Neural networks that function like the human visual cortex may help realize faster, more reliable pattern recognition

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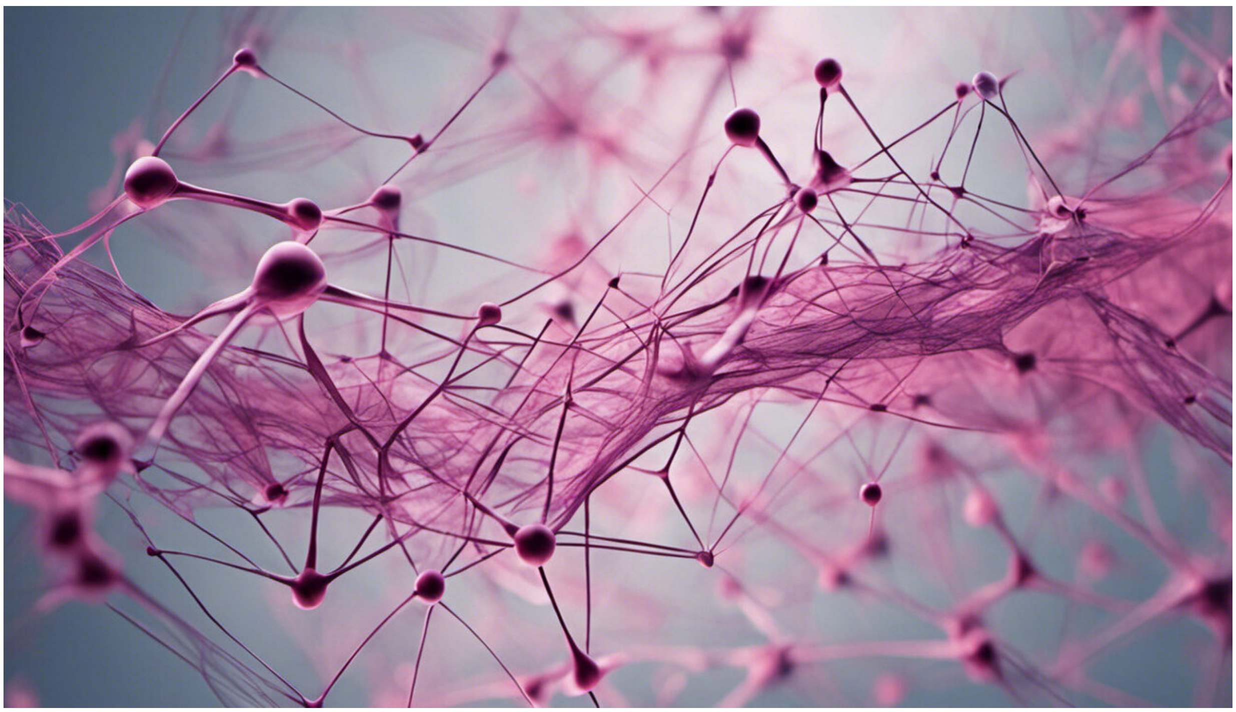

Credit: AI-generated image (disclaimer)

Despite decades of research, scientists have yet to create an artificial neural network capable of rivaling the speed and accuracy of the human visual cortex. Now, Haizhou Li and Huajin Tang at the A*STAR Institute for Infocomm Research and co-workers in Singapore propose using a spiking neural network (SNN) to solve real-world pattern recognition problems. Artificial neural networks capable of such pattern recognition could have broad applications in biometrics, data mining and image analysis.

Humans are remarkably good at deciphering handwritten text and spotting familiar faces in a crowd. This ability stems from the visual cortex—a dedicated area at the rear of the brain that is used to recognize patterns, such as letters, numbers and facial features. This area contains a complex network of neurons that work in parallel to encode visual information, learn spatiotemporal patterns and classify objects based on prior knowledge or statistical information extracted from patterns.

Like the human visual cortex, SNNs encode visual information in the form of spikes by firing electrical pulses down their 'neurons'. The researchers showed that an SNN employing suitable learning algorithms could recognize handwritten numbers from the Mixed National Institute of Standards and Technology (MNIST) database with a performance comparable to that of support vector machines—the current benchmark for pattern recognition methods.

Their SNN has a feedforward architecture and consists of three types of neurons: encoding, learning and readout neurons. Although the learning neurons are fully capable of discriminating patterns in an unsupervised manner, the researchers sped things up by incorporating supervised learning algorithms in the computation so that the learning neurons could respond to changes faster.

The researchers tested the performance of the SNN by challenging it with images from the MNIST, which contains 60,000 training images and 10,000 testing images of handwritten numbers (ranging from zero to nine). After several training iterations, the SNN could recognize all the numbers in the database. The accuracy of the SNN was high (around 94 per cent) for training images and moderate (around 79 per cent) for testing images. Compared with support vector machines, the encoding and learning processes of the SNN were fast for training images and moderately fast for testing images.

"We utilized biologically plausible mechanisms to build a cognitive system that is capable of effective and efficient cognitive computations," says Tang. "Together with other related works, this paper paves the way for constructing a general structure of spiking neural systems for cognitive computation."

More information: Yu, Q., Tang, H., Tan, K.C. & Li, H. Rapid feedforward computation by temporal encoding and learning with spiking neurons. *IEEE Transactions on Neural Networks and Learning Systems* 24, 1539–1552 (2013). dx.doi.org/10.1109/TNNLS.2013.2245677

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