ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Design a DSP Operations using Vedic Mathematics

P.Sreemantha
M.Tech Student,
Department of ECE,
KITS for Women's, kodad, T.S, India.

Ms.B.Jyothirmayee
Associate Professor,
Department of ECE,
KITS for Women's, kodad, T.S, India.

ABSTRACT:

Digital Signal Processing (DSP) operations are very important part of engineering as well as medical discipline. Designing of DSP operations have many approaches. For the designing of DSP operations, multiplication is play important role to perform signal processing operations such as Convolution and Correlation. The new approach of this implementation is mentally and easy to calculate of DSP operations for small length of sequences. In this paper a fast method for DSP operations based on ancient Vedic mathematics is contemplated. The implementation of high speed DSP operations of two finite length sequences using Vedic Urdhava-Triyagbhayam Multiplication Sutra (approach/method) is done. Urdhava-Triyagbhayam Sutra is very efficient multiplication formula applicable for all types of multiplication. This algorithm is implemented in MATLAB and all the operation is performed in single Graphical User Interface (GUI) window. Vedic mathematics based DSP operations reduce the processing time as compare to inbuilt function of MATLAB. It reduces the 40-60% time from inbuilt function and this algorithm operates in concept of Vedic multiplier.

Index Terms:

DSP, Vedic mathematics, Vedic Multiplier, Vedic Convolution, Vedic Correlation, GUI.

1. INTRODUCTION:

Many Indian Secondary School students consider Mathematics a very difficult subject. Some students encounter difficulty with basic arithmetical operations. Some students feel it difficult to manipulate symbols and balance equations. In other words, abstract and logical reasoning is their hurdle.

Many such difficulties in learning Mathematics enter into a long list if prepared by an experienced teacher of Mathematics. Volumes have been written on the diagnosis of 'learning difficulties' related to Mathematics and remedial techniques. Learning Mathematics is an unpleasant experience to some students mainly because it involves mental exercise. Of late, a few teachers and scholars have revived interest in Vedic Mathematics which was developed, as a system derived from Vedic principles, by Swami Bharati Krishna Tirthaji in the early decades of the 20th century. Dr. Narinder Puri of the Roorke University prepared teaching materials based on Vedic Mathematics during 1986 - 89. A few of his opinions are stated hereunder:

i) Mathematics, derived from the Veda, provides one line, mental and superfast methods along with quick cross checking systems.

ii) Vedic Mathematics converts a tedious subject into a playful and blissful one which students learn with smiles.

iii) Vedic Mathematics offers a new and entirely different approach to the study of Mathematics based on pattern recognition. It allows for constant expression of a student's creativity, and is found to be easier to learn.

iv)In this system, for any problem, there is always one general technique applicable to all cases and also a number of special pattern problems. The element of choice and flexibility at each stage keeps the mind lively and alert to develop clarity of thought and intuition, and thereby a holistic development of the human brain automatically takes place.

v) Vedic Mathematics with its special features has the inbuilt potential to solve the psychological problem of Mathematics - anxiety.

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2. METHODOLOGY:

1.2 Vedic Mathematical Formulae:

the list of the formulae from stray references in the text. The list so compiled contains Sixteen Sutras and Thirteen Sub - Sutras as stated here under.

1. Ekadhikena Purvena – By one more than the previous one.
2. Nikhilam Navatascaramap Dasatah – All from 9 and last from 10.
3. Urdhva-Tiryagbhyam – Vertically and crosswise.
4. Paravartya Yojayet – Transpose and adjust.
5. Shunyam Samyasamuccaye – When the sum is the same that sum is zero.
6. (Anurupye) Shunyamanyat – If one is in ratio, the other is zero.
7. Sankalana-Vyavakalanabhyam – By addition and by subtraction.
8. Puranapuranabyham – By the completion or no completion.
9. Calana-Kalanabyham – Differences and Similarities.
10. Yaavadunam – Whatever the extent of its deficiency.
11. Vyastisamanstih – Part and Whole.
12. Sesanyankena Caramena – The remainders by the last digit.
13. Sopantyadvayamantyam – The ultimate and twice the penultimate.
14. Ekanyunena Purvena – By one less than the previous one.
15. Gunitasamuccayah – The product of the sum is equal to the sum of the product.
16. Gunakasamuccayah – The factors of the sum is equal to the sum of the factors.

3. IMPLEMENTATION:

In the text, the words Sutra, aphorism, formula is used synonymously. So are also the words Upa-sutra, Sub-sutra, Sub-formula, corollary used. Now we shall have the literal meaning, contextual meaning, process, different methods of application along with examples for the Sutras. Explanation, methods, further short-cuts, algebraic proof, etc follow. What follows relates to a single formula or a group of formulae related to the methods of Vedic Mathematics.

