TECH-CHRONICLE
AN INTERNATIONAL E-JOURNAL ON
EMERGING TRENDS IN SCIENCE, TECHNOLOGY AND MANAGEMENT

Removal of Salt and Pepper Noise Using Unsymmetrical Trimmed Adaptive Median Filter

Mr. Vaibhav Agrawal
Electronic Engineering,
J D Collage of Engineering and Management
RTMN University, Nagpur, India
E-mail ID vaibhavachalpur@gmail.com

Prof.Sunil R.Gupta
Guide and Asso.
Prof of Electronic Engineering,
J D Collage of Engineering and Management
E-mail ID sungt_in@rediffmail.com

***Abstract*— Digital image contains impulse noise and removal of impulse noise from the image is very challenging area in digital image processing. In recent years many developments were made for removal of such noise which helps to improve quality of image. For the removal of salt and pepper noise this paper is been proposed. This paper proposes unsymmetrical trimmed adaptive median filter algorithm is used for restoration of image quality. The algorithm proposed replaces the noisy pixels i.e. either salt value or pepper value by trimmed median value. 0's or 255's in a window is replaced by median value in the window. This paper is combination of adaptive filter and unsymmetrical trimmed median filter to overcome the flaws in them.**

Keywords—- Impulse noise, median filter, adaptive filter, unsymmetrical trimmed adaptive median filter.

Introduction

An image is an array or a matrix of square pixels (pictures elements) arranged in rows and columns. Digital images are normally corrupted by noises such as impulse noise which is subdivided as salt and pepper noise and random valued noise. Impulse noise is introduced in images due to various reasons such as malfunctioning of pixels in camera sensors, faulty locations in hardware, acquisition and during transmission. Images corrupted by salt and pepper noise takes maximum or minimum value. Many works were done for the restoration of image. Initially introduced median filter, which is non- linear filter, replaces the center pixel with a value equal to the median of all pixels in current window. Various filters were introduced with different algorithms but basically they all work on median filter with some additional features to overcome the flaws and shortcomings seen in median filter.

Ease of Use

A. Standard median filter

(SMF) removes impulse noise by changing luminance value of the center pixel of the filtering window with the median of the luminance values of pixels contained within the window. It removes thin lines but blurs the image. It cannot differentiate between corrupted and non-corrupted value, so all the values are altered increasing the time of processing and for high intensity of noise, window size is increased which reduces the originality of image

B. Weighted median filter

(WMF) is similar to SMF, except that WMF has weight associated with each of its filter element. These weights correspond to number of sample duplication for calculation of median value. It is classified as (a) central weighted median filter i.e. it gives more weight only to central value of window (b) adaptive weighted median filter.

C. Directional median filter

It works by separating its 2-D filter into several 1-D filter

D. Iterative median filter:

In this same procedure is repeated several times and the number of iterations needed is depended on level of corruption and also the nature of input image. In general iterative median filter, with (n) iterations requires (n-1) temporary images

E. Adaptive median filter

It is designed to eliminate problems faced with SMF. In AMF the size of window surrounding each pixel is variable and variation depends on median of pixels in present window. If median value is an impulse, then the size of window is expanded else processing is done in current window specifications. The center pixel of the window is evaluated to verify whether it is an impulse or not.

F. Switching median filter

It minimizes the undesired alteration of non-corrupted pixels by the filter. It involves two stages: noise detection and noise cancellation. Decision based filter is based on predefined threshold value. The major drawback of this filter is robust decision. Robust decision is difficult and also it does not consider the local features of image, resulting unsatisfactorily recovered images when noise level is high. Also it causes streaking effect due to repeated use of neighboring element so to avoid this, decision based unsymmetrical trimmed median filter is proposed. It also fails for more than 80% of noise. so this paper proposes the combination of adaptive filter and decision based unsymmetrical trimmed adaptive median filter. It can remove salt and pepper noise with intensity as high as 90%. The outline is as follows: section 2 describes unsymmetrical trimmed adaptive median filter, section 3 describes its algorithm, section 4 shows its flow chart, section 5 is all about result and conclusion.

