Binary Angle Measurement (4A)

- Redundant CORDIC
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06/20/2012

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BAM Background

T. Vladimirova, "FPGA implementation of sine and cosine generators using CORDIC algorithm", Proceedings of 2006 MAPLD International Conference

[Bake76] P.W. Baker, "Suggestion for a Binary Cosine Generator", 1975

[Erce87] M.D. Ercegovac, "Fast Cosine/Sine Implementation Using CORDIC Iterations", 1987

[Taka91] N. Takagi, "Redundant CORDIC Methods with a Constant Scale Factor For Sine and Cosine Computation", 1991

[Timm92] D. Timmerman, "Low Latency Time CORDIC Algorithms", 1992

Redundant Singed Digit (RSD)

RSD binary system

three digit set { 0, +1, -1} $\{0,\ 1,\ \bar{1}\}$

Redundant Adder

$$Y = \sum_{i=0}^{n} y_i \cdot 2^i = \sum_{i=0}^{n} \left(y_i^{*} - y_i^{**}\right) \cdot 2^i \qquad y_i^{*},\ y_i^{**} \in \{0,\ 1\}$$

Redundant CORDIC Schemes

Limitations of Redundant CORDIC

- Conversion to / from RSD (Redundant Sign Digit)
- Sign evaluation of a RSD number σ_i
- The Scale Factor is not constant K_n

  [Erce87] the scale factor is calculated during computation, corrected at the end of rotation

  [Taka91, Timm92] the scale factor is compensated during iteration process

  [Bake76] pre-computation of angle rotation σ_i

Double Rotation

[Taka91]

Combination of two sub-rotation

– rotation	⇐	– – sub-rotations
+ rotation		– + sub-rotations
0 rotation		+ + sub-rotations

two sub-rotations ⇐ double rotation

$\sigma_i = \pm 1$ ⇒ $\sigma_i \tan^{-1}(2^{-i-1})$ and $\sigma_i \tan^{-1}(2^{-i-1})$

$\sigma_i = 0$ ⇒ $+\tan^{-1}(2^{-i-1})$ and $-\tan^{-1}(2^{-i-1})$

[Timm92]

σ_i has to be estimated from the most significant digit

if all the digits inspected are zero

then it is necessary the knowledge of the remaining digits

Parallelizing the generation of σ_i by prediction

initial value in binary representation

$$z_0 = \sum_i Z_i 2^{-i} \qquad Z_i \in \{0, \ 1\}$$

$$z_0 = \sum_i \sigma_i 2^{-i} \qquad \sigma_i \in \{-1, \ +1\}$$

References

[1] http://en.wikipedia.org/
[2] CORDIC FAQ, www.dspguru.com
[3] T. Vladimirova, “FPGA implementation of sine and cosine generators using CORDIC algorithm”, Proceedings of 2006 MAPLD International Conference
[4] P.W. Baker, “Suggestion for a Binary Cosine Generator”, 1975
[5] M.D. Ercegovac, “Fast Cosine/Sine Implementation Using CORDIC Iterations”, 1987
[6] N. Takagi, “Redundant CORDIC Methods with a Constant Scale Factor For Sine and Cosine Computation”, 1991
[7] D. Timmerman, “Low Latency Time CORDIC Algorithms”, 1992