Research Background and Statement

(by Dr. Gopal Chandra Jana)

I am Gopal Chandra Jana; I completed PhD in the Department of Information Technology at the Indian Institute of Information Technology Allahabad (IIIT-Allahabad) under Dr. Anupam Agrawal (Professor @Dept. IT, IIIT-A, UP, India) in August 2024.

My PhD research is based on the domain of EEG signals Analysis (specifically channel selection, signal decomposition, features representation, and extraction), Artificial Intelligence (specifically traditional ML, DL, RL), and Epileptic Seizure detection (subject-specific and cross-subjects).

Based on PhD research, I have generated four SCIE-indexed journal papers, five WoS and Scopus conference publications, and one Software Copyright; details of the same have been mentioned in the list of publications file.

Also, during my MTech. CSE (School of Computer Engineering, KIIT Deemed to be University), I completed my post-graduate thesis in Applied Machin Learning and EEG & MEG signals analysis for discriminating motor movements. Based on MTech. research, I have generated one SCIE-indexed journal, one SCOPUS-indexed journal, and one WoS Conference publication.

My PhD and MTech journey with self-motivation, curiosity, enthusiasm, and a proactive attitude to learn and adopt new tools and techniques helped me explore the advancement of AI concepts in medical imaging. Also, I believe in integrity, responsibility, continuity, consistency, and dignity in any responsibility.

During my M. Tech. and PhD, I have attended many Seminars, Workshops, Conferences, Symposiums, and short-term courses and rescaled my interpersonal skills to learn a new concept and adapt it to the next level of research and academics. A few tools and techniques of expertise are summarized below, which I can adopt in my feature research work.

A few expertise of mine:

- During my PhD and M. Tech., I have demonstrated research expertise growing in EEG signals analysis and machine learning.
- Rich experience in modeling and computer simulation, using MATLAB and Python.
- Experienced with mostly familiar EEG signals processing tools like EEGLAB with MATLAB, EDFbrowser, pyEDF. Also, I have some ideas related to other existing EEG data visualization and processing tools like the Bioelectromagnetism-Matlab toolbox, eeg-analysis-toolbox with MATLAB, etc.
- Techniques explored and used related to Signal processing/Analysis are Filtering techniques (Butterworth etc.), FFT, DWT, EMD, ICA, etc.
- Techniques explored and used related to Machine Learning are ANN, SVM, ELM, ANFIS, CNN, CapsNet, including Transfer Learning and Reinforcement Learning.
- Experienced with other popular tools like FSL, which is a comprehensive library of analysis tools for FMRI, MRI, and DTI medical imaging.

- Experienced with Portable Batch System (PBS) to handle the distribution of batch jobs and interactive sessions across the available nodes in the high-performance GPU/CPU cluster.
- Explored Google Cloud Platform to set up a VM with GPU to run high computing jobs.
- Experienced with Linux/Windows, High Performance Computing, LaTeX-Overleaf, Origin, MS-office, Moodle for LMS, etc.
- Experienced with manuscript preparation, review, modification, communication, rebuttal preparation for reviewers and proofreading, etc., related to manuscript preparation for publication.
- Exploring explainable AI, DL, and RL concepts.

With this knowledge and experience, I'm interested in extending research in the field of Artificial intelligence in health care, which includes the core knowledge of Artificial intelligence, Reinforcement Learning, Machine Learning, Deep Learning, Computer Vision, and Signal Processing. The application area of these techniques would be in the domain of Medical Image and Signal analysis. But not restricted.

Specifically, I want to extend and accommodate my knowledge and experience to get funded projects that may enrich my research to the next level, which will be a valuable addition to my employer.

Moving forward, I am excited to continue my research in artificial intelligence and Computer Vision in healthcare or wherever applicable. I am open to working with principal investigators or project heads to pursue the Institute Center of Excellence (CoE) research vision. ***I'm also interested in setting up a Research Lab in collaboration with national and international researchers***. I am confident that my knowledge and experience make me well-suited to take on new challenges and make meaningful contributions to the field.

Thank and Regards

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BCIAAI Research Lab: Brain-Computer Interface (BCI) and Applied Artificial Intelligence (AI) Research Lab

(**3 years roadmap**)

Year wise target	Quarterly Target
Year 1: Foundation and Initial Research **(Ist Quarte**r**)**	**1. Establish Lab Infrastructure** • **Objective:** Set up the essential infrastructure for the BCIAAI Research Lab. • **Actions to be taken:**

