Shi Zhao

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SUMMARY

3rd-year Ph.D. student in Electrical Engineering at Caltech specializing in optics, computational imaging, advanced microscopy, optical system design, image processing, and deep learning.

- 3+ years of hands-on experience in end-to-end optical system development, including optical system design, system alignment, calibration, and image reconstruction algorithm development.
- Expertise in image processing, inverse problem solving, optimization, and AI-driven image analysis.
- Strong foundation in physics and mathematics, particularly in optics and electromagnetics.

EDUCATION

Department of Electrical Engineering, California Institute of Technology

- Ph.D. in Electrical Engineering (Advised by Prof. Changhuei Yang) Sep 2023 – Expected June 2027
- M.S. in Electrical Engineering (Cumulative GPA: 4.20/4.30) Sep 2023 –June 2025

School of Physics, Peking University

- Bachelor of Science in Physics (Major GPA: 3.80/4.00) Sep 2019 – June 2023

SKILLS

- **Optics**: Microscopy, Physical Optics, Diffractive & Fourier Optics, Optical Alignment, Optical System Design
- **Computational & AI**: Optimization and Inverse Problems, Physics-based Modeling and Simulation, Image Denoising, Image Processing, AI for Science, Deep Learning, Machine Learning
- **Programming and Software**: Adept in Python (PyTorch), MATLAB; Familiar with COMSOL, SolidWorks, Linux, Git

RESEARCH PROJECTS

Digital Defocus Aberration Interference for Automated Microscopy Feb 2025- August 2025

- Advisor: Professor Changhuei Yang, Caltech
- Developed a novel physics-based autofocusing technique that detects defocus distance from fringes in the summed Fourier spectra of two-LED partially coherent illumination. [Arxiv 25]
- The technique outperformed conventional approaches in autofocusing range, speed, robustness, photon efficiency, simplicity, and generalizability, and is compatible with complex-field imaging techniques for digital refocusing.

Efficient, High-throughput, Aberration-free Computational Imaging Sep 2023- Present

- Advisor: Professor Changhuei Yang, Caltech
- Developed the hybrid-illumination multiplexed Fourier ptychographic microscopy technique for efficient, high-resolution, large field-of-view (FOV), aberration-corrected, complex-field imaging, achieving 3.1 mm^2 FOV and 1 μm resolution, with aberration tolerance up to 78 μm defocus. [Arxiv 25]
- Developed a gigapixel-scale, high-throughput whole-slide complex-field imaging platform using annular ptychographic imaging with AI-based sample localization, GPU-accelerated reconstruction, and automated stitching, achieving 70 % reduction in acquisition time and 50× faster reconstruction speed. [BOE 24]

AI-based Variability Prediction of Stem Cell-derived Embryo Models Sep 2023- Aug 2024

- Advisor: Professor Changhuei Yang, Caltech
- Developed a hybrid deep learning framework to predict developmental variability in stem-cell-derived embryo models, achieving 88% accuracy at 90 h post-seeding. [NC 25]

Spectroscopic OCT for Classification of Human Polyps Oct 2022- Dec 2022

- Advisor: Professor Adam Wax, Duke University
- ➢ Processed OCT volume scans of tissues to extract optical properties such as optical power and scattering coefficient.
- ➢ Implemented machine learning classification models to classify human polyps of different morphologies. [J. Biophotonics]

One-Pot Multi-Frame optical coherence tomography (OCT) Denoising Apr 2021-Sep 2021

- Advisor: Professor Qiushi Ren, Peking University
- ➢ Participate in developing a noise-to-noise denoising framework based on a one-pot learning strategy. [IJCV 24]
- ➢ Benchmarked the method against existing approaches for OCT speckle noise reduction, demonstrating superior performance.

PUBLICATION

Paper in Review

1. **S. Zhao**, H. Zhou, C. Yang, "Hybrid-illumination multiplexed Fourier ptychographic microscopy with robust aberration correction," arXiv:2509.05549 (2025), under review at *JPhys Photonics*.
2. H. Zhou*, **S. Zhao***, Y. Fan, et al., "Digital defocus aberration interference for automated optical microscopy," arXiv:2507.10867 (2025), under review at *Nature Communications*.

Peer-Reviewed Publications

3. [In press] Z. Dong, H. Zhou, R. Cao, O. Zhang, **S. Zhao**, et al., "Analytic Fourier ptychotomography for volumetric refractive index imaging," *Nature Communications* (2025).
4. P. Caldarelli, L. Deininger, **S. Zhao**, et al., "AI-based approach to dissect the variability of mouse stem-cell-derived embryo models," *Nature Communications* 16 (1), 1772 (2025).
5. S. Lin, H. Zhou, R. Cao, **S. Zhao**, et al., "Dome-APIC illumination design for high space-bandwidth product analytic imaging," *Biomedical Optics Express* 15, 1666–1677 (2025).
6. **S. Zhao***, H. Zhou*, C. Yang, et al., "Efficient, gigapixel-scale, aberration-free whole slide scanner using angular ptychographic imaging with closed-form solution," *Biomedical Optics Express* 15, 5739–5755 (2024).
7. L. Jin, Q. Guo, **S. Zhao**, et al., "One-pot multi-frame denoising," *International Journal of Computer Vision* 132 (2), 515-536 (2024).
8. W. Y. Kendall, Q. Tian, **S. Zhao**, et al., "Deep learning classification of ex vivo human colon tissues using spectroscopic optical coherence tomography," *Journal of Biophotonics* 17, e202400082 (2024).

Patents

1. H. Zhou, S. Zhao, C. Yang, "Digital defocus aberration interference for automated optical microscopy." CIT-9339-P (2025)

HONORS & AWARDS

- ➢ Caltech Medical Engineering Department Fellowship Sep 2024
- ➢ Caltech Electrical Engineering Department Fellowship Sep 2023
- ➢ Scholarship of Alumni 7702, PKU Oct 2022
- ➢ Scholarship for Weiming Student, PKU Jun 2022
- ➢ Scholarship for Chenyang Wang and Ya Cheng Program, PKU Dec 2021
- ➢ Scholarship for Wanshun Qin and Yunhui Jin Program, PKU Dec 2020
- ➢ National Gold Medal of the Chinese Physics Olympiad (CPhO) Nov 2018