Rana Mozumder

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Education

Vanderbilt University (VU) *USA*

Ph.D. in Biomedical Engineering *Aug 22- Present*

- **CGPA:** 3.912/4.00.
- **Research:** Neuroengineering, Cognitive neuroscience, Computational neuroscience.
- **Key Courses:** Special topics in Deep Learning, Advanced Quantitative Image Analysis, Analysis of fMRI, Quantitative Methods in BME, Fundamentals of Neuroscience II.

Bangladesh University of Engineering and Technology (BUET) *Bangladesh*

Bachelor of Science, Biomedical Engineering *2016-2021*

- **CGPA:** 3.78/4.00
- **Research:** Biomedical signal processing.
- **Key Courses:** Digital Signal Processing, Random Signal Processing, Medical Imaging, Biomedical Instrumentation, Tissue Engineering.

Research Experiences

Department of Biomedical Engineering, VU *USA*

Graduate Student *Aug 22- Present*

- **The asynchronous state of working memory maintenance.** In this work we are trying to answer a very important/debated question in the field: Is persistent activity an artifact of averaging? Along with traditional approch like raster plot, peri-stimulus time histogram, and inter-spike interval analysis, we are using machine learning algorithms to decode stimulus from neural activity.
- **Integration of audiovisual motion in dorsolateral prefrontal cortical neurons.** Our results demonstrate that dorsolateral prefrontal neurons integrate auditory and visual motion signals, extending multisensory computations beyond sensory cortices into prefrontal circuits that support higher-order cognition. Read the preprint *here*.
- **Contributions of narrow- and broad-spiking prefrontal and parietal neurons on working memory tasks.** We divided neurons into two groups: narrow and broad-spiking by extracting feature from their waveform and explored how these different cell types contribute to perform cognitive tasks. This work got published in Frontiers in Systems Neuroscience. Paper link
- **Single-neuron and population measures of neuronal activity in working memory tasks.** This work compared traditional single-neuron approaches with population-level analysis and what kind of insights we can get from both kind of approaches. This work is now published in Journal of Neurophysiology. Paper link

Department of Biomedical Engineering, BUET *Bangladesh*

Undergraduate Student *2018 - 2021*

- **Subject Independent Mental Task Classification using Energy based Features from EEG Signal (UG thesis).** In this work two methods were investigated for classification. Firstly, the signal was divided into five different frequency bands and Entropy and Log-variance of signals were calculated to construct the feature vector. And secondly, Variational Mode Decomposition (VMD) analysis was performed and then, same energy related features were extracted from the Intrinsic Mode Functions found after VMD analysis to form the feature vector. In both cases k-Nearest Neighbors was used as the classifier. Thesis report

Work Experiences

Constantinidis Lab *USA*

Graduate Research Assistant *Aug 22- Present*

- Leading optogenetic experiments on NHPs in the lab.
- Designing new experiments, training non-human primates (NHPs) on novel tasks.
- Multimodal recording: electrophysiological recording with various laminar probes, e.g., Plexon, Diagnostic Bio Chips, Neuropixels probes, and behavioral data (eye-tracking).
- Data preprocessing and spike sorting to create datasets
- Analysis of data: Single-neuron, Population-level, and Local Field Potential (LFP) analysis.
- CT and MR image analysis (Registration, Segmentation) for surgery.

Biomedical Engineering Department, VU *USA*

Graduate Teaching Assistant for *Biomedical Instrumentation* course *Fall'23, Fall'24*

- Guided senior-level students in building robust hardware systems for recording biophysical signals such as ECG.
- Assisted in designing and debugging microcontroller codes to collect, preprocess, and visualize physiological data.
- Led hands-on lab sessions, providing one-on-one support to students in troubleshooting and optimizing their systems.
- Evaluated student projects and provided constructive feedback to enhance their technical and analytical skills.

Sanofi Bangladesh *Bangladesh*

Trainee Engineer *2019*

- Worked there as an intern as a part of our academic curriculum.
- Explored their plants, research and development wing, product design, and engineering section to gain insight into the industrial production of drugs.

