Derek A. Paley

Assistant Professor, Department of Aerospace Engineering
Member, Neuroscience and Cognitive Science Program
Director, Collective Dynamics and Control Laboratory
University of Maryland
3150 Martin Hall, College Park, MD 20742
(301) 405-5757 | (301) 314-0213 (fax)
dpaley@umd.edu | http://terpconnect.umd.edu/∼dpaley

Short Bio

Derek A. Paley is an Assistant Professor in the Department of Aerospace Engineering at the University of Maryland and the Director of the Collective Dynamics and Control Laboratory. He received the B.S. degree in Applied Physics from Yale University in 1997 and the Ph.D. degree in Mechanical and Aerospace Engineering from Princeton University in 2007. His research interests are in the area of nonlinear dynamics and control, including cooperative control of autonomous vehicles, adaptive sampling with mobile networks, and spatial modeling of biological collectives.

Research

- **Nonlinear dynamics and control:** *Cooperative control of autonomous vehicles in the air and sea*
- **Mobile sensor networks:** *Optimal and adaptive sampling of spatiotemporal processes*
- **Biocomplexity:** *Quantitative modeling of animal groups and grouping behavior*

Appointments

2009–present, **Member**, Program in Neuroscience and Cognitive Science
2007–present, **Assistant Professor**, Department of Aerospace Engineering

Education

1993–1997, **B.S. Applied Physics**, Yale University
Thesis: *Artifacts from respiration in functional echo-planar magnetic resonance imaging*

2002–2007, **Ph.D. Mechanical and Aerospace Engineering**, Princeton University
Thesis: *Cooperative control of collective motion for ocean sampling with autonomous vehicles*

Employment

1997–2000 **Analyst**, Metron, Inc., Reston, Virginia
Designed and implemented signal processing and optimization algorithms and software for Naval research

2000–2002 **Software Engineer**, Bluefin Robotics Corp., Cambridge, Massachusetts
Designed and implemented control, navigation, and operations software for autonomous underwater vehicles

Research and Scholarly Activities

Books

[1] N. J. Kasdin and D. A. Paley. An introduction to engineering dynamics. In preparation, under contract with *Princeton University Press*.

Articles in Refereed Journals

[13] L. Techy, D. A. Paley, and C. A. Woolsey. UAV coordination on time-optimal paths in wind. Submitted.

[12] S. Hernandez and D. A. Paley. Three-dimensional motion coordination in a spatiotemporal flowfield. Submitted.

[11] D. A. Paley and C. Peterson. Stabilization of Collective Motion in a Time-Invariant Flowfield. *J. Guidance, Control, and Dynamics*, 32(3):771–779, 2009.

[10] D. A. Paley. Stabilization of Collective Motion on a Sphere. *Automatica*, 45(1):212–216, 2009.

[9] D. A. Paley, F. Zhang, and N. E. Leonard. Cooperative control for ocean sampling: The Glider Coordinated Control System. *IEEE Trans. Control Systems Technology*, 16(4):735–744, 2008.

[8] R. Sepulchre, D. A. Paley, and N. E. Leonard. Stabilization of planar collective motion with limited communication. *IEEE Trans. Automatic Control*, 53(3):706–719, 2008.

[7] D. A. Paley, N. E. Leonard, and R. Sepulchre. Stabilization of symmetric formations to motion around convex loops. *Systems and Control Letters*, 57(3):209–215, 2008.

[6] F. Zhang, D. M. Fratantoni, D. A. Paley, J. M. Lund, and N. E. Leonard. Control of coordinated patterns for ocean sampling. *Int. J. Control*, 80(7):1186–1199, 2007.

[5] D. A. Paley, N. E. Leonard, R. Sepulchre, D. Grünbaum, and J. K. Parrish. Oscillator models and collective motion: Spatial patterns in the dynamics of engineered and biological networks. *IEEE Control Systems Magazine*, 27(4):89–105, 2007.

[4] R. Sepulchre, D. A. Paley, and N. E. Leonard. Stabilization of planar collective motion: All-to-all communication. *IEEE Trans. Automatic Control*, 52(5):811–824, 2007.

[3] N. E. Leonard, D. A. Paley, F. Lekien, R. Sepulchre, D. M. Fratantoni, and R. E. Davis. Collective motion, sensor networks and ocean sampling. *Proc. IEEE*, 95(1):48–74, 2007.

