

Sattwik Basu

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Education

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- 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

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- Diffusion Guidance via Contrastive Learning for Blind Inverse Problems** *Urbana, IL*
University of Illinois at Urbana-Champaign *May 2025 – Present*
- Built a diffusion-driven inverse framework for solving blind non-linear inverse problems with non-differentiable and potentially unknown forward operators.
 - Designed a likelihood surrogate using contrastive training to guide a diffusion posterior sampler through non-smooth forward operators (e.g., path-planning algorithms). Theoretically showed that the InfoNCE based-surrogate is a valid approximation of the true likelihood score.
 - Applied this to the spatial inverse problem of reconstructing indoor floorplans using only human movement trajectories as inputs. Outperformed baselines in ablations with higher IoU and fewer structural artifacts.
- Solving Inverse problems using Latent Diffusion** *Urbana, IL*
University of Illinois at Urbana-Champaign *Oct 2024 – May 2025*
- Developing a multi-modal indoor layout estimation framework that uses walk trajectories obtained from audio, IMU, and Wi-Fi data as inputs.
 - Trained a VQVAE (with GAN loss) on building floor plan images with simulated walking trajectories. Next, a Latent Diffusion Model is trained to in-paint structural elements such as walls and doors. The model is evaluated on real-world walk trajectories showing promising performance.
 - Currently expanding the framework to use a Diffusion Posterior Sampler to estimate layouts in areas that were not physically traversed by the user to achieve a more comprehensive reconstruction.
- Non-convex Optimization using Curvature-guided Langevin Monte Carlo** *Urbana, IL*
University of Illinois at Urbana-Champaign *Jan 2024 – Sept 2024*
- Proposed a *Curvature-guided Gaussian Smoothing* optimization strategy that utilizes the expected Hessian of the objective function to dynamically adapt the Langevin sampler, enhancing convergence rates and accuracy in non-convex optimization
 - Applied this technique to a Maximum-Likelihood parameter estimation framework for polynomial chirp

mixtures (audio, RF, biomedical etc.), specifically designed to operate effectively in low SNR environments

- Demonstrated that the estimator outperforms classical signal processing techniques and both Vanilla and Annealed Langevin Dynamics with marked benefits seen in high-order polynomial chirp mixtures

Musical Source Counting using Deep Learning

Rochester, NY

University of Rochester

Aug 2017 – Dec 2017

- Developed a CNN based algorithm for detecting the number of active instruments in polyphonic music (woodwind quartets). This project on music information retrieval aimed at using polyphony estimates to improve performance of downstream tasks such as source separation, audio transcription and others
- Improved performance of multi-label instrument classifiers by using the polyphony estimates from the our model(improved acc. from 64% to 83%)
- Compared results with then SOTA multi-pitch estimation algorithms and demonstrated an increase in accuracy of the polyphony estimates (76.7% vs 56.4%)

Room Equalization: Bringing a Concert Home

Rochester, NY

University of Rochester

Mar 2016 – Aug 2017

- Designed a Room EQ + Convolution Reverb algorithm for recreating concert hall acoustics in home listening environments
- Applied MINT inverse filtering to equalize room frequency response for playback and used measured binaural impulse responses from various concert halls to impress the acoustical properties
- Developed prototypes on a two-loudspeaker system with crosstalk cancellation and carried out subjective evaluation on 15 test subjects

Work Experience

Senior Audio DSP Engineer

Novi, MI

Harman International, HALOsonic Innovation Group

Jan 2022 – June 2022

- Invented adaptive algorithms for real-time music/speech interference cancellation and online secondary path IR estimation to prevent MFxLMS ANC systems from misadapting due to the presence of music/speech signals or changes in cabin acoustics
- Led the R&D efforts on developed LPC based noise shaping and power scheduling techniques to mask the presence of auxiliary noise used in real-time secondary path estimation algorithms
- Developed simulation tools in MATLAB for predicting and analyzing ANC performance

Audio DSP Engineer

Novi, MI

Harman International, HALOsonic Innovation Group

July 2018 – Dec 2021

- Designed a narrowband active road noise cancellation algorithm. Developed mathematical models to theoretically describe the tradeoffs between stepsize, leakage, notch response, and out-of-band noise boosting
- Invented a virtual mic ANC algorithm to reduce engine noise at locations far away from error microphones using an adaptive array processing algorithm. This technology helps in achieving better engine noise control performance in underdetermined MIMO ANC systems with reduced or non-optimum error mic placement
- Led the R&D efforts on auto-tuning algorithms for ANC systems using eigenanalysis of impulse response matrices. Demonstrated improvements in noise cancellation. Reduced total production tuning time by 70%
- Developed audio/speech analysis tools using CQT & Bark filterbanks, Variable Size DFTs & multirate DSP

Research Intern, Audio Augmented Reality (AR)

Mountain View, CA

Harman International, Future Experience Group

May 2017 – August 2017

- Implemented beamforming and source separation algorithms using Non-negative Tensor Factorization (NTF) and Autoencoders, 8-9 dB SDR on speech/audio mixtures
- Developed CNN based audio classifiers using log-mel spectrogram inputs on the UrbanSounds8K dataset. Additionally tested SVMs using MFCC features as a comparative baseline
- Prototyped an auditory AR system pipeline to selectively separate/suppress audio sources and classify individual speech sources using Deep Learning

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, L^AT_EX

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