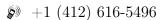
# Alankar Kotwal | ♥ aloo@cmu.edu | № +1 (412) 616-5496 | ♠ alankarkotwal



## 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 shape 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 applying my research in interferometry to real-life depth sensing and imaging situations, and exploring related fields such as 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
- Built a prototype interferometer on an optical table demonstrating spatially-gated and pathlengthresolved 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 deep learning-based 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

Mau 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 optimization 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 Swept-angle synthetic wavelength interferometry

To be submitted to ACM Transactions on Graphics [slides]

A. Kotwal, A. Levin and I. Gkioulekas

Interferometric transmission probing with coded mutual intensity

ACM Transactions on Graphics, 2020 [link]

A. Kotwal, A. Levin and I. Gkioulekas

CONFERENCE PUBLICATIONS 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

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

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]

 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

Dec 2015

- 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

#### 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, 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<sup>th</sup> International Olympiad on Astronomy and Astrophysics, representing India

Bronze medal at the  $5^{\rm th}$  International Earth Sciences Olympiad, representing India

KVPY Scholarship 2011 by the Government of India for students interested in basic sciences