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SYSTEMSOLUTIONS

THE INSTITUTE FOR SYSTEMS RESEARCH
A. JAMES CLARK SCHOOL *of* ENGINEERING

www.isr.umd.edu



Happy birthday, ISR!

We celebrate 30 years of systems research and education

director's MESSAGE

The National Science Foundation Engineering Research Center (ERC) program and the Institute for Systems Research (ISR) are both 30 years old! As one of the "original six" ERCs, ISR has not only survived but thrived. We've led the way in systems thinking and systems research for the past three decades and had a hand in many of the major developments in communications, control and computing—our original mission.

Throughout our history, ISR has been agile, sensing and taking advantage of new opportunities and synergies as they come to the fore. In addition to our original foci, we are now known for our strengths in model-based systems engineering, neuroscience, robotics, microsystems, wireless networks and cyber-physical systems.

We paused to celebrate in May, with a large gathering that honored our past and looked to the future. Close to 400 of our friends from industry and government, university officials, faculty, staff, students and alumni joined us for a day of keynote addresses, a large poster session and a convivial luncheon. University of Maryland President Wallace Loh even led the assembly in a rousing version of "Happy Birthday."

Now we're looking to the future with major new initiatives in the works that will come to fruition in the next year.

Several of our senior faculty have spent more than a year crafting a thought-provoking strategic research program that will guide ISR for the next five years. As I write this, we are in the midst of lively faculty discussion and commenting as the program is honed.

We are also in the midst of a University-mandated review of the Institute. A committee of faculty, staff and students has

been working for nearly a year to prepare a 100-page report covering the Institute's history, accomplishments, opportunities and challenges. This report is about to be reviewed by ISR faculty, the Clark School dean, and an external review committee that will convene early next year. The final review and recommendations then will be given to University of Maryland Provost Mary Ann Rankin.

ISR has been working with the Clark School development office to reach out to our alumni both locally and in the San Francisco Bay Area by hosting local events (see page 14) and making in-person visits. We are also working to establish an endowed Ph.D.-level student fellowship. You can learn more at www.isr.umd.edu/giving/ISR-Fellowships. I encourage you to consider making a generous donation to help future students.

Finally, in the spirit of ISR's long tradition of interdisciplinary research, this fall the University of Maryland launched a campus-wide Brain and Behavior Initiative. ISR, along with our colleagues in the Neuroscience and Cognitive Science program, played a catalyzing role in this effort. The initiative will integrate systems science and engineering with the methods of neuroscience and biology to bring about innovative tools and technologies. Learn more about this work on page 4.

I hope you'll join me in celebrating the work of ISR: always reviewing, planning and implementing for the future!

Best regards,



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Happy birthday to us!

As one of the "original six" Engineering Research Centers, ISR and the National Science Foundation ERC program share a 30th birthday this year.

Our May 2015 30th Anniversary event celebration honored our NSF founders, Maryland officials, and all the ISR directors, faculty, staff, students, alumni, and government and industry colleagues throughout our history.

We had such a great time that we've sprinkled photos from the event



ISR STAFF AND DIRECTOR REZA GHODSSI
WISH THE INSTITUTE A VERY HAPPY ANNIVERSARY!

throughout this issue of *System Solutions*. We hope you enjoy seeing the festivities and spotting folks you know. If you were one of the nearly 400 people in attendance, maybe you will even run into yourself. Enjoy!

ON THE COVER

ISR DIRECTORS (L-R) REZA GHODSSI, STEVE MARCUS, GARY RUBLOFF, JOHN BARAS AND EYAD ABED CUT THE 30TH ANNIVERSARY CAKE AT THE BIG CELEBRATION IN MAY.

Bergbreiter, Kanold part of MURI research teams

Associate Professor **Sarah Bergbreiter** (ME/ISR) and ISR-affiliated Associate Professor **Patrick Kanold** (Biology) are each members of five-year Multidisciplinary University Research Initiative (MURI) research teams announced by the Department of Defense in 2015.

Bergbreiter is participating in “Evolutionary Mechanics of Impulsive Biological Systems: Guiding Scalable Synthetic Design,” an Army Research Office MURI. Duke University is the lead institution; Maryland,

Stanford, Harvard, UMass Amherst and UC Irvine are also participating.

Kanold is part of “Understanding and Controlling the Coupled Electrical, Chemical and Mechanical Excitable Networks of Living Systems,” an Air Force Office of Scientific Research MURI led by the University of Maryland’s Wolfgang Losert (IREAP/IPST). John Fourkas (Chemistry/Biochemistry) is also on the team. Other universities participating include Arizona State, Johns Hopkins and UC Davis.

In total, University of Maryland researchers are involved with six of the 22 MURI teams announced by the Department of Defense in 2015. This ties Maryland with MIT and Stanford for being involved in the most MURIs this year.

