

Eric Justh

Institute for Systems Research
A.V. Williams Bldg. Rm. 3111
University of Maryland
College Park, MD 20742

Phone: (301) 405-7413
E-mail: justh@umd.edu

FAX: (301) 405-6707
URL: www.isr.umd.edu/~justh

EDUCATION

Ph.D. in Electrical Engineering, Dec. 1998. University of Maryland, College Park. GPA: 4.0/4.0

Major: Controls.

Minor: Communications and Signal Processing.

Dissertation: Control of Large Actuator Arrays Using Pattern-Forming Systems.

MSEE, University of Maryland, College Park, 1994. GPA: 4.0/4.0

Thesis: Convergence Analysis of a Class of Networks of Nonlinear Coupled Oscillators.

BSEE, BS Math, University of Maryland, College Park, 1992. GPA: 4.0/4.0

Graduated Summa Cum Laude.

PROFESSIONAL EXPERIENCE

Assistant Research Scientist (50% appointment, May 2001-present)

Institute for Systems Research, University of Maryland, College Park, MD.

- Developed (in collaboration with P.S. Krishnaprasad) a model for multi-vehicle formation control based on gyroscopically interacting particles, using the language of curves and moving frames. Simple steering laws have been demonstrated to give rise to formations, and for pairs of particles, Lyapunov functions have been found which guarantee global convergence and non-collision. We have also studied (in collaboration with F. Zhang) obstacle-avoidance and boundary-following laws based on similar principles.
- In on-going work (in collaboration with P.S. Krishnaprasad), simple steering laws to achieve motion camouflage have been found, and a finite-time analysis was used to assess their performance. Although our investigation was motivated by biology, this work has strong connections to missile guidance.
- The multi-vehicle formation work has an essential experimental component, which is divided between the Intelligent Servosystems Lab (ISL) within the Institute for Systems Research and the Electronic Warfare Division at the U.S. Naval Research Laboratory. We are collaborating with NRL to develop a Piccolo (small UAV) autopilot hardware-in-the-loop simulation testbed, for the ultimate purpose of achieving formation flight with a team of Dragon-Eye (meter-scale) UAVs. Within the ISL, a hovercraft testbed is being used both as a teaching device and as an aid in addressing such practical issues as combining inertial sensing with GPS, performing real-time control over wireless links, etc.

Senior Scientist (part-time, Jan. 2001-present)

Microcircuit Design, Inc., College Park, MD.

- Design, simulation, layout, and experimental testing of novel high-frequency (>1GHz) analog VLSI circuits for communications and signal processing applications.
- Primary accomplishment (in collaboration with government personnel) was the development of a wide-band analog CMOS channelizer circuit with novel on-chip feature-detection processing for a class of signals of importance in electronic surveillance. The resulting system would be sufficiently compact and low-power to fly on unmanned aerial vehicles, and the radiation-hardened process used would allow it to be deployed in space, as well.

Post-Doctoral Research Associate (Jan. 1999-May 2001)

Institute for Systems Research, University of Maryland, College Park, MD. Work performed both at the University of Maryland and at the Intelligent Optics Laboratory of the U.S. Army Research Laboratory, Adelphi, MD.

- Helped to develop (in collaboration with colleagues at the Army Research Laboratory and the University of Maryland) a novel high-resolution wave-front measurement and control system with potential applications in phase-contrast microscopy, imaging through atmospheric turbulence, laser communications, and directed-energy systems.
- Performed optical experiments using lasers and spatial light modulators at the Army Research Laboratory.

Scientist/Electrical Engineer (part-time, 1995-2000)

SFA, Inc., Crofton, MD. Research in the area of analog VLSI circuits performed at the U.S. Naval Research Laboratory, Washington, DC.

Engineer/Engineering Technician (part-time, 1990-1995)

Naval Research Laboratory, Washington, DC. Variously a student employee and self-employed consultant through SFA, Inc., Crofton, MD.

