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DESIGN OF ENHANCED SQRT CARRY SELECT ADDER FOR VLSI IMPLEMENTATION OF 2D- DISCRETE WAVELET TRANSFORM

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ABSTRACT

In this paper, two-dimensional Discrete Wavelet Transform (2-D DWT) based image compression is presented with the help of developed Enhanced square root carry select adder (ESCSLA). The Enhanced Carry select adder is replacing the RCA and BEC unit to D-latch circuit. It provides better results than compared to the conventional adders. DWT and ESCSLA circuit is designed through Very Large Scale Integration (VLSI) System design environment. Low power consumption, less area and high speed are the main concerns in VLSI System design. Hence, our aim is to reduce the hardware complexity of ESCSLA and improve the performance of DWT in terms VLSI concerns. In our work, three levels of decomposition are made for image compression. With the help of pixel values of image and Enhanced square root carry select adder circuit, 2-D DWT image compression technique is implemented through Verilog HDL design. The performance of ESCSLA circuit is better than conventional Binary to Excess1 (BEC) based Square Root Carry Select Adder (SQRT CSLA) in terms of silicon area and power consumption. Hence, the performance of DWT also increased when incorporating EHRCA circuit into addition process of DWT computation.

Key words: Ripple Carry Adder (RCA), Carry Select Adder (CSLA), Discrete Wavelet Transform (DWT), Enhanced Square root carry select adder (ESCLA), Very Large Scale Integration (VLSI).

1. Introduction

The image processing finds prominent applications in three important aspects. The three aspects are improvement of pictorial information for human perception, image processing for application in autonomous machines, image storage and retrieval. Typical applications of this type are noise filtering. Sometimes the image is very noisy. So the noise has to be filtered so that the image appears better. The second aspect is that there are times at which we have to improve the contrast of the image. Captured image sometimes looks blurred. We have to make sure the image processing techniques rectifies the blurred image and improves the contrast of the image so that we get the better version of the same image. The third aspect is with regard to compression. Image when stored as raw data, consumes large amount of memory which makes high end multimedia capabilities of todays digital equipment impossible. The raw image data contains lots of redundant information and this is the reason why it occupies large amount of memory. The frequency information gives valuable insights into the properties of image and gives us a clear view of the way redundancy has to be removed without loss of significant information.

2. Related Work

Tran, M. Q. et al [1] described the Discrete Wavelet Transform based solution to Graphical Processing Units. It was discussed that the Discrete Wavelet Transform based solutions to Graphical Processing Units did not leverage the full power of the units under consideration. GPU optimizing strategies using Discrete Wavelet Transform like shared memory, registers, warp shuffling instructions, and thread- and instruction-level parallelism. Hybrid approach to boost up the performance is discussed.

Shih-Hau, F. et al [2] described, channel state information was preferred over Received Signal Strength indicator for indoor Wi-Fi positioning systems. Channel State Information has rich details regarding the channel, but the problem is that the accuracy is affected for channels with higher dimensions. The method for fingerprinting based indoor localization is described. The algorithm operates on the channel state information sequence by taking multilevel Discrete Wavelet Transform and normalizing the coefficients using histogram equalization. The robust features are then reconstructed by taking inverse Multilevel Wavelet Transform of the normalized coefficients.

Paul, H. et al [3] detailed a method for image compression based on contrast sensitivity of the perception of the human visual system. Contrast sensitivity functions were conventionally obtained using fixed size Gabor functions. The basis functions of multi-resolution decompositions such as wavelets often resemble Gabor functions. They are of variable size and shape. Conventional Contrast Sensitivity Functions cannot be used here. A set of tests are conducted and Contrast Sensitivity Functions for a range of multi resolution transforms are obtained which are Discrete Wavelet Transform, the steerable pyramid, the dual-tree complex wavelet transform, and the curvelet transform.

Min, L. [4] et al described that conventionally watermark was embedded by degrading the host audio signal. The zero audio watermarking is done by using Discrete Wavelet Transform, Discrete Cosine Transform and Singular Value Decomposition methods. Registration of the watermark is done by taking Singular Value Decomposition of the generated coefficients, so that the watermark is embedded without degrading the host audio signal quality. The watermark method is robust to most of the signal processing operations.

3. Wavelet Transform

Several forms of the Fourier Transform exist depending on the space where the transform is defined. In the same manner since Wavelet Transform is an extension of the Fourier Transform, there are also several forms of Wavelet Transform, each for a particular space of sequences or functions.

The Discrete Wavelet Transform (DWT) is a fundamental form of Wavelet Transform and is defined on $l^2(Z_N)$, a group of N-dimensional vectors in Hilbert space over which the theory of the Discrete Fourier Transform is built. The simplicity of the Wavelet Transform lies within the finite dimension of the space $l^2(Z_N)$. The observations yield the completeness of the orthonormal wavelet basis.

The other form is declared on $l^2(Z)$ which is a Hilbert space of infinite generally non-periodic complex signals. The operation is in Discrete Time signals and therefore the background theory used is Discrete Wavelet Transform. The infinite dimensionality makes the theory more demanding, requiring a more complete set of orthonormal basis functions.

The third and most complicated fact about the theory of Wavelet Transform is the Continuous Wavelet Transform which is defined on $L^2(R)$, a Hilbert space of complex square-integrable functions. The construction of Wavelets is reduced to construction of Multi Resolution Analysis.

3.1 Image Compression using DWT

An input image is fed through a series of filter to find out the wavelets coefficient. The procedure starts passing the image through a digital low pass filter with impulse response. Filtering an image signal related to the numerical operation of convolution of an image signal with the impulse response of the filter. A digital low pass filter removes all frequencies that are half of the highest frequency in the signal. Resolution is defined as the amount of information in the signal that is affected by filtering operations.

