A Low-cost Portable Digital Holographic Lens-Free Imaging System for 3D Analysis of Insect Microstructures and Ecological Applications

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This project presents an in-line lens-free digital holographic imaging system capable of single-frame 3D reconstruction. I used a 532 nm monochromatic source to illuminate the sample, and the resulting interference between the direct and diffracted waves is recorded by a CMOS sensor to form a hologram. Then, I applied angular spectrum propagation computationally to reconstruct the object's amplitude and phase distributions. The system employs a simplified optical configuration without objective lenses, combined with phase unwrapping algorithms. Quantitative 3D reconstructions were demonstrated on biological samples including butterfly antennae and an earthworm cross-section. Compared with conventional microscopy, this approach significantly reduces cost, complexity, and alignment requirements while maintaining meaningful 3D imaging capability.

Awards Won: