

# Dr. Andrea L'Afflitto

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## **Contact Information**

865 Asp Ave.  
Aerospace and Mechanical Engineering  
The University of Oklahoma  
Norman, OK 73019 USA  
WWW: <http://lafflitto.com>

Voice: (405) 325-7885  
Fax: (405) 325-1088  
E-mail: [a.lafflitto@ou.edu](mailto:a.lafflitto@ou.edu)

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## **Work Experience Assistant Professor.**

*Department of Aerospace and Mechanical Engineering, The University of Oklahoma, Norman, OK. August, 2015 – Present*

Research in robust output-feedback control, optimal control, and differential games theory for aerospace engineering applications. *Application:* design of autopilots for UAS.

*Courses taught:*

- Flight Controls (F. 2015–2017, G/U)
- Nonlinear Dynamical Systems and Control (Sp. 2016, 2017, G/U)
- Advanced Dynamics & Control of Mechanical Systems (F. 2017, G/U)
- Optimization & Optimal Control (Sp. 2018, G/U)

*Service:*

- Graduate studies committee member (F. 2017 – Present).

## **Summer Faculty Fellow.**

*Army Research Lab, Aberdeen, MD. May, 2017 – August, 2017*

Collaboration on the design, implementation, and testing of nonlinear robust controls for quadrotor aircraft.

## **International Space Station – Systems and Operations Engineer.**

*German Aerospace Agency (DLR), Cologne, Germany. January, 2007 – May, 2008*

Payload and operations coordinator of EXPOSE-E: a payload installed outside the European module Columbus for the International Space Station.

## **Education**

### **Ph.D. in Aerospace Engineering.**

*Georgia Institute of Technology, Atlanta, GA, USA. August 2011 – April 2015*

Research in *optimal control, finite-time state-feedback optimal control, partial-state state-feedback optimal control, and semistabilization of nonlinear dynamical systems.*

### **Master of Science in Mathematics.**

*Virginia Polytechnic Institute and State University, Blacksburg, VA, USA. August 2009 – May 2010.*

Research in calculus of variations and optimal control theory with applications to spacecraft and aircraft fuel-optimal path planning.

### **Master of Science in Aerospace Engineering and Astronautics.**

*Federico II University, Naples, Italy. September 2004 – September 2006.*

Research in space systems design in conjunction with an internship at the Italian Space Agency (ASI). *Summa cum laude.*

### **Bachelor of Science in Aerospace Engineering.**

*Federico II University, Naples, Italy. September 2001 – September 2004.*

Research in space systems design in conjunction with an internship at Co.Ri.S.T.A. (Alenia Spazio Group). *Summa cum laude.*

## Publications

### Books:

- B1. A. L’Afflitto. *A Mathematical Perspective on Flight Dynamics and Control*, Springer, London, UK – ISBN 978-3-319-47466-3.

### Book Chapters:

- BC1. K. Mohammadi and A. L’Afflitto. *Robust Adaptive Output Tracking for Quadrotor Helicopters*, in “Adaptive Robust Control and its Applications” , Dr. Le Anh Tuan ed., InTech, pp. 77-100, ISBN: 978-953-51-5729-8.
- BC2. A. L’Afflitto, W. M. Haddad. *A Variational Approach to the Fuel Optimal Control Problem for UAV Formations*, in “Recent Advances in Aircraft Technology” , Dr. Ramesh Agarwal ed., InTech, pp. 221-248, ISBN: 979-953-307-635-4.

