

# Shreyas Kumar

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## EDUCATION

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**Indian Institute of Engineering Science and Technology (IIST)**

Kolkata, India

Bachelor of Technology in Mechanical Engineering

June 2025

GPA: 8.6/10.0, Distinction

## RESEARCH EXPERIENCE

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**Human-interactive Robotics (HiRo) Lab**

Indian Institute of Science, Bengaluru, India

advised by [Prof. Ravi Prakash](#)

Jul 2024 - Present

- Under collaboration with [Prof. Fares J. Abu-Dakka](#) from **New York University, Abu Dhabi**
  - Developing a real-time task parameterized policy transport framework employing Kernelized Movement Primitives (KMPs).
  - Building a semantic keypoint extraction pipeline that derives task-relevant parameters directly from scene-level object representations to enable scene-agnostic skill generalization.
- Under collaboration with [Prof. Anh Nguyen](#) from **University of Liverpool**
  - Led a large-scale data collection effort comprising 9000 real-world demonstrations to establish a benchmark for complex grasping tasks requiring semantic understanding across grasp phases [1].
  - Developed a teleoperation and data acquisition framework on the Franka FR3 – wrote custom C++ ROS controllers, integrated multi-camera RGB-D sensing, and automated extrinsic camera calibration within a reproducible, synchronized data logging pipeline.
- Derived an analytical expression for closed-form solution of the Hamilton-Jacobi-Bellman (HJB) equation. [2]
- Developed Certified Gaussian Manifold Sampling (CGMS) [3], enabling safety-certified reinforcement learning (RL) for Variable Impedance Control (VIC) with Lyapunov stability and torque-aware constraints and formalized its robust adaptation under external disturbances and model uncertainties by guaranteeing input-to-state stability (ISS).
- Introduced PACER [4], an Imitation Learning (IL) algorithm that learns latent task phases to align demonstrations and filter local corruptions for stable learning from few ( $\leq 5$ ) imperfect demos—currently benchmarking against SoTA F1/10<sup>th</sup> algorithms.

**IITGN Robotics Lab**

Indian Institute of Technology, Gandhinagar, India

advised by [Prof. Harish P.M.](#)

Jan - Jun 2025

- Grasping at the Edge of Instability (Bachelor Thesis) [5]
  - Investigated the mechanics of force-production tasks in robotic grasping of compliant objects, showing how deformation induced torque coupling leads to a bifurcation-type loss of equilibrium when contact forces exceed a critical threshold.
  - Derived a closed-form stability condition characterizing the transition from stable force application to sudden grasp failure.
  - Extended the theoretical framework to both motor-driven and tendon-driven robotic hands, analyzing how redundancy influences force generation, and derived a redundancy optimization algorithm to maximize stable force production under compliance-induced constraints.
- Developed a bimanual snap-fit assembly framework for delicate tasks by integrating (i) SnapNet, a CNN-GRU attention network trained solely on joint velocity data, (ii) a unified dynamical-system based dual-arm coordination scheme, and (iii) an event-triggered VIC to absorb (otherwise damage-inducing) residual impact energy during contact events. [6], [7]

**IITGN Robotics Lab**

Indian Institute of Technology, Gandhinagar, India

advised by: [Prof. Harish P.M.](#)

Jun - Jul 2024

- Proposed and implemented (i) adaptive null-space control, (ii) path-dependent object impedance control, and (iii) sensor fusion via Extended Kalman Filter (EKF) to enable real-world experiments of a novel Iterative Learning Control (ILC) based approach [8] for rapid task generalization in robotic grasping and manipulation tasks.

## Control System & Instrumentation Lab

advised by Prof. Roshni Maiti

IEST, Kolkata, India

Jan - Mar 2024

- Designed a fuzzy predictor with Lyapunov-based adaptation for real-time disturbance estimation, integrated the predictor with a fast terminal sliding mode controller to reject the estimated disturbances and ensure finite-time convergence. [9]

## PUBLICATIONS

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\* Denotes Equal Contribution

