Accessible Microscopy! A Cellphone-Based Fourier Ptychography Microscope for High-Resolution, Large Field-of-View, and High-Speed Imaging

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The high cost of traditional microscopes presents a barrier to accessibility for critical pursuits such as drug development, cancer research, and clinical diagnostics, rendering them inaccessible to the average consumer. Currently, no microscope can maintain high performance while being cheap and accessible. This project addresses the accessibility issue of microscopy by developing a cost-effective cellphone-based Fourier Ptychography (FP) microscope, bringing high-performance microscopy to billions of cellphone users worldwide. FP microscopy, a new and emerging computational imaging technique, combines multiple low-resolution images acquired at various illumination angles into one high-resolution, large field of view (FOV) image. This project proposes and demonstrates, for the first time, a cellphone-based FP microscope utilizing a compact design and a custom program to achieve a user-friendly FP microscope with high spatial resolution, large FOV and high temporal throughput. A prototype was developed, validated through cell inspection, and then compared against expensive table-top microscopes. The developed cellphone microscope has achieved a resolution of 2.2 um (comparable to that of the table-top microscope with a 40x magnifying lens), a FOV of 2.01 mm^2 (comparable to that of the table-top microscope with a 10x magnifying lens), and high-speed data acquisition (completing the necessary dataset acquisition for FP reconstruction in 0.6 s). This microscope was achieved all at a cost of <$200 CAD. It is expected that the developed cellphone FP microscope will open doors for observing live cells for drug development, cancer research, and clinical diagnostics. This project will broaden microscopy access and allow for applications in resource-limited environments.