ISSN 2047-3338

Noise Suppression using Local Parameterized Adaptive Iterative Model in Areas of Interest

I. Suneetha[1] and Dr. T. Venkateswarlu[2]
[1]ECE, AITS, Tirupati, India
[2]ECE, SVUCE, Tirupati, India
[1]iralasuneetha.aits@gmail.com, [2]warlu57@gmail.com

***Abstract*— Digital Image Processing means processing of digital images by using a computer via algorithms. Noise corrupts the image during sensing with malfunctioning cameras, storing in faulty memory location, or sending through a noisy channel. Sometimes intensity of noise with which an image can be corrupted is different in its various areas. The main objective of this paper is to develop a faster and better algorithm for suppressing salt and pepper noise in different areas of interest from noisy images. This paper proposes a method for noise suppression using a Local Parameterized Adaptive Iterative Model in areas of interest. The proposed method provides good results subjectively as well as objectively for both gray scale and true colour images. The proposed method is useful for interactive image processing applications as it has a family of possible denoisy images for a single noisy image.**

***Index Terms*— Digital Image Processing (DIP), Parameterized Adaptive Iterative (PAI), Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Area of Interest (AOI)**

I. INTRODUCTION

THE image enhancement is one of important block in the fundamental steps in DIP as it provides visually acceptable images without knowing the source of degradation for human viewers and/or automated image processing techniques. Spatial domain image enhancement modifies the image pixels directly where as in frequency domain involves finding transform of image, multiply with required transfer function and then finding inverse transform. We reviewed enhancement techniques for gray scale images in spatial domain and implemented them using MATLAB [1]. These techniques have been extended to true colour images also in [2]. Image enhancement through contrast improvement can be done by using a Linear Parameterized Gradient Intercept (PGI) model [3]. Image enhancement through noise suppression can be done using a Nonlinear Parameterized Adaptive Recursive (PAR) model [4]. Image enhancement through contrast improvement and noise suppression can be done using a Parameterized Hybrid Model [5]. The above three global models work well when an entire image is corrupted uniformly. It fails to enhance when various areas of an image corrupts differently. Local models [6] can be developed to enhance an image in AOI. This paper proposes a method for noise suppression using a local PAI model in areas of interest in spatial domain.

II. PROPOSED METHOD

Let f(x,y) be original image, fn(x,y) be its noisy image and g(x,y) be the denoisy image. Relation between noisy image and denoisy image of the proposed method for i=1, 2, 3…n is:

$$g_i(x,y) = cmed[f_{ni}(x,y)] \quad (1)$$

where cmed means Conditional median filter that performs filtering to noisy pixels only, n is the number of areas of interest. For an i^{th} area of interest in noisy image, A_i is window size that is adaptive and I_i is Iteration or recursive number. A_i and/or I_i can be varied for suppressing the salt and pepper noise This filter has high Peak Signal to Noise Ratio (PSNR) as it performs filtering to only noisy pixels of noisy image. The proposed nonlinear method is given the name Local Nonlinear Parameterized Adaptive Iterative (LPAI) model', as a family of possible denoisy images can be obtained to achieve effective noise suppression for an area of interest. As the proposed model performs condition median filtering to only noisy pixels for area of interest LPAI model can also be named as Local Conditional Median Filter (LCMF).

III. PROPOSED ALGORITHM

The following are the steps involved in image enhancement through noise suppression in AOI using LPAI algorithm for gray scale and true color images.

Gray scale image:

1. Read an input image f(x, y).
2. f_n(x, y) is a noisy image of f(x, y).
3. Divide fn(x,y) into two sub images
   Based on AOI:f_{n1}(x, y) and f_{n2}(x, y)

