Robust Algorithm for Impulse Noise Detection

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***Abstract* - Efficiency of noise removing algorithms depends on two main parameters first one is how accurately it identify the noisy pixels and second one is how much accurately it calculate the replacing value for noisy pixels. This Paper presents highly efficient algorithm to detect impulse noise (salt and pepper) up to 99% of noise ratio. Experimental results shows efficiency of algorithm is more than 99.5 %.**

Keywords -Noise detection, Impulse Noise, Image Enhancement and Median Filters.

I. INTRODUCTION

Recent Studies in image processing noise reduction plays very vital rule. With respect to image processing noise is an extra thing added to original image which decreases the image quality. To remove noise so many linear and non linear algorithms are proposed [1-2]. Noise reduction is a two step process 1) noise detection and 2) noise replacement. In first step location of noise is identified and in second step detected noisy pixels are replaced by estimated value. Efficiency of noise reduction algorithm depends on both noise detection and noise replacement. In literature so many iterative window based noise reduction techniques are proposed and depending on noise ratio different window size are used [3-6]. With respect to noise ratio size of window varies means to calculate window size estimated value of noise ratio is required vice versa. Hence we must use the single window size or else we have to design algorithm to calculate required window size without this noise reduction algorithms becomes incomplete. In this paper highly efficient algorithm for noise detection is proposed and algorithm estimates required size of window automatically hence estimation of noise ratio is not required.

II. PROPOSED ALGORITHM

To detect noisy pixels present in Corrupted image (Ic) algorithm 1 is used and information about corrupted pixels are stored in binary image (NL) and Window (WL) of size 2L+1 is used to scan Ic. Initial values of all pixels present in NL are initialized to 0. To detect corrupted pixels initial value of L is set to 1 and Ic is scanned by WL. Center pixel of WL (Ic(x,y)) is considered as test pixel. Ic(x,y) is not corrupted pixel if value of Ic(x,y) is greater than WLmin and less than WLmax otherwise Ic(x,y) is corrupted pixel. WLmin and WLmax are the minimum and the maximum values of pixels present in WL. If pixel Ic(x,y) is corrupted 1 is stored in NL(x,y). Calculate the no of 0's present in NL and store in variable CL. C1 means number of non corrupted pixels present in Ic when window size L=1. If CL value is less than or equal to C(L-1) then Image NL contains the information of noisy pixels. If NL(x,y) is 0 means pixel Ic(x,y) is not corrupted else Ic(x,y) is corrupted pixel.

Algorithm 1

Step1. Take Corrupted Image (Ic).
Step2. Initialize L=1.
Step3. Scan Ic by Window (WL), Initialize all NL(x,y) to 0 and consider the center Pixel Ic(x,y) of WL as Test pixel.
Step4. Calculate WLmin and WLmax of WL using rest of Ic(x,y).
Step5. If Ic(x,y)<=Wmin and Ic(x,y)>=Wmax then Ic(x,y) is corrupted pixel.
Step6. If Ic(x,y) is corrupted pixel set NL(x,y)=1 else set NL(x,y)=0.
Step7. Calculate no of 0's present NL and store in CL.
Step8. If CL>C(L-1) then increment Window size L=L+1 and repeat step 3 to step8.
Step9. Binary Image NL is a final Noise image.
Step10. Stop.

III. PERFORMANCE EVALUATION

To evaluate the performance of proposed algorithm 250 X 250 Lena, 300 X 300 Camera and 250X250 Coin images are used. Efficiency of algorithm can be measured by equation (1). Correctly detected pixels are the pixels which process same status in both theoretical and calculated value of algorithm. Not correctly detected pixels process different values in both theoretical and calculated value of proposed algorithm.

$$\text{Efficiency} = \frac{(\text{No of Correctly detected pixels})}{(\text{Total no pixels})} \times 100 \qquad (1)$$

Theoretical calculation of correctly detected pixels are calculated by comparing original I(x,y) and corrupted image pixels Ic(x,y) (2). K is binary image shows actual noisy pixels.
If K(x,y) =0 pixel is not corrupted else pixel is corrupted pixel.

$$K(x,y) = \begin{cases} 0 & \text{if } I(x,y) = Ic(x,y) \\ 1 & \text{Otherwise.} \end{cases} \qquad (2)$$

