**LOW-POWER APPROXIMATE UNSIGNED MULTIPLIERS WITH CONﬁGURABLE ERROR RECOVERY**

**Abstract:**

Approximate circuits have been considered for applicationsthatcantoleratesomelossofaccuracywithimprovedperformance and/or energy efﬁciency. Multipliers are key arithmetic circuits in many of these applications including digital signal processing (DSP). In this paper, a novel approximate multiplier with a low power consumption and a short critical path is proposed for high-performance DSP applications. This multiplier leveragesanewlydesignedapproximateadderthatlimitsitscarry propagation to the nearest neighbors for fast partial product accumulation. Different levels of accuracy can be achieved by using either OR gates or the proposed approximate adder in a conﬁgurableerrorrecovery.Themultipliersusing these twoerror reduction strategies are referred to as approximate multiplier 1 (AM1) and approximate multiplier 2 (AM2), respectively. Both AM1 and AM2 have a low mean error distance, i.e., most of the errors are not signiﬁcant in magnitude. Compared to a Wallace multiplier optimized for speed, an 8×8 AM1 with 4 MSBs (most signiﬁcantbits)forerrorreductionandsynthesizedusinga28 nm CMOS process shows a 60% reduction in delay (when optimized for delay) and a 42% reduction in power dissipation (when optimizedforarea).Ina 16×16 design,halfoftheleastsigniﬁcant partial products are truncated for AM1 and AM2, which are thus denoted as TAM1 and TAM2, respectively. Compared with the Wallace multiplier, TAM1 and TAM2 save from 50% to 66% in power, when optimized for area. Compared to existing approximate multipliers, AM1, AM2, TAM1 and TAM2 show signiﬁcant advantages in accuracy with a high performance. AM2 has a better accuracy compared to AM1 but with a longer delay and higher power consumption. Image processing applications including image sharpening and smoothing are considered to show the quality of the approximate multipliers in error-tolerant applications. By utilizing an appropriate error recovery, the proposed approximate multipliers achieve similar processing accuracy as traditional exact multipliers, but with signiﬁcant improvements in power.

**TOOLS:**

1. **XilinxISE 14.7**

**LANGUAGE:**

1. **VerilogHDL**