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Section

Microwave and Wireless Communications

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Section Editor-in-Chief

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Section Information

It has already been over more than a hundred years since Maxwell's predictions of the electromagnetic wave presence and experiments by Hertz. Needless to say, contemporary information and communication technology (ICT), especially microwave wireless communication technology, has a direct and indirect impact on our lives at present. In other words, this technology area consists of many fields, element and system technologies and has many applications.

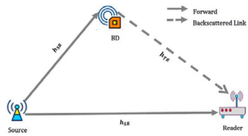
In the section of "microwave, wireless communication", we would like to invite advanced theories and technologies across a wide spectrum. These can be related to microwave and millimeter wave communication, including radar sensor, etc., which may be fundament or application, element or system, hardware or software, methodology theory or measurement. We hope to present the state-of-the-art technologies in this section.

Featured Papers

DOI:10.3390/electronics12102263

A Novel Hybrid Artificial Bee Colony-Based Deep Convolutional Neural Network to Improve the Detection Performance of Backscatter Communication Systems

Authors: Sina Aghakhani, Ata Larijani, Fatemeh Sadeghi, Diego Martín and Ali Ahmadi Shahrakht



Abstract: Backscatter communication (BC) is a promising technology for low-power and low-data-rate applications, though the signal detection performance is limited since the backscattered signal is usually much weaker than the original signal. When the detection performance is poor, the backscatter device (BD) may not be able to accurately detect and interpret the incoming signal, leading to errors and degraded communication quality. This can result in data loss, slow data transfer rates, and reduced reliability of the communication link. This paper proposes a novel approach to improve the detection performance of backscatter communication systems using evolutionary deep learning. In particular, we focus on training deep convolutional neural networks (DCNNs) to improve the detection performance of BC. We first develop a novel hybrid algorithm based on artificial bee colony (ABC), biogeography-based optimization (BBO), and particle swarm optimization (PSO) to optimize the architecture of the DCNN, followed by training using a large set of benchmark datasets. To develop the hybrid ABC, the migration operator of the BBO is used to improve the exploitation. Moving towards the global best of PSO is also proposed to improve the exploration of the ABC. Then, we take advantage of the proposed deep architecture to improve the bit-error rate (BER) performance of the studied BC system. The simulation results demonstrate that the proposed algorithm has the best performance in training the benchmark datasets. The results also show that the proposed approach significantly improves the detection performance of backscattered signals compared to existing works.

DOI:10.3390/electronics12041001

A Review on Cell-Free Massive MIMO Systems

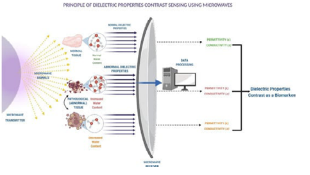
Authors: Joumana Kassam, Daniel Castanheira, Adão Silva, Rui Dinis and Atilio Gameiro

Abstract: Cell-free massive multiple-input multiple-output (CF mMIMO) can be considered as a potential physical layer technology for future wireless networks since it can benefit from all the advantages of distributed antenna systems (DASs) and network MIMOs, such as macro-diversity gain, high channel capacity, and link reliability. CF mMIMO systems offer remarkable spatial degrees of freedom and array gains to mitigate the inherent inter-cell interference (ICI) of cellular networks. In such networks, several distributed access points (APs) together with precoding/detection processing can serve many users while sharing the same time-frequency resources. Each AP can be equipped with single or multiple antennas, and hence, can provide a consistently adequate service to all users regardless of their locations in the network. This paper presents a detailed overview of the current state-of-the-art on CF systems. First, it performs a literature review of the conventional CF and scalable user-centric (UC) CF mMIMO systems in terms of the limited capacity of the fronthaul links and the connection between APs and user equipments (UEs). As beyond networks will rely on higher frequency bands, it is of paramount importance to discuss the impact of beamforming techniques that are being investigated. Finally, some of the CF promising enabling technologies are presented to emphasize the main applications in these networks.

DOI:10.3390/electronics12051101

Applications of Microwaves in Medicine Leveraging Artificial Intelligence: Future Perspectives

Authors: Keerthy Gopalakrishnan, Aakriti Adhikari, Namratha Pallipamu, Mansunderbir Singh, Tasin Nusrat, Sunil Gaddam, Poulami Samaddar, Anjali Rajagopal, Akhila Sai Sree Cherukuri, and Anmol Yadav et al.

