INTERNATIONALJOURNALOFENGINEERING SCIENCES&MANAGEMENT

Impulse Noise Removal Using Mathematical Morphology

Rajeev Thakur[1] and Kashmira Sharma[1*]

[1]Assistant professor, Department of Electronics Engineering NRI College of Engineering Bhopal, M.P.-India

[1*]M.Tech Scholar Department of Electronics Engineering NRI College of Engineering Bhopal, M.P.-India

ABSTRACT

From this paper, all efforts are made to develop an efficient filtering technique to suppress the most common salt and pepper noise because this noise mostly comes during image capture transmission, storage, as well as during image copying, scanning, and display. For examples, impulse noise can be generated through TV broadcasting and due to information losses. So to remove this impulse noise here a novel filter algorithm is proposed. In the first stage of detection both global and local characteristics of the noisy image are used. Use of global characteristics lowers the computational complexity. The second stage is fashioned in a different way for better performance Here a novel, effective and simple approach is implementing using powerful open-close sequence (OCS) filter to restore images that are corrupted by 40%–80% probability impulse noise. Simulation result shoes unique result which imposed our effort good with respect to resources available.

INTRODUCTION

As noise in an image is a serious problem. In this section various types of noise corrupting an image signal are studied; and mathematical models for the different types of are presented. In general image signal gets corrupted with noise during acquisition, storage and retrieval process. Acquisition noise is usually additive white Gaussian noise (AWGN) with very low variance. It is mainly due to very high quality sensors. It is seen that the applications like remote sensing, biomedical instrumentation, the acquisition noise may be high. The acquisition noise is negligible due to the fact that human visual system cannot recognize a large dynamic range of noise. An image is usually quantized at 256 levels. Thus each pixel is represented by 8 bits. The technology offers very high quality sensors that do not have noise level greater than half of the resolution of the ADC. So in practical application, the acquisition noise level is much below than the noise amplitude available in such high quality sensors. Thus, the acquisition noise need not be considered.

Researchers are mainly concerned with noise in transmission system. In general transmission channel is linear, but dispersive due to a limited bandwidth. The image signal may be transmitted either in analog or in digital form. If an analog image signal is transmitted through a linear dispersive channel, then the image edges get blurred and the image gets corrupted with AWGN since no practical channel is noise free. If the channel is so poor that the noise variance is high enough to make signal level to very high positive or high negative, then threshoding operation done at front end of the receiver will contribute to saturated maximum and minimum values. Such noisy pixels will be seen as white and black spots. This type of noise is known as salt and pepper noise (SPN). It is also known as impulse noise.

PROPOSED METHODOLOGY

It is noticed that if a signal with sharp edges is corrupted by high linear filters, designed to remove the noise, also smooth out signal edges. The impulse noise cannot be reduced sufficiently by linear filters. It is known from the literature that signals are not linear in nature. Generally, when the filters are not linear, they show better performance than when they are linear in the removal of impulse noise from the image. The salt and pepper type noise occur when the picture elements in the camera sensors do not function well or error in the memory location or during digitization process. A non linear scheme is called median filtering with success in this situation [1, 3, and 4]. Statistical and robustness properties [11] and the existence of fast algorithm [12] make the median very suitable for impulse noise filtering. The main drawback of the median is that it also modifies pixels not contaminated by noise thus removing the fine details in the image [13]. Therefore various remedial measures have been proposed for the median filter. They work in two steps: 1) detection of impulse noise and 2) replacement of impulses with estimated values, where the median is commonly used estimator. They are like the adaptive median filter, the multistate median filter, or the median filter based on homogeneity information, Improved Progressive Switching Median Filter [5-10]. It is noticed that if a signal with sharp edges is corrupted by high linear filters, designed to remove the noise, also smooth out signal edges. The impulse noise cannot be reduced sufficiently by linear filters. It is known from the literature that signals are not linear in nature. Generally, when the filters are not linear, they show better performance than when they are linear in the removal of impulse noise from the image. The salt and pepper type noise occur when the picture elements in the camera sensors do not function well or error in the memory location or during digitization process. A non linear scheme is called median filtering with success in this situation [1, 3, and 4]. Statistical and robustness properties [11] and the existence of fast algorithm [12] make the median very suitable for impulse noise filtering. The main drawback of the median is that it also modifies pixels not contaminated by noise thus removing the fine details in the image [13]. Therefore various remedial measures have been proposed for the median filter. They work in two steps: 1) detection of impulse noise and 2) replacement of impulses with estimated values, where the median is commonly used estimator. They are like the adaptive median filter, the multistate median filter, or the median filter based on homogeneity information, Improved Progressive Switching Median Filter [5-10]. use different optimization parameters: a threshold T [13], four thresholds in SD-ROM in [14] and others are based on previous training [13, 15, and 16].

