

KARTIK B. ARIYUR

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EDUCATION

PhD	<i>Mechanical and Aerospace Engineering</i>	UC San Diego, 2002
MS	<i>Mechanical and Aerospace Engineering</i>	UC San Diego, 1999
BTech	<i>Mechanical Engineering</i>	Indian Institute of Technology Madras, India, 1996

HONORS AND AWARDS

Expert panelist—Innovation and Problem-Solving	NASA-Purdue Workshop Convergent Data Science Solutions to Safer Systems, 12 July 2017
Invited lecture—The Problem of Autonomy	University of Illinois, Urbana Champaign, Oct 28 2016
Hot topic speaker—Creating more Moore’s laws	San Diego Venture Summit, September 2015
IEEE-CSS Conference Editorial Board	Appointed, June 2013
IEEE-CSS Technical Committee on Power Generation	Invited, January 2011
Invited lecture—Sensing for Navigation	Texas A&M, Aerospace Eng., April 22 2010
Invited lecture—Energy management	Lehigh University, Mechanical Eng., 16 April 2010
Guest seminar—Optimum seeking	Varian Semiconductor, January 2009
Marquis’ Who’s Who in the World, Science	2008-present
Marquis’ Who’s Who in America	2007-present
SAE Power Systems Conference Outstanding Paper Award	2004
Honeywell Technical Achievement Award	2003

PERSONAL SUMMARY

From the beginning of my graduate studies, my work has focused on building *autonomy* into a variety of systems, i.e., ensuring that systems perform with predictable safety or energy efficiency in uncertain operating conditions. I have tackled questions relevant to society with rigor, succeeding sometimes, and coming up with negative results at other times. My work on extremum seeking control used in dozens of industries, my pilot filtering algorithms at Qualcomm running in cell phones worldwide, my health monitoring algorithms for gas turbine engines running in 70% of commercial aircraft APUs (auxiliary power units) worldwide, main engines in regional jets, and the Joint Strike Fighter, all enable autonomous operation of engineering systems. My research straddles most engineering disciplines, as seen from my publications (with 1212 Google citations) and patents in industry (17 issued and several more pending). This is because measurement, estimation therefrom, and feedback control loops based on these are common to most scientific disciplines, from engineering through physics, biology and economics. To solve these problems, I have collaborated with engineers from every continent (papers and patents with researchers from the US, several Asian, African, and European, countries). My group’s research at Purdue has laid out the framework for safe smart grid renewable integration, maturing solar power to that of traditional power sources, modernizing traditional navigation, making it possible for large scale UAV autonomous operations, and increasing the energy efficiency of hydraulic machines. My current work on lidar traffic tracking aims to make gathering of traffic data autonomous, and work on the use of magnetic mapping has attained indoor geolocation to within 20cm. In the course of work on oscillation attenuation for hydraulic machines and developing requirements for health monitoring-adaptive control integration for the USAF, we have obtained several fundamental insights into the conditions for engineering systems to run autonomously, some of which are under review.

HIGHLIGHTS — 3 BOOKS, 2 BOOK CHAPTERS, 16 JOURNAL PAPERS, 51 CONFERENCE PAPERS, 17 PATENTS ISSUED, CITATIONS: ISI—145, GOOGLE—1212

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FUNDING—NSF-CCEFP, GOOGLE, AFRL, HONEYWELL, AEP, THORNBERRY LLC, INDOT, DOT, MELLON FOUNDATION (MY SHARE \$600K)
INDUSTRIAL COLLABORATION—LOCKHEED MARTIN, UTOPIA COMPRESSION, ACADEMY OF AERONAUTICS, TERRAFORE

SERVICE

Organizer	TRIZCON 2018@Purdue University	2018
Associate Editor	IEEE Control System Letters, February 2017—present	
Technical Editor	International Journal of Adaptive Control and Signal Processing, 2005-present	
Program Committee	American Control Conference, 2008—present (most years)	
Program Committee	IEEE Conference on Decision and Control, 2014--present	
Program Committee	IEEE/SAE/ACM/IFAC Connected Vehicles Las Vegas 2013, Vienna, Austria, 2014	
Program Committee	IEEE SysCon 2014, Ottawa, Canada, 2014	
Program Committee	4th International Conference on Intelligent Robotics and Applications, Aachen, Germany, 6 - 9 December 2011	2011
Program Committee	IEEE Multi-Conference on Systems and Control, Denver, CO, 2011	
and Organizer of Invited Session on Autonomous Navigation: Sensing and Control		
Program Committee	Hybrid Systems Computation and Control, Santa Barbara, CA, 2006	
DOE Technical Review panels		2009, 2010, 2015, 2017
NSF Review Panel		2009, 2012
Dept. of State Review panel	Iraq Scientist Fellowship Program, 2011	
Professional memberships	ASME, IEEE, AIAA, Institute of Navigation, SIAM	

PROPOSALS

SAMMS

NOVEL APPROACHES FOR INTEGRATED CONTROLS WITH THERMAL
MANAGEMENT SYSTEMS (TMS) AND POWER

(AFRL, 2016)

PURDUE (FUNDING—TOTAL \$1.75M/MY SHARE \$800K)

- TSCAN—LIDAR TRAFFIC SCANNER FOR COLLECTING REAL-TIME TRAFFIC DATA (INDOT, CO-PI) (2014)
- EQUITABLE WATER POLICY USING BIG DATA (MELLON FOUNDATION, PI) (2014)
- GUARANTEED LIDAR-AIDED MULTI-OBJECT TRACKING AT ROAD INTERSECTIONS (DOT, CO-PI) (2014)
- ADAPTIVE GUIDANCE AND CONTROL ISHM INTEGRATION REQUIREMENTS STUDY (AFRL, PURDUE CO-PI, 3 YEARS) (2012)
- AUGMENTATION OF CELL PHONE GEOLOCATION VIA MAGNETIC MAPPING AND VIRTUAL PEDOMETRY (GOOGLE, PI) (2012)
- ACTIVE VIBRATION DAMPING OF HYDRAULIC MACHINES (NSF-CCEFP, CO-PI) (2012)
- SELF-CALIBRATING GYRO (THORNBERRY LLC, CO-PI) (SPRING 2011)
- PREDICTION MODEL FOR GRID POWER CONSUMPTION (AEP, CO-PI) (SPRING 2011)
- SMART GRID CONTROLLERS (HONEYWELL ACS, PI) (FALL 2010)
- INTRODUCING ENERGY METHODS INTO BIOLOGY (PRF, PI) (2009)

