Computational Efficient Method for Denoising of Salt and Pepper Noise for Image Enhancement

Neetesh Raghuwanshi, Bharti Chourasia

Abstract*: Digital Image processing is basically a computer-algorithm which is used to enhance the quality of image to understand the feature of image and exact the meaningful features information from image. Image processing has wider range of algorithms to be applied to the input image and can escape the difficulty as the signal distortion and add noise in input image at the time of processing of images. Noises affect the image visualization and degraded the image quality, sometimes chaotic variation in value of pixel intensity, lighting effect or because of poor contrast, image can't be used directly because many time interest feature information not received as output that's one reason image processing is significant for removal of noise from images, so noise removal is becomes trending field in image processing. Median filter method is one of most popular method to eradicate the effect of noise from image and it enhances the image quality to take meaningful feature easily from image. In this paper removing of noise using median filter to enhance the image quality is discussed, also the importance and applications of enhancement technique are covered. Parameter PSNR and MSE is also used to analysis the image quality along with the visualization of image. Simulation results show that Median filter gives good outcome for salt & pepper noise as compare to other filtering method. MATLAB software is used as simulation tool.

***Keywords* : Salt & pepper, Median filter,PSNR,MSE,denoising.**

I. INTRODUCTION

In the Transmission of images/pictures over channels, Images are defiled by salt and pepper noise, because of faulty communication. Salt and Pepper is like a particles of salt and peppers distributed over the whole images means white and black spot are showed in image and these spot sometime affect the feature of interest and meaningful information not possible to acquire from image, so removing of noise is play very important role in image processing[2]. In images processing, most important task is improvement of pictorial information for human interpretations. The mode to getting and analyzing visual-data by computerized image preparing which is done by computers.. Initially, image can be represented as a two-dimensional f (l, m). The image f (l, m) whereas l and m are spatial co-ordinates and amplitude of 'f' at a pair of coordinates (l, m) is termed as the intensity of an image on this point in time. The images are mainly two types. They are Gray scale image and colour image. In Gray scale image, An image is a function I of two spatial coordinates of an image plane is a gray scale image. The image I(l, m) is located at the intensity of the image at the point (l, m)in the image plane. And another is Colour image. In this colour image, the image has the three functions that are R for red, G for green and B for blue. An image might be continuous by the reference to the l and m coordinates and is also occur in amplitude. The coordinates and the amplitude of an image are converted into the digital image to be digitized. Sampling is obtained by digitization of the coordinates values. Quantization is obtained by the digitization of the amplitude values. The sampled image f(l, m) has M X N size where M represent no of rows and N represent no of columns[3]. Another illustration is that the origin of coordinate system at the point (r, c) = (1, 1). Hence, r is ranged from 1 to M and c is of from 1 to N in integer values. Moreover, the image processing toolbox employed another image coordinate convention termed as spatial coordinates, where columns is denoted by x and rows is denoted by y.

The digital image function can be symbolized as:

$$A\,(l, m) = \begin{pmatrix} A\,(0,0) & A\,(0,1) & \cdots & A\,(0,N-1) \\ A\,(1,0) & A\,(1,1) & & A\,(1,N-1) \\ \vdots & & \ddots & \vdots \\ A\,(M-1,0) & A\,(M-1,1) & \cdots & A\,(M-1,N-1) \end{pmatrix} \ldots.\ (1)$$

in this array, each and every element is named as the image pixel, image element or picture element or pixel, pixel term is famous among all. Normally, digital image is to represent in the matlab matrix:

$$A\,(l, m) = \begin{pmatrix} A\,(1,1) & A\,(1,2) & \cdots & A\,(1,N) \\ A\,(2,1) & A\,(2,2) & & A\,(2,N) \\ \vdots & & \ddots & \vdots \\ A\,(M,1) & A\,(M,2) & \cdots & A\,(M,N) \end{pmatrix} \ldots\ldots.\ (2)$$

normally, the terms M and N are stand for the number of rows and columns of a matrix respectively.

