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Editorial

Antennas and Propagation Aspects for Emerging Wireless Communication Technologies

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The increasing demand for high data rate applications and the delivery of zero-latency multimedia content drives technological evolutions towards the design and implementation of next-generation broadband wireless networks. In this context, various novel technologies have been introduced, such as millimeter-wave (mmWave) transmission [1], massive multiple input multiple output (MIMO) systems [2], and non-orthogonal multiple access (NOMA) schemes [3] in order to support the vision of fifth generation (5G) wireless cellular networks. The introduction of these technologies, however, is inextricably connected with a holistic redesign of the current transceiver structures as well as the network architecture reconfiguration. To this end, ultra-dense network deployment along with distributed massive MIMO technologies and intermediate relay nodes have been proposed, among others, in order to ensure improved quality of services to all mobile users. In the same framework, the design and evaluation of novel antenna configurations able to support wideband applications is of utmost importance for the 5G context support. Furthermore, in order to design reliable 5G systems, the channel characterization in these frequencies and in the complex propagation environments cannot be ignored because it plays a significant role.

In this Special Issue, fourteen papers are published, covering various aspects of novel antenna designs for broadband applications, propagation models at mmWave bands, the deployment of NOMA techniques, radio network planning for 5G networks, and multi-beam antenna technologies for 5G wireless communications.

Khan T et al. [4] have designed a novel cedar-shaped multiband frequency reconfigurable antenna for WLAN, WiMAX, and X-band satellite wireless communication systems. The broad tunability of operating bands is achieved by employing switches to alter the effective electrical length of the radiating element of the antenna. The proposed antenna design is evaluated for specific output metrics, such as reflection coefficient, antenna gain, and radiation pattern, through simulation as well as measurements. The authors highlight the efficient radiation of the proposed antenna structure in all desired bands.

Zhang and Pan [5] present a novel reconfigurable filter antenna for impulse radio-ultrawideband (IR-UWB) applications integrated with WLAN and WiMAX. According to the presented results, the proposed antenna design can integrate the WLAN and WiMAX narrowband with the IR-UWB operating band without changing the size and time domain performance compared with the original UWB antenna. These features enable the proposed filtering antenna to be widely used in IR-UWB systems integrated with WLAN/WiMAX.

Cheema and Salous [6] have conducted various high time resolution spectrum occupancy measurements and analysis for 2.4 GHz WLAN signals. To this end, it was found that distributions such as Gamma and lognormal can be used to model the idle state of a 2.4 GHz WLAN channel along with the generalized Pareto distribution. In addition, in this work, analysis is performed per channel, which shows that different concurrently

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measured channels in radio technology may have different idle time window statistics and their idle states can be modelled using different distributions.

Gouveia et al. [7] have conducted an extensive review on different antenna designs for non-contact vital sign measurements. In this context, specific guidelines for proper antenna design are highlighted, that are related to frequency selection, polarization, directivity, gain, and size.

Saito et al. [8] propose an extension of the ray tracing simulation method for a typical outdoor-to-indoor (O2I) scenario, in which the incident radio waves penetrate indoors through building windows. The presented method consists of the Fresnel zone shielding loss calculation and the transmission loss calculation by equivalent dielectric plate. To this end, radio propagation measurements have been conducted in a high-building environment by using the developed UAV-based measurement system. According to the presented results, the penetration loss of direct and reflection rays was significantly underestimated in the ray-tracing simulation and the proposed method could correct the problem.

Nomikos et al. [9] focused their work on leveraging the capabilities provided by low-complexity single-antenna cooperative relays with buffers and NOMA. More specifically, an opportunistic relay selection algorithm was developed, allowing a cluster of single-antenna relays to operate in full-duplex mode through the successive relaying principle. In addition, buffering facilitated the seamless combination of half-duplex relaying with successive source broadcasting and relay transmissions, enhancing the reliability of the two-hop NOMA relay network, and lowering the delay of the transmission, while increasing the number of transmitted packets to both destinations.

Guan and Fujimoto [10] present a compact patch antenna backed by a conductor plane which functions as reflector, and is placed below the antenna to suppress EM radiation to the human body. The proposed antenna with an L-shape proximity feeding scheme generates a dual-resonance mode for a wide impedance bandwidth. A prototype was designed, fabricated, and compared with the conventional direct-fed patch antenna. Measured reflection coefficient and radiation characteristics of the proposed antenna agree well with the simulation results, which shows wide impedance bandwidth at 2.45 GHz ISM band for antenna working in the free space and on the human body.

Khalid et al. [11] present a four-port MIMO antenna for 5G mmWave applications. Each MIMO antenna of the proposed design is composed of a wideband and a high gain antenna array of two elements. The operating frequency band covers 25.5–29.6 GHz, having a bandwidth of 4.1 GHz. The good radiation characteristics of the reported antenna system certify it for future devices operating in the 5G mmWave bands.

Athanasiadou et al. [12] focus their work on providing a generic analysis for radio network planning in the 5G era, emphasizing the need for dense standalone small-cell networks in the mmWave band of 28 GHz. According to the presented results, the area throughput is increased for dense microcell deployment. Moreover, sectored microcells double the throughput for ultra-dense networks compared to dense networks, because better interference control is achieved through the operation of one, instead of two or three, sector antennas.

Sehrai et al. [13] demonstrate a quad-element MIMO antenna for 5G mmWave applications. The operation band of the proposed antenna covers from 23 GHz to 40 GHz. The prototype of the MIMO wideband antenna was fabricated and tested. A good coherence between the experimental and simulated results is achieved. The proposed MIMO antenna operates efficiently with a significant return loss, wide bandwidth, high gain, and high element isolation, which make it a potential candidate for 5G mmWave applications.

Chen et al. [14] present a wideband filtering–radiating Yagi dipole antenna. An antenna prototype has been fabricated and tested. Measured results demonstrate a wide bandwidth covering from 3.64 GHz to 4.38 GHz (18.5%) and three desired radiation nulls. In addition, this antenna has the features of low profile, compact size, and easy fabrication, which will make it a good candidate for modern 5G wireless communication systems.

Lialios et al. [15] have developed three different true-time-delay analog beamforming networks: a multi-layer Blass matrix, a Rotman lens, and a multi-layer tree topology. For each beamforming network, the design methodology as well as the analysis of electromagnetic performance have been developed separately, thereby showing their suitability for future communication systems.

Maximidis et al. [16] propose a novel antenna array architecture based on high-gain linear sub-arrays. An array structure has been designed so as to achieve a directivity of 46.5 dBi, which is 2.2 dB higher than the corresponding 100% aperture efficiency limit.

Finally, Gerasimov et al. [17] have reported a series of experiments for measuring wave propagation in underground pedestrian tunnels as well as in a subscale laboratory model. The simulations based on a modified ray tracing method were suitable for predicting the wave propagation in a tunnel for different frequencies and showed that a scale model in a laboratory environment can be a suitable replacement for field experiments.

We would like to take this opportunity to thank all authors for submitting papers to this Special Issue. We also hope that readers will find new and useful information on antenna design techniques for 5G applications, related channel measurements, as well as additional issues related to proper network planning and dimensioning.

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