Artificial synapse creation makes brain-on-a-chip tech closer to reality

Computer chips which work like the human brain may be coming soon to a device near you.

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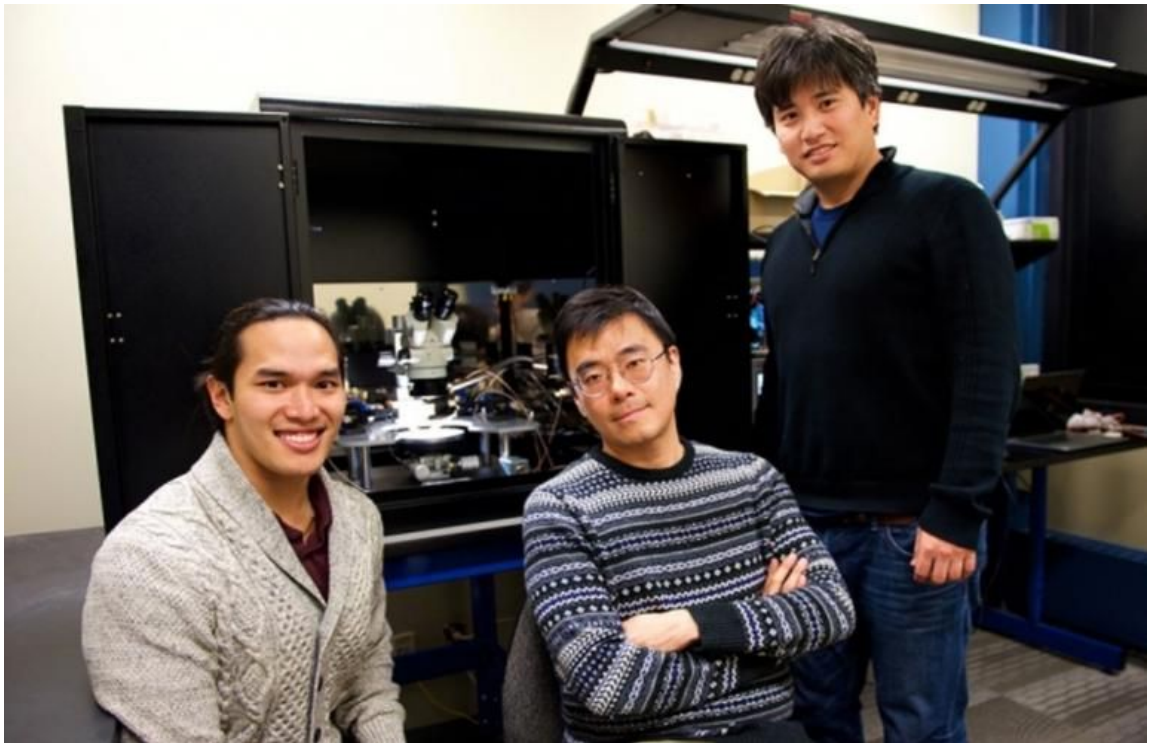

Kuan Qiao

Researchers have engineered an artificial synapse in an important step to making brain-on-a-chip processing a reality.

A team of researchers in the emerging field of neuromorphic computing from the Massachusetts Institute of Technology (MIT) revealed the project on Monday, which aims to

The more we learn about the human brain, the less we seem to know. What we do know, however, is there are roughly 100 billion neurons in the organ which fire to issue instructions to each other via synapses -- the spaces between neurons which facilitate the exchange of neurotransmitters.

In one single human brain, there are over 100 trillion synapses. Each one can strengthen some connections between neurons or lessen others, which enables us to recognize patterns, learn, make decisions and remember at rapid speeds.

This speed and ability to transform depending on circumstance are what researchers worldwide have been trying to adapt to computing to enhance the capabilities of our computing systems far beyond current capabilities through what is known as brain-on-a-chip processing.

Our PCs carry out computations based on binary and on/off signaling. In the field of neuromorphic computing, however, processors are intended to work in an analog manner, exchanging signals in the same way as neurons depending on the type and number of ions which would flow across synthetic synapses.

It is hoped that brain-on-a-chip systems could process millions of streams of computations and information in the same way that the human brain does and have the power of today's supercomputers.

However, creating the neural synapse artificially has proven a challenge to scientists. At least, until now.

The team from MIT said that they have developed an "artificial synapse in such a way that they can precisely control the strength of an electric current flowing across it, similar to the way ions flow between neurons."

A small chip has been created with the synapses, which are made with silicon germanium and measuring 25 nanometers across. During testing, the researchers found that the chip was able to recognize handwriting samples with 95 percent accuracy.

Previously, it has been difficult to control ion flow, as existing designs use amorphous materials without a defined structure. This results in unlimited possible paths -- which impacts the efficiency and results of neural network learning and computations.

However, the material used -- due to its inherent, uniform structure -- has resulted in a more stable ion flow.

"Once you apply some voltage to represent some data with your artificial neuron, you have to erase and be able to write it again in the exact same way," says Professor Jeehwan Kim, a different directions because there are lots of defects. This stream is changing, and it's hard to control. That's the biggest problem -- nonuniformity of the artificial synapse."

Beyond handwriting, the team says that the artificial synapse design may enable small, portable neural network devices that could perform complex computations only possible today through supercomputers in the future.

"Ultimately, we want a chip as big as a fingernail to replace one big supercomputer," Kim says. "This opens a stepping stone to produce real artificial hardware."

The research has been published in the journal Nature Materials and was supported in part by the National Science Foundation.