

# Alankar Kotwal

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| RESEARCH INTERESTS   | I am passionate about Medical Vision, Robots in Surgery, Computational Imaging & Optics, Estimation, Learning, Optimization, Astrophysics and Cosmology. I also like Networks and Graphics.  |                               |
| EDUCATION            | <b>Indian Institute of Technology Bombay</b> , Mumbai, India   | <i>July 2012 – Present</i>    |
|                      | Fifth Year, Dual Degree (Bachelor & Master of Technology), Department of <a href="#">Electrical Engineering</a><br>Specialization: <i>Signal Processing</i> , <b>CGPA: 9.08/10.00</b> , Minor: <i>Computer Science and Engineering</i>   |                               |
| PUBLICATIONS         | <ul style="list-style-type: none"><li>• Baid, A., Kotwal, A., Bhalodia, R., Awate, S., <i>Joint Desmoking, Despeckling, and Denoising of Laparoscopy Images via Graphical Models with Variational Bayesian Expectation Maximization</i>. To be submitted to the <a href="#">14<sup>th</sup> International Symposium on Biomedical Imaging (2017)</a>.</li><li>• Kotwal, A., Rajwade, A. V., <i>Optimizing Codes for Source Separation in Compressed Video Recovery and Color Image Demosaicing</i>. Submitted to the <a href="#">42<sup>nd</sup> International Conference on Acoust., Speech and Signal Processing (2017)</a>. Paper <a href="#">here</a>, preprint: <a href="#">arXiv:1609.02135 [cs.CV]</a>.</li><li>• Kotwal, A., Bhalodia, R., Awate, S., <i>Joint Desmoking and Denoising of Laparoscopy Images</i> (oral), Proc. of the <a href="#">13<sup>th</sup> International Symposium on Biomedical Imaging (2016)</a>. Paper <a href="#">here</a>.</li><li>• Clarke, J. et al., <i>Field Robotics, Astrobiology and Mars Analogue Research on the Arkaroola Mars Robot Challenge</i>, Proc. of the <a href="#">14<sup>th</sup> Australian Space Research Conference 2014</a>. Paper <a href="#">here</a>.</li></ul> |                               |
| RESEARCH INTERNSHIPS | <b>The AIR Lab, Carnegie Mellon University Robotics Institute</b>  | <i>Summer 2015</i>            |
|                      | Guide: <i>Prof. Sebastian Scherer &amp; Stephen Nuske</i><br><b>Stereo Odometry from a Downward-facing Stereo Camera on an Aerial Vehicle</b> <ul style="list-style-type: none"><li>• Developed correlation-based tracking for aerial vehicles with a downward-facing stereo camera</li><li>• Estimated height, orientation using a robust homography fit between stereo pairs, position with rigid tracking, achieved better speed and height ranges than the Pixhawk camera without an inertial unit</li></ul>   |                               |
|                      | <b>Laboratory for Cosmological Data Mining, University of Illinois, Urbana–Champaign</b>   | <i>Summer 2014</i>            |
|                      | Guide: <i>Prof. Robert Brunner, under Google Summer of Code</i><br><b>A Pixel-Level Machine Learning Method for Calculating Photometric Redshifts</b> <ul style="list-style-type: none"><li>• Classified sources into galaxies, stars and background based on broad-band pixel flux</li><li>• 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</li></ul>   |                               |
|                      | <b>Srujana – Center for Innovation, L. V. Prasad Eye Institute</b>   | <i>Winter 2014</i>            |
|                      | Guide: <i>Ashutosh Richhariya, Ophthalmic Biophysics, LVPEI</i><br><b>Super-Resolution with Fourier Ptychographic Microscopy</b> <ul style="list-style-type: none"><li>• Worked on understanding and implementing Fourier Ptychographic Microscopy for microscopy slides</li><li>• Analyzed possible extensions of this method to imaging reflective surfaces like the eye</li></ul>   |                               |
| RESEARCH PROJECTS    | <b>A New Bayesian Framework for Laparoscopic Image Dehazing and Denoising</b>  | <i>January 2015 – Present</i> |
|                      | Guide: <i>Prof. Suyash Awate, CSE, IITB</i> <ul style="list-style-type: none"><li>• Developed a Bayesian inference problem for jointly undoing the effect of surgical smoke, specularities and noise on laparoscopy images for better contrast and post-processing (like instrument tracking)</li><li>• 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</li></ul>   |                               |
|                      | <b>Optimizing Sensing Matrices for Compressed Sampling Recovery</b>  | <i>Master's Thesis</i>        |
|                      | Guide: <i>Prof. Ajit Rajwade, CSE &amp; Prof. V. Rajbabu, EE, IITB</i><br><i>December 2015 – Present</i> <ul style="list-style-type: none"><li>• Studied applications of the principles of compressed sensing to video for compression along time</li><li>• Relaxed the need for a dictionary on space and time and strictly smooth motion using a source-separation approach and designed positive sensing matrices with low mutual coherence for this</li><li>• Currently optimizing general sensing matrices using error bounds verifiable in polynomial time</li></ul>   |                               |
|                      | <b>The IITB Mars Rover Project</b>   | <i>May 2013 – Present</i>     |
|                      | <ul style="list-style-type: none"><li>• Building a prototype Mars rover capable of extra-terrestrial robotics with a rocker-bogie suspension</li><li>• Designed circuits for on-board control and interfaced peripherals, currently developing localization and autonomous navigation and exploring the role of machine vision for automating rover operations</li><li>• Participated in a simulated Martian expedition in the Australian outback, at the <a href="#">Arkaroola Mars Robot Challenge</a> and at the Mars Society's <a href="#">Mars Desert Research Station</a>, Utah</li></ul>  |                               |

