Approximation of Hyperbolic Tangent Activation Function Using Hybrid Methods

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Abstract

The contribution of this work is the approximation of a nonlinear function used in ANN, the popular hyperbolic tangent (HT) activation function (AF). The system architecture is composed of several scenarios that provide a tradeoff of performance, precision and area used in FPGA. The results are compared in different scenarios and with current literature on error analysis, area and system performance.

Proposed Methods for the Approximation of the HT

HPR (Hybrid with PWL and RALUT) and HPC (Hybrid with PWL and Combinational) methods use division into parts (PWL) with the goal of acquiring high precision and an amount of elements adapted to the variation of interval. Combinational techniques and RALUT can reduce hardware resources with suitable. In the HPR hardware, the mapping is made from amount of addressing bits related with the scenario interval. To make mapping in the HPC hardware each interval contains a sum of products (SOP) to each output bit. SOP is made based in the amount of elements in interval and simplified with the Quine–McCluskey algorithm.

Analysis of the Results

The system contains 500 inputs samples for the error analysis, area, and performance in implementing the HT AF in hardware. With all samples the implementation of the scenarios were run in approximately 40 µs for Spartan 3E platform, with clock period of 20 ns.

Conclusion

This paper presented the implementation of a system for approximating a HT AF into a reconfigurable device. Scenarios 1 to 5 are good options in the precision HT AF to the FPGA. The scenarios 6 to 9 don't need BRAM and the precision is relatively compromised with the previous scenarios, but has the best tradeoff.