# A Review on Vedic Mathematics Used in Digital Signal Processing

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*Abstract*— Digital signal processing (DIP) is the technology that is omnipresent in almost every engineering discipline. It is also the fastest growing technology this century and, therefore it poses tremendous challenges to the engineering community. Faster additions and multiplications are of extreme importance in DSP for convolution, discrete Fourier transforms digital filters etc. The core computing process is always is multiplication routine; therefore, DSP engineers are constantly looking for new algorithms and hardware to implement them. Vedic Mathematics is the name given to the ancient system of mathematics, which was rediscovered, from the Vedas between 1911 and 1918 by Shri Bharti Krishna Tirthaji. The whole of Vedic mathematics is based on 16 sutras (word formulae) and manifests a unified structure of mathematics. As such the methods are complementary, discrete and easy, as compare to other calculation. In this paper we have present literature review on Vedic Mathematics with digital image processing.

***Key words:*** Vedic Mathematics, Nikhilam Sutra, Urdhva-tiryakbhyam, RSA algorithm.

## I. INTRODUCTION

Vedic multiplication is an important fundamental function in convolution operation which is basic concept to design FIR filter. In a DSP system a multiplier must be fast and must have sufficient precision (bit width; think logic circuits) to support the desired application. A high quality filter will in general will require more multiplications than one of lesser quality, so throughput suffers if the multiplier is not fast. Multiplier based on Vedic Mathematics increases the efficiency of system and reduces the processing time. Multiplication-based operations are currently implemented in many Digital Signal Processing (DSP) applications such as convolution, Fast Fourier Transform (FFT), and filtering etc. Since multiplication dominates the execution and processing time of most DSP algorithms, so there is a need of high speed multiplication technique. At the present time, multiplication time is the main factor in determining the instruction time of a DSP chip.

Here direct method of computing the discrete linear convolution [11] of finite length sequences is used. Vedic Mathematics is the ancient system of mathematics which has a unique technique of calculations based on 16 Sutras. The work has proved the efficiency of Urdhva Tiryakbhyam Sutra. Vedic method for multiplication which strikes a difference in the actual process of multiplication. Urdhva Tiryakbhyam Sutra is most efficient Sutra (algorithm), giving minimum delay for multiplication of all types of numbers; either small or large. Multiplication dominates the execution time of most DSP algorithms so there is a need of high speed multiplier [5]. Vedic mathematic is part of a four Vedas (books of wisdom). It is part of Sthapatya- Veda (book on civil engineering and architecture), which is an Upaveda (supplement) of Atharva Veda. It gives explanation of several mathematical terms including arithmetic, geometry (plane, co-ordinate), trigonometry, quadratic equations, factorization and even calculus. His Holiness Jagadguru Shankaracharya Bharti KrishnaTeerthaji Maharaj (1884-1960) comprised all this work together and gave its mathematical explanation while discussing it for various applications. Swamiji constructed 16 Sutras (formulae) and 16 Upasutras (sub formulae) after extensive research in Atharva Veda.

Obviously these formulae are not to be found in present text of Atharva Veda because these formulae were constructed by Swamiji himself. Vedic Mathematics is not only a mathematical wonder but also it is logical. Due to these phenomenal characteristics, Vedic Mathematics has already crossed the boundaries of India and has become an interesting topic of research in abroad. Vedic Mathematics deals with several basic as well as complex mathematical operations. The word "Vedic" is derived from the word **"Veda"** which means the store house of all knowledge. Vedic Mathematics is mainly based on 16 Sutras (or aphorisms) dealing with various branches of mathematics like arithmetic, algebra, geometry etc.

## II. ANCIENT VEDIC MATHEMATICS

The word "Vedic" is a Sanskrit word derived from the word "Veda" which means the collection of all knowledge. Veda is a gift from ancient sages of India to this world. From the ancient time Vedas were passed from previous generation to next generation orally rather than written. Vedic Mathematics is mainly based on 16 Sutras (or aphorisms) dealing with various branches of mathematics like arithmetic, algebra, geometry etc. These Sutra's meanings with few words enlisted below alphabetically:

(1) (Anurupye) Shunyamanyat – if one is in ratio, the other is zero.
(2) Chalana-Kalanabhyam – Differences and similarities.
(3) Ekadhikina Purvena – By one more than the previous one.
(4) Ekanyunena Purvena – By one less than the previous one.
(5) Gunakasamuchyah – The factors of the sum is equal to the sum of the factors.
(6) Gunitasamuchyah – The product of the sum is equal to the sum of the product.
(7) Nikhilam Navatashchramam Dashatah – All from 9 and last from 10.
(8) Parvarya Vojayet – Transpose and adjust.
(9) Purnapurnabhyam – By the completion or no completion.
(10) Sankalana- Vyavakalanabhyam – By addition and by subtraction.
(11) Shesanyankena Charamena – The reminders by the last digit.
(12) Shunyam Saamyasamuchyah – When sum is the same that the sum is zero.

