Iksung Kang

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Pronouns: he/his/him

Education

Massachusetts Institute of Technology — Cambridge, MA
Doctor of Philosophy, Department of Electrical Engineering and Computer Science — *2020 – 2022*

Massachusetts Institute of Technology — Cambridge, MA
Master of Science, Department of Electrical Engineering and Computer Science — *2017 – 2020*

Seoul National University — Seoul, South Korea
Bachelor of Science, Department of Electrical and Computer Engineering (as class valedictorian) — *2011 – 2017*

Experience

University of California, Berkeley — Berkeley, CA
Postdoctoral fellow, Department of Neuroscience (Advisor: Na Ji, Stella X. Yu) — *Jul 2022 - Present*

- **Adaptive optics with machine learning**: Developed a general-purpose adaptive optics framework for widefield and two-photon fluorescence microscopy using neural fields.
- **Fluorescence microscopy for visual neuroscience**: Utilized adaptive optical fluorescence microscopy combined with machine learning for structural and activity imaging, as well as data analysis, in the visual cortex of a live mouse brain.
- **Compressive microscopy**: Collaborated on the design of high-speed optical compressive widefield fluorescence microscopy for sub-millisecond neuronal signal dynamics.

Research Assistant — Cambridge, MA
Massachusetts Institute of Technology (Advisor: George Barbastathis) — *Jan 2019 – May 2022*

- **Phase retrieval**: Devised a physics-informed machine learning algorithm with random phase modulation for robust phase retrieval under low-photon conditions.
- **Phase tomography**: Designed a dynamical machine learning algorithm for limited-angle phase tomography of multi-layered phase objects.
- **Synchrotron X-ray ptycho-tomography**: Implemented supervised and self-supervised deep learning for three-dimensional nanoscale X-ray imaging of integrated circuits inside semiconductors, under synchrotron X-ray ptycho-tomography and ptycho-laminography geometries.
- **Broadband holography**: Performed simultaneous optical wavelength analysis and holographic reconstruction from a diffraction intensity of a broadband CMOS LED illumination using self-supervised deep learning.

Seoul National University — Seoul, South Korea
Undergraduate researcher — *2016*

- **Low-cost MRI**: Devised a cost-effective solution for the main magnetic field generation in a small-sized MRI.

Seoul National University — Seoul, South Korea
Research intern, Graduate School of Convergence Science and Technology — *2014*

- **Neural recording ASIC**: Participated in designing an ASIC for wireless electrical recording of neural signals from a live mouse brain.

Research Interests

Computational Optical Imaging

- Adaptive optical fluorescence microscopy
- Tomography (optical, X-ray)
- Broadband holography
- Phase retrieval

Machine Learning Algorithm Design

- Neural fields (coordinate-based neural representation)
- Physics-informed supervised, self-supervised deep learning
- Nonlinear inverse problems

Patents

1. **Adaptive optical correction in two-photon fluorescence microscopy with neural fields**
   U.S. Patent Application No. 63/707,628, filed October 15, 2024
   Co-inventors: **Kang I**, Ji N.

Preprints

2. **Adaptive optical correction for in vivo two-photon fluorescence microscopy with neural fields**
   Kang I, Kim H, Natan R, Zhang Q, Yu SX, Ji N
   ***bioRxiv* (2024)** 2024.10.20.619284. https://doi.org/10.1101/2024.10.20.619284

1. **Optical segmentation-based compressed readout of neuronal voltage dynamics**
   Kim S, Ko G, **Kang I**, Tian H, Fan LZ, Li Y, Cohen AE, Wu J, Dai Q, Choi MM
   ***bioRxiv* (2023)** 2023.11.10.566599. https://doi.org/10.1101/2023.11.10.566599

Journal Publication

11. **Coordinate-based neural representations for computational adaptive optics in widefield microscopy**
    Kang I*, Zhang Q*, Yu SX, Ji N
    ***Nature Machine Intelligence* (2024)** 6, 714–725. https://doi.org/10.1038/s42256-024-00853-3
    *Contributed equally and co-correspondence authors.

