Australian Journal of Basic and Applied Sciences, 9(15) Special 2015, Pages: 131-135

ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

VLSI Architecture and Design for Variable Cut-Off Frequency High Pass Filter for Edge Preservation in Digital Images

[1]C.G. Vignesh, [2]B. Arivu Selvam, [3]Dr. S. Sudha

[1]*PG Student, Easwari Engineering College, Department of Electronics and Communication Engineering, Chennai, India.*
[2]*Assistant Professor, Easwari Engineering College, Department of Electronics and Communication Engineering, Chennai, India.*
[3]*Professor, Easwari Engineering College, Department of Electronics and Communication Engineering, Chennai, India.*

ARTICLE INFO

Article history:
Received 10 March 2015
Received in revised form 20 March 2015
Accepted 25 March 2015
Available online 10 April 2015

Keywords:
Mean filter, Edge preservation, Median filter, High pass filter, Balanced histogram technique

ABSTRACT

Accuracy of the image processing algorithm depends on the quality of the input image. Filters are used to remove the noise pixels from the image. Mean filter is used to remove the Gaussian noise from the image. Edge pixels are lost due to the mean filtering operation. Edges are preserved with the help of the specialized architecture. Preserved edges are recombined with mean filtered image to improve the image quality. Filter structure is designed with the hardware description language and it is simulated using Xilinx ISE 13.1.

To Cite This Article: C.G.Vignesh, B. Arivu Selvam, Dr. S. Sudha., VLSI Architecture and Design for Variable Cut-Off Frequency High Pass Filter for Edge Preservation in Digital Images, ***Aust. J. Basic & Appl. Sci.**, 9(15): 131-135, 2015*

INTRODUCTION

Accuracy of the image processing algorithm is high when the input image is noise free. But during the acquisition and transmission images are corrupted with the noises. Many filter structures are proposed to remove the noise pixel present in the images. Filter structures are widely classified as Linear and nonlinear filters. Linear filters are the filters in which output of filter structure has linear relationship with the input value. Linear filters efficiently remove the Gaussian noise present in the image. Non Linear filters are the filters in which output does not have linear relationship with the input values. Non Linear filters efficiently remove the salt and pepper noise.

Mean filter is widely used linear filters. Input image is processed in window by window. To replace noisy pixel mean value calculated from the pixel values present in the window. Mean value can introduce a new pixel value which is not present in the input window. Due to the introduction of pixel value the edge pixel values are lost. In the case of nonlinear filters the filter will not introduce any new pixel values. Median filter is widely used nonlinear filter structure. Median of the values present in the windows is calculated to replace the noisy pixel. No new pixel is introduced due to which the edge information is preserved. But the major drawback of filter structure is inefficient in removal of the Gaussian noises present in the images.

Standard Median filter act as nonlinear smoother while retaining the edges in the images. Filter structure are easy to implement and consumes very less area. Power consumption of the circuits used for the median filtering operation is also less. But the efficiency of standard median filters in removal of the Gaussian noise very poor.

Mean filters have easier to implement and used to eliminate the short tailed noise occurring in the images. But major disadvantage of the filter structure loss of edge from the image and also the filter structure are insensitive to the impulse noises present in the images.

New filter structure shown in this paper combines the feature of both linear as well as nonlinear filter structure. Edges values are preserved using edgedetection logic. Preserved edges are combined with the filtered output to improve the image quality. Due to the combination of the two filter structures the IEF value of the image got increased.

The paper is structured as following sections Section II we introduce the new filter structure. Section III briefs about the implementation of filter structure in Xilinx. Results and discussions are presented in section IV. Conclusions are presented in section V.

Filter Structure:

Filter structure consists of alpha trimmed mean filter to remove Gaussian noise. Impulse noise from

Corresponding Author: C.G. Vignesh, Easwari Engineering College, Department of Electronics and Communication Engineering, Chennai, India.
E-mail: cgvigneshcg@gmail.com

the input image is removed with the help of the median filter. Edges are preserved with the help of the high pass filter arrangement. The filter structure is shown in the Fig. 1

Alpha trimmed mean filter removes the maximum and minimum values from the processing window. Mean values are computed on the remaining pixels present in the window. The alpha trimmed filter equation is given in equation 2.1

$$\text{Mean} = \frac{1}{(M*N)-P}\sum_{i=p}^{(M*N)-P} A_i \qquad (2.1)$$

Where p is the alpha pixels needed to be removed.
M is the number of rows in window
N is the number of columns in window
Ai is the pixel value.

