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A Review: Bilateral Filter for Real Time Image De-noising

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ABSTRACT: Bilateral filtering has gained a high awareness level in medical image processing and non-destructive testing. Bilateral filtering method is that it allows for considering both the spatial locality and neighbouring points with similar amplitudes at the same time which make it can better preserving the image edges and textures than the conventional linear filtering algorithms. This paper illustrates the survey of Adaptive Bilateral Filter (ABF), Local Tone Mapping(TM), and Lazy Sliding Window for SIMD Architectures, Histogram-Based Bilateral Filtering (BF), FPGA Vision and SNRP Network Protocol, Pulse Coupled Neural Network (PCNN). In this paper a spatially adaptive bilateral filtering image de-noising algorithm with low computational complexity is proposed.

KEYWORDS: Bilateral filter, image processing, non-destructive testing

I.INTRODUCTION

Bilateral filtering has popular in image processing due to its capability of reducing noise while preserving the structural information of an image. The detail-preserving property of the filter is mainly caused by the nonlinear filter component .It selects the pixels of similar intensity which are averaged by the linear component afterward. The amount of noise reduction via selective averaging and the amount of the blurring via low-pass filtering are both adjusted by two parameters. There are many applications in image processing such as Contrast Management, Depth Reconstruction, Data Fusion, 3D Fairing where it is important to remove noise in the images before these subsequent processes. Thus various techniques for removing noise in images are described in this paper.

Bilateral filtering algorithm is a non-linear and non-iterative image de-noising method in spatial domain which utilizes the spatial information and the intensity information between a point and its neighbours to smooth the noisy images while preserving edges well. The bilateral filter is chosen for one unique reason: It reduces noise while preserving details. The design is described on register-transfer level. The distinctive feature of this design concept consists of changing the clock domain in a manner that kernel-based processing is possible, which means the processing of the entire filter window at one pixel clock cycle. This feature of the kernel-based design is supported by the arrangement of the input data into groups so that the internal clock of the design is a multiple of the pixel clock given by a targeted system. The bilateral filter embodies the idea of a combination of domain and range filtering. The domain filter averages the nearby pixel values and acts thereby as a low-pass filter. The range filter stands for the nonlinear component and plays an important part in edge preserving. This component allows averaging of similar pixel values only, regardless of their position in the filter window. If the value of a pixel in the filter window diverges from the value of the pixel being filtered by a certain amount, the pixel is skipped.

The rest of the paper is organized as follow; the section II describes literature survey in short. Section III illustrates the different noise removal techniques. Section IV describes proposed technique for image de-noising. Conclusion and references are described in section V.

II. LITERATURE SURVEY

Many researchers have worked on image de-noising techniques. The adaptive bilateral filter (ABF) for sharpness enhancement and noise removal is presented [2]. A noise reduction method and an adaptive contrast enhancement for local tone mapping (TM) is presented[3].The proposed local TM algorithm compresses the luminance of high dynamic range (HDR) image and decomposes the compressed luminance of HDR image into multi-scale sub bands using the discrete wavelet transform . A parallel version of the bilateral filter using a lazy sliding window, suitable for SIMD-type architectures is presented [4]. An efficient and scalable design for histogram-based bilateral filtering (BF) and joint BF (JBF) by memory reduction methods and architecture design techniques to solve the problems of high memory cost, high computational complexity, high bandwidth, and large range table is presented [5]. A pulse-coupled neural network (PCNN) with multichannel (MPCNN) linking and feeding fields for colour image segmentation is presented [6]. Different from the conventional PCNN, pulse-based radial basis function units are introduced into the model neurons of PCNN to determine the fast links among neurons with respect to their spectral feature vectors and spatial proximity. Objective methods for assessing perceptual image quality traditionally attempted to quantify the visibility of errors (differences) between a distorted image and a reference image using a variety of known properties of the human visual system [7].

III. IMAGE DENOISING TECHNIQUES

Various methods for image de-noising are conferred as follow.

1.	Adaptive Bilateral Filter (ABF)
2.	Local Tone Mapping (TM)
3.	Lazy Sliding Window for SIMD Architectures
4.	Histogram Based Bilateral Filtering (BF)
5.	Pulse Coupled Neural Network(PCCN)
6.	Image Quality Assessment

Table. 1. Methods for image de-noising.

1) ADAPTIVE BILATERAL FILTER (ABF)

Image restoration aims to recover a high-quality original image from a degraded version of that image given a specific model for the degradation process. This is in contrast to image enhancement techniques that improve the appearance of an image without reference to a specific model for the degradation process. The ABF sharpens an image by increasing the slope of the edges without producing overshoot or undershoot. It is an approach to sharpness enhancement that is fundamentally different from the unsharp mask (USM). This new approach to slope restoration also differs significantly from previous slope restoration algorithms in that the ABF does not involve detection of edges or their orientation, or extraction of edge profiles. In the ABF, the edge slope is enhanced by transforming the histogram via a range filter with adaptive offset and width. The ABF is able to smooth the noise, while enhancing edges and textures in the image. The parameters of the ABF are optimized with a training procedure. ABF restored images are significantly sharper than those restored by the bilateral filter. Compared with an USM based sharpening method—the optimal unsharp mask (OUM), ABF restored edges are as sharp as those rendered by the OUM, but without the halo artifacts that appear in the OUM restored image. In terms of noise removal, ABF also outperforms the bilateral filter and the OUM. ABF works well for both natural images and text images [2].