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(13) Sopaantyadvayamantyam – The ultimate and twice the penultimate.
(14) Urdhva- Tiryagbhyam – Vertically and crosswise.
(15) Vyashtisamanstih – Part and whole.
(16) Yaavadunam – Whatever the extent of its deficiency.

The attractive feature of Vedic Mathematics lies in the fact that is reduces the complex looking calculations in conventional mathematics to a very simple one. This is so because the Vedic formulae are claimed to be based on the natural principles and sutra on which the human mind works. This is a very interesting field and presents some effective algorithms which can be applied to various branches of engineering such as computing and digital signal processing [9,10].

## III. URDHAVA TRIYAGBHYAM SUTRA

Urdhava Triyagbhyam is a Sanskrit word that intends to say "vertically and crosswise" [12, 13] in English. Vertically and crosswise multiplication procedure is also known as array multiplication technique i.e. the first bit of multiplicand and the first bit of multiplier are multiplied with vertically and crosswise method. The multiplication technique is based on an algorithm Urdhava Triyagbhyam of ancient Indian Vedic Mathematics. This basic sutra helps to do almost all the numeric computations in easy and faster manner. This algorithm can be applicable to all cases of any N x N bit multiplication. This sutra also shows the effectiveness of reducing the N x N multiplier structure into an efficient 4x4 multiplier structures. The efficiency of Urdhava Triyagbhyam method for multiplication that delivers a difference in the actual process of multiplication itself.

## IV. NIKHILAM NAVATASCHARAMAM DASATAH

The formulae simply means: "all from 9 and the last from 10". The formula can be very effectively applied in multiplication of numbers, which are nearer to bases like 10, 100, 1000 i.e., to the power of 10. The procedure of multiplication using the Nikhilam involves minimum number of steps, time saving and only mental calculation. The numbers taken can be either less or more than the base considered. The difference between the number and the base is termed as deviation. Deviation may be positive and negative. Positive deviation is written without positive sign and the negative deviation is written using Rekhank (a bar on the number). Now observe following table-

| Number | Base | Number - Base |
|---|---|---|
| 14 | 10 | 14 - 10 |
| 8 | 10 | 8 - 10 |
| 97 | 100 | 97 - 100 |
| 112 | 100 | 112 - 100 |
| 993 | 1000 | 993 - 1000 |
| 1011 | 1000 | 1011 - 1000 |

## V. DIGITAL SIGNAL PROCESSOR (DSP) OPERATION

Digital signal processing is a specialized microprocessor with its architecture optimized for the operational needs of digital signal processing. The goal DSP operation of performs different type of task in processor. DSP work directly effect to the microprocessor working –

### *A. Multiplication*

In this situation, we are using the "asterisk" (*) to denote multiplication. Realistically, we should use the "x" symbol for multiplication. In later examples, we will use the asterisk for other operations.

A[n] * B[n] = [(W*I) (X*J) & (Y*K) (Z*L)]

### *B. Division*

A[n] / B[n] = [(W/I) (X/J) & (Y/K) (Z/L)]

Even though we are using the square brackets for discrete data sets, they should not be confused with matrices. These are not matrices, and we do not perform matrix operations on these sets.

### *C. Time – Shifting*

If we time shift a discrete data set, we essentially are moving the zero-time reference point of the set. The zero point represents "now', creates the starting point of our view of data, and the points location is typically established by a need of the processing we're involved it.

Discrete data values are time oriented. Values to the right of the zero point are called "future Values", and values to the left are "past values". When the data set is populated on the both sides the zero references, "future" and "past" are synthetic terms relative to the zero point "now", and don't refer to current physical time. In this context, the data values have already been collected and as such, can only come from our past.

### *D. Convolution*

This operation can be performed using this MATLAB command: **conv**

Convolution is a much easier operation in the discrete time domain than in the continues time domain. Let's say we have two data sets, A[n] and B[n]:

A[n] = [1 & 0 1 2]
B[n] = [2 & 2 2 1]

We will denote convolution with the asterisk (*) in this section; it isn't "multiplication" here. Our convolution function is shown like this:

Y[n] = A[n] * B[n]

And it specifies that we will store our convolution values in the set named Y[n].

Convolution is performed by following a series of steps involving both sets of data points. First, we time invert one of the data sets. It doesn't matter which one, so we can pick the easiest choice:

A[n] = [1 & 0 1 2]
B[-n] = [1 2 2 2 &]

Next, we line up the data vertically so that only one data item overlaps:

A [n] -> [0 0 0 1 & 0 1 2]
B [-n] -> [1 2 2 2 & 0 0 0]

There are some examples of DSP operation. In this paper we have to focus on perform these operations on the on "Vedic Mathematics" with the help of different type of Vedic operations.

## VI. CONCLUSION

Fast filtering process is one of the most critical issues to any filter. Fast computation of any filter processor consumes less

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time to filter the input response. Multiplication technique is the deciding factor which decides the speed of processor or how fast the computation or filtering process taking place. The use of faster multiplier will do the faster filtering process. Since the concept of Vedic multiplication technique depends on mental calculation with the help of simple rules and principles. Thus Vedic mathematics plays vital role in the fast filtering process of FIR filter.

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