

Himanshu Kumar, Ph.D.

POST-DOCTORAL FELLOW IN NEUROENGINEERING & EPILEPSY

Cleveland, OH, USA
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Google Scholar Profile

RESEARCH INTERESTS

Neurotechnology, brain signal processing, stereotactic EEG (sEEG) and scalp EEG analysis, epilepsy research, affective computing, cognitive neuroscience, machine learning, and explainable AI (XAI).

WORK EXPERIENCE

Postdoctoral Fellow

Oct 2024 – Present | Cleveland, OH, USA

Neurological Institute, Cleveland Clinic

- SPIKE Lab, working with Dr. Balu Krishnan on neurotechnology and brain signal processing for epilepsy research.
- Developed seizure segmentation methods in stereotactic EEG (sEEG) using contrastive latent representations and envelope-based changepoint methods.
- Investigated seizure onset zone (SOZ) localization using advanced signal processing and deep learning.
- Applied super-resolution superlet transform and transformer-based networks for sEEG pattern classification.

Guest Scientist (DAAD & AROP Fellow)

Mar 2021 – Sep 2022 | Aachen, Germany

University Hospital RWTH Aachen (Dept. of Psychology, Psychotherapy and Psychosomatics)

- Supervised by Prof. Ute Habel; conducted research on EEG-based trait impulsivity.
- Developed whole-brain connectome-based predictive modeling analysis for trait impulsivity classification.
- Applied explainable machine learning (XAI) models to identify critical EEG power bands and networks indicating impulsive traits.

Doctoral Research Scholar

Jan 2019 – Aug 2024 | Chennai, India

Indian Institute of Technology (IIT) Madras

- NIID Lab, Department of Applied Mechanics and Biomedical Engineering.
- Developed multimodal (EEG, PPG, EDA) physiological signal processing pipelines for emotion recognition.
- Designed nonlinear phase-based and bispectral quadratic phase coupling connectivity measures for robust affective computing.

Research Intern

May 2017 – July 2018 | New Delhi, India

Rajiv Gandhi Cancer Institute and Research Centre

- Biomedical instrumentation, signal processing, and medical imaging research.

EDUCATION & TRAINING

Doctor of Philosophy (Ph.D.) in Biomedical Engineering

2019 – 2024 | Chennai, India

Indian Institute of Technology (IIT) Madras

Advisors: Prof. S. Ramakrishnan, Dr. Subha D. Puthankattil

Thesis: "Analysis and classification of audio-visual stimuli induced arousal and valence emotional states using EEG signal"

Integrated Master of Technology (M.Tech.) in Biomedical Engineering

2013 – 2018 | Prayagraj, India

Indian Institute of Information Technology (IIIT) Allahabad

Five-year dual degree (B.Tech. & M.Tech.). CGPA: 9.0/10.0. Graduated with Academic Excellence Bronze Medal.

Thesis: "Detection of Valvular Heart Diseases Using Heart Sounds (PCG) and Machine Learning"

FELLOWSHIPS & GRANTS

DAAD Bi-National Doctoral Guided Research Fellowship

2021 – 2022 | Germany

German Academic Exchange Service (DAAD) / Funded by German Federal Ministry of Education and Research

Advanced Research Opportunities Program (AROP) Fellowship

2021 | Germany

RWTH Aachen University

Half-Time Research Assistantship (HTRA)

2019 – 2023 | India

Ministry of Education (formerly MHRD), Government of India

Institute Travel Award

2022 | UK

IEEE Engineering in Medicine and Biology Conference (EMBC), Glasgow

SERVICE & REVIEWING

Peer Reviewer: *IEEE Transactions on Affective Computing, Brain Communications, Journal of Neural Engineering, Signal, Image and Video Processing, Scientific Reports.*

PUBLICATIONS

INTERNATIONAL JOURNALS

Kumar, H., Ganapathy, N., Puthankattil, S.D., & Swaminathan, R. (2026). "Subject-independent emotion recognition with EEG bispectral quadratic phase coupling features and explainable machine learning." *Biomedical Physics & Engineering Express*. DOI: 10.1088/2057-1976/ae711a

Kumar, H., Govindarajan, S., Ramakrishnan, M.S., Karthick, P.A., & Ganapathy, N. (2026). "EEG-Based Emotion Recognition using Super-Resolution Superlet Transform and Self-Attention Convolutional Neural Network." *Biomedical Signal Processing and Control*.

