Praneet **Vayalali**

Graduate Research Assistant

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Summary

A highly motivated PhD candidate with a passion for aviation pursuing research in the field of flight dynamics and control with focus on fault tolerant control on VTOL aircraft. Current work focuses on utilizing redundant control effectors for damage tolerance on VTOL aircraft by applying modern control design techniques.

Education

Ph.D. in Aeronautical Engineering
Aug. 2016 - July 2021

Rensselaer Polytechnic Institute (RPI), **GPA - 3.83/4**
Troy, NY, USA

Master of Technology in Aerospace Engineering
July 2014 - July 2016

Indian Institute of Technology Kanpur (IIT K), **GPA - 9.25/10**
Kanpur, India

Bachelor of Technology in Aerospace Engineering
July 2009 - June 2013

Amrita School of Engineering (ASE), **GPA - 8.91/10**
Coimbatore, India

Technical Skills

Softwares	RPI GenHel derivative model, MATLAB/SIMULINK, CONDUIT, CIFER, LabView, Ansys Fluent, Abaqus, Xfoil
Languages	C++, Python
General	Git, Linux, Microsoft Office Suite, Latex

Research Experience

Post-Damage Reconfiguration for Rotorcraft with Control Redundancy
Aug. 2016 - Current

Ph.D. Dissertation, Advisor - Dr. Farhan Gandhi
RPI, NY, USA

- Examine adaptive and robust fly-by-wire flight control strategies that can tolerate damage/degradation in various control effectors to enable safe flight on VTOL aircraft with control redundancy.
- Perform nonlinear flight simulation and handling qualities (ADS-33E) based analysis on the use of various control allocation and modern control design techniques on a UH-60 Black Hawk and derivative compound helicopter platforms.

Post-Failure Control Reconfiguration on a High-Speed Lift-Offset Coaxial Helicopter
Aug. 2019 - Current

Research Project, Advisor - Dr. Farhan Gandhi
RPI, NY, USA

- Work with a team of two to investigate the potential for fault compensation in flight for a lift-offset coaxial helicopter by examining the interchangeability of controls at different points within the flight envelope, thereby identifying allowable fault cases for the vehicle.
- Helped with the development of an elastic blade coaxial-pusher helicopter trim model based on the X2 Technology^{TM} demonstrator which was then used to explore trim control variation in different flight regimes.

Frequency Domain Based System Identification of a Small-Sized RUAV
May 2015 - Jul. 2016

Master's Thesis, Advisor - Dr. A. Abhishek
IIT Kanpur, India

- Characterized a fully instrumented small-size rotary-wing unmanned aerial vehicle (RUAV) using a frequency domain based experimental system identification technique.
- Flight test of a 1 kg class RUAV was conducted and its responses were recorded. The closed-loop responses were analyzed to extract a bare-airframe 6-DOF linear flight dynamics state space model of the aircraft for hover flight condition. This was followed up by flight test validation.

Axial Compressive Testing of Single Carbon Fibers
Aug. 2013 - Jul. 2014

Research Project, Advisors - Dr. C.S. Upadhyay & Dr. P.M. Mohite
IIT Kanpur, India

- Conducted over 500 axial recoil tests on single carbon fibers of varying lengths and diameters (order of 10 microns) in order to determine the compressive strength of the fiber. This experimental data was then used to statistically model the scattering in strength due to various parameters.

Detection of Cracks in a Wind Turbine Blade using Modal Analysis

Jan. 2012 - Jun. 2013

Bachelor's Thesis, Advisors - Dr. Laxman Vaitla & Dr. V.L. Satheesh (National Aerospace Laboratories)

ASE, India

- Examined frequency response of non-rotating GFRP (Glass Fiber Reinforced Plastic) rectangular beams using finite element analysis for varying delamination sizes and positions.
- Conducted sinusoidal sweep experimental tests on GFRP beams to validate the simulation results.
- Performed modal analysis (using finite element method) on rotating composite beams to simulate rotating wind turbine blades.

Projects

Backstepping Control for a Variable-RPM Quadrotor Aircraft

Jan. 2019 - May 2019

Nonlinear Control Systems Course Project

RPI, NY, USA

- Demonstrated the applicability of backstepping control design to a hobbyist scale quadrotor vehicle.
- Examined the performance of a backstepping feedback controller in comparison to a PID controller on the quadrotor.

Extreme Altitude Mountain Rescue Vehicle

Jan. 2019 - May 2019

The Vertical Flight Society's 36th Annual Student Design Competition

RPI, NY, USA

- Proposed a synchropter as a VTOL aircraft design capable of search and rescue missions at the summit of Mt Everest, where only one helicopter has ever landed and taken off again.
- Developed a 6-DOF flight dynamics model and analyzed the autonomous dynamics of the proposed rotorcraft design. Design constraints include freezing temperatures, thin air and hostile weather conditions with degraded visual environment all contribute to making rescue work in high-altitude environments particularly dangerous or impossible.
- Won third place in the graduate category the vertical flight society's 36th annual student design competition.

