

OPTICAL NEAR-FIELD PTYCHOGRAPHY

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Research Background: Quantitative Phase Imaging (QPI) is a high contrast, stain free microscopy method that combines novel optical geometries with computer algorithms to accurately image path length variations without artefacts [1]. We have developed a novel QPI technique adapting ideas from nearfield ptychography [2] and applying them at optical wavelengths for use in the imaging of cells.

Method: In a similar way to standard ptychography [3], near-field ptychography solves the phase problem from a set of diffraction patterns. However, operating in the near-field means that the conventional requirement to spatially localise the illumination is dropped, and so large fields of view can be imaged with very few diffraction measurements. Our optical realisation of near-field ptychography is shown in Figure 1. A magnified image of the sample is projected onto a weak diffuser, located in the image plane of a standard microscope. The detector is located a short distance downstream of the diffuser, and collects a small number of diffraction patterns at a set of small lateral offsets of the sample. The diffraction patterns are processed by an iterative algorithm [3] to produce a complex image of the sample.

Results & Conclusions: Figure 2 shows an example phase reconstruction of red blood cells from data consisting of six diffraction patterns. The frame took 0.86s to collect using unoptimized data collection with MATLAB, and the technique could therefore operate at a frame rate of 1.15 frames/s. Because ptychography automatically compensates for illumination inhomogeneity, the technique has excellent signal to noise and high phase sensitivity.

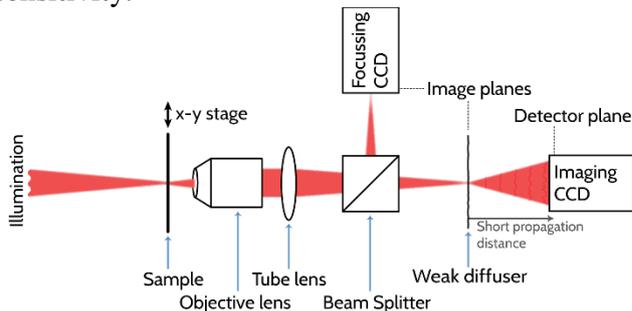


Figure 1: The setup used for optical near-field ptychography. The sample moves independently from the rest of the components.

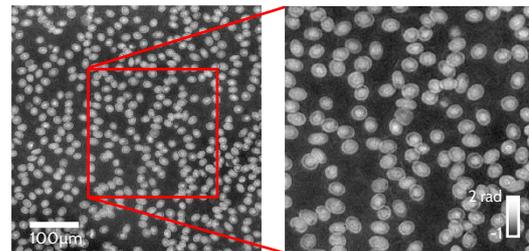


Figure 2: A phase image of a frog's red blood cells, reconstructed from six diffraction patterns.

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