

Sattwik Basu

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Education

University of Illinois at Urbana-Champaign , Urbana, IL <i>Ph.D. in Electrical and Computer Engineering</i>	<i>Aug 2022 – Present</i>
◦ 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 <i>M.S. in Electrical and Computer Engineering</i>	<i>Aug 2016 – May 2018</i>
◦ 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 <i>Performer's Certificate in Piano Performance</i>	<i>Oct 2014 – May 2016</i>
SRM University, School of Engineering , Chennai, India <i>B.Tech. in Electrical and Electronics Engineering</i>	<i>July 2010 – May 2014</i>

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 <i>University of Illinois at Urbana-Champaign</i>	<i>Urbana, IL</i> <i>May 2025 – Present</i>
◦ 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 <i>University of Illinois at Urbana-Champaign</i>	<i>Urbana, IL</i> <i>Oct 2024 – May 2025</i>
◦ 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 <i>University of Illinois at Urbana-Champaign</i>	<i>Urbana, IL</i> <i>Jan 2024 – Sept 2024</i>
◦ Proposed a <i>Curvature-guided Gaussian Smoothing</i> 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

University of Rochester

Rochester, NY

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

University of Rochester

Rochester, NY

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

Harman International, HALOsonic Innovation Group

Novi, MI

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

Harman International, HALOsonic Innovation Group

Novi, MI

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)

Harman International, Future Experience Group

Mountain View, CA

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/supress audio sources and classify individual speech sources using Deep Learning

Publications

Contrastive Diffusion Guidance for Solving Spatial Inverse Problems S. Basu , C. Amballa, Z. Xu, J. Sampedro, S. Nelakuditi, R. Roy Choudhury (In submission)	Sept 2025
Can NeRFs see without Cameras? C. Amballa, S. Basu , Y. Wei, Z. Yang, M. Ergezer, R. Roy Choudhury Advances in Neural Information Processing Systems (NeurIPS), San Diego, 2025	May 2025
Estimating Multi-Chirp Parameters using Curvature-guided Langevin Monte Carlo S. Basu , D. Dutta, Y. Wei, R. Roy Choudhury IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Hyderabad, 2025	Sept 2024
Tuning NeRFs to Multipath Wireless Signals C. Amballa, S. Basu , Y. Wei, R. Roy Choudhury (Preprint)	Sept 2024
Study of the Effects of Active Noise Cancellation on Music Playback S. Basu , J. Tackett, D. Trumpy, Adam Walt, S. Adari SAE Technical Paper, Noise and Vibration Conference, Grand Rapids, MI, 2021	Sept 2021
Musical Polyphony Estimation S. Basu , S. Kaireer Audio Engineering Society Convention 144, Milan, 2018	May 2018
Bringing a Concert Home S. Basu , S. Kaireer Audio Engineering Society Convention 143, New York, 2017	Oct 2017

Patents

A Method for Generating an Imperceptible Stimulus Signal for Online Secondary Path Estimation K. Bastyr, S. Basu , J. Tackett, D. Trumpy US Patent App. 18/462,223	Sep 2023
An Adaptive Secondary Path Algorithm using IR Fingerprinting for Multichannel ANC Systems S. Basu , K. Bastyr, J. Tackett, D. Trumpy, G. Kim, T. Feng US Patent 12230241	Oct 2022
System and Method for Estimating Secondary Path Impulse Response for Active Noise Cancellation S. Basu , J. Tackett US Patent 12249310	Oct 2022
Virtual Location Noise Signal Estimation for Engine Order Cancellation S. Basu , J. Tackett, D. Trumpy, T. Tousignant, J. May US Patent 11183166	Nov 2021

Teaching Experience

Teaching Assistant <i>University of Illinois at Urbana-Champaign</i>	<i>Urbana, IL</i> <i>Jan 2024 – Dec 2025</i>
○ ECE 498/598: Deep Generative Models ○ ECE 101: Introduction to Digital Computing	
Teaching Assistant <i>University of Rochester</i>	<i>Urbana, IL</i> <i>Aug 2016 – Dec 2017</i>
○ 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 SHARC^s, 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