Deep Learning for Single-Pixel Imaging Without Normalization and Image Output

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1. Introduction

Single-pixel imaging is an interesting method to reconstruct an image by use of a photodetector and modulated illuminations [1]. Although a large number of illumination patterns enable us to reconstruct a fine image, it takes so much time to obtain the image. Recently, researchers have tried to drastically reduce the number of illumination patterns by using deep learning, on numerical simulations and actual experiments [2]. The reconstructed data itself is obtained as array data calculated by the correlation between detected intensity and illumination [3]. However, the data is normalized and negative values seems to be changed to zero before the output to reconstructed image (Fig. 1). In this study, we examine the effect of the type (array or image) and normalization of reconstructed data on its restoration through the neural network, by numerical simulation.

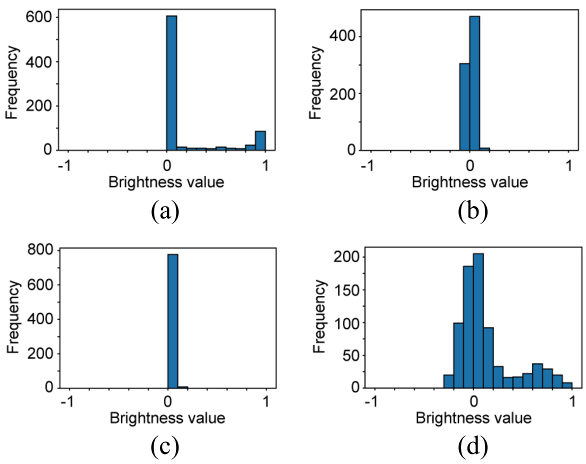

Fig. 1 Examples of distribution of brightness values of (a) original image, (b) reconstructed array, (c) image made of reconstructed array, and (d) array normalized by maximum value. The number of random masks used in reconstruction is 5000.

2. Experiment

We used MNIST dataset (training: 60,000; validation: 9,500; test: 500), and adopted U-Net [4]. The quality of restored image was measured by structural similarity value (SSIM). The number of random mask patterns was set to 20 and 200. The neural network for restoration was constructed on SONY NNC.

3. Result

There seemed to be no difference in SSIM value between array and image input when mask number was 20. However, when mask number was 200, SSIM value was slightly better in array input than in image input (Fig. 2). In the both number of masks, neural network successfully restored a fine image, whereas SSIM value was varied widely in 20 masks (Fig. 3).

3. Conclusions

Our neural network can restore fine image from reconstructed data of single-pixel imaging without normalization and image output, particularly in the case of many masks.

Acknowledgements

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References

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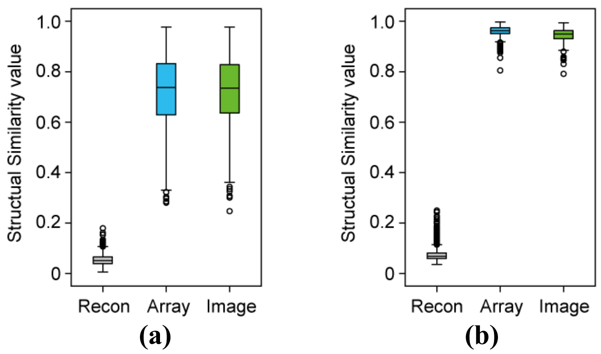

Fig. 2 Boxplot of SSIM value of restored images. 'Recon' indicates reconstructed image. 'Array' and 'Image' indicate the image restored by using array and image data of reconstructed image, respectively. (a) 20 masks and (b) 200 masks were used.

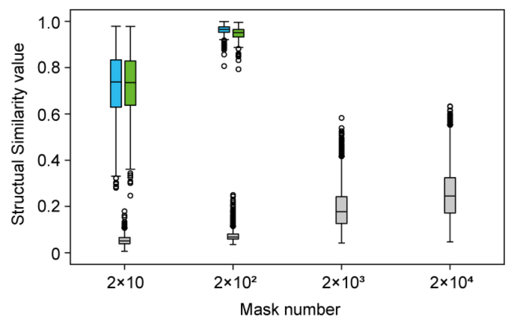

Fig. 3 SSIM values of reconstructed images compared by mask number. The results in Fig. 2 is added to this plot.