Cross-Modality Deep Learning Brings Bright-Field Microscopy Contrast To Holography

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SUMMARY

UCLA researchers in the Department of Electrical Engineering have developed a novel deep neural network that generates speckle- and artifact-free high-quality images at different sample depths from a single hologram. The resulting images are equivalent to bright-field images taken throughout a 3D sample.

BACKGROUND

Digital holographic microscopy allows imaging and reconstruction of objects in 3D with one single measurement. However, due to the coherent light source and reconstruction methods used in digital holography, the quality of images suffers. Specifically, the contrast and the noise are problematic. Traditional bright-field microscopy uses incoherent light sources and takes many images at different depth of field in order to reconstruct an object in 3D. The image quality, however, is far superior and free of speckles or artifacts. Therefore, novel methods that raise the image quality of digital holography to bright-field standards while still maintaining the simplicity of holographic measurement are needed in practical applications.

INNOVATION

A novel method of improving the image quality of digital holographic microscopy was developed using deep learning. A generative adversarial network (GAN) is trained using back-propagated holographic images and their matching bright-field images at each depth of field. After just one training, the resulting deep neural network can output high quality, speckle- and artifact-free images from a single hologram at all depths of field that match the quality of bright-field images at those depths. This approach brings the best of both worlds by fusing the simplicity of holographic measurements and the high image quality of traditional bright-field microscopy.

APPLICATIONS

- Imaging flowing samples within liquids such as cells and other small particles
- Different holographic imaging modalities
- Different imaging modalities that use coherent light source

ADVANTAGES

- Speckle- and artifact-free, high quality
- Maintaining the simple one hologram measurement
- Adaptable, can be applied to other imaging modalities

PATENT STATUS

Country	Type	Number	Dated	Case
Germany	Issued Patent	60 2019 054 383.2	06/26/2024	2019-464
France	Issued Patent	3881137	06/26/2024	2019-464
United Kingdom	Issued Patent	3881137	06/26/2024	2019-464
United States Of America	Issued Patent	12,020,165	06/25/2024	2019-464

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OTHER INFORMATION

KEYWORDS

digital holographic microscopy; deep learning; deep neural network; generative adversarial network; bright-field microscopy; image contrast

CATEGORIZED AS

- **Optics and Photonics**
  - All Optics and Photonics
- **Imaging**
  - 3D/Immersive

RELATED CASES

2019-464-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Automated Semen Analysis Using Holographic Imaging
- Extended Depth-Of-Field In Holographic Image Reconstruction Using Deep Learning-Based Auto-Focusing And Phase-Recovery
- Detection and Spatial Mapping of Mercury Contamination in Water Samples Using a Smart-Phone
- Computational Cytometer Based On Magnetically-Modulated Coherent Imaging And Deep Learning
- Lensfree Tomographic Imaging
- Single Molecule Imaging and Sizing of DNA on a Cell Phone
- Microscopic Color Imaging And Calibration
- Quantification Of Plant Chlorophyll Content Using Google Glass
- Rapid, Portable And Cost-Effective Yeast Cell Viability And Concentration Analysis Using Lensfree On-Chip Microscopy And Machine Learning
- Holographic Opto-Fluidic Microscopy
- Design Of Task-Specific Optical Systems Using Broadband Diffractive Neural Networks
- Revolutionizing Micro-Array Technologies: A Microscopy Method and System Incorporating Nanofeatures
- Tunable Vapor-Condensed Nano-Lenses

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