Yide Zhang

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TRAINING AND EDUCATION

California Institute of Technology, Pasadena, California USA

Postdoctoral Scholar, Medical Engineering   *2019 - Present*

University of Notre Dame, Notre Dame, Indiana USA

Doctor of Philosophy, Electrical Engineering   *2014 - 2019*
Master of Science, Electrical Engineering   *2014 - 2017*
Dissertation: *Super-Sensitivity and Super-Resolution Quantitative Multiphoton Microscopy*

Huazhong University of Science and Technology, Wuhan, China

Bachelor of Engineering, Automation *with Highest Honors*   *2010 - 2014*
Thesis: *Research on Memristor-Based Memory Networks and Computing Technology*

RESEARCH EXPERIENCE

Caltech Optical Imaging Laboratory   2019 - Present
Postdoctoral Scholar   Advisor: Lihong V. Wang, Ph.D.   Pasadena, California USA

- Development of novel phase-contrast compressed ultrafast photography (CUP), a technique that images light-speed phase change signals in a single shot with up to 350 frames captured at up to 1 trillion frames per second.
- Development of universally-calibrated photoacoustic topography through an ergodic relay (PATER), a method that uses a single-element ultrasonic transducer to capture a wide-field photoacoustic image with a single laser shot at a 1 kHz frame rate.

Biophotonics Research Group   2014 - 2019
Research Assistant   Advisor: Scott S. Howard, Ph.D.   Notre Dame, Indiana USA

- Developed a theoretical framework for optimizing the SNR of multiphoton frequency-domain fluorescence lifetime imaging microscopy (FD-FLIM) and verified the results with Monte Carlo simulations.
- Experimentally demonstrated a super-sensitivity FD-FLIM technique with a two-fold improvement in imaging speed compared to the theoretical limit of conventional FD-FLIM.
- Theoretically analyzed the lifetime measurement error in FD-FLIM under fluorophore saturation conditions and experimentally demonstrated a method for eliminating this error.
- Invented stepwise optical saturation (SOS), a super-resolution fluorescence microscopy technique that could be easily implemented and required neither additional hardware nor complex post-processing.
- Generalized the concept of SOS and experimentally demonstrated the first implementation of super-resolution imaging in FD-FLIM.
- Combined deconvolution with SOS (DeSOS) to image cells in their native physiological environment and provided an open-access application for the generation of DeSOS images.
- Constructed the Fluorescence Microscopy Denoising (FMD) dataset that consisted of 12,000 real fluorescence microscopy images; it was the first microscopy image dataset dedicated for Poisson-Gaussian denoising and had been used to benchmark conventional and deep learning based denoising methods.
- Developed a novel and unbiased approach to segment FLIM images automatically by K-means clustering of FLIM phasors and demonstrated successful image segmentation on 2D and 3D FLIM images of fixed cells and living animals acquired with two different FLIM systems.
- Demonstrated that super-resolution radial fluctuations (SRRF), a super-resolution fluorescence microscopy technique, can be used to enhance the resolution of transmission electron microscopy images.

- Invented instant FLIM, a method that allows real-time streaming of fluorescence intensity, lifetime, and phasor imaging data through simultaneous image acquisition and instantaneous data processing; it was used to generate the first *in vivo* 4D FLIM of microglial dynamics in intact and injured zebrafish and mouse brains up to 12 hours.
- Took charge of the design, budget, construction, and demonstration of all the experimental setups mentioned above; built the hardware and wrote the software from scratch.
- A news article about my Ph.D. research: https://ee.nd.edu/thewire/articles/your-motivation-matters-engineering-to-heal

National Key Laboratory of Image Processing & Intelligence 2012 - 2014
Research Assistant *Advisor: Zhigang Zeng, Ph.D.* *Wuhan, China*
- Simulated neural activities including learning, associative memory and forgetting in a memristive neural network with integrate-and-fire CMOS neurons and spike-rate-dependent plasticity synapses.
- Implemented exponential adaptive lag synchronization of two memristive neural networks using fuzzy methods.

