S M Taslim Uddin Raju

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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 Karray 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 (3rd 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* • 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* • Courses: MTE 241 – Introduction to Computer Structures and Real-Time Systems, ECE 459 – Programming for Performance, and ECE 222 – Digital Computers • Contributed 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)* • Courses: CSE 1101 – Structure Programming, CSE 1102 – Structure Programming Laboratory, CSE 2113 – Computer Architecture and CSE 4112 – Machine Learning • Taught 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)* • 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* • Courses: 06131205 – Structure Programming, 06131206 – Structure Programming Laboratory, 07142213 – Computer Architecture, 05413109 – Numerical Methods • Delivered 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 • Designed integrated framework combining graph neural networks and LLMs for whole slide images classification and captioning • Achieved 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 • Implemented an automated medical Q&A system by fine-tuning LLM models such as GPT-2, Llama2, Bloom, and T5 • Evaluated 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 • 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 • Developed a DNN-based algorithm to estimate systolic and diastolic blood pressure (BP) using only Photoplethysmography (PPG) signals from 125 subjects with 218 records • Applied 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 • Introduced a non-invasive method for monitoring Glucose and Hemoglobin levels using Smartphone video and NIR LED device • Generated 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 • Engineered a CNN-based network with class rebalancing for state-of-the-art lesion detection on ISIC-2016 and ISIC-2017 datasets • Integrated 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," ***EEE Transactions on Medical Imaging,* IEEE** [Manuscript Number: TMI-2025-3074]

(S2) **S. T. UdU.din 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	**Prof. M. M. A. Hashem**
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