PRINCE SAVSAVIYA

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Research Interests

Statistical learning and decision-making for robotic systems. I am broadly interested in integrating representation learning, model-based reinforcement learning, and robust control with high-fidelity simulation and efficient computation to enable reliable autonomy. My focus lies at the intersection of robotics, machine learning, and physics-based simulation, with particular emphasis on using simulations as training grounds for adaptive controllers and combining data-driven methods with first-principles models. I am especially interested in learning residual models on top of physics-based simulators and developing techniques for robust sim-to-real transfer.

Education

University of California, Riverside (UCR) — M.S., Computer Science Riverside, CA *Expected March 2026*
Advisor: Dr. Tamar Shinar
Thesis: Learning-augmented, GPU-accelerated simulation for multi-physics (FSI); ALE mesh motion, partitioned coupling, PETSc/CUDA optimization.
Relevance: scalable data/compute pipelines and control-adjacent optimization directly transferable to training robotic foundation models at scale.

Adani Institute of Infrastructure Engineering (GTU) — B.E., Information & Communication Technology Ahmedabad, India *May 2024*
Senior project: Physics-informed ensemble learning for battery health prediction.

Publications

1. Kadiwala, S.; **Savsaviya, P.**; Pandey, S. V.; Singh, A. K.; Prochowicz, D.; Akin, S.; Khanna, S.; Yadav, P. "Decoding degradation: The synergy of partial differential equations and advanced predictive models for lithium-ion battery" *Journal of Power Sources*, 2025. doi: 10.1016/j.jpowsour.2024.235771.

Research Experience

Graduate Researcher — University of California, Riverside **Riverside, CA** **May 2025 – Present**

- **Validated** an ALE-ready projection fluid solver (P2/P1) and one-way ALE driver against Turek–Hron suites (CFD/CSM/FSI), matching reference drag/lift and tip displacement within $\leq$ **2–5%** on L3–L5 meshes (DolfinX/FEniCSx).
- **Built** solid and fluid *sub-mesh splitters* from a merged FSI mesh (5 levels, L0–L5), preserving cell/facet tags; added interface DOF mapping with geometric alignment and permutation, achieving round-trip position mismatch $\leq 10^{-15}$ (numerical round-off).
- **Automated** a parameterized Python+Gmsh benchmark generator with regression tests and CSV logging (drag/lift, pressure drop, tip displacement), reducing new-case setup time by $\sim$**80%** and enabling repeatable runs.
- **Optimized** GPU-aware MPI and **PETSc/CUDA** solver paths (transfer overlap + solver configuration), improving multi-GPU throughput by $\sim 2\times$; delivered reproducible HPC builds and profiling scripts.
- **Prototyping** physics-informed ML predictors, including ideas inspired by Hamiltonian neural networks, aimed at reducing fixed-point iterations in partitioned FSI coupling; designing feature sets, data pipelines, and initial models to explore this direction (ongoing work)

Research Intern — Adani University **Ahmedabad, India** **May 2023 – Dec 2023**

- **Developed** a physics-informed ML framework for lithium-ion battery health by combining PDE-based aging models with ensemble regressors (SVR, RF, GBR, GPR, etc.).
- **Processed** a dataset of 200,000 + battery cycles; automated feature engineering and hyperparameter search using Optuna, improving experimental turnaround by $\sim$30%.
- **Achieved** $\sim$98% reduction in MSE and 86% reduction in RMSE vs. data-only baselines, showing clear gains from embedding physics into the model.
- **Outcome:** work culminated in a peer-reviewed article in *Journal of Power Sources* (see Publication 1).

Projects

GPU-Aware FSI Benchmark Suite (Thesis) **DolfinX/FEniCSx · PETSc/CUDA · Gmsh** **2025**

- **Implemented** ALE-ready projection fluid solver (P2/P1) and dynamic hyperelastic solid solver; synchronized via interface mapping, mesh motion, and traction/pressure transfer.

- **Validated** on Turek–Hron (CFD/CSM/FSI) with reference agreement on drag/lift and tip displacement $\leq$ **2–5%** (L3–L5 meshes).
- **Built** multi-mesh L0–L5 pipeline with automated runs and CSV logging; ParaView-ready XDMFs for velocity, pressure, and mesh displacement.
- **Takeaway:** reproducible, multi-mesh training/validation workflows and GPU scaling experience applicable to humanoid skill learning at fleet scale. (after your current bullets)

Quadrotor PID Control (eYantra, IIT Bombay) **ROS/ROS 2 · Gazebo · PX4/MAVROS** **2023**

- **Implemented** cascaded PID (attitude & position) for a simulated quadrotor in Gazebo; tuned gains via step-response and Ziegler–Nichols heuristics.
- **Integrated** PX4 flight stack via MAVROS; configured IMU/baro/GPS sensor models; validated hover, waypoint tracking, and disturbance rejection.
- **Results:** steady-state position error <0.15 **m**, rise time <1.2 **s**, overshoot $<8\%$ on standard trajectories.
- **Led** a team of **3**; set up Git/CI workflows and testing scenarios; achieved **top-10 regionally**.

