IKSUNG KANG

261 Li Ka Shing Center, Berkeley, CA 94720, USA
(+1) 617-449-8969 | fresneltransform@gmail.com | he/his/him

EDUCATION

Ph.D.	**Massachusetts Institute of Technology** Electrical Engineering and Computer Science Advisor: George Barbastathis	2022
M.Sc.	**Massachusetts Institute of Technology** Electrical Engineering and Computer Science Advisor: George Barbastathis	2020
B.S.	**Seoul National University** Electrical and Computer Engineering	2017

EMPLOYMENT

Postdoctoral Fellow July 2022 – Present
University of California, Berkeley, CA / Advisor: Na Ji, Stella X. Yu

- Developed a self-supervised machine learning algorithm that jointly estimates wavefront aberrations and 3D structures of mouse brain neurons and eye lens structures from widefield and two-photon fluorescence microscopy images *in vivo*. [J11, C8]

Research Assistant 2018 – 2022
Massachusetts Institute of Technology, Cambridge, MA / Advisor: George Barbastathis

- Devised a novel physics-informed machine learning approach with random phase modulation for robust low-photon phase retrieval. [J1, J2, C6, T1]
- Designed a dynamical machine learning framework for limited-angle phase tomography of multi-layered objects. [J6, C3]
- Implemented supervised and self-supervised deep learning for non-invasive three-dimensional nanoscale imaging of integrated circuits under X-ray ptycho-tomography and ptycho-laminography geometries. [J8, J9, J10, C4, C9, T3]
- Performed simultaneous optical wavelength analysis and holographic reconstruction from an experimental diffraction intensity from a novel LED illumination using self-supervised deep learning. [J7]
- Collaborated on the design of high-speed optical compressive imaging for sub-millisecond neuronal signal dynamics. [C5, C7]
- Resulted in 10 peer-reviewed articles.

Undergraduate Researcher 2016

Seoul National University, Seoul, South Korea

- Devised a cost-effective solution for the generation of the main magnetic field in a small-sized MRI. [C1]

Research Intern Winter 2014

Graduate School of Convergence Science and Technology, Seoul National University

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

RESEARCH INTERESTS

Computational Imaging	- Computational adaptive optics - Deconvolution microscopy (widefield, multi-photon) - Computational functional imaging - 3D/4D computational tomography (laminography) - Ptychographical imaging - Computational holography - Low-photon phase retrieval - Phase modulation imaging techniques
Efficient Algorithm Design	- Self-supervised machine learning - Physics-embedded deep learning - Coordinate-based (implicit) neural representations - Nonlinear inverse problems

PEER-REVIEWED JOURNAL PUBLICATIONS

J11. **I. Kang***, Q. Zhang*, S. X. Yu, N. Ji, "Coordinate-based neural representations for computational adaptive optics in widefield microscopy," ***arXiv*** (submitted), doi: https://arxiv.org/abs/2307.03812. (* equal contribution)

J10. **I. Kang**, Y. Jiang, M. Holler, M. Guizar-Sicairos, A. F. J. Levi, J. Klug, S. Vogt, G. Barbastathis, "Accelerated deep self-supervised ptycho-laminography for three-dimensional nanoscale imaging of integrated circuits." (Accepted for publication in ***Optica***.), doi: https://doi.org/10.1364/OPTICA.492666. [IF: 10.644]

J9. **I. Kang***, Z. Wu*, Y. Jiang, Y. Yao, J. Klug, S. Vogt, G. Barbastathis, "Attentional Ptycho-Tomography (APT) for three-dimensional nanoscale X-ray imaging with minimal data acquisition and computation time," ***Light: Science & Applications*** 12(131), doi: https://www.nature.com/articles/s41377-023-01181-8. (* equal contribution) [Cited: 3, IF: 20.257]

J8. Z. Wu*, **I. Kang***, Y. Yao, Y. Jiang, J. Deng, J. Klug, S. Vogt, G. Barbastathis, "Rapid three-dimensional nanoscale imaging via deep neural networks and multi-angle ptychography," ***eLight*** 3(7), doi: https://doi.org/10.1186/s43593-022-00037-9. (* equal contribution) **[Cited: 2]**

J7. **I. Kang***, M. de Cea*, J. Xue, Z. Li, G. Barbastathis, R. J. Ram, "Simultaneous spectral recovery and CMOS micro-LED holography with an untrained deep neural network," ***Optica*** 9(10), pp. 1149-1155 (2022), doi: https://doi.org/10.1364/OPTICA.470712. (* equal contribution) **[Cited: 3, IF: 10.644]**