Honeywell

OAV-II, Organic Air Vehicle-II

(2005)

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- Agency: **DARPA**
- Contributed portion on path planning and collision avoidance that Honeywell eventually worked on **HURT, Heterogeneous Urban Reconnaissance Surveillance Target Acquisition** (2003)
- Agency: **DARPA**
- Wrote the control portions of the proposal that Honeywell eventually worked on **WNSIA, Wireless Network for Secure Industrial Applications** (2002)
- Agency: **DOE**
- Contributed to portion on control over wireless sensor networks

RESEARCH EXPERIENCE AT SAMMS

- Integration of aerospace gas turbine engine with thermal management and power** (2016—present)
- Health monitoring algorithms for Big Vehicle Data** 2017-present

RESEARCH EXPERIENCE AT PURDUE

Traffic Tracking with LiDAR (DoT, INDoT) (October 2013 – present)

- Calibration of Lidar with Inertial Unit
- Self Calibration of Lidar
- Constrained tracking of traffic and background estimation
- Collaboration with Civil Engineering, Prof. Tarko's group.

2 journal papers in process, 1 conference presentation; 1 MS thesis in progress

Control of Energy Systems (Honeywell, AEP, Terrafore) (October 2008 – present)

- Determining the sweet spots for renewable energy sources through combining financial instruments with real time energy management and local power sources.
- Find out optimal deployment strategies for renewable sources to minimize grid transients
- Finding the conditions for safe operation of the smart grid under market mechanisms
- Control of solar thermal plants with life cycle constraints
- 2 journal papers accepted, 1 in process, 1 book chapter, and 3 conference papers; 1 PhD completed

Sensors for Navigation (Thornberry LLC, Google) (Purdue, August 2008 – present)

- Obtain orientation and position measurements without GPS or gyroscopes—use only magnetometers, cameras for sun angle, and accelerometers for the g-vector.
- Rigorous techniques for LIDAR-based scene recognition and relative navigation
- The use of gait models for odometry with Inertial Units
- Self Calibrating gyroscopes
- 5 journal papers in process and 9 conference papers
- 5 MS theses completed + 3MS and 1 PhD theses in progress

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Autonomous Path and Mission Planning (startup) (Purdue, August 2008 – present)

- Developed collision free Integrated Surveillance and Reconnaissance using multiple UAVS and minimal human involvement
- Developed performance guarantees in the presence of sensor, actuator and map errors.
- 1 journal paper, 2 in process, and 5 conference papers; 1 MS thesis and 1 PhD thesis completed and 1 PhD thesis in progress

Adaptive Control (startup, NSF, AFRL) (Purdue, March 2009 – present)

- Showed that persistency of excitation conditions can be systematically designed through an extremum seeking approach
- 3 journal papers in process, and 3 conference papers; 1 PhD Thesis completed, and one in progress.

Security Systems (startup, Lockheed Martin) (Purdue, March 2009 – present)

- Determined the Nash equilibrium in a security game for both the defense and the criminals in the case of N layers of security and M criminals in collusion.
- Also found optimal randomization and feedback strategies for security system settings to minimize breaches.
- Collaboration with Lockheed Martin San Diego
- 2 conference papers

RESEARCH EXPERIENCE (prior work)

Personal Navigation (Honeywell Intl. Inc., October 2007 – August 2008)

- Project funded by Honeywell Aerospace — GPS denied navigation for first responders and soldiers
- Detection of motion modes (e.g., walking, crawling) and stride models for pedometry in those modes

Quantum Control (Honeywell Intl. Inc., October 2007 – December 2007)

- Project funded by Honeywell Aerospace — survey for sensing applications of quantum effects/control
- Discovered two major possible research directions — stabilizing known phenomena across wider temperature range and discovering potential functions that would permit analytic solutions to the governing equations

Analysis and Design of GPS Receivers(Honeywell Intl. Inc., March 2006 – August 2008)

- Project funded by Honeywell Aerospace — Analysis and Synthesis for avionics GPS receivers
- Stability and performance analysis of GPS tracking loops
- Design of GPS software defined receiver for the L5 signal

GPS Denied Navigation (Honeywell Intl. Inc., January 2006 – December 2007)

- Project funded by Honeywell Aerospace — ensuring GPS-like accuracy without GPS availability
- Estimating rotation and translation from stereo vision through maximum likelihood methods
- Analysis of the benefit of adding the inputs of various sensors to the navigation system (e.g., radar, lidar)

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USUKITA (Honeywell Intl. Inc., November 2006 – May 2007)

- Project funded by US DoD and UK MoD — theory for wireless networks
- Optimization theoretic framework for practical network capacity bounds

Distributed Intelligence Technology (Honeywell Intl. Inc., January 2006 – March 2007)

- Project funded by Honeywell ACS — integrating sensors into a wireless surveillance network
- Built upon results from real-time camera tracking to make higher level wireless bandwidth allocation feasible

Real Time Surveillance (Honeywell Intl. Inc., February 2005 – December 2005)

- Project funded by Honeywell Security — designing autonomous target tracking with Pan-Tilt-Zoom cameras
- Decentralized control and handoff system designed
 - Nonlinear control laws with global exponential tracking except in a small region near the camera
 - Novel use of a rangefinder (ultrasonic or laser) in conjunction with cameras

Path Planning (Honeywell Intl. Inc., October 2005 – December 2005)

- Project funded Honeywell Aerospace — analysis of path planning methods
- Determined limits of various methods and developed efficient implementation of Laplacian path planning
- Laplacian Path Planning used in DARPA OAV-II demonstration

DARPA SEC, Software Enabled Control (November 2004 – May 2005, Honeywell Intl.)

