Kushagra Tiwary

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Research Statement

I am a PhD Student and an engineer, and my overarching interests are in physics-based computer vision (eg. using physics of light simulation with data-driven works) and the Generative Design of Visual Intelligence (eg. using agents for the design of new kinds of vision). **My Thoughts here.**

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**)

University of Illinois, at Urbana-Champaign — Champaign, IL

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

Selected Press

- **Tedx Boston: Can AI Recreate 500 Million Years of Vision Evolution?**: **Tedx Boston**
- **NYT: The Data That Powers A.I. Is Disappearing Fast**: **New York Times (2024)**
- **Forging the Future of Business with AI with Forbes & Imagination In Action**: **Can AI Explain the Evolution of the Eyes?**
- **Forging the Future of Business with AI with Forbes & Imagination In Action— Panel on Frontiers of AI Research**: **Frontiers of AI Research from Current MIT PhDs — MIT 2024**
- **Second round of seed grants awarded to MIT scholars studying the impact and applications of generative AI**: **MIT News (2023)**
- **2023 Qualcomm Innovation Fellowship Recipient**: **via EECS News** **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)**

Selected Honors & Awards

- **Impact papers on Generative AI $70,000**: Invited to submit a perspective piece on the impact of Generative AI on science and engineering to MIT Press ($\frac{1}{16}$ proposals selected across MIT) **MIT News**
- **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)

Selected Invited Talks & Workshops

- **Oral at NECV 2024- New England Computer Vision Conference**: What if Eye? Computationally Emulating the Evolution of Visual Intelligence
- **Talk at MIT BCS- Tomaso Poggio's Group**: Computational Evolution Framework for Testing Visual Intelligence Hypotheses, October 2024
- **UCR Graduate Semiar Series**: Computational Evolution of Visual Intelligence, September 2024
- **Organizer for ECCV Workshop on Neural Fields Beyond Conventional Cameras**: Workshop accepted at the European Conference on Computer Vision (ECCV) in Milan, Italy (ECCV Attendance: 10k+), September 2024
- **Organizer & Speaker: AI For Accelerating Scientific Discovery**: Using AI to Accelerate Science, RD, and Augment Engineering & Design. **slides**
- **CSAIL Graphics Seminar**: 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 Apr 2023
- **Advances in Data-Driven Imaging**: IEEE International Conference on Computational Photography (ICCP), Aug 2022, **Talk**

Selected Research Experience

Camera Culture, MIT Media Lab Cambridge, MA
Graduate Research Assistant *Jul 2021 - Present*

- **Ph.D. Student**: My work broadly focuses on Physics-based Computer Vision and Generative Design of Visual Intelligence.
- **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)

Selected Publications I've been thinking about lately (See **G. Scholar** for full List)

Generative Design of Visual Intelligence

Kushagra Tiwary*, Aaron Young*, ... Tomaso Poggio, Dan-Eric Nilsson, Brian Cheung*, Ramesh Raskar* **"What if Eye? Computationally Emulating the Evolution of Visual Intelligence "**, *Nature Communications, Under Submission, 2024*

Kushagra Tiwary et. al, **"A Roadmap for Generative Design of Visual Intelligence"**, *Published at MIT Press, Impacts of Generative AI, 2024*

Physics based Computer Vision

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

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**

***** denotes **equal contribution**

Selected Relevant Industry Experience

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

- **Lead 2^{nd} Gen. Vision Network Design**: Lead architect for *a giant Multi-Tasking Model* deployed on the nationwide fleet; *Lead release testing* of models on next-gen vehicles in Boston. Wrote MultiTasking Codebase from scratch; decreased training and release time by over 25%. (Patented)
- **Lead Traffic Light Detection & Estimation**: Lead of Traffic Light Detection and Estimation Framework deployed on next-gen vehicles in Boston & Washington DC vehicles. (Patented)
- **Software 2.0 Framework**: Designed company's first Software 2.0 (*Active Learning framework*) that automatically sampled over **40 different rare-events** from disengagement using a system of Teacher Networks from incoming Vision and Lidar Data across nationwide deployments. (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**: What sensors to select for a self-driving vehicle? (lidars, cameras, thermal, traffic light etc.)

Patents

- **Efficient detection of structure and status of traffic lights**: **WO2022246412A1**
- **Crowd-Sourced Neural Radiance Fields**: **Patent Pending**

Other

- **Programming**: Python, C/C++, Tensorflow 1.x/2+, pytorch, OpenCV, TensorRT, ONNX, gRPC, Postgres-dB, MX-NET, Docker
- **Languages (Full & Professional Working Proficiency)**: English, Spanish (*lived in Spain for 5 years)*, Hindi
- **Reviewer**: TPAMI'CS (IEEE Transactions on Pattern Analysis and Machine Intelligence), CVPR'24, International Conference on 3D Vision (3DV'2024), MakeMIT 2022 Judge
- **Mentees**: *Nikhil Behari* (Research Associate), *Bhavya Agarwal* (UROP Supervisor, Undergraduate at MIT), *Chaitanya Kapoor* (Undergraduate at BITS Pilani), *Sheshank Shankar* (Undergraduate at Univeristy of Washington)