

Region Proficient Stochastic Computing Based 4-Tap Fir Filter for Dsp Applications

N.Srinivasulu, P. Teja , Priyadarsini. M, V. Arunkumar,V. Venkatesh

Abstract: Filter designs are applied in a several applications like medicinal diagnosing, picture/Speech handling. In various applications, a FIR is a channel whose impulse response is of limited period, in view of it settles to zero in finite time. The filtering operations are executed continuously or in discrete manner. As the multiplier is the slowest component in the system, it will affect the performance of the FIR filter. In this paper, Finite Impulse Response filter based on altered Braun multiplier and baugh multiplier is designed along with the carry look ahead adder, in which former reduces both area and delay in Xilinx. In this project error rectification is also designed in matlab Here we have developed an Area efficient stochastic computing based on 4 tap FIR filter for DSP application.

Index Terms: Stochastic Computing (SC), Finite Impulse Response (FIR) filter, Multipliers, Adders.

I. INTRODUCTION

Discrete FIR separating finds broad utility in high performance and low-power embedded computing system that range from wireless emitters/receivers to video and picture processing units. When designing and executing FIR filters, particularly for DSP applications, for example, channel adjustment, matched filtering and pulse shaping both high throughput and high request are wanted so as to accomplish separating solidness and direct stage property. Be that as it may, to achieve all these structure destinations at the same time, software based programmable filters dependent on digital signal processor cores are not sufficient that they are not very energy efficient and regularly work at moderately low speed. Consequently, committed FIR filter structures are unavoidable.[1] On account of its simple hardware equipments, Stochastic Computing (SC) FIR filter is continuously picking up its pace. Be that as it may, SC design intrinsically occurs errors since it is created probabilistically. Therefore, high-request SC FIR configuration is characteristically error inclined independent of the execution of individual SC module.

Up until now, a large portion of the ongoing works centre for the most part around the execution of SC unit, for example, inner product without considering a significant part of the decrease of SC processing blocks. Subsequently, the structure of high-precision high-request SC FIR channel is still testing. In our proposed SC FIR design[1], generally, we concentrate for the most part to decrease the number of SC blocks in order to reduce SC error. We basically reduce the number of SC blocks by applying Fast FIR Algorithm (FFA). For a q-by-q FFA, the m-tap FIR filter could essentially be decreased to m/q-tap, bringing about lowering the SC error fundamentally.[2] In addition, our structure smartly chooses higher SC value over lower one, since lower value SC produces higher rate errors. Recreation results demonstrate that the proposed methodologies can fundamentally build the exactness of higher-request SC FIR filter, in this way making ready of advancing stochastic DSP modules in practical applications.

II. BASIC THEORY OF STOCHASTIC COMPUTATION

The essential principle of SC is that the computational information (in bit-streams) are represented as stochastic sequences and are processed in type of digitized probabilities. Normally, the representations and all the included computations dependably exist in the real number unit interval $[0, 1]$. Stochastic representation can be coded in two arrangements: SC-unipolar and SC-bipolar [1]. In SC-unipolar arrangement, the info s is a genuine number inside the unit interval, for example $0 \leq s \leq 1$. For instance, a 2's supplement binary input bit-stream $\{0100\}_2$ is represented in stochastic bit streams S , consisting of 4 of bit '1' out of $2^4 = 16$ bits (remaining bits are zeros). This stochastic bit streams S , is additionally translated as $p = P(S = 1) = 4/16$. Then again, in SC-bipolar position, the scope of the real number input, s , is stretched out to $-1 \leq s \leq 1$. Consider a 2's complement binary input bitstream $\{1100\}_2$. In SC-bipolar bit streams S , the deterministic value is mapped to $p = P(S = 1)/2 = 12/(16 \times 2) = 6/16$. [2]. In other words, stochastic representation observes the probability of 1s at arbitrary position in S . Such representation serves as the main reason of having high fault tolerance in SC. A solitary bit flip in a long bit stream causes a minor change in unique logical value. On the opposite, a single bit-flip in the conventional 2's complement calculation will result in huge error particularly if the bit-flip happens on the higher-order bit

