

# Editorial for Special Issue on Underwater Wireless Optical Communication

Underwater wireless optical communication (UWOC) has gained increasing research interest worldwide from both academic and industrial communities, because of its high bandwidth, compact antennas, low latency, cost-effectiveness, and low power consumption. In the underwater world, the wireless optical links can be complementary to or even more competitive than its acoustic counterpart. Nevertheless, the hostile underwater environment sets up natural obstacles to most information carriers, including the lightwave, even at the right wavelength. Much attention has been recently paid to this interesting and challenging area, leading to impressive progresses. Hence, we launched this focus issue to discuss recent advances and progress in UWOC, and aimed to further stimulate future advancements in this emerging field.

This focus issue includes twelve invited papers contributed by active research groups worldwide. There are four review papers. Xu provided a tutorial on the basic concepts and essential features of UWOC, as well as an overview of work being conducted in this field. Research challenges and possible roadmaps are discussed in detail. Cossu provided a comprehensive survey on the challenges, the experimental realizations, and the state of the art in UWOC researches. The review by Yang *et al.* focused on a hybrid laser diode (LD) and light-emitting diode (LED)-based UWOC system, including both challenges and trends for UWOC. He *et al.* reviewed recent advances in UWOC from a perspective of advanced modulation formats, highlighting the effectiveness and robustness of Volterra nonlinear equalizer in UWOC systems.

Interest in the understanding of the UWOC channel remains strong. One fast simulation method using Markov chains was introduced by Zhou *et al.* to simulate angular, energy, and temporal characteristics of pulsed laser beam propagation underwater. UWOCs with varied Maalox, chlorophyll, and sea salt concentrations were studied by Tian *et al.*, and the influence of light attenuation was investigated systematically. Ooi *et al.* experimentally and statistically studied the impact of turbulence arising from temperature gradient variations and air bubbles on non-line-of-sight optical channels. In particular, another two invited papers specifically focused on the effects of air bubbles on UWOC. For different bubble density and size, log-normal, gamma, Weibull, and generalized extreme value distributions are tested by Xu *et al.* to fit the fluctuation of the signal intensity at the receiving end, followed by an experimental demonstration in the bubble scenarios using on-off keying and pulse position modulation. Chen *et al.* systematically investigated the bubble-induced performance degradation for UWOC with different bubble sizes and positions. They also investigated the effectiveness of spatial diversity on the mitigation of the bubble-induced impairment to the UWOC link.

Researchers continue to invent new techniques for more powerful UWOC. Chi *et al.* compared various filters in terms of performance and computational complexity in UWOC and experimentally demonstrated a 1.2 m/2.325 Gbps UWOC with a commercial blue LED. A 50 Gbps UWOC across the water-air-water interface was demonstrated by Lu *et al.*, using four-level pulse amplitude modulation and a reflective spatial light modulator that can potentially conquer oceanic engineering problems to establish a reliable UWOC link.

In addition, a UWOC network can be implemented to further enhance the transmission range, flexibility, and robustness by virtue of multiple hops and reliable network operation. Yin *et al.* investigated the performance of the two-way multi-hop system for UWOC, with an exact closed-form expression for outage probability being derived considering oceanic turbulence with a log-normal distribution.

An extraordinary growth in UWOC has indeed been witnessed recently, and this special issue is expected to provide the research community with a useful snapshot of the UWOC field. UWOC is a very comprehensive subject and calls for more and more interdisciplinary cooperation in future research. Foreseeing the emerging new developments in the UWOC field, we strongly encourage our colleagues working in this promising area to submit their future breakthroughs in this field to *Chinese Optics Letters*.

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