

## An image Denoising Method Based On Multi Resulation Bilateral Filter

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**Abstract**— Bilateral filter is a nonlinear filter and the method image edge information mainly in filtering considers both gray level similarities and geometric closeness of the neighboring pixel without smoothing edges. Based on the study and research of bilateral filter found of the bilateral filter is well suited to image denoising. The bilateral filter is appropriate for color and grey picture filtering system with strong performance. It has appeared to be a successful picture denoising procedure. We can use it to the blocking artifacts reduce. A vital issue with the program with the bilateral filter is the choice of the channel parameters which influence the outcomes essentially. Other hand research interest of bilateral filter is increasing speed of the calculations rate. There are three main efforts of this dissertation. First I will discuss about empirical study of the optimal selection of parameter in image denoising. Here I proposed a development of multi resolution bilateral filter where bilateral filter is used to the low frequency sub-band of a signal decomposed through wavelet filter. Multi resolution bilateral filter combined with wavelet thresholding to develop a new image denoising development which finished up to be very efficient in noise eliminating in real noisy image. Second contribution is a flexible method to reduce compression artifacts for avoid over smoothing texture areas and to effectively eliminate blocking and performing artifacts. In this research first detected the block boundary discontinuities and texture regions these are then use to manage the spatial and strength parameters of bilateral filter. The analyze outcome confirm that the suggested method can improve the quality of renewed image far better than the most preferred bilateral filter. Third part is the development of the fast bilateral filter which is convenience for combination of multiple windows to estimate the Gaussian filter more accurately.

**Keywords**— Bilateral Filter; Image Denoising; Multi Resolution

### I. INTRODUCTION

Different sources of noise can be found in a digital image. For instance, we can tell about dark noise which is generally the cause of thermally generated electrons of at sensing sites. It is highly dependent to the sensor temperature as well as proportional to the exposure time. Another source of noise that forms due to the quantum uncertainty in photoelectron generation is called the shot noise. This noise is characterized by Poisson distribution. Other two types of noises that occur while converting the number of electrons generated to pixel intensities are called amplifier noise and quantization noise. There are many factors those influence the overall noise characteristics in an image. These are – sensor type, temperature, exposure time, pixel dimensions and ISO speed. Noise is in general spatial position and channel dependent.

Image de-noising is an important issue in the field of image processing. It is an important foundation for the other image processing, such as image recognition, understanding. In

accordance with processing domains of the image denoising, the existing algorithms can be divided into two categories: spatial domain ones and transform domain ones [3].

The former ones refer to those who process image pixels directly. While, the later ones need to map the images that are to de-noised to the transform domain, and process them according to the nature of their transform domain coefficients, and finally transform them into space domain. Spatial domain methods include linear spatial filtering and nonlinear spatial filtering. Linear spatial filtering method is also known as mean filtering, which reduce noise in the image through linear filtering. Nevertheless, it will bring in blurry, and the level of blurring is proportional to the extent of the neighborhood radius [4]. Median filter is one of nonlinear spatial filters, and its basic idea is to use middle pixel gray values in the neighborhood instead of the pixel gray values. This algorithm can reduce the level of noise in the premise of preserving edges or textures. Frequency domain filtering methods include Fourier method and wavelet method [5, 6].

Gaussian filter has been widely used in the early denoising applications, but it tends to remove image details (such as textures and edges) in the process of de-noising. So the literature [7] proposed the bilateral filter method to denoise images. In this method, the convolution kernel is also related to inter-pixel colors (grays) besides geometric distances. Bilateral filter can effectively solve the problems of the Gaussian filter that we have discussed above. However, we note that the bilateral filter just adds the two factors (geometric distance factor and color difference factor) simply, resulting in that the color factor plays a decisive role, and the distance factor is ignored in most cases. Therefore, we propose to use the theory of weights to weight the two factors in order to achieve equal status of the two factors.

## II. LITERATURE SURVEY

Although the bilateral filter was first proposed as an intuitive tool, recent papers have pointed out the connections with some well-established techniques. In [20], it is shown that the bilateral filter is identical to the first iteration of the Jacobi algorithm (diagonal normalized steepest descent) with a specific cost function. [21] And [22] relate the bilateral filter with the anisotropic diffusion. The bilateral filter can also be viewed as a Euclidean approximation of the Beltrami flow, which produces a spectrum of image enhancement algorithms ranging from the linear diffusion to the nonlinear flows [23]–[25]. In [22], Buades et al. proposes a nonlocal means filter, where similarity of local patches is used in determining the pixel weights. When the patch size is reduced to one pixel, the nonlocal means filter becomes equivalent to the bilateral filter.

In order to solve the image denoising problem based on bilateral filter this paper contains few parts. In first part I will discuss about the proposed method for image denoising where a multi resolution bilateral filter is applied for real image noise elimination and blocking artifacts reduction and then next part is all about the results of the experiments in image denoising and compression artifacts reduction and finally makes the summary and conclusion.

## III. IMPLEMENTATION

Bilateral filtering algorithm is implemented in following steps are explained in detailed as given in fig 1.

