IRENE GRACE KAROT POLSON

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EDUCATION

University of Pennsylvania *Aug 2022 - May 2024*
MSE in Mechanical Engineering and Applied Mechanics Mechatronic and Robotic Systems

Indian Institute of Technology, Kanpur *July 2018 - May 2022*
Bachelor of Technology in Aerospace Engineering CPI: 8.8/10.0
Member of Society of Aerospace Engineers | Aquatics Team

RESEARCH EXPERIENCE

Derivative-free Adaptive Spacecraft Attitude Control April 2021 – June 2022
Advisor: Dr. Dipak Kumar Giri, ACC Paper *Indian Institute of Technology, Kanpur*

- Developed a purely adaptive control system with derivative-free weight update laws on a spacecraft attitude system represented using MRPs.
- Working on applications of machine learning and evolutionary optimization techniques on adaptive laws and its update rates as a part of my undergraduate research project.

Autonomous Multi-Drone Systems for Large Structure Inspections March 2021 – Jan 2022
Advisor: Dr. Debasish Ghose, INAE Report *Indian Institute of Science, Bangalore*

- One amongst 60 students selected from across India as a candidate for the Indian National Academy of Engineering Mentorship Program 2021-22.
- Developed an in-house controller and a 3D coverage path planning algorithm using Lissajous curves without explicit geometry. It can easily be implemented at nominal computation costs.

Control System Design using Bond Graph Representation March - June 2021
Advisor: Dr. N. Selvaganesan, ICC7 Paper *Indian Institute of Space Science and Technology*

- Developed a power-based graphical representation of quadcopter system and its controller using bond graph approach. Reduced model is derived and is used to obtain feedback.
- The entire closed-loop MIMO system is represented using 20-sim software and simulations were performed to meet satisfactory stable responses under tracking and disturbance conditions.

Wingtip Vortices Parameter Estimation to Analyze Instabilities Nov 2019 – Dec 2020
Advisor: Dr. Navrose, Report *Indian Institute of Technology, Kanpur*

- Verified Batchelor and Lamb-Oseen Models at low Reynolds using curve fitting of simulation data for Re=1000 using MATLAB curve fitting tools and VisIT flow visualization software.
- Analyzed the instabilities leading to the formation of wingtip vortices using parameter estimation.

TECHNICAL EXPERIENCE

Airbus Internship April - Sept 2021
Aircraft and Flight Analytics Group | Airbus India Pvt Ltd *Bangalore, India*

- Developed an algorithm to automatically identify and classify commercial aircrafts into training, delivery and test flight groups. It was developed in Java using flight parameters and black-box data.
- This software was deployed for in-house analysis of flight data.

Controls System Development Internship Sept 2020 - Feb 2021
Range Aerospace Pvt Ltd | Start Up Team *Bangalore, India*

- Employed system identification techniques using in-flight data to find best-fit model of helicopter.
- Automated the process of control gains tuning using Genetic algorithm and MAVLink connections.
- Optimization and parameter setting was carried out using MATLAB. Simulations were conducted using JMAVsim and prototype testing through serial connections to Pixhawk.

Zeus Numerix Summer Internship May – Sept 2020
Target Flight Recognition from Satellite Data *Pune, India*

- Implemented Kalman Filter over Neural Networks to perform target tracking on passive Radar signal bearing angles. Using the bearing angles and timestamps, we predict the target trajectory.
- Classified satellite images into classes of military targets using PyTorch and Sci-Kit learn libraries. Data-sets with 25000+ images of planes were used for testing and validation.

PUBLICATIONS

[1] **I. G. Karot**, M. Kumar and N. Selvaganesan, "Control System Design for MIMO System using Bond graph Representation - Quadcopter as a Case Study," 7th Indian Control Conference, Dec 20-22, IIT Bombay. Paper, Presentation

[2] **I. G. Karot** and D.K. Giri, "Spacecraft Attitude Control using Derivative-free Purely Adaptive Controller," 2022 American Control Conference, June 8-10, Georgia, USA Paper, Presentation

SELECTED PROJECTS

Evolutionary Optimisation of Adaptive Control Gains Aug - Dec 2021
AE471- Undergraduate Research Project, Report *Indian Institute of Technology, Kanpur*

- Improved the performance of control system using Genetic algorithm optimization of adaptation rates in simple adaptive controller. The gain search is limited using Lyapunov stability criteria.
- Tested the performance of different fitness functions and its effect on gain selection. Simulated its application to spacecraft attitude control problem and validated its efficacy and stability.

