Neural networks within multi-core optic fibers

By mlondon
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By mlondon February 4, 2017

Cohen, E, Malka D, Shemer A, Shahmoon A, Zalevsky Z, London M. 2016.

Abstract:

Hardware implementation of artificial neural networks facilitates real-time parallel processing of massive data sets. Optical neural networks offer low-volume 3D connectivity together with large bandwidth and minimal heat production in contrast to electronic implementation. Here, we present a conceptual design for in-fiber optical neural networks. Neurons and synapses are realized as individual silica cores in a multi-core fiber. Optical signals are transferred transversely between cores by means of optical coupling. Pump driven amplification in erbium-doped cores mimics synaptic interactions. We simulated three-layered feed-forward neural networks and explored their capabilities. Simulations suggest that networks can differentiate between given inputs depending on specific configurations of amplification; this implies classification and learning capabilities. Finally, we tested experimentally our basic neuronal elements using fibers, couplers, and amplifiers, and demonstrated that this configuration implements a neuron-like function. Therefore, devices similar to our proposed multi-core fiber could potentially serve as building blocks for future large-scale small-volume optical artificial neural networks.

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