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Multiplication of two input streams, which is computational serious in conventional, signed binary computing, can be performed using single logical gate in SC. Consider two stochastic input bit-streams, X1 and X2 and the output for their mutiplication, Y, is derived, as,

$$y = P(Y = 1) \\ = P(X1 = 1)P(X2 = 1) + (1 - P(X1 = 1))(1 - P(X2 = 1))$$

Stochastic multiplication in bipolar configuration is clearly a logical XNOR operation between input bit-streams, X1 and X2 in digital circuit. For unipolar format, multiplication is performed using a logical AND activity. Stochastic multiplier for both unipolar and bipolar configurations are as depict Figure 1.

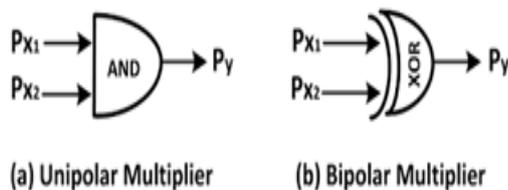


Figure 1. Stochastic Multiplier for (i) SC-unipolar and (ii) SC-bipolar formats.

III. METHODOLOGY

MULTIPLIER

In digital electronics, a multiplier is a device that is used for the multiplication of two binary numbers. Multipliers can be classified into two types: 1. Array multipliers 2. Tree multipliers Braun, Booth, Modified and Booth, Baugh-Wooley multipliers fall into the class of array multipliers.

Booth Multiplier:

Booth Multiplier uses the Booth encoding algorithm to reduce the partial products number by considering the two bits of multiplier at a time. Booth algorithm is valid for both signed and unsigned numbers. It will accept the number in 2's complement form based on the radix -2 computation.

The Modified Booth multiplier is used for the generation of the partial products and for implementing large parallel multipliers.

Wallace Tree Multiplier:

Wallace tree Multiplier comes into the category of tree multipliers and in the Wallace tree multiplier, the multiplicand-multipliers are added in parallel by using the tree of carry save adders. Carry save adders will add three binary numbers and it will produce two binary numbers. Its advantage is it will have a small delay.

Here, In this paper our proposed multipliers are Braun multiplier and Baugh-Woolley multiplier.

Braun Multiplier:

Braun Multiplier is known for its regular structure and its simple parallel multiplier that is commonly called as carry save array multiplier. It contains array of

adders and AND gates that are arranged in iterative structure so that it does not require logic registers. Braun multiplier is also known as non-additive multiplier since it does not add additional operand to the result of multiplication.

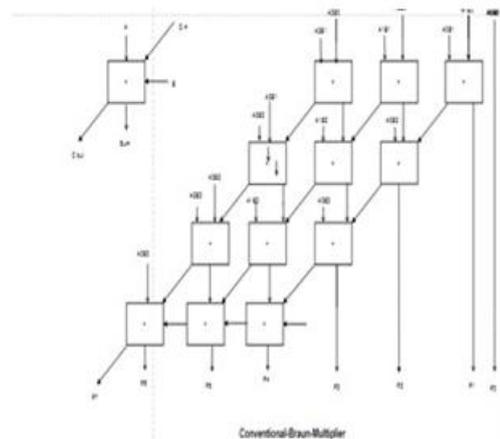


Figure 2: Architecture of Braun Multiplier
Baugh-Wooley multiplier is very efficient in multiplying both signed and unsigned numbers. Baugh-Wooley multiplier will exhibit less delay, low power dissipation and it will occupy less area compared to the other array multipliers. [6]