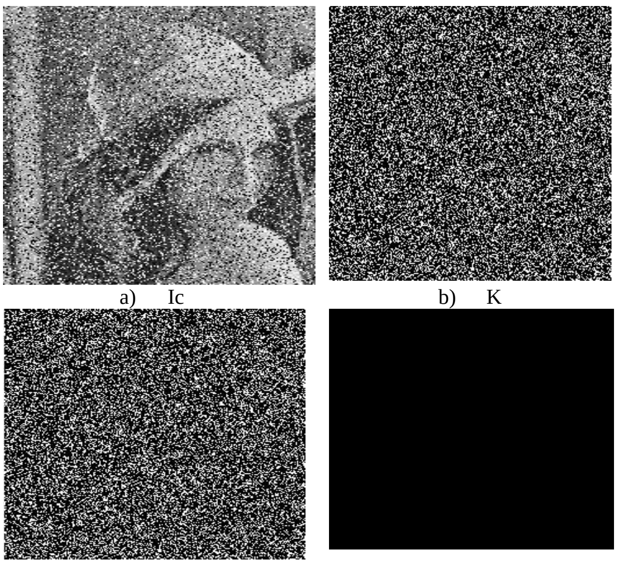
N is binary images shows calculated noisy pixels using proposed algorithm (3).

$$N(x,y) = \begin{cases} 0 & \text{if } Ic(x,y) \text{ is uncorrupted Pixel} \\ 1 & \text{Otherwise.} \end{cases} \qquad (3)$$

Correctly and non correctly detected pixels are calculated based on comparing K(x,y) and N(x,y) (4).

$$C(x,y) = \begin{cases} 0 & K(x,y) == N(x,y) \\ 1 & \text{Otherwise.} \end{cases} \qquad (4)$$

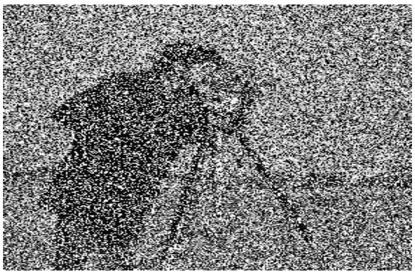
Number of 0's present in C represents correctly detected pixels (NP) and Number of 1's present in C represents not correctly detected pixels (NN). Figure 1(d), 2(d) and 3(d) show the efficiency of proposed algorithm and graphical analysis of efficiency is shown in figure4, 5 and 6.



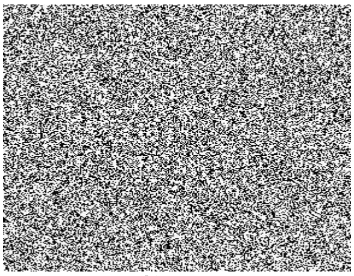
a) Ic b) K

c) N d) C and (NN=0)

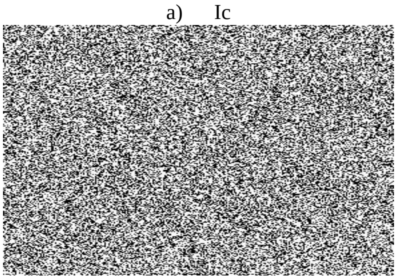
Figure1. Shows different outputs of 250X250 Lena image when noise density is 30%.



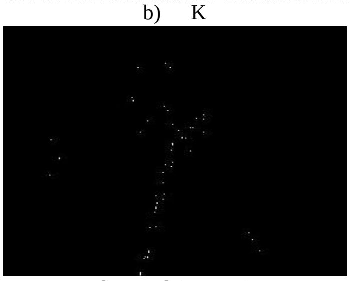
a) Ic



b) K

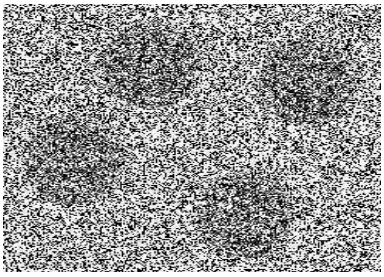


c) N

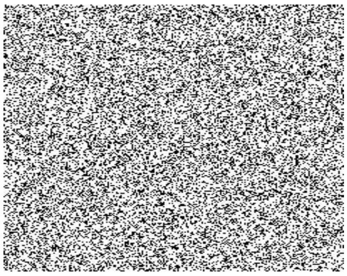


d) C and (NN=70)