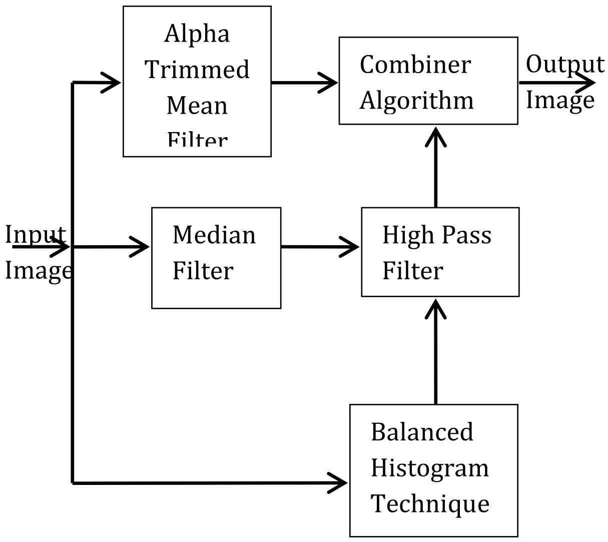


Fig. 1: Filter Structure.

Median filter removes the noises by using the similarity of neighborhood pixels. Intensity of the image at a particular point will not have much variation with the neighboring point. Based on the above logic the image is processed in the window. Median value is calculated from the processing window.

Sudden change in the intensity values are considered as edges in the images. Threshold value is used to identify the sudden change in the intensity of the image pixels. When the pixel value is greater than the threshold value then the pixel value is stored separately.

Balanced histogram technique computes threshold based on the computation of mean values in images. When the pixel value is greater than the mean value then it is separated in one group. Mean value is calculated for the group. Similarly the pixel value greater than the threshold values are separated as another group. Mean is calculated for the new group. New mean computed by taking average of the two separate mean values.

Combiner structure is used to merge the preserved edges and the mean filtered output. When the preserved edges values other than zero then the particular pixel value is replaced with the preserved edge values.

IEF is metric used to measure the sharpness of the image. IEF values are varied by varying the amount edge preserved. IEF value is calculated by using the following equation

$$\text{IEF} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\{(N(i,j)-X(i,j)\}^2}{\sum_{i=1}^{m}\sum_{j=1}^{n}\{(Y(i,j)-X(i,j)\}^2} \qquad (2.2)$$

Where N (i, j) represents the noise pixel value
X (i, j) represents the pixel value of original image and
Y (i, j) represents the pixel value of denoised image.

HDL Implementation:

Modules are developed with the help of HDL. Image is converted to hex values and the converted values are fed as inputs to the HDL module.

Mean Filter:

Mean filter removes the noise by computing mean values between the pixels. Nine pixels processed at each clock cycle. Nine pixel values are arranged in the ascending order. Alpha value pixels are discarded from the input pixels. Two pixels are discarded from nine pixels. Mean value is computed for the remaining seven pixels

161	159	154
159	171	168
82	95	67

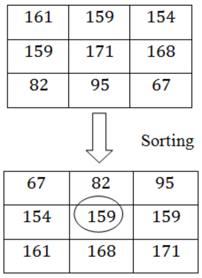
Sorting

67	82	95
154	159	159
161	168	171

Pixel values 67 and 171 are discarded and mean value is calculated.
Mean value = 139

Median Filter:

Median Filter removes the noise by computing the median value. Window consists of nine pixels. For each and every clock pulse nine samples are processed. Nine pixels are arranged in an ascending order. Fifth value corresponds to the median value of the filter structure. Median value calculation is illustrated below



Median value = 159

High Pass Filter:

High pass filter preserves the edges by using the specialized structure. Difference between two neighboring pixels is calculated. When the difference between the two pixel values is greater than the threshold value then the pixel is considered as the edge pixel. Edge pixels are alone retained remaining values are changed as zero.

Combiner Structure:

Combiner structure is used to combine the filter output with the preserved edges. For each and every clock cycle the system checks the preserved edge pixel values. When pixel value is other than the zero then the filtered value is replaced with the preserved edge value. Simple comparator and mux structure is used to implement combiner structure. Combiner structure compares the values with zero it produces output as '1'. When the output is 1 the mux selects the pixel value from the filtered output image.

