EFFICIENT ON-LINE TESTING METHOD FOR A FLOATING-POINT ITERATIVE ARRAY DIVIDER

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Abstract

This work is a part of researches directed to checking methods development for approximate calculations executed in floating-point circuits in a mantissa part. A problem of the truncated non-restoring division residue checking is solved. It provides an efficient implementation of truncated division reduced almost twice hardware amount and time in iterative array divider.

1. Definition of problem

We offer an on-line testing method for a floating-point iterative array divider by implementing a residue checking.

A traditional residue checking method adapts for exact calculations executed in a completed operation doubled a result size on comparison with operand size.

Peculiarity of operations with mantissas is calculation of n-bits approximate result. It leads to truncating n of low result bits in completed operation.

An effective mantissas processing is achieved with use of truncated operations almost twice reduced hardware overhead and raise a speed for iterative array circuits without lowering of accuracy. It is peculiarly important for iterative array divider, so well as its hardware overhead and execution time proportional to operand size square.

Besides, the truncated operations essentially diminish amount of restricted bits of calculated result. This brings negative effect down from error detection in restricted bits for the residue checking method.

Known approaches to residue checking of mantissas processing founded on duplication of truncated operation or its restoring to completed operation. A lack of effective checking methods limits implementation of truncated operations. The new residue checking methods were offered for approximate calculations executed in iterative array multiplier and floating-point adder [1, 2]. In this paper the problem of truncated division residue checking in iterative array floating-point divider is consider.

2. Truncated division

We consider an iterative array non-restoring divider operated with normalized mantissas. Truncation of calculations is executed on last k rows of array. A number $k=n-log_2(n+2)$ is determined from calculation accuracy preservation condition. A truncated non-restoring division is an inverse operation for truncated multiplication of the binary divisor $d\{1 \div n\}$ on quotient $q\{0 \div n\}$, represented in notation 1, $\overline{1}$. This notation defines positive or negative weights for bits with value 1 or $\overline{1}$.

Truncated ($2n$-k)-bits product V_{TR} of divisor $d\{1 \div n\} \cdot 2^{-n}$ on quotient $q\{0 \div n\} \cdot 2^{-n}$ is connected with dividend A and truncated remainder R_{TR} by the formula

$$V_{TR} = A - R_{TR}, \qquad (1)$$

3. Checking of truncated division

We consider a residue checking by modulo $m=2^L-1$, where $L=2, 3, \ldots$ [3]. A formula (1) is transformed in (2).

$$KV_{TR} = KA - KR_{TR}, \qquad (2)$$

where $KV_{TR}=V_{TR} \bmod m$; $KA=A \bmod m$; $KR_{TR}=R_{TR} \bmod m$.

A check code KV_{TR} of truncated product V_{TR} is calculated with use of residue checking method for a truncated multiplication [1].

The offered residue checking method detects all of typical errors for iterative array non-restoring divider with truncated operation. The checking hardware overhead is reduced from square dependence on operand size to linear one without lowering of the detection ability. This opens a way for the wide spread implementation of the truncated division, which almost twice reduces hardware overhead and raises a speed of iterative array divider. Except, the truncated operation significant diminishes an error detection probability in restricted bits of computed result.

4. References

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