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Deep Learning Enabled Oblique Illumination-Based Quantitative Phase Imaging

Category: Biomedical Imaging Technology

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Summary

This technology introduces a novel approach to quantitative phase imaging (QPI) by leveraging deep learning and oblique back-illumination microscopy (qOBM) to produce high-resolution, 3D quantitative phase images of thick samples in a single capture. Traditional QPI techniques are limited to thin samples and require multiple captures, but this invention simplifies the process, reduces motion artifacts, and allows for the investigation of fast dynamic processes. The system uses a cost-effective, LED-powered microscopy setup with fiber optics for illumination and employs a custom generative adversarial network (GAN) for real-time image reconstruction.

Development Stage

Prototype and First Operational Test Complete

Problem Statement & Solution

Advancements in biomedical research and diagnostic technologies are heavily reliant on the ability to view and analyze biological processes in real-time and with high resolution. Traditional quantitative phase imaging (QPI) techniques, however, face significant limitations such as their applicability only to thin samples and the requirement for multiple captures to reconstruct high-quality images. These constraints make it difficult to study rapid biological phenomena effectively and can introduce motion artifacts.

Researchers at the Georgia Institute of Technology have developed an innovative 3D imaging technology that overcomes these challenges. By integrating deep learning with oblique back-illumination microscopy, this new method allows for high-resolution, 3D quantitative phase imaging of thick samples in a single capture, enhancing the study of dynamic processes while reducing complexity and costs associated with traditional high-resolution systems.

Advantages

- Enables high-resolution 3D imaging of thick samples, overcoming limitations of traditional QPI techniques.
- Significantly reduces imaging time by requiring only a single capture, enabling the study of dynamic processes.
- Reduces motion artifacts, enhancing image quality and reliability.
- Employs deep learning for real-time image reconstruction, facilitating live visualization.
- Utilizes an affordable, LED-powered microscopy system, making advanced imaging more accessible.

Commercial Applications

- Improving surgical edge detection in vivo.
- Continuous monitoring of live cell and organoid cultures at high speeds.
- Biomedical research, particularly in cell growth, function, and dynamic process investigation.
- Potential applications in diagnostics and therapeutic monitoring through enhanced imaging capabilities.

Lead Inventor: Francisco E Robles Guerrero, PhD

Intellectual Property Status: Patent has filed - WO2023205775A2

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