Annesya Banerjee

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Research Interests: Auditory Perception, Hearing Prostheses, Computational Neuroscience

Education

2021 – 2027   **PhD Candidate, Harvard University**
Program in Speech and Hearing Bioscience and Technology (SHBT)
Thesis Advisor: Dr. Josh McDermott

2017 – 2021   **Bachelor of Engineering, Jadavpur University**
Department of Electronics and Tele-Communication Engineering (ETCE)

Research Experience

June'22 – Present   **Graduate Research Assistant**, Dept. of Brain and Cognitive Sciences, MIT
Advisor: Dr. Josh McDermott
Developing neural network based models to accurately simulate cochlear implant (CI) mediated hearing perception. The goal of this work is to disentangle the roles of signal processing and brain plasticity in shaping CI perception, understand the factors behind large variability in patient outcomes, and utilize the model to propose improved stimulation strategies for future CIs.

Jan.'22-May'22   **Rotation Student**, Massachusetts Eye and Ear, Harvard Medical School
Advisor: Dr. Heidi Nakajima
* Designed a piezo-electric film based middle-ear microphone to sense acoustic signals for a fully-implantable cochlear implant.
* Tested the microphone prototype on multiple human cadaveric temporal bones for stability, sensitivity and frequency response analysis.
* Developed the MATLAB code for experimental result analysis and comparison to commercially available microphones.

July.'21-Dec.'21   **Rotation Student**, Massachusetts Eye and Ear, Harvard Medical School
Advisor: Dr. Sunil Puria
* Contributed in developing the Python code for using the Simulation Based Inference (SBI) toolbox to estimate the parameters of finite element models of the middle and inner ear.
* Developed the MATLAB code to compare the estimated results with experimental data using different error metrics and for different inference algorithms.

May'19-July'19   **Undergraduate Research Intern**, Indian Institute of Science (IISc)
Advisor: Dr. Prasanta K. Ghosh
* Designed and implemented the prototype of a multichannel acoustic array system to be used for adventitious lung sound localization.
* Developed the MATLAB code for filtering the DC and ADC noise from the recorded signals as well as compensate for the hardware related non-linearity.

Jan.'19 – June'21   **Undergraduate Research Assistant**, Jadavpur University
Advisor: Dr. P. Venkateswaran
* Developed the entire hardware and software system of a drone with capabilities to capture sound, perform on-board computation and identify the azimuth and elevation location of the sound source(s) relative to the drone position.
* Demonstrated the utility of the drone system to aid in search and rescue operations during low visibility conditions.
* Extended the work to incorporate 5G communication in the drone system.

Teaching Experience

Sept.'22 – Dec.'22   **MIT Brain and Cognitive Sciences**, Teaching Assistant
MIT BCS 9.016 *Introduction to Sound, Speech, and Hearing*
Instructors: Dr. Satrajit Ghosh, Dr. Heidi Nakajima, Dr. Sunil Puria

Technical Skills

Machine Learning	Tensorflow, PyTorch
General Coding	Python, MATLAB, C, LaTeX, SLURM
Behavioral Research	Amazon Mechanical Turk, Prolific, PsychToolbox
Hardware Design	Microcontrollers (8051, Arduino), Raspberry Pi, Texas Instruments (TI), Digital Signal Processing (DSP) Kit, Analog Devices Analog-Digital-Converters (ADC)
Design Tools	Anaconda, Circuit Maker, Proteus, Xilinx Vivado Suite, COMSOL
Audio Analysis Tools	Audacity, PRAAT

Awards and Achievements

2021   **Division of Medical Sciences Graduate Student Fellowship**, Harvard University.

Best Student of the Year 2021 Gold Medal, Jadavpur University.

Best Outgoing Female Student (Runner Up), IEEE SAARC Countries

Dept. of Electronics and Telecommunication Engg. Gold Medal, Jadavpur University

2019   **Supriya Kumar Basu Memorial Fellowship**, Jadavpur University
(Awarded to the Top Rank Holder across all Engineering departments.)

2017   **Jagadish Bose National Science Talent Search Senior Fellowship**
(Awarded to 30 students chosen Nationally through a highly competitive three-level examination to support their Undergraduate education.)

Grants Awarded

2021-2022   **5G-enabled Listener Drone: Integrating 5G with Acoustic Drone for Disaster Relief**
Department of Telecommunication, Govt. of India
Amount: INR 6,00,000

2020   **Design of Portable Ventilators for COVID-19 Crisis**
University of California, Berkeley, USA
Amount: USD 1,000

2019-2020   **Listener Drone: Incorporating Audition Abilities in Drones and Its Potential Application for Search and Rescue Operations**
WeRobotics, USA
Amount: USD 15,000

Research Publications

2023   Zhang, J., Graf, L., **Banerjee, A.**, Yeiser, A., McHugh, C., Kymissis, J., Olson, E., Nakajima, H., Lang, J., 2023. An Implantable Piezofilm Middle Ear Microphone: Performance in Human Cadaveric Temporal Bones. *Journal of the Association for Research in Otolaryngology (JARO)*. [Submitted]

Research Publications (continued)

2021   ▌   **Banerjee, A.**, Nilhani, A., Dhabal, S., Venkateswaran, P., 2021. A novel sound source localization method using a global-best guided cuckoo search algorithm for drone based search and rescue operations. *In Unmanned Aerial Systems: Theoretical Foundation and Applications*, pp. 377-417. Academic Press.

