

# [CV] Neeraj Kumar Sharma

BrainHub Fellow  
Learning and Extraction of Acoustic Patterns Laboratory  
Indian Institute of Science (IISc), Bangalore, India

e-mail: [neerajww@gmail.com](mailto:neerajww@gmail.com)  
website: <https://neerajww.github.io>

## RESEARCH OUTLINE

**Keywords:** Speech and audio signal analysis (sampling, analysis, modification, and reconstruction), Time-frequency analysis, and psychoacoustics.

**Thesis title:** Information-rich Sparse sampling of Time-varying Signals

**Abstract** Sound signals such as speech, and birdsongs are composed of time-varying oscillations. Depending on the underlying physical principle used in the generation of the sound, the time-varyingness in the oscillations can range between very high to very low. Interestingly, our auditory system analyzes this time-varyingness to trigger our perception, and cognition. And it does this with a performance which is unparalleled when compared to any sound analyzing system. Motivated to improve the design of sound analysis systems, the thesis contributions are two fold. Firstly, it analyzes time-varyingness in speech signals without assuming any quasi-stationarity (a striking contrast to conventional approaches). It is found that the proposed analysis (and algorithms) lend *analysis-modification-synthesis* of speech in a manner which preserves the naturalness. The results show that non-parametric processing of time-varying attributes in speech may be key in encoding perceived information. Secondly, the thesis proposes an event-triggered sampling (ETS) paradigm to analyze time-varyingness in non-stationary signals, such as speech. In ETS scheme, a sample is drawn from the continuous-time signal whenever a preset event occurs. The analyzed preset events are higher-order zero-crossings of the signal, and the focus is on capturing the time-varyingness in signals using these events. The idea behind proposing using ETS is to approximate the event-locked firing observed experimentally in synapses between inner-hair cells and auditory nerve fibers. ETS results in sub-Nyquist rate samples which are non-equispaced in time. Algorithms are devised to analyze these samples. It is found that processing samples captured via ETS has potential benefits, and performance in estimation of time-varying parameters can outperform that obtained with conventional uniform Nyquist-rate sampling. The areas explored in the research contributing to the thesis include the following.

- sampling theory, signal representations, transforms, and sparse signal processing.
- speech acoustics, auditory processing, and psychoacoustics
- feature extraction, and classification

## EDUCATION

### PhD Scholar

Indian Institute of Science, Bangalore, India  
Advisor: Prof. Dr. Thippur V. Sreenivas, Dept. ECE, IISc

August 2009 - June 2017 (thesis submitted)

### Bachelor of Technology

Instrumentation and Electronics Engineering  
College of Engineering and Technology, Bhubaneswar, India  
CGPA: 9.21/10

August 2005-2009

### 12th Board Schooling

DAV Public School, Unit-8, Bhubaneswar, India  
Percentage: 86%, Central Board of Secondary Education

2003-2005

### 10th Board Schooling

DAV Public School, Unit-8, Bhubaneswar, India  
Percentage: 88%, Central Board of Secondary Education

2002-2003

## ADDITIONAL RESEARCH EXPOSURE

### Visiting Faculty Staff

Speech Learning and Perception Laboratory  
Carnegie Mellon University, Pittsburgh, USA  
Mentor: Prof. Dr. Lori H. Holt

July – Present, 2017

### BrainHub Fellow

Learning and Extraction of Acoustic Patterns Laboratory, IISc  
Mentor: Dr. Sriram Ganapathy

March – Present, 2017

### Project Staff

Large Scale Audio Analytics, Speech and Audio Group, IISc  
Mentor: Prof. Dr. Thippur V. Sreenivas

April – Oct, 2016

**Visiting Researcher****April – July, 2014**

Audition Lab, Ecole Normale Supérieure, Paris, France

Mentor: Dr. Daniel Pressnitzer (ENS, Paris), and Dr. Laurent Daudet (ESPCI, Paris)