Notable Projects

2024	**Behavioral Decoding Using Recurrent Neural Networks (RNNs),** We compared different types of RNNs to decode a behavioral feature from neural activity. We also explored how temporal history affects current decision-making, and contributions of different brain regions. Project presentation	*Neuromatch*
2023	**Non-linear Dimensionality Reduction and Visualization of Latent Space Representation of Neural Data in a Working Memory Task,** In this work, a transformer-based autoencoder model is proposed to perform dimensionality reduction of neural data. Visualization of the encoded latent space shows that the clusters of correct and error trials separately. These results indicate the potential of this kind of analysis over linear methods.. Project report	*VU*
2023	**Preprocessing and Higher-level Analysis on a fMRI Dataset to Visualize the Effect of Shape and Word Stimuli,** We investigated how the brain responds to word recognition and how task effects in the Visual Word Form Area (VWFA) differ from those in the other areas of the brain. Our main goal was to preprocess raw fMRI data, perform a GLM analysis to understand how the brain responded to various stimuli, and end with a functional connectivity study to understand the correlation of the brain regions with the VWFA. Project report	*VU*
2021	**Deep Learning Based Decoding of Motor Imagery for Practical Brain-Computer Interfaces,** We used transfer learning for Brain-Computer Interfaces (BCI), addressing motor imagery decoding. The challenge lies in transferring from multiple data sets which use different EEG setups comprising hundreds of users, to a set of new users that need to be up and running with only minutes' worth of training data. A novel architecture, ENET - Conv, was proposed to address the stated problems.	*BUET*
2021	**An Automatic Segmentation of White Blood Cell (WBC) nucleus and Classification of WBC using CNN,** First, the WBC images were pre- processed, and the nucleus of each cell was marked with an square-shaped mask. Then, a multi-layered CNN model was utilized to classify different types of WBCs. Finally, the method was investigated on three publically available datasets.	*BUET*
2018	**Developing a non-invasive blood glucose monitoring device,** An IR transmitter was used to transmit IR light through human finger and an IR receiver was used to receive the transmitted light after being absorbed by the blood glucose molecule. Then linear regression analysis was performed to measure the blood glucose level.	*BUET*
2021	**Developing an in-vitro mechanical testing set-up,** A sealed compartment was built and was filled with water to create an in-vitro environment. The compartment had holes to attach an artery and we used a webcam to measure the fluctuation in diameter in real time as fluid was passed through it.	*BUET*
2019	**Developing a Face Recognition System,** Three different classifiers were built to recognize a face dataset. First method included PCA and SVM classifier based face recognition. For the second method, a CNN architecture (ALexNet) was trained for classification. And lastly, in the third method, a pre-trained model (VGG-16) was utilized using transfer learning.	*BUET*
2019	**Extraction of breathing rate from PPG signal using Empirical Mode Decomposition,** Firstly, Empirical Mode Decomposition was applied to the preprocessed signals, and then, Fourier Transform was used to reveal the frequency of the Intrinsic Mode functions and breathing rate was, finally, calculated from the corresponding frequencies.	*BUET*
2019	**Heart Rate Detection from PPG signal using Arduino Uno and LCD,** Used a Photoplethysmogram (PPG) sensor to acquire the PPG signal of the subjects and programmed on a Arduino Uno IDE to calculate heart rate by measuring the peaks of the signal in a certain time interval. Then, the result was displayed on a LCD screen.	*BUET*

Publications & Manuscripts

2025	**Mozumder, R. ,** Wang, Z.,Dang, W., Zhu, J., Hammond, B. & Constantinidis, C. The asynchronous state of working memory maintenance (under review).	*Preprint*
2025	Karimi, A.**, Mozumder, R.,** Schoenhaut, A., Rausis, O., Wallace, M., Ramachandran, R. & Constantinidis, C., Integration of audiovisual motion in dorsolateral prefrontal cortical neurons (under review). Paper link	*Preprint*
2024	**Mozumder, R. ,** Chung, S., Li, S. & Constantinidis, C. Contributions of narrow- and broad-spiking prefrontal and parietal neurons on working memory tasks. Front. Syst. Neurosci. 18, (2024). Paper link	*Frontiers in Systems Neuroscience*
2023	**Mozumder, R.,** & Constantinidis, C. Single-neuron and population measures of neuronal activity in working memory tasks. J. Neurophysiol. 130, 694–705 (2023). Paper link	*Journal of Neurophysiology*

Skills

Programming/Scripting	Python, Matlab, R, C
Softwares/Packages	Jupyter, Matplotlib, Numpy, Scipy, Pandas
Deep Learning	Pytorch, Keras, TensorFlow
Medical Image Analysis	3D Slicer, AFNI, FSL
Data Acquisition	Open Ephys
Simulation & Design	Matlab & Simulink, Proteus, ANSYS, Solidworks, LabVIEW
Miscellaneous	Exploratory Data Analysis, Data Visualization, LaTeX, Microsoft Office, Google Workspace, Adobe Illustrator
Soft Skills	Time Management, Teamwork, Problem-solving, Documentation, Experiment Design, Presentation.

Honors & Awards

Design for Life Competition *Bangladesh*

4th Place *2020*

- A low-cost ventilator was designed during COVID epidemic with readily available products like a one-way valve, removac set, suction air filter, and gearbox motor with Scoth Yoke mechanism to control the speed of ventilation.

Dean's List Honor *Bangladesh*

Three times awardee *2017, 2018, 2021*

- Awarded for CGPA>3.75 during a academic year.

Board Scholarship by Intermediate and Secondary Education Board, Bangladesh *Bangladesh*

Four times Awardee *2008-2020*

- Awarded for excellent academic result.

Leadership & Voluntary Experiences

Aug 23-Present	**Biomedical Engineering Graduate Student Association,** Treasurer	*USA*
2016-21	**Badhan, Ahsanullah Hall Unit, BUET Zone,** Active member	*Bangladesh*
2019	**Ahsanullah Hall Kali Puja Committee,** President	*Bangladesh*
2020	**Ahsanullah Hall Bani Archana Committee,** Secretary	*Bangladesh*

Languages

English: Professional fluency **Bengali:** Native Proficiency, **Hindi:** Professional fluency, **Spanish:** Basic Knowledge.