Riddhish Bhalodia

Senior Undergraduate

Contact Information

Department of Electrical Engineering
Indian Institute of Technology Bombay
126, Hostel 06, IIT Bombay
Powai, Mumbai, India 400 076

Phone: (+91) 9769472731
E–Mail: riddhish@iitb.ac.in
riddhishb@gmail.com
Webpage: riddhishb.github.io

Research Interests

I am passionate about math intensive problems relating to image computing (specifically in the domain of medical images), machine learning, estimation theory and control systems. I like working on blind source separation problems, image/signal estimation and recovery models, MR image analysis and reconstruction, sparse signal processing, and compressieve sensing. I am active electronics and robotics enthusiast, I like robot navigation systems, and electronics design for micro-controller applications.

Education

Indian Institute of Technology Bombay, Mumbai, India — *July 2012 – Present*
Bachelor of Technology, Department of Electrical Engineering

- **Major CGPA:** 8.10/10 (Detailed List of Courses)
- **Minor Degree:** Department of Systems & Controls
- **Honors:** Department of Electrical Engineering

Research Internships

Chief Technical Office, WIPRO Technologies
Guide: Sindhu Bhaskaran & Raja Shekhar Reddy — *Summer 2015*

Haptics in Virtual Reality Based Online Retail Platforms

E-Commerce has seen a definitive boom in present years, and is still rapidly growing. This gives an immense opportunity for researchers and developers to come up with innovative solutions, virtual reality (VR) being one of them. My task at WIPRO technologies was to combine the VR with haptics feedback, giving a 4^{th} dimension to virtual reality.

- Generated graphical models for hands and objects in JavaFX and used Leap Motion Device for kinesthetic feedback which allows user to control the virtual hands through gestures.
- Collision detection between the virtual object and virtual hands, sent the generated events via Bluetooth to an haptic glove, where a micro-controller controls the haptic actuators.
- The prototype had only five actuator but the code is capable of handling 2000 such micro sensors without modifications. This was combined with Oculus-Leap VR engine.

AVIPULSE Project, Indian Institute of Technology, Mumbai
Guide: Prof. Preeti Rao — *Summer 2014*

Pattern Recognition for Identification of Bird Species from Bird Calls

Identifying the species of bird from it's calls can be a useful tool for ornithologists, bird watchers, wildlife photographers and forest officials. The goal of the research was to reach at a robust tool for identifying bird species from their calls.

- We proposed to characterize the signals by spectral and temporal features like, MFCC, pitch, spectral centroid, zero crossing rates etc. Implemented automatic syllable segmentation and the subsequent feature extraction for the noise free bird call recordings. Used these features as the training database for supervised classification.
- Used Naive Bayes' clustering algorithms to classify the feature space into bird species, along with this we also used the location prior based on the user input, hence limiting the database which improved the accuracy and computational speed. The accuracy of the clustering by confusion matrix was 94%. (Team of Two)

Research and Technical 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, with clinical expert evaluation, shows the advantages of our method over the state of the art. The results are submitted to the International Symposium on Biomedical Imaging 2016 for publication. (Team of Two)

Undergraduate Thesis: Multi-Channel Speech Separation and Dereverberation
Guide: Prof. Rajbabu Velmurugan, EE, IITB *July 2015 – Present*

Reverberation is a hindrance not only to the perceptual intelligibility of the speech but also to the performance of Automatic Speech Recognition (ASR) systems, hence, there is a need for an efficient framework for dereverberation and blind source separation (BSS) coupled together.

- Exploration of *non-negative factorization* (NMF) based approaches for speech separation and dereverberation. Results show that due to quasi-stationary nature of speech the convolutive NMF outperforms the standard framework. Evaluation done with both supervised and unsupervised setting.
- Emphasis on combining the *models of spatial covariance* matrices of the multi-channel data to perform the separation into spatial images and then perform standard single channel dereverberation on each of the spatial images.
- Performing single source multi-channel dereverberation through non-negative tensor factorization (NTF). The results show steady SR-MR improvements and marginal improvements in WER for even large reverberation times ($T_{60} = 730ms$).

