K S Nithurshen

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Research Interests: **Systems** — High-Performance Computing, Parallel & Sparse Numerical Computing, Scientific Computing, GPU Programming, Compilers & Code Generation, Operating Systems
Visual Computing — Computer Vision, Neural Rendering (Gaussian Splatting, NeRF), Deep Learning, Image Processing, Computer Graphics

EDUCATION

Shiv Nadar University — Delhi-NCR, India
Bachelor of Technology in Computer Science and Engineering — 2024 – 2028
Current CGPA: ***9.79 / 10.0***

Course Work:

- **AI & Data:** Machine Learning, Large Language Models, Artificial Intelligence†, Information Retrieval†
- **Systems & Core:** Operating Systems, Computer Organization & Architecture, Digital Electronics, Database Systems, Cloud Computing, OOP, Distributed Systems†
- **Theory & Math:** Data Structures & Algorithms, Applied Linear Algebra, Multivariate Calculus, Probability & Statistics, Discrete Mathematics

†*In progress, Monsoon 2026.*

Maharishi Vidya Mandir Senior Secondary School — Chennai, India
Class XII – Central Board of Secondary Education (CBSE) — 2022 – 2024
Percentage: ***93.2% (466/500)*** | *Subjects: Mathematics, Physics, Chemistry, Computer Science, English*

The Indian Public School — Karur, India
Class X – Central Board of Secondary Education (CBSE) — 2009 – 2022
Percentage: ***93.6% (468/500)***

HONORS & AWARDS

- **Dean's List**, Shiv Nadar University (Monsoon 2024, Spring 2025, Monsoon 2025, Spring 2026) – awarded for ranking in the *Top 10%* of the department by academic merit/CGPA.

PUBLICATIONS

SpineContextResUNet: Efficient 3D ResUNet for Spine CT Segmentation — August 2025 – March 2026
First Author | Published at IEEE CBMS 2026 (Limassol, Cyprus) — [IEEE Xplore] | [arXiv] | [GitHub]
Advisor: Dr. Saurabh J. Shigwan | Shiv Nadar University

- Architected a ∼1.7M parameter 3D ResUNet with a parallel ASPP Context Block to capture 3D spatial context.
- Achieved 88.17% (CTSpine1K) and 88.13% (VerSe2020) Dice, outperforming a parameter-matched SwinUNETR baseline by ∼15% in limited-data 3D regimes.
- Engineered Gaussian-weighted sliding inference for low-powered and edge platforms where heavy nnU-Nets encounter OOM errors and validated focus using Grad-CAM.

TALKS & PRESENTATIONS

Oral Presentation, *SpineContextResUNet* | 39th IEEE Int. Symposium on Computer-Based Medical Systems (CBMS 2026), Limassol, Cyprus — June 2026

EXPERIENCE

Multi-Domain Image Restoration via Self-Supervised Domain Generalization — August 2026 – Present
Undergraduate Researcher | Dept. of CSE, Shiv Nadar University
Advisor: Dr. Snehasis Mukherjee

- Architecting an unpaired generative framework based on CycleGAN with Barlow Twins feature decorrelation and Alignment-Uniformity regularization to prevent dimensional collapse and artificial texture hallucinations.
- Engineering custom CUDA kernels for fused batch cross-correlation matrix computation ($\mathcal{L}_{BT}$) and parallel inter-domain gradient projection ($g_i^\top g_j$), slashing meta-optimization latency.
- Integrating Gradient-Guided Annealing (GGA) and Arithmetic Meta-Optimization (GA-META) to resolve conflicting update trajectories and preserve restoration fidelity across diverse disturbance domains.
- Evaluating out-of-distribution (OOD) restoration benchmarks across heterogeneous degradation profiles, including atmospheric haze/rain (Rain100, RESIDE), sensor noise (SIDD), and Monte Carlo rendering artifacts.

Google Summer of Code (GSoC 2026) – EROFS Filesystem — May 2026 – November 2026
Open Source Developer / Contributor — [Final Report] | [GSoC Page]
Mentors: Xiang Gao, Yifan Zhao, Chunhai Guo

- Architected a producer-consumer decompression pipeline in `fsck.erofs` using a workqueue and dynamic pcluster batching, eliminating thread spinning and decoupling CPU-bound decompression from synchronous I/O.
- Integrated concurrent directory traversal with worker thread pools by localizing shared global state into per-task payloads, with mutex-protected hardlink and statistics tables.
- Cut extraction time by up to 77% (LZMA), 35% (ZSTD), and 31% (LZ4HC) over the single-threaded baseline.
- Patch series (1/2, 2/2) applied by the maintainer to `experimental-mt-extraction` ahead of upstream integration.

