ISSN: 0975-766X
CODEN: IJPTFI
Available Online through *Research Article*
www.ijptonline.com

REMOVAL OF SALT AND PEPPER NOISE USING MEDIAN FILTERS-A CASE STUDY

[1]R Naveena, [1]V Darthy Rabecka,[2] G Rajkumar,[2] V Elamaran
[1]Dept., of ECE, SEEE, SASTRA University, Thanjavur, Tamil Nadu, India.
[2]Assistant Professor, Dept., of ECE, SEEE, SASTRA University, Thanjavur, Tamil Nadu, India.
Email:rmnaveena@gmail.com

Received on 06-11-2015 *Accepted on 23-12-2015*

Abstract

An improved Algorithm to reduce salt and pepper noise using median filter for restoration of corrupted images is proposed in this study. Salt and pepper noise is a form of noise it present itself as sparsely occurring white and black pixels. Median filtering is very widely used in digital image processing to remove noise because, under certain conditions, it preserves edges while removing noise. In the present study window boundary index is checked by means of iterative process. The window size is reshaped to 1-D, sorted to get a median value and thus the noise is filtered. Experimental results of the improved algorithm outperforms other two Algorithms in terms of metrics like MSE, PSNR, IEF(Image Enhancement Factor), ET(Elapsed Time) and the results are shown using MATLAB simulation software tool. The dominance of algorithm in this study is justified through visual interpretation.

Keywords: Salt and Pepper noise, Median filter, Window boundary index.

Introduction

Digital image processing stems from two principal application areas, improvement of pictorial information for human interpretation and processing of image data for storage [1]. Normally in digital image processing, removing the noise is one of the preprocessing technique. In recent years many data are embedded in images for security purpose. If the images are corrupted with noise, the data will be damaged and we couldn't recover the correct data. So there is a need to remove the noise.

In general there are two common noise models. They are Gaussian noise and Impulse noise. The impulse noise is further classified into fixed valued noise (Salt and Pepper noise) and Random valued noise. The pixel value changes to either 0

or 255 when fixed value noise is applied. When random valued noise is applied the intensity of the pixel value is changed to random. The median filter is one of the easiest methods to suppress salt and pepper noise. This filtering operation is performed with a conventional median filter [2]. Image restoration concerns the removal or reduction of degradations which have occurred during the acquisition of image [3]. Thus the image is enhanced using filtering operation. The aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide `better' input for other automated image processing techniques. Image enhancement techniques can be divided into two broad categories. Spatial domain methods, which operate directly on pixels, and frequency domain methods, which operate on the Fourier transform of an image. Advance image enhancement software also supports many filters for altering image in various ways. Median filters are preferred for removing impulse noise because of their simplicity and less computational complexity [4].

Materials and Methods

Median filter Implementation

Algorithm-1

Salt and Pepper noise is applied to an image and it is filtered using in-built median filter MATLAB command. MSE, PSNR, IEF and Elapsed time is calculated after filtering the noise. The following steps are used to implement Algorithm-1.

Step 1: Read an image.

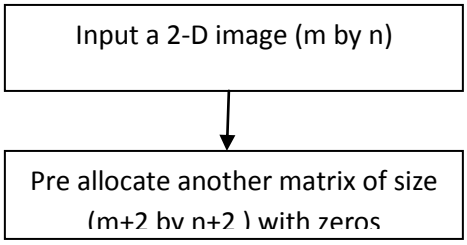
Step 2: Apply salt and pepper noise to an image.

Step 3: Filter the noise using in-built median filter MATLAB command.

Step 4: Display the filtered output image.

Algorithm- 2

We use median filtering to remove Salt and Pepper noise without using in-built function. Algorithm-2 is depicted in Fig.1.



