NEURAL NETWORK BASED INVERSION OF THE QUANTITATIVE PHASE IMAGING PROBLEM

Ayan Sinha, Ons M' Saad, Justin Lee, Shuai Li and George Barbastathis
Massachusetts Institute of Technology
Room 3-461, 77 Massachusetts Avenue, Cambridge, MA 02139-4307
E-mail: sinhayan@mit.edu

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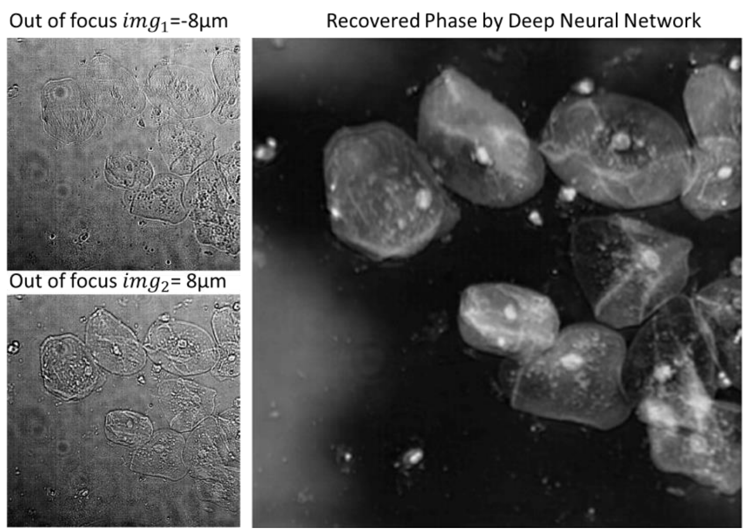
ABSTRACT

The phase retrieval problem in optics seeks to recover the phase of a coherent light field given time-averaged intensity measurements. We demonstrate a deep learning technique for neural networks to "learn" solutions to the problem of phase retrieval from an intensity focal stack. We approach the phase retrieval inverse problem from the perspective of model-free sensing: instead of trying to linearize the inverse problem or derive system equations, we let the network attempt to learn in a data-driven manner what those underlying (nonlinear) equations and relationships may be. Specifically, we train our neural networks on a generalized database of natural images and demonstrate in simulation that our technique performs competitively against other focal-stack phase retrieval techniques such as [1] at varying levels of noise. Furthermore, the deep neural network trained to recover phase from two synthetic 128x128 pure phase images generalizes well to recover the phase of 1024x1024 unstained cheek cells captured at the same distance(s) using a Nikon microscope [2]. This illustrates that our specific neural network architecture composed of residual up-sampling and down-sampling blocks [3] effectively acts like a 'phase retrieval module' independent of the size of the input intensity images.



Overall, our approach demonstrates a general paradigm of training data-hungry deep neural networks using synthetic data generated by forward models in optics to solve highly non-linear inverse problems on experimental data,

References

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