Fawad Farooq Ashraf

Aerospace Engineer

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🏹 Personal Portfolio   in @fawadkhanf3

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🪪 Profile

An Aerospace Engineer with interest in Flight Dynamics, Flight Vehicle Guidance, Navigation & Control, Nonlinear State Estimation & Filtering, Fault Detection and Machine Learning. A highly determined person in accepting the challenges positively and enhancing skills for personal development and commitment to the organization.

🎓 Education

Master of Science in Aerospace Engineering
Beihang University ↗
  09/2023 – present
  Beijing, China

Bachelor of Science in Aerospace Engineering
Institute of Space Technology ↗
CGPA: 3.63/4.0 (90.75%), Cum Laude
Thesis: Iterative Guidance Scheme for Satellite Launch Vehicles
  10/2014 – 07/2018
  Islamabad, Pakistan

FSc Pre-Engineering
Punjab College of Information Technology
Percentage: 89.1%
  08/2012 – 07/2014
  Rawalpindi, Pakistan

Matric (Science)
Divisional Public School & College
Percentage: 94.1%
  08/2002 – 07/2012
  Rawalpindi, Pakistan

💼 Professional Experience

Research Associate - Flight Dynamics & Control
Institute of Space Technology ↗
  08/2018 – present
  Islamabad, Pakistan

Freelance MATLAB/Flight Control Design Expert
Fiverr International Ltd. ↗
  01/2023 – 08/2023
  Online

Internee

Centers of Excellence in Science & Applied Technologies

05/2018 – 07/2018

Islamabad, Pakistan

📰 Publications

State Estimation for a Unicycle Robot using Multi-Rate Sensor Fusion: A Comparative Study

IEEE Xplore - Proceedings of 20th IBCAST

sent to publisher after presentation

2023

H-infinity Control of Scalar Nonlinear Systems

Elsevier - Proceedings of 22nd World Congress of IFAC

sent to publisher after presentation

2023

Detection of Oscillatory Failures in Hydraulic Actuators of Aircraft using Linear Predictive Coding and Signal Spectrum Analysis

Elsevier - Proceedings of 22nd World Congress of IFAC

sent to publisher after presentation

2023

An Application of a Set-Valued State Estimator Based on Constrained Zonotopes in GNSS-INS Integration ⬈

IEEE Xplore - Proceedings of 9th ICCAR Conference

DOI: 10.1109/ICCAR57134.2023.10151757

2023

Feasibility Analysis of Numerical Integration Techniques in Onboard Flight Control Computer for Impact Point Prediction ⬈

IEEE Xplore - Proceedings of 19th IBCAST Conference

DOI: 10.1109/IBCAST54850.2022.9990247

2022

Iterative Guidance Scheme for a Satellite Launch Vehicle along a Three Dimensional Trajectory ⬈

IEEE Xplore - Proceedings of 19th IBCAST Conference

DOI: 10.1109/IBCAST54850.2022.9990247

2022

Iterative Guidance Scheme for Satellite Launch Vehicles ⬈

IEEE Xplore - Proceedings of 16th IBCAST Conference

DOI: 10.1109/IBCAST.2019.8667124

2019

📚 Courses

Machine Learning (Specialization)

Stanford University through Coursera

72 Class Hours (Non-Credit Specialization with 3 Courses)

- Course 01: Supervised Machine Learning - Regression & Classification
- Course 02: Advanced Learning Algorithms

08/2023

- Course 03: Unsupervised Learning, Recommender Systems & Reinforcement Learning

Aerial Robotics

06/2023

University of Pennsylvania through Coursera

17 Classroom Hours (Non-Credit Course)

Fundamentals of Flight Mechanics (Specialization)

06/2023

ISAE-SUPAERO through Coursera

25 Classroom Hours (Non-Credit Specialization with 4 Courses)
- Course 01: Flight Mechanics - The Basis
- Course 02: Flight Mechanics - Anemobarometry
- Course 03: Flight Mechanics - Lift and Trajectory
- Course 04: Flight Mechanics - Propulsive Balance & Energy

Flight Vehicle Guidance, Navigation and Control (GNC) - Analysis & Design (Prof. Bong Wie)

09/2022 – 10/2022

American Institute of Aeronautics & Astronautics (AIAA)

16 Classroom Gours / 1.6 Continuing Education Units

Design of Space Launch Vehicles (Prof. Don Edberg)

04/2022 – 05/2022

American Institute of Aeronautics & Astronautics (AIAA)

30 Classroom Hours / 3.0 Continuing Education Units

MATLAB Programming for Engineers and Scientists (Specialization)

10/2022

Vanderbilt University through Coursera

113 Classroom Hours (Non-Credit Specialization with 3 Courses)
- Course 01: Introduction to Programming with MATLAB
- Course 02: Mastering Programming with MATLAB
- Course 03: Introduction to Data, Signal and Image Analysis with MATLAB

MATLAB Fundamentals

07/2022 – 07/2023

MathWorks Training Services
- MATLAB Onramp
- SIMULINK Onramp
- Control Design Onramp with SIMULINK
- Object-Oriented Programming Onramp
- App Building Onramp
- Optimization Onramp
- Machine Learning Onramp