	○ Acquire necessary equipment (e.g., EEG systems, high-performance computing - with collaboration). ○ Set up software environments (e.g., MATLAB, TensorFlow, PyTorch). ○ Recruit a multidisciplinary team (AI researchers, neuroscientists, engineers). Develop protocols for data collection, analysis, and ethical compliance.
Year 1: Foundation and Initial Research **(IInd Quarter)**	**2. Literature Review and Skill Development** • **Objective:** Build a strong foundation in the latest BCI and AI techniques. • **Actions to be taken:** ○ Conduct an extensive review of current research in BCI and AI. ○ Identify gaps and potential areas for innovation. ○ Provide training workshops for the team on advanced AI and signal-processing techniques. ○ Develop partnerships with other research labs or industry partner
Year 1: Foundation and Initial Research **(IIIrd Quarter)**	**3. Pilot Studies and Data Collection** • **Objective:** Begin initial research projects and gather preliminary data. • **Actions to be taken:** ○ Design and conduct pilot studies on specific BCI applications (e.g., Prevention, Detection and diagnosis, Rehabilitation and restoration, Neuroergonomics and smart environment, Neuromarketing and advertisement, Educational and self-regulation, Games and entertainment, Security and authentication, and Assistive technology). ○ Collect and preprocess EEG or related neuroimaging data. ○ Test AI models for signal processing, noise reduction, and feature extraction. ○ Publish initial findings in conferences or workshops.
Year 1: Foundation and Initial Research **(IVth Quarter)**	Assessment and completion of the pending targets for the previous quarter.
Year 2: Advanced Research and Development **(Ist Quarter)**	**1. AI Algorithm Development** • **Objective:** Develop and refine AI models tailored for BCI applications. • **Actions to be taken:** ○ Create machine learning models for brain signal classification and pattern recognition.

	○ Explore deep learning techniques for complex signal analysis. ○ Implement real-time processing algorithms for adaptive BCI systems. ○ Compare the performance of various AI models and optimize for accuracy and speed.
Year 2: Advanced Research and Development **(IInd Quarter)**	**2. Applied Research Projects** • **Objective:** Apply BCI-AI models to specific use cases and applications. • **Actions to be taken:** ○ Develop a BCI system for neurorehabilitation (e.g., autism, Alzheimer's, stroke recovery). ○ Explore BCI applications in HCI, such as controlling smart devices or VR smart environments. ○ Collaborate with medical professionals to conduct clinical trials or user studies. ○ Analyze the data and refine the models based on user feedback and performance.
Year 2: Advanced Research and Development (**IIIrd Quarter**)	**3. Dissemination and Collaboration** • **Objective:** Share research findings and establish collaborations. • **Actions to be taken:** ○ Publish research papers in reputable journals and present at conferences. ○ Organize workshops or seminars to share knowledge with the academic and industry community. ○ Apply for additional funding to support ongoing and future research. ○ Establish formal collaborations with other universities, research institutions, or industry partners.
Year 2: Advanced Research and Development (**IVth Quarter**)	Assessment and completion of the pending targets for the previous quarter.
Year 3: Innovation and Impact (**Ist Quarter**)	**1. Advanced Applications and Prototypes** • **Objective:** Develop and demonstrate advanced BCI applications using AI. • **Actions to be taken:** ○ Create working prototypes of BCI systems for real-world applications (e.g., assistive technologies, cognitive enhancement tools, but not limited).

	○ Test prototypes in real-world settings and gather feedback for further improvements. ○ Explore commercialization opportunities or technology transfer with industry partners.
Year 3: Innovation and Impact (**IInd Quarter**)	**2. Longitudinal Studies and Data Analysis** • **Objective:** Conduct in-depth analysis and long-term studies. • **Actions to be taken:** ○ Perform longitudinal studies to assess the effectiveness of BCI systems in rehabilitation or cognitive enhancement (specifically, the focus should be on the mentioned BCI applications). ○ Analyze large-scale data sets to identify trends and refine AI models further. ○ Investigate the ethical and societal implications of BCI technologies and propose guidelines.
Year 3: Innovation and Impact (**IIIrd Quarter**)	**3. Strategic Planning and Future Directions** • **Objective:** Plan for the next phase of research and lab growth. • **Actions to be taken:** ○ Evaluate the success of the three-year plan and identify areas for further research. ○ Set new research goals based on findings and emerging trends in BCI and AI. ○ Expand the lab's focus to include interdisciplinary research, such as combining BCI with other emerging technologies (e.g., IoT, wearable devices). ○ Continue building partnerships and securing funding for long-term sustainability.
Year 3: Innovation and Impact (**IVth Quarter**)	Assessment and completion of the pending targets for the previous quarter.
	Dr. Ram Bilas Pachori Professor, Department of Electrical Engineering, IIT Indore, Simrol, Indore, 453552, Madhya Pradesh, India
	Dr. Rantna Sharma, Professor, Dept. of Physiology, AIIMS New Delhi, Delhi, India
	Dr. Rajendra Acharya Professor (Artificial Intelligence in Health),

Possible mentors for the BCIAAI Research Lab	Section School of Mathematics, Physics and Computing, University of Southern Queensland, Australia.
	Dr. Yudong Zhang Chair Professor at the School of Computing and Mathematical Sciences, University of Leicester, UK.