3D Score-Based Diffusion for Amorphous Carbon Structure Synthesis May 2026 – August 2026
Research Intern | Dept. of Materials Science & Engineering, IIT Gandhinagar
Advisor: Dr. Raghavan Ranganathan

- Built and trained a 3D score-based diffusion model (GNN score function) on 512-atom *ab-initio* melt-quench simulation datasets to automate atomic coordinate generation for the host lab's materials research pipeline.
- Developed custom CUDA kernels to accelerate 3D periodic neighbor-list construction and score evaluation, reducing diffusion training and sampling latency.
- Synthesized critical research datasets comprising 400 unique structures per density across 0.9–3.5 g/cm^3, scaling generation across 13 system sizes from 128 up to 16,384 atoms.
- Achieved zero-shot generation across unobserved, interpolated target densities; confirmed topological realism and physical consistency via Radial Distribution Functions (RDF), bond angle distributions, and coordination numbers.

OPEN SOURCE CONTRIBUTIONS

erofs-utils, Apache DataFusion, Blender, pandas, scikit-learn, Mesa & aeon [GitHub] | [Blender]

- **Apache DataFusion (Rust):** Implemented Substrait consumer support translating `like_match`/`like_imatch` expressions from the Substrait plan IR into DataFusion logical plans; added `elapsed_compute` metric tracking for CSV scan operators.
- **erofs-utils (C):** Six patches merged upstream – use-after-free hardening in `erofs_destroy_workqueue` thread teardown, QPL job-initialization and S3 object-iterator memory leaks, and undefined bit-shift behavior in zstd `dict_size`.
- **Blender (C/C++):** Merged fixes for a Python API crash when setting `NodeSocket.bl_idname` and a Geometry Nodes Points-to-Volume positional offset regression.
- **Python scientific stack:** Merged fixes across pandas (`interval_range` dtype inference, `Series.info`), scikit-learn (`OneHotEncoder handle_unknown`), Mesa (exception hierarchy, emitter API), and aeon (ElasticEnsembles).

PROJECTS

Rigel: Custom CUDA Differentiable 3D Gaussian Splatting Engine [GitHub]

- Built an end-to-end 3DGS renderer and trainer from scratch in CUDA C++, implementing CUB radix depth-sorting, cooperative shared-memory tile rasterization, and analytical EWA backward kernels without autograd.
- Engineered a fused 2-layer appearance MLP kernel alongside a zero-copy headless Vulkan interop path via POSIX opaque file descriptor memory sharing.

Irena: GPU path tracer in C++ and OpenCL with Vulkan interop and BVH acceleration [GitHub]

- Built a path tracer using OpenCL for compute and Vulkan for graphics via explicit API interoperability.
- Implemented a Bounding Volume Hierarchy (BVH) in C++ to accelerate ray-triangle intersections and scene traversal.
- Implemented an asset pipeline to load 3D geometries and materials, successfully rendering benchmarks like Cornell Box.

Avior & Avior-CUDA: High-Performance Image Denoisers [GitHub (avior)] | [GitHub (avior-cuda)]

- Developed a zero-dependency C++17 image denoiser from scratch, engineering custom Deflate/Inflate codecs and chunk-level PNG parsing.
- Implemented an $O(1)$ fast NLM filter via displacement-parallel summed-area tables over a QoS-pinned CPU thread pool.
- Architected a direct CUDA C++ port, exploiting shared-memory coalescing and warp-level reductions to maximize streaming multiprocessor throughput.

TECHNICAL SKILLS

Languages: C, C++, Python, Rust, CUDA C/C++, Bash, SQL, GLSL

GPU & Parallel Systems: CUDA, OpenCL, Metal, POSIX threads, Linux Kernel/VFS APIs

Graphics & Vision: OpenCV, TorchVision, 3D Gaussian Splatting, NeRF, Vulkan, OpenGL, BVH & ray tracing

Deep Learning: PyTorch, PyTorch Geometric, TensorRT, ONNX Runtime, scikit-learn

Profiling & Tools: Nsight Compute/Systems, compute-sanitizer, perf, GDB, Valgrind, AddressSanitizer, Flamegraphs, CMake, Make, Docker, SLURM, Git

POSITIONS OF RESPONSIBILITY

Teaching Assistant | Discrete Mathematics August 2026 – Present
Supervisor: Dr. Arnab Ganguly | *Shiv Nadar University*

- Conduct weekly tutorial sessions on set theory, graph theory, combinatorics, and formal mathematical proofs.
- Assist course instructors with grading problem sets, hold office hours, and clarify student queries on the subject.

AI/ML Team Lead | ACM Student Chapter, Shiv Nadar University September 2025 – Present

- Spearheaded the core team in architecting and training a custom text-to-image diffusion model in PyTorch.
- Instructed a 10-week cohort of 150+ undergraduate students on deep learning fundamentals and practical workflows.
- Organized competitive machine learning hackathons and hands-on workshops to drive chapter engagement.

REFERENCES

Dr. Arnab Ganguly | Assoc. Prof., Shiv Nadar University | arnab.ganguly@snu.edu.in
Dr. Raghavan Ranganathan | Assoc. Prof., IIT Gandhinagar | rraghav@iitgn.ac.in
Dr. Saurabh J. Shigwan | Asst. Prof., Shiv Nadar University | saurabh.shigwan@snu.edu.in
Dr. Snehasis Mukherjee | Assoc. Prof., Shiv Nadar University | snehasis.mukherjee@snu.edu.in