II. UNSYMMETRICAL TRIMMED ADAPTIVE MEDIAN FILTER

Salt and pepper noise only takes maximum or minimum value i.e. positive or negative value. Positive impulse appears as white (salt) with intensity 255 and negative impulse appears as black (pepper) with intensity 0. The idea behind this is to reject noisy pixel from selected window (3*3 or 5*5). In unsymmetrical trimmed median filter (UTMF) window size is fixed i.e. (3*3). In this UTMF the selected 3*3 window elements are arranged in either increasing or decreasing order.

Then the pixel values 0's or 255's are removed from the image. Then the median value of the remaining pixels is taken. This median value is used to replace noisy pixel. But at high noise intensity when more than 75% of pixels are corrupted atmost only two pixels will be available for reference. So to overcome this problem (UTAMF) is introduced. In this the window size is selected dynamically depending on the total number of noisy or corrupted pixels i.e. if more than 75% or more pixels are noisy in window of size (3*3), then window size is increased to 5*5 and elements are arranged either in their increasing or decreasing order and then 0's and 255's in window removed i.e. salt and pepper value. The noisy pixel is then replaced by median value of remaining pixels.

III. ALGORITHM:

The proposed Unsymmetrical Trimmed Adaptive Median Filter (UTAMF) algorithm processes the corrupted images by first detecting the salt and pepper noise. The processing pixel is checked whether it is noisy or noise free. If the processing pixel lies between maximum and minimum gray level values, then it is noise-free pixel and it is left unchanged. If the processing pixel takes the maximum or minimum gray level, then it is noisy pixel which is processed by UTAMF. While processing image, always noisy image is taken as reference for calculation of median and processing pixel is replaced median in output image. This is explained as follows. Let A be the input noisy image and B be the output image which initially is a copy of the input noisy image A. Now the image A acts as the reference image and it is processed pixel-by-pixel and the corresponding pixel in the image B is replaced with the output pixel which is obtained as a result of processing done on image A. The steps of the UTMAF are explained as follows.

Step 1: Read Noisy Image.

Step 2: Select 2D window of size 3x3 with center element as processing pixel. Assume that the pixel being processed is Pij.

Step 3: If Pij is an uncorrupted pixel (that is, 0< Pij<255), then its value is left unchanged.

Step 4: If Pij = 0 or Pij = 255, then Pij is a corrupted pixel.

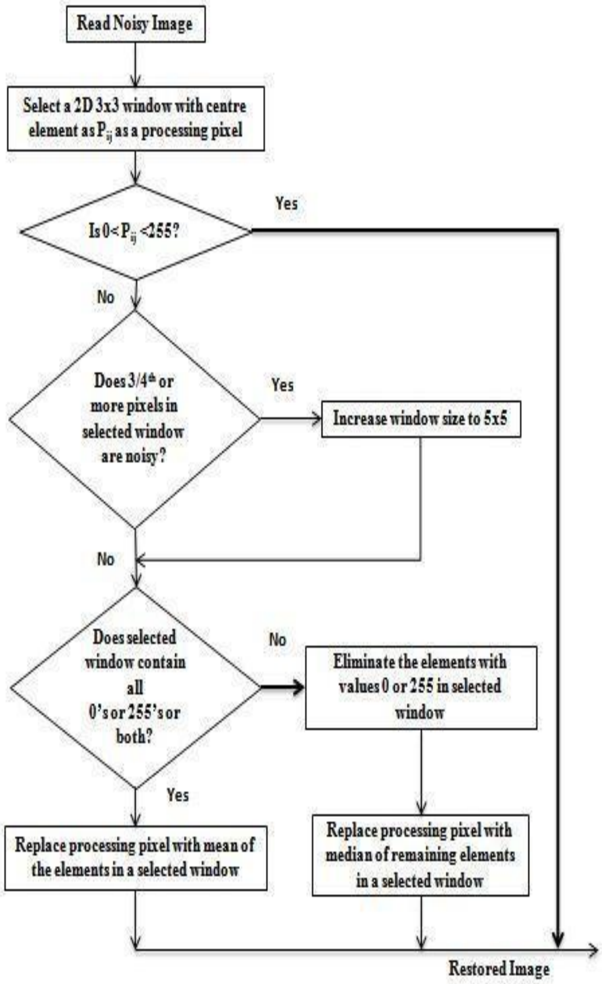
Step 5: If 75% or more pixels in selected window are noisy then increase window size to 5x5.

Step 6: If all the elements in the selected window are 0's and 255's, then replace Pij with the median of the elements in the window else go to step 6.