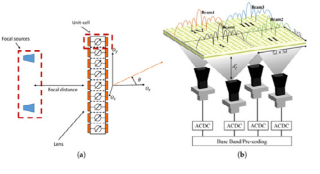


Abstract: Microwaves are non-ionizing electromagnetic radiation with waves of electrical and magnetic energy transmitted at different frequencies. They are widely used in various industries, including the food industry, telecommunications, weather forecasting, and in the field of medicine. Microwave applications in medicine are relatively a new field of growing interest, with a significant trend in healthcare research and development. The first application of microwaves in medicine dates to the 1980s in the treatment of cancer via ablation therapy; since then, their applications have been expanded. Significant advances have been made in reconstructing microwave data for imaging and sensing applications in the field of healthcare. Artificial intelligence (AI)-enabled microwave systems can be developed to augment healthcare, including clinical decision making, guiding treatment, and increasing resource-efficient facilities. An overview of recent developments in several areas of microwave applications in medicine, namely microwave imaging, dielectric spectroscopy for tissue classification, molecular diagnostics, telemetry, biohazard waste management, diagnostic pathology, biomedical sensor design, drug delivery, ablation treatment, and radiometry, are summarized. In this contribution, we outline the current literature regarding microwave applications and trends across the medical industry and how it sets a platform for creating AI-based microwave solutions for future advancements from both clinical and technical aspects to enhance patient care.

DOI:10.3390/electronics12051162

Hybrid Precoding Applied to Multi-Beam Transmitting Reconfigurable Intelligent Surfaces (T-RIS)

Authors: David Demmer, Francesco Foglia Manzillo, Samara Gharbieh, Maciej Śmierzchalski, Raffaele D'Errico, Jean-Baptiste Doré, and Antonio Clemente

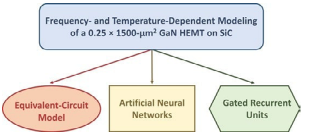


Abstract: In this work, we study hybrid precoding techniques applied to multi-user Transmitting Reconfigurable Intelligent Surface (T-RIS) systems. The T-RIS considered here is a large array of electronically reconfigurable antenna elements illuminated by a small set of active sources. When it comes to digital signal-processing techniques applied to T-RIS systems, it is necessary to consider realistic models to bridge the gap with theoretical results. For this reason, we propose a multi-beam T-RIS propagation model with strong phase quantization constraints and limited beam codebooks. First, the proposed model is validated by characterizing a Ka-band T-RIS. Then, we optimize the quad-beam T-RIS structure by tuning the focal distance between the lens and the focal sources according to two metrics: (i) the per-user antenna gain (analog-only approach), and (ii) the per-user average rate (hybrid digital/analog approach). For both indicators, the system performance is evaluated in a multi-user scenario by assuming imperfect channel state information. We show that considering only the analog precoder is sufficient to optimize the T-RIS. However, the fully hybrid precoding scheme is required to deal with inter-user interference. We propose a codebook-aware optimization that improves the aperture efficiency of the T-RIS system.

DOI:10.3390/electronics12081771

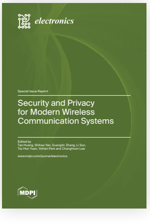
A Comprehensive Overview of the Temperature-Dependent Modeling of the High-Power GaN HEMT Technology Using mm-Wave Scattering Parameter Measurements

Authors: Giovanni Crupi, Mariangela Latino, Giovanni Gugliandolo, Zlatica Marinković, Jialin Cai, Gianni Bosi, Antonio Raffo, Enza Fazio, and Nicola Donato



Abstract: The gallium-nitride (GaN) high electron-mobility transistor (HEMT) technology has emerged as an attractive candidate for high-frequency, high-power, and high-temperature applications due to the unique physical characteristics of the GaN material. Over the years, much effort has been spent on measurement-based modeling since accurate models are essential for allowing the use of this advanced transistor technology at its best. The present analysis is focused on the modeling of the scattering (S-) parameter measurements for a 0.25 μm GaN HEMT on silicon carbide (SiC) substrate at extreme operating conditions: a large gate width (i.e., the transistor is based on an interdigitated layout consisting of ten fingers, each with a length of 150 μm, resulting in a total gate periphery of 1.5 mm), a high ambient temperature (i.e., from 35 °C up to 200 °C with a step of 55 °C), a high dissipated power (i.e., 5.1 W at 35 °C), and a high frequency in the millimeter-wave range (i.e., from 200 MHz up to 65 GHz with a step of 200 MHz). Three different modeling approaches are investigated: the equivalent-circuit model, artificial neural networks (ANNs), and gated recurrent units (GRUs). As is shown, each modeling approach has its pros and cons that need to be considered, depending on the target performance and their specifications. This implies that an appropriate selection of the transistor modeling approach should be based on discerning and prioritizing the key features that are indeed the most important for a given application.

Special Issue Book



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