ISSN:2321-1156

International Journal of Innovative Research in Technology & Science(IJIRTS)

A COMPARISON OF BILATERAL FILTER AND DIRECTION BASED ADAPTIVE WEIGHTED SWITCHING BILATERAL FILTER FOR REMOVING MIXED NOISE IN IMAGE PROCESSING

Tarun Sethi[1] , Rupelirupanita Dash [2] , Tunirani Nayak [3]

Institute Of Technical Education And Reserch(ITER), SOA University. Bhubaneswar, Odisha, India

Abstract

This paper deals with an Adaptive based Switching Bilateral Filter for removing universal noise in highly corrupted image. In contrast with the previous approach where Blurring occurs while filtering the entire image without considering the non-corrupted pixels, which is reduced here by using the adaptive Median Filter with binary vector (BV). Operation Carries in three stages. At first an Adaptive Median Filter is used to identify the corrupted pixels to remove the mixed impulses. At the second stage, the edge is preserved by using edge detector and the noise detector is to classify the noisy pixels, whether it is impulse noise or Gaussian noise. The noise detector has a high noise detection rate and higher classification rate. In the third stage, the Switching Bilateral Filter (SBF) with sorted quadrant Median vector (SQMV) scheme for removing universal noise and also restores the output image. The proposed Adaptive based Switching Bilateral Filter achieves high peak signal-to-noise ratio and great image quality by effectively removing universal noise.

Index Terms—Image Processing, Adaptive median filter, Gaussian noise, impulse noise, noise detector, nonlinear filters, switching bilateral filter, switching scheme,MATLAB

I. *Introduction*

Image enhancement, one of the important image processing technique, can be treated as transforming one image to another to improve the interpretability or perception of information for human viewers, or to provide better input for other automated image processing techniques. The survey of available techniques is based on the existing techniques of image enhancement. Such as analysis, detection, and filtering. We can filter an image to emphasize certain features or remove other features. The noise removal technique proposed here is based on the modification of the well known filters. i.e Gaussian filter, median filter, spatial filter, Wigner filter, bilateral filter, switching bilateral filter. Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time.

The median filter is a nonlinear digital filtering technique, often used to remove noise. Spatial filtering is actually a mask of weights arranged in a rectangular pattern. Bilateral filter encompasses both the spatial distance and amplitudinal distance between a centre point and its neighboring points. Wigner filter is capable of dealing with the wide range of Gaussian noise and gives consistent performance. The switching bilateral filter with sorted quadrant median vector scheme for removing universal noise and also restores the output image. Edge detection has a potential role in image processing. Unwanted data is filtered out ,whereas the important structural features of the image are preserved. Earlier methods of edge detection comprise of convolution of the image with an operator which is designed to be sensitive to higher gradients in the image. There are several types of edge detection techniques. Selection of the best edge detection operator is a crucial step. Noise is any undesired information that contaminates an image. Noise appears from the digital image acquisition process, where fluctuations caused by natural phenomena add a random value to the exact brightness value for a given pixel. Noise in electronics is affected by environmental conditions such as temperature, and may vary during the acquisition of an image database. The two common types of noise in images are Impulse or salt-and-pepper-noise and random or Gaussian noise. Random noise can be expressed in the form of its mean and variance values. Impulse noise randomly and sparsely corrupts pixels to two intensity levels relative high or relative low when compared to its neigh boring pixels. In image processing, various linear and non linear filtering methods have been proposed for the removal of noise. Linear filtering techniques used for noise reduction in images are simply given by the average of the pixels contained in the neighborhood of the filter mask However; linear filters cannot reduce impulse noise effectively and have a tendency to blur the edges of an image. Nonlinear filters have been developed for removing impulse noise such as the traditional median filter. "The genetic programming (GP) filter is based upon the learning algorithm that is used to build two detectors, and this method requires a training procedure to arrive at an optimal classification based upon the measure of pixels and their neighbors". The median-based signal-dependent rank ordered mean (SDROM) filter can remove impulse noise rather effectively, but when applied to images with Gaussian or mixed noise, it often produces a visually disappointing output . This is because the rank-ordered mean gets corrupted in a high noise intensity window

"The adaptive centre weighted median filter (ACWMF), uses an evaluation of the centre weighted medians and adaptive thresholds for detection [. When applied to Gaussian or mixed noise images, it creates blur and removes the details". The directional weighted median (DWM) filter uses an iterative filtering approach, and the detector is based upon absolute differences within the filtering window.

