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

PREPRINTS

2. **Adaptive optical two-photon fluorescence microscopy using neural fields**
   Kang I, Kim H, Natan R, Zhang Q, Yu SX, Ji N
   Manuscript in preparation.

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   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
Massachusetts Institute of Technology

Spring 2020
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
Korea Foundation for Advanced Studies Overseas Program

Feb 2018
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)
Teaching & Learning Laboratory, Massachusetts Institute of Technology

Spring 2022
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
Massachusetts Institute of Technology

Spring 2020
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
EECS Korean Graduate Students Society, Massachusetts Institute of Technology

2019 – 2020
Cambridge, MA

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

Founder & Group Leader
Korean Graduate Students Swimming Club, Massachusetts Institute of Technology

2019 – 2021
Cambridge, MA

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

Event Officer
Korean Graduate Students Association, Massachusetts Institute of Technology

2018 – 2019
Cambridge, MA

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

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

2018
Cambridge, MA

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

Event Chair
EECS Graduate Students Association, Massachusetts Institute of Technology

Summer 2018
Cambridge, MA

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

Student Ambassador
Kakao Ventures

2018
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

George Barbastathis
Ph.D advisor, he/his/him
Professor of Mechanical Engineering at Massachusetts Institute of Technology
Email: gbarb@mit.edu

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