Pranav Sankhe

GENERAL INFORMATION

Nationality: Indian
DOB: 10th January, 1998

CONTACT INFORMATION

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RESEARCH INTERESTS

My research interests include but aren't limited to Time Series Processing (Video Processing, Audio Processing, Wireless Communication, Music Transcription), Machine Learning (Deep Learning Models, Bayesian statistics), Computer Vision and Computational Neuroscience. I am interested in fundamental questions which surround us.

EDUCATION

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

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

PUBLICATIONS

- Pranav Sankhe, *An Information Theoretical Approach Towards the Reconstruction of Tempo from EEG Responses*. Accepted at **CogMIR 2019**. *Awarded the Best Paper Award*
- Pranav Sankhe, Animesh Kumar *Cortical Representations of Auditory Perception using Graph Independent Component Analysis on EEG*. Accepted at **AESOP 2019**.
- Sankhe, P., Azim, S., Goyal, S., Et al., *Indoor Positioning System using LSTMs over WLAN Network*. Accepted at **IEEE WPNC 2019.**
- Agrim Gupta, Pranav Sankhe, Et al., *Predictive Quantization for MIMO-OFDM SVD Precoders using Reservoir Computing Framework*. Submitted to **Wireless Letters.**

PATENTS

- Filed a patent, *"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 using 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

INDUSTRY INTERNSHIPS

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*

RESEARCH PROJECTS

Indoor Positioning System using LSTMs over WLAN Network
Guide: Prof. Srikant Sukumar, System and Controls, IIT Bombay   *Jan'16 – Aug'18*

- QuarterFinalist of India Innovation Challenge conducted by DST & Texas Instruments
- Designed and developed a self-adaptive WiFi based system to localize in indoor environments
- Proposed a set-up of stationary WiFi nodes to model the multipath fading and shadowing effects

- Used an LSTM network for time series modeling of received signal strength values to estimate the distance of a target object from the reference node
- Achieved state of the art accuracy of $5.85cms$ on a range of $10m$ with a confidence interval of 93% significantly advancing the previous state of art accuracy which was $40cms$
- Filed a patent at the Indian Patent Office and submitted a publication at the IEEE WPNC 2019

Information Theory Approach for Music Reconstrution
Guide: Prof. Prasanna Chaporkar, Electrical Engineering, IIT Bombay　　　　　　*Dec'18 - May'19*

- Modeled the process of hearing and measurement of EEG as a non-linear communication channel
- The EEG potential is modeled as a Multidimensional Gaussian Mixture Model
- Used Mutual Entropy(MI) between the input and output to quantify information transfer
- Established bounds on the input stimuli structure for reconstruction
- Identified coherent cortical regions involved in hearing and music perception tasks
- Publication accepted at CogMIR 2019 and awarded the **Best Student Paper** Award

Graph Independent Component Analysis on EEG data to find Auditory Cortical Regions
Guide: Prof. Animesh Kumar, Electrical Engineering, IIT Bombay　　　　　　*Aug'18 - June'19*

- Modelled the recorded brain activity data(EEG) as Graph Structure(adjacency matrix)
- Constructed and applied Graph Independent Component Analysis to find subnetworks which underly the cognitive processes
- Identified the most active subnetwork corresponding to hearing and music perception task and found the results to be in coherence with neuroscientific literature
- Discovered the variation of subnetworks and their weights with change in music stimuli thus providing new insights on music perception
- Publication submitted to AESOP 2019

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
- Implemented the Dense Adversary Generation algorithm to generate adversarial examples
- Achieved an accuracy drop from 68.28 % to 8.06% thus pointing at the loopholes in the state of the art segmentation network

Polyphonic Transcription for Percussive Recordings using Deep CRNNs
Guide: Prof. Preeti Rao, Electrical Engineering, IIT Bombay　　　　　　*Aug'18 - June'19*