- Project funded by DARPA — multi-UAV coordinated mission control and autonomous target tracking
- Mission objectives: Persistent surveillance, autonomous target tracking and handoff, eyes on target request
 - Discretization of urban battle space using planar Voronoi diagrams at different altitudes
 - Using vehicle navigation limits to determine traversable graphs
 - One dimensional optimal control of UAVs on the graphs to give traverse times
 - Mixed Integer Linear Programs to solve for vehicle resource allocation

Local Area Augmentation System (October 2004 – December 2005, Honeywell Intl. Inc.)

- Project funded by the FAA — providing GPS corrections to landing aircraft
- Worked on Health Monitoring for the LAAS receivers
- Set thresholds (based on probability distributions with dimension up to 30) based on false detection rate
 - Will be used on LAAS systems worldwide

Analysis of Health Monitoring in Gas Turbine Engines (September 2004 – December 2004, Honeywell Intl. Inc.)

- Project funded by Honeywell Engines — cost benefit analysis of health monitoring on Gas Turbine engines
- Determined limits to monitoring benefits based on sensor reliability

Stabilization and Safety Verification of Hybrid Systems (January 2003 – January 2005, Honeywell Intl. Inc.)

- Project funded by NASA Ames — designing control laws and verifying safety of the resulting system
- Control synthesis and verification done for a NASA life support system

Wireless Datalink Maximization (Honeywell Intl. Inc., October 2003 – December 2003)

- Positioning autonomous vehicles to maximize the wireless datalink between them
- Involved simulation test-bed with two ray model and design of stable dynamic optimization

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Obstacle Avoidance via Radar Feedback (Honeywell Intl. Inc., June 2003 – August 2003)

- Simple feedback laws for real-time avoidance of unmapped obstacles by unmanned vehicles

Aerodynamic Modeling (Honeywell Intl. Inc., November 2002 – May 2003)

- Development of modified lifting line theory for prediction of dynamic ground effect for fixed-wing aircraft

Predictive Trend Monitoring (Honeywell Intl. Inc., September 2002 – December 2003)

- Fault prediction via statistical trending for gas turbine engines — *Patent issued*
- Statistical characterization of parameter trends, and determination of thresholds for faults and degradation rates
- Being used on Honeywell Auxiliary Power Units in thousands of airplanes around the world

Adaptive Filtering (Qualcomm Inc., September 2001–August 2002)

- Development, testing and implementation of adaptive filtering algorithms — *Patents filed*
- Currently in use in all CDMA chipsets sold around the world

Pulsed Detonation Engines (UC San Diego, 2002)

- Regulation of equivalence ratio profiles in pulsed detonation engines in a cold-flow experiment

Compressor Instability Control (UC San Diego, 2002)

- Near-optimal stable operation of deep-hysteresis aeroengine compressors under large disturbances

Control of Formation Flight (UC San Diego, 2001)

- Extremum seeking control for optimizing the position of the trailing aircraft in formation flight for minimum power demand. The design is robust to existing plant nonlinearities, and allows rapid convergence of the trailing aircraft position to an optimal position in the upwash field of the leading aircraft, promising significant saving of fuel consumption (up to 20%)

Multiparameter Extremum Seeking and Slope Seeking (UC San Diego, 1999-2000)

- Development of a linear SISO stability test for multiparameter extremum seeking (the method involves online extremization of a plant output with respect to its inputs through feedback)
- Derivation of systematic design guidelines to satisfy the stability test
- Development of *slope seeking*, a new adaptive control technique that allows a plant to operate at a certain slope of its input-output map. The results include a rigorous design algorithm with stability and performance guarantees

Combustion Instability Control (UC San Diego; United Technologies Research Center (UTRC), East Hartford, CT, 1998)

- Model validation for UTRC combustor models using experimental data
- Participation in UTRC efforts in extremum seeking control of combustion instabilities
- Development of an averaged model for thermoacoustic instabilities in a gas turbine combustor, and its identification from experiments
- Nonlinear identification of combustion dynamics from experimental data

Helicopter Noise Control (University of Maryland, College Park, 1997)

- Active control of blade vortex interaction noise on a helicopter blade element – Problem formulation, design of feedback controls for noise attenuation, and development of an adaptive scheme for noise cancellation, with proof of stability by the method of averaging and testing through simulation

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PUBLICATIONS

Books

1. "Navigation with Signals and Constraints of Opportunity," Elsevier, to appear in May 2017.
2. "Hierarchical TRIZ Algorithms," Larry Ball, Kartik B. Ariyur and Paul Dwyer, *3mpub.com*, 2007.
3. "Real-Time Optimization by Extremum Seeking Control," K. B. Ariyur and M. Krstic, John Wiley & Sons, NY, October 2003. **Citations: ISI N/A Google 413**

Reports

1. "TScan: Stationary LiDAR for traffic and safety studies—Object detection and tracking (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2016/24)," A. P. Tarko, K. B. Ariyur, M. A. Romero, V. K. Bandaru, and C. G. Lizarazo. West Lafayette, IN: Purdue University. <http://dx.doi.org/10.5703/1288284316347>, 2016.

Book Chapters

1. "Utility Scale Solar Power with Minimal Energy Storage," Q. Luo and K. B. Ariyur, *Solar Radiation*, Elisha B. Babatunde Ed., ISBN: 978-953-51-0384-4, InTech, Available from: <http://www.intechopen.com/books/solar-radiation/utility-scale-solar-power-with-minimal-energy-storage>
2. "Wikinomics Playbook," recognized as one of the principal contributors in this mass effort at mass collaboration organized by the authors of Wikinomics, <http://www.socialtext.net/data/workspaces/wikinomics/attachments/wikinomics:20080213154459-1-3411/original/the%20wikinomics%20playbook%2002%202008.pdf> 2008.

