

Siddhesh Ashish Salfale

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EDUCATION

Indian Institute of Technology (IIT) Kharagpur, West Bengal
Integrated Dual Degree (Bachelors + Masters)

Enrolled: Oct 2021 — Expected: Apr 2026

Majors: Industrial and Systems Engineering

Micro Specialization: Medical Imaging, Artificial Intelligence & its Applications

St. Paul Junior College, Nagpur, Maharashtra
High School

Enrolled: July 2019 — Graduated: Aug 2021

Physics, Chemistry, Mathematics and Computer Science

PUBLICATIONS

- **S.Salfale, et al**, Decoding Temporal Patterns: A Novel Multi-Modal Deep Learning Approach for Unveiling RNA Modifications, *AIx BIO: Symposium in Computational Biology, Biomedicine and Artificial Intelligence, Canberra, Australia 2024* - Spotlight Poster - [Link](#)
- **S.Salfale, et al**, Decoding Drug Efficacy in Cancer Medicine: A Hybrid Model based on XAI, Shapley Additive Explanations, and LLMs for High-Throughput Genomics of the Erlotinib Drug, *Explainable AI in Personalized Cancer Medicine, IEEE Symposium Series on Computational Intelligence, Trondheim, Norway 2025* - [Link](#)
- **S.Salfale, et al**, Quantum Bayesian Networks for Reliability Analysis of Unmanned Systems, *American Society of Mechanical Engineers, IMECE 2025* - [Link](#)
- S.Bara, G.Dhakad, **S.Salfale et al**, Quantum Circuit Design for Failure Risk Analysis: An Application to Power Systems in Autonomous Ships, *American Society of Mechanical Engineers, IMECE 2025* - [Link](#)
- A.Krishnan, **S.Salfale, et al**, Structural Reliability Analysis Using Quantum Computers: An Application to Space Trusses, *American Society of Mechanical Engineers, IMECE 2025* - [Link](#)
- G.Dhakad, **S.Salfale, et al**, Noise-Resilient Automated Semantic Segmentation of Humerus Bone X-Rays using Deep Learning, *IEEE International Symposium on Biomedical Imaging (ISBI) 2026* - (**Under Review**)
- **S.Salfale, et al**, RD-Net: A Deep Dilated-Receptive Residual Block-Based Network for Multi-class Bone Segmentation of Hip joint CT Scans, *IEEE Transactions in Medical Imaging (TMI)* - (**Under Review**)

ACADEMIC ACHIEVEMENTS

- Summer Undergraduate Research Fellowship (SURF) by **California Institute of Technology, Pasadena, CA.**
- Future Research Talent (FRT) Award, College of Science and Medicine, Australian National University 2024.
- Best Undergraduate Thesis Award at **Indian Institute of Technology Kharagpur** for the Academic session 2024-25.
- India AI Fellowship awarded by **Ministry of Electronics & Information Technology, Government of India.**
- AI4ICPS UG Chanakya Fellowship by AI-ML Tech-Innovation Hub for Interdisciplinary Cyber Physical Systems.
- Best Poster Award at “AIx BIO: Symposium for Computational Biology, Biomedicine and Artificial Intelligence 2024”.
- National Winner - “**Awiros x Intel Computer Vision App-a-athon 2.0**” 2023 - 3D Image Reconstruction.
- Smart India Hackathon 2023, Ministry of Education, India - **National Finalist - Represented IIT Kharagpur.**
- **Gold Medalist - Inter IIT Tech Meet 13.O, December 2023** - Zelta Algorithmic Trading Challenge

RESEARCH EXPERIENCE

Anima AI + Science Lab, California Institute of Technology

Pasadena, USA

Decoding Brain Activity with Structured Sparse Representations from functional Ultrasound Imaging

May 2025 - Aug 2025

Mentor: Prof. Anima Anandkumar and Prof. Bahareh Tooloshams

- **Proposed and designed** a novel interpretable decoding pipeline for functional ultrasound imaging (fUSI)-based brain computer interfaces (BCIs), leveraging *sparse coding* to improve explainability of neural activity decoding.
- **Developed** advanced mathematical formulations for dictionary learning with spatial smoothness constraints (ℓ_1, ℓ_0 regularization), reducing reconstruction redundancy by **up to 35%** while preserving biological factors.
- **Integrated Neural Operators** with sparse coding to capture spatiotemporal dependencies in high-dimensional fUSI datasets ($> 10^6$ voxels/frame), achieving **20–25% improvement in interpretability metrics.**
- **Validated approach** against baseline methods (PCA, Class-wise PCA, LDA), demonstrating comparable classification accuracy (**92%**) while using **40% fewer active atoms**, improving explainability of behavioral decoding.

