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Editorial

MOCAST 2021

Spyridon Nikolaidis [1,*] and Rodrigo Picos [2,*]

[1] Physics Department, Aristotle University of Thessaloniki, 54636 Thessaloniki, Greece
[2] Industrial Engineering and Construction Department, University of Balearic Islands, 07122 Palma, Spain
* Correspondence: snikolaid@physics.auth.gr (S.N.); rodrigo.picos@uib.es (R.P.)

The International Conference on Modern Circuits and Systems Technologies (MOCAST) was first launched in 2012 inside the framework of a European Project (JEWEL). Its aim was to provide a forum for researchers in Mediterranean and European areas to share and discuss their latest developments. Over the years, MOCAST has consolidated its position as a leading conference, successfully passing even the test of the COVID-19 pandemics in 2021. This special issue is, thus, very special, since it corresponds not only to a recompilation of some of the best papers at the Conference but is also a tribute to all those researchers that kept on working, many times at home with reduced resources, and holding on to the very basic idea of science, which is sharing knowledge.

In this special issue we have twelve papers, covering a very wide range of topics, as in the Conference itself.

In [1], the authors present a circuit able to emulate a memristive system using switched capacitors as the variable resistance and implementing the model of the memristor using stochastic computing.

The second paper [2] explores how 3D integration affects the parasitic coupling using a two-layer 3D pixel as the case of study. Specifically, they use TCAD simulations to study a Back-Side Illuminated, 4T–APS, 3D Sequential Integration pixel with both its photodiode and Transfer Gate at the bottom tier and the other parts of the circuit on the top tier.

The third paper [3] deals with another hot topic, applying AI techniques to help detect the effects of COVID-19 on patients by analyzing X-ray chest images. They propose a robust, lightweight network where the excellent classification of four classes (COVID-19, normal, viral pneumonia, and lung opacity) is performed. The experimental results show that the proposed modified architecture of the model achieves very high classification performance in terms of 21,165 chest X-ray images, and at the same time, it meets real-time constraints in a low-power embedded system.

In [4], the authors present a novel design of current pre-amplifiers suited for visible light communications. In this paper, three pre-amplification topologies for the VLC receiver AFE are presented and compared. All three use bipolar transistors (BJT): the first consists of a single BJT, the second of a double BJT in cascade connection, and the third of a double BJT in Darlington-like connection. In order to validate the performance characteristics of the three topologies, simulation results are provided with respect to the light illumination intensity, the data transmission frequency, and the power consumption.

In [5], Markov chains are used to study the performance of 2D and 3D networks on chips. In this work, a formal way of describing a bufferless NoC topology as a set of discrete-time Markov chains is presented. It is demonstrated that by combining this description with the network average distance, it is possible to obtain the expectation of the number of hops between any pair of nodes in the network as a function of the flit deflection probability. Comparisons between the proposed model and cycle-accurate simulation demonstrate the accuracy achieved by the model, with negligible computational cost. The useful range of the proposed model is quantified, demonstrating that it has an error of less than 10% for a significant proportion (between 33% and 75%) of the injection rate

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range below saturation. Finally, a simple equation for comparing mesh topologies with a "back-of-the-envelope" calculation is introduced.

In [6], the authors present an IoT system suitable for monitoring and controlling a hydroponic farm. The system is based on three types of sensor nodes. The main (master) node is responsible for controlling the pump, monitoring the quality of the water in the greenhouse, and aggregating and transmitting the data from the slave nodes. Environment-sensing slave nodes monitor the ambient conditions in the greenhouse and transmit the data to the main node. Security nodes monitor activity (movement in the area). The system monitors water quality and greenhouse temperature and humidity, ensuring that crops grow under optimal conditions according to hydroponics guidelines. Remote monitoring for the greenhouse keepers is facilitated by monitoring these parameters via connecting to a website. An innovative fuzzy inference engine determines the plant irrigation duration. The system is optimized for low power consumption in order to facilitate off-grid operation.