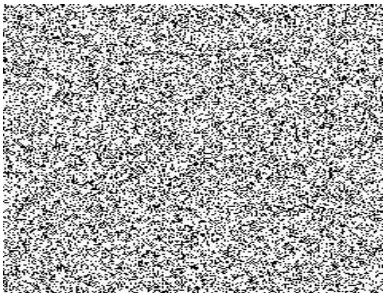
Figure2. Shows different outputs of 300X300 Camera image when noise density is 60%.



a) Ic



b) K



c) N

d) C and (NN=12)

Figure3. Shows different outputs of 250X250 Coin image when noise density is 70%.

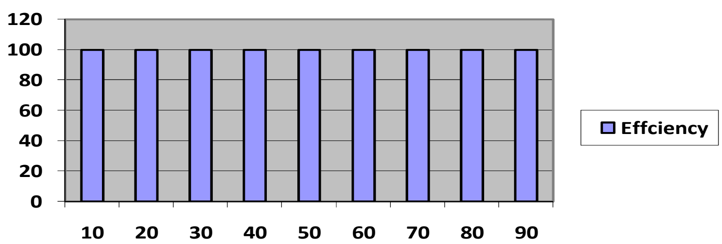


Figure4. Shows efficiency of proposed algorithm for 250X250 Lena image

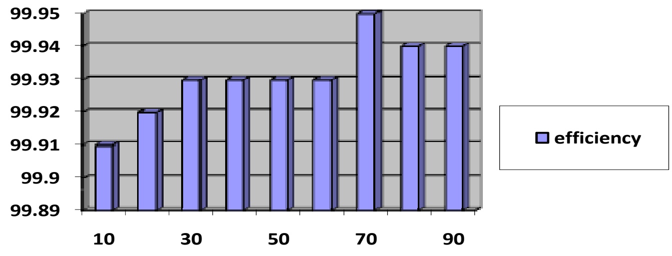


Figure5. Shows Efficiency of proposed algorithm for 300X300 camera image

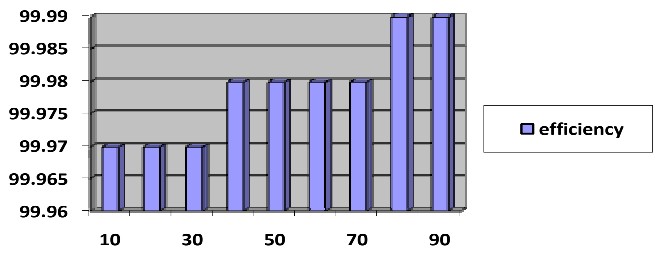


Figure6. Shows efficiency of proposed algorithm for 250X250 Coin image

The Proposed algorithm can be combined with other linear and non linear algorithm to get more accurate results. Proposed algorithm is combined with 3X3 MF, 5X5 MF and AMF. In table 1 performance of (3X3 MF, 5X5 MF, AMF) and performance of algorithms when proposed algorithm is combined are (3X3 CMF, 5X5 CMF, CAMF) shown respectively. In figure7 graphical analysis of table 1 is shown and figure8 shows different filter outputs for 250X250 Lena image with 30% of noise ratio. Efficiency of algorithms are measured calculating MSE and PNSR values using equations (5) and (6).

$$PSNR = 10\log 10 \times \frac{255 \times 255}{MSE} \quad (5)$$

$$MSE = \frac{\sum_{I} \sum_{j} (Xij - Rij)^{2}}{(M \times N)} \quad (6)$$

Where

X	-	Original Image.
R	-	Restored Image
M x N	-	Size of Image.
MSE	-	Mean Square Error.
PSNR	-	Peak Signal to Noise Ratio.

