RESEARCH ARTICLE OPEN ACCESS

An Area-Efficient Truncated Adaptive Booth (AET-AB) Multiplier for Signal Processing Applications

Dr.Shine N Das
Associate professor Department of computer science college of Engineering,
Munnar, kerala - India

ABSTRACT
Essentially, the key element of speech processing, Digital Signal Processing and audio processing is a multiplier. The conventional array of partial products to creates extra rows and irregularity. The steady multiplication products are truncated to *m* bits. In this article, we introduced an adaptive booth concept it is based on the multiplier truncation. Therefore, the complexity of partial product and overhead are reduced using our proposed methodology. The proposed concept architecture is implemented in Verilog HDL software also the design of RTL is manufactured. Experimentally, the bit multiplication of 8×8 with 8, 10, 12, 14 and 16 bits are used.

Keywords: Signal, VLSI, HDL, (AET-AB) Multiplier, Speech processing.

I. INTRODUCTION

Fundamentally, the digital system designing with the major critical design constrain is power consumption. The crucial digital system like space system, surveillance units, system security, functional defences and medical supervisory are highly significant with low power, high reliable and low overhead area of functional units [1]. The energy consumption is reduced by using approximate computing concept but it never produces the accurate output. Recently, the requirement of VLSI (Very Large-Scale Integration) is increased day by day because of low power consumption and hand held device demand. For the designing process of the VLSI circuit, there is a trade-off among the occupied area and power delay [2]. Especially, the arithmetic operations cause the signal processing in the area of energy consumption. The Graphics signal processing, central signal processing and digital signal processing units are the major component of the arithmetic circuit. For the operation of energy consumption and high latency by multiplication operation is used frequently [3]. In signal processing units, the error-tolerant are produced by using multiplier approximation. Hence, many more circuit level methods are used for the designing of adder and fault-tolerant respectively. Significantly, the Baugh Wooley and Booth are the widely used multiplier algorithms and it produces the powerful hardware implementation output. Mostly the Booth algorithms were effectively used and numerous alterations are discussed in the survey section. Moreover, the adder complexity and row of partial product array are reduced by using higher radix booth multiplication [7]. Thus, the partial product selector and generator complexity are increased by means of higher radix Booth algorithm. Thereby, low AADP of 20.8% of Booth multiplier radix-8 optimize the adder unit and it produces low power truncated plan.

II. RELATED WORKS

More researchers have been introduced the procedure and methods about area-efficient truncated based multiplier of the booth for the application of signal processing. Few of the existing methods are discussed in this section. Juang et al. [8] debated about the algorithm of recursive DFT yet the computation cycles are reduced. The DTMF application of input strength decline, higher performance and splitting register are obtained. The numerous memory requirement of DTMF detector to decode twenty-four channels only. But the memory word program of thousand with data memory of 800 by means of the word length becomes 16-bit. Consoli et al. [9, 10] suggested the method of latched pulsed pull-push and it delivers effective energy competence and less productivity. While compared to the pulsed transmission gate, the pulsed latch of pull-pushed produces higher accurate outcomes. Sivakumar et al. [11] introduced Fixed Width multiplier for the generation of partial product with the usage of modified booth algorithm. The gate basics of easy and effective sorting network are to produce the compensation function as many areas efficient. Thus, the error distribution is unsymmetrical in nature and it never appropriates to the application of multimedia. Liu et al. [12] described booth multiplier of approximate radix-4 concept. This method is more accurate and effective in terms of approximate accumulation. Because of the triple multiplicand, the least significant bit from the approximate adder of radix-8 is produced. Therefore, the radix-4 is used to encode the most significant bit but the higher radix value required to encode the most significant bit respectively.

Antelo et al. [13] recommended a modified booth algorithm for partial product generation. Therefore, the output of the encoder is to approximate the quantization error and the carry approximation is produced from the bias compensation. Hence, the error performance and speed with higher circuit performance are obtained also asymmetrical error distribution is obtained. Pouiklis et al. [14, 15] have been discussed about the flip-flop type of look-ahead clock. By using this method ten percentage of power more overly reduced. The predefined changeable and logic synthesis amalgamation is to create the enabled clock signal and it directs the clock pulses as redundant. Sasikala et al. [16] were presented the architecture of dynamic segmentation process based on the leading location, the n bits to truncate the input operand. It produces the outcome of negative mean relative error and less truncation output. Saravanan et al. [17] proposed a signal processor of low-power ECG. It is used in point detector in support of neuro modulation with fully integrated SoC and implementation problems. The shadow latch input is accumulated by the issues are solved by using filter FIR respectively but the data storing process to make many problems. The error is reduced because of the increasing number of components. Liu et al. [18, 19] suggested a concept of simple approximation and it is used to estimate the number of antilogarithm and logarithm. Thus, the final result can create logarithmic summation.

