Impulse denoising using Hybrid Algorithm

Ms.Arumugham Rajamani ME (PhD) [1] Dr.Vellingiri Krishnaveni ME PhD [2]

[1] Department of ECE, PSG Polytechnic College, Coimbatore, India, 9843871174
[2] Department of ECE, PSG College of Technology, Coimbatore, India, 9842075343
[1] Email: rajamani_saranya@rediffmail.com
2 Email:vk@ece.psgtech.ac.in

Abstract:

Many real time images facing a problem of salt and pepper noise contaminated,due to poor illumination and environmental factors. Many filters and algorithms are used to remove salt and pepper noise from the image, but it also removes image information. This paper proposes a new effective algorithm for diagnosing and removing salt and pepper noise is presented. The existing standard algorithms like Median Filter (MF), Weighted Median Filter (WMF), Standard Median Filter (SMF) and so on, will yield poor performance particularly at high noise density. The suggested algorithm is compared with the above said standard algorithms using the metrics Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) value.The proposed algorithm exhibits more competitive performance results at all noise densities. The joint sorting and diagonal averaging algorithm has lower computational time,better quantitative results and improved qualitative result by a better visual appearance at all noise densities.

Keywords: Median filter, Diagonal averaging algorithm, sorting algorithm, Salt and pepper noise, Peak signal to noise ratio, Mean square error.

1. INTRODUCTION

The two mostly occurred types of noise in digital images are Gaussian noise and Impulse noise. The impulse noise is categorized into fixed noise (salt and pepper noise) and random noise. The character of digital images is altered by the contaminated impulse noise, which is caused by wrong functioning of pixels in camera sensors, transmission of information in noisy channels, or due to a problem in the memory location of the hardware. Salt and pepper noise scattered throughout the picture in such a way pixels can hold only the maximum and minimum values (0 and 255 respectively) in the dynamic range of image [1]. The main reasons for unreliable information take into their true signal positions are due to the digital images captured by problematic sensors and transmitted through erroneous radio channels. These noisy signals when exist as maximum or minimum magnitudes relative to the surrounding signals are called the impulses. So impulse noise removal is a very important preprocessing step to go through the subsequent stages of image processing applications. The initial effort made towards impulse noise removal by the linear operators tends to destroy lines, sharp edges, blur other fine image details of the impulse corrupted digital image due to their inability to simultaneously wipe out noise and maintain high frequency data. Later,the nonlinear filters were considered as capable of dishing out the impulse characteristics and the first and foremost role was taken up by the nonlinear Median Filter. The best known and most widely used nonlinear digital filter called median filter, and is recognized for its capacity to remove impulse noise as well as preserve the borders[3]. The primary demerit of a Standard Median Filter (SMF) is that it is effective only for low noise densities. SMFs exhibits blurring in the case of high noise densities for large window sizes and not enough noise suppression for small window sizes[4]. The median filter works uniformly across the picture elements and therefore lead to modifying both noise and non noise pixels [5]. Therefore, the effective removal of impulse often tends to images with blurred and distorted features. Generally, the filtering should be applied only to noisy pixels, while other pixels should not be disturbed. But the median filter is working unconditionally across the whole image as practiced in the conventional approaches would inevitably alter the intensities and remove the image details of the enciphered pixels [2]. Thus, a noise-sensing process to differentiate between noiseless pixels and the corrupted pixels before applying nonlinear filtering is desirable. With this perspective, the weighted median filter has given ample attention in image processing applications. It is different from the classical median filter in such a way that the weighted median filters (WMF) have excellent detail preserving and noise suppression features [6]. The domains like noise reduction, picture restoration and field interpolation, where WMF's have been implemented. Despite their popularity, digital implementations of WMF are computationally complex and expensive because they demand to perform, when needed, a sorting operation and a strategy for duplication for each pixel. Though some works have been implemented to reduce the number of data involved in the weighted median computations, massive applications of median filters by applying digital techniques remains unsolved [7]. Therefore a technique with lower computations and altering only the corrupted pixels is suggested in this paper. Earlier, algorithms use combinations of row, column and horizontal and vertical sorting which increases computational and hardware complexity. Also decrease in operating speed due to more computations is observed. The hybrid approach combines Lone Horizontal and Vertical Sorting (LHVS) algorithm and Diagonal Averaging Algorithm (DAA) proposed in this paper, uses horizontal and vertical sorting and diagonal value alone to obtain appreciable results in terms of computational complexity and visual appearance than existing algorithms. This combined algorithm gives better results in both qualitative and quantitative analysis than other existing competitive filters.