Step 7: Eliminate 0's and 255's from the selected window and find the median value of the remaining elements. Replace Pij with the median value.

Step 8: Repeat steps 2 to 6 until all the pixels in the entire image are processed

FLOW CHART



A. *Figures and Table*

The performance of the proposed algorithm is tested with different greyscale and colour images. The noise density (intensity)

TABLE I
COMPARISON OF PSNR VALUES OF DIFFERENT ALGORITHMS FOR LENA IMAGE AT DIFFERENT NOISE DENSITIES

Noise in %	PSNR in dB					
	MF	AMF	PSMF	DBA	MDBA	MDBUTMF
10	26.34	28.43	30.22	36.4	36.94	37.91
20	25.66	27.40	28.39	32.9	32.69	34.78
30	21.86	26.11	25.52	30.15	30.41	32.29
40	18.21	24.40	22.49	28.49	28.49	30.32
50	15.04	23.36	19.13	26.41	26.52	28.18
60	11.08	20.60	12.10	24.83	24.41	26.43
70	9.93	15.25	9.84	22.64	22.47	24.30
80	8.68	10.31	8.02	20.32	20.44	21.70
90	6.65	7.93	6.57	17.14	17.56	18.40

TABLE II
COMPARISON OF IEF VALUES OF DIFFERENT ALGORITHMS FOR LENA IMAGE AT DIFFERENT NOISE DENSITIES

Noise Density in %	IEF					
	MF	AMF	PSMF	DBA	MDBA	MDBUTMF
10	10.36	23.20	171.63	390.67	422.58	648.98
20	28.17	37.76	207.31	358.91	377.42	568.43
30	30.02	42.57	190.92	322.89	324.74	590.83
40	23.12	40.98	143.49	268.49	275.24	424.18
50	11.72	36.11	62.98	208.77	217.18	345.13
60	6.73	25.21	6.61	190.70	175.89	261.66
70	3.31	7.89	3.28	128.58	129.65	171.69
80	2.00	2.91	1.98	67.42	73.24	101.72
90	1.37	1.31	1.37	33.85	33.33	34.23

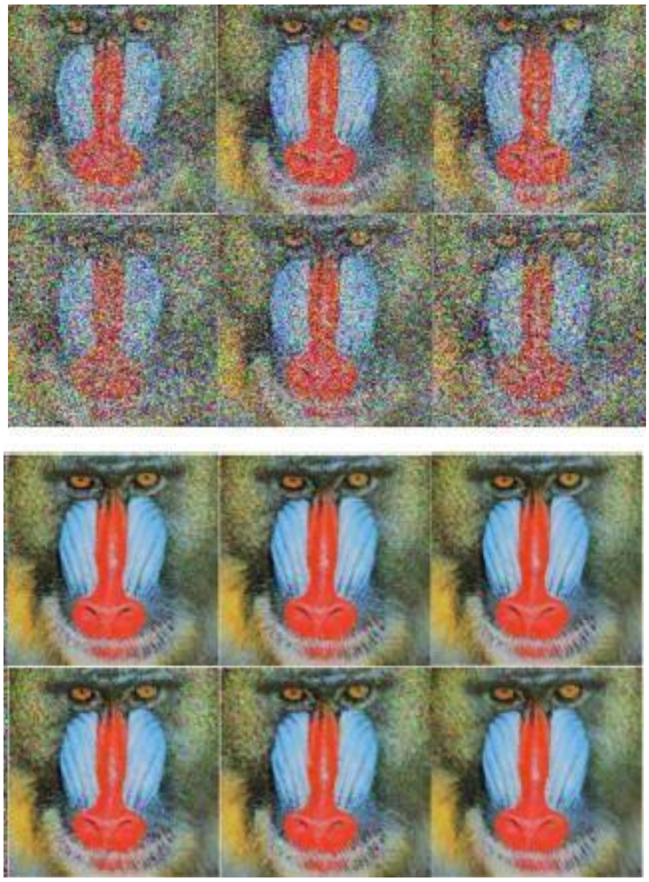
is varied from 10% to 90%. Denoising performances are quantitatively measured by the PSNR and IEF as defined in (1) and
(3), respectively:

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

$$MSE = \frac{\sum_i \sum_j \left(Y(i,j) - \hat{Y}(i,j)\right)^2}{M \times N} \quad (2)$$

$$IEF = \frac{\sum_i \sum_j \left(\eta(i,j) - Y(i,j)\right)^2}{\sum_i \sum_j \left(\hat{Y}(i,j) - Y(i,j)\right)^2} \quad (3)$$

where MSE stands for mean square error, IEF stands for image enhancement factor,M*N is size of the image, Y represents the original image, Y denotes the denoised image, representsthe noisy image.
The PSNR and IEF values of the proposed algorithm are compared
against the existing algorithms by varying the noise density from 10% to 90% and are shown in Table I and Table II. From the Tables I and II, it is observed that the performance of the proposed algorithm (MDBUTMF) is better than the existing algorithms at both low and high noise densities.