2) LOCAL TONE MAPPING (TM)

Tone mapping (TM) is a method that maps high dynamic range (HDR) image to low dynamic range (LDR) image for display devices with limited dynamic range (DR).TM algorithms have been developed for reproducing the tone mapped colour image, in which colour, contrast, and detail components are enhanced using luminance compression and colour reproduction by considering the human visual system or the local statistical characteristic.The local TM algorithm compresses the luminance of high dynamic range (HDR) image and decomposes the compressed luminance of HDR image into multi-scale sub bands using the discrete wavelet transform. For noise reduction, the decomposed images are filtered using a bilateral filter and soft-thresholding. And then, the dynamic ranges of the filtered sub bands are enhanced by considering local contrast using the modified luminance compression function. Finally, the colour of the tone-mapped image is reproduced using an adaptive saturation control parameter. The tone-mapped image using the proposed local TM is generated. Computer simulation with noisy HDR images shows the effectiveness of the proposed local TM algorithm in terms of visual quality as well as the local contrast. It can be used in various displays with noise reduction and contrast enhancement. In local TM algorithm, the decomposed sub bands are filtered using a de-noising

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filter, which consists of bilateral filtering and soft-thresholding. The LL sub band (low-frequency sub band) is filtered using the bilateral filter, whereas LH, HL, and HH sub bands (high-frequency sub bands) are smoothed using soft-thresholding for effective noise reduction [3].

3) LAZY SLIDING WINDOW FOR SIMD ARCHITECTURES

An efficient implementation of the bilateral filter on parallel architectures of digital signal processors is presented. The fact that the bilateral filter applies the same processing at every pixel makes it especially suitable for single instruction multiple data (SIMD) type processors, such as many modern DSPs and multimedia extensions in many general purpose CPUs (e.g., Intel SSE). A special type of raster scan referred to as the lazy sliding window, which allows performing bilateral filtering in a manner efficient both in storage and the number of computations is presented [4].

4) HISTOGRAM BASED BILATERAL FILTERING (BF)

Presents memory reduction methods exploit the progressive computing characteristics to reduce the memory cost to 0.003%–0.020%, as compared with the original approach. Furthermore, the architecture design techniques adopt range domain parallelism and take advantage of the computing order and the numerical properties to solve the complexity, bandwidth, and range-table problems. The example design with a 90-nm complementary metal–oxide–semiconductor process can deliver the throughput to 124 Mpixels/s with 356-K gate counts and 23-KB on-chip memory [5].

5) PULSE COUPLED NEURAL NETWORK (PCCN)

Object detection and recognition are natural capabilities of human beings but are tremendous challenges to implement using artificial systems. Different from the conventional PCNN, pulse-based radial basis function units are introduced into the model neurons of PCNN to determine the fast links among neurons with respect to their spectral feature vectors and spatial proximity. The computing of the colour image segmentation can be implemented in parallel on a field-programmable-gate-array chip. Furthermore, the results of segmentations are applied to an object-detection scheme. The typical PCNN model is confined to the processing of gray scale images. One of the reasons is that the essence of its interneuron coupling is defined in terms of products of scalars. For pixels featured with colour vectors, the relationship between the timing of a pulse and a pixel's feature will no longer be scalar to scalar. Another reason is the computational burden of the algorithm. A typical PCNN is a 2-D or 3-D array of neurons with one-to-one pixel-to-neuron correspondence. Including its complex dynamics and multiple interneuron coupling, the computation will be undoubtedly time consuming for colour images if executed in sequential codes. Recently, some modified PCNNs are reported to be applied to multichannel image fusion and real-time path planning [6].

6) IMAGE QUALITY ASSESSMENT

Under the assumption that human visual perception is highly adapted for extracting structural information from a scene, an alternative complementary framework for quality assessment based on the degradation of structural information is presented. As a specific example of this concept, a Structural Similarity Index and demonstrate its promise through a set of intuitive examples, as well as comparison to both subjective ratings and state-of-the-art objective methods on a database of images compressed with JPEG and JPEG2000 is developed. An objective image quality metric can play a variety of roles in image processing applications. First, it can be used to dynamically monitor and adjust image quality. Second, it can be used to optimize algorithms and parameter settings of image processing systems. In a visual communication system, a quality metric can assist in the optimal design of pre-filtering and bit assignment algorithms at the encoder and of optimal reconstruction, error concealment, and post-filtering algorithms at the decoder [7].

IV.PROPOSED DENOISING METHOD

One of the first role of bilateral filtering was image de-noising. Later, the bilateral filter became popular in the computer graphics community because it is edge preserving, easy to understand and set up, and because efficient implementations. The existing Median filters are known for their capability to remove impulse noise without damaging the edges. Median filters are known for their capability to remove impulse noise as well as preserve the edges. The main drawback of a standard median filter (SMF) is that it is effective only for low noise densities. At high noise densities, SMFs often exhibit blurring for large window sizes. Bilateral filtering method is that it allows for considering both the spatial locality and neighbouring points with similar amplitudes at the same time which make it can better preserving the image edges and textures than the conventional linear filtering algorithms. The main

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advantages of this design are the capability of real-time processing and economical and effective utilization of resources.The bilateral filter might not be the most advanced de-noising technique but its strength lies in its simplicity and flexibility. The weights can be adjusted to take into account any metric on the difference between two pixels and information about the reliability of a given pixel can be included by reducing the weights assigned to it. A spatially adaptive bilateral filtering image de-noising algorithm with low computational complexity is proposed to improve the performance of the system [1].

V. CONCLUSIONS

Proposed Image Denoising Method is suitable for noise removal as it is having less complexity compared to other techniques.Thus it is simple and easy to implement. Also it has high PSNR as compared with other methods. The proposed method is synchronous and capable of real-time processing supporting high clock frequencies. Scalability of the design in order to enable the implementation of arbitrary filter window size with low effort is possible. Maximal operating frequency depends on the chosen FPGA family.

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