PREPRINTS

R1 **Yide Zhang**, Ian H. Guldner, Evan L. Nichols, David Benirschke, Cody J. Smith, Siyuan Zhang, and Scott S. Howard, "High-speed, long-term, 4D *in vivo* lifetime imaging in intact and injured zebrafish and mouse brains by instant FLIM", *bioRxiv*, Feb. 2020, DOI: 10.1101/2020.02.05.936039.

JOURNAL PUBLICATIONS

J13 Varun Mannam, **Yide Zhang**, Xiaotong Yuan, Cara Ravasio, and Scott S. Howard, "Machine learning for faster and smarter fluorescence lifetime imaging microscopy", *Journal of Physics: Photonics*, Aug. 2020, DOI: 10.1088/2515-7647/abac1a.

J12 **Yide Zhang**, Sergei Rouvimov, Xiaotong Yuan, Karla Gonzalez-Serrano, Alan C. Seabaugh, and Scott S. Howard, "Resolution enhancement of transmission electron microscopy by super-resolution radial fluctuations", *Applied Physics Letters*, vol. 116, no. 4, pp. 044105, Jan. 2020, DOI: 10.1063/1.5128353.

J11 **Yide Zhang**, Takashi Hato, Pierre C. Dagher, Evan L. Nichols, Cody J. Smith, Kenneth W. Dunn, and Scott S. Howard, "Automatic segmentation of intravital fluorescence microscopy images by K-means clustering of FLIM phasors", *Optics Letters*, vol. 44, no. 16, pp. 3928-3931, Aug. 2019, DOI: 10.1364/OL.44.003928.

J10 **Yide Zhang**, Evan L. Nichols, Abigail M. Zellmer, Ian H. Guldner, Cody Kankel, Siyuan Zhang, Scott S. Howard, and Cody J. Smith, "Generating intravital super-resolution movies with conventional microscopy reveals actin dynamics that construct pioneer axons", *Development*, vol. 146, no. 5, pp. dev171512, Mar. 2019, DOI: 10.1242/dev.171512. Supplementary software available at DOI: 10.7274/r0-5hhg-5578. Featured News 1 Featured News 2

J9 **Yide Zhang**, David Benirschke, Ola Abdalsalam, and Scott S. Howard, "Generalized stepwise optical saturation enables super-resolution fluorescence lifetime imaging microscopy", *Biomedical Optics Express*, vol. 9, no. 9, pp. 4077-4093, Sept. 2018, DOI: 10.1364/BOE.9.004077.

J8 **Yide Zhang**, Prakash D. Nallathamby, Genevieve D. Vigil, Aamir A. Khan, Devon E. Mason, Joel D. Boerckel, Ryan K. Roeder, and Scott S. Howard, "Super-resolution fluorescence microscopy by stepwise optical saturation", *Biomedical Optics Express*, vol. 9, no. 4, pp. 1613-1629, Apr. 2018, DOI: 10.1364/BOE.9.001613. ***NDIIF Award for Best Biological Imaging Publication 2018***. Featured News

J7 Genevieve Vigil, **Yide Zhang**, Aamir Khan, and Scott Howard, "Description of deep saturated excitation multiphoton microscopy for super-resolution imaging", *Journal of the Optical Society of America A*, vol. 34, no. 7, pp. 1217-1223, July 2017, DOI: 10.1364/JOSAA.34.001217.

J6 Aamir A. Khan, Genevieve D. Vigil, **Yide Zhang**, Susan K. Fullerton-Shirey, and Scott S. Howard, "Silica-coated ruthenium-complex nanoprobes for two-photon oxygen microscopy in biological media", *Optical Materials Express*, vol. 7, no. 3, pp. 1066-1076, Mar. 2017, DOI: 10.1364/OME.7.001066.

