Dr. Amita Giri

Postdoctoral Associate, MIT
Cambridge, USA
amita3gb@mit.edu http ://amitagiri-mcgovern.mit.edu/

I am currently a Postdoctoral Associate at MIT's McGovern Institute for Brain Research, specializing in computational neuroscience and signal processing. My research focuses on developing novel mathematical MEG/EEG brain source localization algorithms with primary applications in understanding the human brain, disease diagnosis, and the advancement of brain-computer interface (BCI) technologies. By deepening our understanding of the human brain, my work aims to make a meaningful impact on individuals facing neurological challenges.

Research Interests

- Biomedical Signal Processing
- Computational Neuroscience
- Brain source imaging or mapping
- Brain Computer Interface (BCI)
- Machine Learning/Deep Learning

Research Experience

Massachusetts Institute of Technology (MIT) *Cambridge, USA*

July 2022 - Present

- Postdoctoral associate at the McGovern Institute for Brain Research at MIT.
- Currently working on an NIH-funded project titled "Development of novel MEG source localization methods to resolve the computational steps of human face perception".
- Acquired expertise in MEG and fMRI neuroimaging modalities, through training and research conducted at the Athinoula A. Martinos Imaging Center at MIT.
- Successfully completed data acquisition from 19 subjects, for this project, and the preliminary findings were presented at the "MEG in Action" symposium.
- Involved in a BCI project titled "Deep Learning-Enabled EEG Decoder for Swift and Accurate Hand Kinematics Reconstruction in Grasp and Lift Tasks".

Education

Indian Institute of Technology (IIT) Delhi *New Delhi, India*

July 2017 - Mar 2022

- Ph.D. at the Department of Electrical Engineering at Indian Institute of Technology (IIT) Delhi with 8.85/10 CGPA.
- Recipient of the prestigious **Prime Minister's Research Fellowship (PMRF)**, awarded to the country's excellent doctoral candidates for pursuing their research.
- My dissertation "Spatial and Anatomical Harmonics Domain based Brain Source Localization" is structured around two poles : a fundamental research pole and an applied research pole.
- Fundamental research pole (FRP) : I worked on developing novel low computational cost brain source localization algorithms to localize the location of neurological disorder epileptic seizures using non-invasive EEG signals. I used the knowledge of advanced signal processing to transform forward and inverse data models into spherical and head harmonics domains to achieve low computational cost and high localization accuracy.
- Applied research pole (ARP) : The enhanced spatial and temporal information from FRP is used to unravel the mechanism of neuromuscular disabilities and human motor learning abilities to facilitate and support communication between human and machines. For system development, the conventional classification based BCI controls external devices by providing discrete control signals to the actuator. Novel deep learning models are developed for continuous decoding of hand kinematic parameter from EEG signal for practical BCI applications.

National Institute of Technology (NIT) Uttarakhand *Uttarakhand, India*

July 2013 - July 2017

- Honored as a **Distinguished Alumnus** by my Alma Mater.
- Bachelors in the Department of Electronics & Communication Engineering with 9.1/10 CGPA.
- Exhibited a strong passion for subjects like Digital Signal Processing, Image Processing, Digital Communication, and Electronic System Design, achieving a perfect CGPA of 10/10 in these courses.
- Completed an advanced course ECL420 : Human and Machine Speech Communication with AA Grade 10/10 CGPA.
- Successfully completed an undergraduate research project on the topic of "The Impact of Different Types of Music on Cognitive Control in Healthy Young Adults."

Projects

Pantazis Lab : MIT

Cambridge, USA

July 2022 - Present

- **F-ratio-based Approach for Enumerating the Number of Active Sources in MEG** - I developed a robust method for accurately estimating the number of active sources in the brain based on the F-ratio statistical approach, which allows for a comparison between a full model with a higher number of sources and a reduced model with fewer sources. The method demonstrated superior performance over existing state-of-the-art statistical approaches, such as the AIC and MDL.
- **Patch based localization of realistic cortical activity** - The current dipole model allows for a small number of unknown parameters but leads to solutions that are oversimplified, sometimes ambiguous and, in the case of extended sources, often erroneous due to inadequate modeling. I am developing a novel patch based flexible source model that avoids making any assumptions about the nature of the source.
- **Deep Learning-Enabled EEG Decoder for Hand Kinematics Reconstruction** - A novel deep-learning model is developed, which utilizes brain data that accounts for the neural processing delay between planning and execution of a motor task. Our proposed model surpasses existing techniques in terms of both reconstruction accuracy and efficiency, representing a significant advancement in the BCI field.
- **Computational Steps of Human Face Perception** - The perception of face characteristics such as gender, age, and identity carried out in a cascade of face-selective cortical areas in the ventral visual pathway. I am working on developing a source localization method, which can localize even highly correlated sources in time, as in the case of face areas.