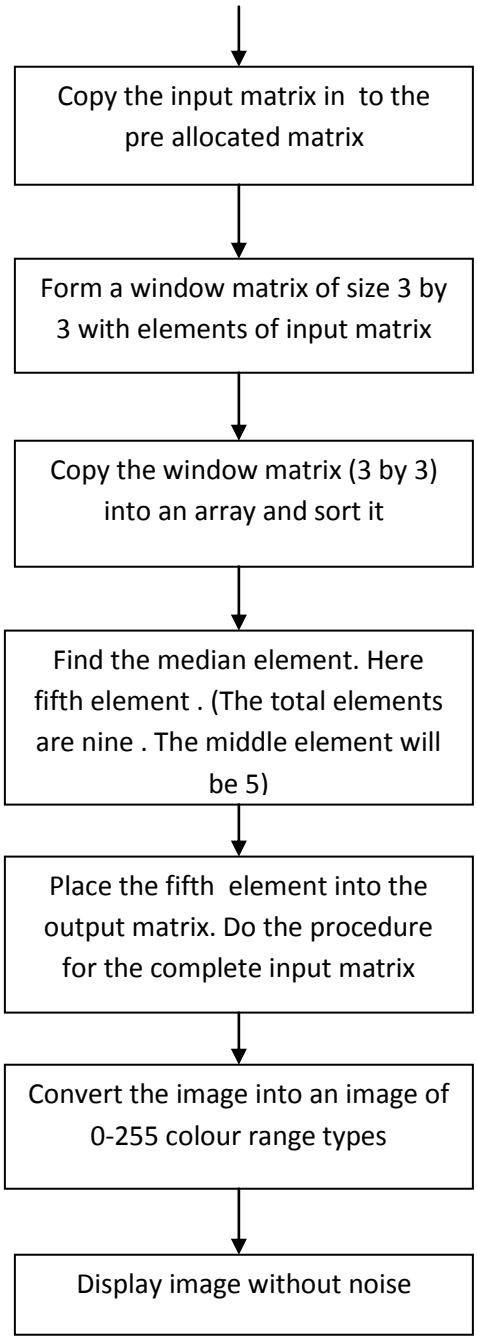


Fig.1: Flow chart for Algorithm-2.

Algorithm-3

The steps involved in Algorithm 3 are as follows,

Step1: Read an image.

Step2: Add Salt and Pepper noise to the image.

Step3: Check window boundary index value iteratively.

Step4: Get window value.

Step5: Find the window size and reshape it to 1-D.

Step6: Sorting operation is performed to get the index of median.

Step7: MSE, PSNR, IEF and Elapsed time is calculated.

Algorithm-3 outperforms other two algorithms in terms of MSE, PSNR, IEF and ET (Elapsed time).

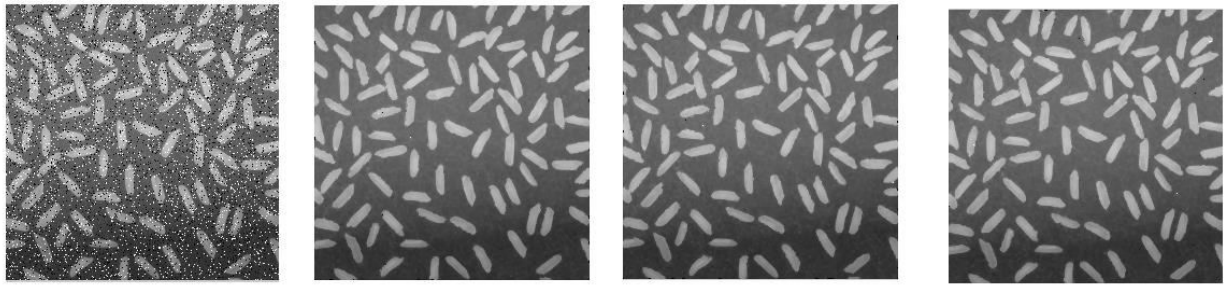
Results and Discussions

Three Algorithms are discussed in this study for median filtering. Algorithm-1 filters the noise based on in-built function of the median filter. This algorithm used for the restoration of corrupted images with noise. The Elapsed time for this algorithm is high. There is a need for reduced Elapsed time and better image quality after restoration. In Algorithm-2 we perform median filtering for Salt and Pepper noise removal without using inbuilt function. On comparing Algorithm-2 with Algorithm-1, Algorithm-2 has minimum MSE, maximum PSNR, maximum IEF and minimum Elapsed time. For further reduction of Elapsed time and improved image enhancement factor we proceed for Algorithm 3.

In Algorithm-3 we perform median filtering for Salt and Pepper noise without using inbuilt function and an efficient method of sorting is performed here using iteration. Comparing experimental results of Algorithm-3 with Algorithm-1 and Algorithm-2, Algorithm-3 proves to be better quantitatively in terms of MSE, PSNR, IEF and Elapsed time. The superiority of the Algorithm -3 is justified qualitatively by means of visual interpretation.

The present study proves the superiority of the Algorithm-3 on different test images. Ten test images are used for simulation purpose. The noise density (10%) is added to the test images and the Salt and Pepper noise is removed using algorithms. Experimental results of two images at a noisy density (10%), and restored images using Algorithm-1, Algorithm-2, and Algorithm-3 are given in Fig.2.

(a) (b) (c) (d)



(e) (f) (g) (h)

Fig.2.Experimental results of CAMERAMAN (a) noisy(10%), restored images using (b)Algorithm-1 ,(c) Algorithm-2,(d) Algorithm-3 and RICE (e) noisy(10%),restored images using (f)Algorithm-1 ,(g) Algorithm-2, (h) Algorithm-3

Performance Metrics

$$\text{MSE} = \frac{1}{RC}\left(\sum\sum(O-R)^2\right) \quad (1)$$

$$\text{PSNR} = 10log_{10}\frac{255^2}{MSE} \quad (2)$$

$$\text{IEF} = \frac{\sum\sum(N-O)^2}{\sum\sum(R-O)^2} \quad (3)$$

Where O, N and R denotes the original, noisy and restored images respectively.

