# An Efficient and Stable Ptychographic Imaging Method

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## 1. Abstract

Ptychography is a lensless coherent imaging technique that leverages various advantages observed in other lensless coherent imaging methods, such as digital holography. These advantages include high phase sensitivity, non-contact, non-destructive imaging, wide field of view, and diffraction-limited optical resolution. The ptychography imaging approach involves obtaining a series of overlapping diffraction patterns by changing the relative positions of the illumination beam and the sample, enabling the reconstruction of the sample's complex amplitude distribution. This paper presents a novel approach utilizing a highly integrated optical cage structure, an electronically controlled mobile platform, and computer control to facilitate the instrumentation of ptychography imaging[1-24].

## 2. Principle Analysis

The scanning coherent diffraction imaging method, based on the principles of ptychography, was initially proposed by Hoppe for investigating crystal structures. Its effectiveness has been validated through studies of scanning electron diffraction microscopy imaging of both crystals and amorphous materials. The ptychography image algorithm necessitates overlapping illumination of each portion of the sample with at least one other region. This coherent stacking of transmitted light between the overlapping and non-overlapping regions in the diffraction pattern imposes constraints on the phase relationship at different sample positions, akin to the impact of reference light in holography. This intrinsic characteristic accounts for the faster convergence speed and higher imaging accuracy exhibited by the ptychography image compared to other coherent diffraction imaging (CDI) methods[1-24].

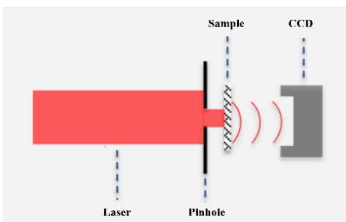


Figure (1). Basic Schematic.

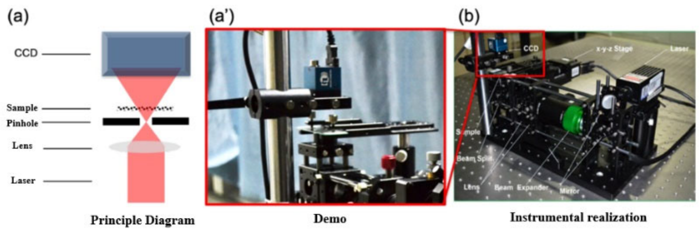


Figure (2). Instrumental Realization.

## 3. Experimental Results

The miniaturized ptychography imaging instrument used in our experiments is depicted in Figure 3. The sample under investigation is a fly-wing slide, and the obtained experimental results are presented in Figure 4 and Figure 5, showcasing the amplitude and phase information, respectively.

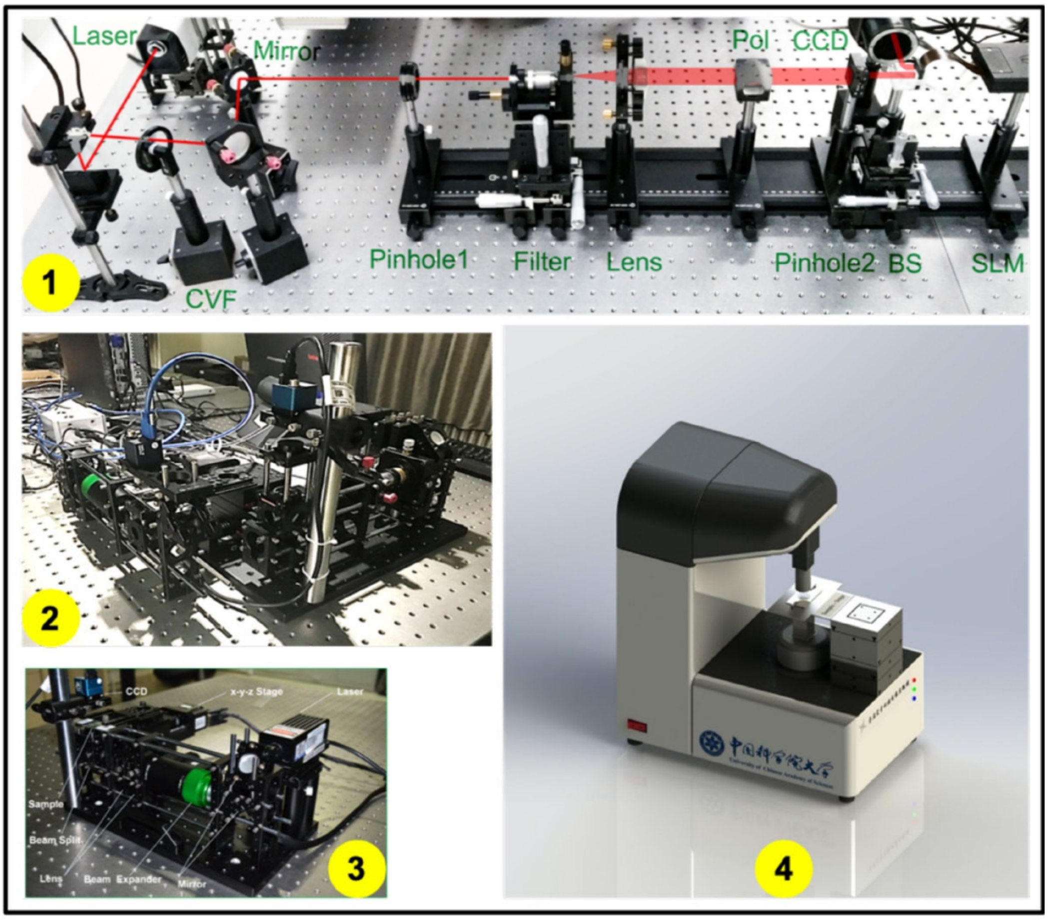


Figure (3). Integrated ptychographic microscopy

Through continuous optimization of the optical path structure, we have successfully reduced the overall size of the imaging device. Subgraph 1 illustrates the experiment conducted using the original rail-type optical platform, while subgraph 2 showcases the optical path configuration after incorporating the cage fixture. In subgraph 3, we present the improved overall structure, which is now compact and movable. Furthermore, we have conducted secondary development on the control of the translation stage and seamlessly integrated it with the stacked microscopic imaging algorithm. This integration enables automatic acquisition and reconstruction in real microscopic imaging experiments, as shown in subgraph 3. Additionally, we have designed a preliminary model of the external device for stack microscopy imaging, depicted in subgraph 4. Overall, these advancements represent significant progress in achieving a more streamlined and efficient ptychography imaging system.

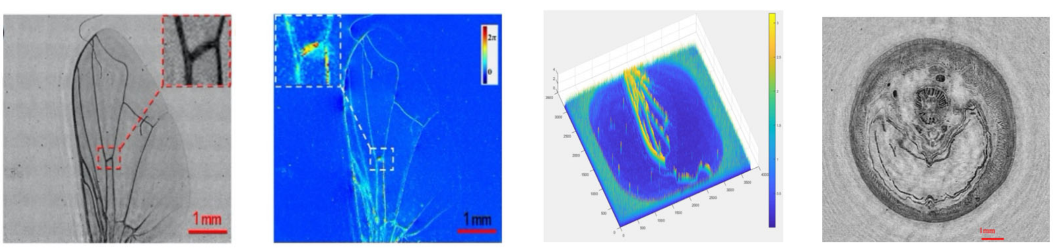


Figure (4). Experiments results: fly-wing slide and Earthworm Crosscut.

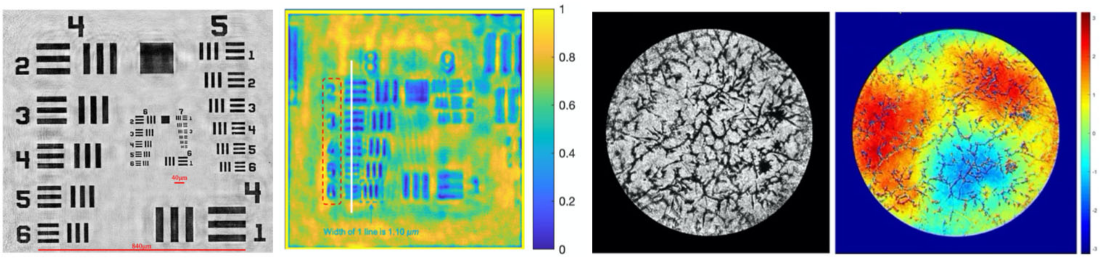

Figure (5). Experiments results: Resolution version USAF1951 and HeLa cells.

## 4. Conclusion

This study successfully achieves the automation of ptychography imaging through comprehensive system integration. Particularly in the areas of imaging and detection, the outcomes of this research hold promising prospects for application in various fields in the future. One of the notable achievements of this project is the significant reduction in data collection time during ptychography imaging. Moreover, it provides improved control over the movement accuracy of the sample under examination, facilitating rapid and precise localization of the desired detection position. Additionally, advancements have been made in optimizing both the optical diffraction process and the data recovery process. Overall, this research represents a substantial step forward in realizing the instrumentation and practical implementation of ptychography imaging and detection. The automation and enhanced capabilities offered by the integrated system hold great potential for further advancements in the field of ptychography and its diverse applications.

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