Image processing is very essential for achieved the desired output from data. Figure 1.1 shows the classification of image processing techniques. Image enhancement can be done by so different techniques such as increase the contract and saturation by change the intensity of image pixels. If image are corrupted by noise than noise removal techniques have to use to enhancement the image quality.

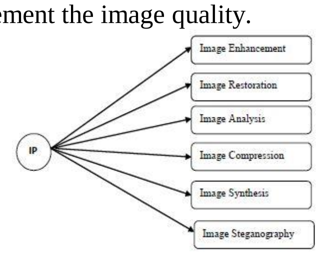

Figure 1 Image Processing Techniques

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II. IMAGE ENHANCEMENT THROUGH DE-NOISING:

Mostly, three decade ago, the processing and acquisition of digital images only part of industrial research laboratories, academic areas medical field and military field but in recent time, image processing not limited under this areas but common person is also used image processing for different different areas such as the images are download from the world wide web (www) and store them in the digitalform, digital satellite tv are used to watch the sports games,movie etc for entairntentment and digital video teleconferencing are very popular for business executives cut deals and also in medical field[2][5]. Hence, those digital images must have to good quality but some times they affected by lighting,environmental condition or during transmission.so before it use it have to process to reduce those effect from image.

DENOISING METHODS: - The filters are generally classified in to two types first one is linear filter and second one is nonlinear filter. Linear filters are also called averaging low pass filter because its tooks the mean or average value of overall pixels present in any window. The blurring of edges and loss of image content are the difficulties which are faced with linear filter, thereby minimizing the precision of output. While non-linear type filter posses a better result than linear filter as they eliminates the noisy pixels without causing edge blurring.Median filter is comes under the non linear filter.

Median filter is an easy and simple implementation of non-linear filter for noise removal. In this median filter technique, the targeted noisy pixels are replaced by median value of its neighbours. The number of neighbours depends upon the window size of filter. The median value is simply described as the mid value in a sorted sequence.

Median (P) = Med {Pi}

Median (P) = Med {Pi}

= Pi(k +1)/2, k is odd

= ½[Pi(k/2)+ Pi(k/2)+1],

k is even P1, P2, P3 ………Pk is the sequence of neighbour pixels.

All pixels in the image has to be arranged in either ascending or descending order, before applying filtering. After performing sorting, the resulting image pixel sequence will be Pi1Pi2Pi3......Pik, .k is usually odd.

III. PROPOSED ALGORITHM

In this section proposed method is discussed identifying the noise in the image and then de-noising it using double threshold median filter as well as preserving edges of image. The window of size 3x3 chooses for noise detection and noise removal. The window contains total 9 elements which are as follows: Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9. First step selects the maximum, minimum and median values of columns and rows. Second step stores these values and selects minimum threshold, maximum threshold and final median value[8]. Third step use threshold values for noise detection and final median value for noise removal. We are parallel calculating the threshold values and median value. So there is no need to perform noise detection and noise removal separately.

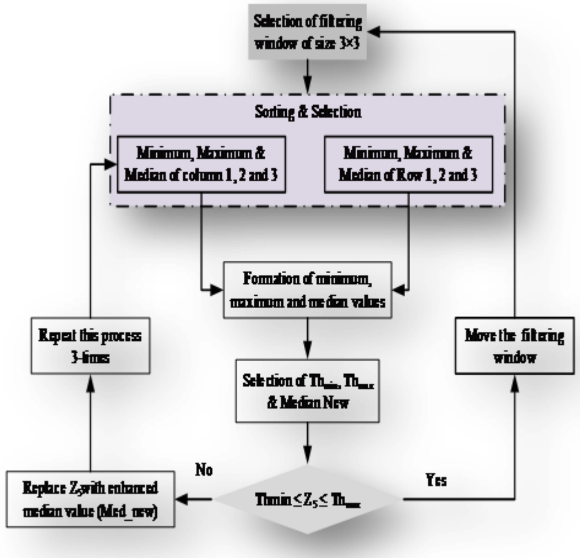

Figure 2: Flow chart of proposed method for filtering window size 3x3

IV. RESULTS & DISCUSSIONS

Th There is some Simulation Parameters are used to compare the performance of our proposed method with exiting method. Simulation parameters are PSNR and MSE.The PSNR value approaches as high as possible the MSE approaches to zero; these results show that a higher PSNR value provides a better image quality. At the other end of the parameter, a small change in the PSNR indicates high numerical differences between image qualities. PSNR is usually represents in terms of the logarithmic decibel scale.

