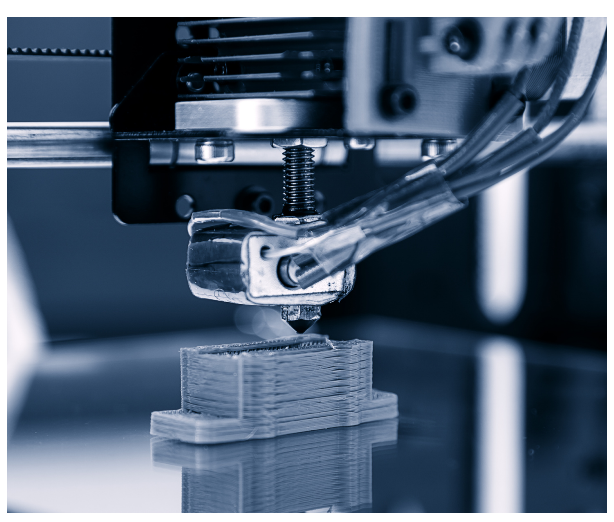
APPLICATIONS OF NEUROMORPHIC COMPUTING

Neuromorphic computing refers to a form of processing that mirrors the structure and functionality of the human brain [2]. Professionals have been developing effective neuromorphic systems for years; however, the field is still relatively new. It does not have as many present-day applications in comparison to its more traditional counterparts. However, even in the early stages of its existence, neuromorphic computing provides great promise. Its unique characteristics will make it a beneficial tool for innovators in a number of fields.

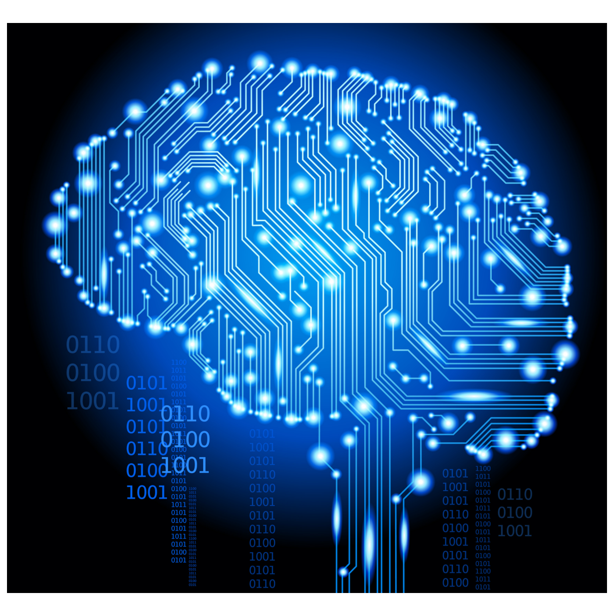
MEDICINE

Neuromorphic devices are extremely effective at receiving and responding to data from their environment [2]. When coupled with organic materials, these devices become compatible with the human body. In the future, neuromorphic devices could be used to improve drug delivery systems. Their highly responsive nature would allow them to release a drug upon sensing a change in body conditions (i.e. varying insulin and glucose levels). Neuromorphic computing devices could also be used in prosthetics. Once again, their ability to efficiently receive and process an external signal is of benefit to this technology. Using neuromorphic instead of traditional devices could create a more realistic, seamless experience for those with prosthetics [2]. Dr. Gkoupidenis describes additional medical applications he hopes to see in the future at 14:11 in his interview.



LARGE-SCALE OPERATIONS & PRODUCT CUSTOMIZATION

Elements of large-scale projects and product customization could also benefit from the use of neuromorphic computing [2]. It could be used to more easily process large sets of data from environmental sensors. These sensors could measure water content, temperature, radiation, and other parameters depending on the needs of the industry. The neuromorphic computing structure could help recognize patterns in these data, making it easier to reach effective conclusions. Neuromorphic devices could also lend to product customization due to the nature of their building materials. These materials can be transformed into easily manipulated fluids. In liquid form, they can be processed through additive manufacturing to create devices specifically fit for the user's needs [2].