Optimal Control in Sprinkler System
Guide: Prof. Ravi Banavar, SysCon, IITB *Autumn 2012*

Optimal control based problem for a garden sprinkler system directed to make it more energy efficient and reduce water consumption was formulated. We minimized time taken by sprinklers and, the deviation of water level from the desired level, we provided a solution to this with quadratic optimization. We also simulated our results using MATLAB GUI Engine. Report here.

Remote Inspection Vehicle
ASME SDC, India Team *Year 2012-2013*

Was part of a 13 member team selected to represent India at ASME Student design Competition 2013. We had to design a robot which could be maneuvered remotely and perform certain tasks. The challenge was designed considering the Fukishima nuclear tragedy in 2011 for the need of a robot to access areas typically inaccessible by humans. We secured 1^{st} position at Nationals and Asia pacific rounds and 2^{nd} at world finals.

- We developed efficient suspension system to maneuver Sharp turns. Also a laser guided system to efficiently deploy and pick up the object. Along with this we managed the motor driver and video transmission system.

Course Projects

Segmentation of Brain MR Images using GMM *Estimation and Identification*
Guide: Prof. Navin Khaneja, EE, IITB *Autumn 2015-16*

Implemented GMM based model for brain MRI segmentation using expectation maximization. Further improvements were done by imposing edge preserving spatial regularity by MRF prior.

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

We applied the Dark Channel Prior method for landscape image dehazing to laparoscopic images. In order to make the process real-time, we replaced refining the transmission map with a differential equation with guided filtering and got good results. Code here (Team of Two)

Poission Image Editing Applications *Computer Vision*
Guide: Prof. Ajit Rajwade, CSE, IITB *Spring 2014-15*

Implemented various applications of Poisson equation like seamless insertion, seamless cloning, texture flattening etc, as part of Computer Vision course project. (Team of three)

Grain Moisture Measurement in Indian Godowns *Electronics Design Lab*
Guide: Prof. Joseph John, EE, IITB *Spring 2014-15*

Designed and developed a product to measure the moisture content of the grains stored in Indian godowns (both hardware and software), as a warning system towards grain spoilage. A *conductance based* as well as *capacitive approach* was used for measurement of moisture content. Right from the designing of PCB, testing it on grains, battery management, to the final packaging of product was done in this semester long project. Report here (Team of Two)

Image Splicing Detection using Local Noise Variances *Digital Image Processing*
Guide: Prof. Suyash Awate and Prof. Ajit Rajwade, CSE, IITB *Autumn 2014-15*

Implemented *image splicing detection* using local noise variances in OpenCV, with good splicing detection rate. Used DCT image space to compute kurtosis values which was used for classifying the images into binary labels, spliced and non-spliced. Improved the detection by cascading it with k-means algorithm. Code here

SMS Based Security System using CPLD *Digital Systems Lab*
Guide: Prof. Jayanta Mukherjee, EE, IITB *Spring 2013-14*

Implemented *UART communication between GSM Module and CPLD* using VHDL. Interfaced Keyboard and GLCD screen to develop a complete prototype. (Team of Two)

Publications

- *Joint Desmoking and Denoising of Laparoscopy Images*
  International Symposium on Biomedical Imaging (ISBI) - 2016(accepted)

Achievements and Awards

Olympiads and Competitive Exams

- Represented India at the 12^{th} Asian Physics Olympiad, Israel, 2011.
- Secured All India Rank (AIR) **65** in IIT-JEE **among** 1.1 **million candidates**
- Was among top 0.1% students in Indian Physics Olympiad 2011 and in Indian Astronomy Olympiad for years 2011 and 2012