Balanced Histogram Technique:

Threshold value to separate the edge values are calculated using the balanced histogram technique. Mean value is computed from the image in a single clock pulse. Separation of pixel values into groups is carried in next clock pulse. New mean values are calculated in the next clock pulse. Iteration of the process is carried for the next fifteen cycles to obtain the accurate mean values from the image.

Simulation Results:

Various images are given as inputs to the filter structure and the corresponding IEF values are calculated using XILINX. The simulation flow is given in the figure

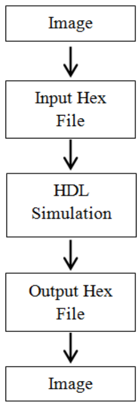


Table 1: IEF values.

S.No	Image	Threshold	IEF
1	Boat	43	9.2731
2	Lena	44	8.3322
3	Rose	39	13.0521

Image is converted to hex files with the MATLAB and it is given as input to the HDL modules in a text file format. Output values are written as hex values and converted as images with the help of MATLAB.

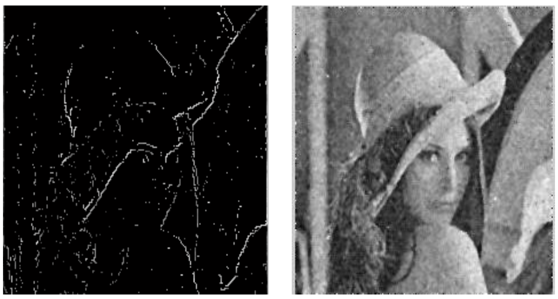


Fig. 3.1: Preserved Edge and reconstructed Lena image.

256X 256 images is processed through HDL coding. Sample output for a single 3X3 window is shown in the below figures. Similarly the entire image is processed through the XILINX ISIM simulator.

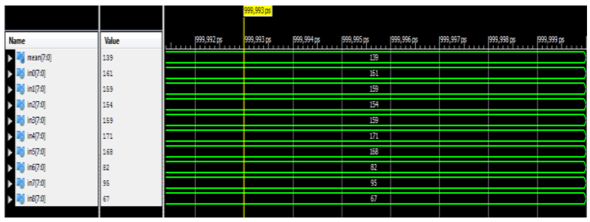


Fig. 3.2: Alpha Trimmed Filter Output.

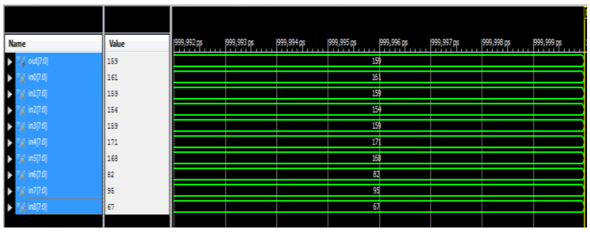


Fig. 3.3: Median Filter Output.

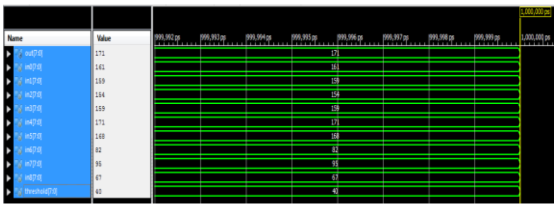


Fig. 3.4: High Pass Filter Output.

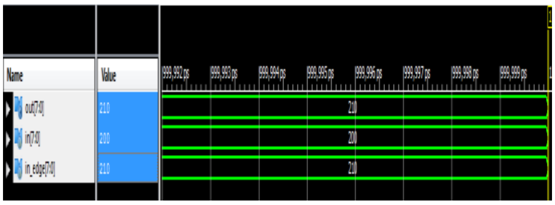


Fig. 3.5: Combiner Output.

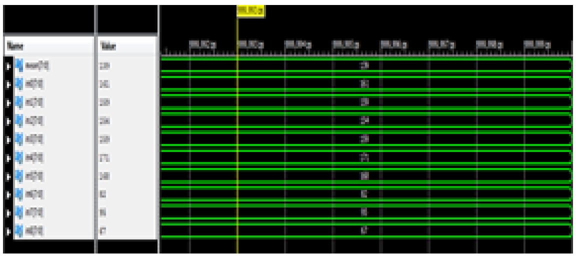


Fig. 3.6: Threshold Value Calculation.

