Physicists identify light sources using artificial intelligence

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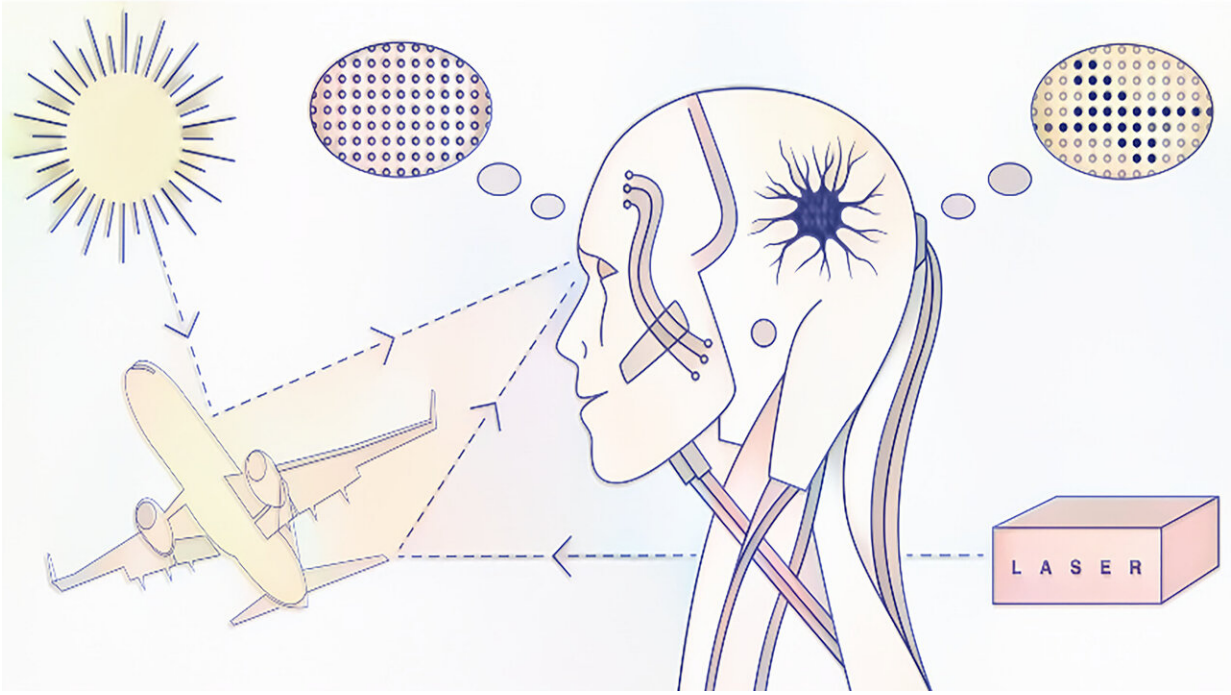

A detector (the eye) measures identical photons from natural sunlight and laser light. The fast identification of light sources is performed by an artificial neuron that is trained to efficiently extract patterns in the quantum fluctuations of photons. Credit: Elsa Hahne

A smart quantum technology for identification of light sources with fewer measurements.

Identifying the source of light plays an important role in the development of many photonic technologies such as LIDAR, remote sensing, and microscopy. Traditionally, identifying light sources as diverse as sunlight, laser radiation or molecule fluorescence has required millions of measurements particularly in low-light environments, which limits the realistic implementation of quantum photonic technologies.

In a paper for *Applied Physics Reviews*, researchers have demonstrated a smart quantum technology that enables a dramatic reduction in the number of measurements required to identify light sources.

"We trained an artificial neuron with the statistical fluctuations that characterize coherent and thermal light," said Dr. Omar Magana-Loaiza, an assistant professor of physics at Louisiana State University. After researchers trained the artificial neuron with light sources, the neuron could identify underlying features associated with specific types of light.

"A single neuron is enough to dramatically reduce the number of measurements needed to identify a light source from millions to less than hundred," said Dr. Chenglong You, a key researcher.

With fewer measurements, researchers can identify light sources much more quickly and in certain applications such as microscopy they can limit light damage as they don't have to illuminate the sample nearly as many times when taking measurements.

"If you were doing an imaging experiment with delicate fluorescent molecular complexes, for example, you could reduce the time the sample is exposed to light and minimize any photodamage," said Dr. Roberto de J. León-Montiel, a professor from the Institute of Nuclear Sciences at the National Autonomous University of Mexico.

Cryptography is another application where these findings could prove

valuable, said Dr. Magana-Loaiza. "In order to generate a key to encrypt an email or message you need to take millions of measurements," he said. "we could speedup the generation of quantum keys for encryption using a similar neuron."

"Given the important role that laser light plays for remote sensing, our work enables the development of a new family of smart LIDAR systems with the capability to identify intercepted or modified information reflected from a remote object," said Dr. You. LIDAR is a remote sensing method that measures distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor.

"The probability of jamming a smart quantum LIDAR system will be dramatically reduced with our technology. In addition, the possibility of discriminating LIDAR photons from environmental light, for example sunlight, will have important implications for remote sensing at low-light levels," he added.

The article, "Identification of Light Sources Using Machine Learning" is authored by Chenglong You, Mario Alan Quiroz Juarez, Aidan Lambert, Narayan Bhusal, Chao Dong, Armando Perez-Leija, Amir Javaid, Roberto de J. León Montiel and Omar S Magana-Loaiza.

More information: Chenglong You et al. Identification of light sources using machine learning, *Applied Physics Reviews* (2020). DOI: 10.1063/1.5133846

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https://techxplore.com/news/2020-05-physicists-sources-artificial-intelligence.html