Umberto SAETTI

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EDUCATION

Georgia Institute of Technology **Atlanta, GA**

- **Postdoctoral Fellow** in School of Aerospace Engineering *August 2019 – May 2021*
  Advisors: Jon Rogers, Mark Costello

Pennsylvania State University **University Park, PA**

- **Ph.D**. Aerospace Engineering (*Flight Dynamics and Controls)* *August 2016 – August 2019*
  Minor: Computational Science
  Dissertation Title: "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads"*
  Committee: Joe Horn (Chair), Ed Smith, J.V.R. Prasad, Constantino Lagoa
- **M.S.** Electrical Engineering (*Control Systems)* *August 2017 – August 2019*
  Thesis Title: "*Dynamic Inversion and Explicit Model Following Flight Control Laws for Quadrotors"*
  Advisor: Constantino Lagoa
- **M.S.** Aerospace Engineering (*Flight Dynamics and Control*) *August 2014 – August 2016*
  Thesis Title: "*Rotorcraft Simulations with Coupled Flight Dynamics, Free Wake, and Acoustics"*
  Advisor: Joe Horn, Co-Advisor: Kenneth Brentner

Polytechnic University of Milan **Milan, Italy**

- **B.S.** Aerospace Engineering *September 2010 – July 2014*
  Advisor: Marco Borri

RESEARCH EXPERIENCE

Auburn University **Auburn, AL**
Assistant Professor, Department of Aerospace Engineering *June 2021- Present*

Georgia Tech School of Aerospace Engineering **Atlanta, GA**
Postdoctoral Fellow, Advisors: Jon Rogers, J.V.R. Prasad, Mark Costello *August 2019 – May 2021*

- Project Title: "***Probabilistic Methods for Advanced Regime Recognition Verification and Validation***"
  - Developed a methodology to perform rotorcraft regime recognition based on motion primitives
  - Applied the methodology to SH-60 Seahawk flight-test data
- Project Title: "***Explicit Uncertainty Quantification for Probabilistic Handling Qualities Assessment***"
  - Extended the Koopman operator to propagate model parametric uncertainty to handling qualities
  - Applied the methodology to small-scale UAS and full-scale rotorcraft
- Project Title: "***Harmonic Balance Trim Solution Method for Periodically-Forced Flight Vehicles***"
  - Developed a numerical scheme for determining the solution of nonlinear time-periodic systems
  - Applied the methodology to study the stability of flapping-wing MAVs
  - Used the method to assess the vibratory loads on flapping-tail concept airplanes and helicopters
- Project Title: "***Flare Control Law using Tau Theory and Dynamic Inversion for Autonomous Helicopter Autorotation***"

NASA Ames, U.S. Army Aviation Development Directorate (ADD) **Moffett Field, CA**
Visiting Scholar, Advisors: Mark Tischler, Tom Berger *December 2018*

- Project Title: "***Identification of Linear Time-Periodic Systems from Rotorcraft Flight Test Data***"
  - Developed a methodology to identify linear time-periodic systems from rotorcraft flight test data
  - Implemented the methodology in CIFER, extending software capabilities
  - Successfully applied the methodology to RASCAL JUH-60 flight test data

Penn State Vertical Lift Research Center of Excellence (VLRCOE) **University Park, PA**
Ph.D. Candidate, Graduate Research Assistant *August 2016 – August 2019*

- Project Title: "***Load Alleviation Control Design Using High Order Dynamic Models***"
  - Developed load alleviation flight control laws for conventional and compound rotorcraft
  - Integrated flight control laws in real-time piloted simulations

- Assessed the impact of load alleviation control on rotorcraft handling qualities
- Reported completed tasks to the U.S. Army ADD

- Project Title: "***Design of Dynamic Inversion and Explicit Model Following Control Laws for Quadrotor Inner and Outer Loops***"
  - Performed system identification and advanced flight control design on quadrotor UAS Reported completed tasks to the U.S. Army ADD
- Project Title: "***Performance and Design Optimization of the F-Helix eVTOL Concept***"
  - Performed basic configuration analysis and optimization
  - Studied the aeromechanical stability of the rotor system Developed a mathematical model of the aircraft in MATLAB/Simulink

Synthesized and integrated a partial authority Stability and Control Augmentation System (SCAS)

