

S M Taslim Uddin Raju

📍 West Haven, CT, USA

✉️ smturaju@uwaterloo.ca

☎️ +1 (203) 410-1912

🌐 [raju32742.github.io](https://github.com/raju32742)

🌐 [insmturaju](#)

🌐 [raju32742](#)

Research Interests

My research focuses on developing multimodal machine learning systems for healthcare by integrating Graph Neural Networks, Vision Transformers, and Large Language Models. I specialize in digital pathology, non-invasive physiological monitoring using smartphone-based PPG, and medical signal processing. I aim to build intelligent, scalable solutions for clinical diagnostics, decision support, and automated reporting. My work emphasizes real-world applicability, bridging advanced AI techniques with practical healthcare needs.

Education

09/2023 – 04/2025	University of Waterloo, Waterloo, ON N2L 3G1, Canada MAsc. in Electrical and Computer Engineering (ECE) – Research GPA: - 85% Thesis: Advanced AI for Histopathological Whole Slide Image Classification and Captioning Specialized: Pattern Analysis and Machine Intelligence (Now Artificial intelligence) Supervisor: Prof. Fakhri Karay Core Courses: Introduction to Machine Learning, Advance Deep Learning, Data and Knowledge Modelling and Analysis
06/2019 – 12/2022	Khulna University of Engineering & Technology, Khulna, Bangladesh Master of Science in Computer Science and Engineering (CSE) – Research GPA: - 4.00/4.00 Thesis: Hemoglobin and Glucose Levels Estimation Techniques Using Optimal PPG Characteristic Features of Smartphone Videos Supervisor: Prof. M.M.A Hashem Core Courses: Advance Deep Learning, Bioinformatics, Soft Computing, Advance Natural Language Processing
04/2015 – 02/2019	Khulna University of Engineering & Technology, Khulna, Bangladesh Bachelor of Science in Computer Science and Engineering (CSE) GPA: - 3.85/4.00 (3 rd Position) Thesis: A Study on Non-Invasive Hemoglobin Measurement Techniques Supervisor: Prof. M.M.A Hashem Core Courses: Machine Learning, Artificial Intelligence, Natural Language Processing, Biomedical Engineering

Professional Appointments/Experiences

09/2023 – 04/2025	University of Waterloo, Waterloo, ON Machine Learning Graduate Researcher, Pattern Analysis and Machine Intelligence (Now AI) Lab <ul style="list-style-type: none">Advanced research in caption generation from histopathological whole slide image (WSI) through Transformer and UNet-Based Adversarial Autoencoder architectures.Specialized in microscopic WSI analysis, developing Vision Transformers and Graph Neural Networks for advanced digital pathology tasks, such as classification and caption generation with LLMs
01/2024 – 04/2025	Teaching Assistant, Department of Electrical and Computer Engineering <ul style="list-style-type: none">Courses: MTE 241 – Introduction to Computer Structures and Real-Time Systems, ECE 459 – Programming for Performance, and ECE 222 – Digital ComputersContributed to course delivery by leading labs, grading assignments and exams, and offering academic support through office hours
12/2020 – 07/2023 (study leave)	Khulna University of Engineering & Technology, Khulna, Bangladesh Lecturer, Department of Computer Science and Engineering (CSE) <ul style="list-style-type: none">Courses: CSE 1101 – Structure Programming, CSE 1102 – Structure Programming Laboratory, CSE 2113 – Computer Architecture and CSE 4112 – Machine LearningTaught undergraduate courses, supervised student projects, and mentored students through academic and technical guidance to support their learning and development
01/2020 – 11/2020	Graduate Researcher, Department of Computer Science and Engineering (CSE) <ul style="list-style-type: none">Pioneered a non-invasive 850 nm NIR-LED wearable device integrated with a smartphone to capture fingertip videos dataset and PPG signal extraction.Engineered advanced ML pipelines – leveraging Deep Neural Networks (DNNs) and Multigene Genetic Programming (MGGP) – to estimate blood glucose, and hemoglobin levels from PPG extracted features
03/2019 – 01/2020	Eastern University, Dhaka, Bangladesh Lecturer, Department of Computer Science and Engineering <ul style="list-style-type: none">Courses: 06131205 – Structure Programming, 06131206 – Structure Programming Laboratory, 07142213 – Computer Architecture, 05413109 – Numerical MethodsDelivered undergraduate lectures, designed course materials and assessments, and guided students through academic support

