Sudeep Salgia

SENIOR UNDERGRADUATE

Contact Information

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Research Interests

I am passionate about math intensive problems relating to theoretical aspects of signal processing and their corresponding real world setups. I like working on image/signal estimation and recovery models, sparse signal processing, compressive sensing and medical image analysis and reconstruction. Besides these, I am highly motivated to work on cross discipline applications and to extend the application of knowledge from one domain to different domains to gain interesting insights.

Education

Indian Institute of Technology Bombay, Mumbai, India (July'14 - Present)
Bachelor of Technology, Department of Electrical Engineering

- Cumulative Performance Index (CPI): 9.74/10.00
- Pursuing Minor in Computer Science and Engineering and Honors in Electrical Engineering

PACE Junior Science College, Borivali, Mumbai, India (July'12 - Apr'14)
Intermediate/+2

- Was among the Top 10 students in Maharashtra by securing an overall percentage of 95.38%

Cambridge School, Mumbai, India (July'99 - Apr'12)
Matriculation

- Secured an overall percentage of 96.00% and was the school topper

Publications

On Bandlimited Spatiotemporal Field Sampling with Location and Time Unaware Mobile Sensors
International Conference on Acoustics, Speech and Signal Processing, 2018

Research Internship

Automated methods for MS Lesion Segmentation (May'17 - July'17)
Guide: Prof. Yi Wang | Weill Medical College, Cornell

The detection and identification of MS Lesions in MR scans is challenging and hence requires an expert radiologist. However, different interpretations of radiologists lead to an element of subjectivity. Thus to eliminate the subjectivity in the outcome and also address the cost issues, it is required to develop computer assisted methods. My work was thus to develop a mathematical model for lesion segmentation using analytical methods that works in the premise of only T2 images.

- Researched and analyzed existing literature and performance metrics, documented algorithms, their scope and constraints and understood their underlying mathematical structure
- Formulated a new mathematical model to detect lesions using only T2 images and implemented the same in consonance with a level-set segmentation based approach, novel to MS lesion segmentation
- Achieved sensitivity of 70% using the above approach, comparable to some of the state-of-the-art methods that use images from multiple modalities and complex learning based approaches

Research Projects

Undergraduate Thesis: Sampling and Estimation of Bandlimited Fields
Guide: Prof. Animesh Kumar | EE, IIT Bombay (July'17 - Present)

Sampling and estimation of Bandlimited fields like pollution and temperature is of great interest for both analytical purposes and practical problems. Thus, it is essential to model sampling in such scenarios accurately keeping in mind practical aspects like economic feasibility and other constraints. My goal was to get theoretical bounds on reconstruction error under different sampling scenarios.

- Studied the sampling of a spatially bandlimited field at unknown locations obtained from an unknown Autoregressive process. The modelling setup was motivated by correlated intersample distances because of smooth velocity of mobile sampler. Proposed a reconstruction algorithm from noisy samples and the error was shown to decrease as $O(1/\text{sampling density})$.
- Analyzed the sampling of spatiotemporally varying fields at unknown locations and time stamps and proposed an algorithm for reconstruction using only the knowledge of the partial differential equation governing the evolution. The error was shown to decrease as $O(1/\text{sampling density})$.

Swendsen Wang Sampling for Brain MRI Segmentation (Jan'17 - Apr'17)
Guide: Prof. Suyash Awate | CSE, IIT Bombay Sampling in high dimensions is often a difficult task as the region with considerable probability mass is concentrated in small regions. The aim of the project was to study sampling in high dimension and extrapolating the idea for image segmentation of medical images as images can be taken as points in high dimensional space with an underlying distribution.

- Implemented popular algorithms for sampling in high dimensions and analyzed their speed-accuracy tradeoff to understand the scope of application of each of the algorithm
- Assessed the extension of setup of the Swendsen Wang Algorithm for image segmentation by comparing its performance with the others on a variety of test cases generated synthetically
- Remodeled the extension to adapt to MRI scan framework to segment brain into its three basic sections and achieved a segmentation accuracy of over 75%

Algorithms for information restoration in images (May'16 - Nov'16)
Guide: Prof. Suyash Awate | CSE, IIT Bombay Image inpainting aims at reconstructing the missing regions within an image in such a way that it is visually plausible to an observer. It is often used in cases like restoration of old paintings and extraction of underlying images corrupted by text over the image. Our aim was to develop a new algorithm using global information from the image.

- Documented an analysis of speed-quality metrics of existing algorithms in image inpainting and studied the performance of different algorithms under various scenarios
- Concieved a new algorithm based on an ingenious approach that uses global information. Outperformed the state of the art methods in both speed and quality metrics on various datasets
- Extended the same to texture specific images to inpaint skin patches and submitted it for an industry level application

Selected Course and Technical Projects

Visible Light Communication (Jan'17 - Apr'17)
Guide: Prof. Kumar Appaiah | EE, IIT Bombay Electronic Design Lab | Team of 3

- Designed a wireless optical link for reliable data transmission at 300 kbps for a distance of 50 cm
- Implemented clock recovery circuit using Phase Locked Loop achieving 100% accuracy
- Devised a simple protocol to send information and clock synchronization bits over the link

Microprocessors (July'16 - Nov'16)
Guide: Prof. Virendra Singh | EE, IIT Bombay Microprocessors | Team of 3

