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Multiplication Techniques used in Vedic Mathematics

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Abstract:

Indian mathematics has an ancient technologies that is 'Vedic mathematics' which as an exclusive system of calculations which depends on simple principles and rules which have 16 Formulae (Sutras). This paper discusses about A high speed complex multiplier design (ASIC) that is Vedic Mathematics. From earliest Indian mathematics "Vedas", adopted the knowledge for planning adder subtractor and multiplier unit. In which, multiplication is a significant factor in mathematics action which is used in number of Digital Signal Processing applications. For execution, the phenomenon of multiplication takes more time, so there is a need of quick multiplier for saving performance time. This paper, discuss about the multiplication using Earliest Indian Vedic Mathematics procedures. In techniques, describes the Urdhva Tiryakbhyam, Nikhilam Sutra, and Karatsuba-of man and technique is obtained from performance analysis due to which solving a whole range mathematical problems by its high speed. It also discuss about the convolution that is an official mathematical process, just as addition, multiplication and integration.

Keywords: *Complex Multiplier, Vedic Mathematics, Convolution, A high speed complex multiplier design (ASIC)*

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Introduction

In arithmetic operations, Complex Multiplication is a significant and enormous purpose in Digital Signal Processing (DSP) and Image Processing (IP). Through the use of two addition/ subtractions and four real number multiplications execute the Complex number multiplication. It is necessary to circulate to most significant bit (MSB) from least significant bit (LSB) in real number processing in case of binary partial products added. After binary multiplications, addition and subtraction limit the overall speed. Multiply and Accumulate (MAC) is Multiplication-based operations and internal produce are between some of the frequently used Computation- Intensive Arithmetic Functions (CIAF) presently performed in several Digital Signal Processing (DSP) that have uses like Fast Fourier Transform (FFT), convolution, cleaning and in microchips in its logic and arithmetic unit. Multiplication controls the performance time of most DSP procedures, so its necessity of high speed multiplier. In determining the tutoring cycle period of DSP chip, multiplication period is still central factor.

As a result of increasing computer and signal treating requests, demand has been increase for processing of high speed. In several image processing application and real-time signal, advanced quantity mathematics processes are significant to attain preferred performance. Multiplication is one of the most significant arithmetic operations and expansion of fast multiplier route has been a topic of attention over periods. Multiplier depends on Vedic Math, fastest and low power multiplier. It is the processor design's building blocks and also known as DSP's heart. The speed of computation of Current multipliers are decrease as the input data increase. Today, many multipliers are available such as array multiplier, combinational multiplier, sequential and parallel multiplier and others. By using Vedic math, building high speed multipliers for processor project is done. Filtering is generally used in DSPs and in numerous applications such as speech processing etc. In DSP, digital multiplier are most commonly used components such as reliable, fast and effective that are used to apply any operation.

n2 gates are hold by multiplier of size n bits. In DSP applications, executed multiplication algorithms that have two major concern which is latency and throughout from postponement perception. Dormancy is real interruption of calculating purpose, a quantity of how lengthy the inputs to a tool are constant is the closing outcome accessible on outputs. But in given period of time, to measure the throughput for counting the multiplications, multiplier is not simply a great postponement block but it is also considered as a big source of power indulgence.

History of Vedic Mathematics

Indian system of mathematics are exist in Ancient Indian sculptures (Vedas) which was re-experienced in early 20th period. It comprises Vedic mathematical formulae that can be useful to several mathematical branches. By using Vedic sutras, predictable mathematical algorithms are basic and also enhanced. It covers several current mathematical expressions containing trigonometry, arithmetic, geometry, factorization, quadratic equations and even calculus. Now a day, growing the demand of image processing, digital signal processing, and other heavy computational requests need quicker calculation by processor. Division and multiplication are the arithmetic processes which need heavy calculations. Old-style methods require a lot of time to solving problem in which comprise carry save, array, Wallace tree booth etc. Multiplier building depends on all those systems which are not well-organized in word of velocity, zone, and power. Vedic mathematics contain some steps to resolve multiplication rather than the old-style multiplication. Vedic mathematics is often grounded on 16 sutra that deal with numerous divisions of mathematics such as geometry, algebra, arithmetic etc.

