Sattwik Basu

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Education

University of Illinois at Urbana-Champaign, Urbana, IL   *Aug 2022 – Present*
Ph.D. in Electrical and Computer Engineering
- **Coursework:** Machine Learning, Advanced Digital Signal Processing, Vector Space Signal Processing, Information Theory, Optimization, Random Processes
- **Advisor:** Prof. Romit Roy Choudhury

University of Rochester, Rochester, NY   *Aug 2016 – May 2018*
M.S. in Electrical and Computer Engineering
- **Coursework:** Audio Signal Processing, Digital Signal Processing, Deep Learning for Audio, Acoustics, Audio Software Design, Random Processes, Music Recording Technology
- **Advisor:** Prof. Mark Bocko

K.M. Conservatory of Music, Chennai, India   *Oct 2014 – May 2016*
Performer's Certificate in Piano Performance

SRM University, School of Engineering, Chennai, India   *July 2010 – May 2014*
B.Tech. in Electrical and Electronics Engineering

Research Interests

I currently work in Generative Models, primarily diffusion, flows, VAEs, and Markov Chain Monte Carlo methods. My goal is to use these techniques to solve inverse problems in signal processing. Prior to this, my focus was on developing multi-channel adaptive signal processing algorithms for various audio DSP applications.

Research Experience

Diffusion Guidance via Contrastive Learning for Blind Inverse Problems   *Urbana, IL*
University of Illinois at Urbana-Champaign   *May 2025 – Present*
- Developed a diffusion-based framework with contrastively learned likelihood surrogates to solve blind, non-linear inverse problems with non-differentiable or unknown forward operators.
- Applied the method to infer indoor layouts from human trajectories and theoretically justified the InfoNCE-based surrogate. Achieving higher IoU and fewer structural artifacts than baselines.

Solving Inverse problems using Latent Diffusion   *Urbana, IL*
University of Illinois at Urbana-Champaign   *Oct 2024 – May 2025*
- Built a multi-modal indoor layout estimation pipeline using trajectories movement trajectories.
- Trained a VQVAE+GAN and Latent Diffusion to inpaint structural elements from sparse observations.

Non-convex Optimization using Curvature-guided Langevin Monte Carlo   *Urbana, IL*
University of Illinois at Urbana-Champaign   *Jan 2024 – Sept 2024*
- Proposed Curvature-guided Gaussian Smoothing to adapt Langevin dynamics using expected Hessian information for faster, more accurate convergence in non-convex landscapes.
- Applied the method to ML estimation of polynomial chirp mixtures in low SNR. Outperformed classical estimators and standard Langevin variants, especially for higher-order chirps.

Musical Source Counting using Deep Learning   *Rochester, NY*
University of Rochester   *Aug 2017 – Dec 2017*
- Designed a CNN-based model to estimate polyphony in woodwind quartets, improving downstream multi-label instrument classification accuracy from 64% to 83%.
- Demonstrated substantially better polyphony estimation (76.7% vs 56.4%) compared to then state-of-the-art multi-pitch estimation algorithms.

Room Equalization: Bringing a Concert Home *Rochester, NY*
University of Rochester *Mar 2016 – Aug 2017*
- Developed a Room EQ and convolution reverb system using MINT-based inverse filtering and measured binaural impulse responses to recreate concert hall acoustics in home environments.
- Built and evaluated a two-loudspeaker prototype with crosstalk cancellation via subjective listening tests on 15 participants.

Work Experience

Senior Audio DSP Engineer *Novi, MI*
Harman International, HALOsonic Innovation Group *Jan 2022 – June 2022*
- Invented adaptive interference cancellation and online secondary path estimation algorithms to stabilize MFxLMS ANC under music, speech, and changing cabin acoustics.
- Led R&D on LPC-based noise shaping and power scheduling for imperceptible secondary-path estimation, and built MATLAB tools to predict and analyze ANC performance.

Audio DSP Engineer *Novi, MI*
Harman International, HALOsonic Innovation Group *July 2018 – Dec 2021*
- Designed production-grade narrowband ANC and virtual-microphone algorithms for road and engine noise control in underdetermined MIMO setups.
- Provided theoretically grounded optimization algorithms and tradeoff modeling for MIMO ANC systems.
- Developed auto-tuning methods using eigenanalysis to cut ANC tuning time by 70% and implemented advanced audio analysis tools (CQT, Bark filterbanks, variable DFTs, multirate DSP).

