Hemant Kumar

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Research Summary

My research focuses on integrating control theory with learning based methods to develop robots that can perceive, adapt, and act intelligently in unstructured environments. I aim to build control theoretically grounded learning systems that leverage foundation model representations to enable safe, generalizable, and reliable robot behavior in real-world, human-centric settings.

Education

University of Maryland, College Park Sept 2022 – Present
Ph.D. in Robotics Advisor: Dr. Nikhil Chopra
Thesis Direction: Autonomous Disassembly of EVs (Electric Vehicles).
Imitation Learning · Reinforcement Learning · Control Theory · VLA's · Truth-worthy Robotics · Computer-Vision

Indian Institute of Technology (IIT), Kharagpur Sept 2015 – May 2020
Bachelors (Honors) and Masters of Technology - Aerospace Engineering Advisor: Dr. Chetan S. Mistry

Patents

- **Hemant Kumar (Lead Inventor)**, Kaustubh Joshi, Nikhil Chopra, ***RACE: Real-Time Adaptive Camera Intrinsic Estimation*** (US-Patent under-review).
- Piyush Goenka, **Hemant Kumar**, Kaustubh Joshi, Alexander Beyer, Tianchen Liu, Nikhil Chopra, ***UniScrew: Electronically Actuated Universal Electric Screwdriver Adapter for Any Robot Arm*** (US-Patent under-review).

Research Publications/Submissions

Conferences

- **Hemant Kumar***, Kaustubh Joshi*, Nikhil Chopra, ***RACE++: A Unified Framework for Real-time Adaptive Camera Calibration***, The IEEE/CVF Conference on Computer Vision and Pattern Recognition CVPR-2026 (under-review).
- **Hemant Kumar**, Kaustubh Joshi, Nikhil Chopra, ***RACE: Real-Time Adaptive Camera-Intrinsic Estimation via Control Theory***, The International Conference on Learning Representations (ICLR-2026) (under-review).
- **Hemant Kumar**, Piyush Goenka, Nikhil Chopra, ***DAWN-Visuomotor Diffusion policy for Imitation Learning for Contact Rich Manipulation Task***, International Conference of Robotic and Automation-2026 (under-review).
- **Hemant Kumar***, Kaustubh Joshi*, Nikhil Chopra, ***From Offline to Online: Adaptive Camera Calibration in Real Time.***, International Conference of Robotic and Automation, ICRA-2026 (under-review).
- **Hemant Kumar**, Chetan S. Mistry, ***Implementation of Similarity Principle and Scaling Laws for Low-to-High Speed Mixed Flow Compressor***, American Society of Mechanical Engineers Turbo Expo Boston 2023 *[Link]*.
- **Hemant Kumar**, Chetan S. Mistry, ***Numerical investigations on aerodynamic design criteria for low speed mixed flow compressor***, American Society of Mechanical Engineers (ASME) GTIndia 2021. *[Link]*
- **Hemant Kumar**, Chetan S. Mistry, ***Numerical Performance and Flow Field study of Centrifugal Compressor with Supercritical Carbon dioxide***, American Society of Mechanical Engineers (ASME) GTIndia 2019. *[Link]*.

Journals

- Piyush Goenka, **Hemant Kumar**, Nikhil Chopra, ***Toward Generalizable Robotic Disassembly: A Visuo-Tactile Pipeline for Screw Unfastening***, Journal of Robotics and Computer-Integrated Manufacturing (under-review).
- **Hemant Kumar**, Chetan S. Mistry, ***Tip Clearance Mechanism in Mixed Flow Compressor***, Journal of Propulsion and Power Research 2023. *[Link]*.

On-Going Projects

- **Benchmarking Vision-Language Models for Disassembly Tasks** - Building a dataset of multi-object assembly/disassembly sequences with question–answer supervision to train and evaluate vision-language model reasoning, correctness, and tool selection.
- **Adaptive Control Wrapper for Foundation Robotics Models** - Developing a control-theoretic wrapper over foundation models, single-policy networks, and VLA models to enable real-time adaptation under uncertainty in contact-rich manipulation tasks.

Experience

- **Research Intern** | **Destro-AI** | ***Remote*** Spring 2026 (upcoming)
  - Developing a foundation Vision-Language-Action model for robotic grasping, picking, and manipulation in warehouse environments using customer driven data to enhance generalization and task understanding.
- **Research Associate** | **Turbomachines Research Lab** | ***IIT Kharagpur*** Aug 2020 -May 2022
  Supervisor: Prof. Chetan S. Mistry
  - Investigated **scaling laws and similarity principles** to predict high-speed compressor performance from low-speed test data, establishing generalized scaling correlations for mixed-flow compressors.
  - Analyzed **condensation and two-phase nucleation phenomena** in supercritical CO_2 compressors, identifying their impact on stability and off-design performance.
  - Designed compressor stages with **variable tip clearances** using in-house code and CFD (ANSYS) to study tip-leakage vortex behavior and 3D flow-field characteristics at high rotor speeds and co-authored two papers.
- **Research Intern** | **Turbomachines Research Lab** | ***IIT Kharagpur*** May 2019 - July 2019
  Supervisor: Prof. Chetan S. Mistry
  - Designed a **subsonic mixed-flow compressor** for a new low-speed turbomachinery facility at IIT Kharagpur; performed theoretical and thermal design calculations for a 3000 Pa pressure rise and 3000 rpm operation.
  - Conducted CFD analysis and performance optimization in **ANSYS**; established the facility's proof-of-concept and co-authored a publication based on the results.
- **Research Intern** | **Turbomachines Research Lab** | ***IIT Kharagpur*** May 2018 - July 2018
  Supervisor: Prof. Chetan S. Mistry
  - Designed and developed a **supercritical CO_2 centrifugal compressor** through theoretical modeling and in-house simulation code; performed CFD analysis in **ANSYS** to study flow-field and performance.
  - Validated results with experimental data from **Sandia National Laboratories** and co-authored a publication.
- **Research Intern** | **DRDO** | ***Chandigarh, India*** May 2017 - July 2017
  Supervisor: Scientist 'E' Munesh Kumar Patle
  - Conducted theoretical design and numerical analysis of a Pulse Detonation Engine (PDE) using ANSYS.
  - Modeled 3D PDE geometry via custom code and analyzed detonation wave propagation, temperature distribution, and performance for various fuel–air mixtures.

