Volume 5, Issue 1, January 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Image Enhancement with Noise Reduction in Spatial Domain

[1]S. Shyam Prasad, [2]R. Priya
[1]PG Student, Department of Computer Science & Engg, Annamalai University, Tamil Nadu, India
[2]Associate Professor, Department of Computer Science & Engg, Annamalai University, Tamil Nadu, India

***Abstract:* Digital images are mostly corrupted by mixed noise from several sources. It is a challenging problem to remove mixed noise in color images. Generally, some image denoising filters can reduce either additive or impulse noise, but it fails to remove both impulsive noise and additive noise. This paper presents modified bilateral filtering method, which can simultaneously remove both impulsive and additive noise, when compared to average filter and vector median filter. The proposed solution first implement and applying the exponential weighting function to the bilateral filtering mechanism, which is determined by whether the current pixel is a possible impulse or not, and it can improve the performance of proposed filtering action. The experimental results show that the proposed bilateral filtering action can simultaneously remove impulsive and additive noise while preserving edge structures.**

***Index Terms:* Image Denoising, Additive Noise, Impulse Noise, Average Filter, Vector Median Filter, Bilateral Filter, MSE, PSNR.**

I. INTRODUCTION

Image enhancement, which transforms digital images to enhance the visual information within, is a primary operation for almost all vision and image processing tasks in several areas such as computer vision [2]. In many situations, images are mostly affected by mixed noise which is a combination of impulsive noise and additive noise [1]. Image noises may be caused by faults in camera sensor and environment conditions which are often not possible to avoid in practical situations and atmospheric disturbances are the common causes for impulsive noise, whereas the thermal effect of various electronic circuits and random photon-fluctuation of photo-electronic devices will typically introduce additive noise to images. It is obvious that noise contamination will significantly decrease the visual quality and affect the performance of image-processing techniques. Therefore, image denoising or filtering is necessary or even indispensable for any image application system and is one of the most common image-processing tasks [5] [6].

MODELING NOISE OF THE IMAGES

a. Additive Noise

The standard model of additive noise is Gaussian, dependent at each pixel and dependent of the signal intensity, caused primarily by thermal noise. Additive noise is a major part of the noise of an image sensor, that is, of the constant noise level in dark areas of the image. In Additive noise, each pixel in the image will be changed from its original value by a small amount.

b. Impulse Noise

Impulse noise is sometimes called Salt and pepper noise or spike noise. In salt and pepper noise, pixels in the image are very different in color or intensity unlike their surrounding pixels. Salt and pepper degradation can be caused by sharp and sudden disturbance in the image signal. An image containing salt-and-pepper noise will have dark pixels in bright regions and vice versa. This type of noise can be caused by dead pixels, analog to digital converter errors and bit errors in transmission.

c. Mixed Noise

Mixed noise is the combination of additive noise and impulse noise. It is caused due to faults in camera sensors, exceptional memory locations in hardware, transmission of images in noisy channels, and atmospheric disturbances.

REMOVING NOISE FROM IMAGES BY FILTERING

Image noise is an unavoidable side-effect occurring as a result of image capture, more simply understood as inaudible, yet inevitable fluctuations. In a digital camera, if the light which enters the lens misaligns with the sensors, it will create image noise. Even if noise is not so obviously visible in a picture, some kind of image noise is bound to exist. Thus, filters are required for removing noises before processing. There are three filters discussed in the paper to remove mixed noise.

Generally, Filter techniques are divided into two types of filters.

A. Linear Filters

Linear filters are used to remove certain types of noise. Averaging or Gaussian filters are appropriate for this purpose. Linear filters also tend to blur sharp edges, destroy lines and other fine image details, and perform poorly in the presence of signal-dependent noise.

Average filter(Mean filter) is one of the linear filter.

B. Non-Linear Filters

In Non-Linear filters, noise can be removed without identifying it exclusively. It employs a low-pass filtering on the assumption that noise always occupies a higher region of spectrum frequency. It removes the noise to very large extent but at the cost of blurring of images. Non linear filters overcome the linear filters. For Example Vector median filter and Bilateral Filter are the non linear Filters.

