

Technical Challenges and Future Prospect of Underwater Optical Wireless Communications

By

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Abstract: Underwater optical wireless communication (UOWC) has attracted growing interest as a promising solution for Gbps-class links in underwater sensor networks, environmental monitoring, and marine robotics. Unlike fiber-optic systems, UOWC using visible light must simultaneously cope with severe absorption and scattering in water, power limitations of commercially available high-power laser diodes, and the severe bandwidth constraints of LED/LD transmitters and photodetectors, whose electrical bandwidth is typically limited to several hundred megahertz. These factors make it challenging to achieve both long-distance and highdata-rate transmission with practical complexity and cost.

In this keynote, I will first give an overview of the fundamental principles of UOWC, with emphasis on the “reversal” specific to this field, where optical devices are much slower than the associated electronic signal processing. I will then introduce our recent experimental work on high-speed UOWC systems, including inverse-nonlinear (INL) PAM4 modulation for extending transmission distance with high-power visible-light laser diodes, redundant-bit-free error reduction based on 2× oversampling and maximum-likelihood sequence estimation (with further enhancement by deep neural networks), and asynchronous multiple access schemes using diverging beams and code-domain techniques. Finally, I will outline some open research challenges in a national project and discuss our future direction toward “Undersea Digital Coherent (UDC, for short)” UOWC, which aims at bringing digital coherent technology specifically optimized for the ocean environment.



Biography of the Presenter: Prof. Dr. Masanori Hanawa is currently Director of the Center for Higher Education and Digital Transformation (DX) and Vice President at the University of Yamanashi, Japan, responsible for academic affairs and DX promotion. His work focuses on advancing DX in higher education, promoting AI-driven education, and fostering the internationalization of graduate programs. In addition to his administrative roles, Dr. Hanawa is actively engaged in research on optical communication and optical signal processing technologies, including underwater optical wireless communication using visible light. He has been leading a national research project supported by NICT, Japan, as well as several international collaborations, and has supervised graduate students from abroad. He is a member of professional organizations such as IEEE, Optica, IEICE, and JSET.