

Training of MO Diffractive Deep Neural Networks by Monte Carlo Method (2)

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Deep Neural Networks (DNNs) have been surprisingly developed and implemented in various applications. However, as the DNNs have become more complicated, the high-speed computing and the energy consumption are much challenging. To solve those issues, we have proposed magneto-optical diffractive deep neural network (MO-D²NN) device [1,2]. In this study, we propose optimization of the learning process of MO-D²NN by Monte Carlo Method (MCM).

The proposed model in this calculation consists of two hidden layers, with a domain size set to 1 μm , the wavelength of the incident linearly polarized light was kept 633 nm, and the distance between the layers and the hidden layers was fixed at 0.5 mm. MNIST dataset has been chosen as input data for the simulation of handwritten digit classification. Magnetic domain patterns in the hidden layers, which were randomly prepared, were rewritten using the MCM with steps of 1 – 1000 for an input of one handwritten digit. This procedure was repeated in series for seven inputs of the handwritten digits.

Figure 1 shows input images of seven handwritten digits, output images obtained after calculations with 1000 steps of MCM for the seven handwritten digits, and the ideal output images. The outputs reflected the convergence of the light intensity towards the appropriate area for each digit, which matched to the target images. This confirms the reliability of the Monte Carlo method to optimize the magnetic domain patterns in the MO-D²NN.

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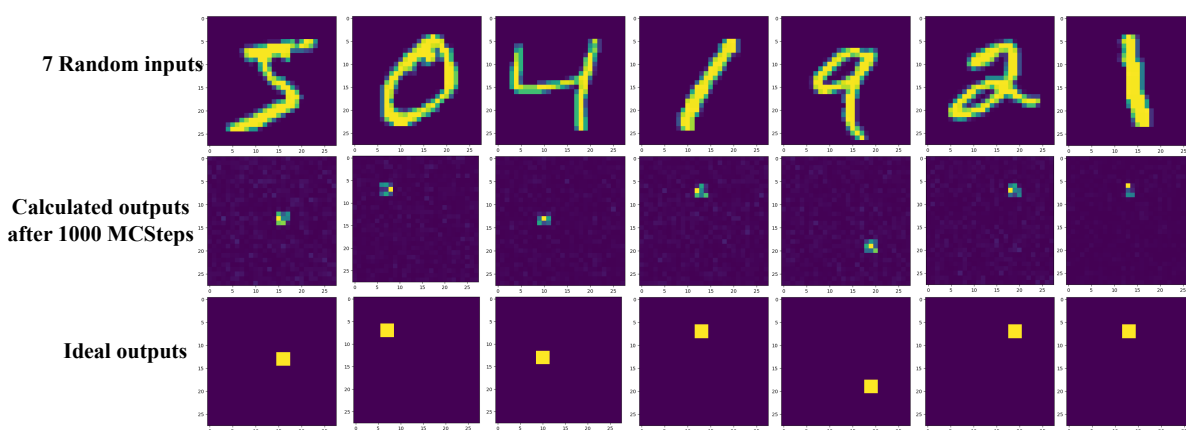


Fig. 1 Input images of seven handwritten digits, output images obtained after calculations with 1000 steps of MCM for the seven handwritten digits, and the target output images

- [1]. T. Fujita, *et al.*, Opt. Exp. 30, 36889 (2022).
- [2]. H. Sakaguchi, *et al.*, DOI 10.1109/TMAG.2023.3281842 (2023).