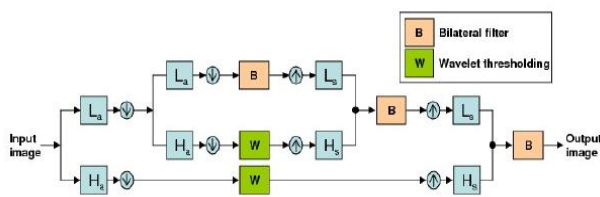


Fig 1: Design steps of bilateral algorithm

As per our previous discussion, it is not necessary that image noise has to be white; it may have different spatial frequency (coarse-grain and fine-grain) characteristics. To eliminate noise in signals, multi resolution analysis is an effective proven tool. Through this, noise and image information can be differentiated better at one resolution level than another. Therefore, we have decided to put the bilateral filter in a multi resolution framework: referring to Figure1, with wavelet decomposition, a signal is decomposed into its frequency sub-bands. In case of, when the signal is reconstructed back, bilateral filtering is applied to approximation sub-bands. The multi resolution bilateral filtering is not like the standard single-level bilateral filtering as it has the potential to remove low-frequency noise components. Bilateral filtering works in approximation up-bands. Additionally, wavelet thresholding can be applied to the detail sub-bands; through this, noise component can be identified and removed effectively. In combination of bilateral filtering and wavelet thresholding this new image denoising framework works.

A bilateral filter is an edge-preserving and noise reducing smoothing filter. Here, the intensity value at each pixel in an image is replaced by a weighted average of intensity values from nearby pixels. And, this weight is based on a Gaussian distribution. Euclidean distance and the radiometric differences (differences in the range, e.g. color intensity) are two things on what the weights actually depend. This systematically preserves edges by looping through each pixel and according weights to the adjacent pixels accordingly which in a result gives a spectrum of images with enhanced algorithms ranging from the L2 linear diffusion to the L1 non-linear flows. In a local neighborhood, the bilateral filter takes a weighted sum of the pixels; this weight depends on intensity distance and spatial distance. Thus the edges are preserved well and noise is also averaged out.

In the following math, at a pixel location  $x$ , the output of a bilateral filter is calculated as-

$$\tilde{I}(x) = \frac{1}{c} \sum_{y \in N(x)} e^{-\frac{\|y-x\|^2}{2\sigma^2 d}} e^{-\frac{\|I(y)-I(x)\|^2}{2\sigma^2 \tau}} I(y) \quad (1.1)$$

In figure 1.1,  $\sigma^2 d$  and  $\sigma^2 \tau$  are the parameters controlling the fall-off of weights in spatial and intensity domains, respectively,  $N(x)$  is a spatial neighborhood of pixel  $I(x)$ , and  $C$  is the normalization constant:

$$C = \sum_{y \in N(x)} e^{-\frac{\|y-x\|^2}{2\sigma^2 d}} e^{-\frac{\|I(y)-I(x)\|^2}{2\sigma^2 \tau}} \quad (1.2)$$

From 1.2 we can see the illustrated 1D bilateral filter. The top right image is the input of noisy signal. The left top

image illustrates the intensity Gaussian; on the other hand, the mid image shows the middle of the special Gaussian.

**Steps for proposed method**

Input: noised image

Output: de-noised image

Convert to grayscale for grayscale mode bilateral filtering

Image decomposition ( $L_a, H_a$ )

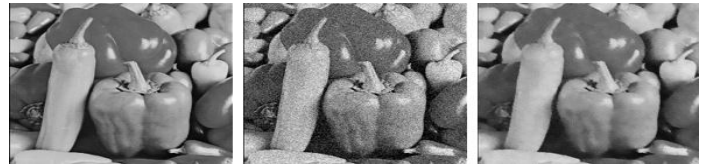
Calculate the weight (distance and intensity) for  $L_a$

decomposed the component ( $L_{a1}, H_{a1}$ ) .

Apply bilateral filtering on  $L_{a1}$  and decompose  $L_{a1}$  . Now compute weights.

Now apply wavelet threshold on  $H_{a1}$  , compose component and calculate weights.

Now compose for bilateral filter and output de-noised image.



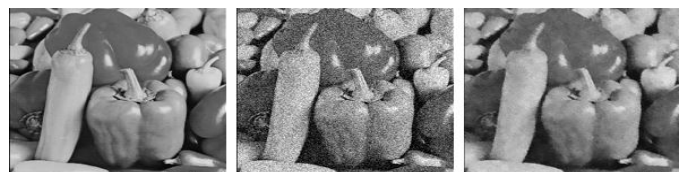
(a) Original Image (b) Noised Image Sigma= 20 (c) Denoised Image



(a) Original Image (b) Noised Image Sigma= 30 (c) Denoised Image



(a) Original Image (b) Noised Image Sigma= 30 (c) Denoised Image



(a) Original Image (b) Noised Image Sigma= 30 (c) Denoised Image

**IV. RESULTS AND DISCUSSION**



(a) Original Image (b) Noised Image Sigma= 20 (c) Denoised Image



(a) Original Image (b) Noised Image Sigma= 20 (c) Denoised Image

**Result Table: 1**

Image	$\sigma_n=20$	$\sigma_n=30$
Peppers	24.9670	24.6703
	22.2279	18.7662
Barbara	24.6615	24.1778
	22.1871	18.7937
Lena	29.0445	27.7501
	22.1511	18.7019

## V. CONCLUSION AND FUTURE SCOPE

In this paper I have designed a scientific analysis of the optimal parameters value for bilateral filter in image denoising and present a multi resolution image framework which is combined with bilateral filter and wavelet threshold. Here I proposed decompose an image in low pass and high pass frequency components and apply bilateral filter method on the approximation sub bands. We got the maximum  $\delta/\tau$  value of bilateral filter is linearly related to the standard derivation of noise. The maximum value of the  $\delta/d$  is relatively separate of the noise power. Outcomes of the result we calculate the noise standard derivation for every level of the sub band decomposition and use a continues several of it for the  $\delta/\tau$  value for bilateral filter.

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