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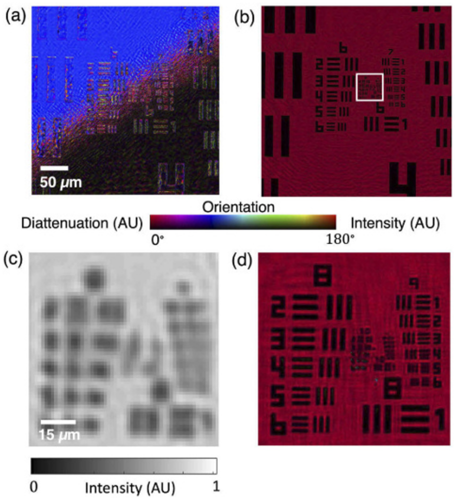

Quantitative polarization imaging with computational illumination

Unmet Need

Quantitative polarimetric microscopy allows for high resolution imaging of structurally complex samples and can reveal fine anisotropic features of cells and materials. Current microscopes that image at micrometer-level detail can only observe a field-of-view that covers several square millimeters, making large sample imaging challenging. Traditional computational microscopy techniques, such as Fourier pytochography, ignore light polarization information and require complex post-processing algorithms. In the United States, there are over 10,000 diagnostic imaging centers and over 2,500 biomedical research institutions that use microscopy for diagnostics and research. It is estimated that 70-80% of healthcare decisions that affect diagnosis and treatment are dependent on timely pathology-based tests and demand is predicted to grow. There is a need for imaging systems that quickly allow for digital imaging of large numbers of complex histology and pathology slides over a large field-of-view with high resolution.

Technology

Duke inventors have developed a high-tech imaging system, which includes specialized hardware and software. This is intended to be used with a standard polarized light microscope to image complex samples at high resolution. Specifically, this technology takes advantage of vectorial Fourier ptychography (vFP) by using an array of light to illuminate a sample rather than a single light source and two light polarizers to enhance image quality. The corresponding software includes an algorithm designed to solve for the complex 2X2 Jones matrix of the sample at each spatial location. This has been demonstrated using a standard polarized light microscope modified with an LED array source with light polarized by a generator. The different features of this technology were validated by imaging a variety of samples including a USAF target for validation of vFP resolution and diattenuation, a collection of randomly oriented monosodium urate crystals, for orientation measurement, and microspheres embedded in media with different refractive indices for retardance and phase validation. Biologically relevant samples were also used including thin sections of fixed cardiac tissue to detect plaques, an important diagnostic indicator of the presence of cardiac amyloidosis.

Other Applications

This technology could be used for a variety of biomedical applications including digital pathology, hematology, immunohistochemistry and neuroanatomy.

Advantages

- Computational imaging method can be applied to any existing microscope hardware
- Allows for faster imaging speeds by avoiding step-and-repeat tiling strategies to create large-area images
- Improves spatial resolution over large fields-of-view compared to the standard optical limit defined by an imaging lens and reduces image complexity
- Remove the effects of polarization dependent aberrations from final image reconstructions

Duke File (IDF) Number

IDF #:T-007658

Meet the Inventors

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Publication(s)

External Link(s)

- Fourier Ptychography Press Release, Duke Computational Optics Lab
- From the lab of Dr. Roarke Horstmeyer
- Towards a vectorial treatment of Fourier ptychographic microscopy (Imaging and Applied Optics Congress, 2020)
- Imaging anisotropy with vectorial Fourier ptychography (Computational Optics, 2021)