HONORS AND AWARDS

1. Achievement Rewards for College Scientists (ARCS) scholarship recipient, 1996.
2. Institute for Systems Research Outstanding Graduate Student Award, 1996.
3. National Science Foundation Graduate Fellow, 1993.
4. Institute for Systems Research Graduate Research Fellow, 1992.
5. Phi Beta Kappa, 1992.
6. National Merit Scholar, 1988.
7. Maryland Distinguished Scholar, 1988.

PUBLICATIONS

Journal Papers:

1. E.W. Justh, P.S. Krishnaprasad, and M.A. Vorontsov, "Analysis of a high-resolution optical wave-front control system," *Automatica*, Vol. 40, pp. 1129-1141, 2004.

2. E.W. Justh and P.S. Krishnaprasad, "Equilibria and steering laws for planar formations," *Systems and Control Letters*, Vol. 52, pp. 25-38, 2004 (see also ISR TR 2002-38).
3. E.W. Justh and P.S. Krishnaprasad, "Pattern-forming systems for control of large arrays of actuators," *Journal of Nonlinear Science*, Vol. 11, No. 4, pp. 239-277, 2001.
4. M.A. Vorontsov, E.W. Justh, and L.A. Beresnev, "Adaptive Optics with Advanced Phase-Contrast Techniques: Part I. High-Resolution Wavefront Sensing," *Journal of the Optical Society of America A*, Vol. 18, No. 6, pp. 1289-1299, 2001.
5. E.W. Justh, M.A. Vorontsov, G.W. Carhart, L.A. Beresnev, and P.S. Krishnaprasad, "Adaptive Optics with Advanced Phase-Contrast Techniques: Part II. High-Resolution Wavefront Control," *Journal of the Optical Society of America A*, Vol. 18, No. 6, pp. 1300-1311, 2001.
6. E.W. Justh and F.J. Kub, "Feedback phase-shift compensation for adaptive interference cancellers," *Electronics Letters*, Vol. 36, No. 17, pp. 1503-1505, 2000.
7. E.W. Justh and F.J. Kub, "Analogue CMOS High-Frequency Continuous Wavelet Transform Circuit," *Electronics Letters*, Vol. 35, No. 1, pp. 4-5, 1999.
8. F.J. Kub and E.W. Justh, "Analog CMOS Implementation of High Frequency Least Mean Square Error Learning Circuits," *IEEE Journal of Solid-State Circuits*, Vol. 30, No. 12, pp. 1391-1398, 1995.

Conference Papers (refereed):

- 1.* E.W. Justh and P.S. Krishnaprasad, "Natural frames and interacting particles in three dimensions," *Proc. IEEE Conf. Decision and Control*, to appear, 2005 (see also arXiv:math.OA/0503390v1).
2. F. Zhang, E.W. Justh, and P.S. Krishnaprasad, "Boundary following using gyroscopic control," *Proc. IEEE Conf. Decision and Control*, pp. 5204-5209, 2004.
3. E.W. Justh and P.S. Krishnaprasad, "Steering laws and continuum models for planar formations," *Proc. IEEE Conf. Decision and Control*, Vol. 4, pp. 3609-3614, 2003.
4. E.W. Justh, P.S. Krishnaprasad, and M.A. Vorontsov, "Nonlinear Analysis of a High-Resolution Optical Wavefront Control System," *Proc. IEEE Conf. Decision and Control*, pp. 3301-3306, 2000 (also ISR TR 2001-6).
5. E.W. Justh and P.S. Krishnaprasad, "Analysis of a Complex Activator-Inhibitor Equation," *Proc. American Control Conference*, Vol. 3, pp. 1613-17, 1999 (also ISR TR 99-13).
6. E.W. Justh, P.S. Krishnaprasad, "A Lyapunov functional for the cubic nonlinearity activator-inhibitor model equation." *Proc. IEEE Conf. Decision and Control*, pp. 1404-1409, 1998 (also ISR TR 98-36).
7. E.W. Justh and P.S. Krishnaprasad, "Convergence Analysis of a Class of Networks of Nonlinear Coupled Oscillators." *Proc. IEEE Conf. Decision and Control*, pp. 1284-1289, 1995.

