

Himani Sinhmar | CV

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Research Interests

I love to work on the unsolved problems in the domain of autonomous vehicles, minimal field robotics, motion planning, and learning.

Currently, I am working on making simple, robust, and reliable swarm robots that achieve task completion with minimal information and restricted individual capabilities. In addition to this, I am collaborating with [Cohen Group](#), [Apsel Lab](#) and [Laboratory for Molecular engineering](#) to synthesize autonomous micron-scale morphing robots for encapsulating biological systems. These tiny robots would have the ability to be injected into the patient and stop the tumors in their tracks when surgery is not an option.

Peer-Reviewed Publications

Himani Sinhmar, Vinod Kumar, *Relative Autonomous Navigation Without Communication Between Spacecraft Using Line of Sight Measurements*, 8th IEEE/CSAA Guidance, Navigation and Control Conference, August 2018, Xiamen, China ([Paper](#))

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

Academic Qualifications

PhD in Mechanical and Aerospace Engineering

Cornell University

2019–Present

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

Integrated Bachelors and Masters in Aerospace Engineering

Indian Institute of Technology Bombay (IIT Bombay)

GPA : 8.7/10.00

2014–2019

- Minor degree: Physics

Central Board (CBSE)

All India Senior School Certificate Examination

Score : 95.6%

2014

Central Board (CBSE)

All India Secondary School Certificate Examination

Score : 10.00/10.00

2012

Notable Achievements

- **Chaired** a session on Navigation Technology in 2018 IEEE/CSAA GNC conference held in China
- Awarded the **Undergraduate Research Award** for Bachelor's thesis
- 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
- Inter-school debate winner and best speaker for four consecutive years

Research Experience

Cooperative Control Under Bias in Measurements

Master's Thesis

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

May'18 - Jun'19

- Developed a Lyapunov based decentralized control algorithm which ensures that a multi-agent system tracks a time-varying trajectory in presence of an unknown sensor bias in relative position measurements
- **Exponential bias estimation** was achieved by using initial excitation based results in adaptive estimation
- Performed simulations for spacecraft formation under bias in the measurement of relative position

In-flight IMU Alignment of a Store Dropped from Aircraft

Research Internship

Guide : Dr. Aditya Paranjape, Imperial College of London

May'18 - Aug'18

- Implemented the Kalman filter for **low-cost INS/GPS integration** and multi-sensor fusion providing accurate and speedy estimates of the store states in a fast prototyping environment
- Innovated a self-alignment algorithm capable of working with limited & near-minimal sensor information
- Modeled and validated an IMU Simulator to create repeatable test data in the absence of an IMU unit
- Developed the algorithm to address the Transfer Alignment problem, such that the final algorithm can be used to solve either problem — Self Alignment or Transfer Alignment

Autonomous Navigation for Spacecraft Rendezvous

Research Internship

Control Dynamics & Simulations Group, ISRO, Bangalore

May'17 - Jul'17

- Formulated and simulated an algorithm for autonomous navigation in the event of **gyro failures or communication eruption** between the spacecraft using only line of sight measurements
- Programmed an Extended Kalman filter for relative state estimation of 6 DOF spacecraft
- Developed a high fidelity model to simulate relative motion in perturbed orbital environment
- Designed a PD controller for static thrusters to perform rendezvous of two satellites

Modeling of Turbojet and Ramjet Propulsion System

Bachelor's Thesis

Guide: Prof. S.P. Mahuliker, Aerospace Engg., IIT Bombay

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

Academic Projects

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
- Presented a sensor fault detection scheme for nonlinear systems with unstructured modeling uncertainty
- Implemented algorithms on a 4th order longitudinal dynamics model of an aircraft in a wings-level cruise

Pratham - IIT Bombay Student Satellite Team

Successfully launched on 26th 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

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 using PID Controller
- 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

Simulations of Internal flows in Turbomachines using FLUENT

Guide : Prof. Kowsik Bodi, Aerospace Engg., IIT Bombay

Jan'16 - May'16

- Modeled axisymmetric swirl flow in a combustion chamber to detect flow reversal
- Simulated channel flow to analyze the effect of fluid parameters on the flow transience to turbulent bursts
- Optimized results by experimenting with meshing models in Ansys-FLUENT to check grid convergence

Launch Simulation and Analysis of Spitzer Space Telescope

Guide: Prof. Ashok Joshi, Aerospace Engg., IIT Bombay

Mar'16 - Apr'16

- Scrutinized the launch and mission objectives of Spitzer Space Telescope
- Performed an end-to-end simulation of the mission for injection of payload on required Heliocentric orbit
- Determined the mass profiles for different stages of the Delta II 7920H ELV rocket used in the mission

Prototype Spark Chamber

Guide: Prof. Pradeep Sarin, Engineering Physics, IIT Bombay

Dec'15

- Examined the working of spark chamber built at the University of Cambridge and Birmingham
- Tested methods to design a spark chamber to overcome the problem of corona discharge
- Revised calculations for the voltage required and the pressure of helium in the chamber to be maintained

Error Analysis in Computational Fluid Dynamics

Guide : Prof. Avijit Chatterjee, Aerospace Engg., IIT Bombay

Jul'16 - Nov'16

- Programmed an algorithm in Python to obtain finite difference scheme of any order of accuracy for a PDE
- Performed Fourier analysis of numerical schemes for dissipation error and stability

3-D Modeling of Beverage Dispensing System

Startup firm implementing Automatic System and Method for Dispensing Beverages

Jul'16

- Modeled the structure of the dispenser comprising of a refrigeration unit and multiple taps in SolidWorks
- Generated a 3-D mesh of the dispenser in ICEM which optimally simulated the complex flow

Position of Responsibility

- **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*
- **Editor, Department Newsletter - Lift off** *May'16 - May'17*

Key Courses

Systems & Control	Autonomous Mobile Robots, Machine learning, Non-linear Dynamics, Multivariable Control, Adaptive Control, Optimal Control, Flight Dynamics, Control System Design Techniques, Navigation and Guidance
Mathematics	Calculus, Data Analysis and Interpretation, Differential Equations, Linear Algebra, Numerical Analysis

Technical Skills

Programming Softwares	MATLAB, Maple, Mathematica, C++, Python, FORTRAN, R \LaTeX ANSYS, ICEM-CFD, SolidWorks, AutoCAD
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