4. For $f_{n1}(x, y)$, select values of A_1 and I_1.
5. Pad all sides of the image with noisy image with $(A_1\text{-}1)/2$ zeros to get $f_{p1}(x, y)$
6. If $0<f_{p1}(x, y) < L\text{-}1$, go to next pixel. Perform cmed filtering to get $g_{p1}(x, y)$.
7. If $g_{p1}(x, y)$ is noisy, vary A_1 and/or I_1.
8. If A_1 varies go to step 4 otherwise go to step 5.
9. Remove the padded zeros in $g_{p1}(x,y)$ to get denoisy image $g_1(x,y)$.
10. For $f_{n2}(x, y)$, select values of A_2 and I_2.
11. Pad all sides of the image with noisy image with $(A_2\text{-}1)/2$ zeros to get $f_{p2}(x,y)$
12. If $0<f_{p2}(x, y) < L\text{-}1$, go to next pixel. Perform cmed filtering to get $g_{p2}(x, y)$.
13. If $g_{p2}(x, y)$ is noisy, vary A_1 and/or I_1.
14. If A_1 varies go to step 11 otherwise go to step 12.
15. Remove the padded zeros in $g_{p2}(x,y)$ to get denoisy image $g_2(x,y)$.
16. Get denoisy image g(x,y) from two denoisy sub images $g_1(x, y)$ and $g_2(x,y)$.

True Colour image:

1. Read an input image f(x,y).
2. $f_n(x,y)$ is a noisy image of f(x,y).
3. Divide fn(x,y) into two sub images Based on AOI:$f_{n1}(x, y)$ and $f_{n2}(x,y)$
4. For $f_{n1}(x, y)$, select values of A_1 and I_1.
5. Extract r_1,g_1,b_1 components from $f_{n1}(x,y)$
6. Pad all sides of noisy $r_1g_1b_1$ images with $(A_1\text{-}1)/2$ zeros to get their padded images $r_{p1},g_{p1},b_{p1.}$
7. Perform cmed filter to r_{p1}, g_{p1}, b_{p1} separately.
8. Get true color image $g_{p1}(x,y)$ from filtered r_{p1}, g_{p1}, $b_{p1..}$
9. If $g_{p1}(x,y)$ is noisy, vary A_1 and/or I_1 .
10. If A_1 varies go to step 6 otherwise go to step 7.
11. Remove the padded zeros in $g_{p1}(x,y)$ to get denoisy sub image $g_1(x,y)$.
12. For $f_{n2}(x,y)$, select values of A_2 and I_2.
13. Extract r_2 g_2,b_2 components from $f_{n2}(x,y)$
14. Pad all sides of noisy $r_2g_2b_2$ images with $(A_2\text{-}1)/2$ zeros to get their padded images $r_{p2},g_{p2},b_{p2.}$
15. Perform cmed filter to r_{p2}, g_{p2}, b_{p2} separately.
16. Get true color image $g_{p2}(x,y)$ from filtered r_{p2}, g_{p2}, $b_{p2..}$
17. If $g_{p2}(x, y)$ is noisy, vary A_2 and/or I_2 .
18. If A_2 varies go to step 14 otherwise go to step 15.
19. Remove the padded zeros in $g_{p2}(x,y)$ to get denoisy sub image $g_2(x,y)$.
20. Get denoisy image g(x,y) from two denoisy sub images $g_1(x, y)$ and $g_2(x,y)$.

IV. RESULTS

The proposed Local Conditional Median Filter (LCMF) performance can be compared to that of conventional global and local methods: Global Traditional Median Filter (GTMF), Local Traditional Median Filter (LTMF), Global Adaptive Median Filter (GAMF), Local Adaptive Median Filter (LAMF), Global Recursive Median Filter (GRMF), Local Recursive Median Filter (LRMF), and Global Conditional Median Filter (GCMF). Consider four grayscale images of file TIF type: man (256x256), Lena (512x512), birds (254x198), and moon (306x420). These images are shown in Fig. 1 have been corrupted by salt and pepper noise by two different intensities: half the area with 0.1 and rest of the area with 0.5. Noisy images are then applied to four global methods: GTMF, GAMF, GRMF, and GCMF.

Let the noisy image can be divided into two areas: AOI_1 and $AOI_{2.}$ They are either left half and right half or top half and bottom half. Noisy sub images obtained using image segmentation are then applied to four local methods: LTMF, LAMF, LRMF, and LCMF. The window size for traditional median filters size is 3x3, for adaptive median filters, it 5x5, and for recursive filters window size is 3x3 with repetition number 2. The window size and repetition number for conditional median filter are same for global and different for local in area of interest. Noise suppression can be judged ([7]-[15]) by visual inspection of the subjective results as shown in figures (Fig. 1-10) and objective results are presented in Table I. The proposed method has highest Peak Signal to Noise Ratio (PSNR) and also there is no effect of rounding the corners in its denoisy images.