Conference Papers (not refereed):

- 1.* E.W. Justh and P.S. Krishnaprasad, "Analysis of a High-Resolution Optical Wavefront Control System," *Proc. Conf. on Information Sciences and Systems*, Vol. 2, pp. 718-723, 2001 (also ISR TR 2002-5).
2. M.A. Vorontsov, E.W. Justh, and L.A. Beresnev, "Advanced phase-contrast techniques for wavefront sensing and adaptive optics," in *High-Resolution Wavefront Control: Methods, Devices, and*

*INVITED PAPER

- Applications II, J.D. Gonglewski, M.A. Vorontsov, and M.T. Gruneisen, eds., *SPIE Proc.*, Vol. 4124, pp. 98-109, 2000 (also ISR TR 2001-7).
3. E.W. Justh, M.A. Vorontsov, G.W. Carhart, L.A. Beresnev, and P.S. Krishnapasad, "Adaptive wavefront control using a nonlinear Zernike filter," in High-Resolution Wavefront Control: Methods, Devices, and Applications II, J.D. Gonglewski, M.A. Vorontsov, and M.T. Gruneisen, eds., *SPIE Proc.*, Vol. 4124, pp. 189-200, 2000 (also ISR TR 2001-5).
 4. G.W. Carhart, M.A. Vorontsov, and E.W. Justh, "Opto-electronic Zernike filter for high-resolution wavefront analysis using a phase-only liquid-crystal spatial light modulator," in High-Resolution Wavefront Control: Methods, Devices, and Applications II, J.D. Gonglewski, M.A. Vorontsov, and M.T. Gruneisen, eds., *SPIE Proc.*, Vol. 4124, pp. 138-147, 2000 (also ISR TR 2001-2).
 5. M.G. Ancona, J.B. Boos, and E.W. Justh, "Modeling of Ultra- Low-Power AlSb/InAs HEMT-RITD Circuits," *Proc. Int. Conf. Indium Phosphide and Related Materials*, pp. 130-134, 2000.
 6. F.J. Kub, E.W. Justh, and B. Lippard, "Self-calibrating Hybrid Analog CMOS Co-Site Interference Canceller," *Proc. IEEE MILCOM Conference*, Vol. 2, pp. 1051-1054, 1999.
 7. E.W. Justh and F.J. Kub, "Analog CMOS High-Frequency Continuous Wavelet Transform Circuit," *Proc. IEEE International Symposium on Circuits and Systems*, Vol. 2, pp. 188-191, 1999.
 8. F.J. Kub and E.W. Justh, "Analog CMOS Implementation of High Frequency Least Mean Square Error Learning Circuits," *Proc. IEEE International Solid-State Circuits Conference*, pp. 74-75, 1995.
 9. F.J. Kub and E.W. Justh, "High Frequency Analog Circuits Implementing Tapped Delay Lines and the LMS Algorithm," *Proc. Long Island Adaptive Antenna Systems Symposium*, pp. 121-123, 1994.
 10. F.J. Kub, E.W. Justh, F.M. Long, and K.K. Moon, "High-Frequency Adaptive Learning Element," *Proc. Government Microcircuits Applications Conference (GOMAC)*, pp. 291-294, 1992.

Technical reports, preprints

1. E.W. Justh and P.S. Krishnapasad, "Steering laws for motion camouflage," preprint, 2005 (arXiv:math.OC/0508023).
2. E.W. Justh, *Control of Large Actuator Arrays Using Pattern- Forming Systems*. Institute for Systems Research Ph.D. Thesis report, Ph.D. 98-6, 1998.
3. E.W. Justh, P.S. Krishnapasad, and F.J. Kub, "Convergence Analysis and Analog Circuit Applications for a Class of Networks of Nonlinear Coupled Oscillators." ISR Technical Report, TR 96-37, 1996.
4. E.W. Justh. "Convergence Analysis of a Class of Networks of Nonlinear Coupled Oscillators." ISR M.S. Thesis report, MS 94-11, 1994.

