulse noise density.

General Terms
Filter.

Keywords
DBUTMF , Impulse Noise, MATLAB, Median Filter, PSMF.

1. INTRODUCTION
The primary sources of noise in digital images arise during image acquisition or transmission. The performance of imaging sensors is affected by a variety of factors, such as environmental conditions during image acquisition, and by the quality of the sensing elements themselves. For instance, in acquiring images with a CCD camera, light levels and sensor temperature are major factor affecting the amount of noise in resulting image[1].

Noise pixels with high intensity values appear as white dots on the image (i.e. salt), while noise pixels with low intensity values appear as black dots on the image (i.e. pepper). Therefore, we use the terms impulse or salt-and-pepper noise interchangeably. As the impulse pixels are having a relatively high contrast toward their surrounding, even at low percentage of corruption, the impulse noise can degrade the appearance of the image significantly [2].Therefore, it is crucial for us to remove the impulse noise before any subsequent image processing operations such as image segmentation and pattern recognition. There are various methods to restore of gray scale images which have been corrupted by Salt-and-Pepper noise.

The median filter was once the most popular filter for removing Impulse noise because of its good demising power and computational efficiency [3]. However, when the noise level is high, some details and edges of the original image are smeared by the filter.

The progressive switching median filter (PSMF) implements a noise detection algorithm before filtering. Both noise detection and filtering procedures are progressively repeated for a number of iterations. This algorithm does not give better results than proposed algorithm at very high noise density[4].

In order to avoid this drawback, An Improved decision based unsymmetric trimmed median filter(IDBUTMF) is proposed to enhance decision based unsymmetric trimmed median filter[5][6] in term of its noise filtering ability as the images are highly corrupted.

The proposed Improved Decision Based Unsymmetric Trimmed Medan Filter (IDBUTMF) algorithm removes these drawbacks at high noise density and gives better Peak Signal-to-Noise Ratio (PSNR). This algorithm is implemented in MATLAB R2012a and tested on some standard images.

2. IMPROVED DBUTM FILTER
The Improved Decision Based Unsymmetrical Trimmed Median Filter (IDBUTMF) algorithm processes the corrupted images by first detecting the impulse noise. The giving out pixel is checked whether it is noisy or noises less. If the processing pixel lies between highest and smallest gray level values, then it is noise-free pixel and it is left untouched. If the processing pixel takes the highest or smallest gray level, then it is noisy pixel which is processed by IDBUTMF.
The steps of the proposed IDBUTMF are:

Step 1: Images which are noisy are interpreted.

Step 2: Select 2D window of size 3x3 with centre element as processing pixel. Presume that the pixel being processed is $X_{(i,j)}$.

Step 3: If $X_{(i,j)}$ is a chaste pixel (i.e. $0 < X_{(i,j)} < 255$), then value is left untouched.

Step 4: If $X_{(i,j)} = 0$ or $X_{(i,j)} = 255$, then $X_{(i,j)}$ is a degraded pixel.

Step 5: If all the elements in the selected window are 0"s or 255’s or both, then replace $X_{(i,j)}$ with the mean [7] of the elements in the window else go to step 6.

Step 6: Eliminate 0’s and 255’s from the selected window and finding the median and mean value of remaining elements, and substitute the $X_{(i,j)}$ with 0.5 of median value and 0.5 of mean value.

Step 7: Repeat steps 2 to 6 until all the pixels in the entire image are processed.

Computational Analysis:

All pixels of an image are checked for the attendance of impulse noise. Special cases are illustrated as mentioned in flow chart of proposed algorithm.

Case I) If processing pixel in the chosen 3x3 window is uncorrupted pixel, then value is left untouched.

88	67	195
156	**89**	123
59	116	69

In this window processing pixel (89) is uncorrupted pixel.

Case II) If all the pixel values in the chosen window contain Impulse noise.

255	0	255
0	**255**	0
0	255	0

All the elements are 0's and 255's in a chosen window then replace with the mean of the elements in the chosen window. Where "255" is processing pixel, i.e. $X_{(i,j)}$.

Here the mean value is 113.33. Hence substitute the processing pixel $X_{(i,j)}$ by 113.33.

Case III): If the chosen window contains salt or pepper noise as processing pixel $X_{(i,j)}$ and adjacent pixel values contains some pixels that adds salt and pepper noise (i.e., 0 and 255 pixel value) to the image.