- [1] H. Zhang et al., "Gripper-aware vision language action models for robotic grasping," Under Review in IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) 2026.
- [2] A. Vyas, **S. Kumar**, J. Kumar Mohanta, and R. Prakash, "Closed form hjb solution for continuous-time optimal control of a non-linear input-affine system," Under Review in 8th Annual Learning for Dynamics and Control Conference (L4DC) 2026.
- [3] **S. Kumar** and R. Prakash, "Safe reinforcement learning for variable impedance control via gaussian barrier sampling," Under Review in IEEE International Conference on Robotics and Automation (ICRA) 2026.
- [4] **S. Kumar** and R. Prakash, "PACER: Progress-aligned curation for error-resilient imitation learning," in *Workshop on Making Sense of Data in Robotics: Composition, Curation, and Interpretability at Scale at CoRL 2025*, 2025. [Online]. Available: <https://openreview.net/forum?id=gaYyBvP2Rz>.
- [5] S. Barat\*, **S. Kumar\***, and H. J. Palanhandalam-Madapusi, "Grasping at the edge of instability," In Preparation for The International Journal of Robotics Research, 2025.
- [6] **S. Kumar**, S. Barat, D. Das, S. Jain, R. Kumar, and H. J. Palanhandalam-Madapusi, "Towards coordinated dual-arm snap-fit assembly skill for delicate applications," in *2025 IEEE-RAS 24th International Conference on Humanoid Robots (Humanoids) Late Breaking Report*, 2025, pp. 934–935. DOI: [10.1109/Humanoids65713.2025.11203142](https://doi.org/10.1109/Humanoids65713.2025.11203142).
- [7] **S. Kumar**, S. Barat, R. Kumar, and H. J. Palanhandalam-Madapusi, "A coordinated framework for dual-arm snap-fit assembly of delicate components," In Preparation for IEEE Transactions on Automation Science and Engineering (T-ASE), 2025.
- [8] S. Barat, S. Patidar, D. Das, **S. Kumar**, S. Jadav, and H. J. Palanhandalam-Madapusi, "Iterative learning for manipulation and grasping against unknown resistance fields that is generalizable to arbitrary trajectories," Under Review in Autonomous Robots, 2024.
- [9] **S. Kumar**, B. Dash, R. Maiti, and D. Guha, "Adaptive fuzzy predictor based fast terminal sliding mode controller design for two-link robot manipulator," in *2024 Tenth Indian Control Conference (ICC)*, 2024, pp. 302–307. DOI: [10.1109/ICC64753.2024.10883745](https://doi.org/10.1109/ICC64753.2024.10883745).

## RELEVANT INTERNSHIPS

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### Indian Space Research Organization

Control Intern

Space Applications Center, Ahmedabad, India

Jan - Feb 2024

- Built a Python framework using Kane's dynamic analysis method for Quadcopter simulation
- Developed a real-time momentum observer and adaptive force estimator for dynamic manipulation tasks in microgravity, enabling accurate force tracking ( $IAE \leq 2.0 \text{ N}\cdot\text{s}$  over 10 s trials) during contact, lift, and manipulation phases.

### Strider Robotics

Robotics Perception Intern

ARTPARK, Bangaluru, India

Dec 2023 - Jan 2024

- Implemented ArUco-SLAM, an algorithm for localization using node graphs of landmarks based on fiducial markers, improved efficiency by 30% through object-oriented refactoring.

- Used a particle filter to map the environment by fusing depth data with IMU data.

ACHIEVEMENTS

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- ◇ Received GAABESU Research Award 2025 (10 of 720 graduating students).
- ◇ Received a prize money of \$500 under the 1965 ME Alumni Award for Technical Excellence 2025.
- ◇ Awarded a travel grant by IEEE CSS for Indian Control Conference 2024.
- ◇ Prize money of \$500 at the regional round of Boeing National Aeromodelling Competition, 2023.
- ◇ Awarded with the prestigious IASc-INSa-NASI Summer Research Fellowship, 2023.
- ◇ Shortlisted for the Institute Innovation Council’s ‘Alpona Banerjee Memorial Endowment Funding Scheme 2023’ and received a \$1000 grant for research in Robotics and Artificial Intelligence.
- ◇ Secured a global critical design review rank of 25 and an innovation rank of 32 in the ASME Human Powered Vehicle Challenge, 2022.

ACADEMIC CONTRIBUTIONS & OUTREACH

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- ◇ Delegate reviewer at ICRA 2026.
- ◇ Mentor at Robot Kinematics for Engineers Workshop 2024 (conducted by IITGN).

SKILLS

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Languages	Python, C/C++, MATLAB
Frameworks	ROS/ROS2, MoveIt!, Gazebo, MuJoCo, Isaac Lab, Mathematica
Libraries	OpenCV, PyTorch, Mink, Pandas, Numpy
Prototyping	SolidWorks, 3D Printing, CNC Lathe and Milling, Laser Cutting