Multichannel Signal Processing Lab & Neurocomputing Lab : IIT Delhi

New Delhi, India

July 2017 -March 2022

- **FRP : Brain Source Localization in Head Harmonics Domain** - To prevent delay in the diagnosis of epileptic seizure location, a low computational cost brain source localization method is developed. A set of basis functions called Head Harmonics (H^2) is developed, which improves the quality of non-invasive source localization method when compared to spherical or conventional spatial domain processing. The basis functions are formulated mathematically based on a realistic head dimension.
- **FRP : Anatomical Surface Reconstruction** - An accurate representation of a three-dimensional (3D) geometry is crucial for structural analysis in many biomedical applications. The two hemispherical area-preserving parameterization methods for simply-connected open and closed surfaces are developed. The hemispherical harmonics basis functions are utilized to yield an accurate representation of hemisphere-like anatomical surfaces such as brain, skull and scalp.
- **ARP : Cortical Source Domain based Brain Computer Interface (BCI)** - In BCI, decoding the motor task from non-invasive EEG measurements is a challenging problem. It is due to the fact that encoding is assumed to be deep within the brain and is not easily accessible by the scalp recordings. To overcome these issues and to study the brain activity on the motor cortex, cortical source domain processing is proposed. Our finding emphasize to use the spatial source distribution knowledge in neuro-feedback training of BCI systems.
- **ARP : Wearable Upper Limb neuroprosthetics for Muscle Augmentation with BCI Interface** - The ability to reconstruct the kinematic parameters of hand movement in motor impaired patients using non-invasive EEG is essential for translational application of BCI. We proposed three novel state-of-the-art deep learning models i.e. multi layer perceptron (MLP), convolutional neural network-long short term memory (CNN-LSTM), and wavelet packet decomposition (WPD) CNN-LSTM for motion trajectory prediction (MTP) with BCI interface. The project is sponsored by Defence Research and Development Organisation (DRDO), Government of India.

Workshops & Invited Talks

- **MEG in Action Symposium** - Gave a talk entitled “An F-ratio-Based Method for Estimating the Number of Active Sources in MEG’ at the MEG in Action Symposium at MIT.
- **Brain Mapping & Artificial Intelligence Workshop 2022** - Invited as a keynote speaker at the Brain Mapping and Artificial Intelligence Workshop 2022, where I presented my work on ”Sensor vs Source Domain BCI”.
- **DRDO Young Scientist Laboratory (DYSL-AT)** - Invited as a speaker to deliver a talk titled ”Brain Source Localization for BCI Applications” at a seminar on BCI and its applications in DRDO.
- **Brain Mapping & Artificial Intelligence Workshop 2018** - Organised Brain Mapping & Artificial Intelligence Workshop at IIT Delhi. The focus of the workshop is to understand the science of brain intelligence and how to translate those knowledge into machine domain.
- **Brain, Computation and Learning** - Attended Brain, Computation and Learning workshop at Indian Institute of Science (IISc) Bangalore. Prominent goal of the workshop is to promote synergistic interactions among neurobiologists and computer scientists.

Achievements

2022 **PMRF Academic Excellence Award**, Acknowledged for exceptional performance among all PMRF fellows and invited to present my research at the PMRF convention in the presence of the Prime Minister.

2021 **Best Paper Award ICACCT-2021**, Our paper titled "Subspace Principal Vector Projection Technique based Interference Suppression for BCI Application" received the Best Paper Award at the International Conference on Advances in Communication & Computing Technology (ICACCT-2021).

2021 **Summer Undergraduate Research Award (SURA)**, Two undergraduate students at IIT Delhi, who worked under my supervision on EEG prototype design, received the SURA recognition.

2018 **Prime Minister's Research Fellow (PMRF)**, Honored with the prestigious Prime Minister's Research Fellow title, awarded to exceptional doctoral candidates in the country.

2017 **IIT Delhi MHRD Fellowship**, Awarded the scholarship by the Department of Higher Education, Ministry of Human Resource Development (MHRD), to pursue high-impact research.