J6. **I. Kang**, A. Goy, G. Barbastathis, "Dynamical machine learning volumetric reconstruction of objects' interiors from limited angular views," ***Light: Science & Applications*** 10(47) (2021), doi: https://doi.org/10.1038/s41377-021-00512-x. **[Cited: 28, IF: 20.257]**

J5. **I. Kang**, S. Pang, Q. Zhang, G. Barbastathis, "Recurrent neural network reveals transparent objects through scattering media," ***Optics Express*** 29(4), pp. 5316-5326 (2020), doi: https://doi.org/10.1364/OE.412890. **[Cited: 9, IF: 3.833]**

J4. G. Allan*, **I. Kang***, E. Douglas, G. Barbastathis, K. Cahoy, "Deep residual learning for low-order wavefront sensing in high-contrast imaging systems", ***Optics Express*** 28(18), pp. 26267-26283 (2020), doi: https://doi.org/10.1364/OE.397790. (* equal contribution) **[Cited: 14, IF: 3.833]**

J3. M. Deng*, S. Li*, Z. Zhang, **I. Kang**, N. X. Fang, G. Barbastathis, "On the interplay between physical and content priors in deep learning for computational imaging", ***Optics Express*** 28(16), pp. 24152-24170 (2020), doi: https://doi.org/10.1364/OE.395204. **[Cited: 37, IF: 3.833]**

J2. **I. Kang**, F. Zhang, G. Barbastathis, "Phase Extraction Neural Network (PhENN) with Coherent Modulation Imaging (CMI) for phase retrieval at low photon counts", ***Optics Express*** 28(15), pp. 21578-21600 (2020), doi: https://doi.org/10.1364/OE.397430. **[Cited: 33, IF: 3.833]**

J1. M. Deng, S. Li, A. Goy, **I. Kang**, G. Barbastathis, "Learning to synthesize: Robust phase retrieval at low photon counts", ***Light: Science & Applications*** 9(36) (2020), doi: https://doi.org/10.1038/s41377-020-0267-2. **[Cited: 70, IF: 20.257]**

CONFERENCE PROCEEDINGS / PRESENTATIONS

C9. G. Barbastathis, S. Pang, **I. Kang**, Z. Wu, Z. Liu, Z. Guo, F. Zhang, "On the use of deep learning for three-dimensional computational imaging," ***SPIE Photonics West 2023: Practical Holography XXXVII: Displays, Materials, and Applications*** (Paper 12445). San Francisco, CA, USA, January 2023, doi: https://doi.org/10.1117/12.2655261.

C8. **I. Kang**, Q. Zhang, N. Ji, "Deep self-supervised learning for computational adaptive optics in widefield microscopy," ***SPIE Photonics West 2023: Adaptive Optics and Wavefront Control for Biological Systems IX*** (Paper 12388-34). San Francisco, CA, USA, January 2023, doi: https://doi.org/10.1117/12.2658934.

C7. S. Kim, J. Wu, **I. Kang**, G. Ko, H. Tian, L. Z. Fan, Y. Li, A. E. Cohen, Q. Dai, M. Choi, "Optical segmentation for compressed readout on sub-millisecond neuronal circuit dynamics – Diffractive Multisite Optical

Segmentation Assisted Image Compression: DeMOSAIC)," ***Frontiers in Neurophotonics (FiNs)***. Quebec City, QC, Canada, October 2022.

C6. Z. Wu, **I. Kang**, T. Zhou, V. Coykendall, B. Ge, M. J. Cherukara, G. Barbastathis, "Photon-starved X-ray Ptychographic Imaging using Spatial Pyramid Atrous Convolution End-to-end Reconstruction (PtychoSPACER)," in ***Imaging and Applied Optics Congress, Technical Digest Serie***s (Optica Publishing Group 2022), paper CF1D.6, doi: https://doi.org/10.1364/COSI.2022.CF1D.6. [Cited: 1]

C5. S. Kim, J. Wu, **I. Kang**, Y. Li, H. Tian, L. Z. Fan, A. E. Cohen, Q. Dai, M. Choi, "Adaptive image segmentation for crosstalk-free high-speed compressive imaging," ***Focus on Microscopy (FOM)***. Online, April 2022.

C4. **I. Kang**, Y. Yao, J. Deng, J. Klug, S. Vogt, S. Honig, G. Barbastathis, "Three-dimensional reconstruction of integrated circuits by single-angle X-ray ptychography with machine learning," in ***Imaging and Applied Optics Congress, OSA Technical Digest*** (Optical Society of America 2021), paper CTu6A.4, doi: https://doi.org/10.1364/COSI.2021.CTu6A.4.