Conclusion:

Filter comprises both linear and nonlinear filtering technique. Removes efficiently both Gaussian and the impulse noise present in the image.IEF values are calculated for the different images. The filter structure is simulated using the XILINX ISE tool. IEF values are higher since the filtered image contains more edge details present in the images. Filter removes the noise values without loss of edge details present in the image. Thresholding to separate the edge pixels are dynamically obtained from the image due to which the IEF value is improved when compared to the manual thresholding technique.

REFERENCES

BOVIK, 2005. A. Handbook of Image and Video Processing, Elsevier Academic Press, New York.

Cang-ju XING, Shou-jue WANG, 2001. ”A New Filtering Algorithm Based on Extremism and Median Value”, Journal of Images and Graphics, 6(A) 6.

Chen, P.Y., C.Y. Lien and H.M. Chuang, 2010. ‘A Low-Cost VLSI Implementation for efficient Removal of Impulse Noise,’IEEE Trans. Very Large Scale Integr. (VLSI) Systems, 18(3): 473-481.

Ramponi, G., 1995. “A simple cubic operator for sharpening an image,” Proc. 1995 IEEE Workshop on Nonlinear Signal and Image Processing, pp: 963-966.

Jakko Astola, Pauli Kuosmanen, 1977. ‘Fundamentals of Non Linear digital filtering’ CRC Press, New York.

Kalai Priya, O., S. Ramasamy, D. Ebenezer, 2011. “VLSI Implementation of Nonlinear Variable Cutoff High Pass Filter Algorithm,” in Electronics Computer Technology (ICECT), pp: 275-278.

Krishnan Nallaperumal, Justin Varghese, *et al.*, 2006. “Adaptive threshold based switching median filter for highly corrupted images”, in proc. of CSI-IEEE First Intnl. Conf. EAIT 2006, Calcutta, India, Elsevier.

Maria Akther, Md. Kaiser Ahmed, Md. Zahid Hasan, 2002. “Detection of Vehicle’s Number Plate at Nighttime using Iterative Threshold Segmentation (ITS) Algorithm”I.J. Image, Graphics and Signal Processing, pp: 62-70.

Neelavathi, P., 2012. “A New Detection Statistics for Removal of Impulsive Noise” International Journal of Computer Application (IJACA), 1(2): 57-63.

Pitas, I., A.N. Venetsanopoulos, 1990. “Nonlinear Digital Filters, principles and applications” kluwer academic publishers, Boston.

Gonzalez, R.C. and R.E. Woods, 2008. Digital Image Processing, Upper Saddle River, New Jersey, USA, ch. 5.

Swenson, R.L. and K.R. Dimond, 1999. “A hardware FPGA implementation of a 2D median filter using a novel rank adjustment technique,” in Seventh International Conference on Image Processing and Its Applications, 1: 103-106.

Shuqun Zhang and Mohammad A. Karim, 2002. “A New Impulse Detector for Switching Median Filters”, IEEE Signal Processing Letters, 9(11).

Shu-tao, L.I., Yao-nan WANG, 2000. “Non-Linear Adaptive Removal of Salt and Pepper Noise from Images”, Journal of Images and Graphics, 5(A): 12.

Srinivasan, E., R. Selvam, D. Ebenezer, 1999. A non linear variable cutoff high pass filter algorithm for VLSI implementation’, Proc. Int. Conf on Information, Communication and signal processing, (ICICS’ 99), NTV, Singapore, 3E2.4#099.pdf.

Uma Maheswari, O. and D. Ebenezer, 2007. ‘Some recent developments in nonlinear robust filtering’, IETE Journal of education.

Australian Journal of Basic and Applied Sciences, 9(15) Special 2015, Pages: 131-135

Uma Maheswari, O. and D. Ebenezer, 2007. “Some recent developments in nonlinear robust filtering”, IETE Journal of education.

Pratt, W.K., 1978. Digital Image Processing, John Wiley & Sons, Inc., New York, NY.

Xie, X., Z. Shi, W. Guo, S. Yao, 2009. "An Adaptive Image Enhancement Technique Based on Image Characteristic, " in Proc. 2009 IEEE Int. Congress Image and Signal Processing, pp: 1-5.

Xiaoyin Xu, Eric L. Miller, Dongbin Chen and Mansoor Sarhadi, 2004. “Adaptive Two-Pass Rank Order Filter to Remove Impulse Noise in Highly Corrupted Images”, IEEE Transactions on Image Processing, 13(2).