Machine learning algorithm applied to the phase control of an array of laser beams

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Resume : The phase control problem is to lock and maintain of an array of laser beams on arbitrary target phase set in a fast dynamical environment. The potential application is a remote laser beam illumination with a high intensity. The difficulty is that direct phase measurements are not possible, but only phase modulations are available. The goal is to set the phases of the laser beams to the target values represented by a vector $\varphi \in [0, 2\pi]^n$, where n is the number of laser beams. This problem can be solved via an opto-numerical algorithm developed in [2]. The optical part of the algorithm is done by means of noisy intensity measurements from a photonic system, the numerical part is an optimization algorithm based on alternating projections. The numerical algorithm has two unavoidable requirements: robustness and efficiency. The experimental data are very noisy and the phase control must done in less than one tenth of millisecond.

We present a machine learning based algorithm [1, 3] that could replace the optimization method of the opto-numerical algorithm. It is shown numerically and verified experimentally that a simple neural network with one fully-connected layer without a bias and with an activation function, can compute $\varphi_k \in \mathbb{C}^n$ such that $\varphi_k \to \varphi$ up to a constant for sufficiently large k. This approach is highly scalable for fixed target and cheaper in comparison with the previous optimization algorithms. Also, the robustness is confirmed experimentally.

Références :

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