**TOSAM: AN ENERGY-EFﬁCIENT TRUNCATION- AND ROUNDING-BASED SCALABLE APPROXIMATE MULTIPLIER**

**Abstract:**

 A scalable approximate multiplier, called truncation- and rounding-based scalable approximate multiplier (TOSAM) is presented, which reduces the number of partial products by truncating each of the input operands based on their leading one-bit position. In the proposed design, multiplication is performed by shift, add, and small ﬁxed-width multiplication operations resulting in large improvements in the energy consumption and area occupation compared to those of the exact multiplier. To improve the total accuracy, input operands of the multiplication part are rounded to the nearest odd number. Because input operands are truncated based on their leading one-bit positions, the accuracy becomes weakly dependent on the width of the input operands and the multiplier becomes scalable. Higher improvements in design parameters (e.g., area and energy consumption) can be achieved as the input operand widths increase. To evaluate the efﬁciency of the proposed approximate multiplier, its design parameters are compared with those of an exact multiplier and some other recently proposed approximate multipliers. Results reveal that the proposed approximate multiplier with a mean absolute relative error in the range of 11%–0.3% improves delay, area, and energy consumption up to 41%, 90%, and 98%, respectively, compared to those of the exact multiplier. It also outperforms other approximate multipliers in terms of speed, area, and energy consumption. The proposed approximate multiplier has an almost Gaussian error distribution with a near-zero mean value. We exploit it in the structure of a JPEG encoder, sharpening, and classiﬁcation applications. The results indicate that the quality degradation of the output is negligible. In addition, we suggest an accuracy conﬁgurable TOSAM where the energy consumption of the multiplication operation can be adjusted based on the minimum required accuracy

 **Index Terms—**Accuracy conﬁgurable, approximate multiplier, area efﬁcient, low energy, scalable, truncating**.**

**TOOLS:**

1. **XilinxISE 14.7**

**LANGUAGE:**

1. **VerilogHDL**