Journal Articles

1. "Robustness for Scalable Autonomous UAV Operations," S. Jung and K. B. Ariyur, *International Journal of Aeronautical and Space Sciences*, Vol. 18 Issue 4 pp. 767—779, December 2017.
2. "System Identification for Building Thermal Systems under the Presence of Unmeasured Disturbances in Closed Loop Operation: Theoretical Analysis and Application," D. Kim, J. Cai, J. E. Braun, and K. B. Ariyur, *Energy and Buildings*, <https://doi.org/10.1016/j.enbuild.2017.12.007> Available online: 14 December 2017.
3. "Automated Wireless Recharging for Small UAVs," S. Jung and K. B. Ariyur, *International Journal of Aeronautical and Space Sciences*, Vol. 18, Issue 3, pp. 588—600, September 2017.
4. "Compensating UAV GPS data accuracy through use of relative positioning and GPS data of UGV," S. Jung and K. B. Ariyur, *Journal of Mechanical Science and Technology*, Vol. 31, Issue 9, pp. 4471—4480, September 2017.
5. "Strategic Cattle Roundup using Multiple Quadrotor UAVs," S. Jung and K. B. Ariyur, *International Journal of Aeronautical and Space Sciences*, Vol. 18, Issue 2, pp. 315—326, May 2017.
6. "Using topography to aid smart phones geolocation," J. Kim, Y. Cui, and K. B. Ariyur, *Wireless Networks*, DOI 10.1007/s11276-017-1500-7, April 2017.
7. "System identification for building thermal systems under the presence of unmeasured disturbances in closed loop operation: lumped disturbance modeling approach," D. Kim, J. Cai, K. B. Ariyur, J. E. Braun, *Building and Environment*, pp. 169—180, Vol. 107, October 2016.
8. "Interval based celestial geolocation using a camera array," C. Liu, F. Yang, and K. B. Ariyur, *IEEE Sensors Journal*, pp. 5964 – 5973, Vol. 16, August 2016.
9. "An interdisciplinary approach for a water sustainability study," N. N. Kong, Q. Li, V. Merwade, K. B. Ariyur, *Applied Geography (Taylor and Francis)*, pp. 189—200, Vol. 2, May 2016.
10. "Control oriented concentrated solar power plant model," Q. Luo, K. B. Ariyur, A. K. Mathur, *IEEE Transactions on Control Systems Technology*, pp. 623—635, Vol. 24, March 2016.

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11. "Cell phone geolocation via magnetic mapping," Y. Cui and K. B. Ariyur, *Automatica*, vol.51, no. 1, pp. 70—79, January 2015. (to appear; available online at <http://www.sciencedirect.com/science/article/pii/S0005109814004993>).
12. "A hemispherical sun sensor for orientation and geolocation," J. Barnes, C. Liu, and K. B. Ariyur, *IEEE Sensors Journal*, vol. 14, no. 12, pp. 4423—4433, December 2014.
13. "Adaptive systems: history, techniques, problems and perspectives," W. S. Black, P. Haghi, and K. B. Ariyur, *MDPI Systems Journal*, vol. 2, no. 4, pp. 606—660, November 2014. (<http://www.mdpi.com/2079-8954/2/4/606>)
14. "Will the smart grid be stable: Approaches for supply-demand imbalances," Q. Luo and K. B. Ariyur, *IEEE Transactions on the Smart Grid*, vol. 5, no. 3, pp. 1361—1368, May 2014.
15. "Enabling operational autonomy for UAVs with scalability," S. H. Jung and K. B. Ariyur, *ALAA Journal of Aerospace Information Systems*, vol. 10, pp. 516—529, November 2013.
16. "A novel pressure feedback based adaptive control method to damp instabilities in hydraulic machines," D. Cristofori, A. Vacca, and K. B. Ariyur, *SAE International Journal of Commercial Vehicles*, vol. 5(2), pp. 586—596, 2012.

PRIOR PUBLICATIONS

17. "[A Nonlinear Hybrid Life Support System: Dynamic Modeling, Control Design, and Safety Verification](#)," S. Glavaski, D. Subramanian, K. B. Ariyur, R. Ghosh, N. Lamba, A. Papachristodoulou, *IEEE Transactions on Control System Technology*, vol. 15, pp. 1003-1017, 2007. **Citations: ISI 2 Google 6**
18. "[An Adaptive Algorithm for Control of Combustion Instability](#)", A. Banaszuk, K. B. Ariyur, M. Krstic, C. A. Jacobson, *Automatica*, vol. 14, pp. 1965-1972, 2004. **Citations: ISI 40 Google 79**
19. "[Slope Seeking: A Generalization of Extremum Seeking](#)," K. B. Ariyur and M. Krstic, *International Journal of Adaptive Control and Signal Processing*, vol. 18, pp. 1-22, 2004. **Citations: ISI 4 Google 15**
20. "[Aeroengine Prognostics via Local Linear Smoothing, Filtering and Prediction](#)," K. B. Ariyur and J. Jelinek, *SAE Transactions, Journal of Aerospace*, vol. 113, pp. 1773-1780, 2004. **(on 70% of commercial A/C APUs)**
21. "[Tailored Fuel Injection for Pulsed Detonation Engines via Feedback Control](#)," A. Aliseda, K. B. Ariyur, O. Sarrazin, J. C. Lasheras, M. Krstic, *ALAA Journal of Propulsion and Power*, vol. 19, pp. 917-921, 2003.
22. "[Formation Flight Optimization using Extremum Seeking Feedback](#)", P. Binetti, K. B. Ariyur, M. Krstic, F. Bernelli, *ALAA Journal on Guidance, Control and Dynamics*, vol. 26, pp. 132-142, 2003. **Citations: ISI 15 Google 45**
23. "[Extremum Seeking Control for Discrete-Time Systems](#)," J. Y. Choi, M. Krstic, K. B. Ariyur, J. S. Lee, *IEEE Transactions on Automatic Control*, vol. 47, pp. 318-323, 2002. **Citations: ISI 44 Google 78**
24. "[Feedback Attenuation and Adaptive Cancellation of Blade Vortex Interaction on a Helicopter Blade Element](#)", K. B. Ariyur and M. Krstic, *IEEE Trans. Control System Technology*, vol. 7, pp. 596-605, 1999. **Citations: ISI 20 Google 20**

Conference Papers

1. "LiDAR-based tracking of vehicles and pedestrians for traffic and safety studies," A. Tarko, M. Romero, V. Bandaru, K. B. Ariyur and C. Lizarazo, *Road Safety & Simulation International Conference*, paper no. 21, October 2017.
2. "Adaptive feedback linearization of a hypersonic vehicle using ES-MRAC," P. Haghi, W. S. Black, and K. B. Ariyur, *Proceedings of the 54th IEEE Conference on Decision and Control*, Osaka, Japan, December 2015.
3. "Behavioral modeling and optimal control of a PHEV mechanical drive system," N. M. Jali, R. T. Myer, R. A. DeCarlo, and K. B. Ariyur, *Proceedings of the 2015 American Control Conference*, pp. 2266—2271, Chicago, IL, July 2015.
4. "Electric machine vs mechanical brakes for traction control with real time extremum seeking control," S. S. Kuruppu, K. B. Ariyur, and N. A. Kulatunga, *Proceedings of the 40th Annual Conference of the IEEE Industrial Electronics Society*, Dallas, TX, October 2014.

