

# HIMANI SINHMAR

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## EDUCATION

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**Ph.D.** *Aerospace Engineering, Cornell University with Prof. [Hadas Kress-Gazit](#)* ('19 - Expected '24)  
Specialization in Dynamics, Controls and Robotics, Minor in Computer Science

**Bachelor and Master of Technology** *Indian Institute of Technology Bombay* ('14 - '19)  
Specialization in System and Controls, Major in Aerospace Engineering, Minor in Physics

## RESEARCH FOCUS AND SKILLS

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My research focuses on developing verifiable-safe motion planners and controllers for robotic systems with resource-efficient hardware to address real-world challenges. I utilize insights from diverse fields such as control theory, collective intelligence, formal methods, sensor networks, and optimization. I have implemented various motion planners on physical platforms such as mobile manipulator [Stretch Robot](#), UAV [Crazyflie 2.1](#), mobile robot [iRobot Create](#).

**Research Interests:** Motion Planning, Control for Autonomy, Autonomous Vehicles, Manipulation

**Programming Languages:** C++, Python, MATLAB, C#

**Tools:** Unity Game engine, Robot Operating System (ROS), ANSYS, SolidWorks

## PEER-REVIEWED PUBLICATIONS

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6. **Himani Sinhmar**, Hadas Kress-Gazit, *Guaranteed Encapsulation of Targets with Unknown Motion by a Minimalist Robotic Swarm*, [[Paper](#)] Transactions on Robotics, (T-RO 2023)
5. **Himani Sinhmar**, Hadas Kress-Gazit, *Decentralized Control of Minimalistic Robotic Swarms For Guaranteed Encapsulation Behavior*, [[Paper](#)] International Conference on Intelligent Robots and Systems (IROS 2022)
4. **Himani Sinhmar**, Marcus Greiff, Stefano Di Cairano *Practical and Safe Navigation Function Based Motion Planning of UAVs*, under review in International Conference on Robotics and Automation, (ICRA 2024)
3. **Himani Sinhmar**, Srikant Sukumar, *Distributed model independent algorithm for spacecraft synchronization under relative measurement bias* [[Paper](#)], Proceedings of the 2019 CEAS EuroGNC conference. Milan, Italy. Apr'19. CEAS-GNC-2019-060
2. **Himani Sinhmar**, Vinod Kumar, *Relative Autonomous Navigation Without Communication Between Spacecraft Using Line of Sight Measurements* [[Paper](#)] IEEE/CSAA Guidance, Navigation and Control Conference, Aug'18
1. Pallavi Sinha, Srikant Sukumar, **Himani Sinhmar**, *Consensus of networked double integrator systems under sensor bias*, [[Paper](#)] International Journal of Adaptive Control and Signal Processing, Nov'22

## PROFESSIONAL AND RESEARCH EXPERIENCE

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**Practical and Safe Motion Planning of UAVs** (Summer'23)

Research Intern with [Dr. Marcus Greiff](#), Mitsubishi Electric Research Labs (MERL)

- Developed a reference governor-based motion planning framework by introducing a refined practical version of artificial potential functions for non-convex free spaces
- Demonstrated certifiable-safe real-time operation of a [Crazyflie UAV](#), in an environment cluttered with polyhedral obstacles and significant input disturbances

## Hardware Algorithm Co-Design for a Morphing Soft Robot

(Fall'19 - Fall'21)

Advisor Prof. [Hadas Kress-Gazit](#), Cornell University

- Created a physics-based simulator using C# scripts and Unity game engine for control synthesis of optimal gaits for a micrometer-sized sheet robots (MetaBots) that could form 3D surfaces from 2D actuation patterns, cycle among different shapes, and locomote

## Decentralized Control for a Minimalistic Robotic Swarm

(Spring'21 - present)

Project with Prof. [Hadas Kress-Gazit](#), Cornell University

- Designed provably correct decentralized control algorithms ensuring complex desired swarm behavior for robots devoid of memory and localization abilities

## Cooperative Control Under Bias in Measurements

(Summer'18 - Summer'19)

Thesis with Prof. [Srikant Sukumar](#), IIT Bombay, Received **Institute Undergraduate Research Award**

- Created an adaptive control law, utilizing collective initial excitation-based results and Lyapunov stability theory to achieve exponential consensus and accurate bias estimation for bipartite network graphs

## Learning for Task Allocation and Motion Planning

(Spring'23)

