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## Shidhartho Roy

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### EDUCATION

#### Carnegie Mellon University

Master of Science in Biomedical Engineering – Research

GPA: 3.69/4.0

Pittsburgh, PA

August 2023

- Thesis title: Characterization of Skin Pigmentation Influence on Near-Infrared Spectroscopy, advisors: Dr. Sossena Wood, Dr. Pulkit Grover.
- BME Research Excellence Award

#### Khulna University of Engineering and Technology

Bachelor of Science in Electrical and Electronic Engineering

GPA: 3.64/4.0

Khulna, Bangladesh

March 2020

- Thesis title: EEG based stress analysis using rhythm specific spectral feature for video game play, advisors: Dr. Md. Salah Uddin Yusuf, Dr. Monira Islam
- Champion - Ignition (national competition) - Project: hospital-based healthcare monitoring systems, and Champion - Builttech Case Study) - Project: smart, energy-efficient high-rise building design along with five other national and international awards

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### EXPERIENCE

#### Carnegie Mellon University

Research Associate, Electrical & Computer Engineering

August 2023 - Present

- Analyzing human decision-making processes using EEG in the realm of human-computer interaction, aiming to optimize user interface design
- Investigating the impact of skin pigmentation and hair on Near-Infrared Spectroscopy (NIRS) signal quality across wavelengths, enhancing the understanding and mitigation of its effects on measurements

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 healthy participants with a higher melanin index along with 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

#### Daffodil International University

Lecturer, Electrical and Electronic Engineering

January 2021 – December 2021

- Instructed a combined total of 240 undergraduate students across six classes in programming and electronics design and supervised two students through their research endeavors in machine learning
- Coordinated with industry and academia personnel for revenue modeling of Daffodil 10 kWp Grid Tied Solar Power System, resulting in a 6% return on investment increase

#### 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

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### PROJECTS

#### XR

##### Liquid PDF

Carnegie Mellon University

November 2023 - Present

Pittsburgh, PA

- Implemented a gaze-controlled, customizable spatial arrangement in the Liquid PDF interface, allowing users to seamlessly transition their focus between the main document and supplementary resources
- Utilizing Bidirectional Encoder Representations from Transformers to identify dominant themes and topics

##### ZenQuest: Mental therapy

Carnegie Mellon University

September –December 2023

Pittsburgh, PA

- Collaborated in the implementation of an intuitive user interface in virtual reality for stress level input, leveraging hand tracking, dynamic animation, and a music engine
- Engineered a tangible input system, mimicking bubble popping, to provide a multisensory experience

## DEEP LEARNING

### **Air Revitalization System Analytics for Deep Space Operations**

Carnegie Mellon University

January 2023 - May 2023

Pittsburgh, PA

- Partitioned complex datasets from ECLSS (Environmental Control and Life Support System) Air Revitalization System for effective categorization of data patterns for enhanced analytical insights
- Engineered a Hidden Markov Model for air filter system states and transitions, and an LSTM network for sensor data recovery, achieving significant improvements in data generation accuracy and predictive reliability

### **Dermo-DOCTOR**

Khulna University of Engineering and Technology

July 2019 - August 2019

Pittsburgh, PA

- 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**

Khulna University of Engineering and Technology

July 2019 - August 2019

Dhaka, Bangladesh

- Introduced a unique residual skip connection approach within DRNet to preserve important spatial information in medical image processing, optimizing for better detection results.
- Validated the network's effectiveness across multiple public datasets, achieving superior segmentation performance and localization accuracy

### **Multi-class probabilistic atlas-based whole heart segmentation**

Khulna University of Engineering and Technology

July 2019 - August 2019

Dhaka, 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 charted future research directions, using a multi-resolution registration pipeline for evaluation

### **Automatic mass classification in breast**

Khulna University of Engineering and Technology

July 2019 - August 2019

Khulna, Bangladesh

- Devised a four-step pipeline using VGG19 and bagged decision trees, optimized via SVM with RBF kernel for robust mass classification.
- Utilized grid search to optimize SVM penalty parameters, achieving a peak AUC of  $0.994 \pm 0.003$  on the INbreast dataset with 5-fold cross-validation.

### **COVID-19 detection**

Artificial Intelligence in Medical Image Computing Lab

February 2021 - October 2021

Dhaka, Bangladesh

- Developed CVR-Net, a multi-scale, multi-encoder ensemble model for COVID-19 detection, achieving superior accuracy in both X-ray and CT image classification
- Evaluated CVR-Net's performance across diverse classification tasks and data sources, highlighting the necessity for independent test sets and balanced demography to mitigate biases and overfitting

## COGNITIVE + NEURO SCIENCE

### **Cognitive Analysis in Sickle Cell Disease**

Carnegie Mellon University

August 2023 - Present

Pittsburgh, PA

- Utilized EEG to detect and delineate specific cognitive function impairments in SCD patients compared to healthy controls, aiming to establish a clear cognitive signature unique to SCD
- Employed signal processing techniques like hemodynamic response analysis and component analyses to reveal distinct brain response patterns in SCD patients, potentially identifying specific EEG frequency bands that are most affected by the disease