$$PSNR = 10 log_{10} \frac{(255)^2}{MSE} \quad \text{.............................} (3)$$

Where MSE (Mean square error), is

$$MSE = \frac{\sum_{i=1}^{m} \sum_{j=1}^{n} \{z(i,j) - A(i,j)\}^2}{m \times n} \quad \text{....................................} (4)$$

With respect to the noise-free original image A.

A. SIMULATION TOOL: MATLAB is a high level technical computing language and algorithm development tool that can be used in several applications such as data visualization/analysis, numerical analysis, signal processing, control design, etc. Using the MATLAB software, solution can be achieved faster than traditional programming languages, such as C, C++. Add on toolboxes are a collections of special purpose MATLAB functions that are available separately.

V. RESULT ANALYSIS

Any handling connected to a picture may bring about a critical loss of data or quality. The PSNR is most normally utilized as a measure of nature of remaking of misfortune pressure codecs e.g., for picture pressure. The flag for this situation is the first information, and the clamor is the qualities presented by incautious commotion.

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When comparing denoising results it is used as an approximation to human visibility of reconstruction quality, therefore in some cases one denoising results may appear to be closer to the original than another methods, even though it has a lower PSNR and a higher PSNR would normally indicate that the denoising method is of higher quality. We have to be extremely careful with the range of results; it is only comparably valid when it is used to compare results from the different denoising algorithms and same content. The PSNR value approaches as high as possible the MSE approaches to zero; these results show that a higher PSNR value provides a better image quality. This algorithm is mainly used for high density impulse noise because many algorithms give good results at low noise densities but very poor results at high noise densities. Using this method, we have performed image de-noising on Lena Image,Boat image , Bridge image Brain image of size 256x256 and simulate their results on MATLAB. For different high noise density levels that are 10%-90%, the resultant peak signal to noise ratio (PSNR) are also mentioned in tables, and we made a comparative analysis based on this PSNR of de-noised image.

A. Result for Lena Image

Clearly that the figure 3 (a) show the original image of Lena image. Figure 3 (b) shows the 0.1 salt noise and restored image, Figure 3 (c) shows the 0.2 salt noise and restored image, Figure 3 (d) shows the 0.3 salt noise and restored image, Figure 3 (e) shows the 0.4 salt noise and restored image, Figure 3 (f) shows the 0.5 salt noise and restored image, Figure 3 (g) shows the 0.6 salt noise and restored image, Figure 3 (h) shows the 0.7 salt noise and restored image, Figure 3 (i) shows the 0.8 salt noise and restored image and Figure 3 (j) shows the 0.9 salt noise and restored image of the Lena image. From the visual outputs, it is very clear that image de-noised by proposed method has good quality

Figure 3 (a) to (j) show the original image of Lena with noise density 01 to 0.9 and restored images.

B. Similarly Result for Brain Image is shown below in figure 4

From the visual outputs, it is very clear that image de-noised by proposed method has good quality.

