# Hemant Kumar

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## Research Summary

My research lies at the intersection of learning based robotics and control theory, with the goal of developing robotic systems that reason, adapt, and act reliably in unstructured real world environments. I aim to build control theoretically grounded learning frameworks that leverage foundation model representations to enable safe, adaptive, and reliable general purpose robot behavior in 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 In-Progress).
- 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 In-Progress).

## Research Publications/Submissions

### Conferences

- **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) *[Link]*.
- **Hemant Kumar**, Piyush Goenka, Nikhil Chopra, ***DAWN-Visuomotor Diffusion policy for Imitation Learning for Contact Rich Manipulation***, International Conference of Robotic and Automation, **ICRA-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 Autonomous Systems (under-review).
- **Hemant Kumar**, Chetan S. Mistry, ***Tip Clearance Mechanism in Mixed Flow Compressor***, Journal of Propulsion and Power Research 2023. *[Link]*.

## Selected Research Projects

- **DAWN: Hierarchical Diffusion Policies for Contact-Rich Robotic Unfastening, ICRA-2026**
    - Proposed **DAWN**, a *hierarchical diffusion based framework* for autonomous robotic unfastening task, enabling structured learning of long-horizon dexterous manipulation.
    - Collected a **large scale real-world dataset** and evaluated DAWN on **1500+ physical trials** on a **Franka Emika robot**, demonstrating strong generalization across unseen fasteners and operating conditions.

- **Benchmarking Vision-Language Models for Disassembly Tasks**
  - Built a multi-modal dataset of multi-object assembly and disassembly sequences with **question-answer supervision** to evaluate foundational vision language models for **instruction grounding**, task reasoning, and targeting generalization to unseen object configurations.

- **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.

- **Hemant Kumar\***, Kaustubh Joshi\*, Nikhil Chopra, *RACE++: A Unified Framework for Real-time Adaptive Camera Calibration for Non-linear Wide Angle Camera Models*

## Experience

**Research Associate | Turbomachines Research Lab | *IIT Kharagpur***      Aug 2020 -May 2022
Supervisor: Prof. Chetan S. Mistry
- Developed physics-based modeling and CFD simulation pipelines (ANSYS) for compressor design and stability analysis; co-authored peer-reviewed publications.

**Research Intern | Turbomachines Research Lab | *IIT Kharagpur***      May 2019 - July 2019
Supervisor: Prof. Chetan S. Mistry
- Designed and evaluated a subsonic mixed-flow compressor using analytical modeling and CFD-based performance optimization.

**Research Intern | Turbomachines Research Lab | *IIT Kharagpur***      May 2018 - July 2018
Supervisor: Prof. Chetan S. Mistry
- Built theoretical and numerical models for supercritical $CO_2$ centrifugal compressors and validated simulations against experimental data.

**Research Intern | DRDO | *Chandigarh, India***      May 2017 - July 2017
Supervisor: Scientist 'E' Munesh Kumar Patle
- Modeled and simulated PDE engine dynamics using numerical methods and 3D CFD simulations

## 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.
**Machine Learning Frameworks:** Diffusion-based Imitation Learning, Offline RL, Robot Foundation Models, VLA's.

## 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.

## 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*.

## Leadership & Honors

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