Penn State Vertical Lift Research Center of Excellence (VLRCOE) **University Park, PA**
M.S. Candidate, Graduate Research Assistant *January 2015 – August 2016*

- Project Title: "***Rotorcraft Noise Abatement Operating Conditions Modeling***"
  - Advanced Dynamic Inversion control laws for a Bell 430
  - Developed helicopter simulations with coupled flight dynamics, free wake, and acoustics
  - Designed a noise abatement tool for customers' use
  - Reported results to the Federal Aviation Administration (FAA) through the Aviation Sustainability Center of Excellence (ASCENT)

Milan Polytechnic Skyward Experimental Rocketry **Milan, Italy**
Flight Dynamics & Control Lead *April 2012 – July 2014*

- Project Title: "***Modeling and Simulation of the Rocksanne I-X Missile***"
  - Determined the stability and control derivatives (Missile DATCOM)
  - Developed 6 DoF nonlinear simulations for stability analysis
  - Incorporated Monte Carlo Dispersions for trajectory and landing point prediction analysis
  - Optimized time between booster burnout and sustainer ignition to maximize the apogee altitude of a two-stage supersonic atmospheric rocket (150% increase in apogee altitude)
  - Launched the first successful university designed Italian rocket in November, 2013

INDUSTRY EXPERIENCE

MathWorks, Inc. **Milan, Italy**
Software Engineer Intern *April 2013 – July 2014*

- Project Title: "***Aeronautical Systems - Guidance and Control***"
  - Developed and lectured a project-based short course in collaboration with Polytechnic University of Milan and Skyward Experimental Rocketry
  - Developed software to interface MATLAB/Simulink with Arduino
  - Integrated simple flight control laws on a small-scale airship
  - Managed data acquisition from sensors to increase product capability

AWARDS

- **Barnes McCormick Memorial Scholarship**, Vertical Flight Foundation, May 2019.
  Awarded for outstanding research as a Ph.D. Candidate in the vertical flight field.

PUBLICATIONS (Manuscript under Review *, Manuscript in Preparation **)

Journal Papers

1. **Saetti U.**, Rogers, J.D., "Revisited *Harmonic Balance Trim Solution Method for Periodically-Forced Aerospace Vehicles,*" Journal of Guidance, Control, and Dynamics, Vol. 44, No. 5, May 2021, DOI: 10.2514/1.G004406.
2. **Saetti U.**, Horn J.F., Berger T., and Tischler M. B., "*Handling-Qualities Perspective on Load Alleviation Control,*" Journal of Guidance, Control, and Dynamics, Vol. 43, No. 10, October 2020, pp. 1792-1804, DOI: 10.2514/1.G004965.

3. **Saetti U.**, and Horn J.F. "*Load Alleviation Flight Control Design Using High Order Dynamic Models,*" Journal of the American Helicopter Society, Vol. 65, No. 3, May 2020, DOI: 10.4050/JAHS.65.032009.
4. **Saetti U.**, Horn J.F., Lakhmani, S., Lagoa C., and Berger, T. "*Dynamic Inversion and Explicit Model Following Flight Control Laws for Quadrotor UAS,*" Journal of the American Helicopter Society, Vol. 65, No. 3, May 2020, DOI: 10.4050/JAHS.65.032006.
5. **Saetti U.**, Horn J.F., Berger T., Lopez M., and Tischler M. B., "*Identification of Linear Time-Periodic Systems from Rotorcraft Flight Test Data,*" Journal of Guidance, Control, and Dynamics, Vol. 42, No. 10, June 2019, pp. 2288-2296, DOI: 10.2514/1.G004406.
6. ***Saetti U.**, Rogers, J.D., "*Motion Primitive Approach to Rotorcraft Regime Recognition,*" (accepted for publication by the Journal of the American Helicopter Society).
7. ***Saetti U.**, and Lovera, M., "*Time-Periodic and High-Order Time-Invariant Linearized Models of Rotorcraft – A Survey.*" (under review by the Journal of the American Helicopter Society)
8. ***Saetti U.**, Enciu, J. and Horn J.F., "*Flight Dynamics and Control of an eVTOL Concept Aircraft with a Propeller-Driven Rotor.*" (under review by the Journal of the American Helicopter Society)
9. *Musso D., **Saetti U**., and Rogers, J.D., "*Probabilistic Approach to Helicopter Usage Spectrum Development.*" (under review by the Journal of the Journal of Aircraft)
10. ****Saetti U.**, Rogers, J.D., "*Koopman Operator Approach to Probabilistic Assessments of Rotorcraft Handling Qualities.*"