II. RELATED WORKS

Hybrid cumulative histogram equalization (HCHE) [2] for adaptive contrast enhancement. Removing mixed noise from images is one of the challenging problem. Thus presented Gaussian and Bilateral filter for unsharp masking for contrast enhancement of images. The approach employs an adaptive median that controls the contribution of the sharpening path in such a way that contrast enhancement occurs in high detail areas and noise detection technique for removal of mixed noise from images. A modified multiscale bilateral decomposition to effectively separate signal and mixed-type noise components. Experimental result is effectiveness of this algorithm, in terms of both the peak signal to noise ratio and visual quality [3].

An improved median filtering algorithm removes or effectively suppresses the impulse noise in the image whiles preserving the image edges information and enhancing the image quality[7]. This method is a spatial domain approach and uses the overlapping window to filter the signal based on the selection of an effective median per window. C. Tomasi, and R. Manduchi [10], introduced the concept of bilateral filtering for edge-preserving smoothing, by means of a nonlinear combination of nearby image values. The method is noniterative, local, and simple. It combines gray levels or colors based on both their geometric closeness and their photometric similarity, and prefers near values to distant values in both domain and range. In contrast with filters that operate on the three bands of a color image separately, a bilateral filter can enforce the perceptual metric underlying the CIE-Lab color space, and smooth colors and preserve edges in a way that is tuned to human perception. Also, in contrast with standard filtering, bilateral filtering produces no phantom colors along edges in color images, and reduces phantom colors where they appear in the original image.

III. PROPOSED APPROACH

The proposed method, average filter and vector median filter and bilateral filter are implemented and compared. Fig 1. Shows the block diagram of proposed system.

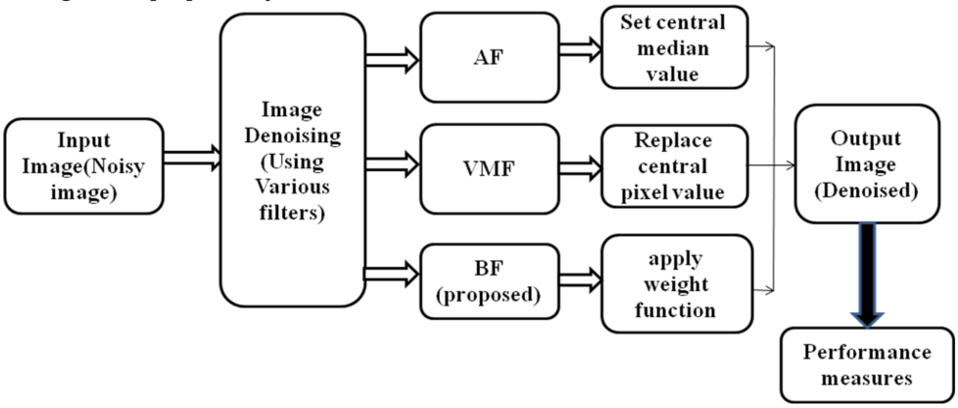

Fig 1. Block Diagram of the Proposed System

(i) Average Filter (AF)

Average filter is the simplest type of filter to remove noise from image. In this technique, each pixel is replaced by arithmetic mean of neighboring pixels. The explanation of averaging theory is that images typically vary slowly over space, so neighboring pixels are likely to have similar values, and it is therefore appropriate to average them together. But this assumption of slow variation in pixels fails at edges and does not preserve them. This can remove light noise but introduces blurriness in image. In equation form, this is written as

$$y[i] = \frac{1}{M}\sum_{j=0}^{M-1} x[i+j] \qquad (1)$$

Where *x* [ ] is the input signal, *y* [ ] is the output signal, and *M* is the number of points in the average.

(ii) Vector Median Filter (VMF)

VMF was proposed to remove salt and pepper noise. It acts in a way that the windows set on each pixel of the image and the value of color components of red, green, and blue in the central pixel of the window are replaced with color components of one of pixels which is in the window. The selected pixel for replacement is the one that has the minimum sum of Euclidean distances compared with other points of the window. It means that the sum of Euclidean distances (*Li*) from all points in the window is calculated considering the Eq. (2) for all pixels in the window, and the pixel with minimum value is considered as the output of VMF filter and the central pixel is replaced with it.

$$L_i = \sum_{j=1}^{N} ||x_{i-} x_j||_2 \ \ for \ \ i = 1, \ldots .. N \tag{2}$$

In the above equation, x_i , x_j and N stand for the central pixel, existing pixels in the window and the number of pixels which are set to be in the window, respectively.

