Kshitij Anand

2nd Year PhD Candidate, MAE, UC Irvine

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Education

University of California, Irvine, USA

PhD Candidate, Mechanical & Aerospace Engineering |GPA: 3.923/4.0 *2023 - Present*

Specialization: Fluid Dynamics

Indian Institute of Technology, Kharagpur, India

Major – Integrated BTech. & MTech. in Aerospace Engineering | Core GPA: 9.40/10 *2018 - 2023*

Minor – Computer Science & Engineering | Additional GPA: 8.5/10

Micro-Specialization - Artificial Intelligence and Applications

Conferences/Competitions/Academic Honors

- ***A Generic Tool for Simulating Two-Dimensional Ideal Flows Over Arbitrary Shapes using the Principle of Minimum Pressure Gradient*** – K. Anand, C. Gonzalez, H. E. Taha – AIAA SCITECH FORUM 2025
- ***Numerical Aerodynamic Modelling of 3-DOF Tandem Wing Flapping Dynamics*** – K. Anand, S. M. Dash, S. Armanini, H. E. Taha – SoCal Fluids 2024
- ***Parametric Modelling of Vortex-Vortex Interactions in 2-DOF Flapping Wings Using Empirical Methods*** – K. Anand, S. M. Dash – Bulletin of the American Physical Society, 2023
- ***A Numerical Study on Three-Dimensional Flapping Dragonfly Wings with Optimized Input Kinematics for Hovering and Forward Flight*** – K. Anand, S. Armanini, &. S. M. Dash – APS DFD 2022
- Awarded ***DAAD-WISE Scholarship*** for pursuing internship at TU Munich in 2022
- Awarded ***MITACS Globalink Research Scholarship*** for pursuing internship at University of Calgary in 2021
- Awarded ***Boeing University Relations Scholarship*** for excellent academic performance and participation in undergraduate research in 2021 by the Dept. of Aerospace Engineering, IIT Kharagpur

Work and Research Experience

Graduate Student Researcher, Aeronautics Dynamics & Controls Lab, UC Irvine **Irvine, USA**

- Supervisor: Prof. Haithem E. Taha *Sep 23 - Current*
- Study of fluid dynamics through the lens of analytical mechanics and formulating solution of incompressible (inviscid / viscous) fluid flow problems (steady and unsteady) as optimization problems
- Developed toolbox based on conformal mapping approach by Theodorsen and the Principle of Minimum Pressure Gradient to simulate steady ideal flows independent of the Kutta condition
- Currently developing the Variational Projection of Navier Stokes' (VPNS) toolbox for simulating incompressible viscous flows which computes the temporal evolution of the flow via an optimization framework
- Key Conceptual Interests: Differential Equations and Geometry, Topology, Numerical Methods, Fluid Dynamics, Dynamics and Controls, Efficient Algorithms and Data Structures for manipulation and storage of Sparse / Banded / Toeplitz Matrices (mostly in C and C++), Numerical Linear Algebra

Teaching Assistant, MAE, UC Irvine **Irvine, USA**

- MAE 108 with Prof. Yun Wang *Fall 2024*
  - Laboratory course introducing undergraduate students to various mechanical subsystems encountered in daily life based on the principles of heat transfer (Conductivity measurements, Volumetric Measurements for Pipe flows Power Plant Tours, Wind Tunnel Force measurements, Otto and Diesel Engine Cycles, Refrigeration)
- MAE 175 with Prof. Haithem E. Taha *Winter 2025*
  - Theoretical undergraduate course on the dynamics and stability of airplanes including basic introduction to SAS via linear feedback control

Graduate Student Member, M.N. Faruqui Innovation Centre, IIT Kharagpur **Kharagpur, India**

- Supervisor: Dr. Aditya Bandopadhyay, IIT Kharagpur Oct *2022 – Mar 2023*
- Project: Modularized Manufacturing of Fixed Wing UAV for surveillance and remote monitoring
- Performed conceptual and detailed design of a manually controlled fixed-wing UAV (T-tail) with prototype manufactured from modular parts made of 3D-printed PLA, wood and carbon composite materials
- UAV features on-board camera for visual monitoring and STM PMod-NAV (9-axis gyro) board used to log flight path data with an aim to perform control effectiveness study leading to enhancement of final product
- Automatic control will be added using the Pixhawk PX4 autopilot (supported with the ROS-MAVLink-QGroundControl environment) with an aim to achieve repeated sorties over a pre-designated flight path at designated altitudes over the area of interest