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5. "Operational autonomy for UAVs with robustness," S. H. Jung and K. B. Ariyur, to appear in the Proceedings of the *ALAA Infotech@Aerospace 2013 Conference*, Boston, MA, August 2013.
6. "Operational and fuel efficiency for multi-UAV missions," S. H. Jung and K. B. Ariyur, to appear in the Proceedings of the *ALAA Infotech@Aerospace 2013 Conference*, Boston, MA, August 2013.
7. "Absolute orientation for a UAV using natural signals," C. Liu, S. H. Jung, and K. B. Ariyur, to appear in Proceedings of the *ALAA Infotech@Aerospace 2013 Conference*, Boston, MA, August 2013.
8. "System identification requirements for well-posed health monitoring in flight control systems," W. S. Black, J. Glassbrook, K. B. Ariyur and D. E. Adams, Oral only presentation in the *ALAA Infotech@Aerospace 2013 Conference*, Boston, MA, August 2013.
9. "Adaptive feedback linearization of nonlinear MIMO systems using ES-MRAC," P. Haghi and K. B. Ariyur, Proceedings of the *2013 American Control Conference*, Washington D.C. June 2013.
10. "Inductive or magnetic recharging for small UAVs," T. S. Lee, S. H. Jung, and K. B. Ariyur, *Proceedings the 2012 SAE Aerospace Avionics and Electronics Conference, 2012*, # 12AEAS—0087, Phoenix Arizona, November 2012.
11. "Quantifying the security of physical facilities: A game theoretic framework," R. Singh and K. B. Ariyur, *Proceedings of the 50th Annual Allerton Conference on Communications, Control and Computing*, pp. 1368—1373, Urbana-Champaign, IL, October 2012.
12. "Adapting first order nonlinear systems using extremum seeking," P. Haghi and K. B. Ariyur, *Proceedings of the 50th Annual Allerton Conference on Communications, Control and Computing*, pp. 1510—1516, Urbana-Champaign, IL, October 2012.
13. "Construction of a sun sensor for orientation and geolocation," C. Liu and K. B. Ariyur, *Proceedings of the 25th International Technical Meeting of The Satellite Division of the Institute of Navigation (ION GNSS 2012)*, pp. 3627—3635, Nashville, TN, September 2012.
14. "Compensating UAV GPS through use of relative positioning to a UGV," S. H. Jung, T. Mina, and K. B. Ariyur, *Proceedings of the 25th International Technical Meeting of The Satellite Division of the Institute of Navigation (ION GNSS 2012)*, Nashville, TN, September 2012.
15. "Augmenting cell phone geolocation via magnetic mapping," Y. Cui and K. B. Ariyur, *Proceedings of the 25th International Technical Meeting of The Satellite Division of the Institute of Navigation (ION GNSS 2012)*, 2469—2473, Nashville, TN, September 2012.
16. "Pedestrian navigation with INS measurements and gait models," Y. Cui and K. B. Ariyur, *Proceedings of the 2011 ION GNSS*, pp. 1409—1418, Portland OR, September 2011.
17. "Smart grid stabilization approaches," Q. Luo and K. B. Ariyur, *Proceedings of the 2011 IEEE Multi-Conference on Systems and Control*, 252—257, Denver, CO.
18. "Miniaturizing the spherical sundial: a hemispherical sensor for orientation and positioning with respect to point sources of light," J. Barnes and K. B. Ariyur, *Proceedings of the 2011 IEEE Multi-Conference on Systems and Control*, pp. 662—667, Denver, CO.
19. "On the Extremum Seeking of Model Reference Adaptive Control in Higher Dimensional Systems," P. Haghi and K. B. Ariyur, *Proceedings of the 2011 American Control Conference*, pp. 1176—1181, San Francisco, CA, June 29—July 1, 2011.
20. "Bounding Inertial Drift in Personal Navigation with Gait Dynamics," Y. Cui and K. B. Ariyur, *Proceedings of the IEEE International Systems Conference (SysCon 2011)*, pp. 28—33, Montreal, Quebec, Canada, April 3—6, 2011.
21. "Robustness for Large Scale UAV Autonomous Operations," S.-H. Jung and K. B. Ariyur, *Proceedings of the IEEE International Systems Conference (SysCon 2011)*, pp. 309—314, Montreal, Quebec, Canada, April 3—6, 2011.
22. "A Mathematical Foundation for TRIZ Methods," K. B. Ariyur, *Proceedings of the IEEE International Systems Conference (SysCon 2011)*, pp. 409—411, Montreal, Quebec, Canada, April 3—6, 2011.
23. "Scalable Autonomy for Unmanned Aerial Vehicles," S.-H. Jung and K. B. Ariyur, *Proceedings of the ALAA Infotech@Aerospace 2011 (Unleashing Unmanned systems)*, AIAA 2011-1655, St. Louis, MO, March 29—31, 2011.