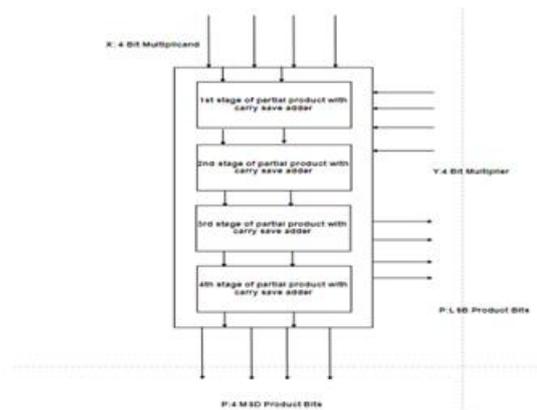


Figure 3: Architecture of Baugh wooley Multiplier

Adders

They are various types of adders such as

- Ripple carry adder** works on the basic addition principle. It contains series of full adders and each of the full adder is used for the addition of two bits along with the carry bit.
- Carry skip adder** uses the skip logic in the propagation of the carry and is useful to speed up the addition propagation
- The Carry increment adder** contains RCA's and incremental circuitry and the addition operation is performed by subdivision of total number of bits into the group of 4 bits and added by using the RCA's.



2. In carry select adder both $c_{in}=0$ and $c_{in}=1$ are executed at the same time and based on the carry, the sum will be selected so that we can reduce the delay

CARRY LOOK AHEAD ADDER

We have used carry look ahead adder it is based on the principle of looking at lower adder bits of argument and it will add if higher order carry is generated. It helps us in reducing the delay by reducing the number of gates through which carry signal must propagate.[3]

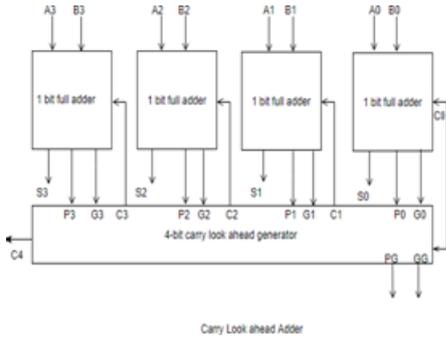


Figure 4: Architecture of Carry Look Ahead Adder

FIR FILTER

Finite impulse response filter in digital signal processing can be explained as a filter whose impulse response will be of finite duration or it will settle to zero in some finite time. Some of the primary advantages of the FIR filter compared to the IIR filter are 1. It requires no feedback 2. It is stable 3. It has a linear phase. The main disadvantage of the FIR filter is that it requires more computational power in general purpose processor in comparison with the IIR filter. Another shortcoming of the FIR filter is that it requires higher order tap than IIR filter to achieve the same performance.[1] In digital signal processing, FIR filter is mainly used for the wireless communication. Usually, FIR filters will be designed using multipliers, adders and the series of delays to create the output of the filter. The output sequence of the FIR filter in time domain can be expressed as

$$y(n) = x(n)h_0 + x(n-1)h_1 + x(n-2)h_2 + \dots + x(n-m+1)h_{m-1}$$

$$= \sum_{i=0}^{m-1} x(n-i)h_i$$

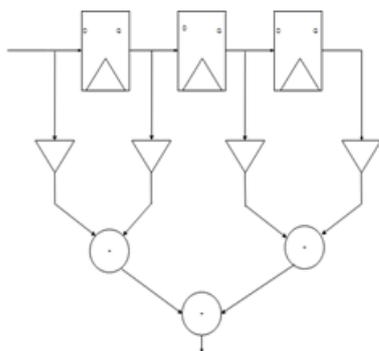


Figure 5: Architecture of FIR filter

IV. RESULTS AND DISCUSSIONS

SC FIR CIRCUIT IN MATLAB

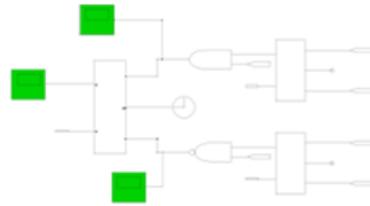


Figure 6: SC Based Fir filter Architecture[2]

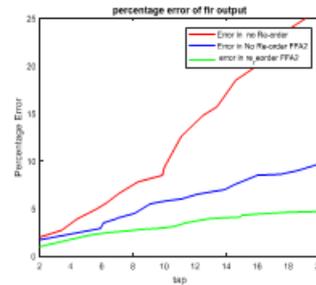


Figure 7: Reduced error in designing Fir Filter
Here We got the output of reduced error when compared to the previous work. Where as the efficiency of Fir have been Increased

BRUAN MULTIPLIER

The table shows the simulation result of the Bruan multiplier. It displays the input and output signals over time, with a scale of 10.00ns. The input signals are labeled 'a[0]', 'a[1]', and 'a[2]', and the output signal is labeled 'out'. The table shows the values of the signals at various time intervals (0ns, 20ns, 40ns, 60ns, 80ns, 100ns).