Peak Signal to Noise Ratio (dB):

$$\mathbf{PSNR} = 20\log_{10}\left[\frac{L-1}{\sqrt{MSE}}\right] \qquad (2)$$

where Mean Square Error:

$$\mathbf{MSE} = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}[f(i,j) - g(i,j)]^2 \qquad (3)$$

TABLE I: PEAK SIGNAL TO NOISE RATIO (DECIBELS)

Image	Man	Lena	Birds	Moon
Original	58.43	58.58	58.95	57.38
GTMF	65.09	66.09	65.31	64.88
LTMF	65.23	66.13	65.42	64.99
GAMF	68.27	72.67	69.15	74.77
LAMF	68.77	73.08	68.66	72.94
GRMF	68.24	70.39	68.37	70.63
LRMF	68.52	70.53	68.60	71.21
GCMF	74.70	80.92	72.84	78.38
LCMF	79.76	80.99	80.85	85.97

Fig. 1: Original images

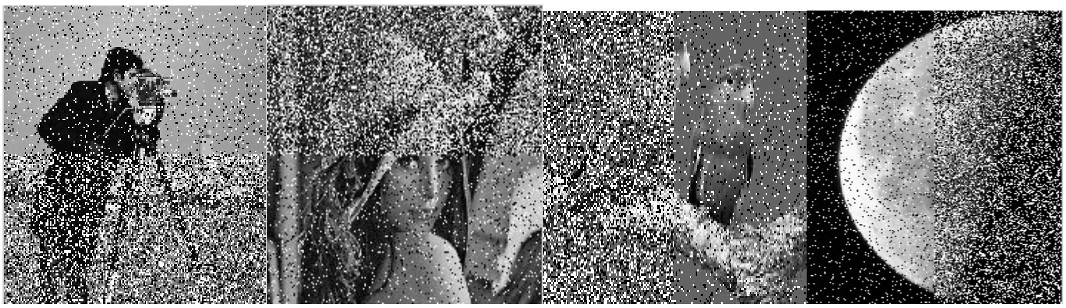

Fig. 2: Noisy images

Fig. 3: GTMF images

Fig. 4: LTMF images

Fig. 5: GAMF images

Fig. 6: LAMF images

Fig. 7: GRMF images

Fig. 8: LRMF images

Fig. 9: GCMF images

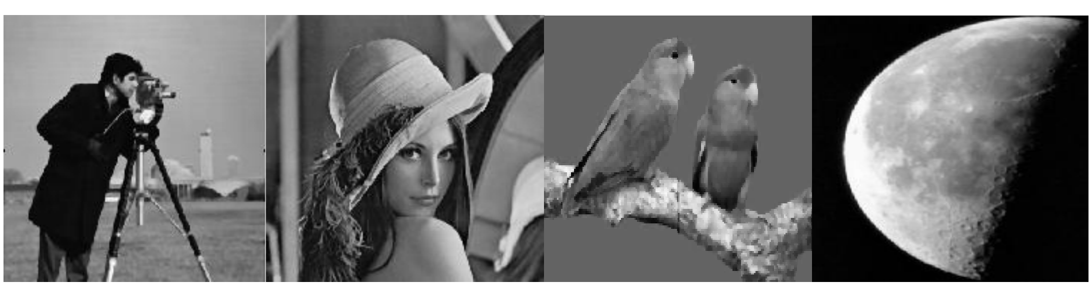

Fig. 10: LCMF images

V. CONCLUSIONS

Noise suppression using Local Parameterized Adaptive Iterative model in area of interest has been successfully implemented for grayscale images and can be extended to true color images in spatial domain. Proposed model work well for different types of images. Choice of A and I depends on type of image. LPAI method can be used as a tool for any photo editing software like photo shop or any existing image processing software by providing two sliding bars for selecting spatial coordinates for x and y of AOI and then two more sliding bars A and I for noise suppression.

Sometimes an image can be corrupted by both poor contrast and unwanted noise differently in its areas. The future scope will be the development of two models: first one is local parameterized hybrid model for achieving both contrast improvement and noise suppression in AOI where as second one is parameterized model for achieving effective spatial domain image enhancement for binary images (grayscale and true color) like text, document, medical, pencil art, vehicle's licence plate and finger prints.