RESULT & CONCLUSION:

The 8-bit images of dimensions M_1 x M_2 (= 256 x 256) pixels is used for simulations. The pixels s(i, j) for $1 \leq i \leq M_1$ and $1 \leq j \leq M_2$, of the image is corrupted by adding impulse noise, with noise density ranging from 0.1 to 0.8. In all the simulations, square windows of dimensions N x N pixels and with different values of width N (= 3, 5, 7) are used. The Peak signal to noise ratio (PSNR) is used to compare the relative filtering performance of various filters. The PSNR between the filtered output image y (i, j) and the original image s (i, j) of dimensions Ml x M2 pixels is defined as:

$$PSNR = 20 * \log_{10}\left(\frac{MAX_I^{\,2}}{\sqrt{MSE}}\right)$$

Where MAX_I max pixel value of the image and MSE is is defined as

$$MSE = \frac{\sum_{i}^{M1}\sum_{j}^{M2}[y(i,j)-s(i,j)]^2}{M1xM2}$$

It can be seen that Peak signal to noise ratio (PSNR) is closely related to mean square error (MSE).The simulation of the proposed filter algorithm is done with MATLAB 7.8.0 on the Leena, pepper, baboon and house images. The simulation result of the filter with different noise density varying from 10% to 80% is shown below.

SIMULATION RESULT FOR LENNA IMAGE

Table 4.1 : PSNR values for different filters on ‘Lenna’ image

Filter	Noise Density							
	10%	20%	30%	40%	50%	60%	70%	80%
Median	29.83	26.82	22.37	18.29	14.79	12.02	9.67	7.86
CWM	30.43	27.38	23.04	19.25	15.54	12.64	10.16	8.23
PWMAD	28.76	27.64	26.12	24.01	20.86	18.04	14.69	11.06
OCS	25.85	25.13	24.63	23.74	22.52	21.17	19.92	17.71