Figure 8: simulation result of Bruan multiplier

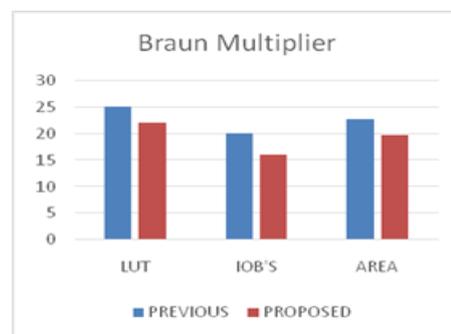


Figure 9: Graph of Braun Multiplier[5]

To reduce significant power consumption and also reducing dynamic power we are using Bruan Multiplier. In this graph it shows that by using Braun multiplier we have reduced area due to reducing in Lut and IOB's compared previous work.

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BAUGH WOOLEY MULTIPLIER



Figure 10:simulation result of Baugh wooley mutiplier

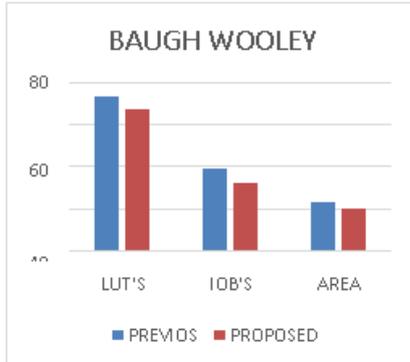


Figure 10:Graph of buagh wooley multiplier[6]

To enhance the path and to enhance the critical path delay we are using this baugh wooley multiplier. Here this graph represents the ess in area consumption due to to the comparison of Lut's and iob's[5]

CARRY LOOK AHEAD ADDER



Figure 11:simulation result of carry look ahead adder

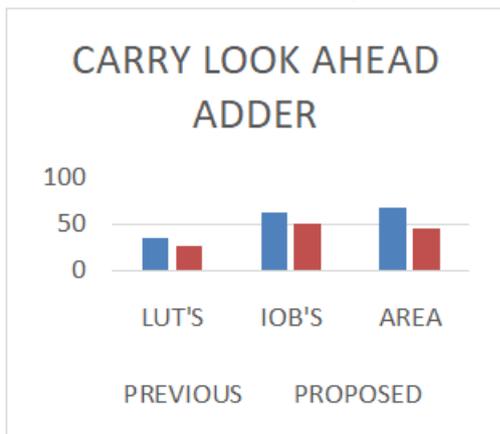


Figure 12: Graph of Carry Look Ahead Adder[3]

Carry Look Ahead Adder calculates one or more Carry bits before the sum which reduces the wait time. This graph of carry look ahead adder represents the less area when compared to the previous work.

4 TAP FIR FILTER

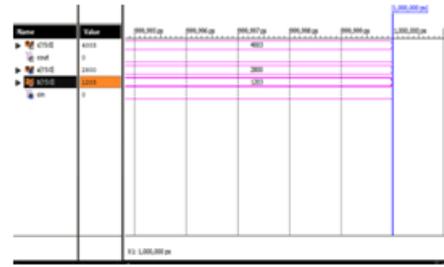


Figure 13 Simulation result of 4 tap fir filter

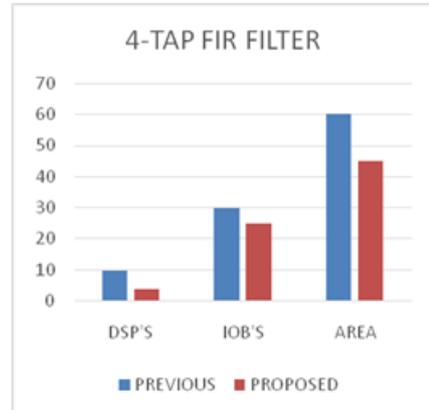


Figure 14:Graph of 4 tap Fir filter[1]