### Journal Papers:

- J1. A. L’Afflitto, R. B. Anderson, and K. Mohammadi, *An Introduction to Nonlinear Robust Control for Unmanned Quadrotor Aircraft*. IEEE Control Systems Magazine – In Press.
- J2. A. L’Afflitto and K. Mohammadi, *Equations of Motion of Rotary-Wing UAS with Time-Varying Inertial Properties*. AIAA Journal of Guidance, Control, and Dynamics – Vol. 41, 2, Feb. 2018, pp. 559-564.
- J3. A. L’Afflitto and W. M. Haddad, *Abnormal Optimal Trajectory Planning of Multi-Body Systems in the Presence of Holonomic and Nonholonomic Constraints*. Journal of Intelligent & Robotic Systems, Vol. 89, 1, Jan. 2018, pp. 51-67.
- J4. A. L’Afflitto and K. Mohammadi, *Robust Observer-Based Control of Nonlinear Dynamical Systems with State Constraints*. Journal of the Franklin Institute, Vol. 354, 16, Nov. 2017, pp. 7385-7409.
- J5. A. L’Afflitto, *Continuous Lyapunov Functions, Differential Games, and Stabilization of Nonlinear Systems*. IET Control Theory and Applications, Vol. 11, 15, Oct. 2017, pp. 2486-2496.
- J6. A. L’Afflitto, *Differential Games, Finite-Time Partial-State Stabilization of Nonlinear Dynamical Systems, and Optimal Robust Control*. International Journal of Control, Vol. 90, 9, June 2017, pp. 1861-1878.
- J7. A. L’Afflitto, *Differential Games, Partial-State Stabilization, and Model Reference Adaptive Control*. Journal of the Franklin Institute, Vol. 354, 1, Jan. 2017, pp. 456-478.
- J8. W. M. Haddad and A. L’Afflitto, *Finite-Time Stabilization and Optimal Feedback Control*. IEEE Transactions on Automatic Control, Vol. 61, 4, April 2016, pp. 1069-1074.
- J9. A. L’Afflitto, W. M. Haddad, and E. Bakolas, *Partial-State Stabilization and Optimal Control*. International Journal of Robust and Nonlinear Control, Vol. 26, 5, Mar. 2016, pp. 1026-1050.
- J10. A. L’Afflitto and W. M. Haddad, *Optimal Singular Control for Nonlinear Semistabilization*. International Journal of Control, Vol. 89, 6, Jan. 2016, pp. 1222-1239.
- J11. W. M. Haddad and A. L’Afflitto, *Finite-Time Partial Stability, Stabilization, and Optimal Feedback Control*. Journal of the Franklin Institute, Vol. 352, 6, Mar. 2015, pp. 2329-2357.
- J12. A. L’Afflitto, W. M. Haddad, and Q. Hui, *Optimal Control for Linear and Nonlinear Semistabilization*. Journal of the Franklin Institute, Vol. 352, 3, Mar. 2015, pp. 851-881.
- J13. E. Rabbow, G. Horneck, P. Rettberg, J. U. Schott, C. Panitz, A. L’Afflitto, et. al. *EXPOSE, an Astrobiological Exposure Facility on the International Space Station – from Proposal to Flight*. Origin of Life and Evolution of Biosphere, Vol. 39, 6, Dec. 2009, pp. 581-598.

### Conference Papers:

- C1. A. L’Afflitto, *Robust Adaptive Control for Constrained Dynamical Systems Following Unreliable Reference Signals*, in proc. American Control Conference, July 2018.

- C2. K. Mohammadi and A. L’Afflitto, *A Continuous First-Order Sliding Mode Control Law, Dynamic Systems and Control Conference*, in proc. Dynamic Systems and Control Conference, October 2017.
- C3. A. L’Afflitto, *Differential Games, Asymptotic Stabilization, and Robust Optimal Control of Nonlinear Systems*, in proc. Conference on Decision and Control, December 2016.
- C4. A. L’Afflitto and W. M. Haddad, *Optimal Singular Control for Nonlinear Semistabilization*, in proc. American Control Conference, Chicago, IL, July 2015.
- C5. W. M. Haddad and A. L’Afflitto, *Finite-Time Partial Stability Theory and Fractional Lyapunov Differential Inequalities*, in proc. American Control Conference, Chicago, IL, July 2015.
- C6. A. L’Afflitto and W. M. Haddad, *Necessary Conditions for Control Effort Minimization of Euler-Lagrange Systems*. AIAA Guidance, Navigation, and Control Conference, AIAA Science and Technology Forum, Kissimmee, FL, January 2015.
- C7. A. L’Afflitto, W. M. Haddad, and E. Bakolas, *Partial-State Stabilization and Optimal Feedback Control*. Conference on Decision and Control, Los Angeles, CA, December 2014.
- C8. A. L’Afflitto, W. M. Haddad, and Q. Hui *Optimal Control for Linear and Nonlinear Semistabilization*. American Control Conference, Portland, OR, June 2014.
- C9. A. L’Afflitto and W. M. Haddad, *Singular Linear-Quadratic Control for Semistabilization*. Conference on Decision and Control, Florence, Italy, December 2013.
- C10. W. M. Haddad, Q. Hui, and A. L’Afflitto, *Semistabilization, Feedback Dissipativity, System Thermodynamics, and Limits of Performance*. American Control Conference, Washington, DC, June 2013.
- C11. A. L’Afflitto and C. Sultan, *On The Optimal Fuel and Energy Consumption for Spacecraft Path Planning in Low Earth Orbit*. IFAC Conference 2011, Milan, Italy, August 2010.
- C12. A. L’Afflitto and C. Sultan, *On the Fuel and Energy Consumption Optimization Problem in Aircraft Path Planning*. IEEE Conference on Decision and Control, Atlanta, GA, December 2010.
- C13. A. L’Afflitto and C. Sultan, *On Calculus of Variations in Aircraft and Spacecraft Formation Flying Path Planning*. AIAA Guidance, Navigation and Control Conference, Toronto, Canada, August 2010.
- C14. A. L’Afflitto and C. Sultan, *Calculus of Variations for Guaranteed Optimal Path Planning of Aircraft Formations*. IEEE International Conference on Robotics and Automation, Anchorage, AK, May 2010.
- C15. A. L’Afflitto and C. Sultan, *Applications of Calculus of Variations to Aircraft and Spacecraft Path Planning*. AIAA Guidance, Navigation and Control Conference, Chicago, IL, August 2009.
- C16. J. Zyiwicki, A. L’Afflitto, E. Rabbow, R. Willnecker, and J. Shieman, *EXPOSE-E: Application of a decentralized payload operations concept for European Payloads on the ISS*. 59th International Astronautical Congress (IAC), 2008.
- C17. E. Rabbow, A. L’Afflitto, C. Paniz, and G. Reitz, *EXPOSE-E – The Astrobiological Exposure Facility on ISS – from proposal to flight*. 59th International Astronautical Congress (IAC), 2008.