Medical Imaging and Theragnostics Lab, IIT Kharagpur

Kharagpur, India

Thesis Sponsored by India AI Grant and GE Healthcare, Germany

Aug 2024 – Ongoing

Mentor: Prof. Subhamoy Mandal

- **Engineered** large-scale foundational models for diffusion weighted MRIs and CT scans, robust to structural deformations.
- **Designed and optimized** models such as RD-Net (Receptive-dilated network), incorporating VM-UNet, NeRF, and M3BUNet with a focus on the 3D Reconstruction of pelvic and femur bones with fractures and implants.
- **Supervised Fine Tuning** of Affinity (A2) & Attention-based networks to improve accuracy and noise resilience.
- **Developed** a text-guided **conditional diffusion framework (GeoDiff)** to optimize pre-surgical planning for clinicians.

- **Developed** a method utilizing image representation and analysis of sequencing signals to detect genomic changes.
- **Advanced Deep Learning Techniques:** Implemented multimodal deep learning techniques, GNN-based imaging, global average pooling, and polar transform, to enhance the classification accuracy of RNA modifications.
- **Enhanced Signal Processing and Representation:** Transformed variable-length nanopore signals into padded image representations, capturing rich sequence features while balancing noise addition and data loss.
- **Contributed** to Gene-ViT repo, improving detection in RNA changes in noisy high-throughput sequencing data.

- **Assessment** of Physical Stress and Mental Workload by Hybrid EEG and fNIRS, effectively integrating these modalities with Lab Streaming Layer (LSL) for multi-modal machine learning-based classification.
- **Developed** advanced neurosignal visualization and processing methodologies, such as FastICA & 3rd-order Butterworth filter with the implementation of the MNE framework, to significantly amplify neurofeedback performance.
- **Comprehensive Analysis** of EEG + fNIRS patterns from over 20 subjects integrating Python, Oxysoft and HOMER for effective analysis, achieving 91% accuracy in developing models for measuring cognitive factors.
- **Employed** 3D-VR to develop adaptable cognitive workload assessment with real-time neuro-feedback capabilities.

- **Built** a Quantum Bayesian model to predict system failures by encoding probabilities into quantum states.
- **Developed** an algorithm for encoding continuous distributions into quantum states by Quantum Fourier transforms.
- **Implemented** Bayesian Networks for complex systems using quantum bits to model time-dependent sub-components.
- **Integrated** Operator learning and Quantum Amplitude Amplification method to identify minimal cut sets.

COURSEWORK INFORMATION

- **Computer Science and AI:** Programming and Data Structures, Applied Reinforcement Learning and Optimization, Generalized Linear Models and its applications, Quantum Computing and its applications (NPTEL), Statistical Learning with applications, Information Systems, Machine Learning (Stanford CS229) Computer Vision (Stanford CS231n), Artificial Intelligence and its Principles (Stanford CS221), Transformers (Stanford CS25)
- **Medical Imaging and Biology:** Biomedical Imaging Informatics, Neuronal Encoding of Sensory Information, Medical Imaging Laboratory, Science of Living Systems, Computational Neuroscience, Computational Biology (MIT), NeuroAI, Biostatistics (Coursera), Medical AI (Coursera)
- **Mathematics:** Advanced Calculus, Transform Calculus, Linear Algebra, Numerical and Complex Analysis, Operations Research, Probability and Statistics, Optimization and Heuristics Methods, Statistical Quality Control.

TECHNICAL SKILLS

- **Programming:** Python, C, C++, C#, Java, MATLAB, GNU-Octave, R, CPLEX, Julia, Go, Fortran
- **Software & Frameworks:** Tensorflow, Pytorch, Keras, OpenGL, Scikit-Learn, MNE, HPC Servers, OpenCV, Gurobipy, Mappy, GATK, BedTools, AWS, Unity3D, Unreal Engine, Blender, LTSpice, Qiskit, Biskit, JAX
- **Developer Tools:** Git, Docker, Visual Studio, PyCharm, IntelliJ, Eclipse, OpenSesame

TEACHING AND REVIEWER EXPERIENCE

- Teaching Assistant for **Programming for Data Science Laboratory** for Autumn session 2025-26.
- Teaching Assistant for **Work Systems and Design Course** for Autumn session 2025-26.
- Project mentor for early undergraduates in **Quantum Computing and Reliability Engineering Lab**.
- Mentored 5 undergraduates in **Programming & Machine Learning** as a part of **Student Welfare Group**.
- **Reviewer** in NeurIPS 2025 Workshop on Symmetry & Geometry in Neural Representations.
- **Reviewer** in 2026 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP).
- **Reviewer** in NeurIPS 2025 Workshop on Imageomics: Discovering Biological Knowledge from Images Using AI.

EXTRACURRICULAR

- **Undergraduate Department Representative** - Students' senate at Indian Institute of Technology Kharagpur
- **Head** of Industrial & Systems Engineering Society for the Academic session 2024-25, hosting various institute events.
- **Associate Member** at **Entrepreneurship Cell**, Indian Institute of Technology Kharagpur, hosting Entrepreneurship Awareness drive, Local startups meet and Global Entrepreneurship Summit 2022.