Kaixuan Wei

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EDUCATION

Doctor of Philosophy, KAUST — 2024.1 - Present
Major in Computer Science, Advisor: Wolfgang Heidrich

Master of Science, Beijing Institute of Technology (BIT) — 2018.9 - 2021.6
Major in Computer Science, Advisor: Ying Fu & Hua Huang

Bachelor of Science, Beijing Institute of Technology — 2014.9 - 2018.6
Major in Electronic Engineering (Xu class)

VISITING POSITION

Princeton University, Advisor: Felix Heide	2021.7 - 2024.1
University of Cambridge, Host: Angelica I. Aviles-Rivero	2019.7 - 2019.9
Microsoft Research Asia (MSRA), Mentor: Jiaolong Yang	2018.4 - 2018.11

RESEARCH INTEREST

Computer vision, computational photography/imaging/optics, optimization

HONORS AND AWARDS

First Prize on Huawei Camera Academic Talent Competition (≈ 7700 $)	2022
Excellent Master Thesis Award, Beijing Institute of Technology	2021
Outstanding Reviewer, CVPR	2021
Xu Scholarship, Beijing Institute of Technology (≈ 7700 $)	2021
Global Top 100 Chinese Rising Stars in AI, Baidu Inc.	2021
Baidu Scholarship, Baidu Inc. (≈ 30600 $)	2020
China National Scholarship, Ministry of Education (≈ 2800 $)	2020
Outstanding (Best) Paper Award, ICML	2020
Visiting Funding, CMIH, University of Cambridge (≈ 4000 $)	2019
China National Scholarship, Ministry of Education (≈ 2800 $)	2019
Excellent Undergraduate Thesis Award, Beijing Institute of Technology	2018

PUBLICATIONS

[TOG'25b] Kaixuan Wei*†, Hector A. Jimenez-Romero*, Hadi Amata*, Jipeng Sun, Qiang Fu, Felix Heide, Wolfgang Heidrich. "Large-Area Fabrication-aware Computational Diffractive Optics", *SIGGRAPH Asia, ACM Transactions on Graphics (TOG)*, 2025. (* indicates equal contribution, † indicates corresponding author)

[TOG'25a] Jipeng Sun, Kaixuan Wei†, Thomas Eboli, Congli Wang, Cheng Zheng, Zhihao Zhou, Arka Majumdar, Wolfgang Heidrich, Felix Heide. "Collaborative On-Sensor Array Cameras", *SIGGRAPH, ACM Transactions on Graphics (TOG)*, 2025. († indicates corresponding author)

[SA'24] Kaixuan Wei*, Xiao Li*, Johannes Froech*, Praneeth Chakravarthula, James Whitehead, Ethan Tseng, Arka Majumdar, Felix Heide. "Spatially Varying Nanophotonic Neural Networks", *Science Advances*, 2024. (* indicates equal contribution)

[TOG'23] Zeqiang Lai*, Kaixuan Wei*, Ying Fu, Philipp Härtel, Felix Heide. "∇-Prox: Differentiable Proximal Algorithm Modeling for Large-Scale Optimization", *SIGGRAPH, ACM Transactions on Graphics (TOG)*, 2023. (* indicates equal contribution)

[IJCV'23] Linwei Chen, Ying Fu, Kaixuan Wei, Dezhi Zheng, Felix Heide. "Instance Segmentation in the Dark", *International Journal of Computer Vision (IJCV)*, 2023.

[JMLR'22] Kaixuan Wei, Angelica Aviles-Rivero, Jingwei Liang, Ying Fu, Hua Huang, Carola-Bibiane Schönlieb. "TFPnP: Tuning-free Plug-and-Play Proximal Algorithm with Applications to Inverse Imaging Problems". *Journal of Machine Learning Research (JMLR)*, 2022.