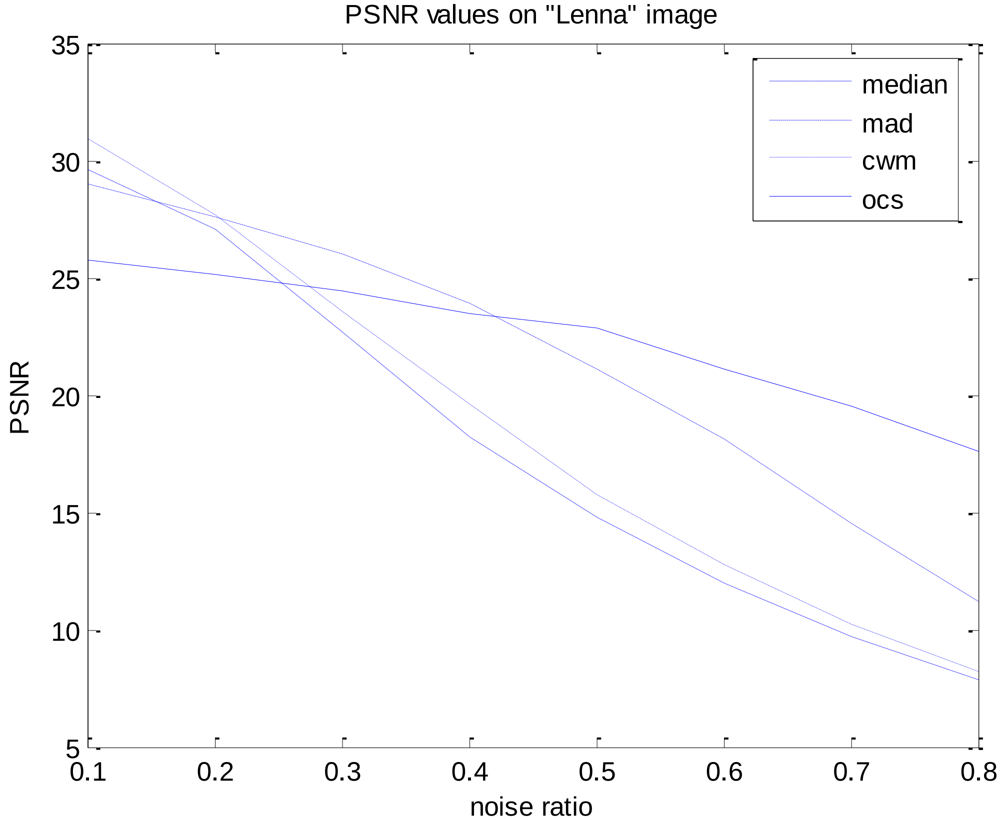

Fig 4.1 : PSNR vs percentage plot for lenna image

SIMULATION RESULT FOR GIRL IMAGE

Table 4.2 : PSNR values for different filters on 'Girl' image

Filters	Noise Density							
	10%	20%	30%	40%	50%	60%	70%	80%
Median	36.50	30.43	24.12	18.61	14.41	11.50	9.31	7.36
CWM	40.00	31.44	24.75	19.90	15.77	12.52	9.93	7.75
PWMAD	37.43	35.42	32.36	28.67	23.99	19.68	15.19	11.34
OCS	27.93	27.40	27.03	26.01	25.19	23.67	24.23	20.35

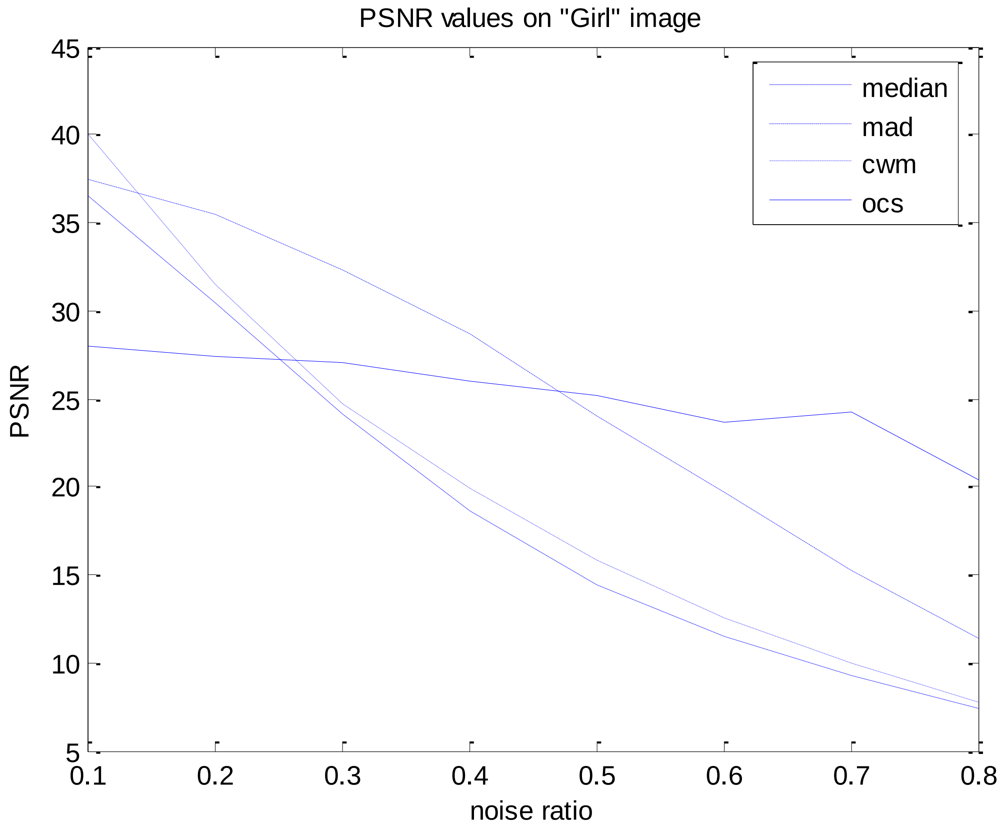

Fig 4.2 : PSNR vs percentage plot for Girl image

In this section, simulation experiments were undertaken to demonstrate the performance of the proposed open-close sequence filter. Comparisons are made with other nonlinear filtering techniques, a standard 3x3 median filter, CWM filter, PWMAD filter. The performance of these filters was tested on the well-known standard image corrupted by salt and pepper noise with equal probabilities.