10. **Accelerated deep self-supervised ptycho-laminography for three-dimensional nanoscale imaging of integrated circuits**
    Kang I, Jiang Y, Holler M, Guizar-Sicairos M, Levi AFJ, Klug J, Vogt S, Barbastathis G
    ***Optica* (2023)** 8, 1000-1008. https://doi.org/10.1364/OPTICA.492666

9. **Attentional Ptycho-Tomography (APT) for three-dimensional nanoscale X-ray imaging with minimal data acquisition and computation time**
   Kang I*, Wu Z*, Jiang Y, Yao Y, Klug J, Vogt S, Barbastathis G
   ***Light: Science & Applications* (2023)** 12(131). https://www.nature.com/articles/s41377-023-01181-8
   *Contributed equally.

8. **Three-dimensional nanoscale imaging via deep neural networks and multi-angle ptychography (RAPID)**
   Wu Z*, **Kang I***, Yao Y, Jiang Y, Deng J, Klug J, Vogt S, Barbastathis G
   ***eLight* (2023)** 3(7). https://doi.org/10.1186/s43593-022-00037-9
   *Contributed equally.

7. **Simultaneous spectral recovery and CMOS micro-LED holography with an untrained deep neural network**
   Kang I*, de Cea M*, Xue J, Li Z, Barbastathis G, Ram R
   ***Optica* (2022)** 9(10), 1149-1155. https://doi.org/10.1364/OPTICA.470712
   *Contributed equally.

6. **Dynamical machine learning volumetric reconstruction of objects' interiors from limited angular views**
   Kang I*, Goy A, Barbastathis G
   ***Light: Science & Applications* (2021)** 10(74). https://doi.org/10.1038/s41377-021-00512-x
   *Correspondence author.

5. **Recurrent neural network reveals transparent objects through scattering media**
   Kang I*, Pang S, Zhang Q, Fang N, Barbastathis G
   ***Optics Express* (2020)** 29(4), 5316-5326. https://doi.org/10.1364/OE.412890
   *Correspondence author.

4. **Deep residual learning for low-order wavefront sensing in high-contrast imaging systems**
   Allan G*, **Kang I***, Douglas E, Barbastathis G, Cahoy K
   ***Optics Express* (2020)** 28(18), 26267-26283. https://doi.org/10.1364/OE.397790
   *Contributed equally.

3. **On the interplay between physical and content priors in deep learning for computational imaging**
   Deng M*, Li S*, Zhang Z, **Kang I**, Fang N, Barbastathis G
   ***Optics Express* (2020)** 28(16), 24152-24170. https://doi.org/10.1364/OE.395204

2. **Phase Extraction Neural Network (PhENN) with Coherent Modulation Imaging (CMI) for phase retrieval at low photon counts**
   Kang I*, Zhang F, Barbastathis G
   ***Optics Express* (2020)** 28(15), 21578-21600. https://doi.org/10.1364/OE.397430
   *Correspondence author.

1. **Learning to synthesize: Robust phase retrieval at low photon counts**
   Deng M, Li S, Goy A, **Kang I**, Barbastathis G
   ***Light: Science & Applications* (2020)** 9(36). https://doi.org/10.1038/s41377-020-0267-2

Conference Proceedings & Presentations

10. **Computational adaptive optics for in vivo two-photon fluorescence microscopy using coordinate-based neural representations**
    Kang I*, Zhang Q, Yaeger C, Pham T, Yu SX, Harnett M, Ji N
    ***SPIE Photonics West* (2024)** 12851-9. https://doi.org/10.1117/12.3008468
    *Speaker, oral presentation.

9. **On the use of deep learning for three-dimensional computational imaging**
   Barbastathis G, Pang S, **Kang I**, Wu Z, Liu Z, Guo Z, Zhang F
   ***SPIE Photonics West* (2023)** 12445. https://doi.org/10.1117/12.2655261

8. **Deep self-supervised learning for computational adaptive optics in widefield microscopy**
   Kang I*, Zhang Q, Ji N
   ***SPIE Photonics West* (2023)** 12388-34. https://doi.org/10.1117/12.2658934
   *Speaker, oral presentation.