**Invited Talks:**

- I1. From theory to practice: A nonlinear robust control to assist quadrotor pilots in adverse conditions. Naval Future Force Science and Technology Expo, July 20, 2017.
- I2. Robust Control, Optimal Control, and Differential Games. University of New Mexico, October 28, 2016.
- I3. Optimal Control and Differential Games: From Spacecraft Attitude Control to Formation Flying. Kirtland Air Force Base, August 11, 2016.

14. Robust Control, Optimal Control, and Differential Games. Wright-Patterson Air Force Base, July 22, 2016.
15. Optimal Control and Differential Games: From Spacecraft Attitude Control to Formation Flying. Italian Center for Aerospace Research (CIRA) – May 19, 2016.
16. Research Challenges in Control Theory for Aerospace Applications. Italian Center for Aerospace Research (CIRA) – May 16, 2016.

### *Awards*

#### **Funding:**

- **A. L’Affitto** *DARPA-RA-17-01-YFA-FP-090, TA24 – A bio-inspired approach to fly undetected in cluttered environments*, DARPA, July 2018 – June 2021. Cumulative: Under negotiation.
- **A. L’Affitto** *T3C1S4C – UAS Control System – Robotics CTA 2017-18 Biennial Program Plan*, Army Research Lab through Robotics Collaborative Technology Alliance, January 2018 – December 2020. Cumulative: **\$185,343**.
- **A. L’Affitto** and Z. Siddique *Collaborative Research: Unmanned Aerial Systems and Specialized Workforce Development to Support Oklahoman Agriculture and Industry*, NSF ATE Program, July 2017 – July 2020. Cumulative: **\$408,804**; Personal share: **\$224,842**.
- **A. L’Affitto**, *Summer Research Experience: Programming UAS for Improved Weather Forecasts*, NSF Oklahoma EPSCoR REU, May – August 2017. Cumulative: **\$5,000**.
- S. Koch, P. Chilson, E. Rasmussen, R. Huck, **A. L’Affitto**, and J. Salazar-Cerreno, *Three-Dimensional Profiling of the Severe-Weather Environment*, NOAA, April 2016 – August 2018. Cumulative: **\$240,200**; Personal share: **\$41,797 + fringe**.

#### **Editorial Activities:**

- IET Control Theory and Applications – Top 5% most outstanding reviewer out of over 1000.

#### **Scholarships and Fellowships:**

- AIAA Guidance Navigation and Control Graduate Student Award, 2015  
*Waived for having gained Ph.D. degree in 2015.*
- Domenica Rea D’Onofrio Scholarship, Fall 2011 – Spring 2015.
- Wolfe Fellowship, Summer 2012.
- Pratt Fellowship, Spring 2009.