Paper [7] deals with the effect of time and amplitude variations on the soft error rate (SER) in VLSI circuits. An accurate SER evaluation is provided based on a SPICE-oriented electrical masking analysis combined with a TCAD characterization process. Furthermore, the proposed work analyzes the effect of a Static Timing Analysis (STA) methodology and the actual interconnection delay on SER evaluation. An analysis of the generated Single Event Multiple Transients (SEMTs) and the circuit operating frequency that are related to the SER estimation is also discussed. Various benchmarks synthesized utilizing 45 nm and 15 nm technology are employed, and the experimental results demonstrate the SER variation as the device node scales down.

Paper [8] proposes a novel schema to implement FIR filters using stochastic computing, showing how this technique is effective in reducing the number of required components, and also the power needed to perform the calculations. Simulation in the spectral domain demonstrates the filter's proper operation and its roll-off behavior, as well as the signal-to-noise ratio improvement using the sigma-delta modulator compared to typical stochastic computing filter realizations. The proposed architecture's hardware advantages are showcased with synthesis results for two FIR filters using FPGA and synopsys tools, while comparisons with standard stochastic computing-based hardware realizations, as well as with conventional binary ones, demonstrate its efficacy.

Paper [9] presents a model for a Tantalum oxide memristor, including parameter estimation, and shows how to apply it to a crossbar. The proposed model is applied and analyzed in hybrid and passive memory crossbars in an LTSPICE environment and is based on the standard Ta_2O_5 memristor model proposed by Hewlett–Packard. The optimal values of coefficients of the tantalum oxide memristor model are derived through the comparison of experimental current–voltage relationships and by using a procedure for parameter estimation. A simplified LTSPICE library model corresponding to the analyzed tantalum oxide memristor is created in accordance with the considered mathematical model. The improved and altered Ta_2O_5 memristor model is tested and simulated in hybrid and passive memory crossbars for a state near a hard-switching operation.

Paper [10] presents an AI-based system able to recognize the art style of a work. The paper presents two different Deep Learning architectures—Vision Transformer and MLP Mixer (Multi-layer Perceptron Mixer)—trained from scratch in the task of artwork style recognition, achieving over 39% prediction accuracy for 21 style classes on the WikiArt paintings dataset. In addition, a comparative study between the most common optimizers was conducted, obtaining useful information for future studies.

Paper [11] proposes a new methodology to encode quantum information into the energy states of a physical system, thus paving the way for the actual implementation of quantum computers. The scheme is based on the notion of encoding logical quantum states using the charge degree of the freedom of the discrete energy spectrum that is formed by introducing impurities in a semiconductor material. They propose a mechanism for performing single-qubit operations and controlled two-qubit operations, providing a mechanism for achieving these operations using appropriate pulses generated by Rabi

oscillations. The above architecture is simulated using the Armonk single-qubit quantum computer of IBM to encode two logical quantum states into the energy states of Armonk's qubit and using custom pulses to perform one- and two-qubit quantum operations.

Finally, paper [12] proposes a Lagrangian relaxation method to optimize gate design (sizing and threshold) in a VLSI system, focusing on timing closure. To this end, they transform a Lagrangian-relaxation-based optimizer into a practical incremental timing optimizer that corrects small timing violations with fast runtime without increasing the area/power of the design. The proposed approach is applied to already-optimized designs of the ISPD 2013 benchmarks assuming they experience new timing violations due to local wire rerouting. Experimental results show that, in single corner designs, timing is improved by more than 36% on average, using 45% less runtime. Correspondingly, in a multi-corner context, timing is improved by 39% when compared to the fully-fledged version of the timing optimizer.

We would also like not to miss the opportunity to thank all the attendants for sharing their work, as well as for their passion for research, which makes it worthwhile organizing a Conference.

Conflicts of Interest: The authors declare no conflict of interest.

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