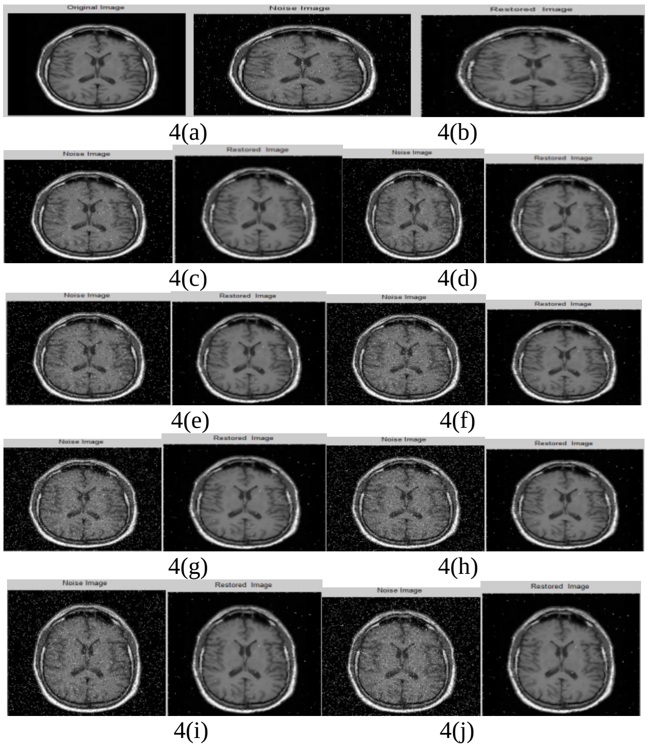

Figure 4 (a) to (j) show the original image of brain with noise density 01 to 0.9 and restored images

C. Also Result for Boat Image shown in figure 5.

From the visual outputs, it is very clear that image de-noised by proposed method has good quality.

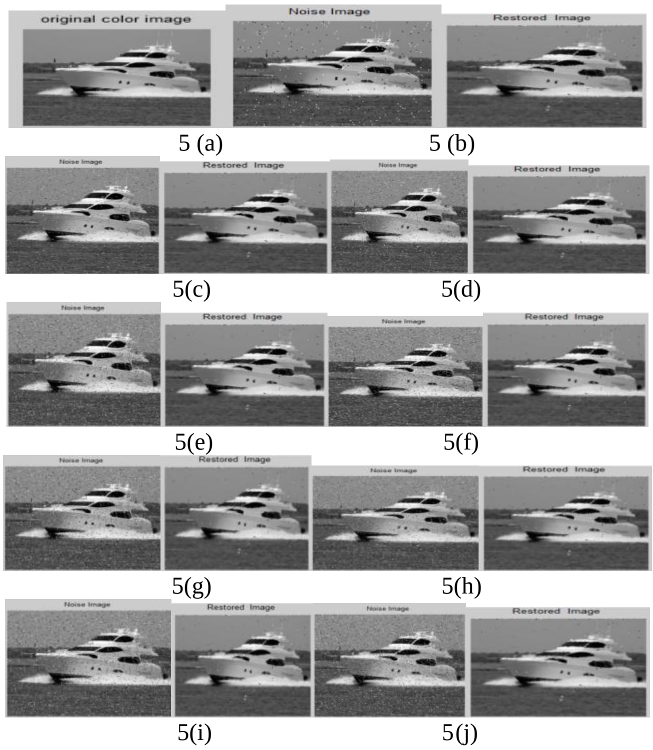

Figure 5 (a) to (j) show the original image of brain with noise density 01 to 0.9 and restored images

D. Result for Bridge Image shown in the figure 6 show the original image of the Bridge image. And with the noise from 0.1 to 0.9 salt noises and restored image, from the visual outputs, it is very clear that image de-noised by proposed method has good quality.

