亮点报道：高效的片上光处理器在线训练算法

DOI: 10.12086/oee.2025.251007.h02

目前主要的在线训练算法每次迭代都需要逐个更新变量来计算损失函数，这会导致大量的计算量和较长的训练时间。因此，寻找一种适用于光学矩阵配置的高效优化算法对大规模光子计算芯片在线训练与多维光通信系统均有较大意义。

华中科技大学武汉光电国家研究中心王健教授带领的多维光子学实验室 (MDPL) 团队在光学矩阵计算芯片在线训练方面取得了进展。该工作提出了一种利用随机并行梯度下降算法 (SPGD algorithm) 的光学神经网络芯片在线训练方法，该方法相比目前主流的离散梯度下降算法、遗传算法、粒子群算法等优化算法极大地减少了运算次数，可以大大节约训练过程中的功耗，有望应用于超大规模光学矩阵计算芯片的在线训练。该团队设计制造了基于级联马赫-曾德尔干涉仪 (MZI) 的 6×6 可重构光处理器芯片并进行了在线训练实验，包括光交换矩阵、光信号解扰矩阵以及二者的结合。

该团队还研究对比了光学矩阵规模扩大到 10×10、16×16、32×32 时 SPGD 算法与传统梯度算法、遗传算法和粒子群算法的运算量，结果表明随着矩阵规模的扩大 SPGD 算法运算量的增幅小于其他算法。

Opto-Electronic Advances, 2024, **7**(4): 240182.
https://www.oejournal.org/article/doi/10.29026/oea.2024.240182

Highlights: Efficient stochastic parallel gradient descent training for on-chip optical processors

DOI: 10.12086/oee.2025.251007.h02

It is of great significance to find an efficient optimization algorithm suitable for optical matrix configuration for online training of large-scale photonic computing chips and multi-dimensional optical communication systems.

In order to verify the feasibility of the proposed optimization method, the research group of Prof. Jian Wang designed and fabricated a 6×6 reconfigurable optical processor chip based on cascaded Mach-Zehnder Interferometers (MZIs) and carried out online training experiments, including optical switching matrix and optical signal descrambling matrix. On this basis, this reconfigurable optical processor chip to high-speed optical communication systems was used to compensate for crosstalk caused by mode mixing during transmission. It can be seen that the quality of the signal is significantly improved when the light passes through the trained photonic chip, and the bit error rate (BER) is greatly reduced.

The computational effort of the SPGD algorithm was compared with the traditional gradient algorithm, GA and PSO algorithm when the optical matrix scale is expanded to 10×10, 16×16, and 32×32. The results show that the increase of the computational cost of SPGD algorithm is less than that of other algorithms.

Opto-Electronic Advances, 2024, **7**(4): 230182.
https://www.oejournal.org/article/doi/10.29026/oea.2024.230182