[2] E. Fiorelli, N. E. Leonard, P. Bhatta, D. A. Paley, R. Bachmayer, and D. M. Fratantoni. Multi-AUV control and adaptive sampling in Monterey Bay. *IEEE J. Oceanic Engineering*, 31(4):935–948, 2006.

[1] D. Raj, D. Paley, A. W. Anderson, R. P. Kennan, and J. C. Gore. A model for susceptibility artefacts from respiration in functional echo-planar magnetic resonance imaging. *Phys. Med. Biol.*, 45(12):3809–3820, 2000.

Other Publications and Presentations

Conference proceedings

[24] D. A. Paley and A. Baharani. Critical damping in a kinetic interaction network. Submitted.

[23] S. Butail and D. A. Paley. 3D reconstruction of fish schooling kinematics from underwater video. Submitted.

[22] S. Hernandez and D. A. Paley. Three-Dimensional Motion Coordination in a Time-Invariant Flowfield. To appear in *Proc. 48th IEEE Conf. Decision and Control*.

[21] S. Butail and D. A. Paley. Vision-based estimation of three-dimensional position and pose of multiple underwater vehicles. To appear in *Proc. 2009 IEEE IROS*.

[20] L. Techy, D. A. Paley, and C. A. Woolsey. UAV Coordination on Convex Curves in Wind: An Environmental Sampling Application. In *Proc. 2009 European Control Conf.*, pages 4967–4972, Budapest, Hungary, August 2009.

[19] N. Sydney, S. Napora, S. Beal, P. Mohl, P. Nolan, S. Sherman, A. Leishman, S. Butail, and D. A. Paley. A Micro-UUV Testbed for Bio-Inspired Motion Coordination. In *Proc. 2009 Int. Symp. Unmanned Untethered Submersible Technology*, Durham, New Hampshire, August 2009. Student Paper Competition Award Winner.

[18] C. Peterson and D. A. Paley. Cooperative Control of Unmanned Vehicles in a Time-Varying Flowfield. In *Proc. AIAA Guidance, Navigation, and Control Conf.*, number AIAA-2009-6117, Chicago, Illinios, August 2009. Invited session on "UAV Flight in Complex Atmospheric Conditions".

[17] D. A. Paley, L. Techy, and C. A. Woolsey. Coordinated Perimeter Patrol with Minimum-Time Alert Response. In *Proc. AIAA Guidance, Navigation, and Control Conf.*, number AIAA-2009-6210, Chicago, Illinios, August 2009. Invited session on "UAV Cooperative Control Technologies for Integrated Defense".

[16] S. Hernandez and D. A. Paley. Stabilization of Collective Motion in a Time-Invariant Flow Field on a Rotating Sphere. In *Proc. American Control Conf.*, pages 623–628, St. Louis, Missouri, June 2009.

[15] D. A. Paley and D. S. Warshawsky. Reduced-Order Dynamic Modeling and Stabilizing Control of a Micro-Helicopter. In *Proc. 47th AIAA Aerospace Sciences Meeting*, number AIAA-2009-1350, Orlando, Florida, January 2009. (9 pages).

[14] D. A. Paley. Cooperative Control of an Autonomous Sampling Network in an External Flow Field. In *Proc. 47th IEEE Conf. Decision and Control*, pages 3095–3100, Cancun, Mexico, December 2008.

[13] D. A. Paley. Stabilization of Collective Motion in a Uniform and Constant Flow Field. In *Proc. AIAA Guidance, Navigation and Control Conf. and Exhibit*, number AIAA-2008-7173, Honolulu, Hawaii, August 2008. (8 pages).

[12] D. A. Paley, N. E. Leonard, R. Sepulchre, and I. D. Couzin. Spatial models of bistability in biological collectives. In *Proc. 46th IEEE Conf. Decision and Control*, pages 4851–4856, New Orleans, Louisiana, December 2007.

[11] D. A. Paley, N. E. Leonard, and R. Sepulchre. Collective motion of self-propelled particles: Stabilizing symmetric formations on closed curves. In *Proc. 45th IEEE Conf. Decision and Control*, pages 5067–5072, San Diego, California, December 2006.

