Synaptic Resistor With Signal Processing, Memory, And Learning Functions

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SUMMARY

Researchers led by Yong Chen from the Department of Mechanical and Aerospace Engineering have developed an artificial synapse for neuromorphic chips that have integrated logic, memory, and learning capabilities.

BACKGROUND

Over the past decades computers have become more powerful due to the miniaturization of the transistors and other electrical components. Now, researchers want to apply these advancements to create a computer that functions more like the human brain where neurons process input information to relay an output to other neurons *via* synapses. These new types of computer chips that have artificial neurons and synapses made up of logic and memory transistors are known as neuromorphic chips. However, the transistors in modern computers and neuromorphic chips do not behave like real neurons. The “learning” that happens in these artificial synapses result from sequential learning where the memory and logic transistors communicate with each other rather than doing it one step like biological neurons. This drawback creates severe limitations in processing power and scalability.

INNOVATION

Researchers led by Yong Chen from the Department of Mechanical and Aerospace Engineering have developed an artificial synapse for neuromorphic chips that have integrated logic, memory, and learning capabilities. These new synaptic resistors can perform computations while also learn at the same time. Based on the timing of input and outputs the resistor can change its conductance, and thus learns over time. The conductance is controlled by a charge storage material, and the conductance changes with how much charge is stored. This amount of charge doesn’t change without simultaneous activation of input and output nor when the chip is powered off, thus giving this synaptic resistor a robust memory element. The nature in which this synaptic resistor learns and retains memory through the use of charge storage makes it analog. All of these aspects make this artificial synapse functionally closer to the biological synapses, and thus can increase the computational power of computers without consuming a lot of power.

APPLICATIONS

- Robotics
- Pilotless aerial vehicles
- Neuromorphic computing
- Artificial intelligence
- Computer processing chips

ADVANTAGES

- Real-time learning
- Fast processing speed from parallel processing
- Low energy consumption–no clock is required
- Behaves more like biological neurons
- Learns dynamically and instantaneously
- Non-volatile memory
- Analog
- Can be programmed to be inhibitory or excitatory
- Small size

CONTACT

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INVENTORS

- Chen, Yong

OTHER INFORMATION

KEYWORDS

Synapse, neuron, neuromorphic chip, chip, parallel processor, artificial intelligence, memory, resistor, memristor, dendrite, circuits, SRAM, GPU

CATEGORIZED AS

- **Biotechnology**
  - Other
- **Computer**
  - Hardware
- **Medical**
  - Devices
- **Nanotechnology**
  - Electronics
- **Semiconductors**
  - Other
- **Engineering**
  - Robotics and Automation

RELATED CASES

2018-379-0

STATE OF DEVELOPMENT

Prototype developed

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,514,303	11/29/2022	2018-379
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