J5 **Yide Zhang**, Genevieve D. Vigil, Lina Cao, Aamir A. Khan, David Benirschke, Tahsin Ahmed, Patrick Fay, and Scott S. Howard, "Saturation-compensated measurements for fluorescence lifetime imaging microscopy", *Optics Letters*, vol. 42, no. 1, pp. 155-158, Jan. 2017, DOI: 10.1364/OL.42.000155.

J4 **Yide Zhang**, Aamir A. Khan, Genevieve D. Vigil, and Scott S. Howard, "Super-sensitivity multiphoton frequency-domain fluorescence lifetime imaging microscopy", *Optics Express*, vol. 24, no. 18, pp. 20862-20867, Sept. 2016, DOI: 10.1364/OE.24.020862.

J3 **Yide Zhang**, Aamir A. Khan, Genevieve D. Vigil, and Scott S. Howard, "Investigation of signal-to-noise ratio in frequency-domain multiphoton fluorescence lifetime imaging microscopy", *Journal of the Optical Society of America A*, vol. 33, no. 7, pp. B1-B11, July 2016, DOI: 10.1364/JOSAA.33.0000B1.

J2 Gang Bao, **Yide Zhang**, and Zhigang Zeng, "Memory analysis for memristors and memristive recurrent neural networks", *IEEE/CAA Journal of Automatica Sinica*, vol. 7, no. 1, pp. 96-105, Jan. 2020, DOI: 10.1109/JAS.2019.1911828.

J1 Shiping Wen, Zhigang Zeng, Tingwen Huang, and **Yide Zhang**, "Exponential adaptive lag synchronization of memristive neural networks via fuzzy method and applications in pseudo random number generators", *IEEE Transactions on Fuzzy Systems*, vol. 22, no. 6, pp. 1704-1713, Dec. 2014, DOI: 10.1109/TFUZZ.2013.2294855.

CONFERENCE PUBLICATIONS

C16 Varun Mannam, **Yide Zhang**, Yinhao Zhu, and Scott Howard, "Instant image denoising plugin for ImageJ using convolutional neural networks", *Biomedical Optics 2020*, Washington, DC USA, Apr. 2020, DOI: 10.1364/TRANSLATIONAL.2020.JW2A.3.

C15 **Yide Zhang**, Yinhao Zhu, Evan Nichols, Qingfei Wang, Siyuan Zhang, Cody Smith, and Scott Howard, "A Poisson-Gaussian denoising dataset with real fluorescence microscopy images", *IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR 2019)*, Long Beach, California USA, June 2019, DOI: 10.1109/CVPR.2019.01198.

C14 **Yide Zhang**, Ian H. Guldner, Evan L. Nichols, David Benirschke, Cody J. Smith, Siyuan Zhang, and Scott S. Howard, "Three-dimensional deep tissue multiphoton frequency-domain fluorescence lifetime imaging microscopy via phase multiplexing and adaptive optics", *SPIE Photonics West 2019*, San Francisco, California USA, Feb. 2019, DOI: 10.1117/12.2510674. ***JenLab Young Investigator Award***. Featured News

C13 **Yide Zhang**, David Benirschke, Ola Abdalsalam, and Scott S. Howard, "Super-resolution multiphoton frequency-domain fluorescence lifetime imaging microscopy by generalized stepwise optical saturation (GSOS)", *SPIE Photonics West 2019*, San Francisco, California USA, Feb. 2019, DOI: 10.1117/12.2507663.

C12 Ola Abdalsalam, **Yide Zhang**, Scott Howard, and Thomas D. O'Sullivan, "Self-calibrated frequency domain diffuse optical spectroscopy with a phased source array", *SPIE Photonics West 2019*, San Francisco, California USA, Feb. 2019, DOI: 10.1117/12.2510422.

