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Original Article

Low Power Design of Geometric Mean Filter Using GWO Pruning

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Abstract: *Geometric mean filter is commonly used in image processing application to remove Gaussian noise. In filter stage requires more number addition and multiplication process .Pruning is an approximation technique used to achieve a low power processing .In this work, Grey wolf optimized (GWO) geometric mean filter designed for low power image processing application. To validate proposed technique in real time scenario, the images with Gaussian noise are considered and GWO-Pruned 16-bit multipliers are utilized to perform multiplication between 16-bit pixels. . The proposed method gives the highest PSNR and computation cost than conventional pruning technique. On an average, the proposed technique has improved the PSNR rate of quality of 8.213 % and achieves energy requirement reduction of 19.36 %, respectively.*

Keywords: *Filter, Geometric, Low Power.*

INTRODUCTION

Today world, developing technologies like IOT and big data are in need of increasing data processing requirements. These technologies have adapted to cooperate with the physical world in order to manage and control the physical processes and systems, which causes in a noteworthy increase in the overall number of computing devices used. Such demands increases total memory requirements, total energy and power demands of processors

Approximate computing is a low power technique utilized to reduce overall power and energy demand of the data processing units with error tolerant features .the total energy and power of system reduced by applying approximate addition and multiplications in data processing units

Low power image and video handling circuits are important in various uses of data processing units. Approximation strategies have newly been accompanied by circuit approximation techniques which exploit the way that these applications are greatly error tolerant and, thus, the quality metrics of image processing can be traded for power consumption. This work GWO optimized pruned Geometric Mean Filter designed and implemented in image processing applications.

RELATED WORK

Various approximation methods have been proposed for various arithmetic circuits design.Kim *et al.* (2016) have introduced a hybrid approximate adder by modifying conventional XOR gate structure. The proposed hybrid adder requires a minimum number of transistors than an accurate adder. Leon *et al.* (2018) have designed an approximate multiplier by using hybrid radix encoding. The encoding method that encrypts MSB bits with accurate radix -4 encoding and encodes LSB bits with approximate higher radix encoding. The proposed encoded multiplier can be used to achieve the preferred energy–accuracy tradeoffs.

Liu *et al.* (2017) have presented an inexact booth multiplier by changing regular Wallace tree multiplier. Approximate radix-4 modified Booth encoding (MBE) method used to construct 16*16 multiplier. The performance of multiplier analyzed in terms of error rate in order to prove the suitability of multiplier for error-tolerant computing. Liu *et al.* (2014) have designed the inexact floating-point adder design for image processing application. Approximate floating-point adders are constructed by using inexact exponent subtractor and mantissa adder.

Xiao Chen *et al.* (2014) have designed an approximate compressed image/video transmission technique by merging the features of both compression and inexact computation. In image processing, image files are divided into numerous smaller sections, and then lossy compression applied.

Suman *et al.* (2014) have designed a geometric mean filter for image enhancement. A technique of image enhancement through geometric mean filter and gamma correction is proposed.

Merhav *et al.* (1999) have introduced a Multiplication-free inexact algorithms for image processing applications. The liner computations of image processing like down sampling and translation filtering utilized for enhancement. The simulation results shows that the approximation based algorithm yields output nearly equivalent to exact processing. Paim *et al.* (2019) have designed an approximate adder for 8 -point Modified Rounded Discrete Cosine Transform (MRDCT). The modification leads to achieving low power operations.

Tu *et al.* (2010) have presented a Neural Network(NN) based pruning method integrated with Particle Swarm Optimization (PSO) algorithm. The PSO algorithm is utilized to optimize and tune the initial parameters of the NN, with the weights and biases etc. The implementation results show that the proposed method achieves greater improvement in both accuracy and period to train NN.

PRUNING BASED CIRCUIT DESIGN

The pruning is an approximate digital circuit design technique by removing or deleting the components or wires of the digital circuits.in pruning process ,the higher power consuming components or wires are selectively removed to achieve a low power processing with minimal error insertion. For larger bit circuits, pruning technique is complex to identify the nodes or wires

GWO-Pruning

GWO pruning introduced to optimize node selection problem by applying hunting behavior of wolf into optimization problem. Here GWO pruning applied to design low power geometric filter for image application

Proposed GWO Pruned Geometric Mean Filtering

An Additive white Gaussian is a noise is initiated by casual signal fluctuations in digital cameras where more intensification is used in a blue channel other than the green and red channel. Geometric Mean Filter utilized to remove noises in image to increase a quality of image .But , from the geometry of filter identified that it requires larger addition and multiplication operations.. In the below Figure 1, it shows the process of filtering and the red, green and blue channel separation. The proposed filter design process shown in Figure 2.

