Shidhartho Roy

EDUCATION

Carnegie Mellon University — Pittsburgh, PA
Ph.D. in Biomedical Engineering — August 2024-Present

- Conducting PhD research on EEG-based biomarkers of pain dysregulation in sickle cell disease, integrating extended reality (XR) paradigms to assess cognitive and sensory processing in real-world contexts.
- Bradford and Diane Smith Fellowship in Engineering, BME Mentorship Award

Carnegie Mellon University — Pittsburgh, PA
Master of Science in Biomedical Engineering – Research — August 2023
GPA: 3.69/4.0

- Relevant technical coursework: Mathematical and Computational Foundations for Machine Learning, Introduction to Machine Learning, Convex Optimization, Biostatistics
- BME Research Excellence Award

Khulna University of Engineering and Technology — Khulna, Bangladesh
Bachelor of Science in Electrical and Electronic Engineering — March 2020
GPA: 3.64/4.0

- Champion - Ignition (national competition) - Project: hospital-based healthcare monitoring systems, and Champion - Builtech Case Study) - Project: smart, energy-efficient high-rise building design along with five other national and international awards
- Research Secretary - IEEE KUET SB, General Secretary, EEE Makers Hub; Vice President, EEE Association

EXPERIENCE

Carnegie Mellon University

PhD Student, Biomedical Engineering — August 2024 – Present

- Identifying NIRS and EEG-based biomarkers of chronic pain by comparing thermal pain-evoked neural responses between sickle cell disease patients and healthy controls
- Designing an XR-based EEG protocol delivering immersive, haptically synchronized pain stimuli to chronic pain patients

Research Associate, Electrical & Computer Engineering — August 2023 – August 2024

- Investigated cognitive load-induced hemodynamic changes in SCD patients using FD-NIRS during DSST to inform the design of cognitive workload-aware user interfaces for clinical populations.

Graduate Research Assistant, Biomedical Engineering — January 2022 - August 2023

- Characterized relationships between melanin concentration and NIRS signals, revealing a 9% decrease in arterial oxygen saturation in participants with a higher melanin index, along with a 53% reduction in SNR estimation
- Conceptualized a novel optode holder design prototype enhancing NIRS capability to study curly hair subjects, leading to improved biomarker detection and signal quality

Khulna University of Engineering and Technology

Researcher, Artificial Intelligence in Medical Image Computing Lab — March 2020 – December 2021

- Collaborated on designing skip connections to regain the local information from shallower layers for heart segmentation in CT and MRI images
- Implemented residual skip connection consisting of a convolutional and regularizing path to compensate lost spatial information in the segmentation and localization

PROJECTS

Pain Perception Estimation during Vaso-Occlusive Crisis in Chronic Pain Patients — February 2021 - October 2021
Carnegie Mellon University — Pittsburgh, PA

- Characterizing multimodal physiological signals (NIRS, EEG, HRV, respiration, pupillometry) during vaso-occlusive crisis (VOC) episodes in chronic pain patients to inform future development of objective pain estimation models.
- Conducted cross-modal validation of physiological responses against fMRI-derived pain biomarkers to identify features relevant for modeling pain perception in real-world clinical scenarios.

Neurophysiological Correlates of Pain During Vaso-Occlusive Crises — August 2023 - August 2024
Carnegie Mellon University — Pittsburgh, PA

- Investigated cognitive load–induced hemodynamic changes in adults with sickle cell disease (SCD) using frequency-domain near-infrared spectroscopy (FD-NIRS) during Digit Symbol Substitution Task (DSST).
- Detected greater post-task StO_2 decline in SCD patients, indicating impaired neurovascular adaptation to cognitive load despite similar task performance.

Investigating Melanin-Induced Bias in Near-Infrared Spectroscopy — January 2022 – August 2023
Carnegie Mellon University — Pittsburgh, PA

- Designed and conducted a human-subject study using frequency-domain NIRS (FD-NIRS) to quantify melanin's impact on signal-to-noise ratio and oxygenation metrics across a diverse population (N=35).
- Traced melanin-induced NIRS signal degradation to 690 nm absorption and noise, providing mechanistic insight into pigmentation bias and informing equitable optical device design

Fake/Real Emotion Brain Pathways January 2022 - May 2022
Carnegie Mellon University Pittsburgh, PA

- Designed and executed an fMRI experiment to decode real vs. self-generated emotions using block-design music stimuli, integrating ICA, ASL, and GLM-based whole-brain analysis across multiple MR modalities.
- Identified activation shifts from emotion-generating regions (e.g., insula, supramarginal gyrus) to cognitive control networks (e.g., frontal pole, precuneus) during fake emotion, supporting differential neural processing of volitional affective states.

