NOVATEUR PUBLICATIONS
International Journal of Research Publications in Engineering and Technology [IJRPET]
ISSN: 2454-7875
VOLUME 3, ISSUE 3, March-2017

ADVANCED FILTERING TECHNIQUES IN IMAGE PROCESSING : A SURVEY

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ABSTRACT:
Nowadays, in the field of image processing so many new technologies are found out and for various purposes such as filtering, edge smoothing, edge sharpening, zooming, enhancing, fusing, noise and blur removing . But these primitive and conventional methods bring some noises and halo artifacts with them as well as they need more time for processing. The algorithms used in these methods are very large and complicated. This method mainly focuses on filtering of images along with image enhancing, image fusion, haze removal and detail enhancement. Weighted Guided Image Filter uses two types of filtering algorithm: First is Global Filtering and second is Local Filtering. Therefore, it makes filtering process easy, less complicated and less time consuming.
KEYWORDS: Haze removal, exposure fusion, weighted guided image filtering, detail enhancement, edge aware weighting, and halo artifacts.

I. INTRODUCTION:

Digital image processing is becoming very crucial tool in every field of science. The field may be medical imaging, film making or study of earth, study of cosmic atmosphere. This requires better image clarity, smooth edges, enhanced vision [14]. This Weighted Guided Image Filter deals all of these and basically edge preserving filtering.

The method of noise removal is classified into two types : Global filters and second is Local filtering. In global filters, the performance criteria consist of a data term and a regulation term. Local filters include bilateral filters, trilateral filters and gradient filters [4],[5].

Here, edge aware weighting is introduced. In edge aware weighting, edges play very important role in vision of objects [6]. Heavy weights are assigned to pixels at edges than those pixels which are at flat areas. Due to this proposed weighting technique, sharp edges are saved and smoothened for better resolution and vision[8].

II. RELATED WORKS ON EDGE-AWARE WEIGHTING TECHNIQUES:

In this section, various edge preserving techniques are discussed. This section establishes base for the proposed work of edge-aware weighting technique. While dealing with the reconstruction of an image, it is necessary to regularize the solution. A simple regularization process assumes that pixels in the image are equally distributed. A practical model of an image assumes that images are made up of smooth regions separated by sharp edges, this is called edge preserving regularization[1].

A. REGULARIZED IMAGE RECONSTRUCTION:

Char bonnier et al proposed method of regularization of images[1]. The image and the auxiliary variables are either assumed as N×N two dimensional fields indexed by i(row number) and j(column number) or denoted as $N^2 \times 1$ exicographically ordered vectors indexed by k. The index transformation between the two representations is,

$$k = i \times N + j \ [1].$$

In the field of computed imaging, the observed data is related to the original image by the following relation :

$$p = R f + \eta \qquad (1)$$

where,
p is observed data, f is original image, R is block Toeplitz and represents the point spread function of the imaging system[2], η is white Gaussian noise[14]. Before the evolution of edge-aware techniques of image filtering, images are restored by using equation(1). This equation preserves edges therefore it is called as deterministic edge preserving regularization. But this reconstructed image contains noise and halo artifacts. Sharp edges involved in the image create obstacle in the smooth vision. Therefore, smoothing and filtering is very essential for clear and enhanced vision.

B. FILTERING TECHNIQUES:

As mentioned before, performing filtering and smoothening is very important for clear vision. There are some classifications of filtering techniques such as bilateral filtering, trilateral filtering, gradient minimization for smoothing. These are given in brief as below:

1. IMAGE SMOOTHING VIA L_0 GRADIENT MINIMIZATION:

This method is related to edge-preserving smoothing which aims to maintain and improve prominent set of edges. In this method, a sparse gradient counting scheme in optimization framework is proposed[3]. The different techniques such as 1D and 2D smoothing. These both techniques are explained in brief as below :

A. 1D smoothing

In 1D smoothing, highest contrast edges are enhanced and smoothing is done in global manner. L. Xu et al had given the method of 1D smoothing where input discrete signal is denoted by g and its smoothed signal is denoted by f. This method counts amplitude changes and is given as,

$$c(f) = \#\{p \mid | f_p - f_{p+1}| = 0\},$$

where p and p + 1 index neighboring samples. $| f_p - f_{p+1}|$ is a gradient w.r.t. p in the form of forward difference. #{} is the counting operator, outputting the number of p.

B. 2D formulation

In 2D formulation, the color difference between two pixels is calculated along x and y directions. The gradient magnitude for color images is given as the sum of gradient magnitude in rgb. Farbman et al has given the solver for 2D formulation [2008].

2. BILATERAL FILTERING:

Bilateral filtering preserves edges and smoothes images in the same way as that of human perception[5]. Bilateral filtering is a non iterative and simple method of filtering. This scheme of bilateral filtering can be carried out by simple neuron like devices which perform their operation once per image. In bilateral filtering, three bands are filtered separately because different bands have different levels of contrast[10].

Therefore, bilateral filters can operate three bands at once. Bilateral filters do the same work in the image range which traditional filters do their work in its domain. The combination of range filtering and domain filtering gives excellent filtration and hence called as bilateral filtering. In bilateral filtering, a low pass filter is applied and then the value of a pixel is replaced by an average and similar nearby pixel values.