Conference Papers

11. **Hayajnh, M. A., **Saetti U.**, and Prasad, J. V. R., "*Identification of High-Order Linear Time-Invariant Models from Periodic Nonlinear System Responses,*" Proceedings of the 47th European Rotorcraft Forum, Virtual, Sep 7-10, 2021.
12. Horn J. F., Scaramal M., and **Saetti U**., "*Load Alleviation Control using Dynamic Inversion with Direct Load Feedback,*" Vertical Flight Society 77th Annual Forum, Virtual, May 10-14, 2021.
13. **Saetti U**., Rogers J. D., "*Linear Time-Invariant Models of the Dynamics of Flapping-Wing Flight,*" Vertical Flight Society 77th Annual Forum, Virtual, May 10-14, 2021.
14. **Saetti U**., Horn J. F., and Brentner, K. S., "*High-Order Linear Time-Invariant Models of Rotorcraft Flight Dynamics, Vibrations, and Acoustics,*" Vertical Flight Society 77th Annual Forum, Virtual, May 10-14, 2021.
15. **Saetti U**., and Rogers J. D., "*A Motion Primitive Prospective on Rotorcraft Regime Recognition,*" Vertical Flight Society 76th Annual Forum, Virginia Beach, VA, Oct 6-8, 2020.
16. **Saetti U**., and Rogers J. D., "*Explicit Uncertainty Quantification for Probabilistic Handling Qualities Assessment,*" Vertical Flight Society 76th Annual Forum, Virginia Beach, VA, Oct 6-8, 2020.
17. **Saetti U.**, Enciu, J. and Horn J.F., "*Flight Dynamics and Control of an eVTOL with a Propeller-Driven Rotor,*" Vertical Flight Society 76th Annual Forum, Virginia Beach, VA, Oct 6-8, 2020.
18. **Saetti U**., and Rogers J. D., "*A probabilistic Approach to Pilot/Vehicle System Performance and Perceived Rotorcraft Handling Qualities,*" Vertical Flight Society Rotorcraft Handling Qualities Technical Meeting, Huntsville, AL, Feb 18-19, 2020.
19. **Saetti U.**, Horn J. F., Berger T., and Tischler M. B., "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads,*" Vertical Flight Society 75th Annual Forum, Philadelphia, PA, May 13-16, 2019.
20. **Saetti U.**, Enciu, J., and Horn J.F., "P*erformance and Design Optimization of the F-Helix eVTOL Concept,*" Vertical Flight Society 75th Annual Forum, Philadelphia, PA, May 13-16, 2019.
21. **Saetti U.**, Horn J. F., Lakhmani, S., Lagoa C., and Berger, T., "*Design of Dynamic Inversion and Explicit Model Following Control Laws for Quadrotor Inner and Outer Loops,*" American Helicopter Society 74th Annual Forum, Phoenix, AZ, May 14-17, 2018.
22. **Saetti U.**, and Horn J. F., "*Load Alleviation Control Design Using Harmonic Decomposition Models, Rotor State Feedback, and Redundant Control Effectors,*" American Helicopter Society 74th Annual Forum, Phoenix, AZ, May 14-17, 2018.
23. **Saetti U.**, and Horn J. F., "*Use of Harmonic Decomposition Models in Rotorcraft Control Design with Alleviation of Vibratory Loads,*" 43rd European Rotorcraft Forum, Milan, Italy, Sep 12-15, 2017.
24. **Saetti U.**, Villafana W., Wachspress D., Brentner K. S., and Horn J. F. "*Rotorcraft Simulations with Coupled Flight Dynamics, Free Wake, and Acoustics,*" American Helicopter Society 72nd Annual Forum, West Palm Beach, FL, May 16-19, 2016.
25. Li Y., **Saetti U.**, Sharma K., Wachspress D., Horn J. F., and Brentner K. S., "*Tools for Development and Analysis of Rotorcraft Noise Abatement,*" American Helicopter Society Sustainability 2015, Montreal, Canada, Sep 22-24, 2015.

