Pranav Sankhe

Contact Information

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Research Interests

I am passionate about Audio Processing (Music Perception, Music Transcription), Machine Learning (Bayesian inference, Variational Bayes, Deep Learning Models), Computational Neuroscience (Human Auditory System, Stochastic Neural Models, Perception Models). I am interested in fundamental questions and I enjoy experimenting with all the above fields in one another.

Education

Indian Institute of Technology Bombay, Mumbai, India *July 2015 – Present*

Fourth Year, Dual Degree (Bachelor & Master of Technology), Department of Electrical Engineering
Specialization: *Communication & Signal Processing*

Publications and Patents

- Sankhe, P., Azim, S., Goyal, S., Et al., *Indoor Positioning System using LSTMs over WLAN Network*. Submitted to IEEE ICC 2019 Conference.
- **Patent filed**: "Indoor Positioning System using LSTMs over WLAN Network", December 2018, Indian Patent Office, Mumbai.

Research Internships

Honda Research Institute, Saitama, Japan *Summer 2018*
Sign Language Translation musing Deep LSTM & 3D ResNet Networks
Guide: Dr. Brock Hieke

- Implemented a Sequence to Sequence Neural Network to learn Sign Language translation
- Designed the encoder for motion recognition using 3D Convolutional layers and LSTMs.
- Significantly decreased the computation time by implementing ResNet 3D Convolutions
- Used 2 channel Optical Flow of the videos as the input for the learning architecture

Arrow AI, A Mumbai based AI Start-Up *Dec'16-Jan'17*
Developing APIs for commercial applications of *Machine Learning* in *TensorFlow*

- Developed and implemented an API for *State Bank of India* which is the largest commercial bank of India, to *estimate expected business capital and time* for new clients
- Designed and developed a *recommendation system* for restaurants using *SVD*
- Implemented an API to scrape transaction details from online PDF bank statements
- Developed an algorithm to estimate the path of consumers in stores using *OpenCV*

SoundREX, A Mumbai based music technology Start-Up *March'16-May'16*

- Creating an immersive experience with personal wristband speakers in music concerts
- Designed a circuit to estimate the location of the user based on the music around

Research Projects

Indoor Localisation System using WiFi Networks and LSTMs
Guide: Prof. Srikant Sukumar, System and Controls, IIT Bombay *January 2016 – August 2018*

- Designed and developed an Indoor Localisation System on WLAN infrastructure
- Designed a WiFi network with Central Access Point and WiFi nodes placed strategically
- Implemented a Deep LSTM Network which estimates the location of a particular WiFi node given the acquired signal data by the WiFi network

- The developed Indoor Positioning is robust and self-adaptable to the changing environmental conditions of the surroundings.
- Achieved state of art accuracy of $5cms$ on a range of $10m$ significantly advancing the previous state of art accuracy which was $40cms$

Polyphonic Transcription for Percussive Recordings
Guide: Prof. Preeti Rao, Electrical Engineering, IIT Bombay *August'18 - Present*

- Implemented a transcription system for drums recordings using Non-Negative Matrix Factorization and achieved an F-measure of 0.66 on the IDMT-SMT drum dataset
- Developing a Neural Network based transcription model for transcription of Tabla recordings [Indian classical percussive intrument]
- Using CNN based acoustic model and LSTMs for sequential modeling to develop an end to end transcription system

Tempo Estimation of music recordings from correspoding EEG signals
Guide: Prof. Gaurav Kasbekar, Electrical Engineering, IIT Bombay *July'17 - Dec'17*

- Applied onset detecting techniques on EEG recordings to extract the tempo of the corresponding music stimulus
- Implemented tempogram estimation using autocorrelation technique assuming EEG as the novelty curve
- Estimated the tempo of the music recordings upto an accuracy of 1 bpm from the EEG data

Corrupted Speech Processing using Perceptive Models and Spiking Neural Networks
Guide: Prof. Udayan Ganguly, Electrical Engineering, IIT Bombay *August'18 - Dec'18*

- Implemented a Source Separation system using auditory input representations inspired from human auditory system
- Implemented a 2 layer Spiking Neural Network to generate a binary mask to separate speech from the background noise
- Achieved separation of speech from noise and synthesized source audio by applying the learned mask on the original audio input

Generating Adversarial attacks on Image Segmentation Neural Networks
Guide: Prof. Dawn Song,Berkeley Artificial Intelligence Research Lab *Sept'17 - Feb'18*

- Generated adversarial attacks on the state of art image segmentation algorithm which uses dilated residual neural networks
- Implemented the universal adversarial generation algorithm known as Dense Adversary Generation algorithm to generate examples to fail the segmentation output
- Achieved an accuracy drop from 68.28 % to 8.06% thus pointing at the loopholes in the state of the art segmentation network

Developing a complete TV Audience evaluation system
A problem statement given by BARC India as a part of 7^{th} Inter IIT Tech Meet *Dec'18*

- Implemented a computer vision based automatic channel logo detector
- Implemented and demonstrated an audio recognition system using the audio fingerprinting technique for recognizing advertisements
- Developed an audio-based classifier to identify TV content vs advertisement
- Secured bronze medal (3rd position) among the 22 teams

Imaging Sun at Microwave and Radio Frequencies
Guide: Prof. Raghunath Shevgaonkar, Electrical Engineering, IIT Bombay *Oct'16-May'17*

- Studied the propagation of *Electromagnetic Waves* in the plasma environment in the *solar corona* and obtained trajectory of rays in the Coronal atmosphere

