Researchers develop system for improved latent fingerprint recognition

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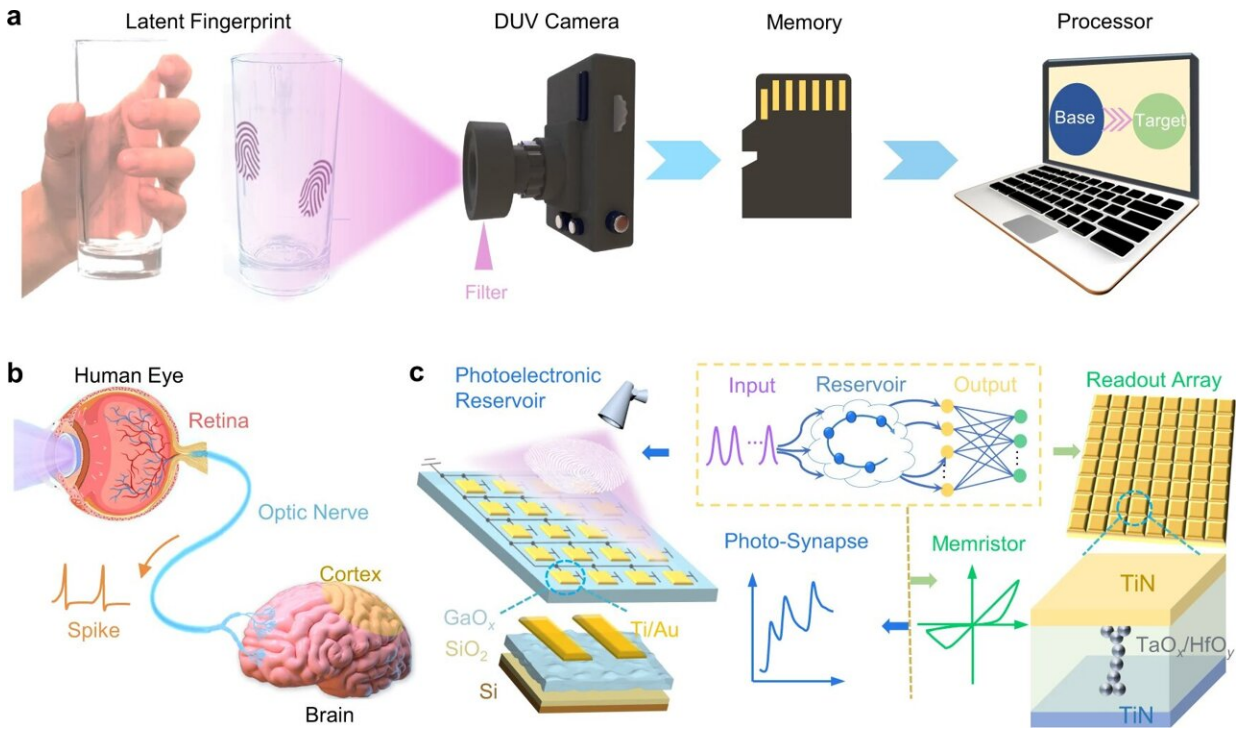

Reservoir computing system based on photo-synapse and memristor device array. a Data processing mode of traditional fingerprint recognition system, realized by independent optical sensor, memory chip and processor. b Schematic of the human visual recognition system comprising the retina, optical neurons, and visual cortex in the human brain. c Proposed RC system with optical synapses as the input layer of the reservoir and the memristor device array as the readout network. The inset in the dashed box is the abstract photoelectronic RC system. The original optical information is transmitted into the photoelectronic reservoir, where the inputs are nonlinearly mapped into feature outputs based on the PPC effect. And then, the memristor array receives the outputs of the

reservoir and implements readout training. Credit: *Nature Communications* (2022). DOI: 10.1038/s41467-022-34230-8

Recently, a research group led by Prof. Long Shibing from the University of Science and Technology of China (USTC) of the Chinese Academy of Sciences, collaborating with Prof. Liu Qi from Fudan University, developed an in-sensor reservoir computing system for latent fingerprint recognition with deep ultraviolet photo-synapses and a memristor array. This study was published in *Nature Communications*.

Deep ultraviolet (DUV) photodetectors play a pivotal role in deep space exploration, environmental monitoring, and bio-information identification. However, the conventional ex-situ DUV fingerprint recognition systems use separated sensor, memory, and processor, which significantly increases latency in decision making and thus overall computing power.

Inspired by the human visual perception system, the research group constructed a DUV in-sensor RC system with optical synapses as the input layer of the reservoir and the memristor device array as the readout network, which can sense and process in parallel to ensure high efficiency and low power consumption.

The research team used the Ga-rich component design and developed amorphous GaOx (a-GaOx) photo-synapses with enhanced persistent photoconductivity (PPC) effects. A non-linear mapping relationship for the DUV in-sensor RC system was constructed by inputting 4-bit equivalent light pulses for simulation so that the image pixel sequence information could be sampled for feature values.

Ultimately, the training of the reservoir outputs was achieved through

the stable polymorphic modulation properties of the memristor device array, enabling small-scale DUV fingerprint recognition. The excellent recognition accuracy of DUV fingerprint images when using a dual-feature strategy and this hardware system is almost identical to the simulated results.

The system achieves 100% recognition accuracy after 100 training epochs and maintains 90% accuracy even in the presence of 15% background noise, in line with the anti-noise characteristics of DUV light.

This fully-hardware DUV in-sensor RC system provides a good reference prototype for efficient recognition and secure applications of latent fingerprints. It is also a critical reference for developing intelligent optoelectronic devices in the DUV waveband.

"This prototype system … will provide more insight into emerging in-sensor reservoir computing. Overall, the topic of this work is truly interesting," said one reviewer for *Nature Communications*.

More information: Zhongfang Zhang et al, In-sensor reservoir computing system for latent fingerprint recognition with deep ultraviolet photo-synapses and memristor array, *Nature Communications* (2022). DOI: 10.1038/s41467-022-34230-8

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