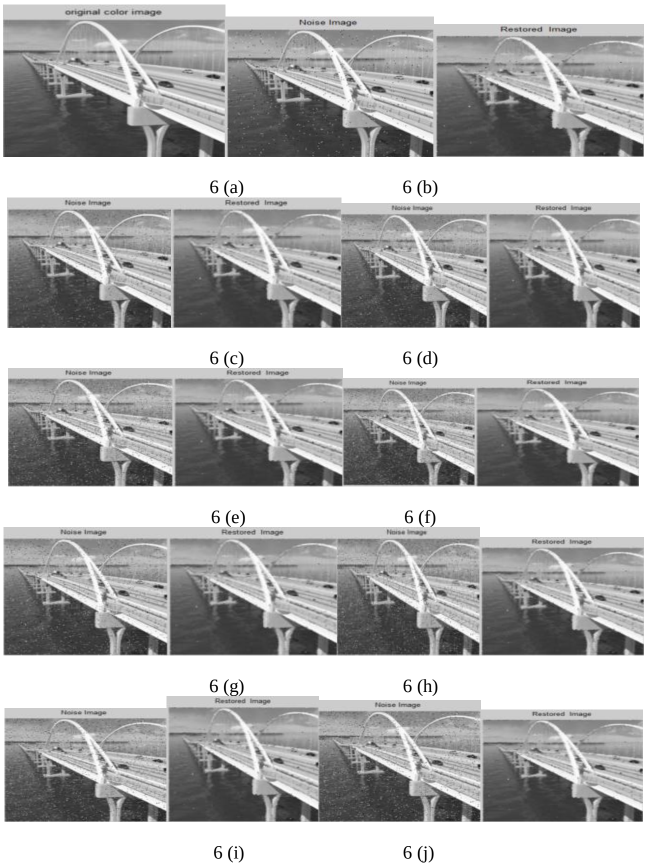

Figure 6 (a) to (j) show the original image of brain with noise density 01 to 0.9 and restored images

COMPARISION RESULT FOR PREVIOUS AND PROPOSED FILTER

The results in the Table 3 clearly show that the PSNR of different method is much better at high density of salt and pepper noise. As the density of noise increasing, the response of proposed filter is becomes better in comparison of other filters.

Table: 3: Comparison of PSNR of Modified Median Filter for Lena Image

Noise Density	Previous Weight Mean Filter [1]	Proposed Modified Median Filter	
	PSNR (dB)	MSE	PSNR (dB)
0.01	36.28	1.1528	47.5132
0.02	33.60	2.2132	44.6806
0.03	31.50	3.2903	42.9585
0.04	29.93	6149	41.6816
0.05	28.74	5.5365	40.6984
0.06	27.96	6.4215	40.0544
0.07	26.76	7.5270	39.3646
0.08	24.76	9.3170	38.4380
0.09	22.38	10.0685	38.1011

The graphical illustration of the performance of different noise density discussed in this research work in term of mean square error (MSE) and peak signal to noise ratio (PSNR) for Lena Image shown in figure 7. From the graphical representation it can be inferred that the proposed modified median filter gives the 29.07% increase peak signal to noise ratio (PSNR) for previous algorithm.

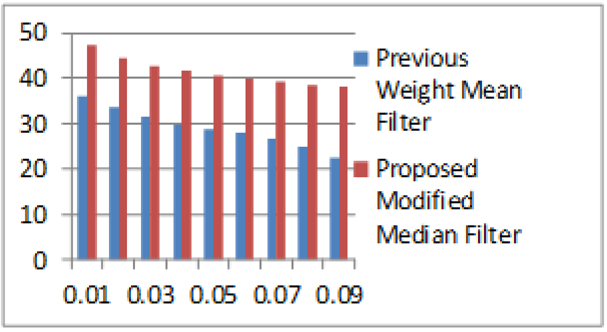

Figure 7 Noise Density V/S PSNR(DB) for Lena Image

z

The results in the Table 4 clearly show that the PSNR of different method is much better that the proposed modified median filter gives the 38.96% increase peak signal to noise ratio (PSNR) for previous algorithm.

Table: 4: Comparison of PSNR of Modified Median Filter for Brain image

Noise Density	Previous Median Filter [2]	Proposed Modified Median Filter	
	PSNR (dB)	MSE	PSNR (dB)
0.01	-	1.9275	45.2808
0.02	-	3.2818	42.9696
0.03	29.81	5.0253	41.1192
0.04	26.05	6.9567	39.7068
0.05	23.24	8.4989	38.8372
0.06	20.97	10.0549	38.1070
0.07	19.20	11.8962	37.3767
0.08	-	13.4730	36.8362
0.09	-	16.1479	36.0496