Nonlinear Control Systems

03/2021 – 07/2021

Capital University of Science and Technology, Pakistan

48 Classroom Hours (Non-Credit Course)

Robust Control Systems   02/2020 – 06/2020

Capital University of Science and Technology, Pakistan

48 Classroom Hours (Non-Credit Course)

Robust Control Design in MATLAB   03/2022

Institute of Space Technology, Pakistan

3 Days Workshop

Kalman Filtering - Design & Practical Considerations   07/2019

Institute of Space Technology, Pakistan

3 Days Workshop

ANSYS Meshing   10/2019

Institute of Space Technology, Pakistan

3 Days Workshop

Radar Systems Engineering   05/2020

Institute of Electrical and Electronics Engineers (IEEE)

54 Professional Development Hours / 5.4 Continuing Education Units

Intelligent Control of Automated Vehicles   05/2020

Institute of Electrical and Electronics Engineers (IEEE)

3 Professional Development Hours / 0.3 Continuing Education Units

What is Internet of Things?   05/2020

Institute of Electrical and Electronics Engineers (IEEE)

3 Professional Development Hours / 0.3 Continuing Education Units

3G, 4G and 5G Fundamentals   05/2020

Institute of Electrical and Electronics Engineers (IEEE)

9 Professional Development Hours / 0.9 Continuing Education Units

📁 Projects

Robust, Optimal & Classical Control of an Inverted Pendulum on a Cart ⧉

  Implemented H-infinity Loop Shaping, Mixed Sensitivity, LQR & PID Control using MATLAB

Robust & Optimal Control of a Canard Configured Fighter Aircraft ⧉

  Implemented H-infinity Loop Shaping, Mixed Sensitivity, LQR, LQG & PID Control using MATLAB

Exact Linearization Control of a Quadrotor via Dynamic Feedback ⧉

  Implemented it as a benchmark example for Sensor-Fusion with Extended Kalman Filter and
  Nonlinear Set-Valued State Estimation & Fault Detection using MATLAB & SIMULINK

**LMI-based Full-State Feedback Linear, LPV & Piecewise Affine H-infinity Control
Design** ⧉

  Tested on Inverted Pendulum with a Stationary Pivot Point & with Cart using MATLAB & YALMIP

Lipschitz Continuous Piecewise Affine Bounds of Nonlinear Systems ⬈

Applied on various Nonlinear Examples using MATLAB & YALMIP

Mesh-based Affine Abstraction ⬈

Applied on various Nonlinear Examples using MATLAB & YALMIP

Invariant & Reachability Set Computations (Based on Correct-by-Construction PCIS Approaches) ⬈

Applied on Adaptive Cruise Control for design of MPC Controller using MATLAB & MPT3

Lambert Guidance, Kepler's Propagator, Proportional Navigation, ZEM/ZEV, Delta & Q-Guidance

Space Shuttle Guidance algorithm (PEG & UPFG) ⬈

Implemented in 2D Reference Frame using MATLAB. Working on 3D implementation and multistage extension

Iterative Guidance Mode algorithm for SLVs ⬈

Implemented in 2D & 3D Reference Coordinate Frames with extension to Multi-Stages. Improved the algorithm for Long Coasting Arcs (using MATLAB & SIMULINK)

Optimal Guidance algorithm for SLVs (Based on Indirect Methods from Optimal Control Theory) ⬈

Both 2D & 3D with Multi-Stage extension using MATLAB. Developed as a benchmark reference to compare other SLV guidance algorithms

Legendre-Gauss-Lobatto Pseudospectral Transcriptions (Direct Optimal Control Methods) ⬈

Applied on various optimization problems using MATLAB, GPOPS-I & GPOPS-II

Collocation Methods for Optimal Control Problems ⬈

Applied on various optimization problems using MATLAB

Optimal Weights selection for H-infinity Mixed Sensitivity using Particle Swarm Optimization ⬈

Strapdown Inertial Navigation ⬈

For a fixed wing UAV & a Quadrotor using MATLAB & SIMULINK

State Estimation of a Quadrotor UAV using Multi-Rate Sensor Fusion ⬈

Using Extended Kalman Filter & Constrained Kalman Filter based on Constrained Zonotopes (MATLAB, SIMULINK, MPT3 & CORA2020)

State Estimation of a Unicyle Robot using Multi-Rate Sensor Fusion

Accurate navigation of a Unicycle mobile robot using Kalman Filter, Extended Kalman Filter, Unscented Kalman Filter, Set-Valued Kalman Filter and Particle Filter (using MATLAB & SIMULINK)

Linear & Nonlinear Set-Valued State Estimation ⬈

Using Direct (Polytopes, Polyhedrons) & Indirect (Zonotopes, Constrained Zonotopes, Zonotope Bundles) Polytopic Sets (MATLAB, MPT3 & CORA2020}. Also includes the implementation of algorithms for conversion of Polytopes to Zonotope Bundles and vice versa using MATLAB & YALMIP

Continuous & Discrete Interval Observers ⬈

Using MATLAB & YALMIP

Fault Detection based on Set-Membership approach using Constrained Zonotopes ⬈

Using both Linear and Non-linear Constrained Zonotopic based Set-Valued Fault Detection.