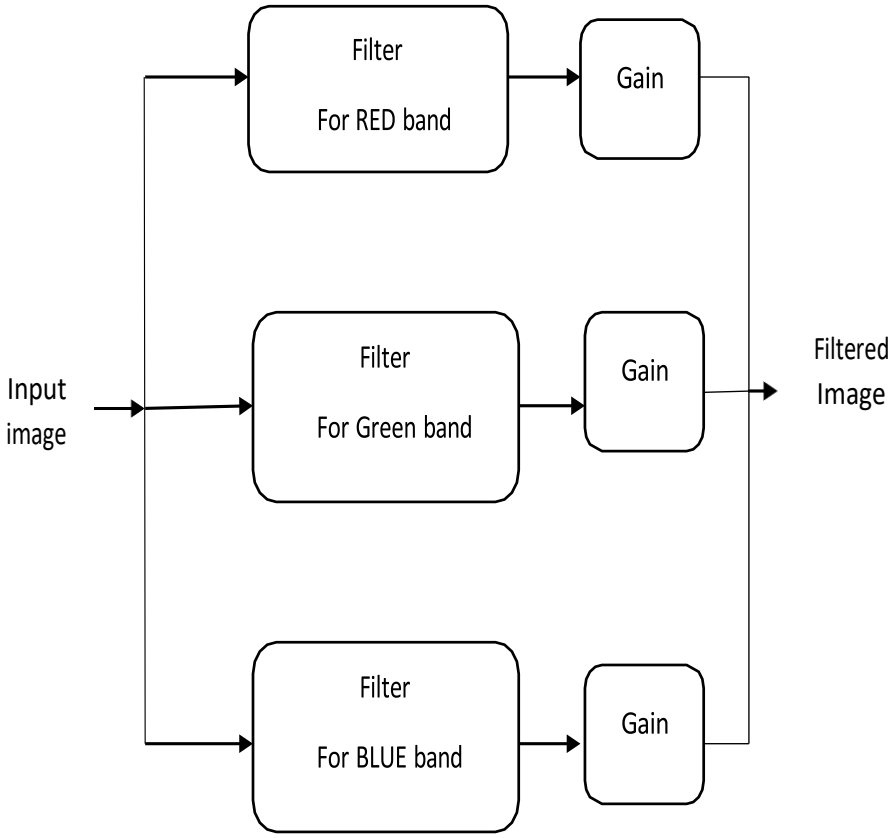


Figure 1 Filter operation

In Geometric mean filter, each pixel renovation is obtained by the product of the pixel in the sub-image window is raised to the power $1/m \times n$ as termed in the below equation:

$$f(x, y) = [\pi(s, t) \in Sxy.\,(s, t)]^{1/min} \quad (4.1)$$

The purpose of this filtering is to make an effective noiseless objective image for a specific application than the original images.

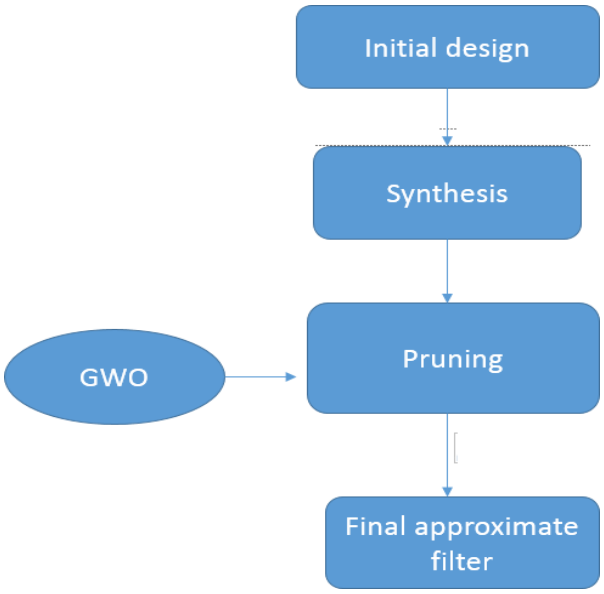


Figure 2 Proposed filter design

RESULT AND DISCUSSION

The proposed design implemented using synopsis complier and MATLAB based simulation using for image quality verification. Usually, VLSI implementation of filters concentrates of adders, multipliers, memories and subtractors. The effect of proposed GWO pruning based multiplier applied in geometric mean filters and analyzed using PSNR. The PSNR of the output image is denoted in dB can be calculated as,

$$PSNR=10\log_{10}((MN*255^2)/(\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}[P(i,j)-P'(i,j)]^2)$$

