



Muhammad Zubair

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Department and Institutional Affiliation(s)

Department of Biomedical Engineering, Pennsylvania State University

Materials Research Laboratory, University of Illinois Urbana-Champaign

A. EDUCATIONAL BACKGROUND

The Pennsylvania State University

University Park, PA

January 2022 - Current

PhD, Biomedical Engineering, GPA: 3.4/4.0

Advisor: Dr. Cunjiang Yu

Jawaharlal Nehru Technological University

Kakinada, AP, India

May 2017 - July 2021

B.Tech, Electronics and Communication Engineering, GPA: 7/10

B. POSITIONS HELD

Research Affiliate

University of Illinois Urbana-Champaign

August 2024 - Current

Graduate Research Assistant

Pennsylvania State University

August 2023 - Current

Graduate Teaching Assistant

Pennsylvania State University

January 2023 – May 2023

Graduate Research Assistant

Pennsylvania State University

January 2022 – Dec 2022

Research Assistant

University of Tabuk, Saudi Arabia

July 2021 – Dec 2021

Research Assistant

Indian Institute of Technology Guwahati

Jan 2021 – July 2021

Summer Intern

Indian Institute of Technology Guwahati

May 2020 – July 2020

Summer Intern

Indian Institute of Technology Guwahati

May 2019 – July 2019

C. RESEARCH EXPERIENCE

University of Illinois Urbana-Champaign

Research Affiliate

August 2024 – Current

Advisor: Dr. Cunjiang Yu

Project 1: A fully wireless, AI-assisted drawn-on-scalp multimodal system for at-home sleep staging

I am developing a fully wireless, drawn-on-scalp wearable system for multimodal neurophysiological monitoring using EEG, EMG, and EOG signals. The project integrates drawn-on-skin electrodes with embedded wireless data acquisition hardware to enable comfortable, long-duration sleep recording outside the laboratory environment and uses AI-based models for automated sleep stage classification. The goal is to create an at-home, app-based sleep monitoring platform that enables accurate, accessible, and scalable sleep assessment without traditional polysomnography setups.

Project 2: Drawn-on-Skin (DoS) neural interface to enable motion artifact-free ambulatory stress monitoring in natural settings

Developed experimental paradigms for ambulatory stress monitoring using draw-on-skin (DoS) neural interface electrodes. Performed multimodal electrophysiological experiments on various subjects. I have analyzed the acquired ambulatory EEG/ECG/EDA data and derive state-of-the-art stress quantification measures using various signal processing and deep learning algorithms.

Project 3: Drawn-on-Skin (DoS) electrode array for acupuncture point localization via bioimpedance mapping

Involved in (1) designing DoS array, measuring impedance at PC6 point, (2) processing the impedance data using regression models, and (3) drafting the manuscript from the achieved outcomes.

Project 4: Drawn-on-Skin (DoS) electrode array for measuring electromyography (EMG) activity via hand gestures from hairy regions of the arm

Involved in (1) drawing process of DoS array on arms, (2) recording of EMG data from hairy regions on various subject's arm while they perform hand gestures, (3) processing the EMG data and classifying the gestures using machine learning models, and (4) drafting the manuscript.

Project 5: Optoelectronic bioink for remote, optical, and nongenetic cell modulation

Developed extensive signal processing algorithm for identifying R-peaks in the cardiomyocytes data to measure heart rate across different stimulation frequencies. The beating of cardiomyocyte cells was stimulated by an optical signal. Also worked on computing QRS morphologies of cardiomyocytes data under sub-threshold stimulation.

The Pennsylvania State University

Graduate

January 2022 – July 2024

Advisors: Dr. Cunjiang Yu and Dr. Xiao Liu

Project 1: Real-time prosthetic hand control via high-density electromyography from drawn-on-skin electrode arrays

Implemented various signal processing and deep learning feature extraction algorithms on EMG data recorded using DoS sensors. Developed deep encoding networks to recognize hand gestures in real-time. This model was used in real-time closed-loop control of prosthetic hands.