3.2 Enhanced SQRT Carry Select Adder

This method replaces the BEC circuit by D-latch. Latches are used to store 1-bit binary information. The latch is one of the sequential circuits so their outputs are depends on the present inputs and previous inputs. In other words, the latch is level sensitive, so when latch are enabled; the operation of latch is changes according with input signal of the latch. The architecture of proposed 16-bit Carry Select Adder is shown in Fig.1.

In this we are using five different ripple carry adders with different bit size and D-Latch. In this proposed method uses only one adder Instead of using two separate adders in the regular carry select adder(CSLA) to reduce the area, and power consumption. In CSLA each of the two additions is performed in one clock cycle. In the 16-bit adder Ripple carry adder used in the least significant bit (LSB) which is 2 bit wide.

The upper half of the adder is most significant part is 14-bit wide the upper of the adder is works depends on the clock, the input carry performed addition when carry goes high. The carry input is assumed as zero while clock goes low and the sum of adder is stored in adder itself.

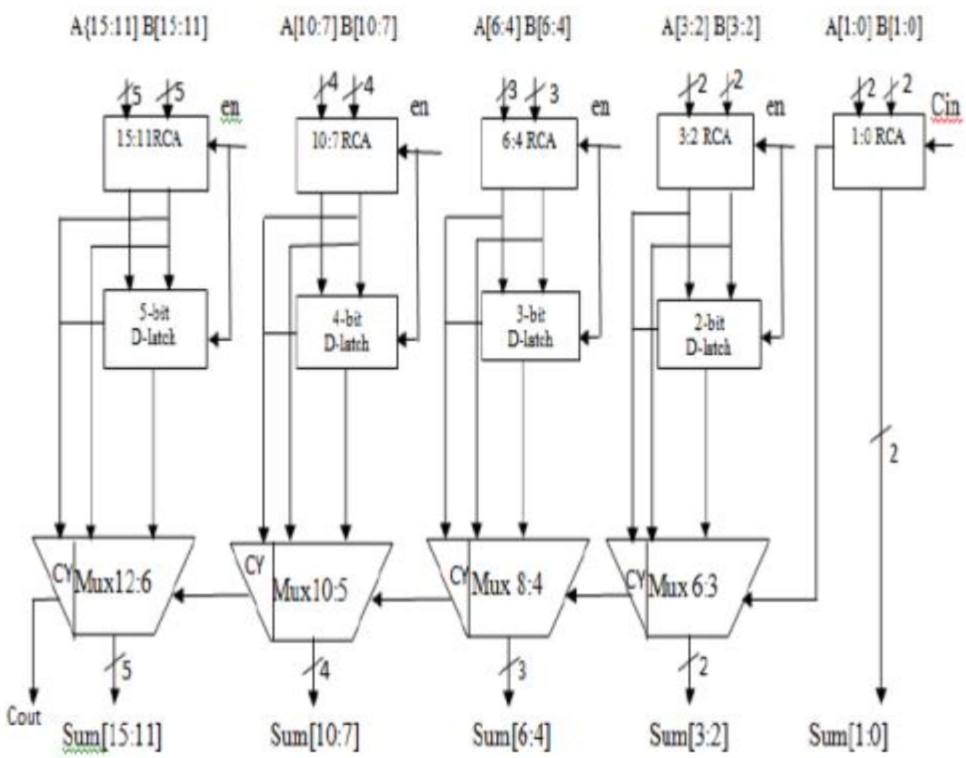

Figure. 1 Enhanced SQRT Carry Select Adder

From the Fig. 1 it can understand that latch is used to store the sum and carry for Cin=1 and cin=0.Carry out from the previous stage i.e., least significant bit adder is used as control signal for multiplexer to select final output carry and sum of the 16-bit adder.

4. Result and Discussions

In this paper, Enhanced SQRT Carry Adder (ESCSLA) circuit is designed using Verilog Hardware Description Language (VerilogHDL). The validation of proposed adder circuit is evaluated using ModelSim 6.3C and Synthesis results are evaluated by using Xilinx 10.1i design tool. Also levels of decomposition of image using 2-D DWT are measured using MATLAB tool.

The RCA circuit is realized in this paper and identified the redundant logic operations. Based on identified redundant logic, EHRCA circuit is designed in our work. The circuit of ESCSLA is most likely latch based SQRT CSLA.

Table 1. Comparison of 16-bit conventional BEC based SQRT CSLA and developed 16-bit ESCSLA circuits

Type	Slices	LUT	Delay (ns)	Power (mW)
Conventional BEC based SQRT CSLA	28	47	15.971	280
Enhanced SQRT CSLA	20	35	14.705	240

5. Conclusion

In this paper, 2-D DWT based image compression is devel- oped with the help of Enhanced Half Ripple Carry Adder (EHRCA). The design of ESCSLA and incorporation of EHRCA into DWT computation is done by Verilog HDL. The developed ESCSLA circuit consumes less hardware resources and power consumption than conventional BEC based SQRT CSLA. The developed ESCSLA circuit offers 9.81% reduction in silicon area and 10.78% reduction in power consumption than conventional BEC based SQRT CSLA. Further, developed ESCSLA circuit is incorporated into addition process of 2D-DWT for image compression. Three levels of decomposition are made in this paper. Simulation results for image compression using 2-D DWT is validated by both Model Sim 6.3C and MATLAB simulation tools. In future, the developed ESCSLA based 2-D DWT will be helpful for image pro- cessing applications like compression, segmentation and fragmentations.

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