

# IRENE GRACE KAROT POLSON

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## EDUCATION

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**Indian Institute of Technology, Kanpur**

Bachelor of Technology in Aerospace Engineering

Member of Society of Aerospace Engineers | Aquatics Team

July 2018 - May 2022

CPI: 8.8/10.0

## RESEARCH EXPERIENCE

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**Derivative-free Adaptive Spacecraft Attitude Control**

April 2021 – Present

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 – Present

Advisor: Dr. Debasish Ghose, [ACC Paper](#)

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

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**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**

*Target Flight Recognition from Satellite Data*

May – Sept 2020

*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**

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- [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, accepted, invited for presentation Dec 20-22, IIT Bombay. [Paper](#)
- [2] **I. G. Karot**, S. Nath and D. Ghose, “Autonomous Drone Systems for Large Structure Inspections using Lissajous Curves,” manuscript 686 submitted to 2022 American Control Conference. [Paper](#)
- [3] **I. G. Karot** and D.K. Giri, “Spacecraft Attitude Control using Derivative-free Purely Adaptive Controller,” manuscript 633 submitted to 2022 American Control Conference. [Paper](#)

## **SELECTED PROJECTS**

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### **Evolutionary Optimisation of Adaptive Control Gains**

Aug - Dec 2021

*AE471- Undergraduate Resaerch 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

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

## TECHNICAL STRENGTHS

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

## SCHOLASTIC ACHIEVEMENTS

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

## CO-CURRICULAR ACHIEVEMENTS

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

## POSITIONS OF RESPONSIBILITY

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<b>Society of Aerospace Engineers</b>	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.	
<b>Aquatics Institute Team</b>	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.	