Patents

2022   ▌   **Annesya Banerjee**, Achal Nilhani. An intelligent cough and speech sensing visual monitoring device. Intellectual Property Rights of India #399949

Research Presentations

2023   ▌   **Banerjee, A.**, Saddler, M., McDermott, J. (February, 2023). Neural Network Models of Hearing Through a Cochlear Implant. *46th Mid-Winter Meeting - Association for Research in Otolaryngology (ARO)*, Orlando, Florida. **[Poster]**

2022   ▌   Zhang, J.*, Yeiser, A.*, **Banerjee, A.***, Cary, B., Graf, L., McHugh, C., Kymissis, J., Olson, E., Nakajima, H., Lang, J. (July, 2022). A Comparison of Implantable Microphones Constructed Around a Piezoelectric Polymer. *14th Mechanics of Hearing (MoH) Meeting*, Helsingør, Denmark. *equal contributions. **[Talk]**

       ▌   Yeiser, A.*, **Banerjee, A.***, Zhang, J., Graf, L., McHugh, C., Song, Y., Kymissis, J., Olson, E., Nakajima, H., Lang, J. (June, 2022). Implantable Piezoelectric-Polymer Microphones for the Middle Ear. *9th International Symposium on Middle Ear Mechanics in Research and Otology (MEMRO)*, Boulder, Colorado. *equal contributions. **[Talk]**

       ▌   Motallebzadeh, H., Deistler, M., Schönleitner, F., **Banerjee, A.**, Macke, J., Puria, S. (June, 2022). Training a Machine-Learning Differential Diagnostic Tool for Conductive Hearing Loss Using Mechanistic Models. *9th International Symposium on Middle Ear Mechanics in Research and Otology (MEMRO)*, Boulder, Colorado. **[Talk]**

       ▌   **Banerjee, A.**, Saddler, M., McDermott, J. (October, 2022). Neural Network Models of Hearing Through a Cochlear Implant. *Harvard University SHBT End of Summer Talk*, Falmouth, MA. **[Talk]**

2020   ▌   **Banerjee, A.**. (October, 2020). 5G enabled drone system with audition capabilities - application in search and rescue operations. *Dept. of Telecommunications, India - India Mobile Congress*. (Virtual due to Covid). **[Talk]**

       ▌   **Banerjee, A.**. (July, 2020). Ways to continue scientific research amidst global pandemic. *Overseas Volunteers for a Better India (OVBI) Foundation* - Virtual. **[Invited Talk]**

       ▌   **Banerjee, A.**. (February, 2020). Listener Drone for Search and Rescue Operations. *WeRobotics Unusual Solutions Final Pitch Event*, Nairobi, Kenya. **[Talk]**

Outreach/Leadership Activities

2023   ▌   **Mentoring Co-Chair**, Harvard Graduate Women In Science and Engineering

       ▌   **Seminar Coordinator**, Science In The News

       ▌   **Teaching Assistant**, Program of Ragon and IMES in Science and Medicine
Topic - Introduction to Neuroscience; Target Audience - High School students.

2022   ▌   **Volunteer**, Cambridge Science Festival
Demonstrated and explained the science of auditory illusions to general public.

2020 – Present

Co-Founder, JU UAV Innovators' Lab
Non-profit educational organization to provide scientific (software and hardware) resources to students for open-source project development.

2020 – 2021

Student Engagement Speaker, Jyangra High School
Talk Title: Drones and Humans - An Application Perspective.

2019 – 2021

Team Leader, Team Jadavpur University
IEEE Signal Processing Cup 2019 (Rank: 13); IISc DiCOVA Challenge 2021 (Rank: 16); Microsoft Deep Noise Suppression Challenge 2021 (Rank: 14)
Technical Leader, Team CoVentilator
UC Berkeley CEND Hackathon 2020 (Winner)

2018 – 2021

Mentor, Jadavpur University Science Club
Mentored 150+ freshmen, sophomores in learning robotics, circuit design, programming, etc.

Organizing Member, Annual Science Workshop, Jadavpur University
Hosts 100+ high school students annually for 2 days workshop on experimental physics, chemistry, basic robotics.

Personal Projects

April'20 – June'21

Viral Cough Cop Device: An intelligent, **low-cost (under $135)** device for first-level screening and identification of potential COVID-19 suspects in public places. Project selected as one of the **Top 32 Global Finalists** of *Microsoft* and *HCL* organized Better Health Hackathon 2020.

Feb.'21 – May'21

Moog-Emotion: A personalized musical instrument to recognize human emotion through speech and play mood-lifting music. Assistive device for healing mental stress, depression and other psychological disorders.
Project selected for demonstration at **Guthman Musical Instrument Fair 2021** organized by *Georgia Institute of Technology*. Received **Best Hardware Project** and **Best Presentation Award** by *Syracuse University*.
Project blog at: https://devpost.com/software/moog-emotion

Aug.'20 – Oct.'20

AuDiNoise: A deep learning based hybrid filtering approach for acoustic noise suppression. : Developed a deep learning + adaptive filtering based hybrid algorithm for joint estimation and suppression of non-stationary background noises from audio signals during teleconferencing.

Aug.'20 – Nov.'20

Echo Debar: Real-Time Acoustic Echo Cancellation by Joint Implementation of Adaptive Filtering and Deep Learning: Developed a novel acoustic echo cancellation algorithm that uses classical signal processing filters combined with deep learning models for real-time echo cancellation in telecommunication devices.

March'20 – May'20

COVENTILATOR: Development of Low-Cost Ventilators for Patients during COVID-19 Pandemic: Worked as the Technical Leader in an *international* team of 6 members. Designed a **low-cost (<$300), easily deployable, medical grade** ventilator system for COVID-19 patients. Available at only 1/10th the cost of ICU ventilators. Our design was selected as the **Winner Project** by *University of California Berkeley* at CEND Hackathon 2020.