- Obtained the plot of sun's temperature profile using the trajectory of the electromagnetic beam and *Radiative Transfer Theory*

Member of Advitiya
Advitiya is the 2nd student satellite of IITB, technically advanced and efficient version of the 1st, Pratham *Apr'17-Present*

- Critically analyzed Astronomical Image Processing and *Image Compression Algorithms* to decide the optimum algorithm based on parameters like compression ratio and computation time.
- Wrote *Embedded C* code to enable *ISP* programming of on-satellite microcontrollers using a master microcontroller to be able to reprogram and tweak the software while the satellite is in orbit

Modelling High Electron Mobility Transistors with Parasitic Capacitance
Guide: Prof. Dipankar Saha, Electrical Engineering, IIT Bombay *Apr'16-Oct'16*

- Analysed *fringing effects* to model the resulting parasitic capacitance at scales of 10^{-12}
- Modelled the current-voltage characteristics of *high frequency transistors* to emphasize the significance of parasitic capacitance in their performance
- Established *techniques* to *reduce the transistor switching delay* introduced due to parasitic capacitance

Course Projects

Bayesian Speaker Verification using Heavy Tailed Priors *EE 761: Advanced Concentration Inequalities*
Guide: Prof. Jayakrishnan Nair, Electrical Engineering, IIT Bombay *Autumn 2018-19*

Investigated change in the performance of the speaker verification system by using heavy-tailed priors instead of Gaussian priors. Variational Bayes method was used to evaluate the posterior probabilities and compute the likelihoods. Paper: *"Bayesian Speaker Verification with Heavy-Tailed Priors" by Patrick Kenny, CRIM.*

Speech Enhancement using Weiner Filter *EE638: Estimation and Identification*
Guide: Prof. Debraj Chakraborty, Electrical Engineering, IIT Bombay *Autumn 2018-19*

We implemented Spectral Subtraction and Wiener Filtering for noise suppression in speech signals and performed a comparative analysis of both these methods to comment on their peculiarities

Evaluation of Robustness of Neural Nets *EE 769: Machine Learning*
Guide: Prof. Amit Sethi, Electrical Engineering, IIT Bombay *Spring 2017-18*

We implemented and compared few adversarial example generation algorithms to prove that the defensive distillation security for neural networks is not secure for certain attack algorithms. Paper: *"Towards Evaluating the Robustness of Neural Networks" by Nicholas Carlini David Wagner, University of California, Berkeley*

Exploring Wavelet Transfrom inspired MIR techniques *EE638: Digital Signal Processing*
Guide: Prof. Vikram Gadre, Electrical Engineering, IIT Bombay *Spring 2017-18*

We explored wavelet transform inspired techniques for tempo extraction from audio signals

Single Image Haze Removal Using Dark Channel Prior *CS663: Digital Image Processing*
Guide: Prof. Suyash Awate & Prof. Ajit Rajwade, CSE, IITB *Autumn 2017-18*

We implemented dehazing of images using dark channel prior. Paper: *"Single Image Haze Removal Using Dark Channel Prior" by Kaiming He, Jian Sun, and Xiaoou Tang.*

PPG Signal Acquisition Module *EE344: Electronic Design Lab*
Guide: Prof. P.C.Pandey, Electrical Engineering, IIT Bombay *Spring 2017-18*

We designed and built a hardware module for faithful acquisition of the PPG signal. We implemented the Baseline Restoration of the signal and auto-LED intensity control. We also provided Bluetooth based connectivity to display the signal on smartphone and laptop

Processor Design *EE309: Microprocessors*
Guide: Prof. Virendra Singh, EE, IITB *Autumn 2017-18*

We designed, simulated and implemented a multi-cycle RISC processor following the LC-3b ISA. Also, we designed and simulated a pipelined RISC processorm using the Little Computer ISA.

Key Talks and Seminars

Sign Language Translation musing Deep LSTM & 3D ResNet Networks *Internship Talk*
Honda Research Institute, Saitama, Japan *July 2018*

I presented results of my summer internship at HRI. The talk included a detailed description of the designed model, discussion of the results future improvisations.

Key Coursework

Electrical Engineering and Computer Sciences

Estimation & Identification, Adaptive & Digital Signal Processing, Speech Processing, Machine Learning, Matrix Computations, Markov Chains and Queuing Systems, Recent Topics in Signal Processing, Advanced Topics in Signal Processing, Science of Information,Learning and Statistics, Advanced Concentration Inequalities, Advanced Probability, Neuromorphic Engineering, Communication Networks, Digital Image Processing

Physics and Mathematics

Differential Equations, Linear Algebra, Complex Analysis, Calculus, Electriocity and Magentism, Quantum Physics

Other

Movement Neuroscience, Mathematical Structures for Systems & Control

Technical Skills

Programming	Python, C/C++, Matlab, Verilog, HTML/CSS, LaTeX
Software Packages	OpenCV
Science Software	Python packages: NumPy, SciPy and Matplotlib, TensorFlow, Scikit-learn
Hardware	*Microprocessors:* 8051, 8085, AVR and PIC and CPLDs, *Embedded Platforms:* Arduino, Raspberry Pi

Extra-curricular activities

Other than my academic interests, I like gardening, trekking, astronomy. I especially enjoy classic rock and hindustani classical music and also people who enjoy my interests. I also love to read and recite classic english/hindi/urdu poetry.