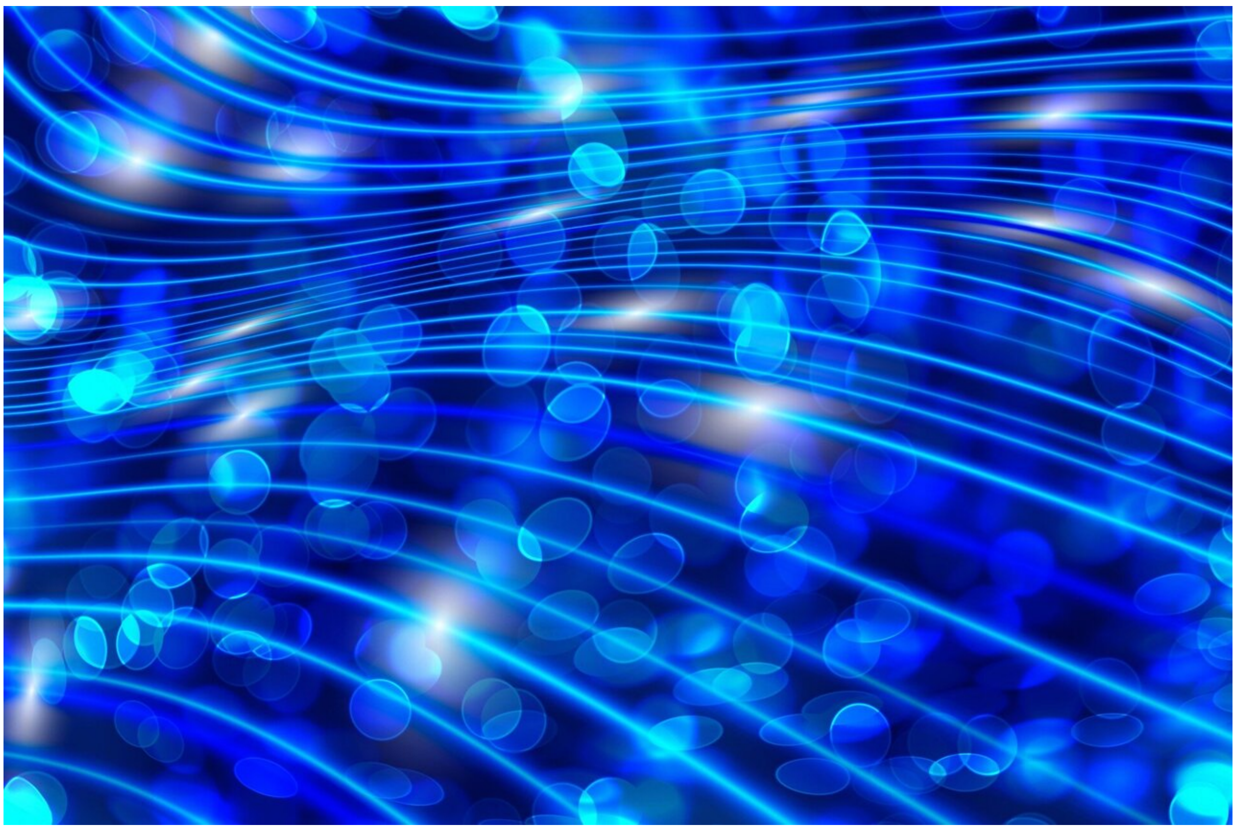
Smart quantum technologies for secure communication

March 16 2021



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Researchers from Louisiana State University have introduced a smart quantum technology for the spatial mode correction of single photons. In a paper featured on the cover of the March 2021 issue of *Advanced*

Quantum Technologies, the authors exploit the self-learning and self-evolving features of artificial neural networks to correct the distorted spatial profile of single photons.

The authors, Ph.D. candidate Narayan Bhusal, postdoctoral researcher Chenglong You, graduate student Mingyuan Hong, undergraduate student Joshua Fabre, and Assistant Professor Omar S. Magaña-Loaiza of LSU—together with collaborators Sanjaya Lohani, Erin M. Knutson, and Ryan T. Glasser of Tulane University and Pengcheng Zhao of Qingdao University of Science and Technology—report on the potential of artificial intelligence to correct spatial modes at the single-photon level.

"The random phase distortion is one of the biggest challenges in using spatial modes of light in a wide variety of quantum technologies, such as quantum communication, quantum cryptography, and quantum sensing," said Bhusal. "In this paper, we use artificial neurons to correct distorted spatial modes of light at the single-photon level. Our method is remarkably effective and time-efficient compared to conventional techniques. This is an exciting development for the future of free-space quantum technologies."

The newly developed technique boosts the channel capacity of optical communication protocols that rely on structured photons.

"One important goal of the Quantum Photonics Group at LSU is to develop robust quantum technologies that work under realistic conditions," said Magaña-Loaiza. "This smart quantum technology demonstrates the possibility of encoding multiple bits of information in a single photon in realistic communication protocols affected by atmospheric turbulence. Our technique has enormous implications for optical communication and quantum cryptography. We are now exploring paths to implement our machine learning scheme in the

Louisiana Optical Network Initiative (LONI) to make it smart, secure, and quantum."

The U.S. Army Research Office is supporting Magaña-Loaiza's research on a project titled "Quantum Sensing, Imaging, and Metrology using Multipartite Orbital Angular Momentum."

"We are still in the fairly early stages of understanding the potential for machine learning techniques to play a role in quantum information science," said Dr. Sara Gamble, program manager at the Army Research Office, an element of DEVCOM ARL. "The team's result is an exciting step forward in developing this understanding, and it has the potential to ultimately enhance the Army's sensing and communication capabilities on the battlefield."

More information: Narayan Bhusal et al, Spatial Mode Correction of Single Photons Using Machine Learning, *Advanced Quantum Technologies* (2021). DOI: 10.1002/qute.202000103

Provided by Louisiana State University

Citation: Smart quantum technologies for secure communication (2021, March 16) retrieved 1 September 2024 from https://phys.org/news/2021-03-smart-quantum-technologies.html

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