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Editorial

High Performance Fuzzy Systems for Real World Problems

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Nowadays, the importance of developing high-performance computers (HPC) and efficient algorithms that take advantage of new technologies is rapidly growing because the diversity and complexity of mathematical models that need simulations are increasing; as well as there are more technical problems that require to process data at high speed. HPC is an invaluable tool for analysts, engineers, and scientist because it offers the resources that they need to make vital decisions, to speed up research and developments, to promote product innovations, and to reduce time to market. With respect to fuzzy logic, there are a wide variety of fuzzy-based applications for consumer electronics that must satisfy real time constrains for processing data at high speed, as well as large quantities of data containing uncertainty from different sources that often cannot be adequately modeled and/or handled by type-1 fuzzy sets.

This special issue contains five papers that deal with important topics that are contributions to confront the above challenges in an original and efficient way. One paper is about a new voltage-input, current-output programmable membership function generator circuit using CMOS technology. Two papers are about improving performance of fuzzy systems using Field Programmable Gate Array (FPGA); in the proposals, the Fusion and SmartFusion FPGAs from Actel are used; moreover, in these papers the use of embedded hard and soft processors, intellectual property cores (IP-Cores), programming using C language and VHDL is illustrated. Two papers address the problem of improving performance of type 2 fuzzy systems.

In the paper entitled "*A novel programmable CMOS fuzzifiers using voltage-to-current converter circuit*" by K. Abdulla and M. Azeem, a new voltage-input, current-output programmable membership function generator circuit (MFC) using CMOS technology is presented. It employs a voltage-to-current converter to provide the required current bias for the membership function circuit. The proposed MFC has several advantageous features. This MFC can be reconfigured to perform triangular, trapezoidal, S-shape, Z-shape, and Gaussian membership forms. This membership function can be programmed in terms of its width, slope, and its center locations in its universe of discourse. The easily adjustable characteristics of the proposed circuit and its accuracy makes it suitable for embedded systems and industrial control applications. The proposed MFC is designed using the spice software, and obtained simulation results are reported in the paper.

The paper entitled "*Designing high-performance fuzzy controllers combining IP cores and soft processors*" by O. Montiel et al. presents a methodology to integrate a fuzzy coprocessor described in VHDL (VHSIC Hardware Description Language) to a soft processor embedded into an FPGA. The aim is to increase the throughput of the whole system; since the controller uses parallelism at the circuitry level for high-speed-demanding applications, the rest of the application can be written in C/C++. The ARM 32-bit soft processor, which allows sequential and parallel programming, is used. The FLC coprocessor incorporates a tuning method that allows manipulating the system response with just modifying one parameter. The authors show experimental results using a fuzzy PD+I controller as the embedded coprocessor. Comparative results for different hardware platforms such as a desktop personal computer, the

Spartan 3 FPGA, the Virtex 5 FPGA, and the Atmel AVR 8-bits microcontroller are presented.

In the paper entitled "*WLAN cell handoff latency abatement using an FPGA fuzzy logic algorithm implementation*," R. Sepúlveda et al. present a predictive fuzzy logic controller FPGA implementation to speed up the processing time to reduce the channel scanning process of a WiFi communication system to a tenth of the standard time. The IEEE 802.11n standard yields data rates up to 450 Mbps, and the 802.11e standard ensures proficient QoS for real-time applications. Still in need of better performance, multicell environments that provide extended coverage allow the mobile station nomadic passage beyond a single cell by means of cell dissociation-association process known as handoff. This process poses a challenge for real-time applications like voice over IP (150 ms maximum delay) and video (200–400 ms) sessions to give the user a seamless cell-crossing without data loss or session breakage. The algorithm of the fuzzy controller is implemented in C language. Experimental results using the FPGA SmartFusion are provided.

In the paper "*Speedup of interval type 2 fuzzy logic systems based on GPU for robot navigation*," L. Ngo et al. illustrate how to install interval type-2 FLS (IT2-FLS) on a graphics processing unit (GPU) and the use of nVIDIA's Compute Unified Device Architecture (CUDA); the authors show experiments for obstacle avoidance behavior of robot navigation. They carry out FLSs analysis in order to take advantage of GPUs processing capabilities to speed up IT2-FLSs. They demonstrate that use of the computer CPU outperforms the GPU for small systems and conclude that as the number of rules and sample rate grow, the GPU outperforms the CPU. They show that there is a switch point in the performance ratio which indicates when the GPU is more efficient than the CPU. GPU runs approximately 30 times faster on the computer.

