Alankar Kotwal

Senior Under-Graduate

Contact Information

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Research Interests

I am passionate about Computer and Medical Vision, Machine Learning, Estimation Theory, Astrophysics and Cosmology. I enjoy learning about and experimenting with Robotics, Computer Networks and Security, Computer Graphics and applications of these fields in one another.

Education

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

Dual Degree, Bachelor & Master of Technology, Department of Electrical Engineering

- **Major CGPA:** 8.78/10 (Detailed List of Courses)
- **Minor Degree:** Department of Computer Science & Engineering

Research Internships

The Airlab, Carnegie Mellon University
Guide: Prof. Sebastian Scherer & Stephen Nuske — *Summer 2015*

Stereo Odometry From A Downward-Facing Stereo Camera On A Vehicle

Fast and accurate stereo odometry is a pre-requisite for many robotics applications like localisation, path planning and navigation. For aerial vehicles like quadcopters, a good way to do odometry is to use a ground-facing camera and track the motion of the (relatively featureless) ground in order to determine the vehicle's position. This has traditionally been done with sensors like the Pixhawk PX4FLOW, which uses a single camera doing correlation-based tracking along with a sonar for odometry. This has several disadvantages, like small camera field of view (meaning small maximum allowed speeds for accurate tracking), bad sonar readings at low range (especially during take-off), requirement of an inertial unit for angle measurement and height-dependent camera focus. We aimed to replace the PX4FLOW with a small-baseline stereo camera for the same purpose. Assuming that most of the field of view lies on a plane parallel to the sensors, the height of the vehicle is obtained from a robust estimate of the horizontal disparity between rectified stereo pairs. Alternatively, height, pitch and roll are jointly estimated using a robust gradient-descent homography fit between rectified stereo pairs. Similar, rigid tracking across frames is then used to measure position. We obtained better depth estimates, better maximum speeds and comparable accuracy without an inertial unit as compared to the PX4FLOW.

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

Distances in Astrophysics have traditionally been measured using a variety of techniques, spectrometry being prominent among them. The basic idea in spectrometry is, given a source with a measurable spectrum, features in the spectrum (like bright emission or dark absorbtion lines) can be fit to obtain the source's redshift, which is a measure of distance at cosmologically significant distances. However, there exist sources which are either very far or very dim, so we do not get enough flux from them to measure their spectrum. Broad-band energies from these sources, as an approximation to the entire spectrum, are used as features for a machine learning algorithm to calculate redshifts for these sources, or alternatively classify them. Unlike previous attempts, we calculate features pixel-wise instead of integrating over entire source area, giving potential benefits like source de-blending and better background separation. The redshift calculation and source classification from the method are reasonably accurate.

Research Projects

A New Bayesian Framework For Laparoscopic Image Dehazing and Denoising
Guide: Prof. Suyash Awate, CSE, IITB — *January 2015 – Present*

Laparoscopic images in minimally invasive surgery get corrupted by surgical smoke and noise. This degrades the quality of the surgery and the results of subsequent processing for, say, segmentation and tracking. Algorithms for desmoking and denoising laparoscopic images seem to be missing in the medical vision literature. We formulated the problem of *joint desmoking and denoising* of laparoscopic images as a *Bayesian inference* problem. This formulation relies on a novel *probabilistic graphical model* of images, which includes a *Markov Random Field (MRF) formulation for color-contrast* and another *MRF for smoothness* on the uncorrupted color image as well as the transmission-map image that indicates color attenuation due to smoke. The results on simulated and real-world laparoscopic images, including clinical expert evaluation, shows the advantages of the proposed method over the state of the art. The results have been submitted to the International Symposium on Biomedical Imaging for publication.

The IITB Mars Rover Project — *May 2013 – 2015*

MSI Description

Scholastic Achievements and Awards

Institute Level Achievements

- Conferred Institute Academic Prize for academic excellence in years 2013-14 and 2014-15
- Secured Semester Point Index (SPI) of 10.00 in 3^{rd} and 6^{th} semester
- Awarded AP grade (for outstanding performance) in 'Numerical Analysis' and 'Nanoelectronics'

Olympiads and Competitive Exams

- Represented India (part of 5 member team) in 43^{rd} International Physics Olympiad held in Estonia 2012. Won Bronze Medal and also felicitated by Infosys Award
- Secured All India Rank (AIR) 58 in IIT-JEE and AIEEE 2012 amongst 1.1 million candidates
- Secured AIR 3 in International Mathematics Olympiad and AIR 9 in National Science Olympiad
- National Top 300 in Indian National Astronomy Olympiad (INAO) thrice during 2010-2012