C11 **Yide Zhang**, Prakash D. Nallathamby, Evan L. Nichols, Cody J. Smith, Ryan K. Roeder, and Scott S. Howard, "Super-resolution and high-speed quantitative multiphoton microscopy", *Seventh*

Annual Harper Cancer Research Institute Research Day, Notre Dame, Indiana USA, Apr. 2018, DOI: 10.7274/r0-zqes-kr15. ***Poster Contest Third Prize***.

C10 **Yide Zhang**, David Benirschke, and Scott S. Howard, "Stepwise optical saturation microscopy: obtaining super-resolution images with conventional fluorescence microscopes", *Biomedical Optics 2018*, Hollywood, Florida USA, Apr. 2018, DOI: 10.1364/TRANSLATIONAL.2018.JTh3A.27.

C9 **Yide Zhang**, David Benirschke, and Scott S. Howard, "Super-resolution fluorescence imaging by stepwise optical saturation microscopy", *IEEE Annual Mini-symposium on Electron Devices and Photonics*, Notre Dame, Indiana USA, Oct. 2017, DOI: 10.7274/r0-bbyt-9j45. ***Best Presentation Award***.

C8 **Yide Zhang**, Genevieve D. Vigil, Aamir A. Khan, and Scott S. Howard, "Doubling the sensitivity of multiphoton frequency-domain fluorescence lifetime images", *CLEO: Science and Innovations 2017*, San Jose, California USA, May 2017, DOI: 10.1364/CLEO_SI.2017.SM3C.6.

C7 Genevieve D. Vigil, **Yide Zhang**, Aamir A. Khan, and Scott S. Howard, "Simulation and experimental design of saturated excitation (SAX) multiphoton microscopy (MPM)", *CLEO: Applications and Technology 2017*, San Jose, California USA, May 2017, DOI: 10.1364/CLEO_AT.2017.JTu5A.64.

C6 **Yide Zhang**, Genevieve D. Vigil, Aamir A. Khan, and Scott S. Howard, "Super-sensitivity and super-resolution multiphoton fluorescence lifetime imaging microscopy", *NDnano Symposium: Nanotechnology in the Treatment of Neurodegenerative Disorders*, Notre Dame, Indiana USA, Mar. 2017, DOI: 10.7274/r0-k1dc-5q52. ***Best Poster Award***.

C5 Aamir A. Khan, Susan K. Fullerton-Shirey, Genevieve D. Vigil, **Yide Zhang**, and Scott S. Howard, "Highly stable two-photon oxygen imaging probe based on a ruthenium-complex encapsulated in a silica-coated nanomicelle", *CLEO: Applications and Technology 2016*, San Jose, California USA, June 2016, DOI: 10.1364/CLEO_AT.2016.ATu4O.3.

C4 Aamir A. Khan, Genevieve D. Vigil, **Yide Zhang**, and Scott S. Howard, "Theoretical analysis of the signal-to-noise ratio of two-photon oxygen imaging probes", *Biomedical Optics 2016*, Fort Lauderdale, Florida USA, Apr. 2016, DOI: 10.1364/CANCER.2016.JW3A.48.

C3 **Yide Zhang**, Genevieve D. Vigil, Aamir A. Khan, and Scott S. Howard, "High-resolution frequency-domain multiphoton fluorescence lifetime imaging microscopy", *Fifth Annual Harper Cancer Research Institute Research Day*, Notre Dame, Indiana USA, Apr. 2016, DOI: 10.7274/r0-vt1g-bp12.

C2 **Yide Zhang**, and Scott S. Howard, "On increasing the imaging rate of frequency-domain multiphoton fluorescence lifetime imaging microscopy", *IEEE Annual Mini-symposium on Electronic and Photonics*, Notre Dame, Indiana USA, Oct. 2015, DOI: 10.7274/r0-dw42-x854.

C1 **Yide Zhang**, Zhigang Zeng, and Shiping Wen, "Implementation of memristive neural networks with spike-rate-dependent plasticity synapse", *IEEE International Joint Conference on Neural Networks (IJCNN)*, Beijing, China, July 2014, DOI: 10.1109/IJCNN.2014.6889740.