Project 2: Monitoring of arterial blood pressure via graphene bioimpedance tattoos

Extracted various features like diastolic BP, systolic BP, inflection point, and maximum slope from the signals recorded using graphene bioimpedance tattoos to predict the true BP. Developed optimized ensemble regression models (XGBoost, AdaBoost, Random Forest, Support Vector Regression, LightGBM & CatBoost) to predict true BP signal using the extracted features.

Project 3: Propagation of spontaneous brain activity under different states of anesthesia

I studied how the organization of brain changes spontaneously under different anesthetic states like wake, light and deep anesthesia. By understanding the propagation of brain activity, we can explain the underlying neural dynamics of brain under different states of consciousness. For this project, I worked on human, rat and monkey fMRI datasets, which involves pre-processing of the fMRI data.

Project 4: Investigation of coupling between CSF-BOLD signals under altered states of consciousness

I have done pre-processing of fMRI data to acquire CSF signal from the lower slices of 3rd and 4th ventricle in brain. Later, I evaluated the changes in CSF-BOLD coupling across different states of anesthesia by correlation.

University of Tabuk, Saudi Arabia

Undergraduate

January 2017 – May 2018

Advisor: Dr. Mohammed Alhartomi

Project: Sleep Apnea Detection in ECG Signals using Dynamical Component Analysis (DyCA) and Machine Learning

I developed two dimensionality reduction algorithms named DyCA and convolutional autoencoder to solve the problem of computational complexity in detection of sleep apnea using ECG Signals. Later I used various machine learning models to classify the features into apnea and non-apnea classes.

University of Geneva, Switzerland

Virtual

June 2021 – December 2021

Advisor: Dr. Tomas

Project: Feature Extraction for Attention Deficit Hyperactivity Disorder (ADHD) from Raw EEG Signals using Deep Learning Algorithms

Developed a 1D-convolution neural network to learn ADHD features from raw EEG signals. The dataset consists of two classes with eyes open and eyes close.

Indian Institute of Technology Guwahati, India

Summer Intern

May 2020 – July 2020

Advisor: Prof. Shaik Rafi Ahamed

Project: Epilepsy detection in EEG signals using machine learning algorithms

I have developed the state-of-the-art dimensionality reduction algorithms, namely SPPCA and SUBXPCA to increase the accuracy of various machine learning models in classification of epilepsy from EEG signals. This work is published in IEEE Sensors Journal.

D. TEACHING EXPERIENCE

The Pennsylvania State University

Teaching Assistant

January 2023 – May 2023

Taught the biomedical instrumentation laboratory course to the undergraduate students. This course involves the building of various electrical circuits, helping students to design the circuits. Held office hours and met with professor weekly to prepare for the upcoming week. Created and evaluated exam papers, projects and assignments for students.