RESEARCH FUNDING

1. PI: J. F. Horn
   Co-PI: **U. Saetti**
   Project Title: "*Performance and Design Optimization of the F-Helix eVTOL Concept*"
   Sponsor: Vinati S.R.L.
   Budget: $ 63,000
   Dates: 11/1/2018 – 10/31/2019

2. PIs: **U. Saetti**
   Co-PIs: J. F. Horn, K. S. Brentner
   Project Title: "*State-Variable Implementation and Linearization of Simulations with Multi-Disciplinary Aeromechanics*"
   Sponsor: Vertical Lift Research Center of Excellence (VLRCOE)
   Budget: $ 1.135M
   Dates: 08/2021 – 08/2026

3. PI: **U. Saetti**
   Project Title: "*On the Analysis of Periodically-Forced Flight Vehicles with Applications to Bioinspired Flight*"
   Sponsor: National Science Foundation (NSF) – Dynamics, Control, and System Diagnostics (DCSD)
   Budget: $ 240,000
   Status: In preparation.
   Dates: 01/2022 – 12/2024

TEACHING EXPERIENCE

Georgia Institute of Technology
- AE 4531 – Aircraft Flight Dynamics: Guest Lecturer (Spring 2020), Course Instructor (Spring 2021).
- AE 4071 – Rotorcraft Aeromechanics: Course Instructor (Spring 2020).

Pennsylvania State University
- AERSP 518 - Dynamics and Control of Aerospace Vehicles: Guest Lecturer (Spring 2018).

Polytechnic University of Milan
- Theoretical Mechanics: Guest Lecturer (Fall 2014).
- Developed and lectured for the joint MathWorks, Inc. and Skyward Experimental Rocketry project-based short course "*Aeronautical Systems - Guidance and Control*" in Fall 2014.

PRESENTATIONS / TALKS

Guest Lectures
- "*Networked Flight Simulation and Control Lab*", Department of Aerospace Engineering, Auburn University, Auburn, AL, April 9, 2021.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", School of Mechanical and Aerospace Engineering, Oklahoma State University, Stillwater, OK, January 5, 2021.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", Department of Aerospace Engineering, Auburn University, Auburn, AL, December 8, 2020.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", Department of Mechanical and Aerospace Engineering, Carleton University, Ottawa, Canada, November 24, 2020.
- "Methods in the Stability Analysis and Control of Periodically-Forced Aerospace Vehicles", Department of Aerospace Engineering, Pennsylvania State University, University Park, PA, November 19, 2020.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", Department of Mechanical Engineering, University of South Carolina, Columbia, SC, November 6, 2020.
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- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", Department of Mechanical and Aerospace Engineering, North Carolina State University, Raleigh, NC, October 28, 2020.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", Department of Mechanical and Aerospace Engineering, University of California, Irvine, CA, March 12, 2020.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", Department of Aerospace Engineering, Embry-Riddle Aeronautical University, Daytona Beach, FL, October 24, 2019.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", Network for Innovative Rotorcraft Safety (NITROS), Department of Aerospace Engineering, Polytechnic University of Milan (broadcasted live to Delft University of Technology, University of Liverpool, and University of Glasgow), Milan, Italy, July 1, 2019.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA, April 17, 2019.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", AIAA Penn State Chapter, Department of Aerospace Engineering, Pennsylvania State University, University Park, PA, April 11, 2019.
- *"Identification of Linear Time-Periodic Systems from Flight Test Data*", U.S. Army Aviation Development Directorate (ADD), NASA Ames Research Center, Moffett Field, CA, December 10, 2018.
- "*Skyward Experimental Rocketry: The Tsiolkovsky Rocket Equation*", Theoretical Mechanics Class, Department of Aerospace Engineering, Polytechnic University of Milan, Milan, Italy, November 12, 2013.
- "*Skyward Experimental Rocketry: A students' Way to Space*", Department of Aerospace Engineering, Polytechnic University of Milan, Italy, October 18, 2012.