**TEACHING ASSISTANTSHIP****Time Frequency Analysis (E9-213)** Jan-May 2012 in IISc. The responsibility involved mentoring on assignments.**Signal Quantization and Compression (E9-221)** Aug-Dec 2011 in IISc. The responsibility involved mentoring on assignments and course project.**RESEARCH MENTORSHIP****May-July 2017** Siddharth Mittal, from IIT Kanpur, on automatic detection of speaker change instants in speech signals.**Jan-March 2016** Shreepad Potadar, from NIT Surathkal, on time-scale modification of speech and audio signals.**Jan-Feb 2016** Anil Sharma, from IIIT Delhi, on scream classification using auditory cortical features.**May-July, 2015** Santhosh Gandreti, from IIT Bhubaneswar, on sound event classification using spectro-temporal analysis.**April-May, 2015** Pawan Kumar Rukmangada, from BMS College Bangalore, on database creation for speaker verification over telephone IVRS.**May-July, 2013** Amrutha Nadarajan, from NIT Trichy, on zero-crossings analysis of speech.**AWARDS**

BrainHub Carnegie Mellon University - IISc Fellowship	2017
IEEE-Eta Kappa Nu (IEEE-HKN) Membership, the honor society of IEEE	2017
IEEE MV Chauhan Paper Contest First Prize Winner	2013
IEEE-IISc Student Branch Best Volunteer Award	2012-13
PhD Scholarship, Ministry of Human Resource and Development, Govt. of India	2009-2015
Finalist in Motorola Scholar Program, Innovative Project Design	2009
Undergraduate Merit Scholarship, Govt. of Odisha	2005-2009
Third Prize in National Level Paper Contest on Renewable Energy, Dhenkanal	2008
Winning entry in the UMO Boycott Bad Design Contest	2008
Selected in State Level Chemistry Olympiad	2004

**GRANTS**

Student Travel Grant Mechanics of Hearing (MoH) to attend MoH Workshop held in Athens	2014
SPIE Officer Travel Grant Student Chapter to attend Leadership Workshop held in Brussels	2014
IEEE Signal Processing Society Student Travel Grant to attend ICASSP held in Kyoto	2012

**PUBLICATIONS**

- Neeraj Sharma, Shreepad Potadar, Srikanth Raj Chetupalli and T. V. Sreenivas, "Mel-Scale Sub-band Modelling for Perceptually Improved Time-Scale Modification of Speech and Audio Signals" (under review), in *Proc. 23rd National Conference on Communications (NCC)*, March 2017, Madras, India.
- Neeraj Sharma, and T. V. Sreenivas, "Event-triggered sampling using signal extrema for instantaneous amplitude and instantaneous frequency estimation", *Elsevier Signal Processing*, 2015.
- Neeraj Sharma, "Time-instant sampling based encoding of time-varying acoustic spectrum", *AIP Conf. Proc. of Intl. Conf. on Mechanics of Hearing*, 2015.
- Neeraj Sharma, Sai Gunaranjan Pelluri, and T. V. Sreenivas, "Moving acoustic source parameter estimation using a single microphone and signal extrema samples", *IEEE Intl. Conf. on Acoustics, Speech, and Signal Processing (ICASSP)*, April 2015, Brisbane, Australia.
- Neeraj K. Sharma and T. V. Sreenivas, "Event-triggered sampling and reconstruction of sparse trigonometric polynomials", *IEEE Intl. Conf. on Signal Processing and Communications (SPCOM)*, July 2014, Bangalore, India.
- Neeraj Sharma and T. V. Sreenivas, "Sparse signal reconstruction based on non-uniform signal dependent samples", *IEEE Intl. Conf. on Acoustics, Speech, and Signal Processing (ICASSP)*, March 2012, Kyoto, Japan.

Manuscripts in preparation:

- Neeraj Sharma, and T. V. Sreenivas, "Time-varying quasi-harmonic modeling of speech".

