An Efficient Line Drop Noise Removal of System Level Design Model

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ABSTRACT - The rapid increase in the range and use of electronic imaging justifies attention for systematic design of an image compression and denoising system and for providing the image quality needed in different applications. The basic measure for the performance of an enhancement algorithm is PSNR, defined as a peak signal to noise ratio. In this work, a simple design is implemented for removing noise from gray scale images, that depends on Two Dimensional Discrete Wavelet Transform (2D-DWT) and a threshold stage is proposed. The proposed design is used to remove impulse noise (the Line Drop Noise) from the corrupted images. This architecture consists of a control unit, a processor unit, two on-chip internal memories to speed up system operations, the proposed architecture is designed and synthesized with the Verilog or VHDL language and then implemented on the FPGA Spartan 3 starter kit (XC3S400PQ208) to check validation of the results and performance of the design.

Keywords: Image Denoising, Impulse Noise (Line Drop Noise), Impulse Detector, Architecture.

1. INTRODUCTION

Images are often corrupted with noise during acquisition, transmission, and retrieval from storage media. Many dots can be spotted in a Photograph taken with a digital Camera under low lighting conditions. Appearance of dots is due to the real signals getting corrupted by noise (unwanted signals). On loss of reception, random black and white snow-like patterns can be seen on television screens, examples of noise picked up by the television. Noise corrupts both images and videos.

The purpose of the denoising algorithm is to remove such noise. Image denoising is needed because a noisy image is not pleasant to view. In addition, some fine details in the image may be confused with the noise or vice-versa. Many image-processing algorithms such as pattern recognition need a clean image to work effectively. Random and uncorrelated noise samples are not compressible. Such concerns underline the importance of denoising in image and video processing.

The goal of image denoising is to remove noise by differentiating it from the signal. The wavelet transform's energy compactness helps greatly in denoising. Energy compactness refers to the fact that most of the signal energy is contained in a few large wavelet coefficients, whereas a small portion of the energy is spread across a large number of small wavelet coefficients. These coefficients represent details as well as high frequency noise in the image. By appropriately thresholding these wavelet coefficients, image denoising is achieved while preserving fine structures in the image.

II. REVIEW OF DISCRETE WAVELET TRANSFORM

A.DISCRETE WAVELET TRANSFORM

The random-valued impulse noise is more difficult to handle due to the random distribution of noisy pixel values. The effective denoising scheme is proposed using DWT with adaptive thresholding. Wavelet denoising attempts to remove the noise present in the signal while preserving the signal characteristics, regardless of its frequency content. It involves three steps: a linear forward wavelet transform, nonlinear thresholding step and a linear inverse wavelet transform.The two dimensional (2D) wavelet transform is an extension of the one dimensional (1D) wavelet transform. To obtain a 2D transform, the 1D transform is first applied across all the rows and then across all the columns at each decomposition level. Four sets of coefficients are generated at each decomposition level: LL as the average, LH as the details across the horizontal direction, HL as the details across the vertical direction and HH as the details across the diagonal direction.

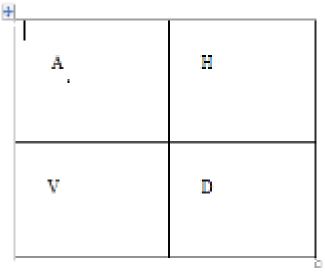


Fig.1. DWT DIAGRAM

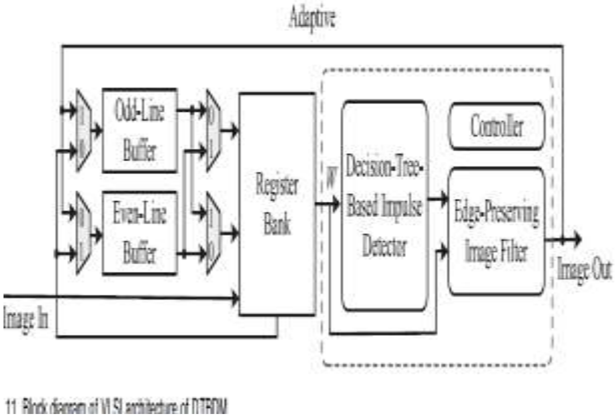


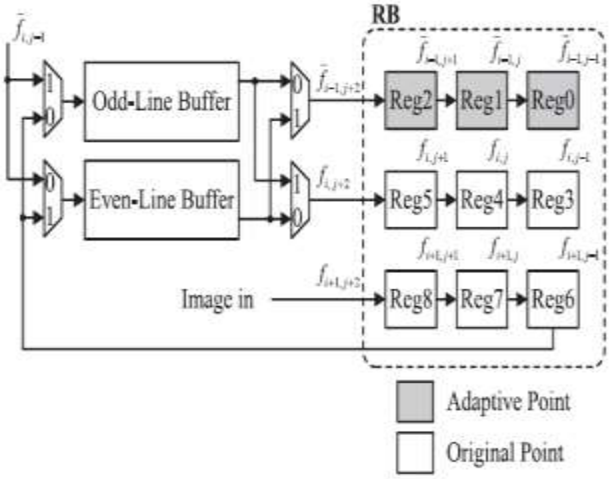
Fig. 2. Block diagram of VLSI architecture

B. Line Buffer (Ping-Pong Buffer)

DTBDM adopts a 3 _ 3 mask, so three scanning lines are needed. If pi;j are processed, three pixels from rowi_1, rowi, and rowiþ1, are needed to perform the denoising process. Here, we use the concept of ping-pong arrangement. With the help of four crossover multiplexers (see Fig. 2), we realize three scanning lines with two line buffers. Odd-Line Buffer and Even-Line Buffer are designed to store the pixels at odd and even rows, respectively, as shown in Fig. 12. To reduce cost and power consumption, the line buffer is implemented with a dual-port SRAM (one port for reading out data and the other for writing back data concurrently) instead of a series of shifter registers. If the size of an image is Iw _ Ih, the size required for one line buffer is Iw _ 3 bytes in which 3 represents the number of pixels stored in the register bank.