Projects (Only Major Project*)

09/2024 – 05/2025	GNN-ViTCap: Microscopic Whole Slide Image Classification and Captioning University of Waterloo, Pattern Analysis and Machine Intelligence Lab <ul style="list-style-type: none">Designed integrated framework combining graph neural networks and LLMs for whole slide images classification and captioningAchieved high accuracy with BLEU-4 = 81.1% and METEOR = 56.7%, with BioMedGPT in image captioning
05/2024 – 08/2024	LLM-Q&A: Automated Medical Q & A Systems Using Fine-Tuned Large Language Models University of Waterloo, Pattern Analysis and Machine Intelligence Lab <ul style="list-style-type: none">Implemented an automated medical Q&A system by fine-tuning LLM models such as GPT-2, Llama2, Bloom, and T5Evaluated using BLEU and ROUGE metrics, with T5 showing superior performance in generating accurate medical answers
09/2023 – 04/2024	TransUAAE-CapGen: Caption Generation from Histopathological Whole Slide Images University of Waterloo, Pattern Analysis and Machine Intelligence Lab <ul style="list-style-type: none">Developed a hybrid UNet-based Adversarial Autoencoder and transformer to generate captions for histopathological images.Achieved high accuracy with BLEU-4 = 86.8% and ROUGE = 89.3%, outperforming traditional LSTM-based models
05/2022 – 05/2023	DNN-BP: A Deep Learning Framework for Blood Pressure Estimation using Optimized PPG Features Khulna University of Engineering & Technology <ul style="list-style-type: none">Developed a DNN-based algorithm to estimate systolic and diastolic blood pressure (BP) using only Photoplethysmography (PPG) signals from 125 subjects with 218 recordsApplied ensemble feature selection on time-domain, frequency-domain, and statistical PPG features, achieving MAE = 2.48 mmHg (SBP) and 1.499 mmHg (DBP), meeting AAMI and BHS standards
01/2020 – 02/2023	Non-Invasive Blood Component Levels Estimation Using Smartphone Fingertip Video Khulna University of Engineering & Technology <ul style="list-style-type: none">Introduced a non-invasive method for monitoring Glucose and Hemoglobin levels using Smartphone video and NIR LED deviceGenerated PPG signal, extracted the PPG features and fed the features to DNN-based models to estimate blood component levels
06/2019 – 08/2020	Dermo-DOCTOR Khulna University of Engineering & Technology, Artificial Intelligence in Medical Image Computing Lab <ul style="list-style-type: none">Engineered a CNN-based network with class rebalancing for state-of-the-art lesion detection on ISIC-2016 and ISIC-2017 datasetsIntegrated segmented lesions and dual-encoder CNN features to enhance lesion detection across varied conditions