Here we have concluded that on comparing various area efficiency in various papers we have reduced the area in FIR filter

V. POWER ANALYSIS:

Power analysis is a vital part of experimental design. It enables us to decide the example estimate required to detect an effect of a given size with a given degree of certainty. On the other hand, it enables us to decide the probability of detecting an effect of a given size with a given level of certainty, under sample size constraints. On the off chance that the probability is unexpectedly low, we would be wise to modify or relinquish the experiment.

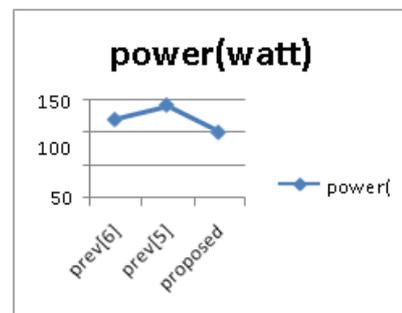


Figure 15 Analysis of Bruagh Multiplier

Where as this graph represents the reduce in power when compared tho the previous work.

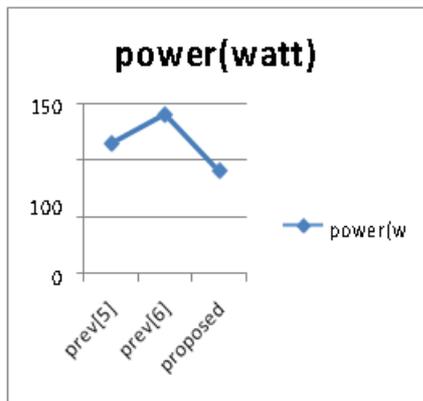


Figure 16 Analysis of baugh Wooley Multiplier.
Here the power of Fir filter has been reduced while using baugh wooley Mutiplier.

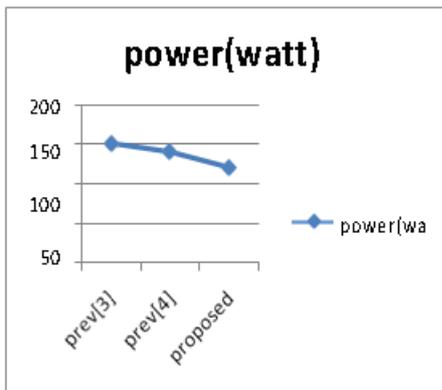


Figure 17 Analysis of Carry Look Ahead Adder
Here we can observe that power had been reduced in our existing paper when can compared to the previous

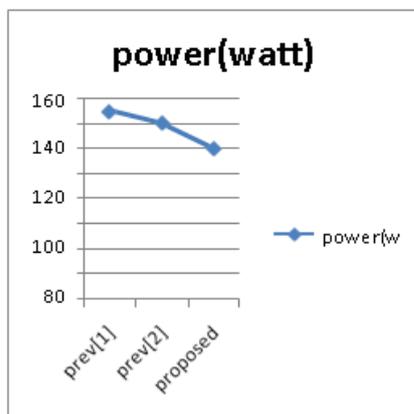


Figure 18 Analysis of Fir Filter
By comparing some of the reference papers and our pap wer can clearly mention that power had been reduced

Table:1 comparison of results

Category	Multiplier	Adder	Fir Filter
LUT'S	22	25	67
IOB'S	16	50	32
AREA	19	454	110

Based on our simulation results we got these values.

VI. CONCLUSION:

In this paper we propose a new method of reducing errors

in SC FIR filter using matlab and also we have developed fir filter using multipliers and adders where we can reduce the area and size. when the area and size are reduced automatically efficiency have been increased.

FUTURE SCOPE:

By getting the simulation results we also can design on boards like Zed board. Image processing and Cryptographic applications can be implemented on boards

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