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24. "Laplacian Path Planning: Implementaion and Generalizations," F. Yang and K. B. Ariyur, *Proceedings of the AIAA Infotech@Aerospace 2011(Unleashing Unmanned systems)*, AIAA 2011-1631, St. Louis, MO, March 29—31, 2011.
25. "Deception Robust Control for Automated Cyber Defense Resource Allocation," J. Lawson, R. Singh, M. Hultner, and K. B. Ariyur, *Proceedings of the IEEE Conference on Cognitive Methods in Situation Awareness and Decision Support (CogSIMA)*, pp. 56—59, Miami Beach, FL, February 22—24, 2011.
26. "Accelerometer Based Inertial Measurement Units," P. Gullipalli and K. B. Ariyur, *Proceedings of the ION International Technical Meeting*, pp. 244—249, San Diego, CA, January 24—26, 2011.
27. "The Safety of Autonomous Ground Vehicles as a Function of Sensing Capability," K. B. Ariyur and M. Mishra, *Proceedings of the ION International Technical Meeting*, pp. 1100—1101, San Diego, CA, January 24—26, 2011.
28. "Coalescence constraints for inkjet print mask optimization," J. William Boley, Kartik B. Ariyur, and George T-C. Chiu, *Proceedings of the 2010 IEEE-ASME Conference on Advanced Intelligent Mechatronics*, pp. 67—72, Montreal, Canada, July 6-9, 2010.
29. "Building thermal network model and application to temperature regulation," Qi Luo and Kartik B. Ariyur, *Proceedings of the 2010 IEEE Multi-conference on Systems and Control*, pp. 2190—2195, Yokohama, Japan, September 8-10, 2010.
30. "Motion estimation and navigational drift correction with LIDAR data," R. A. Balaebail and K. B. Ariyur, *Proceedings of the ION International Technical Meeting*, pp. 167—175, San Diego CA, January 25-27, 2010.
31. "Direct orientation and position measurements via magnetometers for miniature autonomous systems," Isabelle A. G. Laureyns, Gautam Sharma, and Kartik B. Ariyur, GNC Challenges for Miniature Autonomous Systems Workshop, Fort Walton Beach, FL, October 26-28, 2009.
32. "The use of natural signals for localization and navigation with application to centimeter sized UAVs," Gautam Sharma, Isabelle A. G. Laureyns, and Kartik B. Ariyur, *Proceedings of the 2010 American Control Conference*, pp. 27—32, Baltimore, MD, June 30-July 2, 2010.
33. "[Real-time energy management: cutting the carbon footprint and energy costs via hedging, local sources, and active control](#)," Qi Luo, Kartik B. Ariyur, and Anoop K. Mathur, *Proceedings of the 2009 ASME Dynamic Systems and Control Conference*, pp. 157—164, Hollywood CA, October 12-14, 2009.

PRIOR PUBLICATIONS

34. "Extremum seeking for model reference adaptive control," Kartik B. Ariyur, Subhabrata Ganguli, and Dale F. Enns, *Proceedings of the AIAA Conference on Guidance, Control and Dynamics*, AIAA 2009-6193, Chicago, IL, August 10—13, 2009.
35. "Region of attraction with performance bounds," Subhabrata Ganguli, Kartik B. Ariyur, and Dale F. Enns, *Proceedings of the AIAA Conference on Guidance, Control and Dynamics*, AIAA 2009-6191, Chicago, IL, August 10—13, 2009.
36. "On the Impact of Time Synchronization on Quality of Information and Network Performance," K. B. Ariyur, T. Schmid, Y. Yi, Z. Charbiwala, and M. B. Srivastava, *Second Annual Conference of ITA*, Adelphi, MD, September 2008.
37. "Autonomous tracking of a ground vehicle by a UAV," K. B. Ariyur and K. O. C. Fregene, *Proceedings of the American Control Conference*, pp. 669—671, Seattle, WA, 2008. **Citations: ISI 3 Google 15**
38. "[Analytic framework and QoS adaptive mechanisms for achieving transport capacity bounds in multi-hop statically routed IEEE 802.11 networks](#)," S. Varadarajan, Y. Yi, K. B. Ariyur, *Annual Conference of ITA*, Adelphi, MD, September 2007.
39. "Safety Verification of Controlled Advanced Life Support System using Barrier Certificates," S. Glavaski, A. Papachristidou, K. B. Ariyur, *In Hybrid Systems: Computation and Control*, LNCS 3414, pp. 306-321, Springer-Verlag, 2005.
40. "[Reactive inflight obstacle avoidance via radar feedback](#)," K. B. Ariyur, P. H. Lommel, D. F. Enns, *Proceedings of the 2005 American Control Conference*, pp. 2978-2982, Portland, Oregon, June 2005.

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41. "[Prediction of dynamic ground effect through modified lifting line theory](#)," K. B. Ariyur, AIAA 2005-4610, *Proceedings of the 23rd AIAA Applied Aerodynamics Conference*, Toronto, Ontario, Canada, June 2005.
42. "Control Design for a Hybrid Dynamical System: A NASA Life Support System," D. Subramanian, K. B. Ariyur, N. Lamba, R. Deshpande, and S. Glavaski, *In Hybrid Systems: Computation and Control*, LNCS 2293, pp. 570-584, Springer-Verlag, 2004.
43. "Slope Seeking and Application to Compressor Instability Control", K. B. Ariyur and M. Krstic, 2002 *IEEE Conference on Decision and Control*, pp. 3690-3697, Las Vegas, NV, Dec. 2002.
44. "Slope Seeking in Equilibrium Maps of Nonlinear Systems," K. B. Ariyur and M. Krstic, *Asian Control Conference*, Singapore, Sept. 2002.
45. "Multivariable Extremum Seeking Feedback: Analysis and Design," K. B. Ariyur and M. Krstic, *Mathematical Theory of Networks and Systems*, South Bend, IN, Aug. 2002.
46. "Control of Formation Flight via Extremum Seeking," P. Binetti, K. B. Ariyur, M. Krstic, F. Bernelli, *2002 American Control Conference*, pp. 2848-2853, Anchorage, AK, May 2002.
47. "Analysis and Design of Multivariable Extremum Seeking," K. B. Ariyur and M. Krstic, *2002 American Control Conference*, pp. 2903-2908, Anchorage, AK, May 2002. **Citations: ISI 6 Google 27**
48. "Stability of Extremum Seeking Control for a Class of Discrete-Time Systems," J. Y. Choi, M. Krstic, K. B. Ariyur, J. S. Lee, *40th IEEE Conference on Decision and Control*, pp. 1717-1722, Tampa, FL, Dec. 2001.
49. "Tuning of a Combustion Controller by Extremum Seeking: A Simulation Study," G. Schneider, K. B. Ariyur, M. Krstic, *Conference on Decision and Control*, pp. 5219-5223, Sydney, Australia, Dec. 2000.
50. "Identification of Averaged Dynamics of a Controlled Combustion Instability," K. B. Ariyur, A. Banaszuk, M. Krstic, *Conference on Decision and Control*, pp. 2017-2022, Sydney, Australia, Dec. 2000.
51. "A Case Study of Performance Improvement in Extremum Seeking Control," E. Elong, M. Krstic, K. B. Ariyur, *American Control Conference*, pp. 428-432, Chicago, IL, Jun. 2000.
52. "Active Control of Blade Vortex Interaction Noise on a Helicopter Blade Element," K. B. Ariyur and M. Krstic, *Proceedings of the SPIE Conference on Mathematics and Control in Smart Structures*, pp. 1053-1057, San Diego, CA, Mar. 1998.