Publications

Published/Accepted Manuscripts

- (J1) N. Hasan, S. B. Shuvo, M. H. Ankon, **S. T. U. Raju**, and N. Siddique, "TransfusionNet: Framework for Cervical Cancer Detection using Deep Learning with Multi-level Bi-Fusion and Aggregated-Fusion", *Results in Engineering*, Elsevier, p107174, vol. 28, Dec. 2025.
- (C1) S. T. Uddin, W. Mostary, M. N. Sakib, **S. T. U. Raju**, and A. R. Mohammad, "Enhancing Automated Medical Question-Answer Systems Using Fine-Tuned Large Language Models." In *2025 2nd International Conference on Next-Generation Computing, IoT and Machine Learning (NCIM)*, pp. 1-6. IEEE, 2025.
- (C2) M. R. Haque, M. M. Islam, **S. T. U. Raju**, H. Altaheri, L. Nassar, and F. Karray, "MMFformer: Multimodal Fusion Transformer Network for Depression Detection", *International Conference on Systems, Man, and Cybernetics*, IEEE, Austria, 2025 [Accepted Tier B1]
- (C3) M. R. Haque, M. M. Islam, **S. T. U. Raju**, H. Altaheri, L. Nassar, and F. Karray, "Multimodal Depression Detection through Mutual Transformer", *IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, IEEE, Austria, 2025 [Accepted Tier B1]
- (C4) **S. T. U. Raju**, M. M. Islam, M. R. Haque, H. Altaheri, and F. Karray, "GNN-ViTCap: GNN-Enhanced Multiple Instance Learning with Vision Transformers for Whole Slide Image Classification and Captioning", *International Joint Conference on Neural Networks (IJCNN 2025)*, 30 June - 5 July 2025, IEEE, Rome, Italy [**Tier A***] [**Thesis Work**]
- (C5) **S. T. U. Raju**, A. R. Mohammad, M. M. Islam, and F. Karray, "TransUAAE-CapGen: Caption Generation from Histopathological Patches through Transformer and UNet-Based Adversarial Autoencoder", *IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC)*, IEEE, Borneo Convention Centre Kuching, Sarawak, Malaysia, 6 - 10 October 2024 [**Tier B1 Conference**] [**Thesis Work**]