7. **Optical segmentation for compressed readout on sub-millisecond neuronal circuit dynamics – Diffractive Multisite Optical Segmentation Assisted Image Compression: DeMOSAIC)**
   Kim S, Wu J, **Kang I**, Ko G, Tian H, Fan LZ, Li Y, Cohen AE, Dai Q, Choi MM
   ***Frontiers in Neurophotonics (FiNs)* (2022)**.

6. **Photon-starved X-ray Ptychographic Imaging using Spatial Pyramid Atrous Convolution End-to-end Reconstruction (PtychoSPACER)**
   Wu Z, **Kang I**, Zhou T, Coykendall V, Ge B, Cherukara MJ, Barbastathis G
   ***Computational Optical Sensing and Imaging* (2022)** CF1D.6. https://doi.org/10.1364/COSI.2022.CF1D.6

5. **Adaptive image segmentation for crosstalk-free high-speed compressive imaging**
   Kim S, Wu J, **Kang I**, Li Y, Tian H, Fan LZ, Cohen AE, Dai Q, Choi MM
   ***Focus on Microscopy (FOM)* (2022)**.

4. **Three-dimensional reconstruction of integrated circuits by single-angle X-ray ptychography with machine learning**
   Kang I*, Yao Y, Deng J, Klug J, Vogt S, Honig S, Barbastathis G
   ***Computational Optical Sensing and Imaging* (2021)** CTu6A.4. https://doi.org/10.1364/COSI.2021.CTu6A.4
   *Speaker, oral presentation.

3. **Probability of error as an image metric for the assessment of tomographic reconstruction of dense-layered binary-phase objects**

Kang I*, Barbastathis G
***SPIE Photonics West* (2021)** 116530T. https://doi.org/10.1117/12.2577264
*Speaker, oral presentation.

2. **Deep neural networks to improve the dynamic range of Zernike phase-contrast wavefront sensing in high-contrast imaging systems**
Allan G, **Kang I**, Douglas E, N'Diaye M, Barbastathis G, Cahoy K
***SPIE Astronomical Telescopes + Instrumentation* (2020)** 1144349. https://doi.org/10.1117/12.2562927

1. **A portable, low-cost, 3D-printed main magnetic field system for magnetic imaging**
Kang I*
***IEEE Engineering in Medicine and Biology Society* (2017)**. https://doi.org/10.1109/EMBC.2017.8037619
*Speaker, oral presentation.

Awards, Honors & Certifications

Ph.D. Study-Abroad Scholarship 2017–2022
Korea Foundation for Advanced Studies (KFAS) *South Korea*

Kaufman Teaching Certificate Program (KTCP) 2022
Massachusetts Institute of Technology *Cambridge, MA*

Biophysics Program Certificate 2018
Massachusetts Institute of Technology *Cambridge, MA*

Summa Cum Laude Award 2017
Seoul National University *Seoul, South Korea*

Eminence Scholarship 2015, 2016
Seoul National University *Seoul, South Korea*

Merit-Based Scholarship 2012, 2015
Seoul National University *Seoul, South Korea*

Superior Academic Performance Scholarship 2011
Seoul National University *Seoul, South Korea*

Invited Talks & Seminars

Invited Talk Nov 2024
Center for Adaptive Optics Fall Science Retreat *University of California, Los Angeles, USA*

Invited Talk Apr 2024
Graduate School of Data Science, Seoul National University *Seoul, South Korea*

Guest Speaker in Mini-symposium – Computational Imaging in Neurophotonics Jan 2023
Seoul National University *Seoul, South Korea*

Speaker in Photobears Lightning talk series Sep 2022
University of California, Berkeley *Berkeley, CA*

Invited Talk Apr 2022
Aerospace Controls Laboratory (ACL), Massachusetts Institute of Technology *Cambridge, MA*

Research seminar Oct 2021
Computational Imaging Lab, Princeton University *Online*

Invited Talk Oct 2021
CRISP (Computation, Representation, and Inference in Signal Processing) Group, Harvard University *Cambridge, MA*

Research seminar Sep 2021
University of California, Los Angeles *Online*

Research seminar Sep 2021
Ji Lab, University of California, Berkeley *Online*

Invited Talk Feb 2021
Neurophotonics Lab, Seoul National University *Seoul, South Korea*

Mentoring Experience

Course Project Mentor Spring 2022
Massachusetts Institute of Technology *Cambridge, MA*

- **Physical Systems Modeling and Design Using Machine Learning**: Mentored a student group of 3 graduate students for their end-term project on the image segmentation of noisy ultrasonic images.
- **Mentored students**: April Marie Anlage, Yiwen Huang, Itay Fayer.

