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Optoelectronic neural network offers packet switching reliability

by Sunny Bains

Using diffractive optical elements to provide inputs to analog neural networks, researchers have demonstrated a highly reliable scheduler for telecommunications switching. Though the technology is still too slow and bulky for applications, researchers say further integration and development could make it commercially viable. The project is a collaboration between British Telecom Laboratories (Ipswich, UK) and Heriot-Watt Univ. (Edinburgh, UK).

A basic problem in communications is how to route information from one person to another. As the data comes in from one channel, it has to be steered through a clear path to its destination. This is straightforward-- except that many other signals have to be routed simultaneously. Figuring out the best way to accommodate as many channels as possible is computationally difficult, so engineers have been looking for other options. Neural networks, with their ability to quickly adapt to changing circumstances, are regarded as a promising technology; however, the problem is how to provide the huge amount of communication required between each of the neurons (Figure 1).

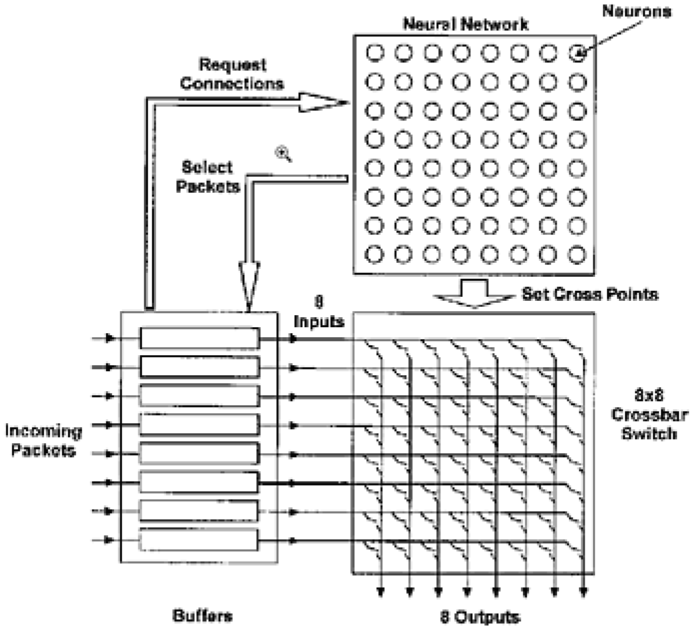

Figure 1. The neural network packet scheduler. First, the network receives "requests" for a particular destination, based on the headers for the packets at the front of each queue. Each of these requests increases the activity of the neuron controlling the particular switch that would enable that route. The neural network comes in because activity of any neuron in a particular row or column inhibits that of the other neurons, so only one switch will be activated and the others will be suppressed.

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The BT/Heriot-Watt team came up with a simple diffractive-optics-based solution of free-space interconnects (Figure 2). The neural network scheduler successfully found the optimal routing in almost every case. The team is now looking at implementing it using integrated smart-pixel structures, and optimizing the time constant of the neurons used to improve speed.

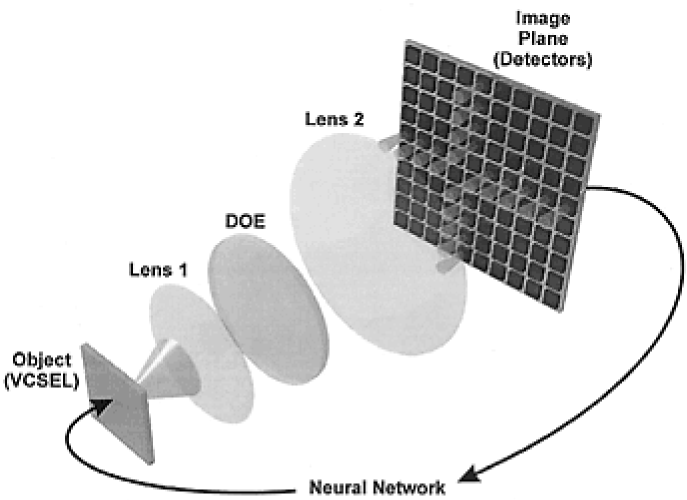
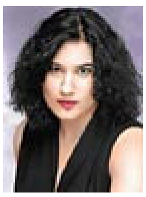


Figure 2. The winner-take-all neural function is implemented by having each neuron broadcast a beam from a vertical-cavity surface-emitting laser (VCSEL) to all the others in its row and column. The more light falls on a neuron, the less able the neuron is to fire itself. Eventually, only nonblocking routes survive.



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Reference

1. Roderick P. Webb, Andrew J. Waddie, Keith J. Symington, Mohammed R. Taghizadeh, and John F. Snowdon, *Optoelectronic neural-network scheduler for packet switches,* **Applied Optics 39** (5), 10 February 2000.