Call for Papers

Programmable Metamaterials for Software-Defined Electromagnetic Control: Circuits, Systems, and Architectures

Guest editors

Julius Georgiou, University of Cyprus, Cyprus: julio@ucy.ac.cy

Tie-Jun Cui, Southeast University, China: tjcui@seu.edu.cn

Sergi Abadal, Universitat Politècnica de Catalunya, Spain: abadal@ac.upc.edu

Tony Low, University of Minnesota, USA: tlow@umn.edu

Scope and Purpose

Metamaterials are artificial structures that enable the realization of novel electromagnetic components with engineered and even unnatural functionalities, opening the door to significant breakthroughs in fields such as imaging, radar, or wireless communications, among others. However, most existing metamaterials are tailored for a single application working under preset conditions at a particular frequency and cannot be reused. This clearly limits their applicability and, considering the complexity of the current metamaterial design processes, increases their cost. In response to these limitations, recent years have seen the emergence of different types of reconfigurable designs, which use components that tune the metamaterial response, and also programmable metamaterials with means for explicit and software-defined control of the electromagnetic functionality of the device.

While the potential of the programmable metamaterials is high, harnessing software-defined electromagnetic control poses significant implementation, integration, and packaging challenges given by the stringent limitations in terms of area, power consumption, or interference levels of this scenario. This imposes severe restrictions in the practicable design space of circuits and systems, thus encouraging the proposal of smart, metamaterial-aware and opportunistic, highly streamlined solutions at the circuit, system, and full architecture levels, as well as the use of emerging technologies such as graphene, nanoscale integrated sensors, energy harvesting, or neural networks in longer term. In this special issue, we seek to address such an emergent topic in a timely manner by providing a broad yet profound view of the programmable metamaterial scenario from the circuits and systems perspective.

The special issue seeks contributions encompassing aspects from the individual tuning mechanisms and low-power circuits for the metamaterial controllers and internal structure, up to the information-centric control systems and application-aware programmable metamaterial architectures. The editors equally welcome submissions about physical prototypes realizable in the near future and more prospective contributions with clear longer-term potential, in any of the following levels of design:

- **Metamaterial level:** tunable, reconfigurable, and programmable metamaterial design with emphasis on the tuning elements and actual implementation. Information-theoretical analysis of digitized metamaterials. 2D materials with promising tunability for metamaterial implementation.

- **Circuit or sub-system level**: integrated low-power circuit design for the controllers, on-chip and chip-to-chip interconnects. Asynchronous circuits, electromagnetic interference aware designs, and/or their integration with the metamaterial.
- **System design level:** complete programmable designs up to the system level, possibly addressing control theory aspects, proposing cyber-physical and/or embedded system architectures, systems with multiple interconnected metamaterials, and/or applications based on programmable metamaterials.
- **Advanced topics:** sensor integration or energy harvesting methods for fully autonomous programmable metamaterials, approximate circuits for low power operation, or neural networks applied to different metamaterial design and implementation aspects.

Topics of Interest

The special issue solicits high-quality and original contributions on topics including, but not limited to:

- Tunable and reconfigurable metamaterials implementations in the GHz, mmWave, and THz bands,
- Coding metamaterial and programmable metamaterial designs for absorption, wavefront manipulation, polarization control,
- Information theoretical analyses of coding and programmable metamaterials,
- FPGA-based prototyping and emulation of programmable metamaterials,
- Customized hardware/software architectures for programmable metamaterials,
- Control theoretical, cyber-physical and/or embedded system architectures and implementations,
- Neural networks applied to control of programmable metamaterials,
- Advanced tuning mechanisms or materials for enhanced reconfigurability,
- Low-power asynchronous circuit design for controllers and interconnects,
- Network-on-Chip and off-chip approaches, wired or wireless, for interconnect design within a metamaterial,
- Low-cost electromagnetic sensors for autonomous operation,
- Energy harvesting methods and analysis in programmable metamaterials,
- Circuit-metamaterial electromagnetic co-interference analysis,
- Integration methods for heterogeneous co-integration of controllers, metamaterials, and auxiliary elements within a single platform,
- Full architectures for applications based on programmable metamaterials.

Submission Procedure

Prospective authors are invited to submit their papers following the instructions provided on the JETCAS website: http://ieee-cas.org/pubs/jetcas/submit-manuscript. The submitted manuscripts should not have been previously published nor should they be currently under consideration for publication elsewhere.

Important Dates

- Manuscript submissions due: 1 December 2019
- First decision: 21 December 2019
- Revised manuscripts due: 10 January 2020
- Notification of acceptance: 25 January 2020
- Final manuscripts due: 10 February 2020

Request for Information

Julius Georgiou (julio@ucy.ac.cy) and Sergi Abadal (abadal@ac.upc.edu)