2017 **State Government Academic Excellence Award**, Recognized with the State Government Academic Excellence Award for all four years during my Bachelor's degree.

2014 **L'oreal India for Young Women in Science**, Received the fully-funded L'Oreal India For Young Women in Science Scholarship, recognizing excellence in undergraduate studies.

2017 **Distinguished Alumni Award**, Honored with the Distinguished Alumnus Award of Class 2017 by NIT Uttarakhand.

2013 **Gold Medalist in 12th Standard**, Achieved the highest percentage of 90% in the science stream (Physics, Chemistry, and Mathematics), receiving a Gold Medal in 12th grade.

2012 **2nd State Rank in Mathematics Olympiad**, Secured the 2nd State Rank and 88th International Rank in the International Mathematics Olympiad.

2011 **Gold Medalist in 10th Standard**, Awarded a Gold Medal in 10th grade for achieving the highest CGPA of 10/10 in the science stream.

Teaching

Teaching Assistant

2021 **Spring 2021**, ELL 319 Digital Signal Processing
2020 **Autumn 2020**, ELL 824 Selected Topics in Information Processing II
2020 **Spring 2020**, ELL 319 Digital Signal Processing
2019 **Autumn 2019**, ELL 100 Basic Electrical Engineering
2019 **Spring 2019**, ELL 319 Digital Signal Processing
2018 **Autumn 2018**, ELL 319 Digital Signal Processing
2017 **Autumn 2017**, ELL 319 Digital Signal Processing

Master Students Thesis Mentor

2019 **Autumn 2019**, Boundary Element Forward Data model
2018 **Autumn 2018**, Study mathematical equations of forward model

Undergraduate Project Mentor

2021 **Spring 2021**, SURA Research Proposal : EEG prototype for Active Brain source localization
2019 **Summer Break 2019**, Cortical source domain based framework for Brain Computer Interface Applications
2019 **Spring 2019**, Interference suppression in EEG source Analysis
2018 **Summer Break 2018**, Comparative analysis of various brain source localization method
2018 **Spring 2018**, Dipole Source Localization

Technical Skills

Programming Languages

- Python
- MATLAB

Neuroimaging Modalities

- Electroencephalography (EEG)
- Magnetoencephalography (MEG)
- Functional magnetic resonance imaging (fMRI)

Publications

International Journal

2023 **Frontiers in Human Neuroscience**, Amita Giri, John C Mosher, Amir Adler and Dimitrios Pantazis, "An F-ratio-Based Method for Estimating the Number of Active Sources in MEG" Frontiers in Human Neuroscience Vol. 17 (2023) doi : 10.3389/fnhum.2023.1235192 (in preprint)

2022 **Nature - Scientific Reports**, Amita Giri, Lalan Kumar, Nilesh Kurwale and Tapan Kumar Gandhi, "Anatomical Harmonics Basis based Brain Source Localization with Application to Epilepsy" Nature, Scientific Reports 12, no. 1 (2022) : 1-14.

2022 **IEEE Transactions on Cybernetics**, Sidharth Pancholi, Amita Giri, Anant Jain, Lalan Kumar, and Sitikantha Roy, "Source Aware Deep Learning Framework for Hand Kinematic Reconstruction using EEG Signal" in IEEE Transactions on Cybernetics, 2022 doi : 10.1109/TCYB.2022.3166604.

2021 **IEEE Sensors Letters**, Amita Giri, Lalan Kumar and Tapan Kumar Gandhi, "Cortical Source Domain Based Framework For Enhanced Brain Computer Interface Applications" vol. 5, No. 12, 2021

2021 **Computers in Biology and Medicine**, Gary Choi, Amita Giri, and Lalan Kumar, "Adaptive Area-Preserving Parameterization of Open and Closed Anatomical Surfaces" in Computers in Biology and Medicine, (2022) : 105715.

2020 **IEEE Transactions on Instrumentation and Measurement**, Amita Giri, Lalan Kumar and Tapan Kumar Gandhi, "Brain Source Localization in Head Harmonics Domain " in IEEE Transactions on Instrumentation and Measurement, vol. 70, pp. 1-10, 2020.

2020 **Signal Processing, Elsevier**, Amita Giri, Gary Choi and Lalan Kumar, "Open and Closed Anatomical Surface Description via Hemispherical Area-Preserving Map" in Signal Processing, Elsevier, vol. 180, 107867, 2021.