GRADUATE COURSEWORK

Linear Control Theory, Covariance Control, Optimal Control, Nonlinear Control, Robust and Adaptive Control, Distributed Parameter Systems Control, Fluid Mechanics, Hydrodynamic Stability, Helicopter Aerodynamics, Smart Structures, Theoretical Mechanics, Dynamical Systems Theory, Nonlinear Analysis, Real Analysis, Functional Analysis, Partial Differential Equations.

TEACHING EXPERIENCE

Purdue University

Instructor	ME597 Innovation and Problem Solving (new course)	Fall 2017, Spring 2018
Instructor	ME584—System Identification (new course)	Fall 2011, 2012, 2013, 2014, 2015, 2016
Instructor 2017	ME578—Digital Control	Spring 2011, 2013, 2014, 2015, 2016,
Instructor	ME365—Measurement Systems	Fall-2008—Fall 2010, Spring 2012

KARTIK B. ARIYUR

Class Instructor (40 hrs)	TRIZ - Creativity as an exact science	Honeywell	2003-2007
Guest lecturer	Adaptive Control (MAE 282)	UC San Diego	Spring 2001
Grader	Nonlinear Systems (MAE 281A)	UC San Diego	Spring 2001
Teaching Assistant	Automatic Control (ENME403)	University of Maryland	Fall 1996

LEADERSHIP EXPERIENCE

IP & Copyright Committee	Purdue University	2012—2013	Member
ME Research Committee	Purdue University	2011—present	Member
MAE Graduate Student Association	UC San Diego	2000 – 2001	Vice-president
ME Class	IIT Madras, India	1994 – 1996	Representative

OTHER SERVICES

Mentoring

- PhD advisor—Sung-Hun Jung, Qi Luo, Fei Yang, Poorya Haghi, Yan Cui, William Black
- MS thesis advisor—Isabelle Laureyns, Gautam Sharma, Sung-Hun Jung, Yan Cui, John Barnes, Thomas Shyy, Priyank Gullipalli, Cheng Liu, William Black, Jason Glassbrook, Benoit Pigneur, Tamzidul Mina, Krishnakumar Sathyanarayanan, Vamsi Krishna Bandaru
- MS non-thesis-- Raj Balaebail, Mayank Mishra, Yu-Feng Hung, Rahul Suresh, Aaditya Gala, Chenhan Wang, Saikat Gupta, Michael Cluskey
- Undergraduate research—Jae Young Choi, Raymond Sutjiono, Peyton Lee, Garrett Baker, Fady Megalli, Ajinkya Shirude, Rohan Handa, Xuefeng Wang, Yujun Wu, Thomas Shyy, Karan Ahuja, Hao Wu, Ruxiao An, Weichao Wang, Chuang Wang, Wenbo Fan, Yahui Wang, Monirul Islam, Tamzidul Mina, Bilal Khan, Jae-Young Kim, Di Wang, Vikramaditya Vikramaditya, Zhouhun Wang, Sanket Mandhan, Abhishek Dhar, Yang Dong
- Faculty advisor for Purdue Lunabotics from Fall 2012
- GEARE Interns: Luis Arteaga, Qi Luo, Yan Cui and Xuefeng Wang
- Remote mentoring: Muhammad Saleem (MS student), TU Darmstadt, Germany, 2011

Before Purdue

- Graduate students (visiting UCSD, 1999-2001) — Ernest Elong (Cameroon), Georg Schneider (Germany), Joon-Young Choi (S. Korea), Paolo Binetti (Italy)
- Undergraduates (Univ. of Minnesota) — two students per year, 2002 through 2007
- Project mentoring at Honeywell
 - Helping project teams with TRIZ analysis to quickly obtain multiple conceptual solutions
 - Fire Sensing
 - APU starter motor program

Reviewer

- Proceedings of the IEEE
- IEEE Transactions on Automatic Control
- IEEE Transactions on Control Systems Technology
- IEEE Transactions on Control of Networked Systems
- IEEE Control Systems Magazine
- Automatica
- European Journal of Control (Elsevier)
- Environmental Modelling and Software (Elsevier)
- Combustion and Flame
- International Journal of Adaptive Control and Signal Processing

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- International Journal of Robust and Nonlinear Control
- Navigation, Journal of the Institute of Navigation
- Journal of Intelligent Material Systems and Structures
- PLOS One
- AIAA Journal of Propulsion and Power
- AIAA Journal of Guidance, Control, and Dynamics
- ASME Journal of Dynamic Systems, Measurement, and Control
- SIAM Journal of Control and Optimization
- IEEE Transactions on Biomedical Engineering
- ASME Journal of Solar energy Engineering
- IEEE Transactions on Robotics
- IEEE Transactions on Systems, Man, and Cybernetics
- IEEE Transactions on Plasma Science
- Mathematical Modelling of Systems
- IET Control Applications
- ASME/AIAA/IEEE/ION Conferences(ACC, CDC, DSCC, PLANS, ICRA and others)

Honeywell focus group on change management

Investigated means for improving engineering employee retention and made recommendations that were successfully implemented

Honeywell Problem Solving Wiki

Created a wiki for engineers from around the world to pose problems and tap global pool of expertise. Problem posing in TRIZ format.

