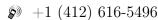# Alankar Kotwal | ✉ aloo@cmu.edu | ☎ +1 (412) 616-5496 | ⌂ alankarkotwal

RESEARCH INTERESTS

My research interests lie in computational imaging, where we aim to combine illumination, sensing and computation in innovative ways to extract information from the environment that a traditional camera cannot. I currently work on optical imaging systems that exploit the wave nature of light to achieve exciting capabilities like seeing through scattering media and micron-scale depth acquisition. Even though my research yet has focused on *imaging*, I look forward to exploring extending my work to applications like.

EDUCATION

Carnegie Mellon University *Aug 2017 – present*
PhD in Robotics (ongoing)

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

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, CSE, 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, CSE, 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	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
	Joint desmoking, specularity 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
	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 *Dec 2012 – Jun 2017*
– 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 *Nov 2014 – Jan 2015*
– Prototyped a Fourier ptychography system to examine histology sections in an eye hospital

Star variability analysis to detect exoplanets in NGC2419 [report, code] *Dec 2015*
– 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] *Dec 2013*
– 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] *Jul 2014 – Nov 2014*
– 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	**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 6th International Olympiad on Astronomy and Astrophysics, representing India Bronze medal at the 5th International Earth Sciences Olympiad, representing India KVPY Scholarship 2011 by the Government of India for students interested in basic sciences