EEG based stress analysis for video game play February 2019 - April 2021
Khulna University of Engineering and Technology Khulna, Bangladesh

- Developed a novel EEG-based BAR features for stress analysis in video gameplay, identifying strategic games as the most stressful
- Modeled gameplay stress adaptability and post-game relaxation, revealing non-gamers' heightened stress and the efficacy of low-pitch music for relaxation

Dermo-DOCTOR July 2019 - August 2020
Artificial Intelligence in Medical Image Computing Lab Khulna, Bangladesh

- Engineered a CNN-based network with class rebalancing for state-of-the-art lesion detection on ISIC-2016 and ISIC-2017 datasets
- Incorporated segmented lesions and dual-encoder features in CNNs to improve lesion detection, while ensuring adaptability and effectiveness in diverse scenarios

DRNet: Diabetic Retinopathy network April 2019 - June 2020
Artificial Intelligence in Medical Image Computing Lab Khulna, Bangladesh

- Introduced a unique residual skip connection approach within DRNet to preserve important spatial information in medical image processing, optimizing for better detection results.

Multi-class probabilistic atlas-based whole heart segmentation March 2019 - March 2020
Khulna University of Engineering and Technology Khulna, Bangladesh

- Implemented a robust whole heart segmentation pipeline using CT and MRI, validated by integrating anatomical knowledge and Bayes inference for enhanced segmentation
- Identified 2D CNN limitations in WHS and evaluating with a multi-resolution registration pipeline

PUBLICATIONS

- Roy, S., Wu, J., Cao, J., Disu, J., Bharadwaj, S., Meinert-Spyker, E., Grover, P., Kainerstorfer, J. M., & Wood, S. (2024). Exploring the impact and influence of melanin on frequency-domain near-infrared spectroscopy measurements. Journal of Biomedical Optics, 29(S3), S33310 **(*Top paper selection*, JBO 2024).**
- Roy, S., Islam, M., Yusuf, M. S. U., & Jahan, N. (2022). *EEG based stress analysis using rhythm specific spectral feature for video game play*. Computers in Biology and Medicine, 148, 105849.
- Hossain, E., Roy, S., Mohammad, N., Nawar, N. and Dipta, D.R., 2021. *Metrics and enhancement strategies for grid resilience and reliability during natural disasters*. Applied energy, 290, p.116709.
- Hasan, M. K., Roy, S., Mondal, C., Alam, M. A., Elahi, M. T. E., Dutta, A., Raju, T.U.., Jawad, M.T., & Ahmad, M. (2021). *Dermo-DOCTOR: A framework for concurrent skin lesion detection and recognition using a deep convolutional neural network with end-to-end dual encoders.* Biomedical Signal Processing and Control, 68, 102661.
- Ghosh, T. K., Hasan, M. K., Roy, S., Alam, M. A., Hossain, E., & Ahmad, M. (2021). *Multi-class probabilistic atlas-based whole heart segmentation method in cardiac CT and MRI*. IEEE Access, 9, 66948-66964.
- Hasan, M. K., Alam, M. A., Elahi, M. T. E., Roy, S., & Martí, R. (2021). *DRNet: Segmentation and localization of optic disc and Fovea from diabetic retinopathy image.* Artificial Intelligence in Medicine, 111, 102001.
- Hasan, M. K., Alam, M. A., Dahal, L., Roy, S., Wahid, S. R., Elahi, M. T. E., & Khanal, B. (2022). *Challenges of deep learning methods for COVID-19 detection using public datasets.* Informatics in Medicine Unlocked, 30, 100945.

CONFERENCES

- Roy, S., Mossazghi, N., Bulger, E., Lin, J., Saber, C., Shinn-Cunningham, B., Kainerstorfer, J. M., Xu, J. Z., & Wood, S. (2024). The potential of using a hemodynamic signal as a biomarker of cognitive load in sickle cell disease. (SfNIRS, UK).
- Mossazghi, N., Roy, S., Disu, J., Abdelmohsen, L., Meinert-Spyker, E., Titikhsha, A., & Wood, S. (2024). Increased synchronization during cognitive flexibility task in sickle cell disease. Proceedings of the OHBM, Brisbane, Australia.
- Roy, S., Duong, A., Meinert-Spyker, E., Cao, J., Kwasa, J., Kainerstorfer, J. M., Grover, P., & Wood, S. (2026). *Novel optode sensor development for functional near-infrared spectroscopy systems and its use in dark, coarse, and curly hair.* Oral presentation, SPIE Photonics West, San Francisco, CA.

SKILLS

Programming languages: Python, C, C#, C++, Java, R.
Frameworks/ Technologies: Scikit, NLTK, Unity Game Engine, TensorFlow, Keras, MATLAB, Arduino, Simulink, GitHub, 3D printing, Monte Carlo simulations, laser cutting.