### *Editorial Activities*

#### **Journals:**

- Elsevier – Control Engineering Practice, Associate editor, 2015 – Present.
- Springer – Journal of Intelligent & Robotic Systems, Guest editor, 2017.

#### **Conferences:**

- Networked and Autonomous Air and Space Systems Conference 2018, Editorial board member.
- American Control Conference 2017, Associate editor.

### *Reviewer*

#### **Books:**

- Springer.

#### **Journals:**

- *Elsevier Automatica*.
- *Elsevier Systems & Control Letters*.
- *Elsevier Journal of the Franklin Institute*.
- *Elsevier Nonlinear Dynamics*.
- *IEEE Transactions on Control Systems Technology*.
- *IEEE Transactions on Automatic Control*.
- *IEEE Transactions on Mechatronics*.

- *IEEE* Transactions on Aerospace and Electronic Systems.
- *IEEE* Control Systems Magazine.
- *Taylor & Francis* International Journal of Control.
- *Taylor & Francis* International Journal of Systems Science.
- *IET* Control Theory and Applications.
- *Wiley* International Journal of Robust and Nonlinear Control.
- *Wiley* Optimal Control, Applications and Methods.
- *Wiley* Asian Journal of Control.
- *AIAA* Journal of Guidance, Control, and Dynamics.
- *Elsevier* Acta Astronautica.

**Conferences:**

- *IEEE* American Control Conference, 2010, 2011, 2013, 2016, 2018.
- *IEEE* Conference on Decision and Control, 2012–2015.
- *IEEE* Multi-conference on Systems and Control, 2010–2012, 2016.
- *IEEE* International Conference on Control, Decision, and Information Technologies, 2018.
- *IFAC* International Conference on Automatic Control, 2011, 2014.
- *AIAA* Conference on Aviation Technology, Integration, and Operations (ATIO), 2011–2012.
- *AIAA* Space Logistics Best Paper Award, 2011.

**Internships**

**Mathematical Modeling.**

*Advanced Superconducting Test Accelerator (ASTA), Fermilab, Batavia, IL. July – August, 2013*

Analyzed electron beam instabilities and designed optimal state-feedback control laws for minimizing beam emittance and convergence of the beams to an assigned manifold.

**System Engineer.**

*Italian Space Agency (ASI), Rome, Italy. January – June, 2006*

Created database structures to support a facility currently in use at the Italian Space Agency aimed at in-house feasibility studies using a *concurrent design methodology* and ECSS standards. Furthermore, contributed to the design in phase 0 of a satellite for Earth observation.

**System Engineer.**

*Consortium of Research of Advanced Remote Sensing Systems (Alenia Spazio Group), Naples, Italy. January – July 2004*

Pre-feasibility study and development of the remote sensing system for a satellite of the Italian Space Agency (ASI) aimed at autonomous robotic on orbit servicing.

**Professional Associations**

- *IEEE* Technical Committee on Aerospace Control – Member
- *AIAA* Technical Committee on Guidance Navigation, and Control – Member
- *AIAA* Space Logistics Technical Committee – Former Member
- *AIAA* Young Professionals Committee – Former Region 1 Deputy Director
- *AIAA* – Senior Member
- *IEEE* – Member

**Specialized Training**

- European Space Agency (ESA) International Space Station (ISS) Payload Advanced Training Course. Aimed at training ISS ground controllers and ISS astronauts to the use of European payloads installed aboard the ISS – ESA Astronauts Center, Cologne, Germany
- ESA Columbus System Course. Aimed at training ISS ground controllers and ISS astronauts to the use of the European module Columbus of the ISS – ESA Astronauts Center, Cologne, Germany
- ESA Columbus Control Center Blocks A and B Training Courses. Aimed at training ISS ground controllers to operate the ISS – German Aerospace Agency, Oberpfaffenhofen, Munich, Germany

***Languages***

Italian (mother language), English (proficient), German (proficient, certified European level B2), French (advanced).

***Community  
Service***

- *AIAA* Oklahoma Section, Region IV – Treasurer, 2015 – Present.
- *AIAA* Scholarship and Student Award – Judge, 2010 – 2015.
- *AIAA* Region 1 Rocket Competition – Chair Organizing Committee, 2011 – 2012.
- *AIAA* Zarem Award – Judge, 2010.