Oscillatory Failure Case (OFC) Detection for Actuator Fault of an Aircraft ⬈

Based on a Nonlinear Observer & IIR Filter using MATLAB & SIMULINK

OFC Detection for Actuator Failure using Linear Predictive Coding & Signal Spectrum Analysis ⬈

Implemented using MATLAB

Numerical Integration Techniques with Adaptive Step-Size Features ⬈

Runge-Kutta Fehlberg, Runge-Kutta Dormand Prince and Bulirsch-Stoer with Richardson Extrapolation. Also Fixed-Step Methods such as Euler Method, Heun's Method (Modified Euler), Classical Fourth-Order Runge-Kutta.

Maximum Object Enclosing Rectangle Algorithm ⬈

Implemented using c++

Largest Inscribed Isothetic Rectangle Algorithm ⬈

Implemented using MATLAB and Python

Connect4 (a game) AI using Reinforcement Learning

SLV Trajectory Analysis and Animation using Systems Toolkit (STK)

Iterative Guidance Scheme for Satellite Launch Vehicles

Final Year Project for BS Aerospace Engineering

This project included the implementation and analysis of Saturn V guidance algorithm IGM (Iterative Guidance Mode) in a 3DOF GNC Simulation. The algorithm was compared with a reference solution developed using Pontryagin's minimum principle from Optimal Control Theory.

Conceptual Design of a Liquid Propellant Rocket Engine

Part of semester course 'Space Propulsion' during BS Aerospace Engineering

Orbit Design & Analysis under Atmospheric Drag Perturbations

Part of semester course 'Spacecraft Dynamics and Control' during BS Aerospace Engineering

Aircraft Autopilot Designs using Proportional (P), Proportional-Derivative (PD) and Proportional-Integral-Derivative (PID) Controllers

Part of semester course 'Flight Control Systems' during BS Aerospace Engineering

Conceptual Design of a Supersonic Bomber Aircraft

Part of semester course 'Aero-Vehicle Design' during BS Aerospace Engineering

CAD Modeling of Aircraft using CATIA

Part of semester course 'Computer Aided Designing' during BS Aerospace Engineering

3D Wing Meshing on ANSYS

Part of semester course 'Computational Fluid Dynamics' during BS Aerospace Engineering

Performance analysis of Boeing B-52 Stratofortress Aircraft

Part of semester course 'Aero-Vehicle Performance' during BS Aerospace Engineering

Design of a Supersonic Nozzle Inlet with Maximum Pressure Recovery

Part of semester course 'Compressible Aerodynamics' during BS Aerospace Engineering

Automatic Light Switching using Light Dependent Resistor

Part of semester course 'Aerospace Instrumentation' during BS Aerospace Engineering

Speed Control of a DC Motor using Potentiometer, H-Bridge and a Micro-Controller

Part of semester course 'Circuits and Electronics' during BS Aerospace Engineering

🎖 Awards

Gold Medal   2018

Institute of Space Technology, Islamabad, Pakistan

For Securing 1st Position in the Sophomore Year of BS Aerospace Engineering

Certificate of Appreciation   2018

Institute of Space Technology, Islamabad, Pakistan

For Securing 2nd Position in the Freshmen Year of BS Aerospace Engineering

Dean's List of Honors   2018

Institute of Space Technology, Islamabad, Pakistan

Magna Cum Laude (Semester 2-4)

Cum Laude (Semester 5-8)

Merit Scholarship   2016

Institute of Space Technology

Tuition Fee Exemption for Semester 1-2 based on Academic Performance

Shield of Appreciation   2014

Punjab College of Information Technology, Pakistan

For Securing 1st Position in FSc Pre-Engineering

Merit Scholarship   2012

Punjab College of Information Technology, Pakistan

Full Tuition Fee Exemption for FSc Pre-Engineering

Shield of Appreciation 2012

Divisional Public School and College, Pakistan

For Securing 1st Position in Matric (Science Group)

Skills

Softwares (MATLAB, Mathematica, ANSYS, CATIA, SolidWorks, LabView, Systems Toolkit - STK, MS Office, RDS, DATCOM, GPOPS-II))

Programming Languages (MATLAB, c, c++, Python, Latex)

Languages

English (IELTS - C1), **Urdu**

Interests

- Sports: Cricket (Beginner), Badminton (Amateur)

- E-Gaming: Counter Strike Global Offensive, Tekken 7

References

Dr. Jamshed Riaz, *Adjunct Professor*, Institute of Space Technology, Islamabad
jamshed54@hotmail.com, +92-321-8545029

Dr. Muhammad Farooq Haydar, *Senior Modelling, Simulation and Control Engineer*, Animal Dynamics, UK
mfarooqhaydar@gmail.com, +92-332-8369505