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Guided Filter for Color Image

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Abstract: Image Enhancement is one of the most important and difficult techniques in digital image Processing. Image Enhancement is used for improving the quality. Many images like medical images, satellite images and real life photographs suffer from poor contrast and noise. It is necessary to enhance the contrast and remove the noise to increase image quality. Filtering is mostly used for enhancement and smoothing of input image. But in some edge preserving filtering technique gradient distortion and artifacts are observed. To resolve these problem guided filter is used. Guided filter is non-iterative, fast, accurate edge preserving filtering. The guided filter computes the filtering output by considering the content of a guidance image, which can be the input image or another different image. Guided filter uses the color images for implementation because color guidance image can better preserves the edges that are not distinguishable in gray-scale. Guided filter simulation done using MATLAB.

Keywords: FPGA, Guided filter, Image Enhancement, MATLAB

I. INTRODUCTION

Image processing is processing of image using mathematical operation. Input for image processing image, series of image and video. Digital image processing is the use of computer algorithm to perform image processing on digital image. In digital processing pre processing, enhancement, information extraction is done. In processing time many images are affected by random variation in intensity or sometimes environmental parameter affect the images. During transmission images introduces the noise so filtering is used for noise reduction. More specifically, filtering can be applied in many applications such as noise reduction, texture editing, smoothing, enhancement, haze removal, and joint up-sampling. Filtering is the most important image processing techniques used for image feature extraction or enhancement. Filtering is mostly used for enhancing and smoothing the input image.

Image enhancement is used in many applications like forensics, atmospheric sciences, medical images, microbiology. Image enhancement improves the quality of image. Image enhancement involves four parameters likes brightness, contrast, saturation, sharpness. Brightness is can be modified by increasing by gamma. Gamma is a non-linear form of increase in brightness. Contrast is the separation between the dark and bright areas of an image. Saturation is increasing the separation between the shadows. Sharpness is related to edges, the contrast along the edges of a photo.

The enhancement methods are divided into spatial domain and frequency domain method. Spatial domain technique is directly deal with the image pixels. In spatial domain for getting desired output the pixel vales are manipulated. In frequency domain techniques, the image is first transferred s into frequency domain. It means that, the Fourier Transform from the image is computed first. Every one of the enhancement operations are performed for the Fourier transform of the specific image and then reverse Fourier transform is performed to get the concomitant image. The most common benefit of image smoothing is to remove the noise from the image. Different edge preserving image smoothing methods are used for preserving the important features or structures or salient edges in the image, so as to lead the improvement in the visual quality of the image. This is a method for edge preserving smoothing, which is related to the previous methods like bilateral filter and fast bilateral filter for the display of high dynamic range images signal processing approach, edge preserving decompositions, multi-scale image decomposition based on local extreme, histogram based image smoothing, L0 gradient minimization.

Mean filtering is easy to implement. It is used as a method of smoothing images, reducing the amount of intensity variation between one pixel and the next resulting in reducing noise in images. For simulation of guided filter Matlab is used. Matlab is set of numerical analysis and high-performance computing software.

Matlab language provides for matrix arithmetic operators, relational operators, logical operators, conditional operators and assignment operator. Matlab is high level language. It gives simple programming. Matlab is easy to use and flexible. System generator is used for model generation in Matlab.

II. RELATED WORK

In fact, each captured image contains noise. Due to various interferences, noise, the image definition gets bad influence. At the same time, noise making the image blurred. The bad condition was submerged fully. It gives analysis big difficulty. Therefore, people need to suppress unwanted noise to improve image quality. For digital image noise reduction, the basic filtering algorithms are used. It includes mean filtering, median filtering, Gaussian filtering, bilateral filtering. In Gaussian filter is sums all the small values taken and average of those values also these average value is assign to the pixel. The bilateral

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filter is perhaps the simplest and most intuitive one among explicit weighted average filters. It computes the filtering output at each pixel as the average of neighboring pixels, weighted by the Gaussian of both spatial and intensity distance. Bilateral filter is non-linear, edge preserving, noise reducing and smoothing filter. Bilateral filter has some major disadvantages. The bilateral filter suffers from gradient reversal artifact.

Another disadvantage is that it uses histogram based approximation to calculate weights. It has more computational complexity. Non average Filters Edge-preserving filtering can also be achieved by non average filters. The median filter is a well known edge aware operator, and is a special case of local histogram filters. Median filter is very effective in removing salt and pepper or impulsive noise. But median filter having disadvantages like computational complexity, non linear filter.

VLSI architecture design of guided filter is discussed in [1]. In this double integral image architecture proposed for guided filter. Guided filter is implemented using ASIC design. This system reduced gate count and on chip memory. It gives better performance than other filter. In this guided filter can save hardware cost without the loss in quality.