1.3 Urdhva – tiryagbhyam:

Urdhva-Tiryagbhyam sutras are the basic sutras which is applicable for all case of multiplication. This itself is very short and compendious consisting of only one combine word and means “vertically and crosswise” i.e. the first bit of multiplicand and the first bit of multiplier are multiplied with vertically and crosswise method. Vertically and crosswise multiplication procedure is also known as array multiplication technique [7]. Fig-1 represents the 6×6 multiplier using vertically and crosswise method. Urdhva – tiryagbhyam is the general formula applicable to all cases of multiplication and also in the division of a large number by another large number. It means

(a) Multiplication of two 2 digit numbers.

Ex.1: Find the product 14 X 12

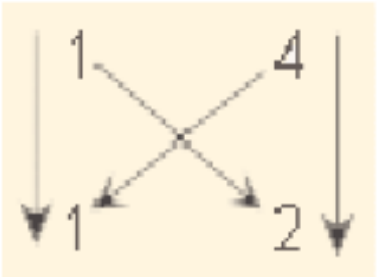
i) The right hand most digit of the multiplicand, the first number (14) i.e., 4 is multiplied by the right hand most digit of the multiplier, the second number (12)i.e., 2. The product 4 X 2 = 8 forms the right hand most part of the answer.

ii) Now, diagonally multiply the first digit of the multiplicand (14) i.e., 4 and second digit of the multiplier (12) i.e., 1 (answer 4 X 1=4); then multiply the second digit of the multiplicand i.e.,1 and first digit of the multiplier i.e., 2 (answer 1 X 2 = 2); add these two i.e.,4 + 2 = 6. It gives the next, i.e., second digit of the answer. Hence second digit of the answer is 6.

iii) Now, multiply the second digit of the multiplicand i.e., 1 and second digit of the multiplier i.e., 1 vertically, i.e., 1 X 1 = 1. It gives the left hand most part of the answer.

Thus the answer is 16 8.

Symbolically we can represent the process as follows



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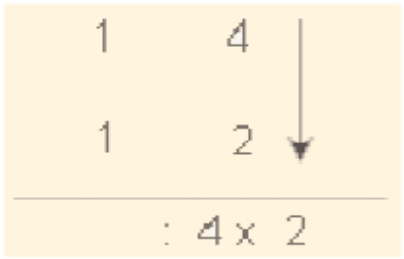

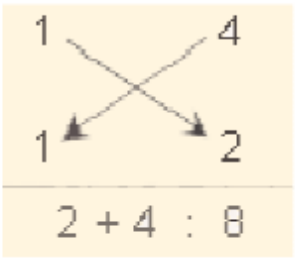

41
X 41

16: 4 + 4: 1 = 1681

What happens when one of the results i.e., either in the last digit or in the middle digit of the result, contains more than 1 digit? Answer is simple. The right – hand – most digit thereof is to be put down there and the preceding, i.e., left –hand –side digit or digits should be carried over to the left and placed under the previous digit or digits of the upper row.

Multiplicand : x0 x1 x2 x3 x4 x5
Multiplier : h0 h1 h2 h3 h4 h5

Step-1 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y0=x0*h0;

Step-2 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y1=x0*h1+x1*h0;

Step-3 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5

Step-4 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y3=x0*h3+x1*h2+x2*h1+x3*h0;

Step-5 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y4=x0*h4+x1*h3+x2*h2+x3*h1+x4*h0;

Step-6 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y5=x0*h5+x1*h4+x2*h3+x3*h2+x4*h1+x5*h0;

Step-7 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y6=x1*h5+x2*h4+x3*h3+x4*h2+x5*h1;

Step-8 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y7=x2*h5+x3*h4+x4*h3+x5*h2;

Step-9 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y8=x3*h5+x4*h4+x5*h3;

Step-10 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y9=x4*h5+x5*h4;

Step-11 x0 x1 x2 x3 x4 x5
h0 h1 h2 h3 h4 h5
y10=x5*h5;

4. DISCUSSION:

Digital Signal Processing (DSP) operations are very important part of engineering as well as medical discipline. Designing of DSP operations have many approaches. For the designing of DSP operations, multiplication is play important role to perform signal processing operations such as Convolution and Correlation. The new approach of this implementation is mentally and easy to calculate of DSP operations for small length of sequences. In this paper a fast method for DSP operations based on ancient Vedic mathematics is contemplated. The implementation of high speed DSP operations of two finite length sequences using Vedic Urdhava-Triyagbhayam Multiplication Sutra (approach/method) is done. Urdhava-Triyagbhayam Sutra is very efficient multiplication formula applicable for all types of multiplication.

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DSP operation is the heart of the mobile communication and satellite communication system. The convolution plays a preciously role in Digital Signal Processing and Image Processing. It is used for designing of digital filter and correlation application. The linear convolution effectively designs by using simple Vedic multiplier. Convolution is basic concept to designing the finite impulse response filter, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT). Linear Convolution of two finite length sequence normally computed by using the application of Discrete Fourier Transform .