3.3 Register bank: The register bank, consisting of nine registers, is used to store the 3 _ 3 pixel values of the current mask W. Fig. 2 shows its architecture where each three registers are connected serially in a chain to provide three pixel values of a row in W, and the Reg4 keeps the luminance value ðfi;jÞ of the current pixel to be denoised. Obviously, the denoising process for pi;j doesn’t start until fiþ1;jþ1 enterers from the input device. The nine values stored in RB are then used simultaneously by subsequent data detector and noise filter for denoising. Once the denoising process for pi;j is completed, the reconstructed pixel value _ fi;j generated by the edge-preserving filter is outputted and written into the line buffer storing rowi to replace fi;j. When the denoising process shifts from pi;j to pi;jþ1, only three new values ðfi_1;jþ2; fi;jþ2; fiþ1;jþ2Þ are needed to be read into RB (Reg2, Reg5, and Reg8, respectively) and other six pixel values are shifted to each one’s proper register. At the same time, the previous input value from the input device, fiþ1;jþ1, is written back to the line buffer storing rowi_1 for subsequent denoising process. The selection signals of the four multiplexers are all set to 1 or 0 for denoising the odd or the even rows, respectively. Two examples are shown in Fig. 3 to illustrate the interconnections between the two line buffers and RB.

Assume that we denoise row2, and set all four selection signals to 0, those samples of row1 and row2 are stored in Odd-Line Buffer and Even-Line Buffer, respectively.



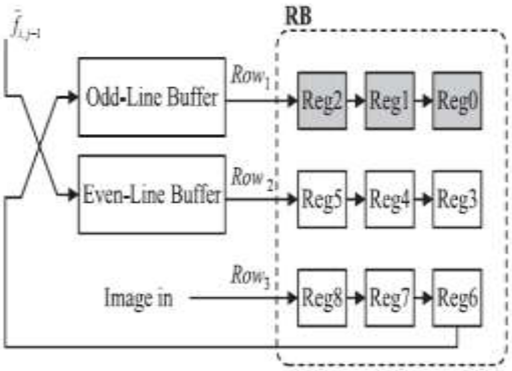
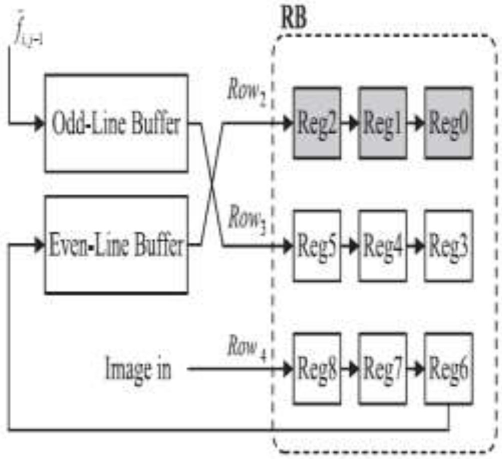
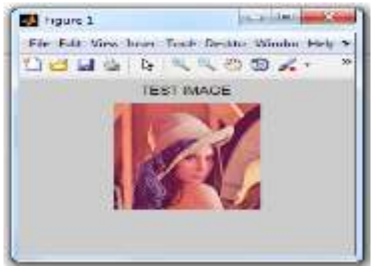


Fig 3 Register bank



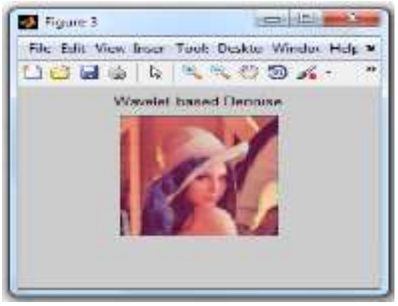
3. RESULTS

1 INPUT AND RECONSTRUCTED SIGNAL

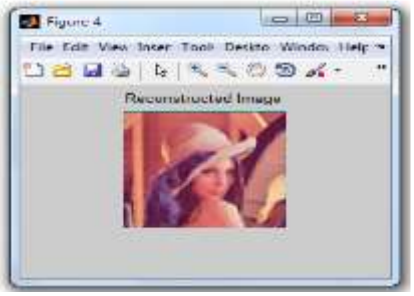


2. LINE DROP NOISE IMAGE

3.WAVELET TRANSFORM



4.RECONSTRUCTED IMAGE



4. CONCLUSION

Random-valued impulse noise is proposed in this project. The approach, a low-cost VLSI architecture for efficient removal of uses the texture analysis to detect the noisy pixel and employs an effective design to locate the edge. With adaptive skill, the quality of the reconstructed images is notable improved. Our extensive experimental results demonstrate that the performance of our proposed technique is better than the previous lower complexity methods and is comparable to the higher complexity methods in terms of both quantitative evaluation and visual quality. it is very suitable to be applied to many real-time applications.

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