Pranay Meshram

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Education

University at Buffalo, The State University of New York
PhD in Computer Science and Engineering — *Present*

University at Buffalo, The State University of New York
Master of Science: Engineering Science Robotics — *Dec 2022*

Technical Skills

Programming Languages: C, C++, Python, Rust

Frameworks: Numpy, OpenCV, Pandas, Sci-kit learn, Pytorch, Open3d, Gazebo, Matplotlib, Plotly, g2o, ROS

Domains: Visual SLAM, Computer Vision, 3D Reconstruction, Depth Estimation, Machine Learning, Geometric Optimization

Research Experience

Meta, Reality Labs — **Redmond, WA**
Research Scientist Intern — *May 2024 - Sept 2024*

Self-supervised Stereo Depth Estimation from Polarization

- Built an end-to-end depth-learning pipeline leveraging polarization physics for self-supervised stereo training.
- Designed a multi-objective learning framework that jointly predicts depth and polarization-based surface normals, achieving a 20% accuracy improvement over state-of-the-art stereo models.
- Explored polarization-based feature representations to enhance geometric consistency and improve depth recovery in texture-less and reflective regions.

University at Buffalo, The State University of New York
Research Assistant — *Present*

CLEAR: Semantic–Geometric Terrain Abstraction

- Developed CLEAR (Connected Landcover Elevation Abstract Representation), a semantic–geometric terrain abstraction that fuses elevation and land-cover data to enable large-scale, physics-aware navigation in unstructured environments.
- Demonstrated 10× faster planning with only 6.7% cost overhead and 6–9% shorter, more reliable paths compared to existing terrain abstraction baselines.
- Extending CLEAR with hypergraph-based hierarchical abstraction to accelerate high-level replanning under dynamic environmental changes such as snow, rain, and visibility degradation.

Quality-Aware 3D Reconstruction and SLAM

- Designed Quality-Aware Loss (QAL)—a drop-in replacement loss for CD/EMD that decouples precision and recall, yielding +4.3-point coverage improvement and enhanced recovery of fine 3D structures for robust robotic perception.
- Created a 4D quality metric for point-cloud evaluation, providing a more comprehensive and interpretable measure of 3D reconstruction quality across coverage, precision, and structure consistency.
- Developed a modular Visual SLAM framework (Rust + C++) supporting extensible mapping and safe concurrency.

Efficient Deep Learning for Edge Perception

- Designed lightweight CNN architectures optimized for FPGA and embedded GPUs, enabling on-device vision inference.
- Achieved 4th place at DAC SDC 2022 and 1st place at ICCAD 2022 TinyML Contest (Low-Latency & Memory-Efficient category).
- Reduced latency and memory footprint through quantization-aware training and custom kernel fusion.

Publications

- QAL: A Loss for Recall–Precision Balance in 3D Reconstruction. Accepted in WACV 2026.
- CLEAR: A Semantic–Geometric Terrain Abstraction for Large-Scale Unstructured Environments. Under review RA-L.
- Empir3D: Point-Cloud Quality Assessment Framework. Under Revision.
- Poster: A Modular, Extensible Framework for Modern Visual SLAM Systems. MobiSys 2022.

Professional Experience

NVIDIA Graphics Pvt Ltd — **Pune, India**
System Software Engineer — *Dec 2018 – May 2021*

- Led development of CUDA language program generating Fuzzer using Deep Learning and implemented solutions reducing engineering effort by 30%.
- Managed the design and verification of the CUDA Compiler for Automotive Safety Project to satisfy ISO 26262.

Renishaw Metrology Systems Ltd — **Pune, India**
Software Engineer — *Jul 2017 – Dec 2018*

- Implemented voxel-based motion path planning and probe compensation algorithms for precision metrology.
- Applied Particle Swarm Optimization to calibration routines → 25% reduction in recurring bug count.

Accomplishments and Achievements

2022: DAC System Design Contest 2022 – 4th place for object detection model on an FPGA.

2022: ACM/IEEE TinyML Design Contest at ICCAD – 1st place for binary classification model on an ultra-low power device.