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REAL TIME IMPLEMENTATION OF GUIDED FILTER

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Abstract -The real time implementation of guided filter highlights the implementation of Guided filter for image and video using VLSI hardware incorporated with real time application. The filter implementation is done with the use of guided image as reference image. A 30 frames/second video is given as input to this architecture and is separated into frames. These frames undergo preprocessing, noise analysis, smoothing of noisy pixels, and enhancement of edge level pixels by using MATLAB. Both color images as well as gray images are simulated by reformation of parameters in the guided filter formulae. Here the double integral image hardware architecture for the guided filter is proposed using FPGA controller by making use of Xilinx Platform Studio and Visual Basic.

The guided filter simulation done using MATLAB is extended to build an architecture using Xilinx Platform Studio and FPGA Controller. With the help of the hardware implementation using FPGA there will be additional benefits like better performance at edges and suppression of color noise while preserving edges. This structure can support full HD 30 frames/second at a reduced gate count and chip memory. Guided filter is the ideal option since it performs better at the edges and suppresses color noise while preserving structures and as a result it is widely adopted in the field of computer vision and computational photography.

Index Terms-Guided filter, VLSI, Bilateral filter, Joint Bilateral filter, Double Integral Image architecture.

I. INTRODUCTION

In image processing it is usually necessary to perform high degree of noise reduction in an image before performing higher-level processing steps. Digital images may be contaminated by different sources of noise. The imperfections in instruments used in image processing, difficulties with the data acquisition process, and interference lead to this unwanted noise generation. So we implement filters to reduce this distraction caused during image processing [2].

Most applications in computer vision and computer graphics involve the concept of image filtering to reduce noise and extract useful image structures. It is also essential for the researches in the areas of Science and Technology such as geographical information systems and astronomy. So inorder to reduce this noise based on smoothing and enhancement we implement guided filtering. The guided filter has an O(N) time (in the number of pixels N) exact algorithm for both gray-scale and color images. And this process could be implemented in real time process based on hardware implementation by using controller as FPGA.

Filtering is an image processing technique widely adopted in computer vision, computer graphics, computational photography, etc. More specifically, filtering can be applied in many applications such as noise reduction, texture editing, detail smoothing/enhancement, colorization, relighting tone mapping, haze/rain removal and joint up sampling[11], [13].

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The most popular technique is the edge-preserving bilateral filter [1],[8] and application of bilateral filter to image noise reduction and Durand [6] used bilateral filter on high dynamic range (HDR) images. Based on bilateral filter, joint bilateral filter is developed in flash/no-flash denoising [15] used joint bilateral filter for upsampling problems. For a bilateral filter, real-time implementation usually adopts histogram-based approximation due to its computation efficiency and memory concern [16]. Guided filter has the non-approximation characteristic and offers an ideal option for real-time filter applications on HD videos.

II. PROPOSED SYSTEM AND SIMULATION

A novel explicit image filter called guided filter computes the filtering output by considering the content of a guidance image, which can be the input image or any other different image [11]. The guided filter can be used as an edge-preserving smoothing operator like the popular bilateral filter [4], but has better behaviors near edges. The guided filter naturally has a non-approximate and fast linear time algorithm, in spite of the kernel size and the intensity range. Currently it is one of the fastest edge-preserving filters. At first, a general linear translation is defined. That is, a variant filtering process, which includes a guidance image I, an input image p, and output image q is defined. Both I and p are provided before and they can be identical. The filtering output at a pixel I is expressed as a weighted average:

$$Qi = \sum j \; Wij \; (I) \; Pj$$

where i and j are pixel indexes. The filter kernel Wij is a dependent on the guidance image I and independent of p. This filter is linear according to p. The guided filtering kernel Wij is given by:- Wij(I)=) (5) Where I is guidance image, p is input image, q is output image, Wij is filter kernel, is variance, Ki is normalizing parameter, Wk is window centered at pixel k and is mean of I. Moreover, the guided filter has a non-approximate and fast linear-time algorithm, whose computational complexity is independent of the filtering kernel size.

