Himani Sinhmar | CV

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Research Interests

Autonomy, Task and Motion planning, Dynamics and Control, Swarm Robotics

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, (EuroGNC 19) [Paper]

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

Academic Qualifications

PhD in Aerospace Engineering   **GPA : 3.99/4.00**
Cornell University   *2019–Present*

○ Advisor: Prof. Hadas Kress-Gazit
○ Minor degree: Computer Science

Integrated Bachelors and Masters in Aerospace Engineering   **GPA : 8.7/10.00**
Indian Institute of Technology Bombay (IIT Bombay)   *2014–2019*

○ Minor degree: Physics

Notable Achievements

○ **Chaired** a session on Navigation Technology in 2018 IEEE/CSAA GNC conference held in China
○ Awarded the **Undergraduate Research Award** for exemplary 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

Research Experience

Decentralized Control for Swarm of Minimalistic Robots
Guide : Prof. Hadas Kress-Gazit, Cornell University   *Mar'21 - Present*

Developed a 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

Micron-scale Morphing Soft Robots for Encapsulating Biological Systems

Guide : Prof. Hadas Kress-Gazit, Cornell University   *Nov'19 - Present*

Created a physics-based simulator using Unity 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*

Executed SLAM algorithm capable of navigating to the given goal point while avoiding collisions with both dynamic and static 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   **Master's Thesis**

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

Guide : Dr. Aditya Paranjape, Imperial College of London   *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   **Research Internship**

Control Dynamics & Simulations Group, ISRO, Bangalore   *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 4th order longitudinal dynamics model of an aircraft in a wings-level cruise

Modeling of Turbojet and Ramjet Propulsion System   **Bachelor's Thesis**

Guide: Prof. Shripad Mahulikar, 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

Pratham - **IIT Bombay Student Satellite Team**

Successfully launched on 26 th 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

Technical Skills

Programming	C++, Python, C#, MATLAB, Maple, Mathematica, R, LaTeX
Softwares	Unity Game engine, ROS, ANSYS, ICEM-CFD, SolidWorks, AutoCAD

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

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*