Himani Sinhmar | CV

Department of Aerospace Engineering – IIT Bombay

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Research Interests

Cooperative and adaptive control, Decentralized control of multi-agent networks in uncertain environment, Reinforcement learning, Guidance and navigation of aerial vehicles

Education

Academic Qualifications

Indian Institute of Technology Bombay (IIT Bombay) **GPA : 8.55/10.00**
B.Tech + M.Tech : Aerosapce Engineering *2014–Present*

- Cumulative GPA of **9.51** in the last four semesters
- Completed Minor degree in Physics

Central Board (CBSE) **Score : 95.6%**
All India Senior School Certificate Examination *2014*

Central Board (CBSE) **Score : 10.00/10.00**
All India Sechondary School Certificate Examination *2012*

Notable Achievements

- **Chaired** a session on Navigation Technology in 2018 IEEE/CSAA GNC conference held in China
- Awarded the **Undergraduate Research Award** for exceptional effort towards the 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

Publications

Himani Sinhmar, Vinod Kumar, *Relative Autonomous Navigation Without Communication Between Spacecraft Using Line of Sight Measurements*, 8^{th} IEEE/CSAA Guidance, Navigation and Control Conference, August 2018, Xiamen, China

Himani Sinhmar, Srikant Sukumar, *Distributed model independent algorithm for spacecraft synchronization under relative measurement bias*, submitted to 5^{th} CEAS Conference on Guidance, Navigation and Control

Himani Sinhmar, Pallavi Rastogi, Shripad P. Mahulikar, *Direct Theoretical Approach to Jet Propulsion Principles based on Pressure Variation inside the Engine*, under revision for submission to CEAS Aeronautical Journal

Research Experience

Consensus of networked Lagrangian system with biased measurements **Master's Thesis**
Guide : Prof. Sukumar Srikant , Systems and Control Engg., IIT Bombay *May'18 - Present*

- Developed a Lyapunov based decentralized control algorithm which ensures that Lagrangian system tracks a time varying trajectory in presence of a non-zero, unknown sensor bias in relative measurements
- Devised a **model independent** composite adaptive controller for consensus of multi agent Euler-Lagrange systems achieving global exponential convergence with **exponential bias estimation**
- Performed simulations for distributed cooperative control of spacecraft formation with relative measurement bias under the constraint that the leader is a neighbor of only a subset of the followers
- Formulating an adaptive controller for leader follower Lagrangian system in case of actuator saturation

Real-time Algorithm for In-flight Guiding Store IMU Alignment **Research Internship**
Radiant Coral Digital Technologies (P) Ltd., Bangalore *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 a novel algorithm for autonomous navigation in the event of **gyro failures or communication eruption** between the spacecrafts using only line of sight measurements
- Programmed an Extended Kalman filter for relative state estimation of 6 DOF spacecrafts
- Developed a high fidelity model to simulate relative motion in perturbed orbital environment
- Designed 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. 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

Academic Projects

State Tracking and Fault Diagnosis in Nonlinear uncertain systems
Guide : Prof. Sukumar Srikant, Systems and Control Engg., IIT Bombay *Jan'18 - April'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 4^{th} order longitudinal dynamics model of an aircraft in a wings-level cruise

***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 low earth orbit satellites, receiving data using off shelf equipments

Self-Balancing Bot
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 a 10-DOF 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 as 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 the results by experimenting with different meshing models in 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*

- Scrutinized the working of spark chamber built at 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 a generalized code in Python to design finite difference scheme of any order of accuracy
- Performed Fourier and numerical analysis of numerical schemes for dissipation error and stability

3-D Modeling of a system for dispensing beverages
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 to optimally simulate the complex flow

Position of Responsibility

- **Editor,** *Department Newsletter - Lift off* *May'16 - May'17*
  - Researched, edited and proofread the content that spoke directly to the audience
  - Interviewed eminent personalities & executed community outreach for article ideas & development
- **Teaching Assistant,** *System Modeling Dynamics and Control* *Jul'18 - Present*
  - Guiding 80+ students with tutorials and MATLAB sessions for a graduate level course
  - Grading quizzes and holding office hours for clarifying doubts of the students

Key Courses

Systems & Control	Non-linear Dynamics, Multivariable Control, Adaptive Control Theory, Optimal Control, Control System Design Techniques, Flight Dynamics, State Estimation: Theory and Applications, Navigation and Guidance
Mathematics	Calculus, Data Analysis and Interpretation, Differential Equations, Linear Algebra, Numerical Analysis, Machine Learning

Technical Skills

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

References

Prof. Shripad P. Mahulikar
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Dr. Aditya Paranjape
Faculty of Aeronautics Engg.
Imperial College of London
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Prof. Srikant Sukumar
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