Vedic Mathematics

By earliest advisors of India, Vedic mathematics was established which is considered as an earliest Indian mathematics. In 1965, Jagadguru Shankaracharya Bharathi Krishna Teerthji Maharaja reviewed again (1884-1960). Swaiji called it mental calculation of Vedic mathematics. 16 sutras (formulae) and 13 sub-sutras (sub-formulae) are contained by the Vedic mathematics. These sutras are not contained Atharva Veda. Vedic mathematics is an exclusive method of calculation that depends on the simple principles and rules by which the complicated mathematical calculation are resolved in few seconds. This field appeared very interesting and give computation procedure by which we are able to solve difficult mathematical equations of numerous engineering branches like computing.

The term 'Vedic' related to Sanskrit word 'Veda' that have meaning a cluster of information. It is a logical device which deals with numerous simple and even complex mathematical actions. The benefits of Vedic technique is given below:

- In solving the equation, the complexity is reduced
- Within 5 seconds, person to solve complex equation
- Finger counting and scratches are avoided
- 10-15 times faster, solving higher level equations

16 sutras and 13 sub-sutras are present in Vedic mathematics which are used to crack equations which is given in below:

1. If one is in ratio, the other is zero - (Anurupya) Shunyamanyat
2. All are multiplier - Gunakasamuchyah
3. By one more than the previous one -Ekadhikina Purvena
4. By one less than the previous one - Ekanyunena Purvena
5. The product of the sum is equal to the sum of the product - Gunitasamuchyah
6. Differential Calculus - Calana-Kalanabyham
7. Transpose and Apply - Paravartya Yojayet
8. By the completion or no completion - Puranapuranabhyam
9. By Addition and by Subtraction - Sankalana-vyavakalanabhyam
10. When the sum is the same that sum is zero - Shunyam Saamyasamuccaye
11. The ultimate and twice the penultimate - Sopaantyadvayamantyam
12. Vertically and crosswise - Urdhava-tiryagbhyam
13. All from 9 and last from 10 - Nikhilam Navatashcaramam Dashatah
14. Particular and General - Vyashtisamanstih
15. By its deficiency- Yaavadunam
16. The remainders by the Last Digit - Sesanyankena Caramena

13 Sub-Sutras are:

1. Remainder rests constant - Sisyate Seshsamjnah
2. Proportionately - Anurupyena
3. First by First and Last by Last - Adyamadye Nantyamantyena
4. By Osculation - Vestanam
5. By alternate elimination and retention - Lopanasthapanabhyam
6. Lessen by the Deficiency - Yavadunam Tavadunam
7. Only the last term - Antyatoreva
8. Deficiency lessen by amount and setup the square of the deficiency - Yavadunam Tavadunikutya Vargankach Yojayet
9. 7 has the multiplicand 143 - Kevalaih Saptakam Gunyat
10. End total is 10 - Antyayordhshakepi
11. Products' sum - Samucchayagunitah
12. Sum's product is products' sum - Gunitasamucchyah Samucchayagunitah.
13. By mere observation - Vilokanam

Vedic multiplier depends on the Vedic multiplication formulae (Sutras) and for the multiply of two digits in the form of decimal digit system, these sutras are used. These same formulae applied on the binary number system. This paper focused on the "Nikhilam Navatascaramam Dasatah", "Urdhva-tiryakbyham", and "Karatsuba-Ofman". Some algorithms are the base of Vedic multiplication which are discussed below:

Urdhva Tiryakbhyam Sutra

Earliest Indian Vedic Mathematics contains some sutras in which Urdhva Tiryakbhyam sutra use multiplier. This sutra is normally multiplication formula that is appropriate for all multiplication cases. This sutras have truthfully refers "Vertically and crosswise" and grounded on a novel notion over which group of all fractional produces run with coexisting accumulation of these fractional

produces. This mathematical process can be widespread for n*n bit number. In parallel, the fractional produces and their calculations are considered, the multiplier is self-governing of clock occurrence of computer. To calculate the product, multiplier will be needed same amount of time and therefore is autonomous of clock occurrence. It has benefit as it reduce the requirement of microprocessor to activate at progressively high clock frequencies but a higher clock occurrence normally result in amplified processing power and its drawback as it also enhances power.

