Kushagra Tiwary

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EDUCATION

Massachusetts Institute of Technology   Cambridge, MA

PhD in Media Arts & Sciences, Camera Culture, Media Lab   *Sep 2023 - Present*

Advisor: (Ramesh Raskar)

Massachusetts Institute of Technology   Cambridge, MA

SM in Media Arts & Sciences, Camera Culture, Media Lab   *Jul 2021 - May 2023*

Advisor: (Ramesh Raskar)

Thesis Committee: Ramesh Raskar (Prof. MIT), Pulkit Agarwal (Prof. MIT), Fadel Adib (Prof. MIT)

University of Illinois, at Urbana-Champaign   Champaign, IL

Bachelors with Honors in Electrical and Computer Engineering   *Aug 2015 - May 2019*

HONORS & AWARDS

- **2023 North America Winner of the Qualcomm Innovation Fellowship**: Fellowship Recipient List, Media Lab News, EECS News
- **MISTI MIT-Israel Zuckerman STEM Fund Award $30,000**: MIT-Israel Zuckerman STEM Fund Award (one of six proposals selected across MIT)
- **Two research proposals selected as finalists**: Qualcomm Innovation Fellowship (2023) (2/200 proposals selected across North American Universities)
- **Harold and Ruth Hayward Scholarship**: Awarded for outstanding academic achievement, service, leadership, and initiative at the University of Illinois, Urbana-Champaign
- **University of Illinois, College of Engineering**: James Scholar & Dean's List

INVITED TALKS, WORKSHOPS & SPEAKERS

- **Organizer & Speaker: AI For Accelerating Scientific Discovery**: Using AI to Accelerate Science, RD, and Augment Engineering & Design.   slides & video upcoming!
- **CSAIL Graphics Seminar (September 2023)**: Neural Rendering and Secondary Cues: Learning Hidden Neural Radiance Fields using Reflections and Shadows   slides & video upcoming!
- **Hyundai Vision Conference**: Invited talk on using Secondary cues for 3D Reconstruction in South Korea
- **Objects as Radiance Field Cameras**: Computational Photo-Scatterography (CPS) Expeditions, CMU Imaging Group Apr 2023
- **Learning From Visual Cues**: Signal Kinetics Group, MIT Media Lab, Dec 2022
- **Neural Representations Through Shadows**: Computational Photo-Scatterography (CPS) Expeditions, Sep 2022, slides pdf
- **Advances in Data-Driven Imaging**: IEEE International Conference on Computational Photography (ICCP), Aug 2022, Talk

RESEARCH EXPERIENCE

Camera Culture, MIT Media Lab   Cambridge, MA

Graduate Research Assistant   *July 2021 - May 2023*

- **Ph.D. Student**: Working on the intersection of Computer Vision & Computational Imaging Systems that mimic biological vision
- **Masters Student**: Thesis Title: *Discovering, Learning & Exploiting Visual Cues*: How can modern data-driven frameworks exploit physics-based cues to observe the hidden and invisible parts of the scene?
  Thesis Committee: Ramesh Raskar (**Advisor**, Prof. MIT), Pulkit Agarwal (Prof. MIT), Fadel Adib (Prof. MIT)
- **Projects & Publications**: *Please see Publications Section for a full list*
  - *Designing Imaging Systems Using Reinforcement Learning*
  - *Turning Objects into Cameras*
  - *Neural Radiance Fields from Shadows*
  - *Perspective Paper on Physics Vs. Learned Priors*
  - *3D, Visual Cues, & Change Detection in Remote Sensing Imagery*: SMART Project

Industry Experience

AI Group, Optimus Ride *(Autonomous Vehicle Startup from MIT)* — Boston, MA
Computer Vision Engineer — *July 2019 - Jul 2021*

- **Lead 2nd Gen. Vision Network Design**: Lead architect for design conversion from many single task networks to a *giant Multi-Task Model* deployed on the nationwide fleet. *Lead release testing* of models on next-gen vehicles in Seaport. Wrote MultiTasking Codebase from scratch; decreased training and release time by over 25%. (Patented)

- **Lead Traffic Light Detection & Estimation**: Led the development of the company's first Traffic Light Detection and Estimation Framework deployed on vehicles in Seaport and Washington DC. (Patented)

- **Active Learning Framework**: Designed company's first Software 2.0 like **Active Learning framework** that can automatically sample over **40 different rare-events** from disengagements, a system of Teacher Networks from incoming streams of Vision and Lidar Data across deployments nationwide. (Patented)

- **Lead Design of Labeling Schema for Perception Stack**: Lead and designed company's first Ground Truth Schema for Perception Tasks with Scale.ai, publicized here. The Schema was expanded from **10** classes to over **100** classes and attributes.

- **Lead expansion of Perception Datasets**: Led and identified areas for Data Collection in Boston with Operations. Expanded vision dataset size by over **100x** and created company's **first** Lidar Dataset (0 to contain over 300K frames)

- **Sensor Suite**: Designed a perception-centric framework to elect a sensor suite that led to the selection of lidars, cameras, and the Traffic Signal sensor suite.

Neural Network Group, Optimus Ride *(Autonomous Vehicle Startup from MIT)* — Boston, MA
Computer Vision Intern — *August 2018 - Dec 2018*

- **Lead Traffic Light Detection Efforts**: Prototype for the Online Traffic Light State Detection system.

- **Lead Data Collection Efforts**: Setup Data Collection efforts for Traffic light and TL State detection tasks.

