Alankar Kotwal
Senior Undergraduate

Research Interests

I am passionate about Computer and Medical Vision, Machine Learning, Optimization, Estimation Theory, Astrophysics and Cosmology. I also like Robotics, Networks & Security and Graphics.

Education

Indian Institute of Technology Bombay, Mumbai, India *July 2012 – Present*

Dual Degree, Bachelor & Master of Technology, Department of Electrical Engineering
Specialization: *Communication and Signal Processing*, **CGPA: 8.83/10.00**

Publications

- Kotwal, A., Bhalodia, R., Awate, S., *Joint Desmoking and Denoising of Laparoscopy Images*, (to appear in) Proc. of the International Symposium on Biomedical Imaging, 2016.
- Clarke, J. D. A., Held, J. M., Dahl, A. *et al.*, *Field Robotics, Astrobiology and Mars Analogue Research on the Arkaroola Mars Robot Challenge Expedition*, Proc. of the 14th Australian Space Research Conference, 2014. Permalink to paper here.

Research Internships

The AIR Lab, Carnegie Mellon University Robotics Institute
Guide: *Prof. Sebastian Scherer & Stephen Nuske* *Summer 2015*
Stereo Odometry From A Downward-Facing Stereo Camera On A Vehicle
- Developed correlation-based tracking for aerial vehicles with a downward-facing stereo camera
- Estimated height, pitch and roll jointly using a robust gradient-descent homography fit between stereo pairs, and position with rigid tracking across frames
- Achieved performance comparable to, maximum speeds and height ranges better than the standard Pixhawk PX4FLOW camera without an inertial unit

Laboratory for Cosmological Data Mining, University of Illinois, Urbana–Champaign
Guide: *Prof. Robert Brunner, under Google Summer of Code* *Summer 2014*
A Pixel-Level Machine Learning Method for Calculating Source Redshifts
- Used broad-band pixel energies from faint sources extracted from SDSS (as a proxy to their entire spectrum) as features for a machine learning algorithm to calculate redshifts
- Accomplished classification of sources into galaxies, stars and background based on pixel features
- Worked on creating an image extraction, alignment, cleaning, segmentation and learning pipeline on SDSS images and on performance improvement and got a reasonably good error rate

Research Projects

A New Bayesian Framework For Laparoscopic Image Dehazing and Denoising
Guide: *Prof. Suyash Awate, CSE, IITB* *January 2015 – Present*
- Developed a Bayesian inference problem for jointly undoing the effect of surgical smoke and noise on laparoscopy images for better contrast and post-processing (like segmentation and tracking)
- Tested this method extensively on simulated and real images yielding significant improvement over state of the art dehazing algorithms in terms of numerical and perceptual accuracy
- Surveyed laparoscopy experts about quality of our results compared to the existing algorithms and found a statistically significant trend that this method yields superior results

Coded Source Separation for Compressed Video Recovery *Dual Degree Thesis*
Guide: *Prof. Ajit Rajwade, CSE, and Prof. V. Rajbabu, EE, IITB* *December 2015 – Present*
- Studied applications of the principles of compressed sensing to video for compression along time
- Currently trying to relax the requirement of a dictionary on both space and time and the requirement of strictly smooth motion using a source–separation approach to this problem
- Aim to design positive $[0, 1]$–uniform sensing matrices with low mutual coherence, making them ideal for compressed video using the source–separation approach.

The IITB Mars Rover Project *May 2013 – Present*
- Aim to build a prototype Mars rover capable of extra-terrestrial robotics, currently have a rover with a rocker-bogie suspension and novel air-filled beach tires
- Designed power, logic and communication circuits for on-board control and interfaced peripherals for perception and actuation, currently developing localization and autonomous navigation and exploring he role of machine vision for automating rover operations
- Participated in a simulated Martian expedition in the Australian outback, at the Arkaroola Mars Robot Challenge and at the Mars Society's Mars Desert Research Station, Utah.

COURSE PROJECTS	**Improved Methods for Compressed Sensing Recovery** *CS709: Convex Optimization* *Guide: Prof. Ganesh Ramakrishnan, CSE, IITB* *Autumn 2015-16*

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COURSE PROJECTS

Improved Methods for Compressed Sensing Recovery   *CS709: Convex Optimization*
Guide: Prof. Ganesh Ramakrishnan, CSE, IITB   *Autumn 2015-16*

> Using convex approximations to the compressed sensing recovery problem, we reconstructed near-exact versions of images at extremely low compressions, with proofs of correctness. Code here.