- (J2) S. T. U. Raju, S. A. Dipto, M. I. Hossain, M. A. S. Chowdhury, F. Haque, A. T. Nashrah, A. Nishan, M. M. H. Khan, and M. Hashem, "DNN-BP: A Novel Framework for Cuffless Blood Pressure Measurement from Optimal PPG Features using Deep Learning Model," *Medical & Biological Engineering & Computing*, Springer, pp. 1–22, 2024.
- (J3) A. Nishan, S. T. U. Raju, M. I. Hossain, S. A. Dipto, S. T. Uddin, A. Sijan, M. A. S. Chowdhury, A. Ahmad, and M. M. H. Khan, "A Continuous Cuffless Blood Pressure Measurement from Optimal PPG Characteristic Features using Machine Learning Algorithms," *Heliyon*, Elsevier, vol. 10, no. 6, 2024.
- (C6) M. Jamil, S. Oman, S. T. U. Raju, and F. Soshi, "A Novel Framework for Enhancing Sensor Data Analysis: Label-Preserving Augmentation and Probabilistic Balancing," *26th International Conference on Computer and Information Technology (ICCIT)*, IEEE, Cox's Bazar, Bangladesh, 13-15 December, 2023
- (C7) H. Neha, S. Sakib, F. Sadaf, and S. T. U. Raju, "Mobile Application to Collect Data and Measure Blood Component Level in a Non-Invasive Way", *26th International Conference on Computer and Information Technology (ICCIT)*, IEEE, Cox's Bazar, Bangladesh, 13-15 December, 2023
- (C8) L. Hossain, I. Hossain, S. T. U. Raju, MS Salim, J. Saha, "A Novel Technique for Classification of Motor Imagery EEG Signal Based on Deep Learning Approaches," *2nd International Conference on Big Data, IoT and Machine Learning (BIM 2023)*, Springer, Dhaka, Bangladesh, 6-8 September, 2023
- (C9) S. Oman, M. Jamil, and S. T. U. Raju, "BCL: A Branched CNN-LSTM Architecture for Human Activity Recognition Using Smartphone Sensors," *International Conference on Next-Generation Computing, IoT and Machine Learning (NCIM 2023)*, IEEE, DUET Gazipur, Bangladesh, 16-17 June, 2023
- (C10) R. T. H. Promi, R. A. Nazri, M. S. Salim, and S. T. U. Raju, "A Deep Learning Approach for Non-Invasive Hypertension Classification from PPG Signal" *International Conference on Next-Generation Computing, IoT and Machine Learning (NCIM 2023)*, IEEE, DUET Gazipur, Bangladesh, 16-17 June, 2023
- (C11) S. M. T. Raju, and M. Hashem, "Real-Time Hemoglobin Measurement Using Smartphone Video and Artificial Neural Network," *International Conference on Electrical, Computer & Telecommunication Engineering (ICECTE 2022)*, IEEE, RUET, Rajshahi, Bangladesh, 29 – 31 Dec., 2022
- (C12) S. M. T. Raju, and M. Hashem, "DNN Based Blood Glucose Level Estimation Using PPG Characteristic Features of Smartphone Videos," *25th International Conference on Computer and Information Technology (ICCIT 2022)*, IEEE, Cox's Bazar, Bangladesh, 17-19 Dec., 2022
- (C13) T. Ahamed, M. N. Islam, S. T. U. Raju, and M. Hashem, "Blood Donor Arrival Forecasting Using Regression Model and Analysis of Donor Behavioural Pattern," *25th International Conference on Computer and Information Technology (ICCIT 2022)*, IEEE, Cox's Bazar, Bangladesh, 17-19 Dec., 2022
- (J4) S. T. U. Raju, A. Sarker, A. Das, M. M. Islam, M. S. Al-Rakhami, A. M. Al-Amri, T. Mohiuddin, and F. R. Albogamy, "An Approach for Demand Forecasting in Steel Industries Using Ensemble Learning," *Complexity*, vol. 2022, no. 1, p. 9928836, 2022
- (C14) F. Sadaf, S. T. U. Raju, and A. Muntakim, "Offline Bangla Handwritten Text Recognition: A Comprehensive Study of Various Deep Learning Approaches" *2021 3rd International Conference on Electrical & Electronic Engineering (ICEEE 2021)*, IEEE, RUET, Rajshahi, Bangladesh, 22 – 24 Dec., 2021
- (C15) A. Ghosh, A. A. Hossain, and S. T. U. Raju, "Classification of Diabetic Retinopathy Using Few-Shot Transfer Learning from Imbalanced Data" *2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS)*, IEEE, Tamilnadu, India, 19 – 20 Mar., 2021
- (J5) M. K. Hasan, S. Roy, C. Mondal, M. A. Alam, M. T. E. Elahi, A. Dutta, S. T. U. Raju, M. T. Jawad, and M. Ahmad, "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*, Elsevier, vol. 68, p. 102661, 2021
- (J6) M. R. Haque, S. T. U. Raju, M. A.-U. Golap, and M. Hashem, "A Novel Technique for Non-Invasive Measurement of Human Blood Component Levels From Fingertip Video Using DNN Based Models" *IEEE Access*, vol. 9, pp. 19 025–19 042, 2021
- (J7) M. A. Golap, S. T. U. Raju, M. R. Haque, and M. Hashem, "Hemoglobin and Glucose Level Estimation From PPG Characteristic Features of Fingertip Video Using MGGP-Based Model," *Biomedical Signal Processing and Control*, Elsevier vol. 67, 2021
- (J8) S. M. A. Ullah, M. M. Islam, S. Mahmud, S. Nooruddin, S. T. U. Raju, and M. R. Haque, "Scalable Telehealth Services to Combat Novel Coronavirus (COVID-19) Pandemic" *SN Computer Science*, Springer, vol. 2, no. 1, pp. 18, Jan. 2021
- (J9) M. M. Islam, S. M. A. Ullah, S. Mahmud, and S. T. U. Raju, "Breathing Aid Devices to Support Novel Coronavirus (COVID-19) Infected Patients," *SN Computer Science*, Springer, vol. 1, no. 5, pp. 274, Aug. 2020
- (C16) S. T. U. Raju, and M. S. Rahman, "Horizontal Vertical and SuperQueen Parity (HVSQ) Method for Soft Error Tolerance," *2020 IEEE Region 10 Symposium (TENSYMP)*, IEEE, Dhaka, Bangladesh, pp. 1734-1737, 5-7 Jun., 2020