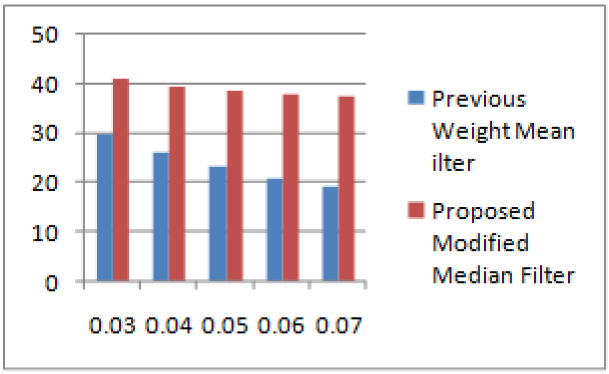

Figure 8 Noise Density V/S PSNR(DB) for brain Image

The results in the Table 4 clearly show that the PSNR of different method is much better at high density of salt and pepper noise. As the density of noise increasing, the response of proposed filter is becomes better in comparison of other filters. The proposed modified median filter gives the 38.96% increase peak signal to noise ratio (PSNR) for previous algorithm. Figure 8 shows the graphical representation of improvement.

Table 5: comparison PSNR of Modified Median Filter for Boat Image

Noise Density	PreviousNewton–Thiele filter[3]	Proposed Modified Median Filter	
	PSNR (dB)	MSE	PSNR (dB)
0.01	41.48	1.2825	47.0502
0.02	38.03	2.9190	43.4785
0.03	36.74	3.8389	42.2887
0.04	335	5.1361	41.0244
0.05	32.57	6.7047	39.8670
0.06	30.93	7.5979	39.3239
0.07	29.03	9.4278	38.3867
0.08	27.01	10.0992	38.0880
0.09	24.66	11.5196	37.5187

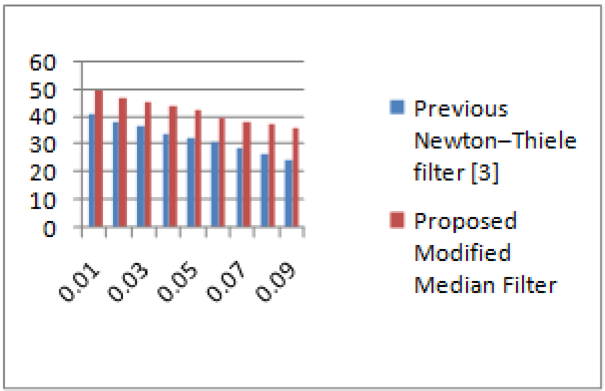

Figure 9 Noise Density V/S PSNR(DB) for Boat Image

Table 5 shows PSNR and MSE value for boat image, proposed modified median filter gives the 23.97% increase peak signal to noise ratio (PSNR) for previous algorithm. Figure 9 shows the graphical representation of parameter values

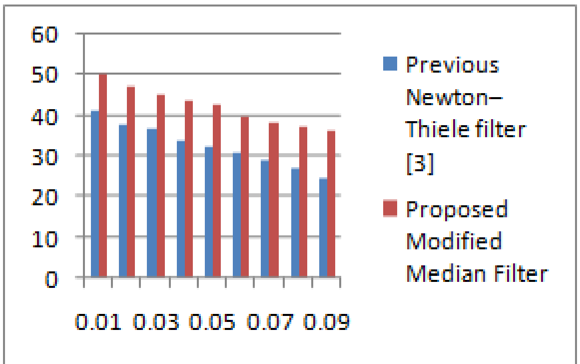

Figure 10 Noise Density V/S PSNR(DB) for bridge Image

Figure 10 shows the graphical illustration of the performance of different noise density discussed in this research work in term of mean square error (MSE) and peak signal to noise

Table: 6: Comparison of PSNR of Modified Median Filter for Bridge Image

Noise Density	Previous Newton–Thiele filter[3]	Proposed Modified Median Filter	
	PSNR (dB)	MSE	PSNR (dB)
0.01	33.31	1.9037	45.3347
0.02	30.15	3.9161	42.2023
0.03	28.75	5.6495	40.6107
0.04	27.47	7.6704	39.2825
0.05	26.34	9.4442	38.3791
0.06	25.25	11.3059	37.5978
0.07	24.03	13.6441	36.7813
0.08	22.75	15.0074	36.3677
0.09	21.06	16.028	36.082

ratio (PSNR). From the above graphical representation it can be inferred that the proposed modified median filter gives the 29.37% increase peak signal to noise ratio (PSNR) for previous algorithm.