Under Processing

2023 **IEEE Transactions on Neural Networks and Learning Systems**, Sidharth Pancholi* and Amita Giri*, "Advancing Brain-Computer Interface System Performance in Hand Trajectory Estimation with *NeuroKinect*" submitted to IEEE Transactions on Neural Networks and Learning Systems. (*Equal contribution)

2023 **Under Preparation**, Amita Giri, Wiley G Smith, Nancy Kanwisher, Amir Adler and Dimitrios Pantazis, "Computational Steps of Human Face Perception" under preparation.

International Conference

2023 **BI**, Amita Giri, John C Mosher, Amir Adler and Dimitrios Pantazis, "Estimating the Number of Active Sources in MEG based on an F-Ratio Method" in 16th International Conference on Brain Informatics (BI 2023). *New York, USA*

2020 **EUSIPCO**, Amita Giri, Lalan Kumar and Tapan Kumar Gandhi, "Robust EEG Source Localization Using Subspace Principal Vector Projection Technique" in 28th European Signal Processing Conference (EUSIPCO), pp. 1075-1079, 2021, IEEE *Amsterdam, Netherlands*

2019 **ACSSC**, Amita Giri, Lalan Kumar and Tapan Kumar Gandhi, "Head Harmonics based EEG Dipole Source Localization" in 53rd Asilomar Conference on Signals, Systems and Computers (ACSSC) , pp. 2149-2153, 2019, IEEE *Pacific Grove, California, USA*

2018 **APSIPA**, Amita Giri, Lalan Kumar and Tapan Kumar Gandhi, "EEG Dipole Source Localization in Hemispherical Harmonics Domain" in 2018 Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA ASC) , pp. 679-684, 2018, IEEE. *Honolulu, Hawaii, USA*

2018 **OHBM**, Santosh Wupadrasta, Amita Giri, Lalan Kumar and Tapan Kumar Gandhi, "Hemispherical Harmonics based Brain Source Localization" in 2018 Organization for Human Brain Mapping (OHBM) *Singapore*

In News

— "IIT Delhi Researchers Propose Non-invasive, Time Efficient and Patient Friendly Diagnostic Tool for Epileptogenic Zone Detection" IIT Delhi Press Release.

— "IIT-Delhi researchers' tool could help in timely detection of epilepsy", Hindustan Times.

— "देश के 20 लाख से अधिक मिर्गी के मरीजों के लिए रामबाण साबित होगी आइआइटी की नई तकनीक", Jagran.

— "Roundup : New algorithm detects source of epileptic seizure and more briefs", Popular Web Archives

— Several online articles and newspaper clipping in press about me getting a Post-Doc position at MIT, USA.

— With my You tube channel, I strive to empower and inspire students in their journey towards their dream college.

Personal Information

- **Date of Birth :** 25 October 1996 (26 Year)
- **Gender :** Female
- **Nationality :** Indian
- **Language :** Hindi, English

References

1. **Dr. Dimitrios Pantazis** - is in the Department of Brain and Cognitive Science at MIT. I am currently working with him as a Post-Doctoral Associate at MEG lab.
   Email Id : pantazis@mit.edu
   Off : +1 (617)-324-6292

2. **Dr. Lalan Kumar** - is in the Department of Electrical Engineering & Bharti School of Telecommunication at IIT Delhi. I have completed my Ph.D. thesis work under his supervision at multichannel signal processing lab.
   Email Id : lkumar@ee.iitd.ac.in
   Off : +91 (11) 2659-7253

3. **Dr. Tapan Kumar Gandhi** - is in the Department of Electrical Engineering at IIT Delhi. I have completed my Ph.D. thesis work under his supervision at neurocomputing lab.
   Email Id : tgandhi@ee.iitd.ac.in
   Off : +91 (11) 2659-1153

4. **Dr. John C Mosher** - is in the University of Texas Health Science Center at Houston (UTHealth), USA. I have the privilege of working closely with Dr. Mosher on my postdoctoral projects, , benefiting from his expertise in signal processing.
   Email Id : john.c.mosher@uth.tmc.edu
   Off : +1 (713)-486-5068

5. **Dr. Amir Adler** - is in the Department of Electrical Engineering at Braude College of Engineering, Israel. I have the privilege of working closely with Dr. Amir on my postdoctoral projects, benefiting from his expertise in signal processing.
   Email Id : adleram@braude.ac.il
   Off : +972-4-9901900

Last Updated on : 01 Sep 2023