Posters/Workshop Publications

- (P1) M. M. Islam, M. R. Haque, S. T. U. Raju, and F. Karray, "FusionEnsemble-Net: An Attention-Based Ensemble of Spatiotemporal Networks for Multimodal Sign Language Recognition", *Multimodal Sign Language Recognition*, IEEE/CVF ICCV 2025 Workshop, Honolulu, Hawaii, USA, October 20th, 2025 [Accepted]

- (P2) M. R. Haque, M. M. Islam, **S. T. U. Raju**, and F. Karray, "A Signer-Invariant Conformer and Multi-Scale Fusion Transformer for Continuous Sign Language Recognition", *Multimodal Sign Language Recognition*, IEEE/CVF ICCV 2025 Workshop, Honolulu, Hawaii, USA, October 20th, 2025[Accepted]
- (P3) **S. T. U. Raju**, and M. M. A. Hashem, "Development of a Novel Non-invasive Smartphone-Based Blood Components Estimation Technique Using Python," PyCon US 2023, Salt Lake City, USA, 19-27 April 2023

Book Chapter

- (B1) M. M. Islam, **S. T. U. Raju**, S. Nooruddin, F. Karray, and G. Muhammad, "Internet of Health Things: an introduction." *In Blockchain and Digital Twin for Smart Healthcare*, pp. 19-44. Elsevier, 2025

Submitted Manuscripts

- (S1) **S. T. U. Raju**, M. R. Haque, M. M. Islam, H. Altaheri, and F. Karray, "ClusGNN-ViT: Integrating Deep Embedded Clustering and GNN-MIL for Microscopic Image Captioning and Diagnosis," *IEEE Transactions on Medical Imaging*, IEEE [Manuscript Number: TMI-2025-3074]
- (S2) **S. T. U. Raju**, A. Das, A. Sarker, S. T. Uddin, M. I. Hossain, and M. P. Mollah, "EwvEn: An Enhancing Weighted Voting Ensemble Algorithm for Demand Forecasting of Steel Industry," *IEEE Transactions on Industrial Informatics*, IEEE [Manuscript Number: TII-25-4967]

Services and Outreach

Journal Reviews

- IEEE Transactions on Industrial Informatics, 2025 [\[PDF\]](#)
- Journal of Biomedical and Health Informatics, 2025 [\[PDF\]](#)
- IEEE Access, 2022, 2025 [\[PDF\]](#)
- IEEE Sensors Journal, 2025 [\[PDF\]](#)
- Discover Computing – Springer Nature, 2025 [\[PDF\]](#)
- International Journal of Intelligent Systems – Wiley, 2025 [\[PDF\]](#)
- Technology and Health Care – Sage Journals, 2025 [\[PDF\]](#)
- Computer Methods in Biomechanics and Biomedical Engineering, 2024 – 2025 [\[PDF\]](#)
- Biomedical Engineering: Applications, Basis and Communications, 2025 [\[PDF\]](#)
- Journal of International Medical Research, 2024 [\[PDF\]](#)
- Scientific Reports – Nature, 2024 [\[PDF\]](#)
- Journal of Engineering – Wiley, 2024 [\[PDF\]](#)
- Signal, Image and Video Processing – Springer Nature, 2024 [\[PDF\]](#)
- IEEE Sensors Letters, 2022 [\[PDF\]](#)
- Plos One 2022 [\[PDF\]](#)

Conferences Reviews

- IEEE SMC 2024: IEEE International Conference on Systems, Man, and Cybernetics: 2024 – 2025 [\[PDF\]](#)
- International Joint Conference on Neural Networks (IJCNN 2025) [\[PDF\]](#)
- 7th International Conference on Electrical Information and Communication Technology (EICT) 2025) [\[PDF\]](#)

