Umberto SAETTI

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EDUCATION

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

Georgia Tech School of Aerospace Engineering **Atlanta, GA**

Postdoctoral Fellow, Advisors: Jon Rogers, J.V.R. Prasad, Mark Costello *August 2019 - Present*

- Project Title: "***Probabilistic Methods for Advanced Regime Recognition Verification and Validation***"
  - Developing 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: "***Probabilistic Assessment of Pilot/Vehicle System Performance and Perceived Vehicle Handling Qualities***"
  - Extended the Koopman operator to propagate pilot model uncertainty to handling qualities
  - Linked pilot model uncertainty to variability in pilot opinion ratings
- Project Title: "***Integrated Flight and Propulsion Control for Rotorcraft***"
  - Currently developing handling qualities standards for vehicles with redundant control effectors for the Federal Aviation Administration (FAA)

NASA Ames, U.S. Army Aviation Development Directorate (ADD) **Moffett Field, CA**

Visiting Scholar, Advisor: Mark Tischler, Co-Advisor: 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.**, Horn J.F., Berger T., Lopez M., Tischler M. B., "*Identification of Linear Time-Periodic Systems from Rotorcraft Flight Test Data,*" Journal of Guidance, Control, and Dynamics, June 24, 2019.
   doi: 10.2514/1.G004406
2. ***Saetti U.**, Horn J.F. "*Load Alleviation Flight Control Design Using High Order Dynamic Models,*" (accepter for publication, Journal of the American Helicopter Society).
3. ***Saetti U.**, Berger T., Horn J.F., Lagoa C. "*Dynamic Inversion and Explicit Model Following Flight Control Laws for Quadroto UAS,*" (accepted for publication, Journal of the American Helicopter Society).
4. ***Saetti U.**, Horn J.F., Enciu J., "P*erformance and Design Optimization of an eVTOL with a Propeller-Driven Rotor,"* (accepted for peer review, Journal of the American Helicopter Society)
5. ***Saetti U.**, Horn J.F., Berger T., Tischler M. B., "*A Handling Qualities Perspective on Load Alleviation Control,*" (submitted to the Journal of Guidance, Control, and Dynamics in October, 2019)

6. ****Saetti U.**, Lovera, M., "*Linear Time-Invariant Approximations of the Relative Dynamics of Spacecraft Formations in Eccentric Orbits,*" (to be submitted to the Journal of Guidance, Control, and Dynamics)

Conference Papers

7. ****Saetti U**., 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, 2020.
8. ****Saetti U**., Rogers J. D., "*A Motion Primitive Prospective on Rotorcraft Regime Recognition,*" Vertical Flight Society 76th Annual Forum, Montreal, Canada, 2020.
9. ****Saetti U**., Rogers J. D., "*Explicit Uncertainty Quantification for Probabilistic Handling Qualities Assessment,*" Vertical Flight Society 76th Annual Forum, Montreal, Canada, 2020.
10. ****Saetti U.**, Horn J.F., Enciu J., "*Flight Dynamics and Control of an eVTOL with a Propeller-Driven Rotor,*" Vertical Flight Society 76th Annual Forum, Montreal, Canada, 2020.
11. ****Saetti U.**, Lovera, M., "*Rotorcraft Linear Time-Periodic Systems – A Historical Perspective,*" Vertical Flight Society 76th Annual Forum, Montreal, Canada, 2020.
12. **Saetti U.**, Horn J. F., Berger T., Tischler M. B., "*Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads,*" Vertical Flight Society 75th Annual Forum, Philadelphia, PA, 2019.
13. **Saetti U.**, Horn J.F., Enciu J., "P*erformance and Design Optimization of the F-Helix eVTOL Concept,*" Vertical Flight Society 75th Annual Forum, Philadelphia, PA, 2019.
14. **Saetti U.**, Berger T., Horn J. F., Lagoa C. "*Design of Dynamic Inversion and Explicit Model Following Control Laws for Quadrotor Inner and Outer Loops,*" American Helicopter Society 74th Annual Forum, Phoenix, AZ, 2018.
15. **Saetti U.**, Horn J. F. "*Load Allevition Control Design Using Harmonic Decomposition Models, Rotor State Feedback, and Redundant Control Effectors,*" American Helicopter Society 74th Annual Forum, Phoenix, AZ, 2018.
16. **Saetti U.**, Horn J. F. "*Use of Harmonic Decomposition Models in Rotorcraft Control Design with Alleviation of Vibratory Loads,*" 43rd European Rotorcraft Forum, Milan, Italy, 2017.
17. **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, 2016.
18. 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, Montreal, Canada, 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: J. F. Horn, J. Rogers, K. Feigh, P. P. Friedmann, C. E. S. Cesnik
   Co-PI: **U. Saetti**, J. Enciu
   Project Title: "*Simulation and Control Design for eVTOL Aircraft Conversion and Low-Speed Terminal Operations*"
   Sponsor: NASA University Leadership Initiative (ULI)
   Budget: $ 2M
   Status: Pending.
   Dates: 08/2020 – 08/2024

TEACHING EXPERIENCE

Georgia Institute of Technology
- AE 4071 - Rotorcraft Aeromechanics: Course Instructor (Spring 2020).
- AE 4531 – Aircraft Flight Dynamics: Guest Lecturer (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 MathWorks, Inc. and Skyward Experimental Rocketry project-based short course "*Aeronautical Systems - Guidance and Control*" in Fall 2014.

PRESENTATIONS / TALKS

Guest Lectures
- "*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
- "*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

- Reviewer, **Journal of the American Helicopter Society (JAHS)**
- Editor, **Magazine of Aviation Development (MAD)**

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, FLIGHTLAB, CIFER, CONDUIT, Missile DATCOM
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*