Md. Jewel Rana

EEG Signal Processing — Brain-Computer Interface — Deep Learning for Neurotechnology

+8801771404992 mdjewelrana.cse.pust@gmail.com Linkedin Github

RESEARCH INTERESTS

EEG Signal Processing | Brain-Computer Interface (BCI) | SSVEP-based BCI Systems | Motor Imagery Classification | Riemannian Geometry for EEG | Common Spatial Patterns (CSP) | Deep Learning for Neurological Disorders | Mental Health Assessment via EEG | Neurotechnology for Clinical Applications

EDUCATION

Pabna University of Science & Technology **2020 – 2025**

B.Sc. in Computer Science and Engineering - ***CGPA: 3.37*** *(Last Semester:* ***3.71****)* *Pabna, Rajshahi, Bangladesh*

RESEARCH EXPERIENCE

Research and Development Engineer **September 2025 – Present**

Brain Computer Interface Lab, AIMS Lab, United International University

- Leading research on **EEG-based machine learning models** for mental health assessment and neurological disorder detection.
- Expertise in **SSVEP (Steady-State Visually Evoked Potential)** paradigm design, data acquisition, and signal processing.
- Proficient in experimental design using **BrainVision Professional Recorder**, **BrainVision Analyzer**, and **PsychoPy** for neuroscience research.
- Implementing advanced signal processing techniques including **Common Spatial Pattern (CSP)**, **Riemannian Geometry**, and **deep learning architectures** (CNN, LSTM, GRU, Transformers).
- Published **1 journal paper** in Cognitive Neurodynamics (Springer) and **4 conference papers** (IEEE) on EEG-based classification systems.
- Conducting interdisciplinary research combining neuroscience, signal processing, and AI for clinical applications.

Open Source Contributor, TorchEEG **2024 – Present**

GitHub Repository

- Contributed to **SSVEP dataset preprocessing pipelines** and expanded the framework with new EEG datasets.
- Fixed critical bugs in EEG signal processing modules to improve framework stability and performance.
- Enhanced documentation for Motor Imagery (MI) and SSVEP classification workflows.

BCI & Neurotechnology Spring School 2025 **Spring 2025**

Intensive Training Program (140 hours)

- Completed comprehensive training in BCI fundamentals, EEG acquisition, and signal analysis techniques.
- Hands-on project: **SSVEP Data Analysis for Brain-Computer Interface Applications** with real-time implementation.
- Gained expertise in experimental paradigm design, artifact removal, and feature extraction for BCI systems.

PUBLICATIONS

Journal Papers

Real-time Driver Activity Detection Using Advanced Deep Learning Models

Cognitive Neurodynamics (Springer), 2025 ***DOI:*** *10.1007/s11571-025-10*

- Proposed **Hybrid CNN-Transformer with Efficient Channel Attention** for real-time driver monitoring using EEG signals.
- Achieved state-of-the-art generalization performance across multiple CNN architectures for safety-critical applications.

Schizophrenia Detection Using Fusion of CSP and Riemannian Geometry

IEEE Access (Under Review)

- Novel framework combining **Common Spatial Patterns (CSP)** and **Riemannian Geometry (RG)** for psychiatric disorder detection.
- Achieved **99.99% classification accuracy** using EEG biomarkers, demonstrating clinical viability.

Short-term Memory-loss Estimation from EEG Workload Classification
Mathematics (MDPI) - Under Review

- Analyzed **mental workload classification** using SVM, ChronoNet, CNN-LSTM, CNN-GRU, and Random Forest (86% accuracy).
- Predicted short-term memory loss and attention degradation from EEG-based cognitive load assessment.

Conference Papers

Real-Time EEG Dynamics: Eyes-Open vs Eyes-Closed Analysis in Females
NCIM, DUET, 2025 — IEEE Xplore — DOI: 10.1109/NCIM61190.2025.11160262

- **Random Forest classification (97% accuracy)** with real-time processing (2.2s execution time) for cognitive assessment.

Explainable EEG Framework for Alzheimer's and FTD Diagnosis Using Pairwise CSP
ICAST 2025 (Accepted) — IEEE Xplore, Scopus

- Developed **explainable AI framework** with SHAP and LIME for transparent dementia diagnosis using **CSP features**.

Multi-Class EEG Motor Execution Using Riemannian Geometry Deep Learning
COMPAS 2025 (Accepted) — IEEE Xplore, Scopus

- **CNN-LSTM hybrid model (82.28% accuracy)** for motor execution classification using **Riemannian manifold features**.

EEG Biomarkers for First Episode Psychosis Detection Using Riemannian Geometry
COMPAS 2025 (Accepted) — IEEE Xplore, Scopus

- Combined **Riemannian covariance features with SVM** for early psychiatric diagnosis with topological data analysis.

TECHNICAL EXPERTISE

EEG/BCI Specific Skills

Signal Processing: Common Spatial Pattern (CSP), Independent Component Analysis (ICA), Riemannian Geometry, Time-Frequency Analysis, Artifact Removal (EOG, EMG), Wavelet Transform, Power Spectral Density (PSD)
BCI Paradigms: SSVEP (Steady-State Visually Evoked Potential), Motor Imagery (MI), Event-Related Potential (ERP), P300-based BCI
Neuroimaging Tools: MNE-Python, TorchEEG, BrainVision Analyzer, BrainVision Recorder, PsychoPy, EEGLAB, Brainstorm, SSVEP Analysis Toolbox
Machine Learning: PyTorch, TensorFlow, Scikit-learn, XGBoost, Random Forest, SVM, CNN, LSTM, GRU, Transformer, Hybrid Architectures
Programming: Python (Advanced), MATLAB, C/C++, Java, SQL
Data Analysis: NumPy, SciPy, Pandas, Matplotlib, Seaborn, Statistical Analysis, Feature Engineering

SELECTED PROJECTS

SSVEP-based BCI System for Real-time Classification **2024-2025**

- Designed and implemented end-to-end SSVEP paradigm using PsychoPy for visual stimulation at multiple frequencies.
- Developed real-time signal processing pipeline with canonical correlation analysis (CCA) and deep learning classifiers.
- Achieved ¿85% classification accuracy for 4-class SSVEP decoding with minimal calibration time.

Motor Imagery Classification Using Riemannian Geometry **2024**

- Implemented Riemannian manifold-based feature extraction for left/right hand motor imagery classification.
- Combined CSP with tangent space projection and deep learning for robust MI decoding (82% accuracy).
- Optimized for real-time BCI applications with low computational latency.

AWARDS & ACHIEVEMENTS

Champion, IEEE Day Programming Competition 2024

Runner-up, IEEE Day Idea Competition 2024 - *Microplastics Detection using AI Camera*

Champion, PUST CSE Intra Department Programming Contest 3.0 and 2.0

2nd Runners-up, PUST Inter-University Programming Contest (IUPC) 2023

600+ Problems Solved on Codeforces (Max Rating: 1311), LeetCode (37+), GeeksForGeeks (60+)

REFERENCES

Available upon request