REFERENCES

[1] Ms. I.Suneetha and Dr.T.Venkateswarlu, "Enhancement Techniques for Gray scale Images in Spatial Domain", International Journal of Emerging Technology and Advanced Engineering, website: www.ijetae.com (ISSN 2250-2459) Volume 2, Issue 4, April 2012, pp.13-20.

[2] Ms. I.Suneetha and Dr.T.Venkateswarlu, "Enhancement Techniques for True Color Images in Spatial Domain", International Journal of Computer Science & Technology (IJCST), Website: www.ijcst.com (ISSN 0976-8491) Volume 3, Issue 2, Version 5, April to June 2012, PP. 814-820.

[3] Ms. I.Suneetha and Dr.T.Venkateswarlu, "Image Enhancement through Contrast Improvement using a Linear Parameterized Gradient Intercept Model", ARPN Journal of Engineering and Applied Scinces(ARPN-JEAS), Website: www.arpnjournals.com (ISSN 1819-6608) Volume 7, No.8, August 2012, PP. 945-949.

[4] Ms. I.Suneetha and Dr.T.Venkateswarlu, "Image Enhancement through Noise Suppression using a Nonlinear Parameterized Adaptive Recursive Model", International Journal of Engineering Research and Applications(IJERA), Website: www.ijera.com (ISSN 2248-9622) Volume 2, Issue 4, July-August 2012, PP. 1129-1136

[5] Ms. I.Suneetha and Dr.T.Venkateswarlu, "Spatial Domain Image Enhancement using Parameterized Hybrid Model", International Journal of Electronics and Communication Engineering & Technology (IJECET), Website: www.iaeme.com (ISSN Print 0976-6464 ISSN Online 0976-6472) Volume 3, Issue 2, July- September 2012, PP. 209-216.

[6] Ms. I.Suneetha and Dr.T.Venkateswarlu, "Image Enhancement through Contrast Improvement in ROI using Local PGI Model", International Journal of Computer Applications (IJCA), Website: www.ijcaonline.com (ISSN 0975-8887) Volume 54-No.4, September 2012, PP. 47-53.

[7] R C Gonzalez, R. E. Woods, Digital Image Processing (3rd Edition, Prentice Hall, 2008).

[8] Takis Kasparis , Nikolaos S. Tzannes, Qing Chen,"Detail Preserving Adaptive Conditional Median Filters'', Journal of Electronic Imaging1(4), 358-364(October 1992).

[9] A. K. Jain, Fundamentals of Digital Image Processing (Englewood Cliffs, NJ: Prentice Hall, 1989).

[10] Raymond H.Chan, Chung-Wa Ho, and Mila Nikolova "Salt-and-Pepper Noise Removal by Median type noise detectors and Detail Preserving Regularization", IEEE Transactions on Image Processing, Vol. 14, No.10, October 2005.

[11] J Rafael C Gonzalez, Richard E. Woods, and Steven L. Eddins, Digital Image Processing Using MATLAB® (Second Edition, Gates mark Publishing, 2009).

[12] M. Nikolova, "A Variational approach to remove outliers and impulse noise", *Imag, Vis.*,vol. 20, no. ½,pp.99-120,Jan-Mar 2004.

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

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

[15] Zhe Zhou, "Cognition and Removal of impulse Noise with Uncertainty " , IEEE Transactions on Image Processing, Vol. 21, No. 7, July 2012, pp. 3157-3167.

Ms. I. Suneetha received the B.Tech and M.Tech Degrees in E.C.E from Sri Venkateswara University College of Engineering (SVUCE), Tirupati, India in 2000 and 2003 respectively. She has 11 years teaching experience and many publications. She is pursuing her Ph.D. Degree at SVUCE, Tirupati and working with EC.E department, Annamacharya Institute of Technology and Sciences (AITS), Tirupati. Her teaching and research area of interest includes 1D & 2D signal processing

Dr.T.Venkateswarlu received the B.Tech. and M.Tech. Degrees in E.C.E from S. V. University College of Engineering (SVUCE) Tirupati, India in 1979 and 1981 respectively. He received the Ph.D Degree in Electrical Engineering from Indian Institute of Technology, Madras (IITM) in 1990. After working a short period at KSRM college of Engineering, Kadapa, he joined and currently working with the department of E.C.E, SVUCE, Tirupati. His teaching and research interest are in digital systems, and multidimensional digital filters.