The trilateral filter is based on the bilateral filter with integrated rank-order absolute difference (ROAD) statistics for impulse noise detection. It has been specially designed for uniform impulse and Gaussian noise removal. To achieve good visual image quality and also preserves the edge but the noise filter not only replaces noisy pixels.

The Switching Bilateral filter removes most of the noise but many non-corrupted pixels are also modified resulting in blurring of the output image and sometimes it fails to identify the Gaussian noise as corrupted pixels and treated as the noisy-free pixels. "As for uniform impulse noise, the classification rate of our proposed filter is lower than SDROM and GP" because some pixels are wrongly marked as noise.

The proposed filter is an adaptive based switching bilateral filter for removing universal noise while preserving weak edges and sharpness. In this method consists of three processing stages. The first stage is to detect the corrupted pixels i.e. first classifies the pixels into two classes, which are "noise free pixel" and "noisy pixel" based on the intensity values and removing mixed impulse. The second stage ,the noise detector is used to classify the noisy pixels, whether it is impulse noise or Gaussian noise. The third stage is to filter by using the switching bilateral filter with Sorted Quadrant Median Vector (SQMV) .

II. NOISE MODEL

Noise gets introduced into the data via any electrical system used for storage, acquisition and transmission .Noise component is considered as random variable and it is characterized by a probability density function (PDF).The following are among the most common PDFs found in image processing applications.

The Gaussian noise has an important property to estimate the mean of a stationary Gaussian random variable. The PDF of a Gaussian random variable z is given in equation

$$P(z)= P(z) = (1/\sqrt{\pi\sigma})e^{\frac{-(z-u)^z}{(z\sigma)^z}} \quad \ldots\ldots\ldots\ldots(1)$$

Where z represents the gray level, u is the mean of z and is its standard deviation. The standard deviation squared, is called the variance of z. Exponential noise The PDF is of exponential noise is

$$P(z)= \begin{cases} ae^{az} & \text{for } z \geq 0 \\ 0 & \text{for } z < 0 \end{cases} \quad \ldots(2)$$

Where, The mean and variance of this density function are

$$u = \frac{1}{a} \ldots\ldots\ldots.(3)$$

$$\sigma^2 = \frac{1}{a^2}\ldots\ldots(4)$$

Uniform noise: Uniform noise is not often encountered in real-world imaging systems, but provides a useful comparison with Gaussian noise. The linear average is a comparatively

Poor estimator for the mean of a uniform distribution. This implies that nonlinear filters should be better at removing uniform noise than Gaussian noise. The PDF of uniform noise is

$$P(z) = \frac{1}{b-a} \quad \text{for} \quad a \leq z \leq b \ldots\ldots(5)$$

The mean of this density function is

$$u = a + \frac{b}{2}\ldots\ldots.(6)$$

$$\sigma^2 = \frac{(b-a)^2}{12} \quad \ldots..(7)$$

Impulse (salt and pepper) noise: The salt-and-pepper noise is sometimes called impulse noise. An image containing salt and-pepper noise will have dark pixels in bright regions and Bright pixels in dark regions. This type of noise can be caused by dead pixels, analogue-to-digital converter errors and bit errors in transmission. Impulse (salt and pepper) noise:

$$P(z)= \begin{cases} Pa & \text{for } z = a \\ Pb & \text{for } z = b \\ 0 & \text{otherwise} \end{cases} \quad \ldots(8)$$

If ,gray level b will appear as a light dot in the image. If either or is zero, the impulse noise is called unipolar. The bipolar impulse noise also is called as salt and pepper noise.