PATENTS

P4 **Yide Zhang**, Zhigang Zeng, Yidong Zhu, Mingfu Cao, Junfeng Zhao, "Signal processing circuit", International Application Number: PCT/CN2015/080610, Patent Numbers: US10586590B2 (granted Mar. 10, 2020), EP3282449B1 (granted Aug. 7, 2019), CN107210064B (granted Feb. 14, 2020).

P3 Scott Howard, **Yide Zhang**, and Cody J. Smith, "Super-resolution fluorescence microscopy by generalized stepwise optical saturation", International Application Number: PCT/US2018/067905, Publication Number: WO2019133837A1.

P2 Scott Howard, Genevieve Vigil, and **Yide Zhang**, "Super-sensitivity multiphoton frequency-domain fluorescence lifetime imaging microscopy", International Application Number: PCT/US2017/021819, Publication Number: WO2017156413A1.

P1 **Yide Zhang**, Zhigang Zeng, Shiping Wen, Mingfu Cao, Junfeng Zhao, "Neuron simulation circuit", CN Application Number: CN201510508806.6A, Publication Number: CN106470023A.

TEACHING EXPERIENCE

Kaneb Center for Teaching and Learning, University of Notre Dame   2018
- Certified participant of the Teaching Well Using Technology program that teaches faculty and graduate students how to use multi-media technology tools such as presentations, audios, videos, and digital timelines in an educational setting to enhance teaching and learning.

Biophotonics Research Group, University of Notre Dame   2017-2019
- Trained undergraduate and first-year graduate students how to perform confocal, two-photon, and fluorescence lifetime imaging experiments using commercial and custom-built microscopes.

Clay Intermediate Center, Clay International Academy   2016
- Participated in an outreach program to go to middle school classrooms and demonstrate cool optics demos and principles to students and inspire them to pursue a career in science.

Department of Electrical Engineering, University of Notre Dame   2015
- As a teaching assistant of EE 30342 - Microelectronic Circuit Design, graded homework, ran weekly Q&A sessions, and assisted undergraduate students in performing microelectronic experiments.

School of Automation, Huazhong University of Science and Technology   2014
- Mentored six undergraduate students to complete their undergraduate thesis projects.

SELECTED AWARDS AND HONORS

2020	**IOP Publishing Outstanding Reviewer Award**, IOP Publishing, Bristol UK
2019	**NDIIF Best Biological Imaging Publication Award 2018**, <u>Featured News</u>
	Notre Dame Integrated Imaging Facility (NDIIF), Indiana USA
2019	**CRC Award for Computational Sciences and Visualization**, <u>Featured News</u>
	Center for Research Computing (CRC), University of Notre Dame, Indiana USA
2019	**JenLab Young Investigator Award**, <u>Featured News</u>
	Multiphoton Microscopy in the Biomedical Sciences XIX, SPIE Photonics West
2018	**James L. Massey Travel Grant**,
	Department of Electrical Engineering, University of Notre Dame, Indiana USA
2018	**Poster Contest Third Prize**,
	Seventh Annual Harper Cancer Research Institute Research Day, Indiana USA
2017	**Best Presentation Award**,
	IEEE Annual Mini-symposium on Electron Devices and Photonics, Indiana USA
2017	**Berry Family Foundation Graduate Fellowship**, <u>Featured News</u>
	Advanced Diagnostics and Therapeutics (AD&T), Indiana USA
2017	**2016 Graduate Student Research Award** (One Awardee at NDEE),
	Department of Electrical Engineering, University of Notre Dame, Indiana USA
2017	**Best Poster Award**,
	NDnano Symposium, University of Notre Dame, Indiana USA
2014	**Outstanding Undergraduate Thesis Award** (Ranking 1/205),
	Huazhong University of Science and Technology (HUST), Wuhan, China
2013	**Meritorious Winner**, Mathematical Contest in Modeling (MCM),
	Consortium for Mathematics and Its Applications (COMAP)
2013	**Decent Capital's Scholarship** (Top 0.1%), Decent Capital
2011-2013	**National Scholarship** ×3 (Top 1%), Ministry of Education of China
2012	**Prominent Student Award** (Top 1%), HUST, Wuhan, China