The MAD detector contains too much false detection error in lowly corrupted images and too much missed detection error in highly corrupted images. It performances badly when the noise ratio is high. The main error of our proposed detector is false detection, and there is almost no missed detection error. The false detection probability descends rapidly when the noise level increases, and it is less than 1% when the noise ratio is above 50%. The efficiency of MRD is also greater than 99% and almost 100% when the noise ratio keeps increasing. It is obvious that the proposed MRD algorithm absolutely performs much better than the MAD detector and is appreciated for the images corrupted by high probability impulse noise. To exhibit the generalization of the proposed algorithm, experiments with other images are shown.

To quantitatively measure the performance of our filtering scheme versus other filters, the results, measured with PSNR (dB), for the cases of 10% to 80% impulse noise. It is seen that the performance of our proposed algorithm definitely is better than other filters when the noise ratio is higher than about 45%. Also our filter performs robustly over all the noise range and represents a slowly decreasing curve as the noise ratio increases. Other filters fall down abruptly and generate a worse result when the noise ratio is high. figure shows the subjective visual qualities of the filtered images using various filters for the standard images as examples.

It can be seen that the simple median filter suppresses little noise and gets the worst result. The CWM and PWMAD filters perform much better than the median filter, but also many noises remain .However, the proposed filter can remove most of the noises effectively while preserving image details very well.

The PSNR of restored images ‘Lenna’, ‘Girl’, corrupted by 60% impulse noise is 21.17, 23.67dB, respectively.

CONCLUSION

We have proposed a novel open-close sequence filter to remove impulse noise in highly corrupted images. The proposed open-close sequence filter is based on mathematical morphology and uses an impulse noise detector. The morphological residue detector powerfully determinates the impulse noise with a low percentage error. The OCS filters effectively remove high probability impulse noises. The block smart erase algorithm briefly eliminates the black and white blocks in the filtered image. The simulation results indicate that the proposed filter performances better than other nonlinear filtering techniques and represents robust ability of impulse noise removal. In the future, various techniques can be considered to incorporate in our scheme to further improve the performance and preserve more details in both highly and lowly corrupted images.

REFERENCES

[1] Jain A. K., "Fundamentals of digital image processing", Prentice Hall of India, 1989.

[2] Gonzalez R.C., Woods R.E., "Digital Image Processing", 3rd edition, Pearson Education, 2009.

[3] Chen Shuyue, Qiu Yen and Feng Jun, "A Nonlinear Filter Based on Row and Column Operation for Positive Impulsive Noise Reduction", Asia-Pacific Conference on Information Processing, pp.44-46, 2009.

[4] Dengwen Zhou and Xiaoliu Shen, "Image Denoising Using Weighted Averaging", International Conference on Communications and Mobile Computing, pp.400-403, (2009),

[5] Hamza A.Ben, Luque P., Martinez J and Roman R, "Removing noise and preserving details with relaxed median filters", J. Math. Image Vision, vol. 11, no. 2, pp. 161–177, oct. 1999.

[6] Pandey Rajoo, "An Improved Switching Median filter for Uniformly Distributed Impulse Noise Removal", Proceedings Of World Academy Of Science, Engineering And Technology, Volume 28, april 2008.

[7] Duan Fei, Zhang Yu-Jin, "A Highly Effective Impulse Noise Detection Algorithm for Switching Median Filters", IEEE Signal Processing Letters, Vol. 17, no.7 July, 2010.

[8] Liu C, Szeliski R, Kang S.B., Zitnick C.L. and Freeman W.T. "Automatic Estimation and Removal of Noise from a Single Image", IEEE Transactions On Pattern Analysis And Machine Intelligence, Vol. 30, No. 2, February, pp. 299-314, 2008.

[9] Boo S.T., Ibrahim H. and Toh K.K.V., "An Improved Switching Median Filter ", International Conference on Future Computer and Communication, Pp.136-139, 2009.

[10] **Motwani M.C.,** Gadiya M.C., **Motwani R.C. and** Harris F.C., "Survey of **Image Denoising** Techniques," Proc. of **GSPx,** 2004.

[11] Gallagher Jr N.C. and Wise G.W., "A theoretical analysis of the properties of median filters" IEEE Trans. Acoust., Speech, Signal Processing, vol. ASSP-29, pp. 1136–1141, 1981.

[12] Huang T.S., Yang G.J. and Tang G.Y., "A fast two-dimensional median filtering algorithm," IEEE Trans. Acoust., Speech, Signal Processing, vol. ASSP-27, pp. 13–18, Feb.1979.

[13] Sun T. and Neuvo Y., "Detail-preserving median based filters in image processing," Pattern Recognit. Lett., vol. 15, pp. 341–347, april 1994.