2. PROPOSED ALGORITHM

This proposed denoising method removes salt and pepper noise from grayscale images by using sorting followed by filtering technique.The proposed algorithm consists of two phases.in the first phase joint sorting is performed and in the second phase diagonal averaging algorithm is used.The two phases are explained as below

2.1 **LHVS Approach**

Sorting is the important step involved in denoising of an image. The proposed algorithm LHVS (Lone Horizontal and Vertical Sorting) employs the sorting of the horizontal and vertical elements alone and thus reducing the computational complexity. After denoising the first 3X3 window, the window is shifted in the horizontal direction once to obtain the next 3X3 window and the procedure is repeated as stated above. The corner pixels can be accordingly padded in order to obtain 3x3 window. This image pixels can be sworn out by using horizontal and vertical shifts suitably and hence successful denoising of the image is accomplished within a short span of time.

The LHVS algorithm is explained with the following steps:

STEP 1: A sliding window of 3 x 3 is considered for processing an image.

STEP 2: The horizontal and vertical elements of the particular pixel under process in a 3 x 3 matrix is taken and sorted.

STEP 3: Each horizontal and vertical row intensity values are checked for salt and pepper noise (0 or 255) and replaced with either of the other two values which is non noisy in a selected horizontal row or vertical column.

STEP 4: Shift pulse is used to move to the next 3 x 3 sliding window.

STEP 5: The same process started in STEP 3 is repeated for the integral picture.

2.2 Diagonal Averaging Algorithm (DAA)

DAA algorithm is mainly used to remove salt and pepper noise in the image after the sorting process gets over. In this algorithm the pixel average will be taken from any one of the two diagonal elements.The diagonal element to be selected may be a right diagonal element or left diagonal elements

$$\begin{bmatrix} A1 & 0 & A2 \\ 0 & 0 & 0 \\ A3 & 0 & A4 \end{bmatrix}$$

This algorithm could be explained by considering the four corner diagonal pixels of a selected moving window, namely A1, A2, A3 and A4 the average will be taken between $\frac{A2+A3}{2}$ and $\frac{A1+A4}{2}$. The proposed algorithm is compared with other filters by using the metrics PSNR (Peak Signal to Noise Ratio)**,** and MSE (Mean Square Error)values. Firstly,checking the noise pixels (0 or 255) is carried out and then apply LHVSDAA algorithm to those noisy pixels by keeping the remaining pixels keep as it is. In the first phase,apply the LHVS algorithm on the corrupted image, then in the second phase apply DAA algorithm to remove salt and pepper noise from the image.

3. RESULTS AND DISCUSSION

The proposed algorithm tested for all degrees of noise corruption right from 10% to 90%. Each time the test images (Lena and Cameraman) which are corrupted by salt and pepper noise of different density ranging from 10% to 90% with an increment of 10% is denoised. The results are obtained and compared with other existing filters such as Median Filter (MF 3X3), Standard Median Filter (SMF) and Weighted Median Filter (WMF). The comparison results are depicted as in the figure1 and 2 for cameraman and Lena gray scale images for various noise density levels(10% to 90%) in terms of qualitative analysis. The comparative performance of the proposed algorithm with other standard algorithms is quantitatively measured by the following parameters such as Peak Signal-to-Noise Ratio (PSNR), Mean Square Error (MSE) and proves that the proposed technique performs better than other techniques.The PSNR and MSE are computed using the following formulas 1 and 2 and the quantitative results have been given in table 1 and 2 respectively for the cameraman image.

$$\text{MSE} = \frac{1}{(m \times n \times 3)} \sum_{x=1}^{m} \sum_{y=1}^{n} (f(x,y) - f'(x,y)) \qquad (1)$$

