Parallel, High Performance, Fuzzy Logic Systems Realized in Hardware

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Abstract

Fuzzy systems play an important role in many industrial applications [1]. Systems of this type can be implemented using different techniques [2, 3]. The most popular is their realization in software. This results from the ease of such implementation that facilitates modifications / corrections and testing. On the other hand, such realizations are usually not convenient when high data rate, low cost per unit and large miniaturization are required. In this work we propose efficient, fully digital, asynchronous (clock-less) realization of existing fuzzy logic (FL) operators [4] suitable for the application in larger fuzzy systems implemented in low-power application specific integrated circuits. The following FL operators are presented: bounded sum, bounded difference, bounded product, bounded complement, union (MAX), intersection (MIN), absolute difference, implication, and equivalence. All of them have been realized in the CMOS 130nm technology and thoroughly verified in Hspice environment. The proposed circuits can be scaled to any signal resolution and can be used in larger fuzzy systems working in parallel and fully asynchronously. In the comparison with analog approach, digital realization, presented in this work, offers important advantages. Circuits of this type feature high noise immunity and low sensitivity to the variation of transistor parameters. Furthermore digital data can be easily stored even for a long period of time that is different than in typical analog solutions.

References

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