III. FILTERS IN IMAGE PROCESSING

GUASSIAN FILTER:

a **Gaussian filter** is a filter whose impulse response is a Gaussian filter. Noise is modelled as Additive White

Gaussian Noise (AWGN) where all the image pixels deviate from their original values following a Gaussian curve.

$$G_{(n)} = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-n^2}{2\sigma^2}}$$

For each image pixel with the intensity value O (i, j) (1 _ i _ M, 1 _ j _ N for an M x N image), the corresponding pixel of the noisy image X(i, j) is given by:

$$X_{ij} = O_{ij} + G_{ij}$$

Where, each noise value G (i, j) is drawn from the zero-mean Gaussian distribution.

MEDIAN FILTER:

it is often desirable to be able to perform some kind of noise reduction on an image or signal. The **median filter** is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing.

ADAPTIVE MEDIAN FILTER

In this section a new algorithm is adaptive median filters with Binary Vector (BV). A processing window of size 3x3 may fail to differentiate between noise and detail. Using a median value from a larger window size 5x5 may cause false noise detection and gets blur in the output image. In this variable sized window is used. This filter is to be robust in removing mixed impulses with high probability of occurrence while preserving sharpness.The output that is obtained from the adaptive median filter with binary vector is taken to the Sorted Quadrant Median Vector (SQMV).

SORTED QUADRANT MEDIAN VECTOR

A Sorted Quadrant Median Vector scheme (SQMV) is introduced. In this scheme, a larger window is split up into four sub windows and finds the median value for each sub window, then the median values in the sub windows is sorted and the result vector is called SQMV. It reveals edge and texture information in the larger window. For a larger window W with size (2N + 1) x (2N + 1), we divide the larger window into four sub-windows of size 1).

WIGNER FILTER:

The Wigner distribution gives better auto term localisation compared to the smeared out spectrogram(SP). However when applied to a signal with multi frequency components cross terms appear due to its quadratic nature.

BILLATERAL FILTER:

A **bilateral filter** is a non-linear, edge-preserving and noise-reducing smoothing images. The intensity value at each pixel in an image is replaced by a weighted average of intensity values from nearby pixels.

SWITCHING BILATERL FILTER

In the switching scheme [1], the noise detector searches for noisy pixels in a corrupted image that is given from adaptive median filter. The switching bilateral filter is filtered the noisy samples only to prevent blurred edges or removal of fine details. Suppose the image detail may be falsely treated as the noise. The ordinary noise detector is used to handle this above situation. But the noisy pixel can be interpreted as the image detail and left unchanged. This type of error can produce a negative effect on the output image quality.

A new algorithm had been proposed for switching bilateral filter. Let X_i be the current pixel and $X_{i+s,j+s}$ be the pixel in the window surrounding $X_{i,j}$The SBF is defined as follows

$$U_{i,j} = \frac{\sum_{s=-N}^{N}\sum_{t=-N}^{N} W_G(s,t)W_{SR}(s,t)X_{i+s,j+t}}{\sum_{s=-N}^{N}\sum_{t=-N}^{N} W_G(s,t)W_{SR}(s,t)}$$

IV. SIMULATION RESULTS AND DISCUSSIONS

Design and implementation of this approach is done in MATLAB by using Image Processing Toolbox.

Simulations are carried out on the well known gray scale images(Lena and Ernestine).These images are corrupted by “salt” (with value 255) and “pepper” (with value 0) noise at various noise intensity vary from 10% to 90%. Comparison of performance of ORSMF with standard median filter and SSMF based on various performance parameters like: Mean square error (MSE), Peak signal to noise ratio (PSNR), Mean difference and Bit error rate.

1. Peak Signal to Noise Ratio: Peak signal to noise ratio measure the degree of image distortion. PSNR is used to measure the quality between the original image and compressed image.
PSNR is defined as:

PSNR= 10*Log$_{10}$ (MAX$_I^2$/MSE)

2. Mean Square Error: In image processing mean square error is the most general measure for performance measurement of the existing method and the coded images. It is computed by using equation

$$MSE = \frac{1}{MN}\sum_{I=1}^{M}\sum_{J=1}^{N}(f(I,J) - f'(I,J))^2$$

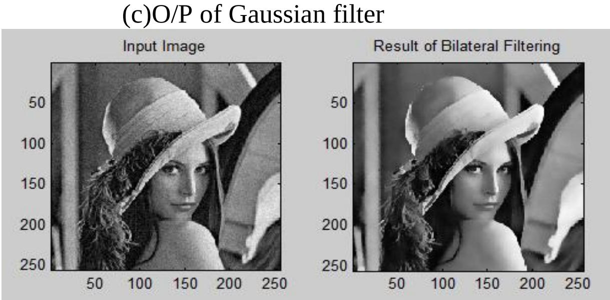
Results for Gray Scale Image

This subsection shows the results for the gray scale image at different noise intensity levels.