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

Noise (%)	Corrupted image	Result
10		
20		
30		
40		
50		
60		

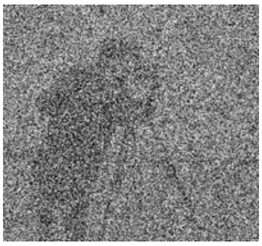
70		
80		
90		

Figure 1:Denoised results for cameraman image for different noise density

Noise (%)	Corrupted image	Result
10		
20		
30		
40		

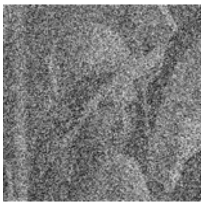
50		
60		
70		
80		
90		

Figure 2:Denoised results for Lena image for different noise density

Table 1: Comparative results of PSNR for the corrupted image (Cameraman)

Noise percentage	10	20	30	40	50	60	70	80	90
JSDAA	82.41	78.56	77.38	75.54	74.51	72.79	70.33	69.32	67.48
Median filter	74.26	70.91	69.87	68.29	67.39	65.87	63.63	60.58	54.31
SMF	54.78	52.56	50.87	47.25	43.54	41.59	38	37.12	35.36
AMF	52.87	51.14	49.84	46.92	44.72	40.83	38.32	36.51	34.88
DBM	51.04	50.45	48.96	47.72	43.78	40.36	37.59	36.08	34.26

Table 2: Comparative results with MSE value for the corrupted image (Cameraman)

Noise percentage	10	20	30	40	50	60	70	80	90
LHVS+DAA	3.73	9.06	12	18	23	34	60	76	116
Median filter	24	53	67	96	119	168	282	569	2410
SMF	2163	3606	5322	12248	28779	45090	103058	126206	189269
AMF	3358	5001	6747	13215	21932	53713	95737	145238	211388
DBM	5118	5862	8262	10992	27232	59852	113261	160354	243826

4.CONCLUSION

An efficient nonlinear algorithm to remove salt and pepper noise is projected. The Lone horizontal and vertical Sorting algorithm clearly reduce the computational time required for diagnosing the corrupted pictures. Likewise, since the noisy pixels are replaced with the neighboring pixels, the picture quality is comparable appreciable. The lower number of computations performed obviously reduces the hardware complexity, thereby increasing the efficiency and reducing the price of the system compared to the other competing algorithms.

REFERENCES

[1] Abhishek R, Srinivas N ,An Advanced Technique for Removal Of Salt & Pepper Noise In Images, International Journal Of Engineering And Computer Science ISSN:2319-7242 Volume 2 Issue 9 September 2013 Page No. 2856-2860.

[2] Tina Gebreyohannes ,Dong-Yoon Kim , Adaptive Noise Reduction Scheme For Salt And Pepper, Signal & Image Processing : An International Journal (SIPIJ) Vol.2, No.4, December 2011.

[3] Bhavana Deshpande, H.K. Verma, Prachi Deshpande, Fuzzy Based Median Filtering for Removal of Salt-and-Pepper Noise,International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-2, Issue-3, July 2012.

[4] Medida.Amulya Bhanu, Gopichand Nelapati, Dr.Rajeyyagari Sivaram, Salt and Pepper Noise Detection and removal by Modified Decision based Unsymmetrical Trimmed Median Filter for Image Restoration, International Journal of Advanced Trends in Computer Science and Engineering, Volume 1, No.3, July – August 2012.

[5] Shyam Lal, Sanjeev Kumar and Mahesh Chandra, Removal of High Density Salt & Pepper Noise Through Super Mean Filter for Natural Images, IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 3, No 3, May 2012.

[6] S.Gopi Krishna, T. Sreenivasulu Reddy , G.K.Rajini, Removal of High Density Salt and Pepper Noise Through Modified Decision Based Unsymmetric Trimmed Median Filter, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 1, Jan-Feb 2012, pp.090-094 90.

[7] K.Aiswarya, V.Jayaraj, D.Ebenezer, A New and Efficient Algorithm For The Removal of High Density Salt and Pepper Noise in Images And Videos, 2010 Second International Conference on Computer Modeling and Simulation.