. Fig. 1. Results of different algorithms for color Baboon image.

CONCLUSION

Removal of Salt and Pepper Noise Using Unsymmetrical Trimmed Adaptive Median Filter from the corrupted image. The directional difference based noise detector can realize accurate noise detection, thus facilitating the prevention of image degradation resulting from the undetected noise pixels and noise-free pixels. The adaptive mean filter can remove the detected impulses effectively while preserving the details very well because it adaptively determines the filtering window size and attaches different importance to the noise-free pixels in the filtering window. The combination of the noise detector with the distinctive median filter provides the adaptive median filter with significantly better noise detection performance, restoration performance and computational efficiency than numerous switching-based filters.

REFERENCES

[1]H.Hwang and R. A. Haddad, "Adaptive median filters: Newalgorithms and results," *IEEE Trans. Image Process.*, vol. 4, no. 4, pp. 499–502, Apr. 1995.

[2]. A. Bovik, *Handbook of Image and Video Processing*. New York: Academic, 2000.

[3]. Aizenberg and C. Butakoff, "Effective impulse detector based on rank-order criteria," *IEEE Signal Process. Lett.*, vol. 11, no. 3, pp. 363–366, Mar. 2004.

[4.] W. Luo, "Efficient removal of impulse noise from digital images," *IEEE Trans. Consumer Electron.*, vol. 52, no. 2, pp. 523-527, May 2006.

[5] F. Russo, "FIRE operators for image processing," *Fuzzy Sets Syst*., vol. 103, pp. 265-275, Apr. 1999.

[6] R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, Englewood Cliffs, NJ: Prentice Hall, 2002.

[7] E. Abreu, M. Lightstone, S. K. Mitra, and K. Arakawa, "A new efficient approach for the removal of impulse noise from highly corrupted images," *IEEE Trans. Image Process.*, vol. 5, no. 6, pp. 1012-1025, June 1996.

[8] T. Chen, K. Ma and L. Chen, "Tri-state median filter for image denoising," *IEEE Trans. Image Process.*, vol. 8, no. 12, pp. 1834-1838,

Dec 1999.

[9] S. Schulte, M. Nachtegael, V. De Witte, D. Van der Waken and E. E. Kerre, "A fuzzy impulse noise detection and reduction method," *IEEE Trans. Image Process.*, vol. 15, no. 5, pp. 1153-1162, May 2006.

[10] T. Chen, K. K. Ma, and L. H. Chen, "Tri-state median filter for image denoising," *IEEE Trans. Image Process.*, vol. 8, no. 12, pp. 1834–1838, Dec. 1999.

[11] T. Chen and H. R.Wu, "Adaptive impulse detection using center-weighted median filters," *IEEE Signal Process. Lett.*, vol. 8, no. 1, pp. 1–3, Jan. 2001.

[12] T. Chen and H. R.Wu, "Space variant median filters for the restoration of impulse noise corrupted images," *IEEE Trans. Circuits Syst. II*, vol. 48, no. 8, pp. 784–789, Aug. 2001.

[13] R. H. Chan, C. Hu, andM. Nikolova, "An iterative procedure for removing random-valued impulse noise," *IEEE Signal Process. Lett.*, vol. 11, no. 12, pp. 921–924, Dec. 2004.

[14] I. Aizenberg, C. Butakoff, and D. Paliy, "Impulsive noise removal using threshold Boolean filtering based on the impulse detecting functions," *IEEE Signal Process. Lett.*, vol. 12, no. 1, pp. 63–66, Jan. 2005.

[15] S. Zhang and M. A. Karim, "A new impulse detector for switchingmedian filters," *IEEE Signal Process. Lett.*, vol. 9, no. 11, pp. 360–363, Nov. 2002.