- Developed an Microprocessor with RISC Architecture in-situ with 15 representative instructions
- Programmed both a 6 stage Pipelined version with forwarding and hazard control and a multicycle version 22 stage FSM for an ISA similar to the one used currently in ARM microprocessors

Natural Language Sentence Matcher (July'17 - Nov'17)
Guide: Prof. Ganesh Ramakrishnan | CSE, IIT Bombay Machine Learning | Team of 4

- Developed and compared several models to find whether two sentences have a similar meaning
- Tested word embedding methods like bag of words, N-gram, CBOW in a fully connected network
- Acheived an accuracy of 82% on the test data using a bi-directional LSTM

CMA Equalizer in GNURadio (July'16 - Nov'16)
Guide: Prof. Jaykrishnan Nair | EE, IIT Bombay Communications Lab | Team of 2

- Developed an out of tree CMA Equalizer block in GNURadio, integrable with existing framework
- Obtained results comparable to the existing block, using gradient descent for equalization

Animation of Bicycle in a room (July'16 - Nov'16)
Guide: Prof. Parag Chaudhri | CSE, IIT Bombay Computer Graphics | Team of 2

- Designed a bicycle in a room in OpenGL using hierarchial modelling to imitate realistic movements
- Mapped the floor and the wall using different textures and added light sources to give a more realistic effect to a video made by combining interpolated frames using ffmpeg

Sign Language to Text Converter (May'15 - June'15)

- Developed a software using Python and OpenCV library to recognize gestures of American Sign Language and display their text equivalent, aimed at increasing comprehensibility of sign language
- Awarded the Best Application Award among 52 projects in the Tech and RnD Exposition, IIT Bombay, an annual exhibtion at IIT Bombay to display the technical activities across the institute

Path Optimization Bot (Jan'15-Apr'15)
Guide: Prof. Kavi Arya | CSE, IIT Bombay Computer Graphics | Team of 2

- Developed using C++, Embedded C, OpenCV library and Windows.h library, a robot that can access a set of given points such that total distance covered by the robot is minimized
- Implemented Wireless Communication using the X-Bee module
- Located the balls and oriented the bot with high accuracy despite the limitations of the hardware

Scholastic Achievements And Awards

- Department Rank 3 in the Electrical Engineering batch of 2018 (Present)
- Secured a perfect 10/10 semester grade point in the fourth, seventh and eighth semester at IITB (2016)
- Selected for the final round of Honda YES Scholarship, among top 20 students across the country on the basis of views on and contribution to eco-technology (2017)
- Secured All India Ranks 214 and 83 in JEE-Advanced and JEE-Mains respectively (2014)
- Awarded the AP grade (top 1%) in Partial Differential Equations and Digital Communications
- Stood among Top 100 in the nation in various Math, Science and Cyber Olympiads (2005 - 2012)
- All Round Best Student for exceptional co and extra-curricular performance throughout school

Relevant Coursework

Signal and Image Processing:
Advanced Topics in Signal Processing, Advanced Image Processing, Algorithms for Medical Image Processing, Digital Image Processing, Digital Signal Processing, Signals and Systems

Communication and Information Theory:
Digital Communication, Network Information Theory, Communication Systems, Communication Lab, Network Theory

Computer Science:
Data Structures and Algorithms, Computer Networks, Computer and Network Security, Computer Graphics, R&D Project, Machine Learning, Computer Programming and Utilization

Mathematics and Others:
Calculus, Linear Algebra, Ordinary Differential Equations, Partial Differential Equations, Complex Analysis, Probability and Random Processes, Data Analysis and Interpretation, Control Systems, EM Waves, Microprocessors, Analog and Digital Circuits, Electronic Design Lab

Technical Skills

Languages	C, C++, Java, Python, MATLAB, VHDL, Assembly, LaTeX
Packages	OpenCV, Ngspice, Git, Quartus, ARM Keil, GNU Radio, Eagle
Hardware	CPLD (Altera MAX V), Intel 8051, Arduino, Raspberry Pi

Leadership Roles

Manager-Projects, Students Technical Activities Body, IIT Bombay (May'16 - Apr'17)

- Shouldered responsibility for evaluation and allocation of student driven socio-technical projects
- Spearheaded collaboration with London School of Economics for their Enactus program and creation of National Innovation Club at IIT Bombay

Department Academic Mentor, IIT Bombay (May'17 - Present)

- Selected among 22 students based on interpersonal skills and academic performance
- Mentoring students with academic backlogs and help them address concomitant social problems

Co-curricular activities

- Volunteer at 'Abhyasika', an initiative which runs tutorials for underpriviledged children to support them in education
- Secured sixth position in Creative Writing Competition in Mood Indigo with entries from all over the world and the essay was published in an anthology (2014)
- Moderator at Brilliant.org, one of the leading websites that provides a community based platform for development of skills in Math and Science for international competitive exams (2014-16)
- Articles **published** in various **print media** (English and Hindi) during the last ten years
- Secured second position in Comic Strip Making, a city level Inter school Competition (2008)
- Secured second position in Creative Writing in Freshiezza, a cultural festival for freshmen (2014)
- Stood third in Mumbai in an inter school quiz competition conducted by Nehru Science Center