Skills

Languages: Python, MATLAB, Familiar with C & C++.

Technologies: Git, Docker, LATEX, MAVLink, Arduino.

Robot Platforms: Universal Robots (UR5e and UR3e), Franka Emika (FR3), Neuromeka IndyRP2.

Robot Software & Simulation: ROS, ROS-2, Gazebo, NVIDIA Issac Sim.

Vision/AR/VR Systems: Intel Realsense, Quest 3, Real-time object detection & Navigation system integration.

Past Research and Projects

- **Advanced Machine Learning: Theory and Applications**, University of Maryland (Feb–Jun 2023) - Developed deep neural and reinforcement learning algorithms for autonomous course navigation.
- **Equilibrium Programming**, University of Maryland (Feb–Jun 2023) - Implemented a bi-level optimization framework using game-theoretic principles for energy market.
- **AIAA Design Competition 2019** - Ranked among the **Top 8 globally** for hybrid-electric UAV engine design, organized by the American Institute of Aeronautics and Astronautics.
- **Aerodynamics of Golf Ball**, IIT Kharagpur (Jul–Nov 2017) - Designed and tested a new dimple geometry using an indigenous force balance setup; validated with CFD and wind tunnel data.
- **Jetpack Design and Analysis**, IIT Kharagpur (Jul–Dec 2018) - Proposed a theoretical model for dual low-bypass turbofan propulsion and control via thrust vectoring optimization.
- **Cardiovascular Biofluid Dynamics**, IIT Kharagpur (Jul 2019–Apr 2020) - Simulated carotid artery flow in COMSOL to analyze hemodynamic patterns and flow separation effects.

Academic Service

Reviewer : RA-L (Robotics Automation and Letters), ICRA'25, ASME.
Graduate Teaching Assistant : ENES221: Dynamics, UMD, College Park. *Spring 2025*.
Graduate Teaching Assistant : ENES102: Mechanics-I, UMD, College Park. *Fall'22, Spring'23, Fall'23*
Graduate Teaching Assistant : AE39003: Structure Lab-II, IIT, Kharagpur. *Fall 2020*.

Positions of Responsibility

- **Captain**, IIT Kharagpur Men's Basketball Team - **Silver Medal**, 54th Inter IIT Sports Meet. *2019–20*
- **Captain**, Inter Hall Basketball Team - **Silver Medal**, General Championship, IIT Kharagpur. *2018–19*
- **Captain**, Inter Hall Basketball Team - **Gold Medal**, General Championship, IIT Kharagpur. *2017–18*
- **Group Leader**, National Service Scheme (NSS) - led in community service initiatives. *2016–17*

Awards and Achievements

- **Institute-Level Achievements**
  - **Dean's Fellowship** from University of Maryland (2023).
  - Conferred the prestigious **Institute Blue Award** for outstanding contribution to Basketball, IIT Kharagpur.
  - Recipient of the **AICTE Postgraduate Scholarship**, Government of India, for academic excellence.
- **Inter IIT Sports Meets**
  - **Captain**, IIT Kharagpur Men's Basketball Team, **Silver Medal**, 54th Inter IIT Sports Meet, IIT KGP ('19–'20).
  - **Participant**, Basketball, 53rd Inter IIT Sports Meet, IIT Guwahati (2018–19).
  - **Gold Medalist**, Basketball, 52nd Inter IIT Sports Meet, IIT Madras (2017–18).
- **Outstation Tournaments**
  - **Silver Medalist**, Basketball, Udghosh 2018, India's largest sports festival, IIT Kanpur.
  - Represented IIT Kharagpur in the **Inter College Basketball League**, organized by the Basketball Federation of India, Kolkata (2018), finishing in **4th place**.
  - Participated in the **West Bengal Senior State Basketball Championship**, Kolkata (2017).
  - Participated in **Spardha 2017**, IIT (BHU) Varanasi.
- **Inter-Hall Tournaments**
  - **Captain**, Nehru Hall Basketball Team, **Silver Medal**, General Championship, , IIT Kharagpur (2018–19).
  - **Gold Medalist**, Inter Hall Basketball Tournament, General Championship, IIT Kharagpur (2017–18).
  - Represented Nehru Hall Athletics Team (**Hammer Throw, Shot-Put**), General Championship (2017).
- **Other Activities**
  - Participated in a week-long **NSS Camp** on first-aid awareness and rural development.
  - Awarded **Young Blood**, Nehru Hall of Residence (2017–18).
  - **Gold Medalist** (2013) and **Silver Medalist** (2012), Regional High School Basketball Championships.