Conference Presentations

- "*A Motion Primitive Prospective on Rotorcraft Regime Recognition,*" Vertical Flight Society 76th Annual Forum, Virginia Beach, VA, Oct 6-8, 2020.
- "*Explicit Uncertainty Quantification for Probabilistic Handling Qualities Assessment,*" Vertical Flight Society 76th Annual Forum, Virginia Beach, VA, Oct 6-8, 2020.
- "*A probabilistic Approach to Pilot/Vehicle System Performance and Perceived Rotorcraft Handling Qualities,*" Vertical Flight Society Rotorcraft Handling Qualities Technical Meeting, Huntsville, AL, Feb 18-19, 2020.
- "*Load Alleviation Control Design Using High Order Dynamic Models*", Vertical Lift Research Center of Excellence (VLRCOE) Annual Review, University Park, PA, November 19, 2019.
- "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads*", Vertical Flight Society 75th Annual Forum, Philadelphia, PA, May 15, 2019.
- "*Performance and Design Optimization of the F-Helix eVTOL Concept*", Vertical Flight Society 75th Annual Forum, Philadelphia, PA, May 15, 2019.
- "*Load Alleviation Control Design Using High Order Dynamic Models*", Vertical Lift Research Center of Excellence (VLRCOE) Annual Review, University Park, PA, November 6, 2018.
- "*Design of Dynamic Inversion and Explicit Model Following Control Laws for Quadrotor Inner and Outer Loops*", American Helicopter Society 74th Annual Forum, Phoenix, AZ, May 15, 2018.
- "*Load Allevition Control Design Using Harmonic Decomposition Models, Rotor State Feedback, and Redundant Control Effectors*", American Helicopter Society 74th Annual Forum, Phoenix, May 14, AZ, 2018.
- "*Load Alleviation Control Design Using High Order Dynamic Models*", Vertical Lift Research Center of Excellence (VLRCOE) Annual Review, University Park, PA, November 14, 2017.
- "*Use of Harmonic Decomposition Models in Rotorcraft Control Design with Alleviation of Vibratory Loads*", 43rd European Rotorcraft Forum, Milan, Italy, September 12, 2017.
- "*Rotorcraft Simulations with Coupled Flight Dynamics, Free Wake, and Acoustics*" American Helicopter Society 72nd Annual Forum, West Palm Beach, FL, May 17, 2016.

AFFILIATIONS

- Vertical Flight Society (VFS)
- American Institute of Aeronautics and Astronautics (AIAA)

SERVICE

- Handling Qualities Technical Committee Member, **Vertical Flight Society (VFS)**
- Reviewer, **Journal of Guidance, Control, and Dynamics (JGCD)**
- Reviewer, **Journal of the American Helicopter Society (JAHS)**
- Reviewer, **Journal of Optimization Theory and Applications (JOTA)**
- Reviewer, **International Journal of Aerospace Engineering**
- Reviewer, **Aerospace Science and Technology**
- Reviewer, **Council of European Aerospace Societies (CEAS) Aeronautical Journal**

RESEACRH SUPERVISION

- Outside Examiner, Daniele Maggiore, "*Model identification and inversion-based control for multi-rotor UAVs*", M.S. Thesis, Politecnico di Milano, September 2019.

RELEVANT SKILLS

Software: C, C++, MATLAB/Simulink, Fortran, Julia, FLIGHTLAB, CIFER, CONDUIT
Language: Italian (native speaker), English (TOEFL IBT 103/120), Spanish (beginner)

RELEVANT COURSE WORK

- **Controls:** Linear Systems, Nonlinear Control, Robust Control, Adaptive Control, Digital Control
- **Estimation**: Linear and Nonlinear Estimation, Kalman Filtering
- **Flight Dynamics and Control**: Aircraft Stability and Control, Rotorcraft Stability and Control, Spacecraft Dynamics, Dynamics and Control of Aerospace Vehicles
- **Dynamics**: Structural Dynamics and Vibrations, Rotorcraft Dynamics, Aerospace Systems Dynamics
- **Aerodynamics**: Rotorcraft Aerodynamics, Introduction to CFD, Foundations of Fluid Mechanics
- **Mathematics**: Foundations of Engineering System Analysis, Theoretical Mechanics
- **Computer Science**: Advanced Computer Programming
- **Experimental Methods**: Advanced Experimental Methods
- **Other**: Orbital Mechanics, Aerospace Propulsion, Aerospace Systems, Road Vehicle Dynamics

INVOLVEMENT

Penn State American Helicopter Society — **University Park, PA**
President — *May 2018 – Present*
Penn State Club Tennis — **University Park, PA**
Travel Team Capitan — *August 2018 – Present*
Milan Polytechnic Varsity Tennis — **Milan, Italy**
Team Captain — *September 2011 – July 2014*