



# Alankar Kotwal

## Detailed Resume

### Education

- 2012–Present **Dual Degree, B. Tech and M.Tech in Electrical Engineering,**  
*Indian Institute of Technology, Bombay, CPI – 8.92/10.*  
Specialization: Communication and Signal Processing, Minor Degree: Computer Sciences and Engineering
- 2010–2012 **Intermediate Examination,**  
*Ratanbai Walbai Junior College of Science, Mumbai, Percentage – 93.83.*
- 2001–2010 **Matriculation,**  
*SVPT's Saraswati Vidyalaya, Thane, Percentage – 95.27.*

### Achievements

- 2012 **Gold Medal, International Olympiad on Astronomy and Astrophysics,**  
*Brazil, International Rank 4, Special Prize for Best Data Analysis.*
- 2011 **Bronze Medal, International Earth Sciences Olympiad,**  
*Italy, Special Prize for Best Performance in Hydrosphere section.*
- 2012 **All India Rank 105, IIT-JEE,**  
among around 5,90,000 participants for entrance to the IITs.
- 2009–2012 **Olympiad Orientation-cum-Selection Camps,**  
Selected for the following camps, among the top 30 students in India (Astronomy: 2012 & 2010, Earth Sciences: 2011, Junior Sciences: 2010 & 2009).
- 2010 **Kishore Vaigyanik Protsahan Yojana Scholarship,**  
Awarded by the Government of India to students interested in research.
- 2008 **National Talent Search Examination Scholarship,**  
Awarded by the Government of India to students interested in research.
- 2011–2012 **Infosys Award for Olympiad Medallists.**
- 2013 **Inter-IIT Messier Marathon,**  
Secured IIT Bombay the second position by putting on board 72 messier objects including the entire Virgo cluster of galaxies.
- 2013 **Other competitions,**  
Won the Innovation Cell recruitment contest for freshmen and the Astronomy Quiz conducted by the Astronomy Club, IITB in 2012 and BITS Goa in 2013.

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## Experience: Astronomy and Astrophysics

- 2014 **Google Summer of Code,**  
*A New Pixel-Level Method for Determination of Photometric Redshifts,*  
Prof. R. J. Brunner and M. C. Kind, Laboratory for Cosmological Data Mining,  
University of Illinois at Urbana-Champaign.
- Developed the software package image-photo-z implementing this new method
  - Worked with SDSS photometry data and extracted pixel-level information for training machine learning algorithms: k-nearest neighbour algorithm and trees for photo-z
  - Worked on parallel programming and performance enhancement for this method
  - Validated the approach and got consistent predictions for redshifts in the testing set
- 2013 **National Initiative for Undergraduate Studies – Astronomy,**  
*An X-Ray Study of Black Hole Candidate X Norma X-1,*  
Prof. Manojendu Choudhury, Center for Basic Sciences, University of Mumbai.
- Analysed statistically timing information from RXTE to detect quasi-periodic oscillations and find their possible relation to accretion disk thickening and synchrotron jets
  - Fitted the spectra obtained with a thermal and non-thermal power-law distribution to obtain essential system parameters and observed unusual oscillations in the inner radius
  - Working on finding a possible cause for these oscillations
- 2012 **National Initiative for Undergraduate Studies – Astronomy,**  
*Estimation of Photometric Redshifts Using Machine Learning Techniques,*  
Prof. Ninan Sajeeth Philip, Inter University Center for Astronomy and Astrophysics, Pune.
- Estimated redshift data from colour index information obtained from SDSS data artificial neural networks
  - Worked on generation of training data from available data by redshifting spectra
- 2013-2014 **Resource Person,**  
*Indian National Astronomy Olympiad Programme,*  
Homi Bhabha Center for Science Education.
- Selected twice as a Student Facilitator and a Resource Person for the Indian Astronomy Olympiad OCSC (Orientation-Cum-Selection Camp) for mentoring camp students, handling academic and organizational arrangements and aiding in evaluations
  - Involved in the selection and rigorous training of the 3 member Indian National team which won 3 Gold Medals at the International Astronomy Olympiad 2013 held in Lithuania
  - Involved in generating problems for the Indian National Astronomy Olympiad which is conducted as a part of selection of students for the camp
- 2014 **Gravitational Lens Identification,**  
See the Computer Sciences section below.

