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LETI SHOWS MEMRISTIVE DEVICES CAN MIMIC DIFFERENT KIND OF SYNAPTIC PLASTICITY INSPIRED BY BIOLOGY

Presented at IEDM 2016, Breakthrough Suggests Path to Embedding Neuromorphic Learning in Low-power Devices that Could Enable Autonomous Systems

GRENOBLE, France – Dec. 6, 2016 – Leti researchers have demonstrated that memristive devices are excellent candidates to emulate synaptic plasticity, the capability of synapses to enhance or diminish their connectivity between neurons, which is widely believed to be the cellular basis for learning and memory.

The breakthrough was presented today at IEDM 2016 in San Francisco in the paper, “Experimental Demonstration of Short and Long Term Synaptic Plasticity Using OxRAM Multi k-bit Arrays for Reliable Detection in Highly Noisy Input Data”.

Neural systems such as the human brain exhibit various types and time periods of plasticity, e.g. synaptic modifications can last anywhere from seconds to days or months. However, prior research in utilizing synaptic plasticity using memristive devices relied primarily on simplified rules for plasticity and learning.

The project team, which includes researchers from Leti’s sister institute at CEA Tech, List, along with INSERM and Clinatec, proposed an architecture that implements both short- and long-term plasticity (STP and LTP) using RRAM devices.

“While implementing a learning rule for permanent modifications – LTP, based on spike-timing-dependent plasticity – we also incorporated the possibility of short-term modifications with STP, based on the Tsodyks/Markram model,” said Elisa Vianello, Leti non-volatile memories and cognitive computing specialist/research engineer. “We showed the benefits of utilizing both kinds of plasticity with visual pattern extraction and decoding of neural signals. LTP allows our artificial neural networks to learn patterns, and STP makes the learning process very robust against environmental noise.”

Resistive random-access memory (RRAM) devices coupled with a spike-coding scheme are key to implementing unsupervised learning with minimal hardware footprint and low power consumption. Embedding neuromorphic learning into low-power devices could enable design of autonomous systems, such as a brain-machine interface that makes decisions based on real-time, on-line processing of in-vivo recorded biological signals. Biological data are intrinsically highly noisy and the proposed combined LTP and STP learning rule is a powerful technique to improve the detection/recognition rate. This approach may enable the design of autonomous implantable devices for rehabilitation purposes

Leti, which has worked on RRAM to develop hardware neuromorphic architectures since 2010, is the coordinator of the H2020 European project NeuRAM3. That project is working on fabricating a chip with architecture that supports state-of-the-art machine-learning algorithms and spike-based learning mechanisms.

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Leti will present 13 papers at the conference, three of which are invited.

About Leti (France)

As one of three advanced-research institutes within the CEA Technological Research Division, Leti serves as a bridge between basic research and production of micro- and nanotechnologies that improve the lives of people around the world. It is committed to creating innovation and transferring it to industry. Backed by its portfolio of 2,800 patents, Leti partners with large industrials, SMEs and startups to tailor advanced solutions that strengthen their competitive positions. It has launched 59 startups. Its 8,500m² of new-generation cleanroom space feature 200mm and 300mm wafer processing of micro and nano solutions for applications ranging from space to smart devices. With a staff of more than 1,900, Leti is based in Grenoble, France, and has offices in Silicon Valley, Calif., and Tokyo. Follow us on http://www.leti.fr/en and @CEA_Leti.

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