Application of Yavadunam Tavadunikritya Varganca Yojayet to Build N-BIT Binary Squaring Algorithm

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Abstract: Generation of N-BIT binary squaring algorithm using Yavadunam Tavadunikritya Varganca Yojayet, one of the Vedic Mathematics formulae by Swami Bharati Krishna Tirthaji. In this paper, we propose a concocted binary squaring algorithm to be further utilized for improvements in building efficient logic circuits for the squaring purpose. The algorithm is novel in itself and it is programmatically executed using C++ to make an analogy for better simulation. The algorithm is recursive in nature and is objected to minimize the steps of logic circuits used for efficient binary squaring.

1 INTRODUCTION

1.1 Vedic Mathematics

Vedic mathematics is a compendium of 16 Sutras (formulae) and 13 sub-sutras (Corollaries) presented by an Indian sage, Shri Bharati Krishna Tirthajee, in his book Vedic Mathematics (Das, Subhamoy,2020) . First published in 1965, the book is considered to be as a major milestone achieved in the field of speed calculation. Swami Bharati Krishna Tirtha claimed that these formulae and corollaries were extracted from Atharva Veda. As per the statements by Swami Bharati Krishna Tirtha, he worked on Vedas, the sacred ancient Indian scriptures, for many years while living in seclusion. However, Swami Bharati Krishna Tirtha faced a major criticism for his failure to produce the proofs for his claims. A thorough research has been done on the authenticity of Swami Tirtha's claims and the claims have been, supposedly, debunked by the scholars unanimously, noting that these set of formulae were mere collection of tricks with no relation with the mathematical developments of Vedic period [2]. A closer look into the formulae shows the application of deductive reasoning. Nevertheless, it is tough to deny the fact that some Vedic tricks reduce the cumbersome effort required in operating on bigger numbers.

The algorithm proposed in this paper is an amalgamation of a Vedic mathematics sutra - Urdhva Triyagbhyam and a corollary of another Vedic mathematics Sutra - Sankalana Vyaykalanabhyam [3], named Yavadunam Tavadunikritya Varga Yojayet. In fact, the presented algorithm is by far the simplified binary representation of usage of Yavadunam Tavadunikritya Varga Yojayet. It is an efficient approach of recursive nature for finding the square of any number. This paper presents an algorithm to find the square of any binary number in an efficient manner. The code for our algorithm presented in this paper is based on decimal to binary conversion. However, the presented algorithm is sought to be used in digital squaring circuits and purely based on binary operations.

1.2 Urdhva Triyagbhyam

It is one of the 16 formulae of Vedic Mathematics which means "Vertical and Crosswise" (Jagadguru Swami et al 2009), this formula is used to calculate the product of two numbers in one line of answer. The product of two numbers is result of certain number of product and sum of products, vertically and crosswise respectively. The use of Urdhva

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Triyagbhyam is desired in the binary product operations in the algorithm presented in this paper.

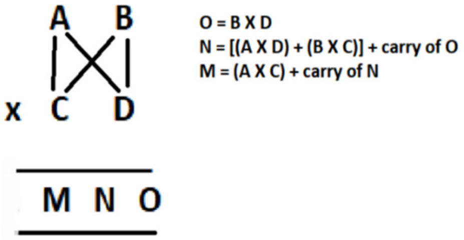

Figure 1: Urdhva-Triyakbhyam

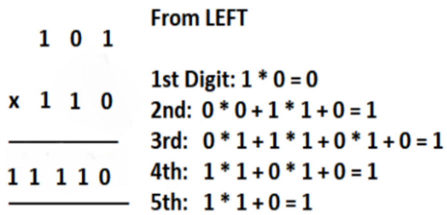

Figure 2: Example of Urdhva-Triyakbhyam

1.3 Yavadunam Tavadunikritya Varga Yojayet

It is a corollary of another Vedic mathematics Sutra - Sankalana Vyaykalanabhyam. This method is used to find the square of any number without long calculations and it is certainly better than the conventional method of finding the square of a number by simple multiplication. It requires lesser number of steps to perform a squaring operation (Jagadguru Swami et al 2009).

2 PROPOSED ALGORITHM

2.1 Related Works

In (Elango S Deepa R, 2018), Deepa A et al. have made a satiating review on the different Vedic formulae used to enhance the capacity of different squaring circuits and design.

In (A. Deepa and C. N. Marimuthu, 2018), Deepa A et al have proposed a Vedic squaring architecture based on Yavadunam algorithm. This paper proposed an enhanced architecture of Yavadunam by using bit reduction technique.

Moreover, (Nisha Angeline M & Anjali M, 2018) overcomes the issue related to delay in multipliers as it states that the array multiplier for Vedic multiplication gives a total of 6.45ns which is less as compared to the total delay of other multipliers, and the power consumption is low for the Vedic multiplication with the Wallace tree multiplier rather than the Baugh-Wooley multiplier.

2.2 Contrast

The algorithm proposed in our paper contrasts from (A. Deepa and C. N. Marimuthu, 2018) in a very subtle manner. It proposes a direct output for binary numbers like 2^N. That is, the algorithm outputs the direct value (ie. Square of $2^N = 2^{(2N-1)}$) for such binary numbers. (A. Deepa and C. N. Marimuthu, 2018) has utilized both the methods (Method 1: The given number is greater than 2^{N-1}. Method 2: The given number is lesser than 2^{N-1}.) of using Yavadunam Tavadunikritya Varga Yojayet [7]. In our algorithm architecture we have used the former as the universal way of fast squaring of any number of bits.