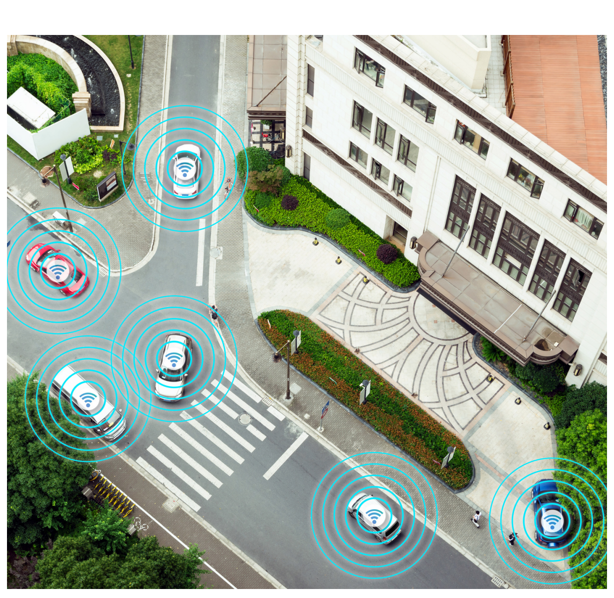


ARTIFICIAL INTELLIGENCE

By definition, the field of neuromorphic computing strives to emulate the functionality of the human brain. The way the brain's neurons receive, process, and send signals is extremely fast and energy efficient. As such, it is natural that professionals in technology, specifically those in the field of artificial intelligence (AI), would be intrigued by this type of computing. As the name suggests, individuals in the field of AI focus on a particular element of the brain--intelligence. Intelligence is the ability for the mind to collect and apply information. Since this concept relates so closely to neuromorphic computing, it would be beneficial for the two fields to collaborate going forward [3]. A focus on mirroring brain functionality at the level of an artificial neuron (and smaller) could be the key to developing computers with truly human-level intelligence. Dr. Gkoupidenis describes his perspective on AI and neuromorphic computing starting at 11:44 during his interview.

IMAGING

Neuromorphic vision sensors produce images in a similar way to the human eye. These imaging devices are "event-based" [4]. This indicates they respond to light intensity (external signal) rather than an internal signal when producing an image [1]. Furthermore, their speed is not dependent on a traditional frame rate. Each pixel in a neuromorphic sensor acts independently from those around it. Additionally, changes in each pixel are communicated within the device almost instantaneously [4]. The combination of these mechanisms allows for much more efficient data use. These sensors also do not experience motion blur or a delayed environmental response like their conventional counterparts. This set of characteristics could make neuromorphic vision sensors a welcome addition to virtual and augmented reality technology.



MISC. OTHER APPLICATIONS

Due to its low energy consumption, neuromorphic computing could be suitable for use on "the edge" [5]. "The edge" refers to the outskirts of a network that would allow the device to be connected to a cloud platform. Since driverless cars must operate in this space, neuromorphic computing could help them respond more effectively to their surroundings. When not connected to a stable internet source, a system employing neuromorphic computing could take over these vehicles. This could make driverless cars safer and more suitable for varying environments. The advanced sensing capabilities of neuromorphic computing could also improve existing "smart technology" [3]. Similar to with driverless cars, this adjustment could make the devices more effective for a wider range of conditions. Neuromorphic computing could also be used to expand methods of communication. A potential relationship between this form of computing and nonverbal communication is described by Dr. Gkoupidenis at 15:42 in his interview.

REFERENCES

[1] Boettiger, J. P. (2020). A Comparative Evaluation of the Detection and Tracking Capability Between Novel Event-Based and Conventional Frame-Based Sensors. *Theses and Dissertations.*

[2] Tuchman, Y., Mangoma, T. N., Gkoupidenis, P., van de Burgt, Y., John, R. A., Mathews, N., Daly, S. R., Malliaras, G. G., & Salloe, A. (2020). Organic neuromorphic devices: Past, present, and future challenges. *MRS Bullletin*, 45(8), 619 - 630. https://doi.org/10.1557/mrs.2020.196

[3] Lutkevich, B. (2020, February). *What is Neuromorphic Computing?*. TechTarget. https://searchenterpriseai.techtarget.com/definition/neuromorphic-computing

[4] Pelé, A. (2020, April 21). *Neuromorphic Vision Sensors Eye the Future of Autonomy*. EE Times. https://www.eetimes.com/neuromorphic-vision-sensors-eye-the-future-of-autonomy/

[5] Greengard, S. (2020). Neuromorphic Chips Take Shape. *Communications of the ACM* 63(8), 9 - 11.