

Bishal Ranjan Swain

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Summary

Ph.D. graduate in Computer Science working on robust representation learning for adaptive and reliable AI systems. My research studies how learned features evolve under distribution shift, using continuous-time dynamics and memory-based mechanisms to improve stability, consistency, and generalization. I focus on multi-modal integration and segmentation, with broader interest in brain-inspired computational models that combine continuous-time dynamics, adaptive memory, and efficient sequence reasoning for robust intelligence under changing environments.

Education

Kumoh National Institute of Technology (KIT), Ph.D. in Computer Science Sept 2022 – Aug 2026

Gumi, South Korea **Advisor:** Prof. Dr. Jaepil Ko

Research Areas: Medical Image Analysis, Multi-modal Representation Learning, OoD, & Sequential Modeling

Pondicherry University, M.Sc. in Computer Science Jul 2018 – May 2020

Puducherry, India; First Class with Distinction; **GPA: 9.36**

Thesis: *Study and Development of 3D Wind Pattern Visualization Models*

College of Basic Science and Humanities, OUAT, B.Sc. in Computer Science Jul 2015 – May 2018

Odisha, India; First Class with Distinction; **GPA: 8.59**

Research & Work Experience

Research Associate, Dream Lab, Indian Institute of Science (IISc)

Jun 2020 – Jul 2021

- Contributed to develop a distributed platform for emulating large-scale networks using containerized infrastructure across multi-node clusters with support for dynamic topology and runtime resource configuration.

Research Intern, National Atmospheric Research Lab (NARL)

Nov 2019 – May 2020

- Research internship aligned with wind-pattern visualization / atmospheric data analysis.

Recent Publications

★ Accepted for publication

Active Memory Feedback Loop for Fast-Slow Dynamics in Liquid Neural Networks ★ 2026

- B. Swain, J. Bae, J. Ko. *40th Annual Conference on Neural Information Processing Systems (NeurIPS)*.

Memory-Induced Attractor Dynamics in Liquid Time-Constant Networks 2026

- B. Swain, J. Hwang, J. Ko. *35th International Conference on Artificial Neural Networks (ICANN)*.

Coupling Liquid Time-Constant Encoders with Modern Hopfield Memory 2026

- B. Swain, K. J. Cheoi, J. Ko. *IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*.

Guided Texture Segmentation via Coordinate-Aware Class-Ratio Mapping 2026

- B. Swain, K. J. Cheoi, J. Ko. *IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)*.

Out-of-Distribution Nuclei Segmentation in Histology Imaging via Liquid Neural Networks with Modern Hopfield Layer 2025

- B. Swain, K. J. Cheoi, J. Ko. *Medical image computing and computer-assisted intervention (MICCAI)*.

SAM Guided Task-Specific Enhanced Nuclei Segmentation in Digital Pathology 2024

- B. Swain, K. J. Cheoi, J. Ko. *Medical image computing and computer-assisted intervention (MICCAI)*.

Nuclei Segmentation in Histopathological Images with Enhanced U-Net3+ 2024

- B. Swain, K. J. Cheoi, J. Ko. *Medical Imaging with Deep Learning (MIDL)*. PMLR.

Phase Fraction Calculation in Multiphase Steel Microstructures Through Semantic Segmentation 2024

- B. Swain, K. J. Cheoi, J. Ko. *International Conference on Applied System Innovation (ICASI)*.

Recent Projects

★ Medical, ▲ Materials, ▼ Inter-discipline

Multi-modal Representation Learning for Medical Imaging ★ Dec 2025 – Jul 2026

- Investigating a representation learning framework that models latent state evolution across modalities using continuous-time dynamics and memory-based refinement, enabling stable integration of heterogeneous inputs and improved consistency under cross-domain and cross-modal variability.

Adaptive Ratio-Guided Segmentation for Metallurgical Microstructures ▲ Feb 2023 – Aug 2025

- Developed a ratio-aware texture segmentation framework that incorporates class-distribution priors and adaptive feature fusion to improve robustness under varying microstructure compositions.
- Achieved +6.1% average Dice improvement with less than 2% additional parameters.

Data-Centric Batch Sampling for Robust Learning under Limited and Imbalanced Data in Nuclei Segmentation ★ Nov 2025 – Jan 2026

- Proposed a feature-driven batch construction strategy using DINOv2 embeddings and density-based clustering to enforce heterogeneity within batches, ensuring diverse representation of the data distribution for training.
- Demonstrated that sampling strategy alone yields significant performance gains, improving Dice score from 88.07% to 91.70% when integrated into the training pipeline, highlighting the importance of data organization beyond model architecture.

Semi-Supervised Instance Segmentation of Battery Particles with Human-in-the-Loop Refinement ▲ Jan 2025 – May 2025

- Designed a three-stage pipeline: SAM-based mask proposal; expert-guided boundary refinement; LoRA-based adaptation for SEM particle images.
- Introduced a labeling protocol to handle ambiguous regions (binder vs particle, merged vs split instances) and enforce fine-grained boundary consistency. Achieved 96.14 pp Dice on instance-level particle segmentation.

Transformer-Based Multi-Variable Rainfall Forecasting from Regional Radar ▼ Aug 2025 – Dec 2025

- Built a multi-variable forecasting model using RegionalClimaX on Korean composite radar data, supporting prediction horizons up to 72 hours.
- Improved test accuracy to 62.1% compared to 56.7% using single-variable inputs.

Robust Diagnosis of Allergic Rhinitis from Nasal Endoscopic Images ★ Sep 2022 – Jan 2023

- Investigated deep learning pipelines for automated diagnosis of allergic rhinitis under high variability in illumination, anatomical structure, and imaging conditions.
- Achieved strong diagnostic performance with F1 scores of 93.10 ± 0.16 . The model demonstrated robustness to variability in endoscopic imaging conditions, including illumination and anatomical differences, highlighting challenges in real-world clinical deployment.

Leadership & Service

Vice President, MICCAI Student Board 2025 – Present

Reviewer: MICCAI 2026, ICML 2026 (Gold), NeurIPS 2026, AAAI 2026, ICLR 2026

Volunteer, Animal Shelter 2022 – Present

Participate in regular volunteer activities and additional outreach programs with recognized 150+ official hours.

Certifications

- TOPIK II (Lv. 5) (Korean proficiency) — National Institute for International Education (2025)
- Korean Social Integration Evaluation (Lv. 4) — KIIP (2025)
- TOEIC (910) — ETS (2022)
- Global Korea Scholarship Recipient — NIIED (2021)
- DeepLearning.AI Specializations (2019–2020) including CNNs, Sequence Models, ML Projects Structuring

Technologies

Core: Python, PyTorch, TensorFlow, CUDA, Git, Linux

Research Interests: Robust Computer Vision, OoD Generalization, Temporal Data, Neural Dynamical Systems

Medical Imaging: Segmentation benchmarks, Multi-source & Irregular datasets, Clinical variability handling