Hidden Markov Model Part-of-Speech Tagging   *EE638: Estimation and Identification*
Guide: Prof. Navin Khaneja, EE, IITB   *Autumn 2015-16*

> We implemented part-of-speech tagging with support for unknown words. An error rate of around 5% and capabilities of the system to discern context were observed.

Laparoscopic Image Dehazing With Dark Channel Prior *CS736: Medical Image Processing*
Guide: Prof. Suyash Awate, CSE, IITB   *Spring 2014-15*

> We applied the Dark Channel Prior method for landscape image dehazing to surgical smoke–affected laparoscopic images, accelerated it in time and got good results.

Stereo Odometry Via Point Cloud Registration   *CS763: Computer Vision*
Guide: Prof. Ajit Rajwade, CSE, IITB   *Spring 2014-15*

> Maximizing kernel density correlation with gradient-ascent and coherent point drift, we registered pointclouds and observed good convergence behavior for small transformations.

Gravitational Lens Separation With PCA   *CS663: Digital Image Processing*
Guide: Prof. Suyash Awate and Prof. Ajit Rajwade, CSE, IITB   *Autumn 2014-15*

> Gravitationally lensed images of galaxies have rare arc-like artifacts that can be used to calculate the mass of the lens. We used Anscombe denoising followed by PCA to build a basis for galaxy images and used the top few eigengalaxies to subtract sources and detect arcs.

ASTROPHYSICS PROJECTS

Detection of Short Gamma-ray Bursts from Astrosat Data   *PH426: Astrophysics*
Guide: Prof. Vikram Rentala, PH, IITB   *Spring 2015-16*

> Among the open problems and new datasets in the field, we tackle detecting short gamma-ray bursts from data acquired by the CZTI Hard X-Ray Imager on board the Astrosat.

Processing and Inference from CCD Images   *NIUS, Astronomy*
Guide: Prof. Priya Hasan, MANUU, Hyderabad   *December 2015*

> We analyzed raw data for the globular cluster NGC2419 taken at the HCT, post-processed it and extracted the variation of magnitudes of stars in the cluster on the scale of a day. Code here.

An X-Ray Study of Black Hole Candidate X Norma X-1   *NIUS, Astronomy*
Guide: Prof. Manojendu Choudhury, Center for Basic Sciences   *December 2013*

> We analyzed spectral data for the X-Ray Binary 4U 1630-47, in a period that corresponds to an outburst in the source for various system parameters like internal radius, temperature and so on.

Estimation of Photometric Redshifts Using Machine Learning   *NIUS, Astronomy*
Guide: Prof. Ninan Sajeeth Philip, IUCAA, Pune   *December 2012*

> Here, we trained a neural network to calculate photometric redshifts and used SDSS data and its redshifted versions to train it, getting good predictions for redshift.

ACHIEVEMENTS AND AWARDS

Olympiads and Competitive Exams

- Represented India at the 6th International Olympiad on Astronomy and Astrophysics, Brazil, 2012. Won a Gold Medal with International Rank 4 and a special prize for Best Data Analysis
- Represented India at the 5th International Earth Sciences Olympiad, Italy, 2011. Won a Bronze Medal and prizes for best performance in the Hydrosphere section and the team presentation
- Secured All India Rank (AIR) 105 in IIT-JEE amongst 1.1 million candidates

Scholarships

- Awarded KVPY Scholarship 2011 by Dept. of Science and Technology, Govt. of India
- Awarded NTSE Scholarship 2008 by NCERT, Govt. of India

TECHNICAL SKILLS

Programming	C/C++, Python, Bash, Matlab, Verilog, SQL, HTML, PHP, LaTeX
Software Packages	ROS/Gazebo, OpenCV, The Point Cloud Library, SPICE Circuit Simulation, EAGLE PCB Design, SolidWorks, AutoCAD, LabView
Science Software	Python packages: NumPy, SciPy and Matplotlib, GNUPlot, Scikit-learn, Astropy, SExtractor, SDSS tools
Hardware	*Microprocessors:* 8051, 8085, AVR and PIC, CPLDs and FPGAs, *Embedded Platforms:* Arduino, RaspberryPi, *standard digital logic*