[10] R. Sepulchre, D. A. Paley, and N. E. Leonard. Group coordination and cooperative control of steered particles in the plane. In K. Y. Pettersen, J. T. Gravdahl, and H. Nijmeijer, editors, *Group Coordination and Cooperative Control*, number 336 in Lecture Notes in Control and Information Sciences, pages 217–232. Springer, 2006.

[9] D. A. Paley, N. E. Leonard, and R. Sepulchre. Oscillator models and collective motion: Splay state stabilization of self-propelled particles. In *Proc. Joint 44th IEEE Conf. Decision and Control and European Control Conf.*, pages 3935–3940, Seville, Spain, December 2005.

[8] J. Jeanne, N. E. Leonard, and D. Paley. Collective motion of ring-coupled planar particles. In *Proc. Joint 44th IEEE Conf. Decision and Control and European Control Conf.*, pages 3929–3934, Seville, Spain, December 2005.

[7] P. Bhatta, E. Fiorelli, F. Lekien, N. E. Leonard, D. A. Paley, F. Zhang, R. Bachmayer, R. E. Davis, D.M. Fratantoni, and R. Sepulchre. Coordination of an underwater glider fleet for adaptive ocean sampling. In *Proc. Int. Workshop on Underwater Robotics for Sustainable Management of Marine Ecosystems and Environmental Monitoring*, pages 61–69, Genoa, Italy, November 2005.

[6] R. Sepulchre, D. Paley, and N. E. Leonard. Graph Laplacian and Lyapunov design of collective planar motions. In *Proc. Int. Symp. Nonlinear Theory and its Applications*, pages 217–232, Bruges, Belgium, October 2005.

[5] D. Paley, N. E. Leonard, and R. Sepulchre. Collective motion: Bistability and trajectory tracking. In *Proc. 43rd IEEE Conf. Decision and Control*, pages 1932–1937, Paradise Island, Bahamas, December 2004.

[4] R. Sepulchre, D. Paley, and N. Leonard. Stabilization of collective motion of self-propelled particles. In *Proc. 16th Int. Symp. Mathematical Theory of Networks and Systems (electronic)*, Leuven, Belgium, July 2004. (10 pages).

[3] E. Fiorelli, N. E. Leonard, P. Bhatta, D. Paley, R. Bachmayer, and D. M. Fratantoni. Multi-AUV control and adaptive sampling in Monterey Bay. In *Proc. IEEE Autonomous Underwater Vehicles 2004: Workshop on Multiple AUV Operations*, pages 134–147, Sebasco Estates, Maine, June 2004.

[2] R. Bachmayer, N. Leonard, J. Graver, E. Fiorelli, P. Bhatta, and D. Paley. Underwater gliders: Recent developments and future applications. In *Proc. IEEE Symp. Underwater Technology*, pages 195–200, Tapei, Taiwan, April 2004.

[1] R. Sepulchre, D. Paley, and N. Leonard. Collective motion and oscillator synchronization. In V. Kumar, N. Leonard, and A. S. Morse, editors, *Cooperative Control: A Post-Workshop Volume of the 2003 Block Island Workshop on Cooperative Control*, number 309 in Lecture Notes in Control and Information Sciences, pages 189–228. Springer-Verlag, 2005.

Invited and other talks

[19] Autonomous motion coordination in a spatiotemporal flowfield. *Laboratory for Computational Sensing and Robotics*, The Johns Hopkins University, 4 November 2009.

[18] Research opportunities in Aerospace Engineering at the University of Maryland. *UNIV100 The Student in the University*, University of Maryland, College Park, Maryland, 21 October 2009.

[17] Research opportunities in Aerospace Engineering at the University of Maryland. *Discovering Engineering Seminar*, Undergraduate Recruitment and Special Programs, University of Maryland, College Park, Maryland, 7 August 2009.

[16] Research opportunities in Aerospace Engineering at the University of Maryland. *Exploring Engineering Seminar*, Women in Engineering, University of Maryland, College Park, Maryland, 17 July 2009.

[15] Why the world needs more engineers, what do engineers like me do, and how to build a better catapult. *Up, Up, and Away Seminar*, Center for Minorities in Science and Engineering, University of Maryland, College Park, Maryland, 8 July 2009.

[14] Observing networks: Motion coordination and information transmission. *Collective Animal Behavior Seminar*, Princeton University, Princeton, New Jersey, 4 June 2009.