Research Intern, Audio Augmented Reality (AR) *Mountain View, CA*
Harman International, Future Experience Group *May 2017 – August 2017*
- Implemented Non-negative Tensor Factorization - and autoencoder-based beamforming/source separation and CNN classifiers on environmental audio for AR use-cases.
- Prototyped an end-to-end auditory AR pipeline to isolate, suppress, and classify target sources in real time.

Publications

Contrastive Diffusion Guidance for Solving Spatial Inverse Problems Sept 2025
S. Basu, C. Amballa, Z. Xu, J. Sampedro, S. Nelakuditi, R. Roy Choudhury
(In submission)

Can NeRFs see without Cameras? May 2025
C. Amballa, **S. Basu**, Y. Wei, Z. Yang, M. Ergezer, R. Roy Choudhury
Advances in Neural Information Processing Systems (NeurIPS), San Diego, 2025

Estimating Multi-Chirp Parameters using Curvature-guided Langevin Monte Carlo Sept 2024
S. Basu, D. Dutta, Y. Wei, R. Roy Choudhury
IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Hyderabad, 2025

Tuning NeRFs to Multipath Wireless Signals Sept 2024
C. Amballa, **S. Basu**, Y. Wei, R. Roy Choudhury
(Preprint)

Study of the Effects of Active Noise Cancellation on Music Playback Sept 2021
S. Basu, J. Tackett, D. Trumpy, Adam Walt, S. Adari
SAE Technical Paper, Noise and Vibration Conference, Grand Rapids, MI, 2021

Musical Polyphony Estimation May 2018
S. Basu, S. Kareer
Audio Engineering Society Convention 144, Milan, 2018

Bringing a Concert Home Oct 2017
S. Basu, S. Kareer
Audio Engineering Society Convention 143, New York, 2017

Patents

A Method for Generating an Imperceptible Stimulus Signal for Online Secondary Path Estimation — Sep 2023
K. Bastyr, **S. Basu**, J. Tackett, D. Trumpy
US Patent App. 18/462,223

An Adaptive Secondary Path Algorithm using IR Fingerprinting for Multichannel ANC Systems — Oct 2022
S. Basu, K. Bastyr, J. Tackett, D. Trumpy, G. Kim, T. Feng
US Patent 12230241

System and Method for Estimating Secondary Path Impulse Response for Active Noise Cancellation — Oct 2022
S. Basu, J. Tackett
US Patent 12249310

Virtual Location Noise Signal Estimation for Engine Order Cancellation — Nov 2021
S. Basu, J. Tackett, D. Trumpy, T. Tousignant, J. May
US Patent 11183166

Teaching Experience

Teaching Assistant — *Urbana, IL*
University of Illinois at Urbana-Champaign — *Jan 2024 – Dec 2025*
- ECE 498/598: Deep Generative Models
- ECE 101: Introduction to Digital Computing

Teaching Assistant — *Urbana, IL*
University of Rochester — *Aug 2016 – Dec 2017*
- ECE 446: Digital Signal Processing
- ECE 140: Introduction to Music Engineering
- ECE 210: Circuits & Microcontrollers

Skills

Languages: Python, MATLAB, C++, C
Deep Learning: PyTorch, Keras, NumPy, SciPy, Scikit-Learn, OpenCV, Librosa
Dev Tools: Microsoft Visual Studio, VS Code, Docker, Git, Jira, LaTeX
Vibroacoustics: HeadAcoustics Artemis
Hardware: TI C66, A15, ADI SHARCs, Function Generators, Oscilloscopes, Audiomatica Clio
Audio Tools: ProTools, AudioMulch, Reaper, GarageBand, Logic, Audacity, Max/MSP, PureData

Awards

Rated **Outstanding** on the University of Illinois List of Excellent Teachers (Spring 2025, Spring and Fall 2024)

Anna-Louise Baker Scholarship for excellence in piano performance, Eastman School of Music, 2017

Tuition scholarship from the Hajim School of Engineering, University of Rochester, 2016