- Neeraj Sharma, and T. V. Sreenivas, "Multi-component time-varying sinusoidal processing using Higher-Order Zero-Crossings" .
- Neeraj Sharma, and T. V. Sreenivas, "Speech and audio processing using event-triggered sampling of Higher-order Zero-Crossings" .

#### TALKS DELIVERED

- Implications From Audition: Informative Instants for Non-Stationary Signal Analysis, in Five Minutes PhD Thesis Presentation at Workshop on Speech Source Modelling & its Applications, July 2016, Gandhinagar.
- Sound processing , invited talk in Annual Techfest of National Institute of Design, 2015, Mysore.
- Throwing Light into the Tunnel: auditory models and perception, invited talk in Winter School on Speech and Audio Processing (WiSSAP) 2015, held in Gandhinagar, India.
- Detect and Sample: Questioning uniform Nyquist-rate sampling, invited talk in IEEE Day Celebrations, Oct 2013, at IISc.
- Sound signal analysis: Some knowns and unknowns, invited talk in SIAM-IISc Chapter, May 2015, at IISc.
- Understanding Signals, in Knowledge Outreach Programme, at Govt. SKSJTI College, Bangalore, Sept. 2013.
- Meaning of Signal Analysis, in Outreach Programme, at College of Engineering and Technology (CET), Bhubaneswar, Dec. 2012.

#### GRADUATE COURSES

Time-Frequency Analysis, Random Processes, Pattern Recognition and Neural Networks, Adaptive Signal Processing, Matrix Theory, Digital Signal Compression, Non-linear Signal Processing, Stochastic Models for Speech Recognition, and Digital Image Processing.

#### SCIENTIFIC TECHNIQUES

Coding in MATLAB, Python, HTML, Java Script, Shell  
 Operating system usage UNIX  
 Report documentation with  $\text{\LaTeX}$  2 $\epsilon$

#### ADMINISTRATION EXPERIENCE

Co-maintained the Dept. of ECE website in 2014-15  
 Executive Committee Member of IEEE-IISc Student Branch

#### ACADEMIC SERVICE

Reviewer for Elsevier Signal Processing journal, ISCA conference Interspeech in 2015 and 2017, IEEE Signal Processing Letters, IEEE Connect conference 2014, IEEE Signal Processing and Communication (SPCOM) Conference 2012, and Sadhana journal.

Contributed as Organization Committee member in the following events.

- Winter School in Speech and Audio Processing, 2012. This is an annual international school on speech and audio processing.
- Sparse Signal Processing Course, 2012, hosted by IEEE Bangalore Chapter.
- Annual Electrical Sciences Divisional Symposium, 2014, IISc. An annual symposium for graduating students of IISc to talk about their findings and collaborate with industries.
- Open Day, 2012, 2013, 2014. An annual one day event hosted at IISc to make public familiar with activities at the institute.

## REFEREES

**Thippur V. Sreenivas**  
Professor, Dept. ECE  
Indian Institute of Science  
Banglore, India  
e-mail: *tvsvree@iisc.ac.in*

**Sriram Ganapathy**  
Assistant Professor, Dept. EE  
Indian Institute of Science  
Banglore, India  
e-mail: *sriramg@iisc.ac.in*

**Lori Holt**  
Professor, Dept. Psychology  
Carnegie Mellon University (CMU)  
Pittsburgh, US  
e-mail: *loriholt@cmu.edu*

**Daniel Pressnitzer**  
Director, Audition Lab,  
Ecole Normale Supérieure (ENS)  
Paris, France  
e-mail: *Daniel.Pressnitzer@ens.fr*

**Chandra Sekhar Seelamantula**  
Associate Professor, Dept. EE  
Indian Institute of Science  
Banglore, India  
e-mail: *chandra.sekhar@ee.iisc.ernet.in*

**Shihab A. Shamma**  
Professor  
University of Maryland  
Baltimore, US  
e-mail: *sas@isr.umd.edu*