RetrieveX — Hybrid Medical Information Retrieval **Django · Lucene/Elasticsearch · BERT · FAISS** **2025**

- **Combined** BM25 with BERT embeddings + FAISS ANN to improve top-3 precision by $\sim$**25%** on a **150k-document** corpus.
- **Delivered** an async REST API with P95 query latency $<$ **200 ms**; productionized with Docker/Kubernetes on AWS.
- Shows large-corpus data curation and retrieval pipelines akin to robot log/video datasets. (RetrieveX)

Predictive Kubernetes Autoscaler **PyTorch · Prometheus · FastAPI · Helm** **2025**

- **Forecasted** CPU/memory **5 min** ahead with LSTM to tune replica counts; reduced over-provisioning by $\sim$**18%** while maintaining **99.9%** SLA under $4\times$ spikes.
- **Integrated** with Kubernetes HPA via a custom controller; CI/CD with GitHub Actions and canary rollouts.
- Demonstrates forecasting + autoscaling patterns relevant to robot fleet scheduling and training jobs.

Physics-Informed Battery Health Prediction **scikit-learn · Optuna** **2023**

- **Developed** ensemble models with PDE aging priors, cutting MSE by **98%** and RMSE by **86%** vs. data-only baselines on 200k+ cycle records.
- **Automated** feature engineering and hyperparameter search; contributed to a peer-reviewed journal publication.

Multi-Asset Risk-Analytics Microservice **FastAPI · Pandas · PostgreSQL · AWS** **2023**

- **Ingested** equities (IEX), bonds (FRED), and FX to compute rolling beta/volatility and cross-asset correlations.
- **Optimized** vectorized backtests to $\sim$**85 s** end-to-end; real-time endpoints $<$ **150 ms**; shipped with monitoring/alerts.

Core Technical Skills

Languages & Query : Python, C++, Java, C, SQL (PostgreSQL/MySQL), Bash, R
Systems & Cloud : Docker, Kubernetes, AWS (EC2, S3, EKS), Linux, REST APIs, MPI
Data & Search : Elasticsearch, Lucene, FAISS
AI, ML & Data Science : Deep Learning (PyTorch, TensorFlow), scikit-learn, BERT/NLP, Computer Vision, MLOps (Optuna), Vector Search
Performance & HPC : CUDA, PETSc, DolfinX/FEniCSx, Gmsh
Robotics & Simulation : ParaView, Matplotlib, ROS/ROS 2, Gazebo, PX4/MAVROS, RViz
DevOps & Quality : Git/GitHub Actions (CI/CD), Unit Testing, Monitoring, Hyperparameter Tuning

Activities & Leadership

Robotics Club — President **Adani Institute of Infrastructure Engineering (GTU), Ahmedabad, India** **2022–2024**

- **Led** a **20 +** member club; set technical roadmap (ROS/Gazebo tracks), budget, and semester goals; coordinated workshops and recruitment.
- **Standardized** ROS/Git workflows and project templates
- **Mentored** project teams (perception, control, simulation); instituted weekly code reviews and debugging clinics.
- **Organized** campus challenges; grew active membership and competition participation (e.g., eYantra).

Teaching & Mentoring

Robotics Club — Workshops: ATmega328 & Firebird V **Adani Institute of Infrastructure Engineering (GTU)** **2022–2024**

- **Designed & delivered** multi-session workshops on the ATmega328 microcontroller (Arduino/AVR-GCC/Atmel Studio): GPIO, timers/counters, PWM, UART/I^2C/SPI, interrupts, and low-level debugging.
- **Led** hands-on labs using **Firebird V** robots: sensor interfacing (IR/encoders), motor control, PID line following, waypoint navigation, and calibration.
- **Trained 40+** students across **6+** sessions (3–6 hours each); created starter templates, wiring guides, and checklists.
- **Outcomes:** teams built deployable line-followers and maze solvers; increased competition participation (e.g., eYantra) and club project throughput.

Selected Coursework

Graduate (UCR): Scientific Computing; Foundations of Machine Learning; Data Mining Techniques; Advanced Operating Systems; Cloud Computing & Cloud Networking; Information Retrieval & Web Search; Artificial Intelligence; Design & Analysis of Algorithms; Advanced Computer Vision; GPU Architecture & Parallel Programming