In the paper entitled "*A hybrid model through the fusion of type-2 fuzzy logic systems and sensitivity-based linear learning method for modeling PVT properties of crude oil systems*," A. Selamat et al. present a proposal for modeling pressure-volume-temperature (PVT) properties, which are crucial for geophysics and petroleum engineers, namely, for utilization in material balance calculations, inflow performance calculations, well log analysis, determining oil reserve estimations, and the amount of oil that can be recovered, the flow rate of oil or gas, and the simulations on reservoir outputs. In this proposal, a hybrid system based on a sensitivity-based linear learning method (SBLLM) that has been recently used as a predictive tool because its unique characteristics and performance, particularly its high stability and consistency during predictions, in combination with a type-2 fuzzy logic system (FLS) to handle uncertainties in reservoir data is used. This work presents comparative studies to compare the performance of the newly proposed T2-SBLLM hybrid system with each of the constituent type-2 FLS and SBLLM. The empirical results from simulation show that the proposed T2-SBLLM hybrid system has greatly improved upon the performance of SBLMM, while also maintaining a better performance about of the type-2 FLS.

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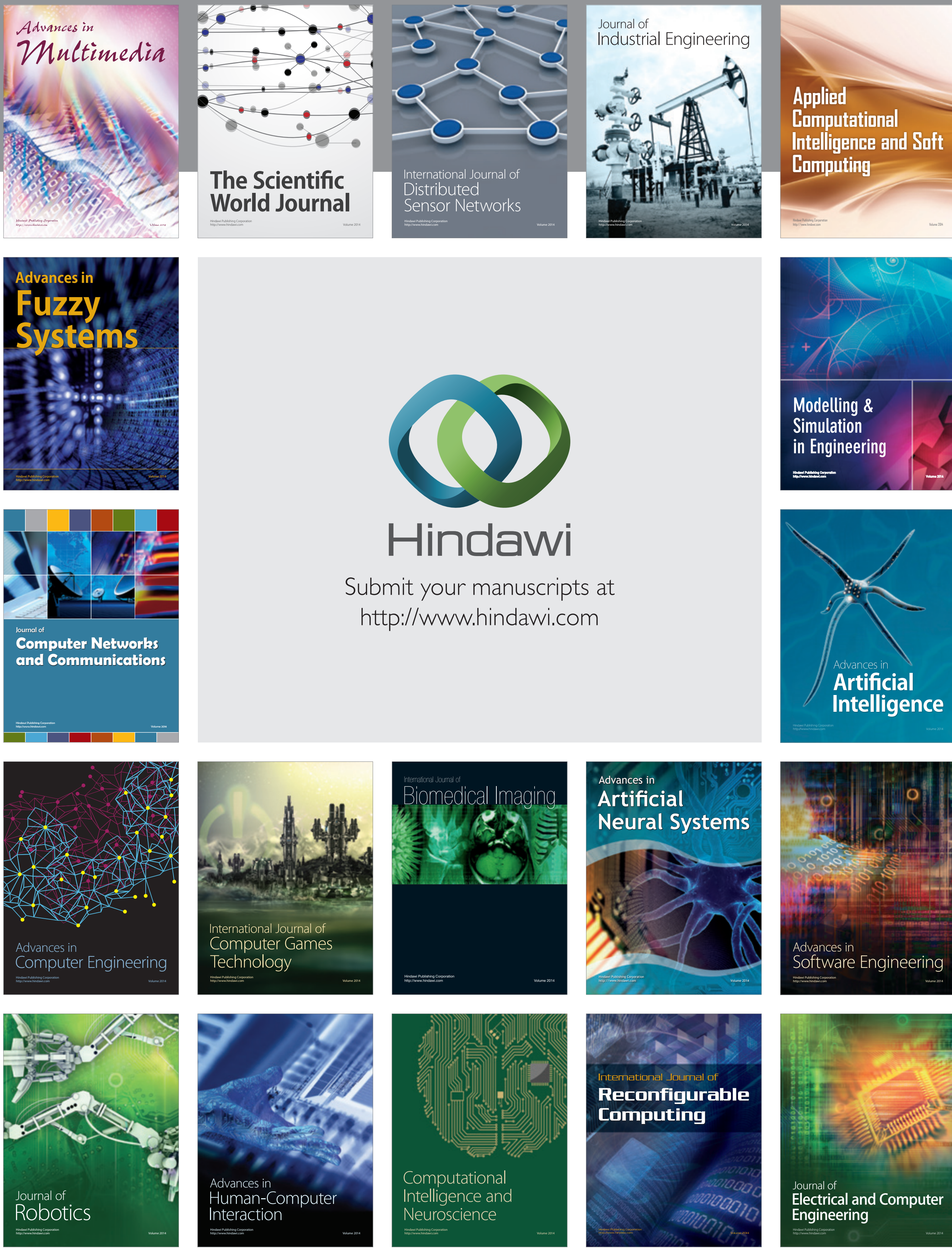
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