

RESEARCH
INTERESTS

I work in computational imaging, where we combine illumination, cameras and computation in innovative ways to sense the environment in a way that a traditional cameras can't. I currently build optical imaging systems that use the wave nature of light to achieve exciting capabilities like seeing through scattering media and micron-scale depth acquisition, with applications in biomedical imaging and fabrication. Some of these are possible only in the lab now: We're bringing them [out in the open](#)!

I look forward to specializing my research to real-life biomedical imaging situations, and exploring related fields like computational displays and holography in the future.

EDUCATION

School of Computer Science, Carnegie Mellon University *Aug 2017 – present*
PhD in Robotics (ongoing)

Electrical Engineering, Indian Institute of Technology Bombay *Jul 2012 – Jun 2017*
Dual Degree (Bachelor & Master of Technology)

RESEARCH
EXPERIENCE

Computational light transport with interferometry [PhD thesis] [[paper](#), [webpage](#)]

Prof. Ioannis Gkioulekas, Robotics, Carnegie Mellon University *Aug 2017 – present*

- Exploring interferometry with light sources having specially designed wave-optics properties for micron-resolution computational light transport, with applications to [optical biomedical imaging](#)
- Prototyped an interferometer on an optical table demonstrating spatially-gated and pathlength-resolved imaging and specialized it to descattering and direct-only light path imaging
- Extended the above work to implement fast, wide-field, micron-scale depth estimation, currently trying a neural reconstruction pipeline for robust depth estimation and phase unwrapping
- Currently experimenting with everyday light sources to achieve the above capabilities passively, incorporating the detrimental effects of real-life conditions such as vibrations and ambient light

Optimizing acquisition for a static X-ray computed tomography system [[paper](#)]

Dr. Rajiv Gupta, Neuroradiology, Massachusetts General Hospital *May 2019 – Jul 2019*

- Explored reconstruction and acquisition optimization methods for a novel portable static X-ray CT system with a circular arrangement of low-power X-ray sources around the patient
- Shadowed radiologists in the hospital to understand the process of diagnosing disorders in patients

A Bayesian framework for laparoscopic image enhancement [[paper](#), [code](#)], [[paper](#), [code](#)]

Prof. Suyash Awate, Computer Science, IIT Bombay *Jan 2015 – Jun 2017*

- Solved a Bayesian inverse problem to undo the detrimental effects of surgical smoke, specularities and noise on laparoscopy images for better visualization and instrument tracking
- Incorporated a novel, learned, histogram-based prior on color channels to restore color contrast in the presence of smoke, and a dictionary-based model for reconstruction in the presence of specularities

Optimizing sensing for compressed sampling recovery [[Master's thesis](#), [paper](#), [code](#)]

Prof. Ajit Rajwade, Computer Science, IIT Bombay *Dec 2015 – Jun 2017*

- Designed physically-realizable compressive acquisition and patch-wise reconstruction for existing compressive cameras using a novel circularly-symmetric coherence criterion
- Empirically analyzed the looseness of various reconstruction error bounds and proposed a sampled average-case error design criterion with a proof-of-concept implementation

Estimating cosmological photometric redshifts with machine learning [[code](#)]

Prof. Robert Brunner, Astrophysics, Univ. of Illinois at Urbana-Champaign *May 2014 – Aug 2014*

- Developed a novel learning-based method for estimating pixel-wise redshifts in the spectra and distances of dim, faraway astrophysical sources imaged by the Sloan Digital Sky Survey
- Implemented overlapping source separation and classification into galaxies, stars and quasars

JOURNAL PUBLICATIONS	Interferometric transmission probing with coded mutual intensity ACM Transactions on Graphics, 2020 [link] A. Kotwal , A. Levin and I. Gkioulekas
CONFERENCE PUBLICATIONS	Joint desmoking, specular removal, and denoising of laparoscopy images via Bayesian inference International Symposium on Biomedical Imaging, 2017 [link] A. Baid, A. Kotwal , R. Bhalodia, and S. Awate Joint desmoking and denoising of laparoscopy images International Symposium on Biomedical Imaging, 2016 [link] A. Kotwal , R. Bhalodia and S. Awate Designing constrained projections for compressed sensing: mean errors and anomalies with coherence IEEE Global Conference on Signal and Information Processing, 2018 [link] D. Shah, A. Kotwal and A. V. Rajwade Signal sensing and reconstruction for a novel multi-source static computed tomography system IEEE International Conference on Acoustics, Speech and Signal Processing, 2020 [link] A. Kotwal , A. Cramer, D. Wu, K. Yang, W. Krull, I. Gkioulekas and R. Gupta
OTHER PROJECT EXPERIENCE	IIT Bombay Mars Rover project <i>Dec 2012 – Jun 2017</i> <ul style="list-style-type: none"> – Designed, manufactured and assembled the electronics for rover and robotic arm mobility – Developed the communication and control software for rover operation and piloted it in tests – Participated in a simulated Mars mission consisting of various activities, such as sample collection, geology studies and rigorous rover testing on a challenging dry river bed in the Australian outback Super-resolution with Fourier ptychographic microscopy <i>Nov 2014 – Jan 2015</i> <ul style="list-style-type: none"> – Prototyped a Fourier ptychography system to examine histology sections in an eye hospital Star variability analysis to detect exoplanets in NGC2419 [report, code] <i>Dec 2015</i> <ul style="list-style-type: none"> – Obtained, corrected and analyzed CCD images of the globular cluster NGC2419 to estimate star brightness variability and locate microlensing events indicative of the presence of exoplanets An X-ray study of black hole candidate X Norma X-1 [report] <i>Dec 2013</i> <ul style="list-style-type: none"> – Estimated the temperature and luminosity of an X-ray binary star system suspected to contain a black hole by fitting X-ray spectra, considering emission processes and line-of-sight absorption A 16-bit pipelined RISC processor on an FPGA [code, code] <i>Jul 2014 – Nov 2014</i> <ul style="list-style-type: none"> – Designed in Verilog and implemented on FPGAs RISC processors based on two architectures
SELECTED COURSEWORK	Computer Vision, Physics-based Methods in Vision, Statistics, Convex Optimization, Machine Learning, Biology, Human Physiology
TECHNICAL SKILLS	Prototyping imaging setups on an optical table Programming: Fluent Python & Matlab Intermediate Java, SQL & Verilog Beginner C/C++ Software packages: ROS/Gazebo, PyTorch, scikit-learn, pandas, Astropy, PsychoPy, NumPy, SciPy Embedded platforms: FPGAs, Raspberry Pi, Arduino
AWARDS	Undergraduate Research Award for Master's thesis, Indian Institute of Technology Bombay, 2017 Gold medal at the 6 th International Olympiad on Astronomy and Astrophysics, representing India Bronze medal at the 5 th International Earth Sciences Olympiad, representing India KVPY Scholarship 2011 by the Government of India for students interested in basic sciences