

# 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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8. **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
7. **Himani Sinhmar**, Hadas Kress-Gazit, *Guaranteed Encapsulation of Targets with Unknown Motion by a Minimalist Robotic Swarm*, [[Paper](#)] Transactions on Robotics (T-RO) 2023
6. **Himani Sinhmar**, Marcus Greiff, Stefano Di Cairano *Practical and Safe Navigation Function Based Motion Planning of UAVs*, Accepted in International Conference on Robotics and Automation (ICRA'24)
5. Marcus Greiff, **Himani Sinhmar**, Avishai Weiss, Karl Berntorp, Stefano Di Cairano *Graph-Based Invariant Set Planning for Quadrotors*, under review in Transactions on Control Systems Technology (TCST) 2024
4. Qingkun Liu\*, Wei Wang\*, **Himani Sinhmar**, Itay Griniasty, Jason Z. Kim, Jacob T. Pelster, Parag Chaudhari, Michael F. Reynolds, Michael C. Cao, David A. Muller, Alyssa B. Apsel, Nicholas L. Abbott, Hadas Kress-Gazit, Paul. L. McEuen, Itai Cohen *Microscopic, continuum, compliant, and electronically configurable metamaterial robots*, under review in Nature Materials, 2024
3. **Himani Sinhmar**, Srikant Sukumar, *Distributed model independent algorithm for spacecraft synchronization under relative measurement bias* [[Paper](#)], 5<sup>th</sup> CEAS Conference on Guidance, Navigation and Control 2019
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 August 2018
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 2022

## INVITED TALKS

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- Invited talk on “Control with Guarantees for Minimalist Multi-Robotic Systems” Daniela Rus Lab MIT, Jan’24
- Invited talk on “Control with Guarantees for Minimalist Multi-Robotic Systems” The Robotic Institute CMU, Jan’24
- Invited talk on “Control with Guarantees for Minimalist Multi-Robotic Systems” GRASP Lab University of Pennsylvania, Jan’24
- Invited talk on “Provably Correct Controllers for Minimalist Robotic Swarm” Collective Intelligence Lab Cornell University, Jan’23
- Guest Lecture on “Building Micro Robots for Encapsulating Biological Systems” Introduction to Computational Science and Engineering (ENGRI 1510) Cornell University, May’22

## 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 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

### Pratham - IIT Bombay Student Satellite Team (Fall'14 - Summer'15)

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

- Assisted in modeling the satellite body, panels, and other onboard components in SolidWorks
- Performed structural and thermal simulations of the satellite in ANSYS along with the designing, modeling, and characterization of Cross Yagi antennas

## 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)
- Co-organized an International conference on *Next Generation Skills Development and Challenges in Aeronautical and Aerospace Industry* with Aeronautical Society of India
- Recipient of INSPIRE scholarship for being in the top 1% in Senior Secondary Examination