E. JOURNAL PUBLICATIONS

1. **Muhammad Zubair** †, Nittin Murthi Dhekshinamoorthy †, Shubham Patel, Diego Hernandez, Cunjiang Yu*, **WearBioRAG: A Retrieval-Augmented Multi-Agent Assistant for Grounded Wearable Bioelectronics Design, Fabrication, and Biosignal Analysis**, *In preparation*, 2026
2. **Muhammad Zubair** †, Shubham Patel †, Longping Chen, Cunjiang Yu*, **Toward Intelligent Skin Haptics: The Emerging Role of Artificial Intelligence in Human-Machine Interaction**, *In preparation*, 2026
3. **Muhammad Zubair** †, Shubham Patel †, Shiyuan Duan, Longping Chen, Diego Hernandez, Haojun Xu, Cunjiang Yu*, **A Fully Wireless, AI-Assisted Drawn-on-Scalp Multimodal Neurophysiological Monitoring Device for At-Home Sleep Staging**, *In preparation*, 2026
4. **Muhammad Zubair**, Shubham Patel, Sumi Sekhar, Long Meng, Xiaogang Hu, Faheem Ershad, Cunjiang Yu*, **Real-Time Control of Prosthetic Hand via Drawn-on-Skin High-Density EMG Arrays and Deep Encoding Networks**, *Submitted*, 2026
5. Shubham Patel †, **Muhammad Zubair** †, Maggie Yang, Faheem Ershad, Charles Shang, Min Zhao, Cunjiang Yu*, **Drawn-on-Skin Electrode Array Enables Acupuncture Point Localization via Bioimpedance Mapping**, *Submitted*, 2026
6. **Muhammad Zubair** †, Shubham Patel †, Shiyuan Duan, Longping Chen, Haojun Xu, Mike Yu, Sumi Sekhar, Phillip Comeaux, Lei Gonzalez, Luis Contreras, Faheem Ershad, Cunjiang Yu*, **Long-Hair Compatible, Imperceptible Drawn-on-Scalp Interfaces for Wireless Multimodal Neurophysiology and Ambulatory Stress Quantification**, *Submitted*, 2026
7. Shubham Patel †, **Muhammad Zubair** †, M. Hussain, Luis Contreras, X. Wang, Y. Lu, W. Zhu, Faheem Ershad, Cunjiang Yu, **High fidelity electrophysiological sensing on non-glabrous skin with drawn-on- skin bioelectronics**, *Submitted*, 2026
8. Shiyuan Duan †, **Muhammad Zubair** †, Cunjiang Yu*, **Artificial Intelligence Enabled Inferential Bioelectronics: Review**, *In preparation*, 2026
9. Faheem Ershad, Zhoulyu Rao, Sushila Maharajan, Fernanda C. Paccola Mesquita, Junkyu Ha, Lei Gonzalez, Tahir Haideri, Ernesto Curty da Costa, Angel Moctezuma-Ramirez, Yuqi Wang, Seonmin Jang, Yuntao Lu, Shubham Patel, Xiaoyang Wang, Yifan Tao, Joshua Weygant, Carlos Ezio Garciamendez-Mijares, Luis Carlos Orrantia Clark, **Muhammad Zubair**, Xiaojun Lance Lian, Abdelmotagaly Elgalad, Jian Yang, Camila Hochman-Mendez, Yu Shrike Zhang*, and Cunjiang Yu*, **Bioprinted optoelectronically active cardiac tissues**, *Science Advances*, 2025 Jan 24;11(4):eadt7210
10. Yu Cheng, Yifei Zhan, Fangyi Guan, Junli Shi, Jingxiao Wang, Yi Sun, **Muhammad Zubair**, Cunjiang Yu, Chuan Fei Guo, **Displacement-pressure biparametrically regulated softness sensory system for intraocular pressure monitoring**, *National Science Review*, Volume 11, Issue 6, June 2024, nwae050, <https://doi.org/10.1093/nsr/nwae050>
11. **M. Zubair** †, Umesh Kumar Naik M †, Rajesh Kumar Tripathy, S. Alzahrani, M. Alhartomi, S. R. Ahamed. **Detection of Sleep Apnea from ECG Signals Using Sliding Singular Spectrum Based Subpattern Principal Component Analysis**, in *IEEE Transactions on Artificial Intelligence*, vol. 5, no. 6, pp. 2897- 2906, June 2024, doi: [10.1109/TAI.2023.3329455](https://doi.org/10.1109/TAI.2023.3329455).
12. S. Agarwal and **M. Zubair**, “Classification of Alcoholic and Non-Alcoholic EEG Signals Based on Sliding-SSA and Independent Component Analysis,” in *IEEE Sensors Journal*, vol. 21, no. 23, pp. 26198- 26206, 1 Dec.1, 2021, doi: [10.1109/JSEN.2021.3120885](https://doi.org/10.1109/JSEN.2021.3120885).
13. **M. Zubair** et al., “Detection of Epileptic Seizures from EEG Signals by Combining Dimensionality Reduction Algorithms with Machine Learning Models,” in *IEEE Sensors Journal*, vol. 21, no. 15, pp. 16861-16869, 1 Aug.1, 2021, doi: [10.1109/JSEN.2021.3077578](https://doi.org/10.1109/JSEN.2021.3077578).

