

# Himani Sinhmar | CV

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## Research Interests

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Autonomous vehicles, Task and Motion planning, Dynamics and Control, Multi-agent Systems

## Peer-Reviewed Publications

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**Himani Sinhmar**, Hadas Kress-Gazit, *Decentralized Control of Minimalistic Robotic Swarms For Guaranteed Encapsulation Behavior*, International Conference on Intelligent Robots and Systems (IROS 2022) [Accepted]

**Himani Sinhmar**, Vinod Kumar, *Relative Autonomous Navigation Without Communication Between Spacecraft Using Line of Sight Measurements*, IEEE/CSAA Guidance, Navigation and Control Conference, August 2018 [Paper]

**Himani Sinhmar**, Srikant Sukumar, *Distributed model independent algorithm for spacecraft synchronization under relative measurement bias*, 5<sup>th</sup> CEAS Conference on Guidance, Navigation and Control, (EuroGNC 19) [Paper]

Pallavi Sinha, Srikant Sukumar, **Himani Sinhmar**, *Consensus of networked double integrator systems under sensor bias*, International Journal of Adaptive Control and Signal Processing [Accepted]

**Himani Sinhmar**, Pallavi Rastogi, Shripad P. Mahulikar, *Direct Theoretical Approach to Jet Propulsion Principles based on Pressure Variation inside the Engine*, Preprint 2018 [Paper]

**Himani Sinhmar**, Hadas Kress-Gazit, *Motion Planning for a minimalist robotic swarm with collision avoidance to encapsulate multiple dynamic targets* [In Preparation]

## Academic Qualifications

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### PhD Candidate

Cornell University

**GPA : 3.99/4.00**

2019–Present

- Advisor: [Prof. Hadas Kress-Gazit](#)
- Major: Robotics and Minor: Computer Science

### Masters of Technology

Indian Institute of Technology Bombay (IIT Bombay)

**GPA: 10.00/10.00**

2018-2019

- Specialization in Systems and Controls

### Bachelors of Technology

Indian Institute of Technology Bombay (IIT Bombay)

**GPA: 8.7/10.00**

2014-2018

- Major: Aerospace Engineering and Minor: Physics

## Technical Skills

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### Programming Tools

C++, Python, C#, MATLAB, Maple, Mathematica, R,  $\text{\LaTeX}$   
Unity Game engine, ROS, ANSYS, ICEM-CFD, SolidWorks, AutoCAD

## Research Experience

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### Decentralized Control for Swarm of Minimalistic Robots

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

Mar'21 - Present

Developed a novel decentralized control algorithm that guarantees the emergence of the complex desired swarm behavior in the presence of sensor noise for robots which have no memory, no localization ability, and no knowledge of the relative locations of their neighbors.

### Simulation Design and Control for Micron-scale Morphing Soft Robots

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

Nov'19 - Present

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

### Simultaneous Localization and Motion Planning (SLAM) for iRobot Create

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

Jan'20 - May'20

Implemented SLAM algorithm on **iRobot Create** capable of navigating to the given goal point while avoiding collisions with static and dynamic obstacles.

### Tool- and Skill- Based Robot Manipulation Task and Motion Planner

Guide : [Prof. Tapomayukh Bhattacharjee](#), Cornell University

Jan'22 - May'22

- Developed a reactive planner which given a high level task specification and object affordances, automatically generates a sequence of motion primitives to satisfy the task in a dynamic environment
- Implemented the planner on **Stretch Robot** for a series of reactive manipulation tasks

### Cooperative Control Under Bias in Measurements

Guide : [Prof. Srikant Sukumar](#), Systems and Control Engg., IIT Bombay

Master's Thesis

May'18 - Jun'19

- Developed a Lyapunov based decentralized control algorithm which guarantees that a multi-agent system tracks a time-varying trajectory in presence of an unknown sensor bias in measurements
- Performed simulations for spacecraft formation under bias in the measurement of relative position

### In-flight IMU Alignment of a Store Dropped from Aircraft

Guide : [Dr. Aditya Paranjape](#), Imperial College of London

Research Internship

May'18 - Aug'18

- Innovated an algorithm capable of working with limited and near-minimal sensor information to address the in-flight transfer-alignment problem
- Implemented multi-sensor fusion for low-cost INS/GPS integration
- Created a Matlab based simulator to generate repeatable test data in the absence of an IMU unit

### Autonomous Navigation for Spacecraft Rendezvous

[Control Dynamics & Simulations Group](#), ISRO, Bangalore

Research Internship

May'17 - Jul'17

- Developed a novel algorithm for autonomous navigation in the event of gyro failures or communication eruption between the spacecraft using only line of sight measurements
- Designed a controller for static thrusters to perform rendezvous of two satellites

### Self-Balancing Robot

Institute Technical Summer Project, IIT Bombay

May'15 - Jun'15

- Fabricated a model to balance an unstable robotic platform on two wheels
- Incorporated an IMU chip with an Arduino for implementing control algorithm
- Improved stability by fusing calibrated values from the gyroscope and accelerometer with Kalman filter

## State Tracking and Fault Diagnosis in Nonlinear uncertain systems

Guide : Prof. Sukumar Srikant, Systems and Control Engg., IIT Bombay

Jan'18 - Apr'18

- Developed a sensor bias estimator accomplishing 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

## Modeling of Turbojet and Ramjet Propulsion System

Guide: Prof. Shripad Mahulikar, Aerospace Engg., IIT Bombay

Bachelor's Thesis

Nov'16 - Nov'17

- Developed a methodology to obtain optimal combustion inlet Mach number and temperature for generating maximum thrust in a ramjet for a given flight condition
- Modeled isobaric and variable pressure combustion in jet engine to assess the propulsive efficiency and thrust
- Articulated the model's application to Scramjet engine for generating net positive thrust

## Pratham - IIT Bombay Student Satellite Team

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

Aug'14 - Apr'15

- 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

## Notable Achievements

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- Awarded the **Institute Undergraduate Research Award**
- **Session Chair** for: *Swarm Robotics* in IROS 2022
- **Session Chair** for: *Navigation Technology* in 2018 IEEE/CSAA GNC Conference
- Lead a session on microscopic robots and differential geometry in EYH conference
- Recipient of INSPIRE scholarship for being in the top 1% in Senior Secondary Examination
- Presided an International conference on *Next Generation Skills Development and Challenges in Aeronautical and Aerospace Industry* organized by Aeronautical Society of India

## Key Courses

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<b>Systems &amp; Control</b>	Autonomous Mobile Robots, Machine learning, Non-linear Dynamics, Multivariable Control, Adaptive Control, Optimal Control, Flight Dynamics, Robot Manipulation, Navigation and Guidance
<b>Mathematics</b>	Calculus, Data Analysis and Interpretation, Differential Equations, Linear Algebra, Numerical Analysis

## Position of Responsibility

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- **Graduate Teaching Assistant**, *Autonomous Mobile Robots* Jan'21 - May'21
- **Graduate Teaching Assistant**, *System Modeling Dynamics and Control* Jul'18 - Nov'18
- **Graduate Teaching Assistant**, *Spaceflight Mechanics* Jan'19 - May'19
- **Graduate Resident Fellow** at Willam T. Keeton House, Cornell University Aug'22 - Present
- **Editor**, *Department Newsletter - Lift-Off* May'16 - May'17