

# Yide Zhang

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## TRAINING AND EDUCATION

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### California Institute of Technology, Pasadena, California USA

Postdoctoral Scholar, Medical Engineering, Electrical 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

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### 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*, vol. 2, no. 4, pp. 042005, Sept. 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 nanoprobe 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

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- C16 Varun Mannam, **Yide Zhang**, Yin hao 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**, Yin hao 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

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- 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

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**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

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

## MEDIA COVERAGE

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- “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

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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

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### 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**

- IOP Trusted Reviewer, IOP Publishing, Sept. 22, 2020.
- 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**

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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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**Scott S. Howard**, Ph.D.  
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 University of Notre Dame  
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**Alan Seabaugh**, Ph.D.  
 Frank M. Freimann Professor  
 Department of Electrical Engineering  
 University of Notre Dame  
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**Cody J. Smith**, Ph.D.  
 Elizabeth and Michael Gallagher Assistant Professor  
 Department of Biological Sciences  
 University of Notre Dame  
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 Assistant Professor  
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