In the Table 1 the MSE, PSNR, IEF and ET (Elapsed Time) values for various test images at a noise density (10%) is shown. Comparing the Algorithms the Algorithm 3 has minimum MSE, maximum PSNR, maximum ISE and minimum Elapsed time. Algorithm 3 outperforms for all the ten test images in terms of MSE, PSNR, IES and ET (Elapsed Time). The PSNR of pout image of Algorithm 3 is 40.5530 which is higher than the PSNR of Algorithm- 2 and Algorithm- 1 that is 39.3780 and 31.8994 respectively. Similarly IEF of pout image of Algorithm-3 is 297.0765 which are higher than the IEF of Algorithm-2 and Algorithm-1 that is 166.1641 and 150.736 respectively. Advantages of Algorithm-3 over other two algorithms are discussed quantitatively and qualitatively. Thus the Algorithm-3 proves to give better results. Our future work deals with the random noise of large dynamic range to achieve further improvement.

Table-1: Comparative results of three algorithms for nine test images at 10% noise density.

Images	Algorithm-1				Algorithm-2				Algorithm-3			
	MSE	PSNR	IEF	ET	MSE	PSNR	IEF	ET	MSE	PSNR	IEF	ET

Cameraman	171.6201	25.7851	12.0347	2.233	163.9292	25.9842	12.5062	1.728	154.6865	26.2363	15.5790	0.707
Rice	66.7318	29.8875	27.6672	1.721	63.6938	30.0898	29.1387	1.543	55.6854	30.6734	33.0321	1.016
Pout	11.1122	37.6728	150.7361	1.990	10.4690	37.9318	166.1641	2.093	5.7251	40.5530	297.0765	0.754
Coins	41.9899	31.8994	47.5220	1.732	39.3780	32.1783	49.617	1.676	37.6437	32.3739	52.7703	1.145
Tress	49.7014	31.1671	50.8048	1.827	47.3298	33.3250	51.4835	1.154	45.3795	34.5675	55.6866	0.039
Tire	52.0705	31.1280	50.7172	2.260	50.1508	32.1805	52.1962	1.988	48.5486	34.9649	54.8996	0.930
Board	217.97	14.7468	3.0256	2.745	216.43	14.9231	4.0123	1.890	215.789	15.3205	5.6247	1.532
Peppers	13.5688	35.8054	151.9598	3.022	12.7713	36.7411	153.1810	1.967	10.8804	37.7644	188.1687	1.661
Spine	5.2534	44.6024	1286.40	3.515	4.6616	45.8794	1478.86	2.964	3.0909	47.2300	3499.839	1.961
Circuit	19.1818	35.3019	111.3187	2.499	18.7815	36.7499	115.9404	2.099	17.8095	38.6243	120.1133	1.825

Conclusions

The present paper provides an improved algorithm for the images with noise and it is restoration. The performance of Algorithm-3 was compared with other two algorithms in terms of MSE, PSNR, IEF and ET (Elapsed Time). From the experimental results discussed, Algorithm -3 is superior to other two algorithms in both quality and quantity aspects.

Acknowledgement

The author would like to thank V.Elamaran, Professor Electronics and Communication Engineering Department, SASTRA University, Thanjavur for constant encouragement and valuable guidance during our research work.

References:

1. RC. Gonzalez, RE. Woods, Digital image processing. 3rd ed. New Jersey, USA: Prentice Hall, 2008.

2. MC. Alasdair Andrew, An Introduction to Digital image processing with Matlab, Victoria University of Technology, 2004.

3. Ahmed Elgammal, Digital Imaging and Multimedia Filters, Dept. of Computer Science Rutgers University,2008.

4. E. Jebamalar Leavline, D. Asir Antony Gnana Singh, Salt and Pepper Noise Detection and Removal in Gray Scale Images: An Experimental Analysis, International Journal of Signal Processing, Image Processing and Pattern Recognition, 2013 ,Vol.6, pp.343-352.

5. T. Nodes, N .Gallagher, Median filters: some modifications and their properties, IEEE Transactions Acoustics, Speech and Signal Processing, 1982,Vol.30 , pp. 739 – 746.

6. Saroj K. Meher, Brijraj Singhawat, An improved recursive and adaptive median filter for high density impulse noise, AEU International Journal of Electronics and Communications, 2014,Vol 68, pp. 1173–1179.

7. M.H. Hsieh, F.C. Cheng, M.C. Shie and S.J. Ruan, Fast and Efficient median filter for removing 1-99% levels of salt-and-pepper noise in images. Eng. Applic. Artif. Intell, 2013,Vol.26, pp.1333-1338.

8. V.Elamaran, Har Narayan Upadhyay, K. Narasimhan and J. Jezebel Priestley, A Case Study of Impulse Noise Reduction Using Morphological Image Processing with Structuring Elements, 2015,Vol.8, pp.291-303.

9. S. Esakkirajan, T. Veerakumar , AN. Subramanyam , CH. PremChand ,Removal of high density salt and pepper noise through modified decision based un-symmetric trimmed median filter. IEEE Signal Process Letters, 2011,Vol.18, pp.287–290.

10. KKV. Toh, H. Ibrahim, MN. Mahyuddin, Salt-and-pepper noise detection and reduction using fuzzy switching median filter. IEEE Trans Consumer Electronics 2008,Vol.54,pp.1956–1961.

Corresponding Author:

R Naveena*,

Email:*rmnaveena@gmail.com*