Power Optimization for UH-60 Black Hawk in Cruise using Variable RPM and Stabilator

Sept. 2017 - Dec. 2017

Independent study for Advanced Design Optimization Course

RPI, NY, USA

- Optimized power using the main rotor speed and stabilator pitch incidence as design variables on a physics-based UH-60 Black Hawk helicopter simulation model at a cruise speed of 140 knots.

Controller Design for a Quadrotor UAV

Jan. 2017 - May 2017

Helicopter Design Course Project

RPI, NY, USA

- Nonlinear flight simulation model with PID and LQR controllers were developed for a 2 kg quadrotor helicopter and their performance was compared in simulation.
- Compared control schemes using controller gains tuned for the hover flight condition and flown for single waypoint and multiple waypoint trajectories.

Design of V/STOL Air Taxi

Dec. 2014 - May 2015

AIAA Foundation Graduate Team Aircraft Design Competition

IIT Kanpur, India

- Worked with a team of seven to propose a design for an air taxi system that operates out of confined urban areas requiring vertical and short takeoff and landing capability.
- Involved in the design of a ducted rotor system for the V/STOL aircraft with consideration of noise and safety.

Journal Articles

- **Vayalali, P.**, McKay, M., Gandhi, F., "Redistributed Pseudoinverse Control Allocation for Actuator Failure on a High-Speed Compound Helicopter," Journal of American Helicopter Society, Submitted (Under Review), November 2020.
- **Vayalali, P.**, McKay, M., Krishnamurthi, J., Gandhi, F., "Fault-Tolerant Control on a UH-60 Black Hawk Helicopter using Horizontal Stabilator," CEAS Aeronautical Journal, Vol. 12(1), Jan 2021, pp. 13-27, DOI:10.1007/s13272-020-00476-5.
- **Vayalali, P.**, McKay, M., Krishnamurthi, J., Gandhi, F., "Horizontal Stabilator Utilization for Post Swashplate Failure Operation on a UH-60 Black Hawk Helicopter," Journal of the American Helicopter Society, Vol. 65, April 2020, pp. 1–13(13), DOI:10.4050/JAHS.65.022009.

Conference Proceedings

- **Vayalali, P.**, McKay, M., Gandhi, F., "Fault-Tolerant Control Allocation on a Compound Helicopter in Cruise," Proceedings of the Vertical Flight Society 77th Annual Forum, West Palm Beach, FL, 11-13 May 2021 (to be presented).
- McKay, M., **Vayalali, P.**, Gandhi, F., "Redistributed Control Allocation for Flight Control Failure on a Coaxial Helicopter," Proceedings of the Vertical Flight Society 77th Annual Forum, West Palm Beach, FL, 11-13 May 2021 (to be presented).
- **Vayalali, P.**, McKay, M., Gandhi, F., "Redistributed Pseudoinverse Control Allocation for Actuator Failure on a Compound Helicopter," Proceedings of the Vertical Flight Society 76th Annual Forum, Virtual, 6-8 Oct 2020.
- McKay, M., **Vayalali, P.**, Gandhi, F., "Post-Failure Control Reconfiguration for a Lift-Offset Coaxial Helicopter," Proceedings of the Vertical Flight Society 76th Annual Forum, Virtual, 6-8 Oct 2020.
- **Vayalali, P.**, McKay, M., Krishnamurthi, J., Gandhi, F., "Robust Use of Horizontal Stabilator in Feedback Control on a UH-60 Black Hawk," Proceedings of the Vertical Flight Society 75th Annual Forum, Philadelphia, PA, 13-17 May 2019.

- **Vayalali, P.**, McKay, M., Krishnamurthi, J., Gandhi, F., "Swashplate Actuator Failure Compensation for UH-60 Black Hawk in Cruise Using Horizontal Stabilator," Proceedings of the 74th American Helicopter Society Annual Forum, Phoenix, AZ, 7-10 May 2018.

Relevant Courses

VFS Forum 76 Short Course on EVTOL Design	Multivariable/Robust Control Systems	Intro to Machine Learning
Nonlinear Control Systems	Systems Analysis Techniques	Rotorcraft Performance, Stability and Control
Helicopter Design	Advanced Design Optimization	Intro to Virtual Instrumentation

Honors & Awards

2018	**Third Place,** The Vertical Flight Society's 36th Annual Student Design Competition	*Virginia, USA*
2017	**Runner-up,** The American Helicopter Society Northeast Region Robert L. Lichten Award Competition	*Stratford, USA*
2012	**Second Place,** RC aircraft modeling event as a part of techfest of Amrita School of Engineering	*Coimbatore, India*
2010	**First Place,** SAE College level Aero Modeling Tier I event	*Coimbatore, India*

Professional Societies

Vertical Flight Society (VFS) *2016 - Current*

STUDENT MEMBER *Fairfax, VA, USA*

- President, RPI student chapter (2020-2021)
- Senior Student Volunteer (SSV), one of the 8 SSVs responsible for all A/V at VFS Forum 76 Virtual (2020)
- Student Volunteer at Forum 73 (2017), Forum 74 (2018) & Forum 75 (2019)

American Institute of Aeronautics and Astronautics (AIAA) *2014 - Current*

STUDENT MEMBER *Reston, VA, USA*

- Participated in the AIAA Foundation Graduate team Aircraft Design Competition (2015)