(iii) Bilateral Filter (BF)

Bilateral filter is firstly presented by Tomasi and Manduchi in 1998. The bilateral filter is a non-linear technique that can blur an image while respecting strong edges, by means of a nonlinear combination of nearby image values. The method is noniterative, local, and simple. It combines gray levels or colors based on both their geometric closeness and their photometric similarity, and prefers near values to distant values in both domain and range. The bilateral filter takes a weighted sum of the pixels in a local neighbourhood, the weights depend on both the spatial distance and the intensity distance. In this way, edges are preserved well while noise is averaged out. Mathematically, at a pixel location x, the output of a modified bilateral filter is calculated as follows,

$$y_{\mathrm{BF}}(\mathrm{s,t}) = \frac{1}{r_{\mathrm{BF}}(\mathrm{s,t})} \sum_{(\mathrm{i,j}) \in \Omega(\mathrm{s,t})} \exp\left(-\frac{(\mathrm{s}-1)^2 + (\mathrm{t}-\mathrm{j})^2}{2\sigma_s^2}\right) . \exp\left(-\frac{||\mathrm{x(s,t)} - \mathrm{x(i,j)}||_2^2}{2\sigma_r^2}\right) \mathrm{x(i,j)} \tag{3}$$

where $||\ .\ ||_2$ denotes Euclidean distance, and, **x**(s, t) is a pixel position, σ_s and σ_r are the standard deviations of the spatial domain and color range domains.

Bilateral filtering method is good efficient method for removing of mixed noise from color images and it is implemented. By analyzing the current pixel, and it check whether impulse or not, the proposed techniques uses different bases: If current pixel **x**(s, t) is found to be a possible impulse, the vector median of the color pixels inside the filter window is chosen as the base of the bilateral filtering, the central pixel remains as the base. In this way, the output of the bilateral filter is determined by the vector median when the central pixel is a possible impulse and dominated by the central pixel itself when the central pixel is not a possible impulse. Thus, the excellent property of the modified BF, i.e., excellent suppression of additive noise without smoothing edges and details, and the ability of removing impulsive noise, are achieved simultaneously by the proposed method. Let **y**(i, j) represent the output of the modified bilateral filter at position (i, j). Since the pixels in the top- left of the current pixel **x**(s, t) have been processed when processing **x**(s, t), the filter window Ω(s, t).

Then, we introduce another exponential type of weighting functions to describe the relationship between two pixels, that the weighting functions is to improve the bilateral filtering action for removal of mixed noise in color images. which is defined as follows,

$$W(x) = \frac{1}{1 + (\exp\ (x))^k} \tag{4}$$

where the parameter k is used to adjust the weighting effect.

IV. EXPERIMENT RESULTS AND DISCUSSIONS

Image Quality Measures

Measurement of image quality is important for many image processing applications. Image quality assessment is closely related to image similarity assessment in which quality is based on the differences (or similarity) between a degraded image and the original, unmodified image. Quality has been measured in terms of well known metrics such as

1. Mean Squared Error (MSE)
2. Peak Signal to Noise Ratio (PSNR)

1. Mean Squared Error (MSE)

It stands for the mean squared difference between the original image and distorted image. The mathematical definition for MSE is

$$MSE = (1/M \times N) \sum_{i=1}^{M} \sum_{j=1}^{N} (a_{ij} - b_{ij})^2 \tag{5}$$

In Equation, a_{ij} means the pixel value at position (i, j) in the original image and b_{ij} means the pixel value at the same position in the corresponding filtered image.

2. Peak Signal to Noise Ratio (PSNR)

PSNR is a classical index defined as the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. It is given by

$$PSNR = 10\log_{10} 255^2/MSE \quad (6)$$

Where 255 is the maximal possible value of the image pixels.