The Selection of Research Problems

Qualitative and quantitative tools to help the Honeywell Strategy Research Group
Use of real options and impulse optimal control to enhance research portfolio performance

PATENTS

Purdue Invention Disclosures

1. System and Method for Urban UAV Surveillance—2103-ARIY-66520 (filed)
2. Adaptive Braking For Electric Vehicles– 2014-ARIY-66638
3. Control of Solar Thermal Plants to Maximize Component Life– 2014-ARIY-66639
4. Dynamic Calibration Of The Clark Sensor And Applications - 2014-ARIY-66640

Issued

1. "System and Method for simultaneous localization and map building," V. L. Bageshwar and K. B. Ariyur, US Patent No. 8478472, July 2, 2013.
2. "System and Method for simultaneous localization and map building," V. L. Bageshwar and K. B. Ariyur, US Patent No. 8340852, December 25 2012.
3. "Method for adjusting power at a node," K. B. Ariyur, US Patent No. 8200270, June 12 2012.

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4. "Method to operate a wireless network having a predictable and stable performance," K. B. Ariyur, Y. Yi, and S. Varadarajan, US Patent No. 8107387, January 31 2012.
5. "System and method for GNSS position aided signal acquisition," B. Schipper and K. B. Ariyur, US Patent No. 8106822, January 31 2012.
6. "Method and device for three dimensional path planning to avoid obstacles using multiple planes," K. B. Ariyur, E. Lautenschlager, and M. R. Elgersma, US Patent No. 8078399, December 13, 2011.
7. "System and method for autonomous object tracking," K. B. Ariyur, S. J. Bedros, V. Morellas, US Patent No. 7907750, March 15, 2011.
8. "Method and system for performing distributed outer loop power control in wireless communication networks," K. B. Ariyur, US Patent No. 7899483, March 1, 2011.
9. "Method and system for autonomous tracking of a mobile target by an unmanned aerial vehicle," K. B. Ariyur and K. O. C. Fregene, US Patent No. 7765062, July 27, 2010.
10. "[Real time planning and scheduling for a team of unmanned vehicles](#)," K. B. Ariyur, D. P. Johnson, D. Subramanian, US Patent No. 7603212, October 13, 2009.
11. "[System and method to perform stable distributed power control in a wireless network](#)," K. B. Ariyur, US Patent No. 7603136, October 13, 2009.
12. "[Trending system and method using window filtering](#)," K. B. Ariyur and J. Jelinek, US Patent No. 7580812, August 25, 2009.
13. "Tracking a moving object from a camera on a moving platform," K. B. Ariyur, S. J. Bedros, V. Morellas, US Patent No. 7541565, June 2, 2009.
14. "[Trending System](#)", K. B. Ariyur, US Patent No. 7474992, January 6, 2009.
15. "Method for optimizing wireless data link capacity between mobile vehicles," K. B. Ariyur, S. S. Kazi, and C. Bommalingaihanpallya, US Patent No. 7457619, November 25, 2008.
16. "Tracking a moving object from a camera on a moving platform," K. B. Ariyur, S. J. Bedros, V. Morellas, US Patent No. 7411167, August 12, 2008.
17. "[Pilot Estimation using prediction error method switched filters](#)," F. Abrishamkar, K. B. Ariyur, and K. Kreutz-Delgado, US Patent No. 7061882 B2, 13 June 2006.

Published Applications

18. "System and method for simultaneous localization and map building," V. L. Bageshwar and K. B. Ariyur, USPTO Publication No. 20100280699, November 4, 2010.
19. "Method for collision avoidance of unmanned vehicle with other aircraft," K. B. Ariyur, M. R. Elgersma, USPTO Publication No. 20100121574, May 13, 2010.
20. "Method and system for optimizing wireless networks through feedback and adaptation," K. B. Ariyur, S. Varadarajan, and Y. Yi, USPTO Publication No. 20090303888, December 10, 2009.
21. "Method to operate a wireless network having a predictable and stable performance," K. B. Ariyur, Y. Yi, and S. Varadarajan, USPTO Publication No. 20090245262, October 1, 2009.
22. "Method and device for three-dimensional path planning to avoid obstacles using multiple planes," K. B. Ariyur, E. Lautenschlager, and M. R. Elgersma, USPTO Publication No. 20090228205, September 10, 2009.
23. "System and method for GNSS position aided signal acquisition," B. Schipper and K. B. Ariyur, USPTO Publication No. 20090207076, August 20, 2009.
24. "Method and system for performing distributed outer loop power control in wireless communication networks," K. B. Ariyur, USPTO Publication No. 20090093267, April 9, 2009.
25. "Method and system for automatic path planning and obstacle/collision avoidance of autonomous vehicles," M. R. Elgersma, S. Dajani-Brown, K. O. C. Fregene, S. Pratt, K. B. Ariyur, USPTO Publication No. 20090088916, April 2, 2009.
26. "Method for adjusting power at a node," K. B. Ariyur, USPTO Publication No. 20090052371, February 26, 2009.

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27. "High fidelity target identification and acquisition through image stabilization and image size regulation," K. B. Ariyur, V. Morellas, S. J. Bedros, USPTO Publication No. 20080118104, May 22, 2008.
28. "Method and system for detection and remediation of sensor degradation in a monitoring device," K. O. C. Fregene, K. B. Ariyur, USPTO Publication No. 20080046213, February 21, 2008.
29. "[Static camera tracking system](#)," K. B. Ariyur, S. Bedros, D. W. Strelow, V. Morellas, USPTO Publication No. 20070286456, December 13, 2007.
30. "[Wireless sensor network with superconducting nodes](#)," K. B. Ariyur, A. K. Mathur, USPTO Publication No. 20070249503, October 25, 2007.
31. "[A calibration system](#)," K. B. Ariyur, A. K. Mathur, USPTO Publication No. 20070107487, May 17, 2007.
32. "[Controller for a life support system](#)," K. B. Ariyur, R. Ghosh, S. Glavaski-Radovanovic, N. Lamba, D. Subramanian, USPTO Publication No. 20060278753, December 14, 2006.
33. "[Map based trajectory generation](#)," K. B. Ariyur, D. Subramanian, USPTO Publication No. 20060235610, October 19, 2006.
34. "[Signal processing with certain materials](#)," K. B. Ariyur, USPTO Publication No. 20060160497, July 20, 2006.
35. "[Collision avoidance involving radar feedback](#)," K. B. Ariyur, P. Lommel, D. F. Enns, USPTO Publication No. 20060058931, March 16, 2006.
36. "[Prediction of dynamic ground effect forces for fixed wing aircraft](#)," K. B. Ariyur, USPTO Publication no. 20050197811, September 8, 2005.