TABLE I : COMPARISON OF PSNR VALUES

Noise Ratio	MF (3X3)	CMF (3X3)	MF (5X5)	CMF (5X5)	AMF	CAMF
10	36.12	37.78	32.76	37.69	34.85	38.46
20	29.99	31.54	30.57	34.03	32.82	34.54
30	24.01	24.83	28.57	30.78	30.71	31.22
40	19.10	20.49	26.47	28.75	28.97	29.28
50	15.35	16.31	23.06	24.16	27.45	27.51
60	12.40	13.45	18.71	19.71	25.89	26.00
70	10.03	11.00	14.27	14.87	24.08	24.10
80	8.16	8.6	10.44	11.13	21.72	21.78
90	6.65	6.96	7.51	7.81	18.68	18.91
Avg	17.98	18.99	21.37	23.21	26.79	27.98

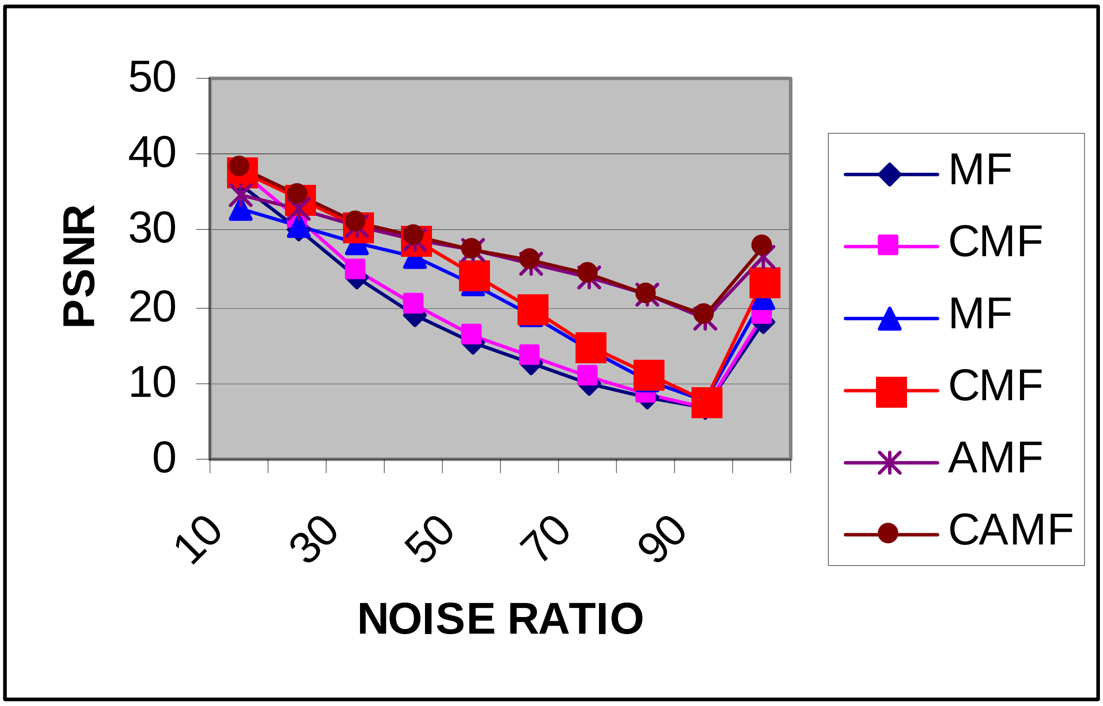


Figure7.Comparison of PSNR values for 250X250 Lena image.

(a) MF(3X3) (b) CMF(3X3)

(c) MF(5X5) (d) CMF(5X5)

(e) AMF (f) CAMF

Figure8. Shows outputs of different filters for 250X250 Lena image at noise density 30%

IV. CONCLUSION

In this paper highly efficient algorithm to detect impulse noise is proposed. An experimental result shows that efficiency of algorithm is more than 99.5% in all noise ratios. Proposed algorithm provides consistent results in both low and high noise ratios. Hence this algorithm is very effective tool for noise reduction. Proposed algorithm is portable it can be used with both liner and non linear algorithm to get improved results. Finally proposed algorithm is complete means without human intervention algorithm calculates required window is automatically.

Proposed algorithm improved the average performance of ((3X3) MF, (5X5) MF and AMF) by 5.6%, 8.6% and 4.5% respectively.

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