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Phyto Neuromorphic Electronics Using Natural Synaptic Converters

Erin Persil*

Department of Organic Chemistry, University of Murcia, Spain

Introduction

Because traditional von Neumann computer design separates memory from computation, calculations need data exchanging between the units. This physical link limits the possible growth in speed and energy efficiency of advanced big data processing. This "von Neumann bottleneck" can be overcome by replicating biological nerve systems and employing artificial synapses that integrate memory and processing operations in one cell, as in biological nervous systems. Emulation of biological synapses and nerves also provides sensing and responding functions with human-like abilities such as event-driven processing and high-accuracy perception, which are restricted in traditional human-interactive systems such as e-skins, human-machine interfaces, and neuro-prostheses [1].

External stimuli elicit sensory signals in biological neurological systems, which are then conveyed by sensory nerves in the peripheral nervous system to the central nervous system, which performs perceptual information processing. Following that, the processed signal is transferred via nerves to develop suitable reactions to the input. By sensing and responding to environmental input, neuromorphic systems that mimic biological PNS and CNS may enable energy-efficient operation to process intricate real-world issues. To simulate perceptual processing, artificial sensory nerves are made up of sensors, artificial neurons, and artificial synapses. Artificial neurons convert sensory inputs to voltage spikes, which are subsequently processed by artificial synapses.

These artificial sensory nerves mimic the event-driven behaviour of organic nerves, consuming energy only when responding to inputs. As a result, artificial nerves utilise far less energy than typical artificial sensory systems, which need frequent scanning of sensing/processing units and use standby energy when input is missing. Furthermore, the artificial nerves have the potential to be beneficial for prosthetic applications since they can create biocompatible spike signals without the necessity of large and stiff external encoding devices. Biological reactions can be induced after perceptual processing by activating specific organs and tissues. The integration of these neuromorphic systems with biological systems, resulting in "bio-hybrid neuromorphic systems," would enable biomimetic signal transmission and information processing at bio-electronic interfaces [2,3].

About the Study

As a result, these systems successfully emulate efficient biological perception processing with sensing and responding abilities, and thus show promise for use in next-generation healthcare monitoring and neuroprosthetic devices that need to detect bio-signals in a human body and stimulate biological organs for appropriate responses. Bio-hybrid neuromorphic electronics, which merge artificial synapses/nerves with biological systems, have been created to enable the implementation of these applications. Because of advantages such as electrical properties that can be tuned by molecular design, simple fabrication processes, soft mechanical properties, low power consumption, and biocompatibility, organic synaptic transistors have been regarded as promising components of bio-hybrid neuromorphic systems. This artificial synapse is being created to mimic real synapses, in which the strength of the synaptic connection between pre- and postsynaptic neurons may be controlled. This capacity is known as synaptic plasticity; it is the foundation of learning and memory in nervous systems, therefore it is a necessary attribute of neuromorphic devices and systems. As a result, OSTs may be employed as biorealistic artificial neural components for neuromorphic computing, internet of things smart sensors, and neural prosthetics [4,5].

Conclusion

Because electrolytes enable interfacing of the devices with biological bodies and organs, OSTs that use electrolytes as gate insulators can process biological information such as electrophysiological signals, bio-physical signals, and bio-chemical signals; in healthcare monitoring and bio-medical applications, these abilities enable the OST to assess the bearer's health. Furthermore, the gadgets have been integrated with sensing and actuating components that resemble bio-logical sensory and motor neurons, allowing for very accurate preceptive and adaptive electronic systems. OSTs may someday replace organic nerves partially or entirely as implantable neuroprostheses for neurological disorders.

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***Address for Correspondence:** Erin Persil, Department of Organic Chemistry, University of Murcia, Spain, E-mail: epersil@odu.edu*

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