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Editorial

Special Issue "Microwave Photonics 2018"

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1. Introduction

Bringing together the worlds of radiofrequency and optics engineering, the interdisciplinary field of microwave photonics (MWP) pursues the generation, processing, and distribution of microwave and millimeter-wave signals by photonic means [1–5]. In comparison to traditional microwave technologies, MWP brings unique advantages inherent to photonics, such as low loss (and, more importantly, independent of radio frequency), high bandwidth, and immunity to electromagnetic interference. In addition, it enables key processing features, such as fast tunability and reconfigurability, which are very complex or even impossible to achieve using conventional electronic approaches [1,2]. These attractive properties are behind the increasing interest, from both the research community and the industry, over the last two decades in various application areas. In telecommunication networks, MWP enables distributed antenna and radio-over fiber systems, where broadband microwave and millimeter-wave signals are delivered from/to a central office to/from a variety of base stations with limited distortion, as well as very low frequency independent losses [6,7]. In signal processing [2–5], MWP systems allow tunable and reconfigurable signal filtering and beam-steering of radiofrequency signals, while photonic analogue-to-digital converters offer the possibility of digitizing broadband signals at THz sampling rate. MWP also allows the implementation of very versatile radiofrequency signal generators and optoelectronic oscillators spanning from ultra-wideband to millimeter-wave signals.

Apart from the considerable added value that MWP brings to traditional microwave and radiofrequency systems, this interdisciplinary field holds a promising future in a myriad of emerging areas, such as the Internet of Things [1], medical imaging systems using terahertz waves [8], optical coherence tomography, distributed sensing, wireless and body personal area networks [9], as well as converged fiber-wireless broadband access networks for 5G communications [10].

2. The Present Special Issue

The present Special Issue gathers eight papers reporting state-of-the-art research progress and breakthroughs accomplished by internationally recognized research teams in the field of microwave photonics through the year 2018. The reported research results, distributed in two research papers [11,12] and six review papers [13–18], cover several of the specific strategic areas outlined in Section 1.

A new microwave frequency measurement technique based on matrix pencil assisted deconvolution is reported in [11] to improve the measurement resolution in scanning receiver systems. In this article [11], a multi-tone microwave signal measurement based on an optical filter is experimentally demonstrated, showing significant measurement resolution reduction of both frequency and power information. The other research article presents a detailed investigation on the cause of ripples in the frequency response of a microwave photonic phase shifter [12]. The authors experimentally demonstrate that incorporating an optical filter in the phase-shifter structure can reduce the amplitude variation and phase deviation over a wide frequency range.

The review manuscripts assess recent results on different devices and systems for microwave photonics signal processing and sensing. In [13], Andreas Beling et al. provide a thoughtful review on high-speed photodetectors for MWP, covering high-power photodiodes and waveguide photodetectors as well as integrated photodiode-antenna emitters with bandwidths up to 150 GHz. The authors also present interesting results from heterogeneous III-V photodiodes on silicon and Ge-on-Si photodiode arrays in particular for analog applications. Linear cell radar devices and systems are reviewed by Yamamoto and co-workers [14]. By linear cell schemes the authors refer to radar systems consisting of many antenna units that are connected by radio-over-fiber structures to monitor linear-shaped areas. This paper [14] overviews different electro-optic devices, such as optical modulators and photodetectors, which play an important role in millimeter-wave linear cell systems for high-resolution imaging.

A review of recent results on simultaneous interrogation of multiple fiber Bragg grating sensors by exploiting microwave photonics is performed by Chen et al. [15]. This work describes the use of both microwave photonic filtering and chirped microwave pulse generation and compression for wavelength-to-power mapping, demonstrating high-resolution and high-speed interrogation. The latest developments in microwave photonic devices based on liquid crystal on silicon (LCOS) technology are reviewed by Zheng and colleagues [16]. The authors revise three microwave signal processing functionalities, namely notch filters, phase shifters, and couplers, and also present a new multi-function signal processing structure based on amplitude and phase control functions in conjunction with a power splitting function in a commercial LCOS-based optical processor.

A research team led by Robert Minasian gathered recent developments in microwave photonic signal processing and sensing based on optical filtering [17]. This review paper presents single-sideband modulation schemes to eliminate dispersion-induced power fading and provides high-resolution spectral characterization functions as well as single passband MWP filters to eliminate spectral periodicity. It also assesses high-performance sensing approaches based on MWP filters or optoelectronic oscillators.

Due to their ability to generate ultra-low phase noise signals, optoelectronic oscillators have attracted considerable attention and are becoming one of the most promising microwave signal sources. The last review paper by Liu and co-workers [18] addresses stable and low-spur optoelectronic oscillators and briefly introduces the operation principle and discusses current research on frequency stability and spurious suppression of optoelectronic oscillators.

3. Concluding Remarks

The research work reported in these eight papers which make up the Applied Sciences Special Issue provides an excellent example of the current progress being achieved in addressing the main challenges arising in the area of microwave photonics. In addition, readers can find suitable information regarding the next steps to be taken in both microwave signal processing and radio-over-fiber distribution research.

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