Dean Hazineh

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Summary

My research interests span machine learning, algorithm development, and physics to realize the next generation of computer vision and imaging systems. I am currently investigating end-to-end inverse design of optical metasurfaces and the co-optimization of hardware and algorithms.

Education

Harvard University — Cambridge, MA
PhD in Applied Physics; GPA: 3.95/4.00 — *Sep 2019 – Present*
MSc in Computational Science and Engineering

Duke University — Durham, NC
BSc in Physics; Graduation with Distinction — *Sep 2013 – May 2017*
BSe in Electrical and Computer Engineering

Research and Work Experience

Computer Vision Research Group, Harvard University
Graduate Research Assistant; PI: Todd Zickler, (Co-)Federico Capasso — *Sep 2019 – Present*

- Lead several projects involving end-to-end design of cameras built with "metalenses" co-optimized alongside image-processing algorithms for depth sensing, spectral reconstruction, and optical filtering.
- Developed an auto-differentiable physics package in Tensorflow (released as D♭) for field propagation/calculation, image rendering, and constrained gradient based optimization of nanoscale structures utilizing MLPs.
- Fabricated nanoscale metasurfaces in a clean-room, conducted optical measurements, and developed prototype vision systems.

Computational Imaging Scientist, Duke University
Research Scientist; PI: Joel Greenberg, Anuj Kapadia — *Sep 2017 – Jun 2019*

- Worked on projects designing and building coded-aperture x-ray systems.
- Developed new imaging modalities and post-processing algorithms for aviation security and medical imaging that accurately reconstructs depth and hyperspectral information.
- Designed and built a table-top optical system and packaged large-scale prototype for clinical testing at the hospital, including all software to interface and control the electronics (e.g. sources and stages).

High-Energy Particle Physics Research Group, Duke University
Undergraduate Research Assistant, PI: Steffen Bass, Seog Oh — *June 2015 – Aug 2017*

- Completed my dissertation early working with Professor Steffen Bass researching fluid dynamical simulations for the novel matter produced in high-energy particle collisions at CERN.
- Conducted experimental work on a separate project with Professor Seog Oh simulating and computing the deformations that occur in deployed particle sensing systems.

Projects

D-Flat: End-to-End Design Software for Metasurfaces | *GitHub* — 2022

- A Python package built with Tensorflow for the inverse-design of flat-optics. In addition to auto-differentiable field solvers, it provides a library of efficient pre-trained MLPs to enhance physics simulations.
- Calculations are wrapped as Keras modules enabling flexible assembly of hardware operations and digital post-processing as end-to-end differentiable models.

Mechanistic Interpretability of LLMs: Probing Emergent World Representations | *GitHub* — 2023

- A project using Pytorch investigating the decision logic of transformer-based neural networks trained to play the game Othello.
- We train and benchmark several deep networks and apply intervention and transformer circuit theory.

Deep-Learning color via cGANs | *GitHub* — 2020

- A python project built with Tensorflow to learn automatic colorization of black-and-white manga panels
- A dataset of several million images is created by web-scrapping and a cGAN is successfully trained for pix2pix transformation.

Relevant Graduate Coursework

Machine Learning: Foundations of Deep Learning; Computational Tools for Statistical Learning: Approximation, Optimization, and Monte Carlo; Inverse Problems Theory; Inference, Information Theory, Learning and Statistical Mechanics; Advanced Scientific Computing: Numerical methods for PDEs;

Physics: Quantum and Classical Electromagnetics; Advanced Quantum Mechanics; Optics and Photonics; Electron Microscopy;

Skills

Programming: C, C++, Python, Tensorflow, Pytorch, Git

Experimental: Scanning Electron Microscope, Electron Beam Lithography, Clean-room training, Laser+lab proficiency