Nikhilam Sutra

Nikhilam Sutra truthfully refers to "all from 9 and last from 10". It is appropriate to all multiplication cases and when digits are included in large, it is more efficient. Since it uses the commendation of the great digit from its adjacent base to execute the multiplication process on it, slighter the difficulty of the multiplication, greater is the unique digit. Here, for the demonstration of sutra, the example is taken as the multiplication of two decimal digits (96 * 93) where base '100' is chosen which is adjacent to and superior than both these two digits.

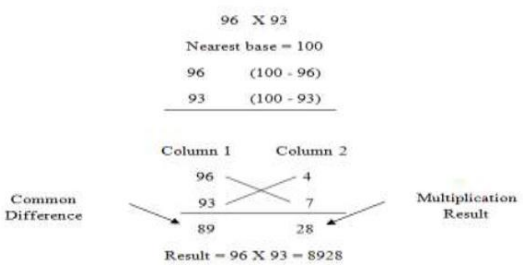

Figure: Multiplication using Nikhilam Sutra

Karatsuba-Ofman

This type of sutra is measured as fastest method for multiplication of long integers. This sutra depends on divide and conquers policy. A multiplication of 2n number integer is comprised to two n number multiplications, one n number subtractions, two (n+1) number multiplication, two left move processes, two n number additions and two 2n number additions.

Complex Multiplier

By using equivalent subtrcators and adders, complex multiplier has been planned by Saha. Complex multiplier design by direct method of implementation which use the Vedic Subtractors and Vedic Multipliers, Multiplication Algorithm

<Input>

A and B: factor and multiplier correspondingly. Both are difficult figures .A=Ar+ jA; and B =Br +jB; (here all are N Bit unidentified figures).

Step l. Select the suitable base using RSU.

Step2. The number is multiplied and then added or subtracted for obtaining the real as well as unreal part of the outcome.

<Output>

Result: Cr and C; are the real and unreal part of complex digit respectively.

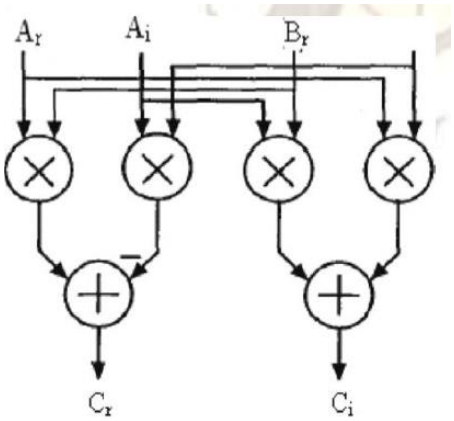

Figure: Implementation of Complex multiplier design

Convolution

Two joining of two signals for the formation of new third signal comes under the mathematical methods. It is the use of 4 bit Vedic Multiplier through which 4*4 multiplier is formed, 2*2 multiplier chunks. Here, the factors using the bit size that n=4 which gives outcomes of 8 bit size. The input is fragmented into smaller chunks of size of n/2 = 2, for both inputs that is a and b. These new formed chunks of 2 bits are given as input to 2*2 multiplier chunk and outcome produced 4 bits, which are output shaped from 2x2 multiplier chunk are sent for adding to an adding tree.

