UNIVERSITY OF MINNESOTA
Driven to Discover℠

Machine learning algorithm for 3D particle field reconstruction

A machine learning algorithm for accurately reconstructing 3D particle fields.

IP Status: Provisional Patent Application Filed; **Application #:** 62/967,330

Applications

- Particle field imaging using holography
- Size distribution of droplets in fuel and agricultural sprays
- Imaging through diffused media, light field imaging, defocus imaging
- Fluid dynamics, crystallization monitoring, environmental science
- Biophysical and medical studies such as aerosol flow, microfluidics, brain activities

Key Benefits & Differentiators

- **Wide range of particle concentrations**: concentrations up to 0.061 ppm - 305 times previous demonstrations - has been tested
- **High extraction rate**: up to 94%
- **High positioning accuracy** (error of
- **High speed**: 30x faster than the analytical RIHVR method
- Not built based on models: generalizable algorithm and reduced training requirements for new hologram datasets

Overview

Researchers in Prof. Jiarong Hong's laboratory have developed **an image reconstruction algorithm using a machine learning approach for accurate reconstruction of three-dimensional particle fields from digital holography.** Image reconstruction algorithms are used to extract useful particle information (such as size and 3D position of bubbles, aerosols, cells, etc.) encoded as complex interference patterns in digital holograms. However, currently available algorithms perform suboptimally at realistic conditions such as when high particle concentrations, high dynamic, background or cross-interference noises are present. Moreover, practically relevant particle field reconstruction often requires sophisticated data acquisition, tedious fine tuning and is computationally intensive.

Using specialized U-net architecture, the algorithm disclosed here has been shown to accurately reconstruct images and extract particle information with high prediction accuracy and extraction rate at significantly wider range of concentrations than previously demonstrated. Particularly, instability issues and reduced localization accuracy caused due to sparsity in the particle field is tackled in this novel algorithm. The algorithm is developed using a combination of synthetic and experimental data, and is optimized for quickly producing high localization accuracy, smooth background and reducing ghost particles. The design of this system reduces the need to fully learn the required physics, therefore reduces the training and tuning requirements for new hologram datasets and is easily adaptable in a wide range of applications. In other words, this learning-based algorithm is highly generalizable. Lastly, this learning-based hologram reconstruction is >30 times faster than currently available methods, making it suitable for developing systems with real-time reconstruction capabilities.

Technology ID

2020-210

Category

Engineering & Physical Sciences/Design Specifications
Engineering & Physical Sciences/Instrumentation, Sensors & Controls
Engineering & Physical Sciences/Photonics
Life Sciences/Diagnostics & Imaging
Life Sciences/Neuroscience
Software & IT/Algorithms
Software & IT/Image & Signal Processing

Learn more

Phase of Development

Pilot scale demonstration in processing high density holograms.

Researchers

Jiarong Hong, PhD
Associate Professor and McKnight Land-Grant Professor
External Link (www.me.umn.edu)

Publications

Machine learning holography for 3D particle field imaging.
Optics Express 28.3 (2020): 2987-2999.,
Machine learning holography for measuring 3D particle size distribution.
arXiv preprint arXiv:1912.13036 (2019).,

Publications

- **Machine learning holography for 3D particle field imaging.** Optics Express 28.3 (2020): 2987-2999.
- **Machine learning holography for measuring 3D particle size distribution** arXiv preprint arXiv:1912.13036 (2019).

Ready for Licensing

This technology is now available for license! The University is excited to partner with industry to see this innovation reach its potential. Please contact us to share your business' needs and your licensing interests in this technology. The license is for the sale, manufacture or use of products claimed by the patents.

Explore other available products at Technology Commercialization