[BMVC'21] Yang Hong*, Kaixuan Wei*, Linwei Chen, Ying Fu. "Crafting Object Detection in Very Low Light", *British Machine Vision Conference (BMVC)*, 2021. (* indicates equal contribution)
[TPAMI'21] Kaixuan Wei, Ying Fu, Yinqiang Zheng, Jiaolong Yang. "Physics-based Noise Modeling for Extreme Low-light Photography", *IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)*, 2021.
[ICML'20] Kaixuan Wei, Angelica Aviles-Rivero, Jingwei Liang, Ying Fu, Carola-Bibiane Schönlieb, Hua Huang. "Tuning-free Plug-and-Play Proximal Algorithm for Inverse Imaging Problems". *International Conference on Machine Learning (ICML)*, 2020. **(Outstanding Paper Award)**
[CVPR'20] Kaixuan Wei, Ying Fu, Jiaolong Yang, Hua Huang. "A Physics-based Noise Formation Model for Extreme Low-light Raw Denoising", *IEEE International Conference on Computer Vision and Pattern Recognition (CVPR)*, 2020. **(Oral)**
[TNNLS'20] Kaixuan Wei, Ying Fu, Hua Huang. "3D Quasi-Recurrent Neural Network for Hyperspectral Image Denoising". *IEEE Transactions on Neural Networks and Learning Systems (TNNLS)*, 2020.
[CVPR'19] Kaixuan Wei, Jiaolong Yang, Ying Fu, David Wipf, Hua Huang. "Single Image Reflection Removal Exploiting Misaligned Training Data and Network Enhancements". *IEEE International Conference on Computer Vision and Pattern Recognition (CVPR)*, 2019.
[NEUCOM'19] Kaixuan Wei, Ying Fu. "Low-rank Bayesian Tensor Factorization for Hyperspectral Image Denoising". *Neurocomputing*, 2019.

ACADEMIC SERVICE

Conference and Journal Reviewer:

- ECCV, CVPR, ICCV, SIGGRAPH, AAAI, NeurIPS, ICLR, ICML
- IEEE Transactions on Image Processing (TIP), IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), International Journal of Computer Vision (IJCV)

PROJECTS

Collaborative On-Sensor Array Cameras
Work was done at Princeton University and KAUST. 2023.8 - 2025.1

- We investigate a collaborative array of metasurface elements that are jointly learned to perform broadband imaging. This work challenges the long-standing assumption that meta-optics cameras are impractical for real-world broadband imaging due to speed and quality constraints.

Spatially Varying Nanophotonic Neural Networks
Work was done at Princeton University. 2021.8 - 2024.11

- We introduce the first spatially varying large kernel optical neural network implemented via nanophotonic metasurface array, empowering ultra-fast machine vision system. We demonstrate the first time an optical neural network can compete with modern electronic neural network while running orders-of-magnitude faster, significantly unleashing the potential of optical computing system.

Domain-specific Language for Large-scale Optimization [TOG'23]
Work was done at Princeton University. 2022.6 - 2023.1

- We introduce ∇-Prox, a domain-specific language (DSL) and compiler that transforms optimization problems into differentiable proximal solvers. Departing from handwriting these solvers and differentiating via autograd, ∇-Prox requires only a few lines of code to define a solver that can be specialized to respect a memory or training budget by optimized algorithm unrolling, deep

equilibrium learning, and deep reinforcement learning. It allows for rapid prototyping of learning-based bi-level optimization problems for a diverse range of applications such as end-to-end computational optics, image deraining, compressive magnetic resonance imaging and energy system planning.

Plug-and-Play Method for Inverse Imaging Problems [ICML'20][JMLR'22]
Work was done at University of Cambridge and BIT. 2019.7 - 2020.2

- We introduce reinforcement learning into the plug-and-play (PnP) framework, yielding a tuning-free (TF) PnP proximal algorithm for a wide range of inverse imaging problems. We demonstrate our TFPnP algorithm often reaches to the comparable performance to the one using "oracle" parameters tuned via the inaccessible ground truth.

Noise Modeling for Extreme Low-light Imaging [CVPR'20][TPAMI'21]
Work was done at MSRA and BIT. 2018.12 - 2019.11

- We present a highly accurate noise formation model based on the characteristics of CMOS photosensors. We demonstrate a network trained only with our synthetic data can compete with or sometimes even outperform the network trained with paired real data.

Single Image Reflection Removal [CVPR'19]
Work was done at MSRA and BIT. 2018.4 - 2018.11

- This work aims to expand the sources of viable real training data by facilitating the use of misaligned training pairs, which are considerably easier to collect. An alignment-invariant loss function is introduced to provide useful supervisions to networks granted unaligned data.

Hyperspectral Image Denoising [NEUCOM'19] [TNNLS'20]
Work was done at BIT. 2017.6 - 2019.2

- We present a hierarchical probabilistic model for hyperspectral image (HSI) denoising based on low-rank Bayesian tensor factorization, which can not only fit the noise adaptively without knowing the specific noise intensity, but also determine the tensor rank automatically without requiring parameter tuning.
- We design a novel neural network tailored to HSI modeling via embedding the domain knowledge. We show our pretrained model can be directly applied to remotely sensed images with various number of bands, without sacrificing the restoration accuracy.

SKILLS

Computing Skills: C++, Python, Matlab, LaTeX, Pytorch, Tensorflow
Language: Chinese (native), English (fluent)