MING DU Ph.D.

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PROFILE

- Developed production-level **computer vision, deep learning, and optimization** algorithms for image modeling, artifact reduction, and anomaly detection in the semiconductor process control industry.
- Created large-scale x-ray 3D **computational imaging algorithms** on **HPC** platforms with **MPI-based parallel computing**.
- **Image reconstruction/restoration** using both **deep learning and model-based optimization** methods.
- Intensive experience in using **automatic differentiation** for inverse problem solving with **PyTorch and TensorFlow**.
- Leadership experience as **project PI** for an ALCC large-scale computing grant.

EXPERIENCE

04/2021 – now
Algorithm engineer
KLA, Ann Arbor, USA

- Developed image processing algorithms for modeling the image formation process in KLA's high-precision photomask inspection systems used for sub-3-nm processes. Implemented algorithm solutions in the C++ codebase.
- Using computer vision and data science techniques, developed image correction and artifact removal algorithms that reduced the false positive rate of the photomask inspection system by over 70%.
- Improved a deep learning-based algorithm for anomaly detection, which exhibited greatly reduced false positive rate than existing methods. Designed and led the evaluation experiments for its productization.
- Directed an internship project on modeling the artifacts generated in the image formation process using model-augmented deep learning method.

08/2019 – 03/2021
Postdoctoral scholar
Argonne National Laboratory, Lemont, USA
Project title: *Learning and differentiating: using artificial intelligence to image beyond the x-ray depth of focus limit*

- Developed *Adorym*, a reconstruction framework capable of performing large-scale 2D/3D phase retrieval, image reconstruction, and parameter refinement for multiple x-ray imaging techniques, built on automatic differentiation of *PyTorch*.
- Developed a generative neural network-based method using "deep image prior" to reconstruct clean images from artifact-corrupted images in x-ray multislice ptychography.
- Developed a distributed algorithm for large 2D wavefield propagation on high performance computers (HPCs).
- Led an ASCR Leadership Computing Challenge (ALCC) project on large-scale 3D reconstruction as Principal Investigator.

09/2015 – 06/2019
Ph.D. candidate (Research assistant)
Northwestern University, Evanston, USA

- Developed *Tomosaic*, a Python software package for beyond-field-of-view x-ray tomography. Achieved 3D reconstruction of a whole mouse brain with 10^{13} voxels from 5.8 TB of raw data, using supercomputers at Argonne Leadership Computing Facility.
- Developed an innovative algorithm for 3D phase retrieval under complicated imaging scenarios, utilizing the automatic differentiation capability of deep learning tools.
- Conducted x-ray tomography and ptychography experiments at the Advanced Photon Source.
- Involved in the commissioning of an automated tomography processing pipeline *Automo/Ripple* at beamline 32-ID of the Advanced Photon Source.
- Built an improved theoretical model for dose estimation in the x-ray imaging of thick hydrated specimens.

01/2014 – 06/2014
Student researcher
Singapore Institute of Manufacturing Technology, Singapore

- Experimentally studied the pore size dependence of anodic aluminum oxide on voltage and electrolyte temperature.
- Developed a tool for unsupervised data analysis.

EDUCATION

2015 – 2019
Doctor of Philosophy, *Northwestern University, Evanston, USA*
Department of Materials Science and Engineering
Advised by Prof. Chris Jacobsen
Thesis title: *To the Breadth, and to the Depth: Scalable 3D Imaging of Extended Objects with High Resolution Using X-ray Microscopy*

2011 – 2015
Bachelor of Engineering, *National University of Singapore, Singapore*
Department of Materials Science and Engineering

SELECTED PUBLICATIONS

[1] M. Du, X. Huang, C. Jacobsen, Using a modified double deep image prior for crosstalk mitigation in multislice ptychography. *Journal of Synchrotron Radiation*. **8** (2021).

[2] M. Du, S. Kandel, J. Deng, X. Huang, A. Demortiere, T. T. Nguyen, R. Tucoulou, V. D. Andrade, Q. Jin, C. Jacobsen, Adorym: a multi-platform generic X-ray image reconstruction framework based on automatic differentiation. *Opt Express*. **29**, 10000 (2021).