Kumar, H., Seshadri, N.P.G., Martinez, D., Najm, I., Alexopoulos, A., Bulacio, J.C., Serletis, D., & Krishnan, B. (2026). "Three-Phase Seizure Segmentation in Stereotactic EEG Using Envelope-Based Multivariate Change-point Analysis." *Annals of Biomedical Engineering*. DOI: 10.1007/s10439-026-04097-7

Kumar, H., Ganapathy, N., & Swaminathan, R. (2025). "Analysis of Dynamics of EEG Signals in Emotional Valence Using Super-Resolution Superlet Transform." *IEEE Sensors Letters*, 9, 1–4. DOI: 10.1109/LSENS.2025.3526907

Hüpen, P., **Kumar, H.**, Swaminathan, R., Habel, U., & Wagels, L. (2024). "Functional Brain Networks of Trait Impulsivity: A Connectome-Based Predictive Modeling Analysis." *Human Brain Mapping*, 45, e70059. DOI: 10.1002/hbm.70059

Banik, S., **Kumar, H.**, Ganapathy, N., & Swaminathan, R. (2024). "Assessment of EEG-PPG Cross Frequency Coherence under Evoked Emotional Arousal." *Current Directions in Biomedical Engineering*, 10(4), 49–52. DOI: 10.1515/cdbme-2024-2012

Kumar, H., Ganapathy, N., Puthankattil, S.D., & Swaminathan, R. (2024). "Analysis of EEG Fluctuation Patterns using Nonlinear Phase-Based Functional Connectivity Measures for Emotion Recognition." *Fluctuation and Noise Letters*, 23(5). DOI: 10.1142/S0219477524500512

Banik, S., **Kumar, H.**, Ganapathy, N., & Swaminathan, R. (2024). "Assessment of Emotion Elicitation using Multimodal Physiological Sensors and Phase Synchronization." *IEEE Sensors Letters*. DOI: 10.1109/LSENS.2024.3426562

Banik, S., **Kumar, H.**, Ganapathy, N., & Swaminathan, R. (2024). "Exploring Central-Peripheral Nervous System Interaction Through Multimodal Biosignals: A Systematic Review." *IEEE Access*, 12, 60347–60368. DOI: 10.1109/ACCESS.2024.3392069

Hüpen*, P., **Kumar*, H.**, Shymanskaya, A., Swaminathan, R., & Habel, U. (2023). "Impulsivity Classification Using EEG Power and Explainable Machine Learning." *International Journal of Neural Systems*, 33(2), 2350006. (*Joint first author) DOI: 10.1142/S0129065723500065

Veeranki, Y.R., **Kumar, H.**, Ganapathy, N., Natarajan, B., & Swaminathan, R. (2021). "A Systematic Review of Sensing and Differentiating Dichotomous Emotional States Using Audio-Visual Stimuli." *IEEE Access*, 9, 124434–124451. DOI: 10.1109/ACCESS.2021.3110773

Kumar, H., Ganapathy, N., Puthankattil, S.D., & Swaminathan, R. (2021). "EEG Based Emotion Recognition Using Entropy Features and Bayesian Optimized Random Forest." *Current Directions in Biomedical Engineering*, 7(2), 767–770. DOI: 10.1515/cdbme-2021-2196

Ganapathy, N., Veeranki, Y.R., **Kumar, H.**, & Swaminathan, R. (2021). "Emotion Recognition Using Electrodermal Activity Signals and Multiscale Deep Convolutional Neural Network." *Journal of Medical Systems*, 45, 49. DOI: 10.1007/s10916-020-01676-6

SELECTED CONFERENCE PROCEEDINGS

Banappa, H.S., **Kumar, H.**, Seshadri, G., Alexopoulos, A., Martinez, D., Najm, I., Bulacio, J.C., Serletis, D., & Krishnan, B. (2025). "Optimal Temporal Resolution for Detecting Functional Connectivity Microstates During Epileptic Seizures Using SEEG." *American Epilepsy Society Annual Meeting*.

Kumar, H., Seshadri, G., Martinez, D., Najm, I., Alexopoulos, A., Bulacio, J.C., Serletis, D., & Krishnan, B. (2025). "Unsupervised Learning of Ictal Patterns from Stereo EEG using Contrastive Latent Representation." *American Epilepsy Society Annual Meeting*.