[14] Abreu E., Lightstone M., Mitra S.K. and Arakawa K., "A new efficient approach for the removal of impulse noise from highly corrupted images," IEEE Trans. Image Processing, vol. 5, pp. 1012–1025, 1996.

[15] Russo F "Evolutionary Neural Fuzzy System for Noise Cancellation in Image Processing", IEEE Trans. Inst & Meas., vol. 48, no. 5, pp. 915-920, 1999.

[16] Kong H. and Guan L., "A noise-exclusive adaptive filtering framework for removing impulse noise in digital images," IEEE Trans. Circuits Syst. II, vol. 45, pp. 422–428, 1998.

[17] Chen T. and Wu H.R. "Adaptive Impulse Detection Using Centre-Weighted Median Filters", IEEE Signal processing Letter, vol.8, no.1, Jan. 2001.

[18] Crnojevic V., Senk V. and Trpovski Z., "Advanced impulse detection based on pixel-wise mad," IEEE Signal Process. Lett., vol. 11, no. 7, pp. 589–592, July 2004.

[19] Patel P., Tripathi A., Majhi B., Tripathi C.R., "A New Adaptive Median Filtering Technique for Removal of Impulse Noise from Images ", ICCCS'11, Feb,2011.

[20] Ataman E., Aatre V.K., and wong K.W., "A fast method for real time median filtering", IEEE trans. On acoustics, speech, signal processing, vol. ASSP-28, no. 4, Aug, 1980.

[21] Lee J.S.," Digital image enhancement and noise filtering by use of local statistics", IEEE trans. On pattern analysis and machine intelligence, vol. Pami-2 no.2, march, 1980.

[22] Ataman E., Aatre V.K., and wong K.W., "Some statistical properties of median Filters", IEEE trans. On acoustics, speech, signal processing, vol. ASSP-29, no. 5, Oct, 1981.
[23] Kundu A., Mitra S.K., and vaidyanathan," Application of two Dimensional generalized mean filtering for removal of impulse noises from images", IEEE trans. On acoustic, speech, signal processing, vol. ASSP-32, no.-3, June, 1984.
[24] Pitas I. and venetsnopoulos A.N., "Nonlinear mean filters in image processing", IEEE trans. On acoustics, speech, signal processing, vol. 10. No. 4, June, 1986.
[25] Lee Y.H. and Kassam S.A.," Generalized median filtering and related nonlinear filtering techniques"' IEEE trans on acoustics, speech, signal processing, vol. ASSP-33, no. 3 June, 1985.
[26] Yin L., Astola J. and Neuvo J., "A New Class of Nonlinear filters- Neural Filters", IEEE Trans. on Signal Processing, vol.41, no.3, Mar,1993.
[27] Hwang H., and Haddad R.A.," Adaptive median Filters: new algorithms and results"' IEEE trans. on image processing, Vol. 4, no. 4, April 1995.
[28] Russo F. and Ramponi G., "A fuzzy operator for enhancement of blurred and noisy images", IEEE Trans. on image processing, vol. 4, No. 8, Aug 1995.
[29] Umbaugh S.E., Computer Vision and Image Processing: A Practical Approach, Eagle wood Cliffs, NJ, prentice Hall, pp. 151-193, 1998.
[30] Neirman A., Heinonen P. and Neuvo Y., "A New Class of Detail Preserving Filters for Image Processing", IEEE Trans. on Pattern Analysis, Machine Intelligence, vol. PAMI-9, pp. 74-90, 1987.
[31] Ko S.J. and Lee Y.H., "Center weighted median filters and their applications to image enhancement," IEEE Trans. Circuits Syst., vol. 38, pp. 984–993, Sep.1991.
[32] Chen T. and Wu H.R., "Space variant Median Filters for restoration of Impulse Noise Corrupted images", IEEE Trans. on Circuits and Systems – II, Analog and Digital Signal Processing, vol. 48, no. 8, pp. 784-789, Aug. 2001.
[33] Chen T., Ma K.K. and Chen L.H., "Tri-state median filter for image denoising," IEEE Trans. Image Processing, vol. 8, pp. 1834–1838, Dec.1999,
[34] Windyga P.S., "Fast Impulsive Noise Removal", IEEE Trans. on image Processing, vol.10, no. 1, pp.173-179. Jan. 2001.
[35] Kim S.R. and Effron A. "Adaptive robust impulse noise Filtering", IEEE Trans. on Signal Processing, vol.43, no.8, pp.1855-1866, Aug.1995.