

Pronab Kumar Paul

pronabpaul77@gmail.com | [Google Scholar](#) | [GitHub](#)

Computer Vision Researcher — Medical Image Analysis — Representation Learning

Computer Vision Researcher working at the intersection of medical image analysis and representation learning. My research focuses on understanding how deep learning models learn visual representations, analyzing their robustness under distribution shifts, and developing trustworthy AI systems for healthcare. I have published peer-reviewed papers in Springer proceedings and engineering journals; my current interests include multimodal medical imaging, foundation models, and robust representation analysis.

RESEARCH INTERESTS

Medical Image Analysis; Computer Vision; Representation Learning; Foundation Models for Medical Imaging; Multimodal Medical Imaging; Domain Generalization; Trustworthy AI; Medical Image Segmentation.

EDUCATION

University of Rajshahi, Bangladesh

Jan 2020 - Oct 2025

B.Sc. in Information and Communication Engineering

GPA: 3.82/4.00

Rank: 4/65 (Top 6%)

Honors: Dean's Award (2020-2025) for sustained academic excellence

Relevant Coursework: Artificial Intelligence and Neural Computing, Digital Image Processing, Linear Algebra, Probability & Statistics, Data Structures and Algorithms, Information Theory and Coding, Cryptography.

TECHNICAL SKILLS

Programming: Python, C++, C

Deep Learning: PyTorch, TensorFlow, MONAI

Computer Vision: OpenCV, CNNs, Vision Transformers, Feature Detection and Description, Image Registration

Machine Learning: Scikit-learn, NumPy, pandas, Statistical Analysis

Medical AI: Medical Image Segmentation, Multimodal Imaging, Representation Learning and Analysis, Explainable AI

Research Tools: Git, LaTeX, Overleaf, Jupyter, Google Colab, Kaggle

RESEARCH EXPERIENCE

Computer Vision Lab, University of Rajshahi

2024 - Present

Research Assistant — Supervisor: Dr. Dipankar Das

Focus: Robust visual representations and privacy-preserving medical AI.

- Conducted large-scale benchmarking of 17+ classical keypoint detectors and descriptors under real-world imaging conditions (Under Review).
- Designed and implemented a Federated Knowledge Distillation framework for multi-institutional medical imaging.
- Developing reproducible analysis frameworks for representation collapse, modality collapse, and robustness under domain shift.
- Contributing to research on interpretable medical AI models for lesion localization and image analysis.

Antenna & Communication Lab, University of Rajshahi

May 2025 - Sep 2025

Research Intern — Supervisor: Dr. Md. Firoz Ahmed

Focus: ML-driven optimization of antenna design.

- Developed ML-based surrogate models for patch antenna performance prediction, achieving $R^2 \approx 0.95$ and reducing simulation time by 60%.
- Co-authored journal papers on wireless sensor networks and IoT applications.

SELECTED PUBLICATIONS

Published

- Paul, P.K.**, Ghosh, A., et al. "Handling Imbalanced Datasets with Real-World Positive Samples for Dengue Prediction Using Machine and Deep Learning Models." *Communications in Computer and Information Science (CCIS)*, Springer, 2025. [DOI](#)
- Ahmed, M.F., Bashir, S., **Paul, P.K.**, et al. "Compact Patch Antenna for Wireless Sensor Networks." *Applied Engineering & Technology*, 2024.
- Islam, M.B., Uddin, A.N.M.S., Bashir, S., **Paul, P.K.**, et al. "Design Optimization of a C/X-Band Metasurface-DGS Microstrip Antenna Using Machine Learning." *Physics Open*, 2026.

Under Review

- Paul, P.K.**, Das, D. "Benchmarking the Robustness of Classical Keypoint Detectors and Descriptors across Real-World Imaging Scenarios." *Under Review*. [SSRN Preprint](#)

SELECTED RESEARCH PROJECTS

Representation Collapse in Self-Supervised Models <i>Representation Learning, Medical AI</i> - Investigated dimensional collapse in self-supervised models using Average Cosine Rank (ACR), effective rank, and spectral metrics. - Developed reproducible analysis pipelines to quantify representation collapse and learned feature diversity. Technologies: PyTorch, OpenCV	2026
Modality Collapse Framework for Multimodal Medical Imaging <i>Representation Learning, Multimodal Medical Imaging</i> - Developed a framework to analyze modality collapse and representation dynamics using layer-wise similarity measures. - Investigated representation behavior under missing-modality and modality-variation scenarios in multimodal medical imaging. Technologies: PyTorch, MONAI, NumPy	2026
Test-Time Augmentation Failure Analysis <i>Domain Robustness, Medical Image Analysis</i> - Systematically evaluated when test-time augmentation improves or degrades medical image analysis performance. - Analyzed prediction stability, calibration, and transformation-induced failure modes. Technologies: PyTorch, OpenCV, Scikit-learn	2025
Effective Rank and Domain Shift <i>Representation Learning, Domain Robustness</i> - Investigated whether the effective rank of learned representations predicts robustness under synthetic image corruptions. - Extended the analysis to medical imaging datasets and released the research code as open source. Technologies: PyTorch, NumPy, OpenCV	2025

AWARDS & HONORS

General Merit Scholarship University of Rajshahi, awarded for academic excellence.	2025-2026
Dean's Award University of Rajshahi, awarded for sustained academic excellence.	2020-2025
Academic Rank: 4th of 65 (Top 6%) B.Sc. in Information and Communication Engineering, University of Rajshahi.	
Second Runner-Up, Learnathon 3.0 Developed a custom gRPC-based code execution engine.	

OPEN-SOURCE RESEARCH CODE

Public research code for representation learning, medical image analysis, multimodal medical imaging, and model robustness.

github.com/pronabpaul