C3. **I. Kang**, G. Barbastathis, "Probability of error as an image metric for the assessment of tomographic reconstruction of dense-layered binary-phase objects," ***Proceedings of SPIE 11653, Quantitative Phase Imaging VII,*** 116530T (5 March 2021), doi: https://doi.org/10.1117/12.2577264.

C2. G. Allan*, **I. Kang***, E. Douglas, M. N'Diaye, G. Barbastathis, K. Cahoy, "Deep neural networks to improve the dynamic range of Zernike phase-contrast wavefront sensing in high-contrast imaging systems," ***Proceedings of SPIE 11443, Space Telescopes and Instrumentation 2020: Optical, Infrared, and Millimeter Wave***, 1144349 (13 December 2020), doi: https://doi.org/10.1117/12.2562927. (* equal contribution) [Cited: 1]

C1. **I. Kang**, "A portable, low-cost, 3D-printed main magnetic field system for magnetic imaging", ***2017 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)***, 2017, pp. 3533-3536, doi: https://doi.org/10.1109/EMBC.2017.8037619.

TECHNICAL REPORTS

T3. G. Barbastathis, J. Song, Z. Wu, **I. Kang**, S. Pang, Z. Guo, "LION: Learning to Invert 3D Objects by Neural Networks," ***Microsystems Annual Research Report*** (2021)

T2. **I. Kang**, S. Pang, Q. Zhang, N. Fang, G. Barbastathis, "Imaging Transparent Objects through Dynamic Scattering Media Using Recurrent Neural Networks," ***Microsystems Annual Research Report*** (2021)

T1. **I. Kang**, F. Zhang, G. Barbastathis, "On the Use of Deep Learning for Retrieving Phase from Noisy Inputs in the Coherent Modulation Imaging Scheme," ***Microsystems Annual Research Report*** (2020)

AWARDS, HONORS, AND CERTIFICATIONS

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

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 for class valedictorian 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 TALK AND SEMINAR

8. **Guest speaker**, Mini-symposium – Computational Imaging in Neurophotonics, Seoul National University Jan. 2023
7. **Lightning talk series**, Photobears (Joint student chapter of SPIE, OSA, and IEEE Photonics Society at UC Berkeley Sep. 2022
6. **Invited talk**, Aerospace Controls Laboratory (ACL), Massachusetts Institute of Technology Apr. 2022
5. **Research seminar**, Computational Imaging Lab, Princeton University Oct. 2021
4. **Invited talk**, CRISP (Computation, Representation, and Inference in Signal Processing) Group, Harvard University Oct. 2021
3. **Research seminar**, University of California, Los Angeles Sep. 2021
2. **Research seminar**, Ji Lab, University of California, Berkeley Sep. 2021
1. **Invited talk**, Neurophotonics Lab, Seoul National University Feb. 2021

MENTORING EXPERIENCE

End-Term Project Mentor Spring 2022
Massachusetts Institute of Technology, Cambridge, MA

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

End-Term Project Mentor Spring 2020
Massachusetts Institute of Technology, Cambridge, MA

- Mentored two student groups of 7 undergraduate and graduate students in total in the ***Learning Machines*** course 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 math and building houses.

TEACHING EXPERIENCE

Kaufman Teaching Certificate Program (KTCP) Spring 2022

Teaching & Learning Laboratory

Massachusetts Institute of Technology, Cambridge, MA

- 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.
- 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

Department of Mechanical Engineering

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 AND MILITARY SERVICE

Group Leader 2019 – 2020

EECS Korean Graduate Students Society, Massachusetts Institute of Technology

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

- 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

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

Group Leader 2018

Sidney-Pacific Inter-Cultural Exchange Program (SPICE)

- 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

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

Student Ambassador 2018

Kakao Ventures, 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 –

Korean Augmentation to the U.S. Army (KATUSA), Republic of Korea Nov. 2014

- 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

Prof. George Barbastathis (Ph.D advisor, he/his/him)
Professor of Mechanical Engineering at Massachusetts Institute of Technology
Singapore Professor of Optics, Singapore-MIT Alliance for Research and Technology (SMART)
Email: gbarb@mit.edu

Dr. Stefan Vogt (Collaborator & Thesis committee member, he/his/him)
Associate Division Director at Argonne National Laboratory
Adjunct Associate Professor at the Feinberg School of Medicine at Northwestern University
Email: svogt@anl.gov

Prof. Na Ji (Postdoc advisor, she/her/hers)
Professor of Neurobiology and Luis Alvarez Memorial Chair in Experimental Physics at University of California, Berkeley
Email: jina@berkeley.edu

Prof. Rajeev J. Ram (Collaborator, he/his/him)
Professor of Electrical Engineering and Computer Science at Massachusetts Institute of Technology
Email: rajeev@mit.edu