- **Mapping of Traffic Lights**: Improved Mapping and Triangulation of Traffic Lights.

- **Efficient Computation**: Converted Caffee Vision Architecture into Tensoflow1.15x to get 3x training and 1.2x online runtime speedups.

Data Infrastructure Team, Schlumberger — Houston, Tx
Cloud Infrastructure Intern — *May 2018 - August 2018*

- **Hyper-ledger Framework**: Implemented a Hyperledger Fabric blockchain-based microservice to validate the concept of securing data and contracts in a transparent way between Schlumberger and its clients.

Publications

Tzofi Klinghoffer*, **Kushagra Tiwary***, Nikhil Behari, Bhavya Agarwal, Ramesh Raskar, "DiSER: Designing Imaging Systems with Reinforcement Learning", *Published at ICCV, 2023*, **website**, **code**, **pdf**

Kushagra Tiwary, "Discovering, Learning, and Exploiting Visual Cues", *Master's Thesis, Department of Media Arts and Sciences, MIT, 2023*, **pdf**

Kushagra Tiwary*, Akshat Dave*, Nikhil Behari, Tzofi Klinghoffer, Ashok Veeraraghavan, Ramesh Raskar, "ORCa: Glossy Objects as Radiance Field Cameras", *Published at CVPR, 2023*, **website**, **code**, **pdf**

Kushagra Tiwary*, Tzofi Klinghoffer*, Ramesh Raskar, "Towards Neural Representations Through Shadows", *Published at ECCV 2022*, **website**, **pdf**

Kushagra Tiwary*, Tzofi Klinghoffer*, Siddharth Somasundaram*, Ramesh Raskar, "Physics vs. Learned Priors: Rethinking Camera and Algorithm Design for Task-Specific Imaging ", *Published at ICCP 2022*, **pdf**

Tzofi Klinghoffer*, **Kushagra Tiwary***, Arkadiusz Balata, Vivek Sharma, Ramesh Raskar, "Physically Disentangled Representations", *Published at ECCV Workshop 2022*, **pdf code**

Kushagra Tiwary, Vincent Bindschaedler, "Simple Black Box Attacks on Neural Networks through Feature Extraction", *Illinois Security Lab, Published at PURE: Promoting Undergraduate Research in Engineering at UIUC 2017* **pdf**

Kushagra Tiwary*, Mark Craft*, Sayan Mitra "V2V Lidar Communication in Occluded Environments", *Undergraduate Reseach, 2019* **pdf**

* denotes **equal contribution**

Patents

- **Efficient detection of structure and status of traffic lights**: [WO2022246412A1](#)
- **Provisional Patent**: U.S Provisional Application Serial No. 63/500,994   *(To be disclosed)*
- **2 Patents Pending**: Use of Reflections for 3D reconstruction for VR & Cameras   *(Application no. pending)*

Press

- **2023 Qualcomm Innovation Fellowship Recipient**: [via EECS News](#)
- **2023 Qualcomm Innovation Fellowship Recipient**: [via Media Lab News](#)
- **Computer vision turns any shiny object into a camera (June 2023)**: [Quantum Photonics Clubhouse Talk](#)
- **Using reflections to see the world from new points of view**: [MIT News (2023), Front Page of MIT on 05/10!!](#)
- **This new AI technique may change how we see the world**: [Interesting Engineering (2023)](#)
- **Aprovechar reflejos para crear imágenes de objetos ocultos**: [La Nacion, *In Spanish!*(2023)](#)
- **Developing safe and reliable systems with high-quality 3D training data**: [Scale AI, (2020)](#)

Reviewing

- **Reviewer**: International Conference on 3D Vision (3DV'2024), TPAMI'CS (IEEE Transactions on Pattern Analysis and Machine Intelligence), CVPR'24, MakeMIT 2022 Judge

Teaching & Leadership Experiences

Media Arts & Sciences, MIT   Cambridge, MA
Course Staff   *FA 2022-23*
- **MAS.S90, "Introduction to Media Arts and Sciences"**:

ECE Department, University of Illinois-Urbana Champaign   Champaign, Il
Course Staff   *August 2015 - May 2019*
- **Undergraduate TA/Grader**: Assisted with the following classes: Machine Learning ([CS 446](#)) & Digital Signal Processing ([ECE 310](#) & Probability in Engr. Lab ([ECE314](#))
- **Vice President IEEE**: Managed Company Events + IEEE Student Funding at UIUC (+20,000$)

Students Mentored

- **Nikhil Behari**: Research Associate, Camera Culture
- **Bhavya Agarwal**: UROP Supervisor, Undergraduate Student at MIT
- **Chaitanya Kapoor**: Undergraduate Student at BITS Pilani
- **Sheshank Shankar**: Undergraduate Student at Univeristy of Washington

Skills

- **Programming**: Python, C/C++, Tensorflow 1.x/2+, pytorch, OpenCV, TensorRT, ONNX, gRPC, Postgres-dB, MX-NET, Caffe, Google Cloud, Docker
- **Languages (Full & Professional Working Proficiency)**: English, Spanish (*lived in Spain for 5+ years*), Hindi

Writings

I occasionally write on https://perceptive.substack.com/. Please refer to the website for more up-to-date information.

- **Ingredients of Modern Perception**: What do you need to make robot with superhuman ability? [Link](#)
- **The Perception Problem**: [Link](#)
- **Generating Fake Data**: [Link](#)
- **Histogram Of Oriented Gradients**: [Link](#)