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## Experience: Electrical Engineering and Computer Sciences

- 2014–Present **Fourier Ptychographic Microscopy for Reflective Imaging**,  
*The LV Prasad Eye Institute and MIT Media Labs.*
- Studied and implemented the technique named Fourier Ptychographic Microscopy for wide-field, high-resolution static imaging
  - Analyzed the physics of the system for the case of transmissive imaging in detail using Fourier optics.
  - Developing a reflective analogue of this method with special emphasis on eye imaging.
- 2014 **Google Summer of Code**,  
See the Astronomy and Astrophysics section above.
- 2013–Present **Computer Vision, The IITB Mars Rover Team**,  
*A Student Initiative at IITB.*
- Work in 2014:
    - Heading the image processing subsystem
    - Exploring stereo vision and structure from motion for autonomous rover navigation
    - Implementation of illumination correction and denoising for camera images
    - Design, implementation and testing of a new algorithm for rover navigation and obstacle avoidance
    - Implementation of the rover software stack on ROS
  - Work in 2013:
    - Programming manual controls and safety on-board
    - Hardware interfacing for peripherals on-board and debugging
- 2014 **The Arkaroola Mars Robot Challenge**,  
*A joint venture of the Mars Society Australia and Saber Astronautics.*
- Tested the Mars Rover prototype developed by the IITB Rover Team in the harsh conditions of the Australian outback
  - Participated in a series of exercises in Mars operations research conducted by Saber Astronautics which included simulated extra-vehicular activities in simulated space-suits
  - Explored Arkaroola geology and studied its similarities to Martian geology
- 2014 **Gravitational Lens Identification Using Image Processing Techniques**,  
*A PCA-based Method for Identifying Lenses in Databases*,  
Prof. A. Rajwade and S. Awate, Department of Computer Sciences,  
Indian Institute of Technology Bombay.
- Improved on source-subtraction algorithms for lens subtraction
  - Implemented the algorithm in Matlab and got a good identification rate lenses
- 2014 **Microprocessor Design**,  
*Design, Implementation and Validation of Three Processors in Verilog*,  
Prof. V. Singh, Department of Electrical Engineering,  
Indian Institute of Technology Bombay.
- Designed and simulated a pipelined processor with the Little Computer Architecture
  - Designed, implemented and tested a multi-cycle RISC processor using the LC-3b ISA
  - Designed a CISC processor with reduced 8085 architecture
- 2014 **Temperature Controller on a CPLD**,  
*A Peltier-Plate Based Fast-Response P-Controller for Temperature Control*,  
Prof. J. Mukherjee, Department of Electrical Engineering,  
Indian Institute of Technology Bombay.

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## Research Interests

### **Astronomy and Astrophysics.**

- Cosmology and the large-scale structure of the universe
- Stellar populations, structure and evolution
- Applications of computer vision to astronomy
- Data mining and its applications for handling astronomical data

### **Electrical Engineering and Computer Sciences.**

- Using computational Fourier Optics for imaging resolution improvement
- 3D shape reconstruction using computer vision techniques
- Robot navigation using stereo vision and structure from motion
- Efficient algorithms for robot navigation using geometry of visual field
- Processor architecture
- Hardware description and simulation

### **Things I'd like to do.**

- Logic minimization
- Operations research in relation to Mars missions

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## Relevant Skills

### **Languages.**

C/C++, Python, Shell Scripting, Java, Matlab, SQL, HTML/CSS, PHP, L<sup>A</sup>T<sub>E</sub>X

### **Science Software.**

Python packages: NumPy, SciPy and Matplotlib, GNUPlot, Scikit-learn, Astropy, SExtractor, SDSS tools

### **Special Software.**

ROS/Gazebo, OpenCV, SPICE Circuit Simulation, EAGLE PCB Design, SolidWorks CAD, AutoCAD, LabView, Django

### **Hardware.**

Microprocessor Architectures: 8051, 8085, AVR and PIC, CPLDs and FPGAs, Embedded Platforms: Arduino, RaspberryPi, Beaglebone, and so on, standard digital logic families

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## Relevant Courses Undertaken

### **Physics and Mathematics.**

The General Theory of Relativity, Quantum Mechanics I\*, Statistical Physics\*, Electromagnetic Waves, Electricity and Magnetism, Classical Mechanics, Differential Equations, Linear Algebra, Complex Analysis, Calculus

### **Computer Sciences.**

Computer Vision\*, Digital Image Processing, Design and Analysis of Algorithms, Data Structures and Algorithms, Discrete Mathematics

### **Electrical Engineering.**

Probability and Random Processes, Communication Systems, Microprocessors, Signals and Systems, Digital and Analog Systems, Electrical Machines and Power Electronics, Electronic Devices and Circuits, Network Theory

\* => Taken in the Spring semester 2014-15.