F. CONFERENCE PUBLICATIONS

1. **M. Zubair**, Tanisha B. Antariksh T. Umesh Kumar Naik M. “Detection of Lung Nodules in Chest Radiographs using Wiener Filter and D-CNN Model,” *Proceedings of the International Conference on Interdisciplinary Research in Technology and Management (IRTM, 2021)*, 26-28 February, 2021, Kolkata, India (1st ed.). CRC Press. <https://doi.org/10.1201/9781003202240>

2. **M. Zubair**, M. Umesh Kumar Naik and G. N. V. S. C. Mouli, "Facile Diabetic Retinopathy Detection using MRHE-FEED and Classification using Deep Convolutional Neural Network," 2020 *IEEE 15th International Conference on Industrial and Information Systems (ICIIS)*, RUPNAGAR, India, 2020, pp. 247-252, doi: [10.1109/ICIIS51140.2020.9342676](https://doi.org/10.1109/ICIIS51140.2020.9342676).
3. **M. Zubair**, G. N. V. S. Chandra Mouli and R. A. Shaik, "Removal of Motion Artifacts from ECG signals by Combination of Recurrent Neural Networks and Deep Neural Networks," 2020 *2nd International Conference on Electrical, Control and Instrumentation Engineering (ICECIE)*, Kuala Lumpur, Malaysia, 2020, pp. 1-7, doi: [10.1109/ICECIE50279.2020.9309609](https://doi.org/10.1109/ICECIE50279.2020.9309609).
4. **M. Zubair**, U. Kumar Naik M and R. Ahamed Shaik, "EMG Artifacts Removal from Multi-Channel EEG Signals using Multi-Channel Singular Spectrum Analysis," 2020 *IEEE Applied Signal Processing Conference (ASPCON)*, Kolkata, India, 2020, pp. 183-187, doi: [10.1109/ASPCON49795.2020.9276684](https://doi.org/10.1109/ASPCON49795.2020.9276684).

G. CONFERENCE PRESENTATIONS

1. **M. Zubair**, M. Umesh Kumar Naik and G. N. V. S. C. Mouli, "Facile Diabetic Retinopathy Detection using MRHE-FEED and Classification using Deep Convolutional Neural Network," 2020 IEEE 15th International Conference on Industrial and Information Systems (ICIIS), RUPNAGAR, India, 2020, pp. 247-252, doi: [10.1109/ICIIS51140.2020.9342676](https://doi.org/10.1109/ICIIS51140.2020.9342676).

H. BOOK CHAPTERS

Shrey Agarwal, Yashaswi Upmon, **Muhammad Zubair**, Umesh Kumar Naik Mudavath,
Chapter 6 - **A robust peak detection algorithm for localization and classification of heart sounds in PCG signals**,
Editor(s): Rajesh Kumar Tripathy, Ram Bilas Pachori, *Signal Processing Driven Machine Learning Techniques for Cardiovascular Data Processing*, Academic Press, 2024, Pages 81-97, ISBN 9780443141416,
<https://doi.org/10.1016/B978-0-44-314141-6.00011-6>.

I. HONORS AND AWARDS

1. Best thesis award for undergraduate project work (2021)
2. Featured article in IEEE Sensors Journal for Classification of Alcoholic and Non-Alcoholic EEG Signals Based on Sliding-SSA and Independent Component Analysis (2021)
3. All India Council of Technical Education (AICTE) - Vishwakarma Award (2020)

J. PROFESSIONAL ORGANIZATIONS

1. IEEE Graduate Student Member (2022-Current)
2. IEEE Student Member (2020-Current)
3. IEEE Engineering in Medicine and Biology Society Member (2020-Current)
4. IEEE Signal Processing Society Member (2020-Current)
5. IEEE Biometrics Council (2020-Current)
6. IEEE Young Professionals (2020-Current)
7. IEEE Council on RFID (2020-Current)

K. JOURNAL PEER REVIEWER

Reviewed more than 50 articles from the following journals:

1. IEEE Transactions on Instrumentation and Measurement
2. IEEE Transactions on Biomedical Engineering
3. IEEE Sensors Journal
4. IEEE Sensors Letters
5. Biomedical Signal Processing and Control
6. Nature Scientific Reports
7. Signal, Image and Video Processing
8. Clusters Computing