63	0	195
156	**0**	123
255	56	255

In this case, eliminate the salt and pepper noise (i.e., 0 and 255 pixel value) from the chosen window. Where "0" is processing pixel, i.e.$X_{(i,j)}$

The 1D matrix is,

$$[63\ 0\ 195\ 156\ 0\ 123\ 255\ 56\ 255]$$

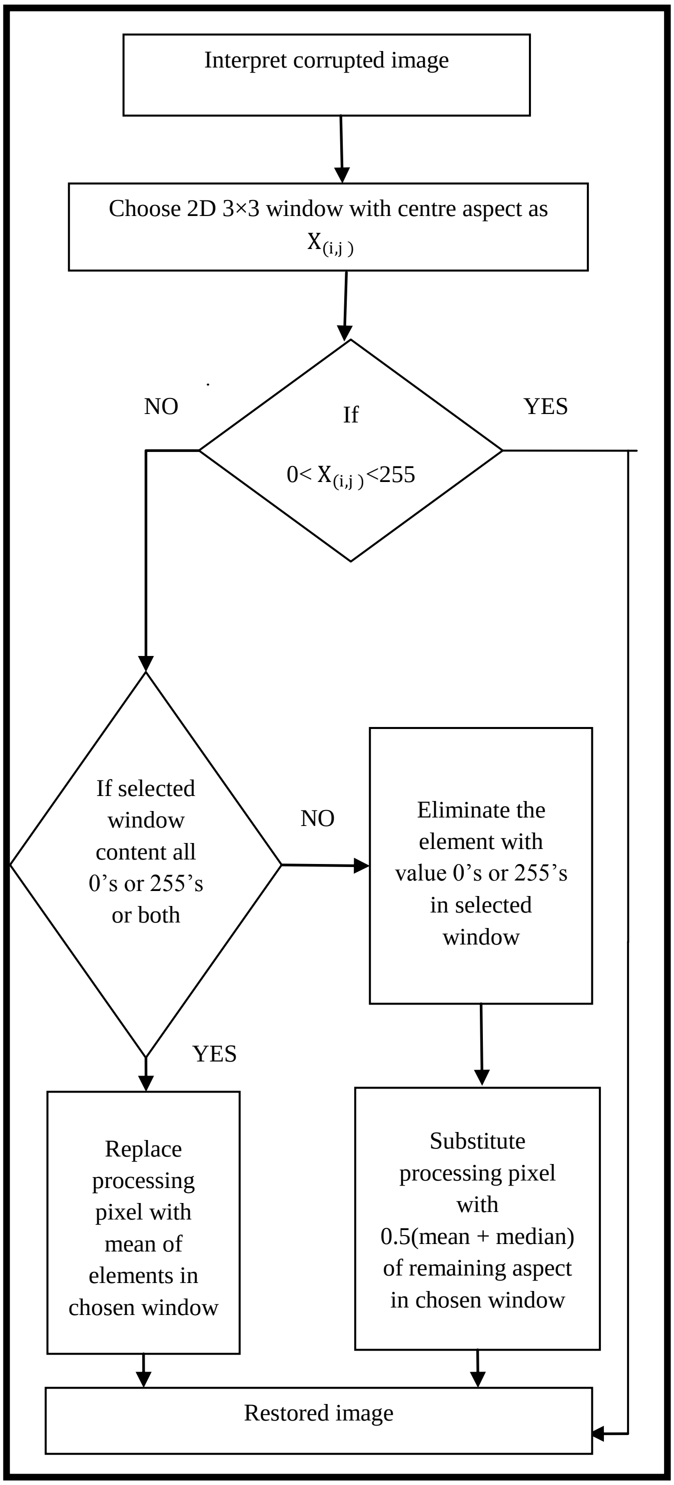


Fig 1: Flow chart of IDBUTMF.

After elimination of 0's and 255's the pixel values in the selected window will be

$$[63\ 195\ 156\ 123\ 56]$$

Here the median value is 123 and mean value is 118.6. Hence replace the processing pixel $X_{(i,j)}$ by 0.5(123+118.6) i.e. 120.8.

3. SIMULATION RESULTS

Performances of algorithms are measured by calculating PNSR (Peak signal to Noise Ratio),

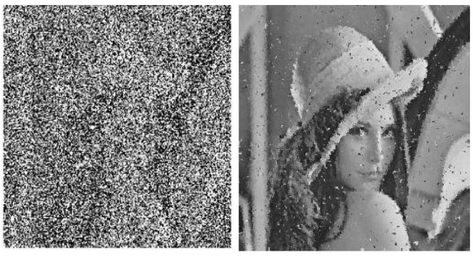
$$\text{PSNR} = 10\log_{10}\{(255)2 / \text{MSE}\}$$

Where, Mean Square Error (MSE) is given by,

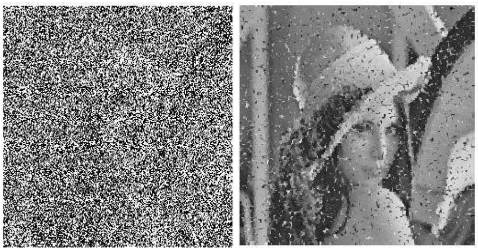
$$\text{MSE} = 1 / \text{N} \sum \{\text{Y}_{(i,j)} - \text{Y}'_{(i,j)}\}^2$$

Where N is the total number of pixels in the original image. $\text{Y}_{(i,j)}$ represents the original image, $\text{Y}'_{(i,j)}$ represents the filtered image.