[13] Coupled oscillator models for analysis and control of interaction networks. *SIAM Conf. on Applications of Dynamical Systems*, session on "Collective Phenomena", Snowbird, Utah, 17 May 2009.

[12] Fish-inspired strategies for information transmission and motion coordination. *International Workshop on Bio-Inspired Sensing and Actuation Technologies for Civil and Mechanical Systems*, National Center for Research on Earthquake Engineering, Taipei, Taiwan, 15 April 2009.

[11] Collective dynamics and control. *Global Engagement Department Seminar*, The Johns Hopkins Applied Research Laboratory, Laurel, Maryland, 25 March 2009.

[10] UAV control for collective motion in a dynamic environment. *Control Design and Analysis Branch Seminar*, Air Vehicles Directorate, Air Force Research Lab, Wright Patterson Air Force Base, Ohio, 5 November 2008.

[9] Why the world needs more engineers, what do engineers like me do, and how to build a better catapult. *Discovering Engineering*, University of Maryland, College Park, Maryland, 7 August 2008.

[8] Recent progress toward a cooperative control framework for planetary-scale sampling in strong and variable currents. *18th Int. Symp. on Mathematical Theory of Networks and Systems*, invited session on "Control of Complex Networks and Environmental Applications", 28 July 2008.

[7] Why the world needs more engineers, what do engineers like me do, and how to build a better catapult. *Up, Up, and Away Seminar*, Center for Minorities in Science and Engineering, University of Maryland, College Park, Maryland, 9 July 2008.

[6] Why the world needs more engineers, what do engineers like me do, and how to build a better catapult. *Spring into the Future Seminar*, Center for Minorities in Science and Engineering, University of Maryland, College Park, Maryland, 16 June 2008.

[5] Cooperative control of autonomous vehicles for environmental sampling. *Biodynamics Seminar*, Department of Aeronautics and Astronautics, University of Washington, Seattle, Washington, 7 March 2008.

[4] Adaptive sampling with underwater gliders: Trajectory optimization, feedback stabilization, and operational implementation. *Ocean Dynamics and Prediction Seminar*, Naval Research Lab, Code 7320, Stennis Space Center, Mississippi, 11 December 2007.

[3] Cooperative control of a UUV fleet: Adaptive ocean samping with underwater gliders fleet: Adaptive ocean samping with underwater gliders. Maritime Applied Physics Corporation, 7 November 2007.

[2] Cooperative control of a sensor network: Adaptive samping with autonomous underwater vehicles. *Signals and Systems Seminar*, Bradley Department of Electrical and Computer Engineering, Virginia Tech, Blacksburg, Virginia, 19 October 2007.

[1] Cooperative control of collective motion for ocean sampling with autonomous vehicles. *Horn Point Laboratory Special Seminar*, University of Maryland Center for Environmental Science, Cambridge, Maryland, 20 September 2007.

Contracts and Grants

U.S. Army/Office of Secretary of Defense, "Synthetic Collective Unmmanned Underwater Laboratory." $300,000, 1 September 2009–31 August 2010, PI.
DeepQuest, LLC (ONR STTR), "Optical Flow and Electroreception for Underwater Motion Coordination and Homing." $37,500, 29 June 2009–25 January 2010, co-PI.
National Science Foundation, "Targeting Observations of Tropical Cyclones using Cooperative Control of Unmanned Aircraft." $275,000, 15 September 2009–14 September 2012, co-PI.
Office of Naval Research, "Autonomous Motion Coordination of Unmanned Naval Platforms in a Dynamic Flowfield." $600,000, 1 August 2009–31 July 2012, PI.
University of Maryland (Minta Martin Award), "Cooperative Control of Autonomous Vehicle Swarms in a Dynamic Environment." $60,000, 1 September 2008–31 August 2009, PI.