2.3 Proposed Algorithm and Explanation

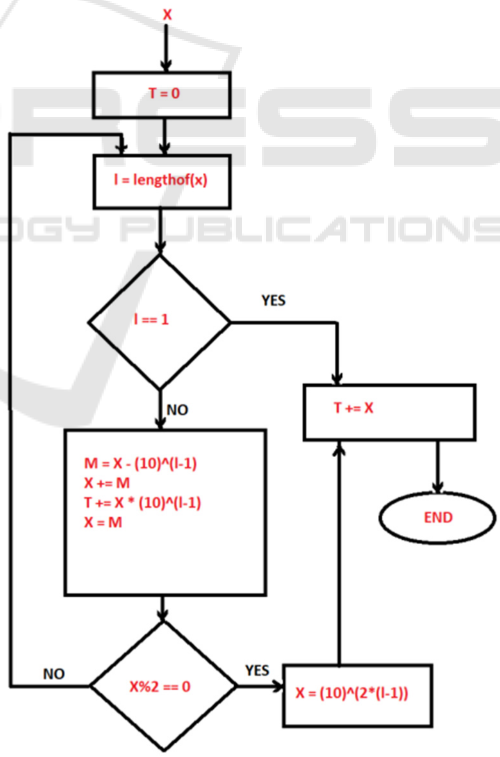

Figure 3: An Efficient Algorithm for N-bit Binary Squaring Approach utilising amalgamation of Vedic Sutras

2.4 Algorithm

Step 1: Input the binary number X that has to be squared.

Step 2: Set the result T = 0.

Step 3: Find the length l of Input X.

Step 4: 1) If length l = 1 then add X to T and output T, and stop the program.
2) Else, move to the next step.

Step 5: Set temporary variable $M = X - 2^{(l-1)}$.

Step 6: Set X = X + M.

Step 7: Set $T = T + (X * 2^{(l-1)})$.

Step 8: Set X = M

Step 9: 1) If X mod 2 = 0, set $X = 2^{2*(l-1)}$ and further add X to T, and stop the program.
2) Else, go to step 3.

Step 10: Output result T.

Step 11: End the program.

2.5 Simulation

```
VALUE OF 1111 IN DECIMAL = 15
USING VEDIC ALGO:
    INPUT X
    T=0
1)  X = 1111
    L = 4
    M = 1111-1000 = 111
    X = X+M = 10110
    T = T + (X * 10^(L-1)) = 0 + (10110 * 1000) = 10110000
    X = M = 111
2)  X = 111
    L = 3
    M = 111-100 = 11
    X = X+M = 1010
    T = 10110000 + (1010 * 100) = 11011000
    X = M = 11
3)  X = 11
    L = 2
    M = 11-10 = 1
    X = X+M = 100
    T = 11011000 + 1000= 11100000
    X = M = 1
4)  X = 1
    T = 11100000+1 = 11100001
DECIMAL VALUE OF T = 225
```

Figure 4: Simulation of Proposed Algorithm

2.6 Code

This code is a C++ implementation of the algorithm. In this code, Yavadunam Tavadunikritya Varga Yojayet is first applied on a decimal number and the result is converted into binary.

```
#include <cmath>
#include <iostream>
#include <bits/stdc++.h>
using namespace std;
#define ull unsigned long long int
// Function to return the binary
// equivalent of decimal value N
int decimalToBinary(int N){
// To store the binary number
        ull B_Number = 0;
        int cnt = 0;
        while (N != 0) {
                int rem = N % 2;
                ull c = pow(10, cnt);
                B_Number += rem * c;
                N /= 2;
// Count used to store exponent value
                cnt++;  }
        return B_Number; }
int countDigit(long long n){
        if (n == 0)
                return 0;
        return 1 + countDigit(n / 10); }
int SquareFinder(int X){
        int M, Result, T=0;
        while(countDigit(X) != 1){
              M = X - pow(10, countDigit(X)-1);
              X += M;
              T += X * pow(10, countDigit(X)-1);
              X = M;   }
        if(countDigit(X)==1)
        T += X*X;
        return T;   }
// Driver code
int main(){
        int e;
        int N = 2;
        cout<<"Enter\n";
        cin>>e;
        cout <<decimalToBinary(SquareFinder(e));
        return 0;
         }
```

3 CONCLUSION

An efficient and generalized algorithmic transformation of Vedic Sutra- Yavadunam Tavadunikritya Varga Yojayet is proposed with its analysis and simulation. A C++ program is written to show the working of the former mentioned algorithm. The code can twin the algorithm if it is applied on a purely binary programming language. The future work is to design digital circuits based on this algorithm and to look for further possibilities to reduce the number of steps required in this approach (Pabitra Kumar Mohapatra, 2018; Prabha 2011; Shatrughna Ojha, 2020, Vandana Shukla) . The algorithm has many such possibilities, like- completely remove the binary operations for inputs in the form of 2^N and produce direct results for the same without any binary operation being applied on the input.

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