Title: Artificial Intelligence-Driven Optoelectronic Data Mining for Advanced High-Integration Multidimensional Sensing

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Multidimensional optoelectronic sensing involves detecting and sensing various optical features such as polarization, depth, spectrum, phase, and optical field. This technology is increasingly in demand and holds significant value in advanced fields such as aerospace detection, precision medicine, and autonomous driving. As the demand for higher performance and precision increases across application scenarios, the development of highly integrated solutions based on a single detector has emerged as a key area of research. This requires developing optoelectronic devices capable of sensing multiple optical features, and more importantly, advancing signal acquisition strategies, and data mining algorithms for optoelectronic responses. Due to the highly nonlinear or even transcendental characteristics of some optoelectronic responses feature, the detection errors of traditional Hadamard inverse processes have become uncontrollable. To address this issue, we propose an optoelectronic data mining algorithm based on artificial neural networks, which leverage their ability to effectively capture complex nonlinear relationships. By efficiently capturing the waveform features of optoelectronic responses, this algorithm mitigates reconstruction distortions and enables high-precision sensing of transient incident light spectra. Using only a single photodetector pixel, we achieved a spectral resolution of 1.2 nm and a peak signal-to-noise ratio of 34 dB, providing a novel and effective strategy for high integration and precision multidimensional optoelectronic sensing.

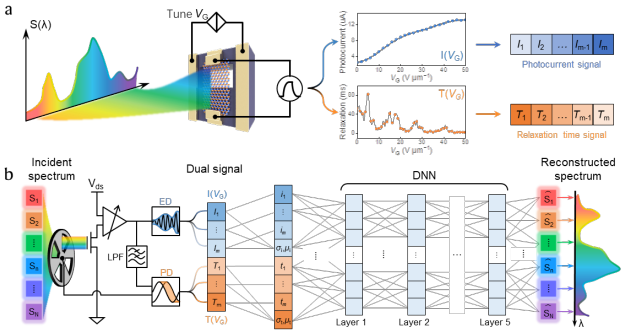

Fig 1. Transient spectra reconstruction based on artificial neural network: an illustration.

Reference

[1] Du, X.; Wang, Y.; Cui, Y.; Rao, G.; Huang, J.; Chen, X.; Zhou, T.; Wu, C.; Yang, Z.; Cuim H.; Zhao, Y.; Xiong, J. “A Microspectrometer with Dual-signal Spectral Reconstruction.” *Nat. Electron.* **2024**, Article ASAP. DOI: 10.1038/s41928-024-01242-9 (accessed 2024-9-17).

Biography

Du Xinchuan received his bachelor's degree of microelectronics from University of Electronic Science and Technology of China in 2019 and is pursuing his PhD degree directly under the supervision of Professor Yanrong Li. His research interests are optoelectronic device design and signal analysis for multidimensional photoelectric sensing.