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Editorial: Emerging Technologies and Applications in Distributed Optical Fiber Sensors

Daniele Tosi[1,2]*, *David Barrera*[3] and *Luca Schenato*[4,5]

[1]School of Engineering and Digital Sciences, Nazarbayev University, Nur-Sultan, Kazakhstan, [2]National Laboratory Astana, Laboratory of Biosensors and Bioinstruments, Nur-Sultan, Kazakhstan, [3]ITEAM Research Institute, Universitat Politecnica de Valencia, Valencia, Spain, [4]National Research Council (CNR), Roma, Italy, [5]National, Inter-University Consortium for Telecommunications (CNIT), Parma, Italy

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Editorial on the Research Topic

Emerging Technologies and Applications in Distributed Optical Fiber Sensors

In the framework of advancing the capabilities for sensing and the ubiquitous detection of parameters, distributed fiber-optic sensors have gained significant traction, as they can detect and spatially and temporally resolve physical quantities. They find increasing applications in structural health monitoring, aerospace, geotechnical engineering, and, more recently, in medical devices. The latest years have seen a shift towards distributed sensing with ultra-narrow scale, approaching millions of sensing points in the fiber, real-time detection, and abating the complexity of the optical hardware involved in the system.

The Research Topic "Emerging Technologies and Applications in Distributed Optical Fiber Sensors" featured on *Frontiers on Sensors* journal reflects on the advancement of such technologies and provides a forum where recent trends have been presented as review and perspective formats: from engineering the design of the optical fibers to enhancing the detection methods, up to the actual applications in environmental sciences.

The first article, presented by Sun et al. provides a bird-eye view of the methods and applications for *in situ* detection of the moisture field distribution using optical fiber distributed sensors. Fibers have been employed in distributed and quasi-distributed schemes for the detection of soil water content and for pore gas humidity; the combined measurement, with high-precision distributed networks provides a significant improvement in geotechnical engineering, moving from the lab to the actual on-site applications.

A second work from Fernandez-Ruiz et al. reviews the latest improvement on distributed sensors from the hardware perspective through time-expanded phase optical time-domain reflectometry (TE-ϕOTDR). This innovative scheme allows achieving narrow, centimeter-level, spatial resolution with rapid sensing, taking inspiration from spectroscopy techniques that combine the light scattering with a spectral comb generated by a simple oscillator. The TE-ϕOTDR finds applications in strain and temperature sensing as a potential relatively low-cost architecture.

The final work, proposed by Lu et al., provides a perspective on the new design of high-scattering fibers optimized for short-scale distributed sensing. While traditional sensors make use of commercial, single-mode fibers (such as the SMF-28 standardized for communications), the possibility of doping the fiber core with nanoparticles induce giant increases of the intensity of the backscattered signal, that,

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Joel Villatoro, University of the Basque Country, Spain

***Correspondence:**
Daniele Tosi
daniele.tosi@nu.edu.kz

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in turn, enable novel multiplexing techniques that operate on the short scale such as in mini-invasive medical devices.

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