Graduate Student Member, Bio-Inspired Aero-Hydrodynamics Research Lab, IIT Kharagpur — **Kharagpur, India**

- Supervisor: Dr. Sunil Manohar Dash, IIT Kharagpur — *Jul 2022 – Mar 2023*
- Master's Thesis: Systematic numerical study of unsteady aerodynamics of tandem insect wings subject to a novel modified form of the Eldredge Function
- Numerical Study using CFD techniques (ANSYS Fluent) conducted to *test the validity and required improvements in the 2D aerodynamic force model proposed by van Veen et. al. (2022)* for the case of tandem flapping insect wings in 2D and 3D
- *Dynamic and Overset meshing methods* are being used in conjunction to improve accuracy and reduce computation time with *PISO algorithm (neighbor skewness correction adjusted by dynamic meshing parameters)*
- *A constant term dependent on angular velocity has been empirically derived* to accommodate forewing-hindwing vortex-vortex interactions in the previous model; spanwise vortex shedding and added mass effects were found to *contribute less than 2% to time averaged lift and thrust forces* for the used input kinematics and are neglected in the model

Summer Research Intern, eAviation Research Group, Technical University of Munich — **Munich, Germany**

- Supervisor: Dr. Sophie Armanini, TU Munich — *May 2022 – Jul 2022*
- Project: Dynamic Modelling of Heave-Stroke-Pitch actuated FWMAV with independent contralateral wings
- 3D CFD simulations were performed for a *novel optimized kinematic profile (modified from Eldredge function to incorporate advance ratios for stroke and heave motions w.r.t. pitch motion)* for tandem dragonfly wings to derive aerodynamic force model
- Mechanical model of a tandem FWMAV with *independent actuation mechanism for heave-stroke and pitch* was developed
- Dynamic modelling of FWMAV was done using *Lagrange-Hamiltonian formulation* to be used in stability analysis

Undergraduate Student Member, BIAH Lab, IIT Kharagpur — **Kharagpur, India**

- Supervisor: Dr. Sunil Manohar Dash, IIT Kharagpur
- Batchelor's Thesis: Investigation of rotational effects in flapping wings — *Jul 2021 – Mar 2022*
- Examination (using CFD Techniques -ANSYS Fluent) and mathematical modelling of the *rotational effects in aerodynamic forces on stroking, pitching, and combined stroking-pitching 2D and 3D rectangular plate* with aspect ratios, flow Reynolds Number and reduced frequency like those of insect flight based on the dragonfly

Summer Intern, Robotarium Lab, University of Calgary | 4Front Robotics Inc. — **Calgary, Canada**

- Supervisor: Dr. Alejandro Ramirez Serrano, University of Calgary — *May 2021 – Jul 2021*
- Project: Conceptual Design of a Highly Transitional and Maneuverable UAV
- Designed *PID controller for flight mode transition* with an objective to *minimize vertical height loss*
- *Proposed conceptual design for the internal structure, wings, winglets, and landing gear mechanism* for a transitional UAV based on market survey and general sizing mechanism for UAVs
- Constructed the *detailed mechanical design of the front and rear landing gears guided* by simulated stress analysis and force (input) response analysis

Senior Mentor, DIY Lab, Indian Institute of Technology, Kharagpur — **Kharagpur, India**

- Embedded and Control Systems Design Mentor — *Oct 2019 – Mar 2020*
- Developed several in-house projects using mobile robots with basic features (Line Follower, Obstacle Detection, Light Detection and Follower) in the process of guiding and training freshman year students
- Specialized focus on 3D printing, mechanical design, using development boards (Arduino, RPi) to implement controllers

NIUS Fellow, Indian Institute of Science Education and Research — **Kolkata, India**

- National Initiative on Undergraduate Sciences (NIUS) Fellow appointed by *HBCSE-TIFR, Mumbai*
- Project: Quantum Image Representation and Encryption — *Sep 2019 – Jan 2021*
- Implemented a secure framework for transferring greyscale images over a quantum computer network using affine transform and keys (based on logistic mapping)