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| COURSE PROJECTS         | <b>Improved Methods for Compressed Sensing Recovery</b>  |   | <i>CS709: Convex Optimization</i>           |
|                         | Guide: <a href="#">Prof. Ganesh Ramakrishnan</a> , CSE, IITB   |   | <i>Autumn 2015-16</i>                       |
|                         | 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 <a href="#">here</a> .  |   |   |
|                         | <b>Hidden Markov Model Part-of-Speech Tagging</b>  |   | <i>EE638: Estimation and Identification</i> |
|                         | Guide: <a href="#">Prof. Navin Khaneja</a> , EE, IITB  |   | <i>Autumn 2015-16</i>                       |
| ASTROPHYSICS PROJECTS   | <b>Laparoscopic Image Dehazing with Dark Channel Prior</b>   |   | <i>CS736: Medical Image Processing</i>      |
|                         | Guide: <a href="#">Prof. Suyash Awate</a> , CSE, IITB  |   | <i>Spring 2014-15</i>                       |
|                         | 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.   |   |   |
|                         | <b>Stereo Odometry via Point Cloud Registration</b>  |   | <i>CS763: Computer Vision</i>               |
|                         | Guide: <a href="#">Prof. Ajit Rajwade</a> , CSE, IITB  |   | <i>Spring 2014-15</i>                       |
| ACHIEVEMENTS AND AWARDS | <b>Gravitational Lens Separation with PCA</b>  |   | <i>CS663: Digital Image Processing</i>      |
|                         | Guide: <a href="#">Prof. Suyash Awate</a> & <a href="#">Prof. Ajit Rajwade</a> , CSE, IITB   |   | <i>Autumn 2014-15</i>                       |
|                         | 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 subtract sources and detect arcs.   |   |   |
|                         | <b>Detection of Short Gamma-ray Bursts from Astrosat Data</b>  |   | <i>PH426: Astrophysics</i>                  |
|                         | Guide: <a href="#">Prof. Vikram Rentala</a> , PH, IITB   |   | <i>Spring 2015-16</i>                       |
| MENTORING EXPERIENCE    | <b>Processing and Inference from CCD Images</b>  |   | <i>NIUS, Astronomy</i>                      |
|                         | Guide: <a href="#">Prof. Priya Hasan</a> , MANUU, Hyderabad  |   | <i>December 2015</i>                        |
|                         | We analyzed raw data for the globular cluster NGC2419 taken at the <a href="#">HCT</a> , post-processed it and extracted the variation of magnitudes of stars in the cluster on the scale of a day. Code <a href="#">here</a> .  |   |   |
|                         | <b>An X-Ray Study of Black Hole Candidate X Norma X-1</b>  |   | <i>NIUS, Astronomy</i>                      |
|                         | Guide: <a href="#">Prof. Manojendu Choudhury</a> , Center for Basic Sciences   |   | <i>December 2013</i>                        |
| TECHNICAL SKILLS        | <b>Estimation of Photometric Redshifts Using Machine Learning</b>  |   | <i>NIUS, Astronomy</i>                      |
|                         | Guide: <a href="#">Prof. Ninan Sajeeth Philip</a> , IUCAA, Pune  |   | <i>December 2012</i>                        |
|                         | 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.  |   |   |
|                         | <ul style="list-style-type: none"> <li>Represented India at the <a href="#">6<sup>th</sup> International Olympiad on Astronomy and Astrophysics</a>, Brazil, 2012. Won a Gold Medal with International Rank 4 and a special prize for Best Data Analysis</li> <li>Represented India at the <a href="#">5<sup>th</sup> International Earth Sciences Olympiad</a>, Italy, 2011. Won a Bronze Medal and prizes for best performance in the Hydrosphere section and the team presentation</li> <li>Secured All India Rank (AIR) 105 in <a href="#">IIT-JEE</a> amongst half a million candidates</li> <li>Awarded <a href="#">KVPY Scholarship</a> 2011 and <a href="#">NTSE Scholarship</a> 2008 by the Govt. of India</li> </ul> |   |   |
|                         | <b>Teaching Assistant</b>  |   |   |
|                         | CS663: Digital Image Processing  | <a href="#">Prof. S. Awate</a> and <a href="#">Prof. A. Rajwade</a>                   | <i>Autumn 2015-16</i>                       |
|                         | CS736: Medical Image Processing  | <a href="#">Prof. S. Awate</a>  | <i>Spring 2015-16</i>                       |
|                         | EE638: Estimation and Identification   | <a href="#">Prof. N. Khaneja</a>  | <i>Autumn 2016-17</i>                       |
|                         | <b>Resource Person, Indian Astronomy Olympiad Programme</b>  |   | <i>May 2013, May 2014</i>                   |
|                         | Involved in mentoring high-school students in Astronomy for their selection to the international Astronomy Olympiads, and in setting up challenging questions and evaluating students.   |   |   |
|                         | <b>Programming</b>   | C/C++, Python, Bash, Matlab, Verilog, SQL, HTML, PHP, L <sup>A</sup> T <sub>E</sub> X |   |
|                         | <b>Software Packages</b>   | ROS/Gazebo, OpenCV, The Point Cloud Library   |   |
|                         | <b>Science Software</b>  | Python packages: NumPy, SciPy and Matplotlib, GNUPlot, Scikit-learn                   |   |
|                         | <b>Hardware</b>  | Common Microprocessors, CPLDs and FPGAs, Embedded Platforms                           |   |