Leadership & Co-curricular Activities

- Mentor, Graduate Mentorship Program, University of Waterloo – Guided new graduate students through mentorship initiative [\[PDF\]](#)
- Supervisor, Capstone Project, KUET – Advised 4th year students in applying deep learning to biomedical data analysis, supporting project completion and publication 2023 [\[PDF\]](#)
- Research Mentor, KUET – Supervised 3rd year undergraduates on deep learning and sensor-based projects, fostering research skills and teamwork 2022 [\[PDF\]](#)
- Mentor, System Development Project, KUET – Supervised 3rd-year students in developing smartphone-based solutions [2021] [\[PDF\]](#)
- Supervisor, Capstone Project, KUET – Advised 4th year students on EEG signal classification using deep learning [\[PDF\]](#)
- Student Coordinator, Department of CSE, KUET (3rd and 4th Year), leading campus tours, and coordinating student volunteers

Voluntary Experiences

- Volunteer Member to assisting with conference logistics, attendee support for 5th International Conference on Electrical Information and Communication Technology (EICT) [2021]
- Collaboration work with one blood organization project, Petersburg, Florida 33716, USA [2020-2021] [\[PDF\]](#)
- Collaboration research with **King Saud University**, Saudi Arabia [\[PDF\]](#)
- **Instructor** for introductory workshop on C Programming in SGPIC (Special Group Interested in Programming Contest) [2016]
- Student Motivator and Examiner in **NHSPC** (National High School Programming Contest) [2016- 2017]

Fellowships, Honors, & Awards

2023 – 2025	Graduate Research Students (GRS) from University of Waterloo [Funding: \$55000 CAD] [PDF]
2023	Scholar Award, IEEE International Conference on Systems, Man and Cybernetics (IEEE SMC) [Funding: \$500 USD]
2023	Scholar Award, PyCon US Poster Presentation, Salt Lake City, Utah USA [Funding: \$2000 (USD)]
2023	Vice Chancellor Awards for top researcher, Khulna University of Engineering & Technology [Outstanding research contributions in Engineering faculty] [Funding: \$500 (USD)] [PDF]
2022	Travel Grant, 25th International Conference on Computer and Information Technology (ICCIT 2022), IEEE, Cox's Bazar, Bangladesh [Funding: \$400 USD]
2021	Travel Grant, 3rd International Conference on Electrical & Electronic Engineering (ICEEE 2021), IEEE, RUET, Rajshahi, Bangladesh [Funding: \$300 USD]
2017 – 2018	Dean's List , outstanding academic performance, KUET [CGPA: 3.93/4.00] [PDF]
2016 – 2017	Dean's List , outstanding academic performance, KUET [CGPA: 3.94/4.00] [PDF]
2015 – 2016	Dean's List , outstanding academic performance, KUET [CGPA: 3.90/4.00] [PDF]
2016 – 2019	Technical Scholarship, Khulna University of Engineering & Technology [Funding: \$250 (USD)/Year]

Skill & Tools

Programming Languages	Python (Primary), C, C++, Java
ML & DL Frameworks	Pytorch , Scikit-learn, Tensorflow, Keras, OpenCV
Development Tools & IDEs	VS Code , LaTeX/Overleaf , Jupyter Notebooks, GitHub

References

Prof. Fakhri Karray Department of Electrical and Computer Engineering Centre for Pattern Analysis and Machine Intelligence University of Waterloo 200 University Avenue West, Waterloo, ON, Canada Email: karray@uwaterloo.ca Website: https://uwaterloo.ca/electrical-computer-engineering/profile/karray	Prof. M. M. A. Hashem Dept. of Computer Science and Engineering Khulna University of Engineering & Technology Khulna-9203, Bangladesh. Email: hashem@cse.kuet.ac.bd Mobile: +8801714003949 Website: https://www.kuet.ac.bd/cse/hashem/
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