Project with Prof. [Sanjiban Choudhury](#), Cornell University

- Developed automated task allocation and task execution using **imitation learning** to optimize resource utilization and cost minimization for a heterogeneous multi-robot team
- Demonstrated the effectiveness of **Dagger and Q-learning policies** in maximizing the collection of objects in maze scenarios with static obstacles and diverse agent capabilities
- Created a dynamic learning environment by generating 10,000 random complex maze instances

## Motion Planning, Localization, and Mapping for iRobot Create [\[github\]](#)

(Spring'20)

Project with Prof. [Hadas Kress-Gazit](#), Cornell University

- Implemented **SLAM** and motion planning algorithms, including **sampling-based methods**, roadmaps, and potential functions, alongside **EKF and particle filters** for state estimation, to enable goal navigation and collision avoidance on the iRobot Create platform using LiDAR and RGB-D data

## Task and Motion Planner for Robot Manipulation [\[github\]](#)

(Spring'22)

Project with Prof. [Tapomayukh Bhattacharjee](#), Cornell University

- Developed a reactive planner that automatically generates adaptable, physically feasible motion plans for diverse tasks given high-level task specifications and object affordances
- Implemented the planner on Stretch Robot for a series of reactive manipulation tasks

## IMU Alignment of a Store Dropped from Aircraft

(Summer'18)

Research Internship with [Dr. Aditya Paranjape](#), Imperial College London

- Engineered an in-flight Inertial Measurement Unit (IMU) transfer-alignment algorithm to facilitate accurate position and attitude estimation for dropped payloads across all flight phases
- Implemented **sensor fusion and state estimation methodologies**, utilizing a fifteen-state Kalman filter for data integration and error estimation within the INS/GPS integration framework
- Constructed sensor models for both the IMU and auxiliary sensors of the payload, incorporating standard error models for accurate representation
- Developed a MATLAB-based simulator capable of generating consistent test data in the absence of IMU, GPS, or magnetometer unit

## Autonomous Navigation for Spacecraft Rendezvous

(Fall'17)

Research Co-op with [Control Dynamics & Simulations Group, ISRO](#)

- Developed an algorithm for autonomous spacecraft navigation, using Line of Sight measurements (LOS) to estimate relative position, attitude, and angular rates, offering a **robust alternative** to traditional gyro-based methods and mitigating errors caused by gyro data loss or communication delays
- Extended an algorithm designed for star tracker-based attitude determination, to estimate relative angular rates solely from LOS measurements between spacecraft using a visual navigation system, with an Extended Kalman Filter (EKF) and validated through numerical simulations

## State Tracking and Fault Diagnosis in Nonlinear uncertain systems

(Spring'18)

Project with Prof. [Srikant Sukumar](#), IIT Bombay

- Developed a sensor bias estimator for state tracking in model reference adaptive control setting
- Implemented algorithms on a 4<sup>th</sup> order longitudinal dynamics model of an aircraft in a wings-level cruise

## Pratham - IIT Bombay Student Satellite Team

(Fall'14 - Summer'15)

Successfully launched on 26<sup>th</sup> September 2016

- Assisted in modeling of the satellite body, panels and other onboard components in SolidWorks
- Performed structural and thermal simulations of the satellite in ANSYS
- Collaborated in the designing, modeling and characterization of Cross Yagi antennas
- Established communication link with the LEO satellites, receiving data using off-the-shelf equipments

## ACHIEVEMENTS AND RESPONSIBILITIES

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- Awarded the **Institute Undergraduate Research Award**
- **Session Chair** for: *Swarm Robotics* IROS 2022, *Navigation Technology* IEEE/CSAA GNC 2018
- Lead a session on microscopic robots and differential geometry in [EYH](#) conference
- **Teaching Assistant**: Autonomous Mobile Robots, Spaceflight Mechanics, Dynamics and Control
- **Reviewer** for *IEEE Transactions on Robotics* and *IEEE Transactions on Control of Network Systems*
- Graduate Resident Fellow at Willam T. Keeton House, Cornell University
- Chief Editor for department newsletter [Lift-Off](#) (2016-17)
- Presided an International conference on *Next Generation Skills Development and Challenges in Aeronautical and Aerospace Industry* organized by Aeronautical Society of India
- Recipient of INSPIRE scholarship for being in the top 1% in Senior Secondary Examination

## KEY COURSES

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<b>Robotics</b>	Autonomous Mobile Robots, Robot Manipulation, Learning for robot decision making Formal methods in robotics, Machine learning, Optimal control, Multivariable control, Adaptive control, Non-linear dynamics, Navigation and guidance
<b>Mathematics</b>	Calculus, Data analysis and interpretation, Differential equations, Linear algebra