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Editorial

Special Issue "Metamaterials and Metasurfaces"

Naser Ojaroudi Parchin [1,*], Mohammad Ojaroudi [2] and Raed A. Abd-Alhameed [3]

1 School of Computing, Engineering and the Built Environment, Edinburgh Napier University, Edinburgh EH10 5DT, UK
2 COGNISCAN, 1 Avenue d'Ester, CEDEX, 87280 Limoges, France; m.ojaroudi@cogniscan.fr
3 Faculty of Engineering and Informatics, University of Bradford, Bradford BD7 1DP, UK; r.a.a.abd@bradford.ac.uk
* Correspondence: n.ojaroudiparchin@napier.ac.uk

Metamaterials and metasurfaces have emerged as promising technologies in the field of antennas and wireless applications. They offer unprecedented control over electromagnetic waves, enabling the design of novel antenna structures with enhanced performance capabilities. By integrating metamaterial structures into antenna designs, it is possible to achieve electrically small antennas without sacrificing efficiency or bandwidth. Metasurfaces, on the other hand, are planar arrangements of subwavelength elements that manipulate the properties of incident electromagnetic waves. They are constructed by patterning a surface with precisely engineered meta-atoms, tailored to achieve specific functionalities. Metasurfaces can be used to control wavefronts, as well as the polarization and reflection properties of antennas. Metasurface antennas offer numerous advantages in wireless applications. They can achieve beamforming and steering capabilities without the need to use bulky and complex phased arrays in future wireless networks. Furthermore, metasurfaces can be used to create conformal and flexible antenna structures. This opens up new possibilities for the utilization of Internet of Things (IoT) applications and wearable devices. The use of metamaterials and metasurfaces can lead to significant advances in wireless communication systems, including improved signal quality, increased data rates, and seamless integration into various devices and environments.

The scope of this Special Issue encompasses a comprehensive exploration of metamaterials and metasurfaces, covering every facet of their design and construction. Moreover, it strives to spotlight captivating advances, prevailing trends, and recent accomplishments in this field. This Special Issue is a collection of 10 papers that are briefly explained in the following.

Lopato et al. [1] examine the impact of fabrication process uncertainties on the quality of terahertz metasurfaces, specifically focusing on how inaccuracies in metasurface fabrication affect resonances. They employ a numerical model to analyze the influence of uncertainties in the different geometric parameters obtained during the fabrication process, including layer deposition, photolithography, and etching processes, with respect to the resonance behavior of the designed metasurface. To validate their findings, the researchers verify the developed numerical model by applying it to a fabricated structure.

Wang et al. [2] investigate the challenge of anti-jamming matching reception for small-signal anti-jamming in the presence of intense electromagnetic jamming. The authors employ the Charnes–Cooper (CC) transform algorithm to identify the most favorable dynamic metamaterial antenna (DMA) array–element–codeword–state matrix, which maximizes the received signal-to-interference-plus-noise ratio (SINR). Through simulations, it is demonstrated that DMA offers notable advantages over traditional array antennas. Moreover, the utilization of DMA leads to reduced communication overhead, with a promising potential to upgrade existing wireless communication systems.

Liu et al. [3] delve into the exploration of negative group delay (NGD) metamaterials by utilizing split-ring resonators (SRRs). Their theoretical analysis involves the calculation of equivalent circuit parameters for two distinct types of SRRs. The measured results of the

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prototypes align closely with the theoretical predictions and simulated outcomes. In addition, through simulations, it is demonstrated that the proposed metamaterials effectively reduce beam walk, showcasing their potential to serve as a solution in this context.

Zhang et al. [4] present the development of an ultra-broadband and angular-stable reflective linear into a cross-polarization converter utilizing a metasurface. The converter's unit cell is constructed using a slant end-loaded H-shaped resonator. Through simulations, is the authors reveal that the proposed design achieves a polarization conversion ratio exceeding 90% within the frequency range of 9.83–29.37 GHz, resulting in a relative bandwidth of 99.69% with high efficiency, ultra-broadband capability, and angular stability.

Amer et al. [5] present a polarization-insensitive broadband metamaterial absorber structure that exhibits wide-angle reception capabilities. The structure is based on square split-ring resonators (SSRRs) and incorporates lumped resistors. The proposed metamaterial absorber achieves absorption levels exceeding 90% over a wide frequency range from 1.89 GHz to 6.85 GHz, with a relative bandwidth of 113%.

Zhang et al. [6] demonstrate an inverse design framework for isomorphic metasurfaces utilizing representation learning. Through the use of autoencoders (AEs) with various architectures, the original high-dimensional space is effectively mapped onto a low-dimensional space with minimal information loss. It achieves a remarkable average accuracy of 94% on test sets, while also providing the design matrix within a matter of seconds, meaning that it significantly saves resources and time compared to traditional methods.

Voronov et al. [7] introduce new configurations of a magnetoinductive device that exhibits directional filter properties. Additionally, a new method is presented to enhance the device's filtering performance by compensating for multipath loss. The authors demonstrate techniques for constructing tunable devices that utilize toroidal ferrite-cored transformers in which experimental results confirm the agreement with the theoretical models.

Tavora de Albuquerque Silva et al. [8] introduce a novel unit cell design for electromagnetic bandgap (EBG) structures, utilizing a HoneyComb geometry (HCPBG). The design offers several advantages, including a reduced occupied area and flexible rejection band properties. Additionally, a strategy for the design of reconfigurable HCPBG filters is presented where the resonance frequency can be adjusted. The behavior and reconfiguration of the HCPBG filter are demonstrated through EM simulations.

Mitra et al. [9] employ transformation electromagnetics/optics (TE/TO) to realize a non-homogeneous, anisotropic material-embedded beam-steering technique without the need for phase control circuitry. The theoretical framework is supported by numerical simulations, validating the feasibility of the proposed approach. These innovative designs and methods have practical applications in various domains such as wireless communications, radar systems, beamforming, and beam steering.

Abdalrazak et al. [10] conduct a comprehensive literature review focusing on the squint phenomena in antenna arrays at mmWave frequencies. The study examines the challenges associated with the squint phenomena. The authors categorize the main effective solutions into beamforming techniques, antenna geometry modifications, and channel estimation algorithms. Additionally, another classification is explored, specifically one that leverages the beam squint phenomenon to improve channel localization and capacity. The literature review provides valuable insights into understanding and mitigating the challenges associated with squint phenomena in mmWave antenna arrays.

We would like to express our sincere appreciation and gratitude to all the authors who have made exceptional contributions to this journal. We would also like to extend our heartfelt thanks to the reviewers for their valuable comments and feedback, which have greatly improved the quality of the articles. Additionally, we would like to acknowledge the editorial board and the editorial office of *Electronics* for their support and guidance throughout the publication process. We hope that our readers will find the articles in this journal informative, insightful, and full of new and valuable information on Metamaterials and Metasurfaces for wireless communications.

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

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