Energy-efficient AI hardware technology via a brain-inspired stashing system

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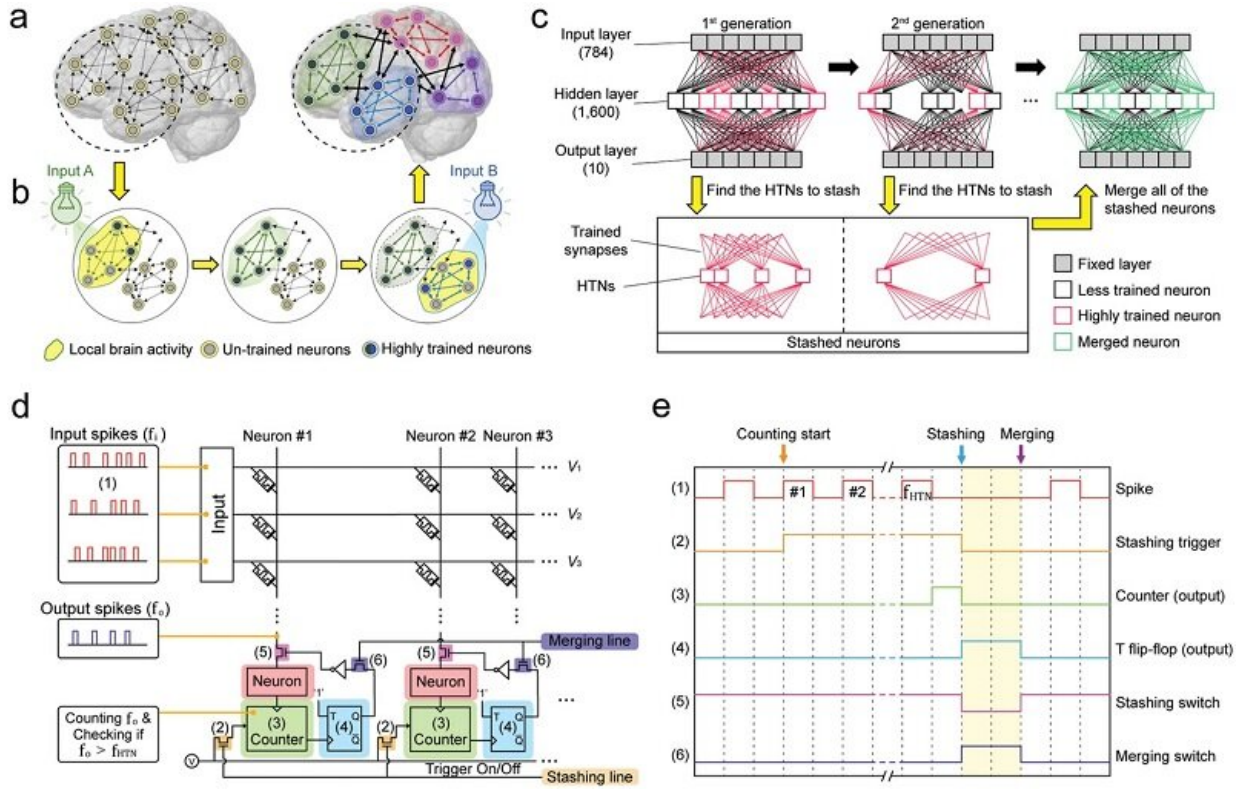

A schematic illustrating the localized brain activity (a-c) and the configuration of the hardware and software hybrid neural network (d-e) using a self-rectifying memristor array (f-g). Credit: KAIST

Researchers have proposed a novel AI system inspired by the neuromodulation of the brain, referred to as a "stashing system," that

requires less energy consumption. The research group led by Professor Kyung Min Kim from the Department of Materials Science and Engineering has developed a technology that can efficiently handle mathematical operations for artificial intelligence by imitating the continuous changes in the topology of the neural network according to the situation. The human brain changes its neural topology in real time, learning to store or recall memories as needed. The research group presented a new artificial intelligence learning method that directly implements these neural coordination circuit configurations.

Research on artificial intelligence is becoming very active, and the development of artificial intelligence-based electronic devices and product releases are accelerating, especially in the Fourth Industrial Revolution age. To implement artificial intelligence in electronic devices, customized hardware development should also be supported. However most electronic devices for artificial intelligence require high power consumption and highly integrated memory arrays for large-scale tasks. It has been challenging to solve these power consumption and integration limitations, and efforts have been made to find out how the human brain solves problems.

To prove the efficiency of the developed technology, the research group created artificial neural network hardware equipped with a self-rectifying synaptic array and algorithm called a "stashing system" that was developed to conduct artificial intelligence learning. As a result, it was able to reduce energy use by 37% within the stashing system without any accuracy degradation. This result proves that emulating the neuromodulation in humans is possible.

Professor Kim says that "in this study, we implemented the learning method of the human brain with only a simple circuit composition and through this we were able to reduce the energy needed by nearly 40%."

This neuromodulation-inspired stashing system that mimics the brain's neural activity is compatible with existing electronic devices and commercialized semiconductor hardware. It is expected to be used in the design of next-generation semiconductor chips for artificial intelligence.

This study was published in *Advanced Functional Materials*.

More information: Woon Hyung Cheong et al, Demonstration of Neuromodulation-inspired Stashing System for Energy-efficient Learning of Spiking Neural Network using a Self-Rectifying Memristor Array, *Advanced Functional Materials* (2022). DOI: 10.1002/adfm.202200337

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