Tushar Nayak

Graduate Student Researcher

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Graduate student researcher in biomedical engineering at Carnegie Mellon University working on computer vision for image-guided robotic intervention, medical imaging, and physics-aware learning systems.

Experience

Graduate Student Researcher, Computational Engineering and Robotics Lab

Carnegie Mellon University | Pittsburgh, Pennsylvania | Aug 2024 - Present

Master's thesis research on computer vision for image-guided robotic intervention and endovascular tele-surgery.

- Built a pipeline for synthetic vessel deformation data generation, multi-view X-ray rendering, and physics auditing for endovascular intervention research.
- Developed MorphPINN, a multimodal network that fuses fluoroscopy with 3D geometric context to predict vessel deformation from sparse imaging.
- Contributed the vision subsystem section to a literature review on robot-assisted endovascular surgery currently under review at the Journal of Intelligent and Robotic Systems.

Summer Researcher

University of Pittsburgh, Surreality Lab | Pittsburgh, Pennsylvania | May 2026 - Present

Researching real-time registration and 3D reconstruction for medical imaging data with collaborators across robotic surgery projects.

- Working with Rishi Basdeo under Professors Edward Andrews and Jacob Biehl.
- Extending master's thesis work toward clinical mixed-reality and surgical visualization settings.

Graduate Research Assistant, Glioblastoma Evolution Prediction

Carnegie Mellon University | Pittsburgh, Pennsylvania | Jan 2025 - Sep 2025

Developed longitudinal MRI forecasting models for glioblastoma progression using Neural ODE-based approaches.

- Built attention U-Net plus Neural ODE forecasting pipelines for multimodal MRI using FLAIR, T1, T2, and post-contrast T1 data.
- Compared multiple model branches, including prefix-history forecasting and physics-informed variants, against persistence baselines.
- Presented the work at Carnegie Mellon's 2025 Biomedical Engineering research forum.

Teaching Assistant

Carnegie Mellon University | Pittsburgh, Pennsylvania | Jan 2025 - Present

Course support across graduate classes in deep learning, computer vision, and biomedical engineering.

- Applied Deep Learning, Spring 2025, with Dr. Clarence Worrell.
- Fundamentals of Computational Biomedical Engineering, Fall 2025, with Dr. Jason Szafron.
- Computer Vision for Engineers, Fall 2025, with Dr. Kenji Shimada.
- Machine Learning in Experimental Biomedical Engineering Research, Spring 2026, with Dr. Newell Washburn.

Education

Master of Science - Research

Carnegie Mellon University | Pittsburgh, Pennsylvania | Aug 2024 - May 2026

Biomedical Engineering, computational focus

Coursework: Computer Vision, Visual Learning and Recognition, Image-Based Computational Modelling and Analysis, Learning for 3D Vision, Clinical Translations of AI

Bachelor of Technology

Manipal Institute of Technology | Manipal, India | Aug 2019 - May 2023

Biomedical Engineering major, Data Science minor

Coursework: Pattern Recognition, Digital Image Processing, Digital Signal Processing, Signals and Systems, Statistical Inference and Machine Learning

Projects

Physics-Informed Endovasculature Deformation Estimation and Registration

Aug 2024 - Present

Master's thesis project on modeling vessel deformation from fluoroscopy for image-guided endovascular robotics.

- Synthetic vessel deformation generation with free-form deformation and guidewire kinematics.
- Multi-view X-ray rendering across clinically relevant projections.
- Multimodal deformation prediction with geometry-aware learning.

Spatiotemporal Glioblastoma Evolution Visual Prediction

Jan 2025 - Sep 2025

Neural ODE-based forecasting of future glioblastoma appearance from longitudinal multimodal MRI.

- Attention U-Net plus Neural ODE modeling.
- History-conditioned forecasting across MRI timepoints.
- Evaluation against simple persistence baselines.

Open Horizon Robotics Perception Curriculum

Jan 2025 - Present

Open-source computer vision curriculum spanning classical vision, deep learning, 3D vision, geometry, and perception physics.

- Authoring learning material for perception and prerequisite mathematics.
- Mentoring student-led projects in the Open Horizon Robotics community.

Publications

Automated histopathological detection and classification of lung cancer with an image pre-processing pipeline and spatial attention with deep neural networks

Cogent Engineering | Jan 2024

Journal paper on lung cancer histopathology classification using a pre-processing pipeline and attention-based deep neural networks.

An explainable artificial intelligence integrated system for automatic detection of dengue from images of blood smears using transfer learning

IEEE Access | Jan 2024

Explainable AI system for dengue detection from peripheral blood smear images using transfer learning.

Deep learning based detection of monkeypox virus using skin lesion images

Medicine in Novel Technology and Devices | Jun 2023

Skin-lesion image classification for monkeypox diagnosis with deep learning and interpretable visual explanations.

Processing and Detection of Lung and Colon Cancer from Histopathological Images using Deep Residual Networks

2023 IEEE International Conference on Electronics, Computing and Communication Technologies | Jan 2023

Conference paper on deep residual networks for histopathological classification of lung and colon cancer.

Awards

Biomedical Engineering Department Head's Fellowship

Carnegie Mellon University | Jan 2024

Department fellowship awarded on entry to the research master's program in biomedical engineering.

Best Paper, AI Track

Second International Conference on Artificial Intelligence, Computational Electronics and Communication | Jan 2023

Awarded for undergraduate research work in applied AI for biomedical image analysis.

Skills

Computer Vision: 3D reconstruction, Image registration, Geometric vision, Fluoroscopy and X-ray modeling, Feature extraction, Motion analysis

Medical Imaging and Biomedical AI: MRI, CT and CTA, Histopathology, Image-guided intervention, Tumor evolution modeling, Clinical data workflows

Machine Learning: Neural ODEs, Physics-informed learning, Attention mechanisms, Convolutional neural networks, Encoder-decoder models, Model evaluation

Teaching and Mentoring: Teaching assistantships, Curriculum design, Technical mentoring, Workshop instruction