Suppose, a low pass filter is applied to image f(x) which produces output image,

$$h(x) = k_d^{-1}(x) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(\xi)\, c(\xi, x) dx \qquad (2)$$

where, c(ξ,x) denotes the geometric closeness between nearby centre x and neighborhood point ξ. The range filter is defined as,

$$h(x) = k_r^{-1}(x) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(\xi) s[f(\xi), f(x)] d\xi \qquad (3)$$

where, function 's' operates in the range of the image function 'f' . Then, combined filtering is defined as,

$$h(x) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(\xi)\; c(\xi, x)\; s[f(\xi), f(x)]\; dx \qquad (4)$$

with the normalization,

$$k(x) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} c(\xi, x)\; s[f(\xi), f(x)] d\xi \qquad (5)$$

This combined filter in equation (5) is called as bilateral filter. This bilateral filter is used for noise reduction, removal of halo artifacts and blur. A grid can be added in the bilateral filter for better enhancement and clear vision. These both techniques are involved in the invention of trilateral filters.

3. TRILATERAL FILTERING:

Trilateral filtering is advanced type of filtering as compared with bilateral filtering. It is a single-pass non linear filter used in edge preserving algorithms for better vision and gives stronger noise reduction. This trilateral filter is built from bilateral filter of C. Tomasi and R. Manduchi [5].

Trilateral filter requires only one user set parameters and filters the image in only one pass[4]. It does not require an iterative solver for filtering. The trilateral filter given by P.Choudhary and Tumbline consists of two modified bilateral filters. Its novel contributions given by them are :

(a) Tilting : Filter window is skewed by bilaterally smoothed image gradient vector.

(b) Adaptive region growing : The domain automatically adapts to local image features.

(c) One parameter : Trilateral filter uses only one parameter for filtering.

These three novel contributions come together to form the trilateral filter with adjustable parameters. Trilateral filters give high noise reduction, better vision, mesh smoothing, HDR tone mapping[11],[13]. Trilateral filtering has the ability to separate details from noisy input image. These bilateral and trilateral filters are used in weighted image guided filter algorithm.

4. REAL TIME EDGE PRESERVING:

Edge preserving image processing is a new technique of filtering the image[6]. In this technique, edges of the images are preserved and smoothed with the help of bilateral grid. J.Chen and team has given the technique for fast filtering and edge preserving.

The bilateral grid used in this technique is defined as, a 3D array that combines two-dimensional spatial domain with one-dimensional range domain. The bilateral grid is first appeared in Paris and Durand's fast bilateral filter [2006].

Bilateral grid is sampled continuously in each domain, let us consider, the sampling rate of the spatial axes as S_s and the sampling rate of range axis as S_r. Then bilateral grid given by J. Chen and team is as follows,

(a) Initialization :

For all grid nodes (i, j, k), Γ(i, j, k) = (0,0)

where, I is the input image and Γ is the constructed bilateral grid.

(b) Filling :

For each pixel at point (x,y),

$$\Gamma\left([x/S_s], [y/S_r], [I(x,y)/S_r] \right) = \left(I(x,y), 1\right),$$

where [.] is the closest integer operator.

(c) Processing :

Any function f which is able to take 3D function as input can be applied to this grid. The grid processing stage of bilateral filter is convoluted by a 3D Gaussian kernel. After processing, the next stage is slicing. The grid is sliced using the input image I to obtain final output which in 2D form.

This bilateral grid is used to enhance the contrast of the images which is an essential tool in High Dynamic Range images.

The contrast of the image can be enhanced by adjusting the histogram of that image. This real time edge preserving technique can be applied for the purpose of progressive abstraction which is very important in the medical field nowadays.

5. GUIDED IMAGE FILTER:

Conventional methods of filtering include Linear Translation Invariant such as Gaussian, Laplacian and Sobel filters[9],[14]. But there are some drawbacks of these filters. A new technique is discovered to overcome these drawbacks and it is Guided Image Filter[7]. Guided image filter has good edge preserving properties and does not involve reverse gradient artifacts. Various edge preserving techniques are classified into explicit weighted average filters and implicit weighted average filters. Guided image filter have combined properties of these two.

A general linear translation filtering process is known as guided image filter and involves guidance image, filtering input image and output image. And hence it is widely used in advanced filtering techniques.

III. CONCLUSION:

In this paper, various techniques of filtering, edge preserving, smoothing, noise removing, enhancing and compression are discussed in brief[8]. Weighted guided image filtering is the most advanced technique of noise removal, image fusion, contrast adjustment[15]. Weighted guided image filter uses primitive techniques of image filtering and combines them for better results.

This survey shows how weighted guided image filter is the better option for image processing[7]. Conventional techniques of image processing require more time for processing and large calculations, equations. But, weighted guided image filter has less running time and less complicated algorithm as compared with primitive techniques. Therefore, it is becoming a widely used tool in the field of image processing.

IV. ACKNOWLEDGMENT:

First and foremost, I would to thank my academic advisor Mr. V . S. Kolkure for guiding and helping me with his great subject acknowledgment. During my tenure, he contributed to a rewarding experience by giving me intellectual freedom in my work, engaging me in new ideas and demanding high quality work in all my endeavors.

A number of people have generally given helpful comments, during the preparation of the manuscript and cooperation. I also thank our Principal for showing positive response to encourage me. I also thank to all direct and indirect help provided by the staff and the entire batch mates for their enthusiasm and great ideas.

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