- Employed a two-stream network to predict the onsets and tabla *bols* jointly
- Implemented a dual objective Convolutive Recurrent Neural Network for transcription
- CNNs were used to build the acoustic model and Bidirectional LSTMs for sequential modeling
- Augmented the *Tabla Solo Dataset* by varying the beat cycles and tempo of the recordings
- Achieved state of the art F-measure of 0.97 resulting in a near-perfect transcription system
- Achieved an F-measure of 0.66 on drum recordings using Non-Negative Matrix Factorization

Predictive Quantization for MIMO-OFDM SVD Precoders using Reservoir Computing Framework
Guide: Prof. Manoj Gopalkrishnan, Electrical Engineering, IIT Bombay　　　　　　*Aug'18 - May'19*

- Estimated Precoding matrices of MIMO wireless channel using feedback from the receiver
- Implemented a reservoir computing framework to quantize precoding matrices
- The reservoir computing frameworks utilize the temporal correlations in the precoders
- Our approach achieved reduced quantization and lower BER compared to earlier work
- Our approach also significantly reduced the power consumption during transmission
- Publication submitted to IEEE Globalcom 2019

Tempo Estimation of music recordings from corresponding EEG signals
Guide: Prof. Gaurav Kasbekar, Electrical Engineering, IIT Bombay   *July'17 - Dec'17*
- Implemented tempogram estimation using autocorrelation technique on EEG signal
- Evaluated and compared time-frequency representations of EEG and audio signals
- Estimated the tempo of the music recordings to 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   *Aug'18 - Dec'18*
- Implemented a Source Separation system using auditory scene analysis
- Implemented a 2 layered Spiking Neural Network to separate speech from the background noise
- Synthesized source audio by applying the learned mask on the original audio input

Developed a complete TV Audience evaluation system using Computer Vision and DNNs
A problem statement given by BARC India as a part of 7th Inter IIT Tech Meet   *Dec'18*
- Implemented a computer vision based automatic channel logo detector
- Implemented advertisement recognizer system using the audio fingerprinting technique
- Developed an audio-based classifier to identify TV content vs. advertisement
- Secured 3rd position among the 22 teams from all the 22 IITs

Imaging Sun at Microwave and Radio Frequencies
Guide: Prof. Raghunath Shevgaonkar, Electrical Engineering, IIT Bombay   *Oct'16-May'17*
- Obtained trajectory of rays in the solar coronal atmosphere in the plasma environment
- Using trajectory of rays and *Radiative Transfer Theory* obtained the solar temperature profile

Member of Advitiy
Advitiy is the 2nd student satellite of IITB   *Apr'17 – Oct '17*
- Analyzed *Astronomical Image Compression Algorithms* to decide the optimum algorithm
- Implemented *Embedded C* code to enable *ISP* on-satellite programming of microcontrollers

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

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

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 built a hardware module for faithful acquisition of the PPG signal.We implemented the Baseline Restoration of the signal, auto-LED intensity control, and bluetooth screen.

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.

KEY TALKS AND SEMINARS

Sign Language Translation musing Deep LSTM & 3D ResNet Networks *Internship Talk*
CogMIR 2019, New York City, USA   *Aug 2019*

> 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.

An Information Theoretical Approach Towards the Reconstruction of Tempo from EEG Responses   *Conference Presentation*
Honda Research Institute, Saitama, Japan   *July 2018*

> I presented my research work on auditory cognition where we used an information theoretical model.

KEY COURSEWORK

Electrical Engineering and Computer Sciences
> Introduction to Machine Learning, First Course in Optimization, Estimation & Identification, Advanced Topics in Signal Processing, Recent Topics in Signal Processing, Fundamentals of Digital Image Processing, Speech Processing, Matrix Computations, Advanced Probability, Science of Information,Learning and Statistics, Digital Signal Processing, Advanced Concentration Inequalities

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 & COURSES

Programming	Python, C/C++, Matlab, NumPy, SciPy and Matplotlib, TensorFlow, Scikit-learn, OpenCV, HTML/CSS, LaTeX
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. I also love to read and recite classic english/hindi/urdu poetry. I was a convener Convener of Institute Electronics Club where we organized 15+ events. I was part of a team which conducted 3 month long programming workshops for underprivileged kids.