VI. CONCLUSION

The proposed filter has proved that it is very efficient for random valued impulse noise because practically noise is not uniform over the channel. It delivers great peak signal to noise ratio (PSNR) and little Mean Square Error (MSE) for profoundly debased pictures, particularly for over half clamor thickness. Salt and pepper noise or impulse noise can occur due to a random bit error in a communication channel. This high density noise can be removed with the help of median filter which is also useful in preserving edges in an image while reducing random noise. The proposed method improved the quality of de-noised image especially for random valued impulse noise. PSNR & MSE has been calculated for the performance analysis and result shows excellent variations in the result. Implementation modified median filter are consumed 29.07% increase peak signal to noise ratio (PSNR) for Lena image, 38.96% increase peak signal to noise ratio (PSNR)for Brain image,
23.97% increase peak signal to noise ratio (PSNR) for Boat image and 29.37% increase peak signal to noise ratio (PSNR)for Bridge image.

FUTURE SCOPE

Based on the results of the investigations presented in this work, some suggestions for the future work in the field of Image restoration are summarized. This method can have great application in the field of communication, because large amount of noise introduced during the transmission of data. The day to day emerging technology requires more and more revolution and evolution in the image processing field.

The proposed denoising technique can provide a good platform for further research work in this respect. This work can be further enhanced to Denoised the other type of images, as well, like RGB, Indexed and Binary images. It will provide a good add on to the already existing denoising techniques used for denoising these images. Moreover, for future work the implemented algorithms can be trained using various techniques like fuzzy logic or neural network, in order to attain the best output without performing calculations for each and every combination. It is further suggested that the proposed algorithm may be extended to various metrics for describing and quantifying the qualities of an image as well those of a filtering process the color images and video framework which may further improve the video denoising.