Table 1 PSNR comparison of filtering of image

Application	Filter	
Benchmark	Pruning	GWO-Pruning
Lena	68.3	72.1
Airplane	73	75.92
Baboon	71.6	73.4
Peppers	54	56.7
Cameraman	70.6	75.8
Moon surface	64	71.3

Table 2 Energy requirement of filtering of image

Application	Filter	
Bench mark	Pruning	GWO-Pruning
Lena	1.90	1.34
Airplane	2.06	1.89
Baboon	1.10	0.94
Peppers	0.98	0.54
Cameraman	1.89	1.71
Moon surface	1.13	0.82

From Table 1 and 2 , it is found that the recommended GWO pruned filter architecture improves the PSNR performance with a minimum energy requirement.The figure 3 and 4 shows input and corresponding output images.

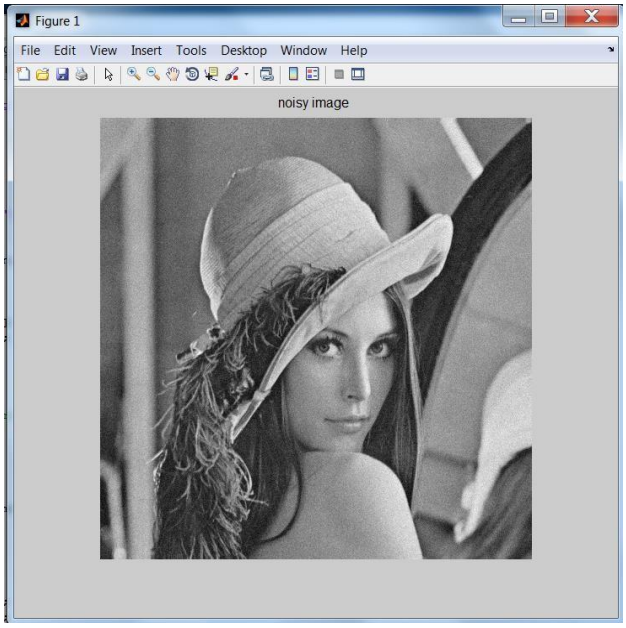
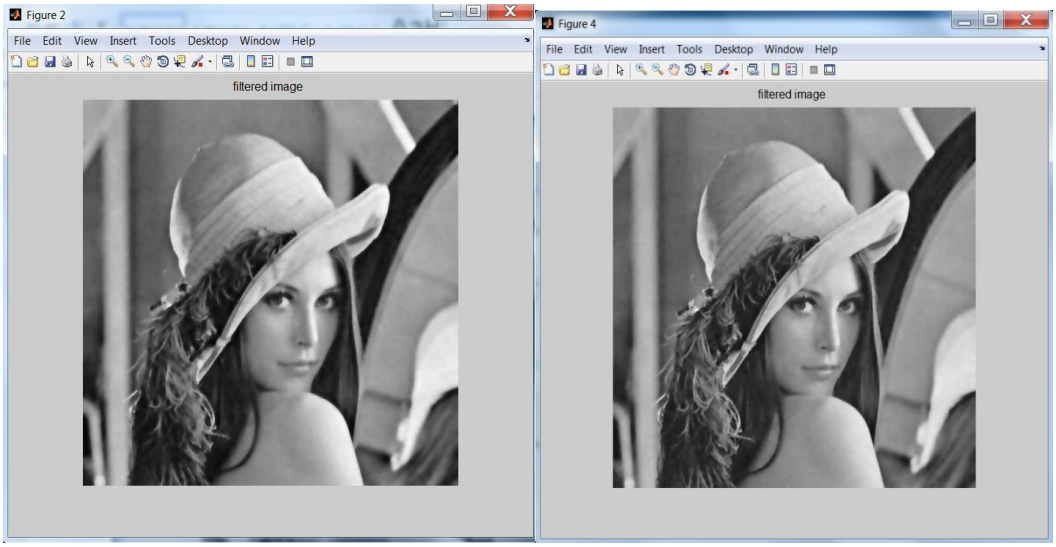


Figure 3 Lena image with Gaussian noise



(a) **(b)**

Figure 4 Geometric mean filtered Lena image (a) Normal pruning and (b)with GWO

CONCLUSION

In this work, a new GWO optimized pruning technique used to design a geometric mean filter . This work uses GWO algorithm for pruning and selective node pruning problem.. The simulation results show that the execution time and the error rate of the proposed method are better than other methods. It would be motivating to test the design for an increasing number of pruning nodes and increasing bit sizes.The proposed technique has improved the PSNR rate of quality of 8.213 % and achieves energy requirement reduction of 19.36 %, respectively

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