Banik, S., **Kumar, H.**, Ganapathy, N., & Swaminathan, R. (2024). "Assessment of Valence Emotional State Using EEG-EDA Coupling and Explainable Classifiers." *Studies in Health Technology and Informatics*, 316, 953–957. DOI: 10.3233/SHTI240569

Kumar, H., Ganapathy, N., Puthankattil, S.D., & Swaminathan, R. (2022). "Assessment of Emotional States in EEG Signals Using Multi-Frequency Power Spectrum and Functional Connectivity Patterns." *IEEE EMBC 2022*, pp. 280–283. DOI: 10.1109/EMBC48229.2022.9871510

Kumar, H., Hüpen, P., Swaminathan, R., & Habel, U. (2022). "Impulsivity Classification Using EEG-Based Features." *Organization for Human Brain Mapping (OHBM) Annual Meeting*.

Kumar, H., Ganapathy, N., Puthankattil, S.D., & Swaminathan, R. (2022). "Classification of Emotional States Using EEG Signals and Wavelet Packet Transform Features." *Studies in Health Technology and Informatics*, 294, 943–944. DOI: 10.3233/SHTI220632

Kumar, H., & Swaminathan, R. (2022). "Time and Frequency Domain Analysis of APB Muscles Abduction in Adult Dominant Hand Using Surface Electromyography Signals." *IEEE MeMeA 2022*. DOI: 10.1109/MeMeA54994.2022.9856551

Kumar, H., Ganapathy, N., Puthankattil, S.D., & Swaminathan, R. (2022). "Assessment of Emotional States in EEG Signals Using Phase Slope Index Based Functional Connectivity Features." *Recent and Modern Biomedical Studies (RMBS)*.

Kumar, H., Ganapathy, N., Puthankattil, S.D., & Swaminathan, R. (2021). "Emotion Recognition in EEG Signals Using Decision Fusion Based Electrode Selection." *Studies in Health Technology and Informatics*, 281, 153–157. DOI: 10.3233/SHTI210139

Kumar, H., Puthankattil, S.D., & Swaminathan, R. (2021). "Analysis of EEG Response for Audio-Visual Stimuli in Frontal Electrodes at Theta Frequency Band Using Topological Features." *Recent and Modern Biomedical Studies (RMBS)*.

Ganapathy, N., **Kumar, H.**, & Swaminathan, R. (2019). "Differentiation of Valence Emotional States in Localized EEG Signals using Motif Patterns." *BIG BRAIN Conference*.

Agarwal, R., **Kumar, H.**, & Shatakshi, S. (2018). "EMG and Grip Force Correlation at Varying Wrist Angles for Dominant vs. Non-Dominant Hand." *IEEE SCEECs*.

Kumar, H., Agarwal, R., & Shatakshi, S. (2018). "Feature Extraction to Detect Diabetic Retinopathy and Glaucoma in Fundus Image." *IRECS*.

Navaneethkrishna, M., Nitinram, S., **Kumar, H.**, Lasya, L., & Swaminathan, R. (2017). "Correlation of the sEMG Signal and Muscle Stiffness during Fatiguing Isometric Contraction of Bicep Brachii Muscle in Dominant and Non-Dominant Hand." *ICMMB*.

INVITED LECTURES	
4th IEEE International Conference on Sensors and Related Networks (Preconference Lecture)	17 Jul 2025 VIT, Vellore
Next Generation Health Technologies: Signal Processing, Teleneurology & AI	06 Jun 2025 AISAT, Kerala
Medical Informatics and Digital Health Programme	21 Mar 2025 IIT Hyderabad
BME Engineering Training Program (IITM & ISRO Human Spaceflight Training)	14 Feb 2025 IIT Madras

PERSONAL & TECHNICAL SKILLS	
SIGNAL PROCESSING & NEUROIMAGING Stereotactic EEG (sEEG), Scalp EEG, fMRI/MEG acquisition, Topological Data Analysis, Time-Frequency & Connectivity Analysis, Superlet/Wavelet transforms.	MACHINE LEARNING & AI Deep Learning (Transformers, CNNs), Explainable AI (XAI), Contrastive Learning, PyTorch, TensorFlow, Keras, Scikit-learn, classification models.
SOFTWARE & ANALYSIS TOOLS EEGLAB, MNE-Python, BrainVision Analyzer, FreeSurfer, SPM12, LabView, Multisim, Origin Pro.	PROGRAMMING & DETAILS Python, MATLAB, C, Java, LaTeX, Git. DOB: 24/09/1994 Nationality: Indian Gender: Male.