Fellowships, Prizes, and Awards

2006–2007 Harold W. Dodds Honorific Fellowship, Princeton University
2006 IEEE Conf. Decision and Control Best Paper in Session Award, IEEE Control Systems Society
2004–2007 Graduate Research Fellowship, National Science Foundation
2004, 2006 Luigi Crocco Award for Teaching Excellence, Princeton University
2002–2006 Gordon Y. S. Wu Fellowship, Princeton University
2002–2005 Associated Member of Pew Program in Biocomplexity, Princeton University
2002–2004 National Defense Science and Engineering Graduate Fellowship, U. S. Department of Defense
2002–2004 Draper Fellowship (declined), Draper Lab/Massachusetts Institute of Technology
1997 Henry Prentiss Becton Prize for Excellence in Engineering and Applied Science, Yale University
1997 Graduated *magna cum laude* with distinction, Yale University

Reviewing Activities for Journals and Other Publications

Automatica, IEEE Control Systems Magazine, IEEE Trans. on Automatic Control, J. Guidance, Control, and Dynamics, IEEE Trans. on Robotics, SIAM J. on Applied Dynamical Systems, J. of Marine Systems, IEEE Trans. on Aerospace and Electronic Systems, Int. J. of Robust and Nonlinear Control, IEEE J. Oceanic Engineering, J. Nonlinear Science, Physical Review E, Dynamics of Continuous, Discrete and Impulsive Systems, IEEE Conf. Decision and Control, American Control Conf., IEEE Int. Conf. Robotics and Automation, IFAC World Congress, IEEE Multi-conference on Systems and Control.

Teaching, Mentoring, and Advising

Courses taught

2008–present, ENAE 301, Dynamics of Aerospace Systems
2008–present, ENAE 743, Applied Nonlinear Control of Aerospace Vehicles

Advising–Academic

2008–present, Advisor, *ESTEEM Research Mentoring Program*
2007–present, Design Review Panelist, *Robotics@Maryland Autonomous Underwater Vehicle Team*
2007–2009, Mentor, *Inventis: Academy of Engineering Leadership*

Advising–Research

Graduate Students

2009–present, Seth Napora
2009–present, Rochelle Mellish
2008–present, Cameron Peterson
2008–2009, Sonia Hernandez, M.S. (UT-Austin) *Three-dimensional motion coordination in a time-varying flowfield*
2007–present, Sachit Butail

Undergraduate Students

2009–present, Awais Raza
2008–present, David Warshawsky
2008–present, Kamala Shetty
2009, Nitin Sydney (UMD) *A micro-UUV testbed for bio-inspired motion coordination.*
2007–2009, Sarah Beal (AAI Corp.) *Image processing for autonomous coordination of an underwater vehicle fleet.*
2007–2009, Seth Napora (UMD) *Onboard Feedback Control for Autonomous Navigation of an Unmanned Submarine.*
2007–2008, Stephanie Petillo (MIT/WHOI) *Evaluation of the Coordinated Sampling Performance of Underwater Gliders in Strong and Variable Currents: A Simulated Case Study in the Chesapeake Bay.*
2007–2008, Adam Reese (GE Aviation) *System Identification of an Automatic Depth Controller on a Small Unmanned Submarine.*

Visiting Students

2009, Zohair Asmail (Thomas Wootten HS)
2009, Christian Aller (Aachen University of Applied Science, Germany)
2009, India Jacobs (MD Space Grant/Morgan State)
2008–2009, Forrest Ingram-Johnson (Eleanor Roosevelt HS/Bowie State)

Service

Professional

2009, Session co-chair, 2009 American Control Conf., St. Louis, Missouri (Cooperative Control)
2009–present, Member ASEE
2008–present, Member, Guidance, Navigation & Control Technical Committee, AIAA
2008, Session chair, 47th IEEE Conf. Decision and Control, Cancun, Mexico (Multi-agent Motion Planning)
2008, Reviewer, Directorate for Engineering Proposal Review Panel, NSF
2008, Reviewer, Aeronautics Scholarship Review Panel, NASA
2007–present, Member, AIAA (Professional Member 2007, Senior Member 2008)
2007–present, Member, SIAM
2006, Session co-chair, 45th IEEE CDC, San Diego, California (Swarms and Collective Behavior)
2002–present, Member, IEEE (Student Member 2002, Member 2007)

Campus

2009, Member, Search Committee (Asst. Dir. Undergrad. Studies), Department of Aerospace Engineering
2008–present, Member, Merit Review Committee, Department of Aerospace Engineering
2008, Volunteer, Faculty Staff Move-In Program, U. Maryland
2008, Member, GN&C Graduate Prize Committee, Department of Aerospace Engineering
2007–present, Member, Undergraduate Committee, Department of Aerospace Engineering