Leakage and total power estimation:

When compared to the existing methodology, the proposed truncated based booth multiplier required low silicon area [23]. Based on the method of partial product reduction with half and full adders significant number values also abridged. The proposed truncated based booth multiplier produces low dissipation of leakage power. The cell reduction in proposed concept is based on the analytical procedure [24]. Thus, the proposed method leakage and total power dissipation are compared with the existing multipliers such as carry width [25], Vedic [26], Voltage mode [27], Wallace trace multiplier [28] respectively. The additional compensation parameter is used to increase the dissipation and switching power. Therefore, the proposed methodology (AET-AB) Multiplier delivers the result of less leakage and total power, which is shown in Fig: 1 respectively.

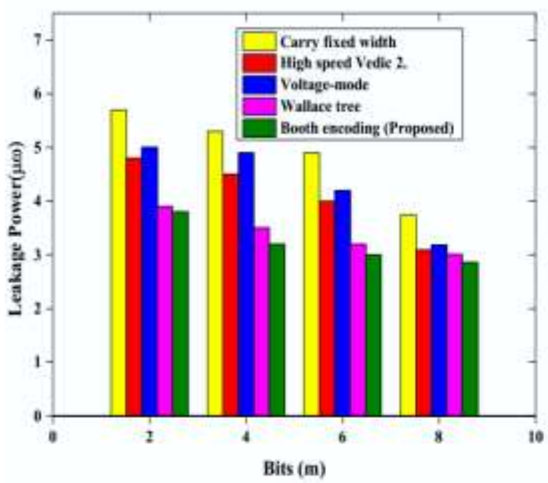

Fig 1: Performance analysis

Table 1: Tabulation of power delay and area estimation

No.of bits (m)	*Power*	*Delay*	*Area*
8	1.209	4.67	650.445
16	4.678	5.98	2345.56
32	21.76	7.98	7993.78

Error estimationusing different error normalization:

The error performances truncations in proposed system effectiveness are checked by using various error factors. Therefore, the normalized error maximum (ε_{EM}), mean absolute error (ε_{MAE}), mean square error (ε_{MSN}), mean error (ε_{ME}) are introduced [30]. The 8×8 bit multiplication of proposed error performance is carried out using $\varepsilon_{EM}, \varepsilon_{MAE}, \varepsilon_{MSN}$ and ε_{ME}. From Fig 12, the value of *m* becomes 8, 10, 12, 14 and 16 respectively. The error maximum 2^m is calculated by a bit of the least significant [31]. In all cases, the 8-bit multiplication produced the error maximum value of 256. The proposed performances of error with various normalizations are illustrated in Fig 12. The proposed truncated based adaptive booth encoding concept is compared with previous methods by means of normalized error. From this, the proposed method delivers much less point of error in all cases and it is tabulated in table 6.

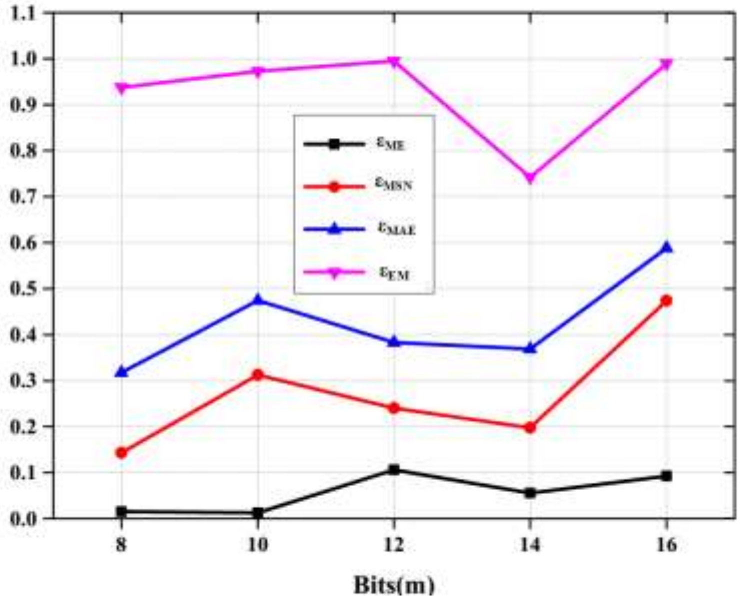

Fig 2: Error performance of the proposed method with different bit values

CONCLUSION

In this paper, we proposed a truncated based adaptive booth encoding for the reduction (AET-AB) Multiplier of extra partial product rows and the signed bit multiplication of 8×8 is used. The synthesis of RTL is designed and implemented in the software of Verilog HDL. The bits of values are 8, 10, 12, 14 and 16 used for experimentation. From our proposed concept, the bit value of *m=8* delivers low area such as 657.3816 (μm^2) also the performance of lower delay and power is obtained. Hence, the error execution of the suggested method is correlated with a normalized error such as error maximum (ε_{EM}), mean absolute error (ε_{MAE}), mean square error (ε_{MSN}) and mean error (ε_{ME}). The error maximum of (2^m) is estimated with the help of least significant bit and it provides optimal error measurement. Thus, the state-of-art concept of booth encoding delivers suitable performance outcomes in case of surface and ratio of chip area respectively.

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