MEDIA COVERAGE

- "Super Resolution Ghosts", University of Notre Dame Stories, Oct. 1, 2019.
- "Bringing Super-Resolution Microscopy to the Masses", Wiley Analytical Science, Sept. 11, 2019.
- "Your Motivation Matters: Engineering to Heal", The Wire at the University of Notre Dame, Sept. 10, 2019.
- "NDIIF Celebrates 10 Year Anniversary at Annual Imaging Workshop", Biophysics at Notre Dame, May 17, 2019.
- "Super Resolution Imaging Made Easy", Wiley Analytical Science, Mar. 5, 2019.
- "Open-Source Application Creates Super-Resolution Images of Cell Development in Living Animals", Notre Dame News, Mar. 1, 2019.
- "Graduate Student Receives JenLab Young Investigator Award", Notre Dame Research, Feb. 18, 2019.
- "K.I.S.S.: A "Simple" Solution to a Common Situation", The College of Engineering at the University of Notre Dame, Apr. 5, 2018.
- "Notre Dame Graduate Students Awarded Fellowships for Cross-Disciplinary Biomedical Research", Notre Dame Research, July 5, 2017.

RESEARCH INTERESTS

Photoacoustic microscopy (PAM), photoacoustic computed tomography (PACT), compressed ultrafast photography (CUP), nonlinear microscopy, multiphoton microscopy (MPM), fluorescence lifetime imaging microscopy (FLIM), super-resolution microscopy, high-speed imaging, deep tissue imaging, adaptive optics, computational imaging, deep learning.

PROFESSIONAL SERVICE

Invited Speaker

- "NDCSSA Excellent Graduate Experience Sharing Session", Notre Dame Chinese Students and Scholars Association (NDCSSA) Talk No. 3, Aug. 28, 2019.
- "NDIIF Best Biological Imaging Publication Award 2018: Stepwise Optical Saturation (SOS) Microscopy and Beyond", 6th Annual Midwest Imaging and Microanalysis Workshop, May 6, 2019.
- "Three-Dimensional, Deep Tissue, Super-Resolution Multiphoton FLIM via Phase Multiplexing", AD&T External Review, Mar. 25, 2019.
- "Research in ND Electrical Engineering: A Graduate Student's Perspective", Notre Dame Electrical Engineering Graduate Applicant Recruiting Event, Mar. 8, 2019.
- "Novel Super-Resolution Fluorescence Microscopy Methods in Application to Bio and Materials Sciences", Notre Dame Electron Microscopy Club Meeting, Feb. 13, 2019.

Journal Reviewer

- Applied Optics
- Applied Physics Letters
- Biomedical Optics Express
- IEEE Transactions on Biomedical Engineering
- Journal of Biomedical Optics
- Journal of Biophotonics
- Journal of Electronic Imaging
- Journal of the Optical Society of America A
- Methods and Applications in Fluorescence
- Nature Biomedical Engineering
- Optical Engineering
- Optics Communications

- Optics Express
- Optics Letters
- Photonics Research
- Review of Scientific Instruments
- Scientific Reports

Contributor to Research Community
- Certified Publons Academy Peer Reviewer, Publons, June 8, 2020.
- Certified Reviewer for OSA Journals, The Optical Society (OSA), Dec. 15, 2019.
- " 'Publish or perish' will not perish", Behavioural and Social Sciences at Nature Research, Oct. 10, 2019.

PROFESSIONAL MEMBERSHIP

Member, The Optical Society (OSA)
Member, International Society for Optics and Photonics (SPIE)
Member, Institute of Electrical and Electronics Engineers (IEEE)

PROFESSIONAL REFERENCES

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