Photonic-Electronic Convolutional Neural Networks

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ABSTRACT

Researchers at the University of California, Davis have developed a combined photonic-electronic neural-network apparatus that combines optical and electronic integrated circuits to perform ultrafast, wavelength-parallel neural network operations with enhanced throughput and low power consumption.

FULL DESCRIPTION

This technology integrates a photonic integrated circuit with a nonvolatile electronic crossbar array via a pipelined optical-to-electrical data path to perform neural network computations. By encoding input data on multiple optical wavelength channels, the photonic circuit performs parallelized neural network operations using a reconfigurable optical coupler mesh network, while the electronic integrated circuit completes subsequent neural operations. This hybrid system leverages the speed and parallelism of photonics along with the programmability and memory capabilities of electronics to achieve efficient, high-throughput neural network processing.

APPLICATIONS

- Artificial intelligence hardware accelerators.
- High-performance computing for machine learning and deep learning.
- Edge computing devices requiring low power and high speed.
- Data centers and cloud platforms running neural network inference.
- Autonomous systems and robotics with real-time AI processing needs.

FEATURES/BENEFITS

- Combines photonic-speed data movement with electronic programmability for practical, reconfigurable systems.
- Enables ultrafast parallel computation via wavelength-division multiplexing (WDM).
- Reduces total energy use through tight photonic–electronic integration.
- Lowers end-to-end latency with optical-to-electrical interfaces.
- Adapts neural operations dynamically using a reconfigurable optical coupler mesh.
- Accelerates in-memory compute and weight storage with nonvolatile electronic crossbar arrays.
- Improves density and scalability using compact integration and optional 3D stacking.
- Eliminates electronic data-movement bottlenecks that limit throughput and increase latency.
- Reduces the energy cost of conventional high performance neural-network hardware.
- Scales performance to support large, complex models by boosting effective throughput.
- Minimizes dependence on external memory by keeping weight storage close to compute (in/near-memory storage).

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INVENTORS

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OTHER INFORMATION

KEYWORDS

artificial intelligence, crossbar arrays, energy efficiency, neural networks, optical computing, photonic integrated circuits, pipelined data path, reconfigurable optical mesh, wavelength-division multiplexing, wavelength-parallel processing

CATEGORIZED AS

- **Optics and Photonics**
  - All Optics and Photonics
- **Computer**
  - Hardware
- **Nanotechnology**
  - Electronics

RELATED CASES

2026-374-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Higher-Speed and More Energy-Efficient Signal Processing Platform for Neural Networks
- Crystal Orientation Optimized Optical Frequency Shifter
- Hyperspectral Compressive Imaging

- Athermal Nanophotonic Lasers
- Ultra-High Resolution Multi-Platform Heterodyne Optical Imaging
- Multi-Wavelength, Laser Array
- Optical Interposers for Embedded Photonics Integration
- Ultrahigh-Bandwidth Low-Latency Reconfigurable Memory Interconnects by Wavelength Routing
- Development of a CMOS-Compatible, Nano-photonic, Laser
- Energy Efficient and Scalable Reconfigurable All-to-All Switching Architecture
- Compressive High-Speed Optical Transceiver
- All-Optical Regenerators
- Tensorized Optical Neural Network Architecture
- Silicon Based Chirped Grating Emitter for Uniform Power Emission
- Energy-Efficient All-Optical Nanophotonic Computing
- All-To-All Interconnection With Wavelength Routing Devices
- 3D Photonic and Electronic Neuromorphic Artificial Intelligence
- Adapting Existing Computer Networks to a Quantum-Based Internet Future

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