### **EEG based stress analysis for video game play**

Khulna University of Engineering and Technology

July 2019 - August 2019

Khulna, Bangladesh

- Pioneered 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

## Fake/Real Emotion Brain Pathways

Carnegie Mellon University

January 2022 - May 2022

Pittsburgh, PA

- Leveraged an interdisciplinary approach combining neuroscience, psychology, and data analytics to investigate complex emotional states
- Hypothesized and observed differential BOLD responses in the limbic system and prefrontal cortex during fake emotion generation

## ELECTRICAL ENGINEERING

### Grid resilience

Khulna University of Engineering and Technology

March 2020 - February 2021

Pittsburgh, PA

- Designed novel metrics like 'resilience risk factor' and applied Monte Carlo Simulations to categorize U.S. grids into four resilience tiers
- Analyzed natural disaster impacts on grids and proposed mitigation strategies, exploring the role of IoT and AI in enhancing resilience

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## PUBLICATIONS

### Journal publications:

1. **Roy, S.**, Islam, M., Yusuf, M.S.U. and Jahan, N., 2022. EEG based stress analysis using rhythm specific spectral feature for video game play. *Computers in Biology and Medicine*, 148, p.105849. PMID: 35870317
2. Hasan, M.K., Alam, M.A., Dahal, L., **Roy, S.**, Wahid, S.R., Elahi, M.T.E., Martí, R. and Khanal, B., 2022. Challenges of deep learning methods for COVID-19 detection using public datasets. *Informatics in Medicine Unlocked*, 30, p.100945. PMID: 35434261
3. Hasan, M.K., **Roy, S.**, Mondal, C., Alam, M.A., Elahi, M.T.E., Dutta, A., Raju, S.T.U., Jawad, M.T. and 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, p.102661.
4. 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.
5. Ghosh, T.K., Hasan, M.K., **Roy, S.**, Alam, M.A., Hossain, E. and Ahmad, M., 2021. Multi-class probabilistic atlas-based whole heart segmentation method in cardiac CT and MRI. *IEEE Access*, 9, pp.66948-66964.
6. Tabassum, S., Rahman, T., Islam, A.U., Rahman, S., Dipta, D.R., **Roy, S.**, Mohammad, N., Nawar, N. and Hossain, E., 2021. Solar energy in the United States: Development, challenges and future prospects. *Energies*, 14(23), p.8142.
7. Hasan, M.K., Alam, M.A., **Roy, S.**, Dutta, A., Jawad, M.T. and Das, S., 2021. Missing value imputation affects the performance of machine learning: A review and analysis of the literature (2010–2021). *Informatics in Medicine Unlocked*, 27, p.100799.
8. Hasan, M.K., Alam, M.A., Elahi, M.T.E., **Roy, S.** and Martí, R., 2021. DRNet: Segmentation and localization of optic disc and Fovea from diabetic retinopathy image. *Artificial Intelligence in Medicine*, 111, p.102001. PMID: 33461693

### Thesis paper:

1. **Roy, S.**, Cao, J., Wu, J., Disu, J., Bharadwaj, S., Meinert-Spyker, E., Grover, P., Kainerstorfer, J. M., & Wood, S. (2023). Characterization of Skin Pigmentation Influence on Near-Infrared Spectroscopy. Unpublished Master's Thesis (in preparation to journal submission), Carnegie Mellon University, Pittsburgh, PA.

### Conference presentations:

1. Hasan, M.K., Aleef, T.A. and **Roy, S.**, 2020, June. Automatic mass classification in breast using transfer learning of deep convolutional neural network and support vector machine. In *2020 IEEE Region 10 Symposium (TENSYMP)* (pp. 110-113). IEEE.
2. Rohan, T.I., Yusuf, M.S.U., Islam, M. and **Roy, S.**, 2020, June. Efficient approach to detect epileptic seizure using machine learning models for modern healthcare system. In *2020 IEEE Region 10 Symposium (TENSYMP)* (pp. 1783-1786). IEEE.
3. **Roy, S.**, Islam, M., Yusuf, M.S.U. and Rohan, T.I., 2020. Frequency Impact Analysis with Music-Evoked Stimulated Potentials on Human Brain. In *Innovations in Electronics and Communication Engineering: Proceedings of the 8th ICIECE 2019* (pp. 505-513). Springer Singapore.
4. Hasan, M.M., Yusuf, M.S.U., Rohan, T.I. and **Roy, S.**, 2019, December. Efficient two stage approach to detect face liveness: Motion based and Deep learning based. In *2019 4th International Conference on Electrical Information and Communication Technology (EICT)* (pp. 1-6). IEEE.
5. Yusuf, M.S.U., Islam, M. and **Roy, S.**, 2019, December. Stress Identification during Sustained Mental Task and Brain Relaxation Modeling with beta/alpha Band Power Ratio. In *2019 4th International Conference on Electrical Information and Communication Technology (EICT)* (pp. 1-5). IEEE.

6. **Roy, S.,** Yusuf, M.S.U., Islam, M. and Rohan, T.I., 2019, September. Age based mood swing analysis and brain mapping for music genre. In *2019 5th International Conference on Advances in Electrical Engineering (ICAEE)* (pp. 165-170). IEEE.
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#### 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, Optics software and technology, Certified level 2 MR personnel, Laser cutting.