Term Projects

- Pintle Injector Design for Liquid-Propellant Thrusters used for powering a small-scale VTOL station
- Course Instructor: Dr. Srinibas Karmakar, IIT Kharagpur
  - A survey on available pintle injectors was performed to obtain an estimate of values of pintle length and swirl velocity required for the thrust needed by the VTOL station | Multiphase (LOx and Petrol) CFD simulations were performed for 3 potential injector designs to perform a comparative study
- Implementation of the Batched Cholesky Decomposition Algorithm on an NVIDIA GPU using CUDA
- Course Instructor: Dr. Soumyajit Dey, IIT Kharagpur
  - Undertaken as a term project for the subject 'High-Performance Computing', we developed an efficient implementation of batched Cholesky decomposition as proposed by Gates et al using the CUDA library in C++ | Validation of the experimental results was performed with respect to the

findings in the paper

- Mathematical Modelling of the interaction of Rotor downwash with fixed wings in a transitional UAV
- Course Instructor: Dr. Sandeep Saha, IIT Kharagpur
    - A survey of experimental and simulation methods to determine the effect of rotor downwash on fixed wings (e.g., Bell V-22 Osprey) was performed to determine the parameters such as rotor positioning, distance from the wing, and rotor speed vs inclination to prepare a mechanical model and simulations were performed to investigate the aerodynamic forces
- Construction of a Mid-Size Wind Tunnel with a Digital Data Acquisition System
- Course Instructor: Dr. Sandeep Saha, IIT Kharagpur
    - Constructed a mid-size open suction wind tunnel [Total length: 8 feet; Test section: (1-foot x 1-foot) x 3 feet] *at home (due to COVID lockdowns)* equipped with a settling chamber, a pitot tube, and a Digital Data Acquisition System running on an RPi board | 3D printed standard air foil (NACA 0012 and 2412) were placed in the wind tunnel to verify the accuracy of the wind tunnel | Maximum averaged error observed was 11% in determining C_L and 8% in C_D values

Coursework Information

Graduate Curriculum Courses

Fluid Dynamics	: Incompressible Inviscid Fluid Flows | Viscous Incompressible Fluid Flows | Compressible Fluid Flows
Dynamics & Controls	: Linear Systems Theory | Analytical Mechanics and Dynamics
Math / CS	: Differential Equations and Perturbation Methods | Advanced C Prog. | Advanced C++ Prog.

Undergraduate Curriculum Courses

Fluid Dynamics / Aerodynamics / CFD: Introductory Aerodynamics | Low-Speed Aerodynamics | High-Speed Aerodynamics | Viscous Flow Theory | Computational Fluid Dynamics | Advanced Fluid Mechanics

Control Theory / Mechanics / Dynamics / Robotics: Introduction to Flight Vehicle Controls | Automatic Control of Aircraft | Linear Systems and Control | Introduction to Flight Mechanics | Flight Dynamics and Stability | Aircraft Design and Optimization | Embedded Sensing, Actuation, Interfacing and Control

Computer Science / Math / AI: Algorithms and Data Structures (C++) | Image Processing | High-Performance Computing | Machine Learning | Artificial Intelligence and its Applications | Deep Learning Foundations and Applications | Linear Algebra for AI & ML | Single Variable and Multivariate Calculus | Linear Algebra | Vector Calculus

Skills

Programming: C++ | C | Python | MATLAB
Frameworks: Eigen | Blaze | NumPy | Pandas | Matplotlib | Seaborn | TensorFlow | Keras | PyTorch | OpenCV | Arduino | Raspberry Pi
Software: ANSYS Fluent | ANSYS Mechanical | SolidWorks | Coppelia Simulator | ROS-PX4-Gazebo

Leadership Positions

- Secretary, Aerospace Engineering Society, IIT Kharagpur | 2018-2020
    - Responsible for boosting the research morale of undergraduate students by organizing workshops and interactive sessions with senior undergraduate and graduate students
- Governor, Literary Society, IIT Kharagpur | 2020-2021
    - Responsible for publication of the Annual Magazine of IIT Kharagpur | Responsible for conducting meetups and performance-based events for literary enthusiasts at the institution