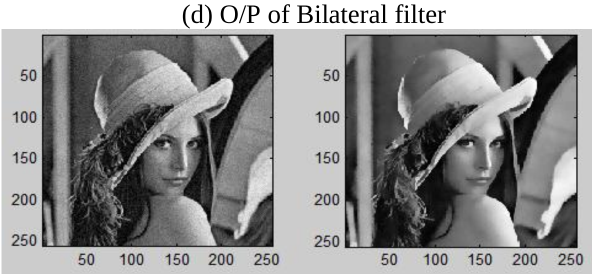
(a)O/P of Winger filter

(b)O/P of Median filter

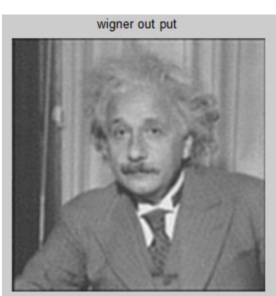
(c)O/P of Gaussian filter



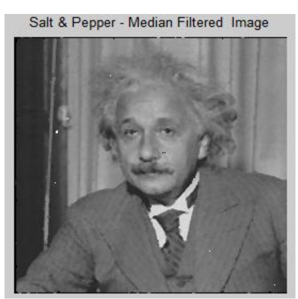
(d) O/P of Bilateral filter



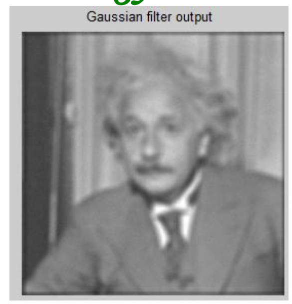
(e) O/P of Switching Bilateral filter



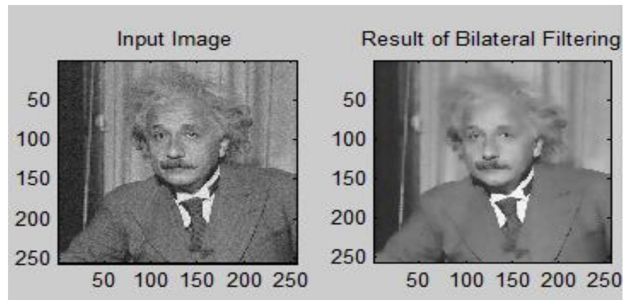
(a)O/P of Winger filter



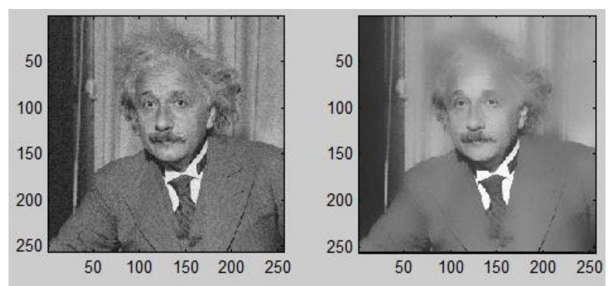
(b)O/P of Median filter



(c)O/P of Gaussian filter



(d) O/P of Bilateral filter



(e) O/P of Switching Bilateral filter

Table1 :LENA IMAGE

FILTER	MSE	PSNR
Switching bilateral	**194.8**	**25.7**
Bilateral filter	**194.2**	**25.32**
Guided filter	**193.9**	**25.29**
Guassian filter	**192.4**	**25.31**
Median filter	**192.2**	**25.29**
Wigner filter	**193.2**	**25.3**
Spatial filter	**193.9**	**25.29**

Table2: EINSTINE IMAGE:

