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High-throughput holographic sensing: A reconstruction-free framework via Vision Transformer foundation models

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Highlights

- Direct classification of raw holograms bypasses reconstruction and phase retrieval.
- Overcomes twin-image artifacts in inline digital holography.
- 99% accuracy maintained across full axial z-stack variations.
- ViT attention captures global diffraction physics effectively.
- Processes 100 holograms/s enabling rapid real time holographic analysis.

Abstract

Digital inline holographic microscopy enables label-free volumetric imaging; however, it is hindered by the computational burden of reconstruction and the resulting twin-image artifacts. We propose a reconstruction-free framework that classifies raw inline interference patterns directly, effectively avoiding the need to address the ill-posed nature of phase retrieval and twin-image challenges for classification tasks. Unlike convolutional neural network-based conventional transfer learning feature extractors restricted by local receptive fields, our Vision Transformer-based RADIO approach leverages self-attention mechanism to extract global diffractive features inherent in the raw holograms. Validated on a dataset of 15,300 experimental inline holograms across variable axial