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Near-field holography image Denoising using Dilated Convolutional Neural Networks

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Near-field holography imaging is essential in science and industry for high-resolution imaging at nanostructures and microscopic scales, but it is highly sensitive to noise, which varies depending on both the detector type and the exposure time. This study introduces a machine learning based denoising method using dilated convolutional neural networks (DnCNN), which effectively reduces noise while preserving spatial details. By training the network with a custom loss function combining MS-SSIM and L1 norm, this approach captures local and global image context to distinguish signal from noise. Experimental results demonstrate that this denoising method significantly removes noise from low-dose holography images across three detectors—Lambda, Eiger, and Zyla—each with distinct noise characteristics due to their photon-counting and sCMOS technologies. The approach effectively reduces noise while preserving critical spatial details, facilitating improved analysis and interpretation in various scientific and industrial applications.

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