PRESENTATIONS

At other conferences, meetings, and workshops:

- 1.* E.W. Justh, invited speaker at the Institute for Pure and Applied Mathematics (IPAM)

*INVITED PRESENTATION

- workshop on “Swarming by Nature and by Design,” Feb. 27 - Mar. 3, UCLA, 2006.
- 2.* E.W. Justh, P.S. Krishnaprasad, and F. Zhang, “Formations from gyroscopic interactions,” presented at the SIAM Conference on Applications of Dynamical Systems, Snowbird, UT, May 23, 2005.
 3. E.W. Justh, P.S. Krishnaprasad, “Swarms in three dimensions,” poster presented at Tech 2004, University of Maryland, College Park, Mar. 19, 2004.
 - 4.* E.W. Justh and P. S. Krishnaprasad, “Swarms, curvature, and convergence,” presented at the Workshop on Future Directions in Nonlinear Control of Mechanical Systems, University of Illinois, Urbana-Champaign, Oct. 4, 2003.
 5. E.W. Justh and P.S. Krishnaprasad, “Swarms, curvature, and convergence,” poster presented at Research Review Day, University of Maryland, College Park, Mar. 21, 2003.
 6. E.W. Justh and P.S. Krishnaprasad, “Simple control laws for UAV formations,” poster presented at the Multi-Robot Systems Workshop, Naval Research Laboratory, Washington, DC, Mar. 17-19, 2003.

For funding sponsors:

1. E.W. Justh, P.S. Krishnaprasad, and F. Zhang, “UAV formations in 3D,” Center for Communicating Networked Control Systems MURI Review, Boston University, Nov. 23, 2004.
2. E.W. Justh and P.S. Krishnaprasad, “Swarms, curvature, and convergence,” Center for Communicating Networked Control Systems MURI Review, Boston University, Oct. 20-21, 2003.
3. E.W. Justh and P.S. Krishnaprasad, “UGV formation control demo,” Naval Research Laboratory, Washington, DC, Nov. 25, 2002.
4. E.W. Justh and P.S. Krishnaprasad, “Steering Laws and Equilibria for Planar Formations,” Dynamics and Control of Agile Formations, Review of Annual Progress, AFOSR Theme Project on Cooperative Control, UMCP, Oct. 25, 2002.
5. E.W. Justh and P.S. Krishnaprasad, “UAV formation control with pulsed communication,” poster presented at the AFOSR Dynamics and Control Workshop, Pasadena, CA, August 12-14, 2002.
6. E.W. Justh and P.S. Krishnaprasad, “UAV formation control with pulsed communication,” Center for Communicating Networked Control Systems MURI review meeting, Boston University, August 7, 2002.
7. E.W. Justh and P.S. Krishnaprasad, “Simple control laws for UAV formation flying,” Naval Research Laboratory, June 27, 2002.
8. E.W. Justh and P.S. Krishnaprasad, “Pulsed communication for networked UAVs,” Center for Communicating Networked Control Systems MURI kickoff meeting, Boston University, July 30-31, 2001
9. E.W. Justh, P.S. Krishnaprasad, M.A. Vorontsov, G.W. Carhart, and L.A. Beresnev, “High-resolution optical wave-front estimation and control,” Center for Dynamics and Control of Smart Structures MURI Review, Harvard University, Oct. 24, 2000.

*INVITED PRESENTATION

10. E.W. Justh, G.A. Kantor, and P.S. Krishnaprasad, "Patterns and Control," Center for Dynamics and Control of Smart Structures MURI Review, Harvard University, Nov. 15-16, 1999.

Other presentations:

1. M.G. Ancona, A. Snow, and E.W. Justh, "Wireless Microsensors and Chemical Mapping for IED Detection," DARPA/MTO Workshop on Standoff Detection of IEDs (Improvised Explosive Devices), Nov. 16, 2005.
2. E.W. Justh, P.S. Krishnaprasad, and F. Zhang, "Coordination teams of Agile Unmanned Vehicles," NATO Electronic Warfare meeting, Arlington, VA, Oct. 27, 2005.
3. E.W. Justh, P.S. Krishnaprasad, and F. Zhang, "Formation control of unit-speed vehicles," Aberdeen, MD, May 18, 2004.
4. E.W. Justh, P.S. Krishnaprasad, and F. Zhang, "Swarms in three dimensions," MURI05 proposal planning meeting, Harvard University, Oct. 1, 2004.
5. E.W. Justh and P.S. Krishnaprasad, "The Intelligent Servosystems Laboratory," and "UAV Formation Flight," briefing for Honeywell, University of Maryland, College Park, Nov. 21, 2003.
6. E.W. Justh and P.S. Krishnaprasad, "Planar steering laws and UAV formations," Johns Hopkins University Applied Physics Laboratory, Laurel, MD, Oct. 27, 2003.
7. E.W. Justh and P.S. Krishnaprasad, "UAV formation flight," briefing for In-Q-Tel, University of Maryland, College Park, Oct. 7, 2003.
8. E.W. Justh and P.S. Krishnaprasad, "Planar steering laws and UAV formations," ISR Student-Faculty Colloquium presentation, University of Maryland, College Park, April 29, 2003.
9. E.W. Justh and P.S. Krishnaprasad, "UAV formation control with pulsed communication," Intelligent Automation Inc., Rockville, MD, September 23, 2002.
10. E.W. Justh and P.S. Krishnaprasad, "High resolution wave-front sensing and control," NASA Goddard and University of Maryland Technical Summit, College Park, Maryland, April 23, 2002.
11. E.W. Justh, P.S. Krishnaprasad, M.A. Vorontsov, G.W. Carhart, and L.A. Beresnev, "High-resolution optical wave-front sensing and control," ISR Systems Lecture, UMCP, Sept. 28, 2001.

PATENTS

1. M.A. Vorontsov, E.W. Justh, L.A. Beresnev, P.S. Krishnaprasad, and J.C. Ricklin, "Wave-front Phase Sensors Based on Optically or Electrically Controlled Phase Spatial Light Modulators for Wavefront Sensing and Control," U.S. Patent number 6,911,637, 2005.
2. F.J. Kub and E.W. Justh, "Analog continuous wavelet transform circuit," U.S. Patent number 6,448,909, 2002.
3. F.J. Kub and E.W. Justh, "Continuous-time adaptive learning circuit," U.S. Patent number 5,781,063, 1998.

PROFESSIONAL MEMBERSHIP AND SERVICE

1. Professional membership
 - Member, IEEE (Control System Society)
2. Reviewer for proposals
 - U.S. Army Research Office
 - U.S. Civilian Research and Development Foundation
3. Reviewer for archival journals
 - IEEE Transactions on Automatic Control
 - Automatica
 - SIAM Journal on Control and Optimization
 - Physics Letters A
 - Journal of the Franklin Institute
4. Reviewer for conferences
 - IEEE Conference on Decision and Control
 - American Control Conference
 - IEEE International Symposium on Circuits and Systems

UNIVERSITY SERVICE

1. Chair, ISR Facilities and Services Committee, Fall 2005 - Spring 2006.
2. ISR Facilities and Services Committee, Fall 2004 - Spring 2005.

GRADUATE STUDENT SUPERVISION

Co-advisor, Zachary R. Kulis (M.S., expected 2006)

Topic: Hovercraft motion control. An RC model hovercraft instrumented with a small inertial measurement unit (IMU), Bluetooth wireless communication, Cricket indoor position sensing, and a shaft encoder (for the thrust fan) is used as a testbed for addressing high-speed vehicle control issues. Filtering of the IMU and Cricket data, control law implementation, and “pilot” interface, are implemented using dSpace, Simulink, and custom C++ code, which run off-board and communicate with the hovercraft over the Bluetooth link. Control laws are developed using a rigid-body model of the hovercraft. Among the issues being addressed are: combining IMU and (Cricket or GPS) position measurements to produce state-variable estimates of sufficiently high quality for feedback control; studying convergence of feedback laws for various equilibria and relative equilibria for the (ideal) nonlinear hovercraft model; simulating the (actual) hovercraft using measured parameters (such as mass and moment of inertia), Bluetooth communication latencies, Cricket and IMU errors, etc., to compare to experiments; and incorporating “pilot” input in an effective way.