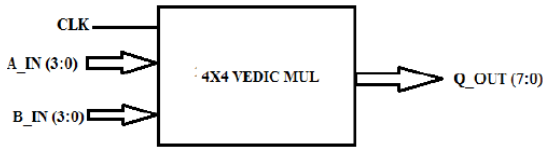

Figure: 4 bit Vedic Multiplier

Little alteration is necessary for advanced digit of bits in input and while in input, the number of bit is divided in two equal parts. An original multiplier architecture depends on Urdhva Triyagbhyam Sutra of Earliest Indian Vedic Mathematics is fixed into planned technique of complication to recover its competence in relation of area and speed.

Deconvolution

Deconvolution is a process in which two functions are taken; one input is convolved sequence y(n) and other one is h(n), by which a single function output x(n) is produced. For Deconvolution, a direct way is offered for performing Deconvolution of binary fixed span orders. The basic motive is especially for the searching the Deconvolution of fixed length sequences.

Review of Literature

Ismail and Sivasubramniam 2010, dictated that Vedic mathematics has positive effects on pupils by solving the multiplication problem in less time. Pupil must remember that the Vedic technique will be useless if applied on which they are out of work produce of two digits less than or equal to five. Vedic method would be used in automated way as one use a device like calculator.

Somani et.al 2012, concluded that Vedic Multiplier consist 16 Sutras in which one Urdhva Tiryagbhyam, is smallest, fastest multiplier using low power. This type of sutras is dominated the other type of sutras as number of bits increases in multiplication. The traditional multipliers can be replaced by Urdhva Tiryagbhyam due to various factors such as space, timing efficiency, lesser area and PDP. In Urdhva Tiryagbhyam, consist of power, PDP and Delay which is reduced by 28.84%, 24.65% and 46.38% compare to Hierarchical Array (HAM) and 10.43%, 17.98% and 26.54% compare to Urdhva Tiryagbhyam multiplier respectively.

Nagaraju, Prakash and Bhaskar 2013, stated that original complex digit multiplier project depends on the formulae of the earliest Indian Vedic Mathematics that is extremely appropriate for high speed complex mathematics routes, have many applications in VLSI signal processing. In spice spectre, employment was done and matched with generally used architecture like dispersed. The developed Complex Multiplier design is modelled and is simulated using Modelsim tool.

Dighorikar and Haridas 2014, concluded that multiplier is very important element in any processor design and a computer spends substantial amount of time in executing and generally the most area consuming. Multiplier contain a major design issue which is optimizing the area and sped. By using new techniques, improvement in multiplication speed which can greatly improve system performance.

Jain 2014, stated that in this paper, emphasis on the different projects of multipliers that are based on Vedic Mathematical sutras. Vedic mathematics sutras can be used in spite of using different arithmetic operation such as division and multiplication etc. and it is used in various applications like digital signal processing, image processing, and computation of complicated calculations. It emphasis on Vedic mathematics sutras that are used in multiplier and provide better result and have a lot of space in the field of computer.

Dharmannavar and Dharmambal 2015, by using Matlab, implementation of IIR and FIR (Infinite Impulse Response Filter). In Graphical user interface window, FIR filter design that is based on window, is applied using Urdhwa Tiryakbyam multiplication Vedic sutra. By observing the outcomes, it is known that the performing time is taken by Vedic technique using Urdhwa Tiryakbyam multiplication is less rather than the conventional techniques. These Vedic sutras are much more efficient to orthodox method. Using filter technique which is use of Urdhwa Tiryakbyam multiplication method to improve the techniques that is used in Image processing, network secutiy, stenography.

Conclusion

Ancient Indian Vedic Mathematics developed original complex digit multiplier which is a project relied on formulas and it have highly appropriate for high speed complex mathematics circuit. In this paper, discuss about the techniques on multiplication factors (16 sutras) due to which mathematics equations are solved in less time and this techniques are very suitable tool. Students are satisfied from

these techniques and they says that these technique are very helpful for them. With the help of Vedic Mathematics, calculating the linear convolution and Deconvolution that are easy to perform and learn.

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