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Editorial

Special Issue on Coherent Optical Communications

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Coherent optical communications have emerged as a groundbreaking technology, enabling data rates of 100 Gbit/s and beyond. The high sensitivity of coherent receivers has revolutionized the field, extending transmission distances and opening new possibilities for efficient data transmission. In this Special Issue, we aim to explore the latest advancements and research contributions in the realm of coherent optical communications. By collating fundamental, methodological, and cutting-edge research, this Special Issue will highlight the diverse aspects of this rapidly evolving field.

One of the key driving forces behind the extensive study of coherent optical communications is their potential for extended transmission distances. The demonstration of digital carrier phase estimation in coherent receivers has played a pivotal role in this regard. By preserving phase information after detection, linear equalization methods can be employed to mitigate linear optical impairments, such as chromatic dispersion and polarization mode dispersion (PMD). In coherent optical links, applying spectrally efficient modulation techniques, inspired by wired or wireless communication systems, can maximize data rates. Multidimensional optimized optical modulation formats hold great promise for achieving higher spectral efficiency. Detecting and correcting errors in high-speed coherent optical communications is a crucial aspect of achieving reliable data transmission. By employing advanced forward error correction (FEC) techniques, researchers can enhance the reach and robustness of optical communication systems. The implementation of high-speed digital coherent transceivers is of utmost importance in the field of coherent optical communications. The practical aspects of implementing such transceivers, including the design and optimization of high-speed transceivers, signal processing, digital signal generation, and coherent receiver architecture, will drive the development of practical and efficient coherent optical communication systems.

The first paper in this Special Issue discusses the Optical Properties Analysis of Scattering Media using GI-OCT Imaging [1]. The researchers successfully developed an OCT system with ghost imaging to improve image quality in scattering media, achieving accurate reconstruction with an SSIM value above 0.7. Their analysis revealed a negative correlation between the extinction coefficient of the scattering media and image contrast, along with a positive correlation with scattering intensity.

The second article in this Special Issue presents a Multi-Level Phase Noise Model for CO-OFDM Spatial-Division Multiplexed Transmission [2]. With a specific focus on coherent communication technology in SDM systems, the paper introduces a comprehensive phase noise model that considers both common laser phase noise and core phase drifts. The study evaluates blind phase search and pilot-aided phase estimation algorithms, showcasing their efficacy in accurately estimating phase noise in a multi-core fiber system.

The third article in this Special Issue explores the enhancement of heterodyne efficiency by analyzing the effect of the degree of polarization (DoP) on uplink and downlink paths [3]. The study indicates that the waist radius (σs_y) and coherence length (δS_{yy}) of the signal beam have a more significant impact on heterodyne efficiency and DoP than turbulence in both paths. Increasing σ_{sy} or δS_{yy} is suggested to improve heterodyne efficiency and DoP in free-space optical heterodyne detection communication for satellite–ground links, particularly in the uplink path.

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The fourth article in this Special Issue centers on Blind Carrier Phase Recovery Using Extended Kalman Filtering in Probabilistically Shaped Coherent Systems [4]. The paper proposes an EKF-PC scheme to improve carrier recovery in optical communication systems with probabilistic shaping. By optimizing parameters such as shaping factors and noise rejection window length, through simulation experiments, the authors demonstrate that the EKF-PC scheme surpasses other algorithms, leading to substantial enhancements in signal-to-noise ratio and overall system performance.

The final article in this Special Issue focuses on Recent Advances in Phase Retrieval Methods for Short-Reach Coherent Optical Communications [5]. As the demand for higher bandwidths increases, short-reach transmission systems are transitioning towards coherent optical communication systems with advanced DSP algorithms. This review article examines self-coherent detection as an intermediate solution for short-reach transmission, discussing various phase retrieval methods such as single sideband transmission, Kramers–Kronig detection, the Gerchberg–Saxton algorithm, and the transport of the intensity equation method.

In summary, the Special Issue on Coherent Optical Communications aims to provide a comprehensive overview of the latest advancements in this rapidly evolving field. The research contributions cover a wide range of topics, including fundamental studies, methodological approaches, and practical applications, thereby shedding light on various aspects of coherent optical communications. It is our hope that this Special Issue not only serves as a summary of different research lines, but also encourages further work and exploration in this exciting field.

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