SAMUNDRA KARKI

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Profile

PhD researcher in AI-native geometry and physics-based simulation at Iowa State University (advisor: B. Ganapathysubramanian). My work bridges **3D geometry understanding, neural fields, and scalable physics engines**. I build INR-based geometry, octree FEM, and shifted-boundary solvers that enable differentiable, GPU-native simulation directly on implicit or generative 3D assets—advancing the next generation of real-time digital worlds. I am now exploring **fast INR editing**, **geometry-aware AI**, and **GPU-accelerated physics for immersive systems**.

Research Interests

- Neural 3D geometry: INR/SDF, generative editing, implicit shape reasoning

- Real-time physics: octree FEM, immersed methods, differentiable simulation

- Large-scale distributed AI systems and GPU-native PDE solvers

Selected Publications

- **S. Karki**, M. Shadkhah, C. H. Yang, A. Balu, G. Scovazzi, and A. Krishnamurthy. *Direct Flow Simulations with Implicit Neural Representations of Complex Geometry.* **Computer Methods in Applied Mechanics and Engineering**, Vol. 446, Art. 118248, 2025.

- **S. Karki**, M. C. Hsu, A. Krishnamurthy, and B. Ganapathysubramanian. *Mechanics Simulations Using Implicit Neural Representations of Complex Geometries.* **Computer-Aided Design**, Art. 103978, 2025.

- M. Shadkhah, C. H. Yang, **S. Karki**, and B. Ganapathysubramanian. *Octree-Based Shifted Boundary Method: Evaluating the Impact of Hanging-Node Removal on Convergence and Solver Performance for Linear PDEs.* **Advances in Computational Science and Engineering**, Vol. 4, pp. 119–141, 2025.

- R. Tali, A. Rabeh, C. H. Yang, M. Shadkhah, **S. Karki**, A. Upadhyaya, S. Dhakshinamoorthy, M. Saadati, S. Sarkar, A. Krishnamurthy, C. Hegde, A. Balu, and B. Ganapathysubramanian. *FlowBench: A Large-Scale Benchmark for Flow Simulation over Complex Geometries.* **Data-centric Machine Learning Research (DMLR)**, 2025.

- **S. Karki**, S. Satyal, K. P. Rijal, P. Koirala, and N. Adhikari. *Comparative CFD Analysis of Kali-Gandaki "A" Francis Runner with Runner Generated from the Bovet Method.* **IOP Conference Series: Earth and Environmental Science**, Vol. 1037, No. 1, Art. 012007, 2022.

Manuscripts in Preparation

- **S. Karki**, A. Krishnamurthy, and B. Ganapathysubramanian. *Stable One-Shot Editing of Implicit Neural Representations via Gram Eigenmodes.* Manuscript in preparation.

- **S. Karki**, A. Krishnamurthy, and B. Ganapathysubramanian. *Learning Geometry for PDEs: Linking Neural SDF Error to Solution Accuracy.* Manuscript in preparation.

- **S. Karki**, A. Krishnamurthy, and B. Ganapathysubramanian. *Hybrid Mesh for Octrees for Linear PDEs.* Manuscript in preparation.

Research Experience

Graduate Research Assistant, CompM Lab, Iowa State University Aug 2023 – Present

- Developing neural-field geometry solvers coupling INR, octree FEM, and shifted-boundary methods (C++/MPI/CUDA).

- Built **FlowBench**: an HPC-scale dataset with PyTorch/ONNX pipelines for large-scale PDE learning.

- Refactoring MPI-parallel solver to CUDA; achieved near-linear scaling across GPU nodes.

- Investigating **real-time INR editing** and **shape diffusion models** for 3D generative design and simulation.

Skills

Python, C/C++, CUDA, MPI, PETSc, PyTorch, ONNX, Rust, HPC;
Neural Fields (INR/SDF), Differentiable Simulation, FEM/SBM, Octrees, 3D Geometry AI

Education

Iowa State University — PhD, Mechanical Engineering (GPA 4.0) Expected 2027
Focus: AI-native geometry, neural simulation, GPU-scale PDE solvers
Tribhuvan University (IOE) — B.E., Mechanical Engineering (Gold Medal) 2022

Additional Experience

AI Fellow, FuseMachine Jan 2023 – Aug 2023
Built predictive maintenance ML pipeline (XGBoost) and GPT-2-based sentiment API via FastAPI.
Computational Engineer / Co-Founder, Zebec & Mokshya Nov 2021 – Aug 2023
Developed correctness-critical blockchain and financial analytics backends (Rust/TypeScript).

Instruction

MLOps (Machine Learning Operations), TRAC, Iowa State University Aug 2024 – Dec 2024