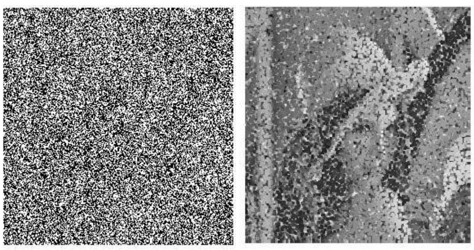
(a)



(b) (c)



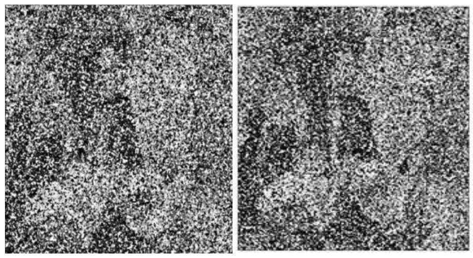
(d) (e)



(f) (g)

Fig 2: Results of Proposed algorithm for Lena image. a) Original image. (b) Noisy image (corrupted by 70% Impulse noise). (c) Output of IDBUTMF. (d) Noisy image (corrupted by 80% Impulse noise). (e) Output of IDBUTMF. (f) Noisy image (corrupted by 90% Impulse noise). (g) Output of IDBUTMF

(a) (b)



(c) (d)

(e) (f)

Fig 3: Results of different algorithms for Pirate image. a) Original image. (b) Noisy image (corrupted by 80% Impulse noise). (c) Output of MF. (d) Output PSMF. (e) Output of MDBUTMF. (f) Output of IDBUTMF.

Table 1: Comparison of PSNR(dB) Values Of Different Algorithms For Lena Image At Different Noise Densities

Noise in %	PSNR in dB				
	MF	PSMF	AMF	MDBUT MF	Proposed
10	27.39	30.79	27.45	32.17	32.95
20	26.32	28.24	26.22	29.22	30.75
30	24.26	25.33	25.24	27.18	28.89
40	21.77	22.65	24.14	25.28	26.58
50	18.32	19.19	22.03	24	25.97
60	16.14	12.13	20.11	21.67	24.05
70	14	9.86	14.77	18.11	22.58
80	11.97	8.67	9.24	13.80	19.52
90	10.42	8.07	8.33	9.46	16.11

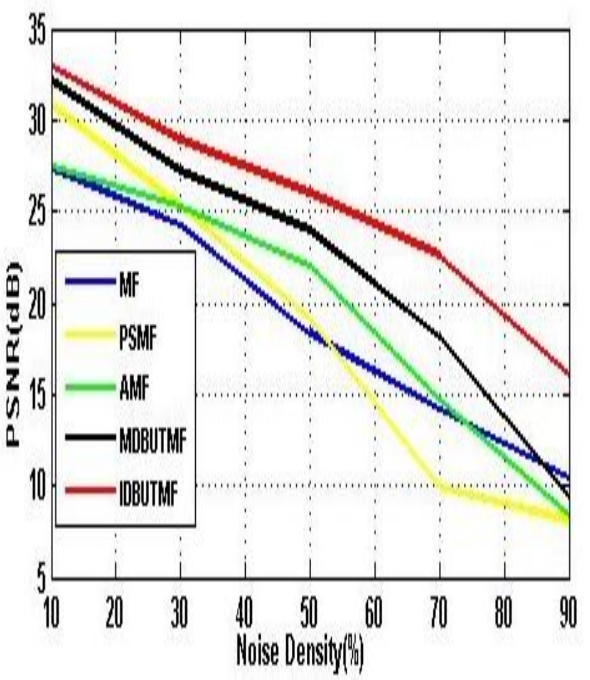


Fig 4: Comparison graph of PSNR at different noise densities for Lena image.

Table 2: Comparison of psnr values of different Test images at different noise density using proposed algorithm

Test Images	**Noise in %**					
	50	60	70	80	90	
Pirate	28.58	25.20	22.45	19.18	14.24	**PSNR in dB**
Cameraman	24.29	23.36	22.78	16.98	12.82	
Moon	24.70	21.41	18.11	14.19	11.43	
Lena	25.97	24.05	22.58	19.52	16.11	

From these tables it can be easily observed that the proposed technique outperforms the other filtering schemes at high noise levels. At low noise level also, the performance of the proposed method is superior than most of the methods used for assessment. IDBUTMF is the only filtering system whose presentation is better than the present system in case of 'Lena' image with high noise level (up to 90%). However, for the other three images i.e. 'Pirate', 'Cameraman' and 'Moon' the proposed scheme outperforms as shown in Tables II. Fig. 2. shows the output images of various filtering methods considered in the study for 80% noise density. This filter has proved its supremacy in preserving edges and fine details over the other prominent filters. It can be seen that the proposed impulse filtering method successfully preserves the details in the image while at the same time efficiently removing the noise.

4. CONCLUSION

In this paper, a new algorithm (IDBUTMF) is proposed which gives better presentation in comparison with MF, AMF[8], PSMF and MDBUTMF in terms of PSNR(dB). The performance of the algorithm has been tested at low, medium and high noise densities on gray-scale images. Even at high noise density levels the IDBUTMF gives better results in comparison with other existing algorithms. The main benefit of proposed algorithm is that its performance is not degraded with increasing noise level as compared to other algorithms. It can easily grip high noise levels up to 90%.Both illustratative and quantitative results are verified. The proposed algorithm is effective for Impulse noise removal in images at high noise densities.

5. REFRENCES

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