Scholarships

- Awarded KVPY Scholarship 2011 by Dept. of Science and Technology, Govt. of India.
- Awarded Cacha Nehru Scholarship for Innovative Excellence 2009 by NCERT, Govt. of India

Competitions

- Part of the college team who were national first in ASME student design challenge, the team went ahead to win the Asia Pacific Round and secured 2^{nd} position at world finals 2013.
- 2^{nd} position in Line follower competition and 1^{st} in innovation cell robotics challenge, organized by Robotics Club, IIT Bombay 2012

Position of Responsibility

Manager, Electronics Club *Year 2014-2015*

Led the team of 9 conveners along with my co-manager in planning and execution of all electronics related hobby activities like workshops, talks, sessions and, competitions for the year 2014-2015. We took several new initiatives like *Hardware Hackathon*, *Techify Your Room* and *BLAH Talks* and expanded the outreach of the club. Year Review of the club: here

Contributor, Scilab Toolbox, FOSSEE *2015-present*

An inter college collaborative initiative to develop Scilab toolbox for the benefit of students. I am currently helping in developing functions in the domain of image processing.

Convener, Electronics Club *Year 2013-2014*

Talks and Workshops

Pattern Recognition in Bird Identification *Invited Talk*
TIDSP Lab, IIT Bombay *July 2014*

Here, I presented results from my 2014 summer internship with AVIPULSE to the research group which it was a collaboration of at IIT Bombay. The talk included a detailed description of the methods used and analysis of results.

Image Processing for Beginners Invited Talk
Robotics Club, IIT Bombay *September 2015*

Overview of image processing techniques and application for freshmen and sophomores, with hands on demonstrations. Presentation: here

Others

Micro-controller Workshop : Presentation and Demo codes here, *Processing Hackathon*, *Techify Your Room Workshops* , *Geometric Control of Speherical Satellite :* Differential geometry term paper , *Brain MR Image Segmentation :* Estimation Theory Term Paper, *Image Steganography – Applications and Algorithms :* presentation here, code here.

Relevant Coursework

Signal and Image Processing

Computer Vision, Algorithms for Medical Image Processing, Digital Image Processing, Estimation and Identification, Speech Processing, Digital Signal Processing, Signals and Systems

Communication and Information Theory

Digital Communication, Information Theory and Coding, Games and Information, Communication Systems, Communication Lab, Network Theory

Systems and Controls

Controls, Controls Lab, Linear and Non-Linear Systems, Differential Geometric Control, Signals and Feedback Systems, Mathematical Structures of Systems and Controls

Mathematics and Others

Differential Equations, Linear Algebra, Complex Analysis, Calculus, Probability and Random Processes, EM Waves, Electronics Design Lab, Analog and Digital Circuits, Advanced Computing for Electrical Engineers (Data Structures and Algorithms), Microprocessors

Technical Skills

Programming	C/C++, Python, Bash, MATLAB, Java, VHDL, HTML, LaTeX
Softwares, Packages	ROS/Gazebo, OpenCV, SPICE Circuit Simulation, EAGLE PCB Design, LabView, Octave, Android Studio, JavaFX, *Python packages*: NumPy, SciPy and Matplotlib, GNUPlot
Hardware	*Microprocessor Architectures:* 8051, 8085, AVR and PIC, CPLDs and FPGAs, *Embedded Platforms:* Arduino, RaspberryPi, Beaglebone *standard digital logic families*

Other Interests

Other than my academic interests, I like trekking and mountaineering activities, playing guitar, swimming, reading novels, anime and Japanese manga. I am an avid listener of classic rock and metal and a big fan of Led Zeppelin and Pearl Jam.

References

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

Prof. Rajbabu Velmurugan, EE
Indian Institute of Technology, Bombay
E–Mail | Webpage

Prof. Ajit Rajwade, CSE
Indian Institute of Technology, Bombay
E–Mail | Webpage

Prof. Ravi Banavar, SysCon
Indian Institute of Technology, Bombay
E–Mail | Webpage