[3] M. Du, D. Gürsoy, C. Jacobsen, Near, far, wherever you are: simulations on the dose efficiency of holographic and ptychographic coherent imaging1. *J Appl Crystallogr*. **53**, 748–759 (2020).

[4] M. Du, Y. S. G. Nashed, S. Kandel, D. Gürsoy, C. Jacobsen, Three dimensions, two microscopes, one code: Automatic differentiation for x-ray nanotomography beyond the depth of focus limit. *Sci Adv*. **6**, eaay3700 (2020).

[5] R. Vescovi[1], M. Du[1], *et al.*, Tomosaic: efficient acquisition and reconstruction of teravoxel tomography data using limited-size synchrotron X-ray beams. *Journal of Synchrotron Radiation*. **25** 1478–1489 (2018).

[6] M. Du, R. Vescovi, K. Fezzaa, C. Jacobsen, D. Gürsoy, X-ray tomography of extended objects: a comparison of data acquisition approaches. *J Opt Soc Am*. **35**, 1871 (2018).

[1] Co-first authors with equal contributions.

SELECTED SPEECHES & TALKS

[1] "Applications of automatic differentiation in image reconstruction and experimental parameter refinement for 3D microscopy*, " 23rd Euro AD Workshop*, Virtual. (2020).

[2] "An automated pipeline for the collection, transfer, and processing of large-scale tomography data*,* "*Biophotonics Congress: Biomedical Optics Congress 2018*, Hollywood, U.S.A. (2018).

CERTIFICATES

2022	Completed class **EECS 598-008 Deep Learning for Computer Vision** with grade **A** As part-time student at *University of Michigan, Ann Arbor*
2022	Certificates of courses in the **Bayesian Statistics** specialization *Coursera*
2020	Course certificates: **Statistical Thinking in Python**, **Unsupervised Learning in Python** *Datacamp*

MEDIA COVERAGE

[1] Andre Salles, Filling in the blanks: How supercomputing can aid high-resolution X-ray imaging. ALCF News Center (2020). [Link]

[2] ALCF, ALCF supercomputers power scientific breakthroughs in 2020. ALCF News Center (2020). [Link]

AWARDS AND ACCOMPLISHMENTS

2020	**Most active reviewers of 2019** awarded by the Optical Society of America.
2020	**Team leader** of an ASCR Leadership Computing Challenge (ALCC) proposal granted by Advanced Scientific Computing Research of the U.S. Department of Energy (24 projects awarded in total).
2019	**Contributed to** an LDRD-funded proposal (2019-0441, $80K/year over 2 years).
2019	**Contributed to** a proposal of the ALCF Data Science Program (awarded 0.25 M nodes hours over 2 years).
2015	**Materials Research Society (Singapore) Medal**.

PROFESSIONAL ACTIVITIES

2020 – 2021	**Principal Investigator** of an ASCR Leadership Computing Challenge (ALCC) grant tilted "Distributed large wavefield propagation and 3D reconstruction beyond the depth of focus limit".
2020	**Selected attendee** of the Argonne Training Program on Extreme-Scale Computing (~76 candidates selected internationally).
2020	**Co-organizer** of workshop titled "Advances in Phase Retrieval Methods for High-resolution X-ray Imaging" in 2020 APS/CNM User Meeting.
2018 – present	**Reviewer** of more than 17 manuscripts submitted to *Optics Express*, *Applied Optics*, and *Biomedical Optics Express*. (Verified peer review records available on Publons with WoS ResearcherID V-4905-2019)
2018 – present	**Member**, The Optical Society of America

SKILLS

Programming: Python, MATLAB, Mathematica, C, C++, R, SQL, Linux, LaTeX, Git

Technical skills: Deep learning, image processing, computer vision, inverse problem solving, non-linear optimization, computational imaging, parallel computing

Other skills: 3D computer graphics (Adobe After Effects, Blender; made a 3D animation showcasing the research outcome of our group, which was displayed at the Department of Energy's Booth during the SC'19 conference); computer aided design (Autodesk Fusion 360)