Guided filter is discussed in [2]. In this guided filter is derived from a local linear model, the guided filter computes the filtering output using guidance image, which can be the input image or another different image. It avoids the gradient reversal artifacts that may observe in detail enhancement and HDR compression.

III. SYSTEM ARCHITECTURE

Guided image filter is proposed that performs edge-preserving smoothing on an image, using the content of the second image i.e. the guidance image, in order to influence the filtering. The guidance image can be the image itself, a different version of the image or a completely different image. If the guidance image is same as the input image to be filtered, the structures are the same i.e. an edge in original image is the same as in the guidance image.

Guided image filtering is one of the spatial domain enhancement technique in which the filtering output is locally a linear transform of the guidance image. It takes into account the statistics of a region in the corresponding spatial neighborhood in the guidance image while calculating the value of the output pixel. Guided filter has good edge-preserving smoothing properties and does not suffer from the gradient reversal artifacts that are seen when using bilateral filter.

It can perform better at the pixels near the edge when compared to bilateral filter. The guided filter is also a more generic concept beyond smoothing. By using the guidance image, it makes the filtering output more structured and less smoothed than the input. It can transfer the structures of the guidance image to the filtering output, enabling new filtering applications such as dehazing and guided feathering. Also, guided filter adopts the fast and non-approximation characteristics of linear time algorithm and provides an ideal option for real time applications in case of HD filtering. Hence, it is considered to be one of the fastest edge preserving filters.

Guided filter generally has an O(N) time (in the number of pixels N) exact algorithm for both gray scale and color images, regardless of the kernel size and the range of intensity. O(N) time represents that the time complexity is independent of the window radius(r) and hence arbitrary kernel sizes can be used in the applications.

A. Guided Filter Algorithm

Here we are considering filtering input image as p, guidance image as I, regularization as ε, and filtering output as q.

1. Reading image pixels.
2. Passing them to 5x5/3x3 line buffers. Here, any window size can be chosen. BRAM and slice register usage is increased with large widow size.
3. Getting all window pixels.
4. Applying averaging filter (f_{mean}) on guidance and input image and also finding correlation (corr) as shown below:

$$mean_I = f_{mean}(I)$$
$$mean_p = f_{mean}(p)$$
$$corr_I = f_{mean}(I .* I)$$
$$corr_{Ip} = f_{mean}(I .* p)$$

5. Computing the covariance by using obtained mean and correlation values:

$$cov_{Ip} = corr_{Ip} - mean_I .* mean_p$$

6. Computing the variance

$$var_I = corr_I - mean_I .* mean_I$$

7. Computing the linear coefficients a & b by using obtained covariance, variance, mean values.

$$a = cov_{Ip} ./ (var_I + \epsilon)$$
$$b = mean_p - a .* mean_I$$

8. Computing mean of linear coefficients a and b

$$mean_a = f_{mean}(a)$$
$$mean_b = f_{mean}(b)$$

9. Calculating the filtered image by using the calculated mean values of linear coefficients a and b:

$$q = mean_a .* I + mean_b$$

IV RESULT AND DISCUSSION

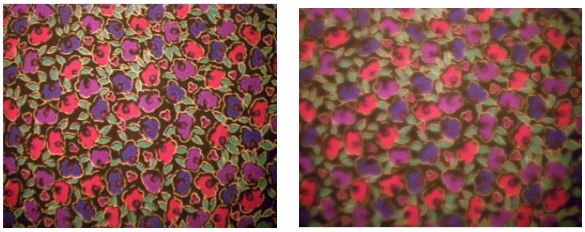
Guided filter is fast and accurate filter. Guided Filter gives smoothen image and enhanced image. Guided Filter algorithm is simulated in MATLAB which is shown in Fig.1. Smoothen and enhance image. Guided filter gives the higher quality image.

(a)Input Image

(b) Smoothen Image

(c)Enhanced Image

Fig.1. Output of Guided filter algorithm in MATLAB (a) Input Image (b) Smoothen Image (c)Enhanced Image



(a)Input Image (b) Smoothen Image

(c) Enhanced Image

Fig.2. Output of Guided filter algorithm in MATLAB (a) Input Image (b) Smoothen Image (c) Enhanced Image

V. CONCLUSION

In this paper, we have presented a novel filter which is widely applicable in computer vision and graphics. Guided filter smooth image and enhance the image and gives the high quality image. Guided filter Algorithm is Simulated in MATLAB. The edge preserving guided filter will be implemented which is based on color images because color guidance image can better preserve the edges that are not distinguishable in gray-scale.

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