REFERENCES

1. BenzartiFaouzi, Hamid Amiri. Image denoising using non linear diffusion tensors. In: 8th IEEE international multi-conference on systems, signals & devices; 22–25 March 2011.p.1–5.
2. JuShen, Sen-Ching S. Cheung. Layer depth denoising and completion for structured-light RGB-D cameras. In: IEEE conference on computer vision and pattern recognition (CVPR); 23–28 June, 2013. p. 1187–94.
3. Yuji Karita, Toshiyuki Tanaka. Restoration of original image from deterioratedimage by probabilistic image model. In: SICE annual conference; August 20–22, 2008. p. 3096–100.
4. [Harold Christopher Burger, Bernhard Scholkopf, Stefan Harmeling. Removingnoise from astronomical images using a pixel-specific noise model. In: IEEEinternational conference on Computational photography (ICCP); 8–10 April,2011. p. 1–8.
5. Johannes R. Sveinsson, Jon AtliBenediktsson. Speckle reduction of SAR imagesusing wavelet-domain hidden Markov models. In: Proceedings of IEEEinternational geosciences and remote sensing symposium (IGARSS 2000) 4; 24–28 July 2000. p. 1666–8.
6. H. Guo, J. E. Odegard, M. Lang, R. A. Gopinath, I. W. Selesnick, and C. S. Burrus, "Wavelet based speckle reduction with application to SAR based ATD/R," First Int'l Conf. on Image Processing, vol 1, pp. 75-79, Nov. 1994.
7. Robert D. Nowak, "Wavelet Based Rician Noise Removal", IEEE Transactions on Image Processing, vol. 8, no. 10, pp.1408, October 1999.
8. S. G. Mallat and W. L. Hwang, "Singularity detection and processing with wavelets," IEEE Trans. Inform. Theory, vol. 38, pp. 617–643, Mar. 1992.
9. D. L. Donoho, "De-noising by soft-thresholding",IEEE Trans. InformationTheory,vol.41no.3,pp.613-27,May1995.http://wwwstatstanford.edu/~donoho/Reports/1992/denoisereleas e3.ps.Z
10. Imola K. Fodor, ChandrikaKamath, "Denoising through wavlet shrinkage: An empirical study", Center for applied science computing Lawrence Livermore National Laboratory, July 27, 2001.
11. R. Coifman and D. Donoho, "Translation invariant de-noising," in Lecture Notes in Statistics: Wavelets and Statistics, vol. New York: Springer-Verlag, pp. 125-150, 1995.
12. R. Yang, L. Yin, M. Gabbouj, J. Astola, and Y. Neuvo, "Optimal weighted median filters understructural constraints," IEEE Trans. Signal Processing, vol. 43, pp. 591–604, Mar. 1995.
13. R. C. Hardie and K. E. Barner, "Rank conditioned rank selection filters for signal restoration," IEEE Trans. Image Processing, vol. 3, pp.192–206, Mar. 1994
14. A. Ben Hamza, P. Luque, J. Martinez, and R. Roman, "Removing noise and preserving details with relaxed median filters," J. Math. Imag. Vision, vol. 11, no. 2, pp. 161–177, Oct. 1999.
15. D. Lee, \New work item proposal: "JPEG2000 image coding system." ISO/IEC JTC1/SC29/WG1 N390, 1996.
16. J. M. Shapiro, "Embedded Image Coding Using Zerotrees of Wavelet Coeficients," IEEE Trans. Signal Proc., vol. 41, pp. 3445-3462, December 1993.3.63
17. H. danyoli and A. mertins "Highly scalable image compression based on spiht for network applications".
18. Rafael C.Gonzalez, Richard E.Woods, Digital Image Processing,Prentice-Hall, 2002 .
19. M. Antonini, M. Barlaud, P. Mathieu, and I. Daubechies, "Image coding using wavelet transform" IEEE Trans. Image Proc., vol. 1, pp. 205–220, Apr. 1992.
20. D. Taubman and A. Zakhor, "Multirate 3-D subband coding of video" IEEE Trans. Image Proc., vol. 3, pp. 572–588, Sept. 1994.
21. UliGrasemann and RistoMiikkulainen, "Effective Image Compression using Evolved Wavelets" ACM, pp. 1961-1968, 2005.
22. Ming Yang and NikolaosBourbakis, "An Overview of Lossless Digital Image Compression Techniques", IEEE, pp. 1099-1102, 2005.
23. Mohammad KabirHossain, Shams MImam ,KhondkerShajadulHasan and William Perrizo," A Lossless Image Compression Technique Using Generic Peano Pattern Mask Tree" IEEE, pp. 317-322, 2008.
24. TzongJer Chen and Keh-Shih Chuang,‖ A Pseudo Lossless Image Compression Method,‖IEEE, pp. 610-615, 2010.
25. Jau-JiShen and Hsiu-ChuanHuang,‖ An Adaptive Image Compression Method Based on Vector Quantization,‖IEEE, pp. 377-381, 2010.
26. Suresh Yerva, Smita Nair and Krishnan Kutty,‖ Lossless Image Compression based on Data Folding,‖IEEE, pp. 999-1004, 2011.
27. Firas A. Jassim and Hind E. Qassim,‖ Five Modulus Method for Image Compression,‖ SIPIJ Vol.3, No.5, pp. 19-28, 2012.
28. Mridul Kumar Mathur, SeemaLoonker and Dr. DheerajSaxena ―Lossless Huffman CodingTechnique For Image Compression And Reconstruction Using Binary Trees,‖IJCTA, pp. 76- 79, 2012.
29. V.K Padmaja and Dr. B. Chandrasekhar,‖Literature Review of Image Compression Algorithm,‖ IJSER, Volume 3, pp. 1-6, 2012.

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