Vehicle Shape Optimisation For Minimization Of Sonic Boom July - Dec 2020
AE311- Compressible Aerodynamics, Report *Indian Institute of Technology, Kanpur*

- Optimized super-sonic flight design by minimizing pressure perturbations generated by the aircraft using a simplified sonic-boom prediction method.
- Leveraged a linearized analysis with some corrections built-in so that non-linear effects can also be modeled in terms of F-function, as defined by Whitman with the help of numerical methods.

Numerical Implementation of 2D Panel Methods Jan - March 2020
AE211- Incompressible Aerodynamics, Report *Indian Institute of Technology, Kanpur*

- Formulated and implemented Source-panel and Vortex-panel methods for flow past an Airfoil using MATLAB. The shape of the airfoil was simulated using traditional airfoil equation.
- The sources were arranged such that the flow through panels and sources summed up close to zero and created the required flow past the airfoil.

Composite Material Aircraft Fabrication May - July 2019
Aeromodelling Club, Report *Indian Institute of Technology, Kanpur*

- Modelled a Twin-boom pusher aircraft on XFLR5 to analyze stability and design. Animated a CAD model of the wings using AutoCAD for laser balsa cutting for wingtip margins.
- Fabricated a composite material twin-boom pusher aircraft using vacuum packing. The model had detachable wings and fuselage. It was successfully flown using a remote control.

RELEVANT COURSEWORK

Controls	Optimal Space Flight Control, Aircraft Control Systems, Automatic Control of Rockets And Spacecrafts, Flight Mechanics
Dynamics	Space Dynamics, Dynamics
Programming	Applied Numerical Methods, Introduction to Computing, Virtual Instrumentation And Sensors, Aircraft Systems Design
Mathematics	Complex Variables, Partial Differential Equations, Ordinary Differential Equations
Coursera	Machine Learning, Control of Nonlinear Spacecraft Attitude Motion, Kinematics: Describing The Motions of Spacecraft

TECHNICAL STRENGTHS

Tools for Controls	PX4 Autopilot, JMAVsim, ROS, MAVLink Protocols, Gazebo
Machine Learning	ANNs, CNNs, Linear & logistic Regression, Regularisation Techniques
Programming Languages	MATLAB/Simulink, C, C++, Python
Scientific Visualization	Tecplot, Paraview Immersive, ViSIT, XFLR5, Curvefitting Toolkit
Libraries	PyTorch, TensorFlow, Sci-Kit Learn, Pandas, Numpy, Matplotlib, PIL
Other Skills	Autocad, Fusion360, NI LabVIEW, Excel, LaTeX

SCHOLASTIC ACHIEVEMENTS

2021	INAE Student mentorship program — Top 60 research proposals in India
2018	Joint Entrance Exam Mains: Ranked 2851 in 1.3 million candidates
2018	Computer Science and Physics Top 0.1 % Scorer — CBSE
2017	KVPY Fellowship — All India Rank: 613 — IISc Bangalore
2016	NTSE Scholarship Stage 1 — Tamil Nadu — Government of India

CO-CURRICULAR ACHIEVEMENTS

2019	Bronze in 4x50m Freestyle Relay — 54th Inter-IIT Aquatics Meet
2018	Bronze in 4x50m Medley Relay — 53rd Inter-IIT Aquatics Meet
2018	Pushpa Garg Scholarship — IIT Kanpur — Awarded to 1 in a batch of 850
2018	Best incoming sportsperson — IIT Kanpur

POSITIONS OF RESPONSIBILITY

Society of Aerospace Engineers — Batch Representative Y18

Acted as a liaison between the committee and fellow batch mates. Conducted multiple workshops for the Aerospace Department students and organized the department Freshers and Farewell.

Aquatics Institute Team — Institute Secretary & Summer Camp Captain

Ensured the smooth conduction on Summer Camp Aquatics and organized a 5KM Long swimming event. Organized annual interhall sports competition, Inferno. Also conducted Aaghaaz (Freshers' interhall sports competition) and workshops in swimming.