

# Numerical simulation on wavefront transformation using self-referential holographic deep neural network

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In recent years, spatial light modulated deep neural networks (DNNs) have been paid much attention. Among them, a diffractive deep neural network (D<sup>2</sup>NN) [1] which has been proposed by A. Ozcan's group at UCLA has proved the high expressiveness of spatial light modulated DNNs by showing the possibility of wide variety of applications such as image classification, quantitative imaging and wavefront transformation. Although D<sup>2</sup>NN is easily realized only by appropriately putting 3D-printed phase plates, we focus on an optoelectronic DNN (OE-DNN) in which optical and electronic calculations are combined to achieve more flexible design of DNNs. Self-referential holographic deep neural network (SR-HDNN) is one of the OE-DNNs and is based on optical processing via volume holograms [2]. Since the optical system of SR-HDNN is the same as self-referential holographic data storage (SR-HDS) which is one of the implementation methods of holographic data storage, SR-HDNN will be able to be integrated into SR-HDS system in the future. Here, we investigate the capability of the wavefront conversion task assuming future applications of SR-HDNN such as denoising of output data pages and generating mask patterns used in recording and reconstruction processes in SR-HDS [3,4].

In this work, we verified the feasibility of the wavefront transformation by performing the fundamental task of phase-to-intensity conversion. Here, we used binarized MNIST dataset and assumed 2-layer SR-HDNN model. The number of gradations and size were set to 256 and 128×128 on spatial light modulator and camera, respectively. The activation function was used intensity observation described as  $z_{in} = |z_{out}|^2$ . Consequently, as shown in Fig. 1, the model has successfully trained the generic image processing method instructed by the training dataset.

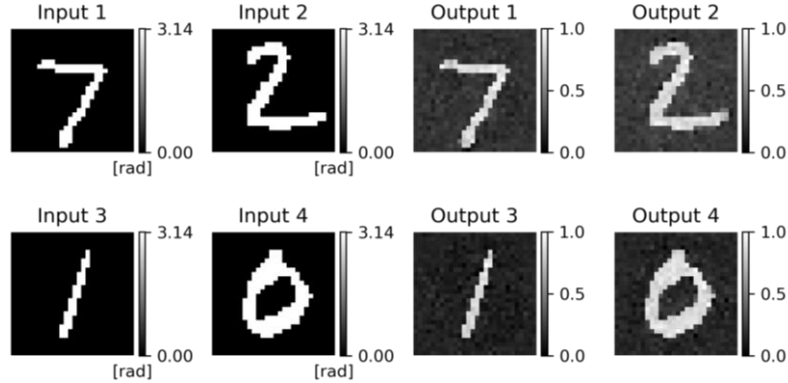


Figure 1: The phase-to-intensity conversion results by SR-HDNN.

## References

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