V. EXPERIMENTAL RESULTS

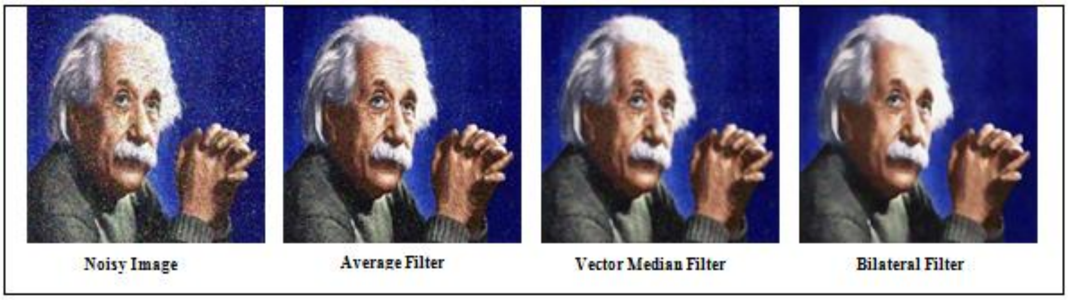

Fig 2. Results of the Proposed Filtering Techniques

Table 1. Quality Measures of Einstein image (256*256)

	AF	VMF	BF
MSE	7.331	6.944	3.072
PSNR	30.827	31.288	38.384

VI. CONCLUSION

To overcome the disadvantages that the average filter and vector median filter cannot remove both impulsive and additive noise, a modified bilateral filtering method is implemented in this paper, which can effectively removed both impulsive noise and additive noise simultaneously. By detecting whether the current pixel is a possible impulse or not, either the central pixel or the vector median is chosen as the base to take part in the bilateral filtering operation. The experimental results demonstrate the validity of the proposed method by showing significant performance improvements and excellent visual effect in suppressing mixed noise.

REFERENCES

[1] Lianghai Jin, Caiquan Xiong and Hong Liu, "Improved bilateral filter for suppressing mixed noise in color images", Elsevier Inc on Digital Signal Processing, Vol. 22, No. 8, pp. 903- 912, 2012.

[2] Alamdeep Singh and Kuldeep Sharma, "Enhancing Image Quality for Highly Noisy Images Using Gaussian and Bilateral Filter", International Journal of Application or Innovation in Engineering & Management (IJAIEM) on Image Processing, Vol 2, No. 9, pp. 339 – 342, Sep 2013.

[3] Jino Lee, Rae-Hong Park and SoonKeun Chang, "Noise reduction using multiscale bilateral decomposition for digital color images", ACC 2012, Part III, CCIS, pp. 193-204, Springer - Verlag Berlin Heidelberg, Aug 2012.

[4] Kwame Osei Boateng, Benjamin Weyori Asubam and and David Sanka Laar , "Improving the Effectiveness of the Median Filter," International Journal of Electronics and Communication Engineering, Vol. 05, No. 1, pp. 85-97, 2012.

[5] P. Venkatesan and G. Nagarajan, "Non Linear Algorithm for Removal of Mixed Gaussian Noise and Impulse Noise Using Fuzzy Filters", ICCCI 2011, January 11-12, 2011.

[6] Zhang Lei, Song Hongxun, "A Hybrid Filter based on an adaptive neuro - fuzzy inference system for efficient removal of impulse noise from corrupted digital images", IEEE 2nd Conference on Environmental Science and Information Application Technology, 2010.

[7] Madhu S. Nair and P.M. Ameera Mol, "Noise Adaptive Weighted Switching Median Filter for Removing High Density Impulse Noise", ACC 2011, Part III, CCIS, pp. 193-204, 2011. Springer - Verlag Berlin Heidelberg, 2010.

[8] Kenny Kal Vin Toh and Nor Ashidi Mat Isa, "Cluster-Based Adaptive Fuzzy Switching Median Filter for Universal Impulse Noise Reduction", IEEE Transactions on Consumer Electronics, Vol. 56, No. 4, November 2010.

[9] Haidi Ibrahim, Nicholas Sia Pik Kong and Theam Foo Ng, "Simple Adaptive Median Filter for the Removal of Impulse Noise from Highly Corrupted Images", IEEE Transactions on Consumer Electronics, Vol. 54, No. 4, November 2008.

[10] C. Tomasi, and R. Manduchi, " Bilateral filtering for gray and color images," Proc. IEEE Int. Conf. Computer Vision, p.839–846, 1998.