FILTER	MSE	PSNR
Switching bilateral filter	193.2	25.7
Bilateral filter	191.9	25.32
Guided filter	191.0	25.28
Guassian filter	191.1	25.29
Median filter	190.0	25.3
Wigner filter	190.2	25.29
Spatial filter	191.3	25.28

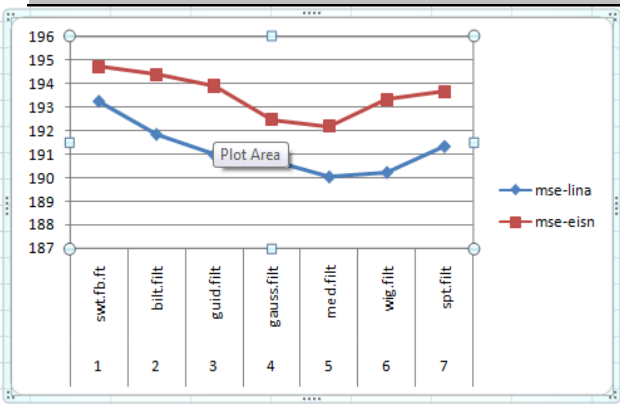


Fig1-MSE curve of filters for Lena and Einstein

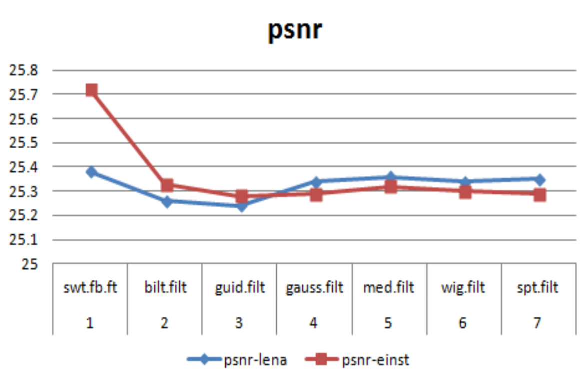


Fig2. Psnr curve curve of filters for Lena and Einstein

IV. CONCLUSION

The major contribution of this paper is to increase the psnr and visually in the noise model cases. In order to increase this ratio proposed the switching bilateral filter having excellent performance in removing the universal noise as well as the increase in the psnr and visually compared to the previous filters. In order to increase this ratio proposed the switching bilateral filter having excellent performance in removing the universal noise as well as the increase in the psnr and visually compared to the previous filters.

REFERENCES

[1] AN ADAPTIVE METHOD FOR NOISE REMOVAL FROM REALWORLD IMAGES"
[2] Vinay Vaidya, C Padole," Night Vision Enhancement using Wigner Distribution", IEEE
[3] 3rd International Symposium on Communications, Control and Signal Processing, 2008., ISCCSP2008, March, pp 1268-1272
[4] Ramesh.s"An efficient approach for removal of universal noise adaptive based switching bilater filter".IEEE 2012
[5] "Performance Study of Edge Detection Operators" International Conference on Embedded Systems - (ICES 2014)
[6] " Edge Detection of Images Using Sobel Operator "International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 1, January 2012) 291
[7] Rashmi , Mukesh Kumar, A.K.Jaiswal, Rohini Saxena"Performance Analysis of Adaptive Canny Edge Detector Using Bilateral Filter". International Journal of Innovative Research in Computer and Communication Engineering *Vol. 1, Issue 4, June 2013*
[8] "Fast and Efficient Algorithm to Remove Gaussian Noise in Digital Images". V.R.Vijaykumar, P.T.Vanathi, P.Kanagasabapathy. IAENG International Journal of Computer Science, 37:1, IJCS_37_1_09
[9] " Removing Noise and Preserving Details with Relaxed Median Filters" ABDESSAMAD BEN HAMZA *Dept. de Matem´atica Aplicada, Universidad de Granada, Spain* PEDRO L. LUQUE-ESCAMILLA
[10] *Dept. de Ingenier´ıa Mec´anica y Minera, Universidad de Jaen, Spain* JOS´E MART´INEZ-AROZA
[11] *Dept. de Matem´atica Aplicada, Universidad de Granada, Spain.* Journal of Mathematical Imaging and Vision 11, 161–177 (1999)