BLOCK DIAGRAM

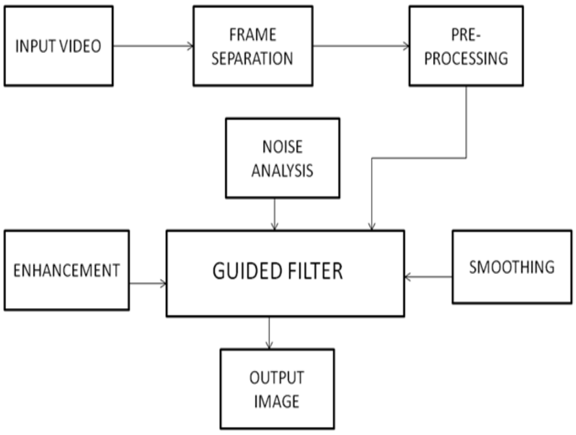

Figure 1: Block Diagram

The methodology starts with inputting a video of avi format into the matlab. This video is then indulged in frame separation into images of jpg or bmp format. It is then preprocessed and then by the analysis using matlab functions noise removal is done; that is by the use of guided filter. This part of input is then dealt with image smoothing, and image enhancement functions to get most accurate output image in the same jpg or bmp format. This is a non-iterative process with no gradient distortion [7], [14]. This filtering is fast and accuracy efficient. The next step is to build a hardware implementation using Xilinx Platform Studio and FPGA.

IMAGE SMOOTHING

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 .

Our method is based on the L0 gradient minimization method. This method globally control total number of non-zero gradients between pixels to enhance the prominent edges.

IMAGE ENHANCEMENT

Image enhancement improves the quality of images for human viewing. It basically improves the interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer. The choice of attributes and the way they are modified are specific to a given task. Moreover, observer-specific factors, like the human visual system along with the observer's experience, will introduce a great deal of subjectivity into the choice of image enhancement methods.

Removing blurring, noise revealing and increasing contrast details are examples of enhancement operations. The image enhancement methods can broadly be divided in to the following two categories: Spatial Domain Methods and Frequency Domain Methods. In spatial domain techniques, the pixel values are manipulated to achieve desired enhancement. In frequency domain methods, the image is first transferred in to frequency domain. All the enhancement operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image.

III. RESULTS AND DISCUSSION

An input video named ‘input 1’ is inputted and it is separated into frames and is saved in a folder. Out of the images in the folder, MATLAB provides an option to select a frame. This frame is smoothed and enhanced separately. The input video selected: ‘inp1(3).avi’ as per Figure 2. The input video selected is separated into frames and these frames are to undergo guided filtering, smoothing and enhancement. The frames are saved in a folder separately. Out of the frames , one is selected.

Figure 2: Selected Image

The selected image from the group of frames is filtered using guided filtering. This image is smoothed for removal of noise 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 which is shown in Figure 3.

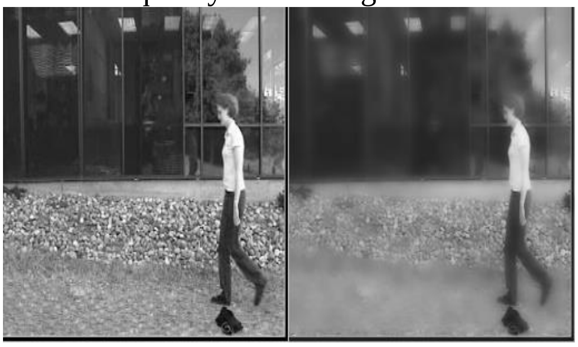

Figure 3: Smoothed Image

The image which is smoothed also undergo enhancement procedure that is illustrated in Figure 4 inorder to remove noise and blurring and to reveal details and improve contrast. Enhancement operations are performed in order to modify the image brightness, and the distribution of the grey levels.

Figure 4: Enhanced Image

IV. SUMMARY

Guided filtering is a widely adopted in computer vision and computational photography[5], [10]. The previously used filters like bilateral and joint bilateral filters have limitations in case of requirement of gate counts and chip memory. As a result, guided filters reduce the need of higher gate counts as well as chip memory. Guided filter is famous for delivering high throughput, saving hardware cost without loss in quality. The previous papers demonstrates that guided filter with an architecture improved the easiness of noise analysis and improved video quality [3], [9], [12]. The new modifications and innovations in this architecture scheme lead to fast and even better filtering approaches. The guided filter simulation done using MATLAB is extended to build an architecture using Xilinx Platform Studio and FPGA Controller.

V. FUTURE DEVELOPMENTS

With the help of the hardware implementation using FPGA there will be additional benefits like better performance at edges and suppression of color noise while preserving edges. The guided filter architecture makes it able to work on non iterative process with no gradient distortion that provides fast and accurate results in real time. This structure can support full HD 30 frames/second at a reduced gate count and chip memory. Applying the proposed architecture to an RGB-guided filter is the primary future work of this paper.

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