Scholarships

- Awarded KVPY Scholarship 2011 by Dept. of Science and Technology, Govt. of India
- Holder of NTSE Scholarship 2008 by NCERT, Govt. of India
- Recipient of Central Board of Secondary Education (CBSE) – Scholarship for Higher Education (SHE) for being in top 1% in High School all over India

Other Projects

Model of Pulse Laser Deposition — *EE669: VLSI Technology*
Guide: Prof. Udayan Ganguly, EE, IITB — *Autumn 2015-16*

Modelling analytically and simulating the non-uniform deposition of target material in Pulse Laser Deposition (PLD) and how to make uniformly deposited films using it.

LC3b Processor Design — *EE309: Microprocessors*
Guide: Prof. Virendra Singh, EE, IITB — *Autumn 2014-15*

Designed original point-to-point based data path and control path for LC3b ISA using FSM for Controller. Implemented the same using VHDL on DE0-Nano.

Movies Information System — *CS317: Database and Information System*
Guide: Prof. Umesh Bellur, CSE, IITB — *Autumn 2014-15*

Created a database system using SQL and made an online application using JSP and Tomcat to access it. Also devised different security levels of access to Database.

Motion Sensor Brick Breaking Game — *EE224: Digital Systems*
Guide: Prof. Jayanta Mukherjee, EE, IITB — *Spring 2013-14*

Revamped the arcade Brick Break Game with Paddles motion governed by the tilt of hand. Interfaced VGA and accelerometer via VHDL on CPLD.

Ballistic Nanowire — *EE432: Special Semiconductor Devices*

Guide: Prof. Dipankar Saha, EE, IITB *Spring 2013-14*

Theoretically analysed Nanowire Transistors under Ballistic Transport via 2 methods viz. QM analysis and analytical approach as suggested by two independent research groups in the field.

Mentoring Experience

Teaching Assistant

CS663: Electricity and Magnetism	Prof. C.V. Tomy	*Spring 2013-14*
MA105: Calculus	Prof. Ravi Raghunathan	*Autumn 2014-15*
PH108: Electricity and Magnetism	Prof. Bhanu Prasad	*Spring 2014-15*

Academic Mentor *April 2014 – Present*

Selected twice as a member of the Department Academic Mentorship Program team, responsible for the academic well-being of the students and aided two students to clear their backlogs and get good grades. Developed detailed course reviews and website for the ease of EE students.

Student Mentor *March 2015 – Present*

Mentoring 12 freshmen from diverse backgrounds for overall development under Institute Student Mentorship Program (ISMP) responsible for providing guidance to the entire freshmen batch.

Technical Mentor *April 2013 – March 2014*

Mentored 1^{st} year students for Robotic Competitions and Institute Technical Summer Projects.

Relevant Coursework

Electrical

Neuromorphic Engg., VLSI Technology, Nanoelectronics, Control Systems, Special Semiconductor Devices, Microprocessors, Probability & Random Processes, Digital Systems, Electronic Devices

Computer Science

Design of Algorithms, Networks, DBMS, Data Structures and Algorithms, Discrete Mathematics

Physics

Semiconductor Physics, Quantum Mechanics I, Solid State Physics, GTR, Classical Mechanics I

Mathematics

Numerical Analysis, Complex Analysis, Differential Equations, Linear Algebra, Calculus

Technical Skills

Programming	C/C++, MATLAB, Java, VHDL, HTML, Assembly, SQL, Octave, JSP
Software Packages	SolidWorks, EAGLE, LaTeX, AutoCAD, GNURadio, Nextnano, Origin
Hardware	CPLD (Altera MAX V), FPGA (Spartan 6), Intel 8051, Arduino

Extra-Curricular Activities

- Conducted survey on Deteriorating Ethics in Institute & critically analysed it. Made propositions.
- Stood 1^{st} in Regional CBSE Science Exhibition and qualified for Nationals in 10^{th} grade
- Bagged 2^{nd} position in Bazinga, Institute Level Physics Quiz, 2014
- Secured 1^{st} position in Fresher's Badminton GC and Treasure Hunt in Fresher's Cultural Fest
- Top rank in the District in MBD Talent Search for 5 consecutive years; $2006 - 10$

References

Prof. Suyash Awate, CSE
Indian Institute of Technology, Bombay
E–Mail | Webpage

Dr. Aniket Sule, Reader
Homi Bhabha Center for Science Education
E–Mail | Webpage