Course Project Mentor Spring 2020
Massachusetts Institute of Technology *Cambridge, MA*

- **Learning Machines**: Mentored a student group of 7 undergraduate and graduate students in total for their end-term projects on (1) the reaction modeling to facilitate pharmaceutical process development using machine learning; and (2) the control of autonomous ocean vehicles using reinforcement learning.
- **Mentored students**: (1) Natalie Suzanne Eyke, Benjamin David Russell, Robyn Wen-Yi Lee; and (2) Timothy Samuel Fountain, Warner A. McGee, HongSeok Cho, Bouke K. Edskes.

Volunteer Feb 2018
Korea Foundation for Advanced Studies Overseas Program *Kingdom of Cambodia*

- Participated as a volunteer in the Kingdom of Cambodia for a week, teaching children physics and building homes for the residents.

Teaching Experience

Kaufman Teaching Certificate Program (KTCP) Spring 2022
Teaching & Learning Laboratory, Massachusetts Institute of Technology *Cambridge, MA*

- **Workshop**: Completed seven workshops to develop teaching skills as part of the teaching certificate program. A major part of the program involved introducing students to relevant research in teaching and learning and laying out future teaching models.
- **Microteaching sessions**: Presented two microteaching sessions that were videotaped, where I received feedback on my performance regarding my teaching and provided feedback to other participants.

Teaching Assistant Spring 2020
Massachusetts Institute of Technology *Cambridge, MA*

- Mentored course research projects, contributed to curriculum design, conducted after-hour office hours, and graded assignments. Class taught totaled around 40 students and comprised course research projects on the connection between machine learning and physical systems.

Leadership

Group Leader 2019 – 2020
EECS Korean Graduate Students Society, Massachusetts Institute of Technology *Cambridge, MA*

- Organized social gatherings and networking to foster cohesion among EECS Korean graduate students.

Founder & Group Leader 2019 – 2021
Korean Graduate Students Swimming Club, Massachusetts Institute of Technology *Cambridge, MA*

- Organized a swimming session twice a week and held social events among swimming club members.

Event Officer 2018 – 2019
Korean Graduate Students Association, Massachusetts Institute of Technology *Cambridge, MA*

- Planned and organized social events to facilitate networking among Korean graduate students.

Group Leader 2018
Sidney-Pacific Inter-Cultural Exchange Program (SPICE), Massachusetts Institute of Technology *Cambridge, MA*

- Organized social gatherings for networking among group members from diverse backgrounds living in Sidney-Pacific graduate residence.

Event Chair Summer 2018
EECS Graduate Students Association, Massachusetts Institute of Technology *Cambridge, MA*

- Organized and led weekly coffee hours to facilitate social gathering and networking among international EECS students.

Student Ambassador 2018
Kakao Ventures *Seoul, South Korea*

- Contributed to the creation of a startup ecosystem on/off campus in Cambridge and worked as a liaison to Kakao Ventures in South Korea.

Sergeant Feb 2013 – Nov 2014
Korean Augmentation to the U.S. Army (KATUSA) *South Korea*

- Worked as the Information Assurance Security Officer and a deputy of Information Assurance Manager (IAM) / Systems Administrator (SA) in accordance with AR 25-2 in Information Management Office, 8th Army NCO Academy and KATUSA Training Academy.

Reviewer Activities

Light: Science & Applications
Nature Portfolio, United Kingdom

Optica, Optics Letter, Optics Express, Applied Optics
Optica Publishing, United States

IEEE Transactions on Medical Imaging
IEEE, United States

Reference

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Na Ji
Postdoc advisor, she/her/hers
Professor of Physics and Neurobiology at University of California, Berkeley
Email: jina@berkeley.edu

Stella X. Yu
Postdoc advisor, she/her/hers
Professor of Electrical and Computer Engineering at University of Michigan, Ann Arbor
Email: stellayu@umich.edu