Design of all DSP operations with the help of high speed Vedic multiplier which increase the efficiency of system and reduces the processing time. In this method compute the 2N-1 point convolution sequence from N point discrete time sequence and N-point circular convolution of using 2N-1 point Convolution of discrete time sequence. To reduce the processing time of DSP such as Right–angle circular convolution is operation proposed alternative method.The convolution of f and g is written fg, using an asterisk or star. It is defined as the integral of the product of the two functions after one is reversed and shifted. As such, it is a particular kind of integral transform:

$$(f * g)(t) \stackrel{\text{def}}{=} \int_{-\infty}^{\infty} f(\tau)\, g(t-\tau)\, d\tau$$

$$= \int_{-\infty}^{\infty} f(t-\tau)\, g(\tau)\, d\tau$$

Linear Convolution:

Let us consider two input sequence

x(n)=[x(0), x(1), ..., x(L-1)] .....(u)

and

h(n)=[h(0),h(1), ... , h(M+1)] .....(v)

The convolution [8] of the length-L input X with the order-M filter h will output the sequence Y(n).

$$y(n) = \sum_{m}^{M} h(m)x(n-m) \quad \ldots (1)$$

$0 \le m \le M$ For h(m) ...(2)

$0 \le n-m \le L-1$ For x(n-m) ...(3)

$m \le n \le L-1+m$ or

$0 \le n \le L-1+M$ For n ... (4)

Then output sequence y(n) is y = [y(0), y(1),.....,y(L-1+M)];

$L_y = L_x + L_h - 1$

h = | M+1 |

x = | L |

y = x*h = | L | M |

From Equation (3)-(L -1) ≤ m- n ≤ 0Adding both side nn -(L -1) ≤ m ≤ nm must satisfy simultaneously the inequalities0 ≤ m ≤ Mn -(L -1) ≤ m ≤ n

From above relation m must be greater than the maximum of the two left- hand sides and less than the minimum of the two right- hand sides.

Max (0,n-L+1) ≤ m ≤ Min(n,M)

Then the Direct form of Convolution

$$y(n) = \sum_{m=\max(0,n-L+1)}^{\min(n,M)} h(m)x(n-m);$$

n=0,1,2,……..L+M-1 ……..(5)

Equation (5) represents the linear convolution of input sequence x and h for n = 0, 1... L+M-1.

Circular Convolution:

Technically linear convolution gives an opportunity to calculate a L-point circular convolution of the two input sequence. The circular convolution of the L+M-1 point linear convolution calculate from given condition.

yc (n) = y0(n) + y0(L + n) …..(6)

n = 0, 1... L-2

Equations (6) represent the Circular Convolution.

Correlation:

Design of correlation is similarly as linear convolution only that we deal with a reflected version of one signal. First input signal is simple but second input signal is reflected. After applying convolution process (Equation (u) is same and reflected the value of equation of (v)). Let us consider two input sequence are x(n) = [x(0), x(1),....., x(L-2), x(L-1)] and h (n) = [h(M+1), h(M), ... , h(1), h(0)]. Convolution operation with both the input sequences, calculate the correlation operation y (n).

5. RESULT:

Vedic operation is implemented on Graphical User Interface window. Basically GUI is a program which provides the benefits of computer's graphics capabilities to make program easy to use. Graphical user Interface provides user an spacious way to interact with software. The most renowned and essential part of the software that is being used today is Graphical User Interface, GUI [10].

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6. CONCLUSION:

A fast computation of DSP operations of two finite length sequences implemented with the help of single GUI window. DSP operations are based on Urdhava-Triyagbhyam method of Vedic mathematics, which reduces the processing time as compare to inbuilt function of Matlab. Proposed algorithm provide average processing time in micro second and conventional operation provide average time in mili second. Mathematics operation time give in Graphical User Interface window is easy to use and user friendly. In future, the Fast Fourier Transform and Filter operation is design with the help of Vedic Urdhava- Triyagbhyam method.

7. ACKNOWLEDGMENTS:

I am P.Sreemantha and would like to thank the publishers, researchers for making their resources material available. I am greatly thankful to Assistant Prof: Miss.B.Jyothirmayee for their guidance. We also thank the college authorities, PG coordinator and Principal for providing the required infrastructure and support. Finally, we would like to extend a heartfelt gratitude to friends and family members.

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Author's Details:

Ms.P.Sreemantha. MTech student, in M.Tech Student, Dept of CSE in KITS for women's,kodad, T.S, India.

Ms.B.Jyothirmayee working as a Assistant at ECE in KITS for women's,kodad, T.S, IndiaJNTUH Hyderabad. she has 3 years of UG/PG Teaching Experience.

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