

A Review of Vedic Multiplier

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Abstract—In this paper, deals with efficient multiplier. The Ancient algorithms of the Vedas that is known as Vedic Mathematics, introduced by Sri Bharati Krishna Tirthaji Maharaja is the base of Vedic Multiplier . Sri Bharati Krishna Tirthaji Maharaja gives 16 Sutra, two of these Sutra are usually use in multiplication algorithms. Nikhilam Sutra and Urdhva-Tiryagbhyam Sutra is disused. Nikhilam sutra is efficiently used for number which is near to the base whereas Urdhva–Tiryagbhyam is applicable for all numbers. Application of the Sutras improves the computational skills of the learners, resulting both high speed and accuracy.

Keywords— Vedic Multiplier, Vedic Mathematics, Nikhilam Sutra and Urdhva–Tiryagbhyam.

I. INTRODUCTION

The earlier microprocessors did not have a Multiplier unit in it; in place of these they used multiply programs, for adding and shifting of the partial results to obtain the final result of multiplication. As the technology grow, faster and faster, the designing of a multiplier unit has becoming major part in the digital world to provide a better results.

The multiplier is the most important unit in every digital system. The speed of digital system depends upon speed of multiplier, area, and throughput. Multipliers using Vedic Mathematics are comparatively high speed and low power dissipation than other conventional multipliers.

II. VEDIC MATHEMATICS

VEDIC MATHEMATICS is a mathematical which deals with 'Sixteen Simple Mathematical formulae which is known as Sutra, from the Vedas' given by Sri Bharati Krishna Tirthaji. Out of 16 Sutra two are discussed below:

A. *Nikhilam Navatascaramam Dasatah*

The formula simply means: “all from 9 and the last from 10”.The sutra apply from the left most digit and begin subtracting 9’from each of the digits; but subtract 10’ from the last digit means right most number.

The formula is applied effectively to the multiplication of numbers, which are closer to bases like 10, 100, 1000 i.e., to the powers of 10. The Nikhilam Sutra for multiplication involves minimum

space, number of steps, time saving and it involves only mental calculation. The numbers is either less or more than the base that is considered.

The result of difference between the number (multiplicand and multiplier) and the base is known as deviation.

Deviations are of two types: positive or negative. Positive deviation is written without any sign and the negative deviation by bar or simply negative sign. Table.1 shows deviations with different bases.

Table .1 Deviations with different Bases

Number	Base	Deviation
14	10	4
8	10	-2
103	100	3

The example, which is given below shows the procedure by which this Sutra could reduce the number of steps to reduce the whole Multiplication.

To multiply 91 X 91. Apply Nikhilam Sutra: All from nine and last from ten on both the numbers.

$$\begin{array}{r} 91 \quad \Rightarrow \quad -9 \\ 91 \quad \Rightarrow \quad -9 \end{array}$$

Figure.1 Subtraction of 10 and 9 from both the numbers.

The arrows in Fig.1 shows the operation of the Nikhilam Sutra being performed, the subtraction of 10 from the rightmost digit and 9’s from all the other digits starting with the leftmost digit.

- Multiply (-9) and (-9) to get ‘81’.

$$\begin{array}{r} 91 \quad \Rightarrow \quad -9 \\ 91 \quad \Rightarrow \quad -9 \quad \times \\ \hline \quad \quad \quad \quad \quad 81 \end{array}$$

Now add cross-wise. We get 82 by adding 91 and -9.

$$\begin{array}{r} 91 \\ 91 \end{array} \begin{array}{l} \diagdown \\ \diagup \end{array} \begin{array}{r} -9 \\ -9 \end{array}$$

Here, we get same result on cross addition.

$$\begin{array}{r} 91 \\ 91 \\ \hline 82 \quad 81 \end{array}$$

Figure 2 Multiplication of 2-bit number.

Thus result of 91×91 will be 8281. This technique is suited for the numbers to be multiplied which are nearer to the base.

B Urdhva - Tiryagbhyam

Urdhva –Tiryagbhyam means “Vertically and crosswise”. It is the general formula applicable decimal number as well as binary numbers and for all cases of multiplication.

It is based on a novel concept through which the generation of all partial products and then concurrent addition of these partial products can be done. Thus parallelism in generation of these partial products and their summation is obtained using Urdhva-Tiryagbhyam. The algorithm can be generalized for n bit number, since the partial products and their sums are calculated simultaneously.

To explain this multiplication, consider the multiplication of two decimal numbers ($12 * 14$). Initially the rightmost digits on the both sides are multiplied and results in least significant digit of product result and if carry is generated. This carry is added in the next step and the process goes on likewise. In each step, least significant bit act as the result digit and all other digits act as carry for the next step. Initially zero is to be taken as carry.

a) Two 2 digit number Multiplication:

Ex.1: Find the product 22×14

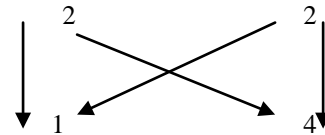
i) The right hand most digit of the multiplicand (22) i.e., 2 is multiplied by the right hand most digit of the multiplier (14), the second number (14) i.e., 4. The product $2 \times 4 = 8$ forms the least significant part of the answer.

ii) Now, diagonally multiply the first digit of the multiplicand (22) i.e., 2 and second digit of the multiplier (14) i.e., 1 (answer $2 \times 1 = 2$); then multiply the second digit of the multiplicand i.e., 2 and first digit of the multiplier i.e., 4 (answer $2 \times 4 = 8$); add these two i.e., $2 + 8 = 10$. It gives the next, i.e., second digit of the answer. Hence second digit of the answer is 0, here carry is generated so add carry (1) to the next step.

iii) Now, multiply the second digit of the multiplicand i.e., 2 and second digit of the multiplier i.e., 1 vertically, i.e., $2 \times 1 = 2$. Add the previous carry. It gives the left hand most part of the answer.

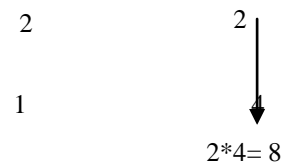
Thus the answer is 308.

Symbolically this can be represented by following process:

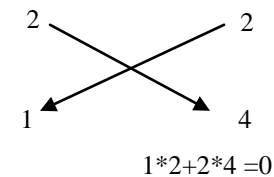


The processes will be from right to left.

Step i)

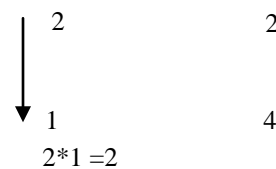


Step ii)



Sum will be 10, so 1 is carry

Step iii)



Now, answer can be written as, 308.

Consider two 4-bit binary numbers $x_3x_2x_1x_0$ and $y_3y_2y_1y_0$. The partial products ($P_7P_6P_5P_4P_3P_2P_1P_0$) generated are given by the following equations:

- i. $P_0 = x_0y_0$
- ii. $P_1 = x_0y_1 + x_1y_0$
- iii. $P_2 = x_0y_2 + x_1y_1 + x_2y_0 + P_1$
- iv. $P_3 = x_0y_3 + x_1y_2 + x_2y_1 + x_3y_0 + P_2$
- v. $P_4 = x_1y_3 + x_2y_2 + x_3y_1 + P_3$
- vi. $P_5 = x_1y_2 + x_2y_1 + P_4$
- vii. $P_6 = x_3y_3 + P_5$
- viii. $P_7 = \text{carry of } P_6$

III. CONCLUSIONS

Urdhva –Tiryagbhyam is only sutra which can be used for both decimal number system as well as binary number system for multiplication with high speed.

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