“The University of Maryland’s outstanding performance in securing these MURI awards demonstrates our world class, interdisciplinary research expertise in science and engineering,” said the university’s Vice President for Research Patrick O’Shea.

Coming to bridges: Tiny networked robot inspectors

The declining structural integrity and safety of America’s bridges is a national concern. New ISR research is developing a network of tiny robots that will increase the frequency of inspections and improve problem detection and diagnosis.

Associate Professor **Nuno Martins** (ECE/ISR) is the principal investigator, and Associate Professors **Sarah Bergbreiter** (ME/ISR) and **Richard La** (ECE/ISR) are the co-PIs of “Designing semi-autonomous networks of miniature robots for inspection of bridges and other large infrastructures,” a three-year, \$850K grant that is part of NSF’s National Robotics Initiative.

According to the U.S. Department of Transportation, of the country’s 605,102 bridges, 64 percent are more than 30 years old and 11 percent are structurally deficient. These structural flaws are found, and repairs specified, primarily through visual inspection. Each inspection requires on-site evaluation by experts who spend many hours assessing the structure’s integrity.

The ISR researchers are creating a self-organizing network of small robots that will be able to remotely and routinely inspect complicated structures, like the assemblage of girders supporting a suspension bridge.

The robots will communicate wirelessly to coordinate and cooperate in the inspection. Whenever possible, they will report back

images and key measurements to experts for evaluation. Because they are both small and networked, the robots will be able to access tight spaces, operate under many kinds of weather conditions, and execute tasks without outside assistance for long periods of time.

Experts will be able to remotely supervise the robot network, which will reduce both cost and the time between on-site inspections.

The researchers are collaborating with Resensys, a Maryland Technology Enterprise Institute Technology Advancement Program company that specializes in remote bridge monitoring. Resensys President and CTO **Mehdi Kalantari** (EE Ph.D. 2005) is an assistant research scientist in the Electrical and Computer Engineering Department.

The Maryland State Highway Administration is a partner in testing the system.



SOMEDAY A NETWORK OF MINIATURE ROBOTS COULD PROVIDE ROUND-THCLOCK MONITORING OF THE INTEGRITY OF BRIDGES AND OTHER INFRASTRUCTURE.

Brain and Behavior Initiative brings together researchers from across the University of Maryland

Unlocking the workings of the human brain and how the brain influences behavior is a 21st century scientific frontier. Advances have galvanized brain research to a point where researchers are on the cusp of major scientific and technological advances, and the United States, Japan and European nations all have major “brain initiatives.”

The University of Maryland already has key engineering, neuroscience and computer science strengths related to brain research. In early 2014, researchers across campus began to meet around an interdisciplinary idea to help Maryland take advantage of this rapidly growing, promising field. ISR and the Neuroscience and Cognitive Science program were leaders in this movement, organizing a workshop attended by more than 150 Maryland faculty, writing a comprehensive report, and working with University of Maryland Provost Mary Ann Rankin on research, organizational and financial possibilities.

In fall 2015, the new campus-wide Brain and Behavior Initiative (BBI) was announced by the Provost. It includes three-year, \$1.8 million support from the Provost’s office, the Vice President of Research, and seven colleges: the A. James Clark School of Engineering; the College of Computer, Mathematical and Natural Sciences; the College of Behavioral and Social Sciences; the School of Public Health; the College of Education; the College of Agriculture and Natural Resources; and the College of Arts and Humanities.

The brain contains many mysteries: how it develops, maintains its health, struggles with disease, ages and works to produce complex behaviors. To solve these mysteries, tools and technologies need to be developed that can measure activity from the cellular level to complex behavior. The BBI aims to revolutionize brain research across disciplines by generating these tools. It also will develop novel approaches to image neuronal function, micro and nano system diagnostics and drug delivery

technologies as well as big data methods that push the frontiers of research.

Likewise, to advance brain research, engineers and material scientists will need to work with neuroscientists and psychologists to push the frontiers of measuring and assessing brain function. As Maryland researchers learned in the campus-wide workshop, this diverse expertise—from computer scientists to public health experts to performance artists—will help BBI break down the silos that keep researchers working in isolation and create a novel and integrated understanding of human behavior. The fact that seven diverse colleges at the university are offering financial support speaks volumes about the unique and truly interdisciplinary nature of the work.

BBI’s first initiative is a seed grant program that will fund innovative research ideas submitted by University of Maryland faculty teaming up across campus. The program began in fall 2015 and seed grant recipients will be announced in early 2016.

Imaging technologies, data analysis techniques hold promise for treating brain diseases

ISR-affiliated Associate Professor **Patrick Kanold** (Biology) is part of a research team developing new imaging technologies and data analysis techniques to better understand how large networks of brain neurons interact to process sensory information.

Funding comes from a three-year, \$1.7 million NIH grant, one of the first awarded through the national BRAIN Initiative led by NIH, DARPA, NSF and the FDA.

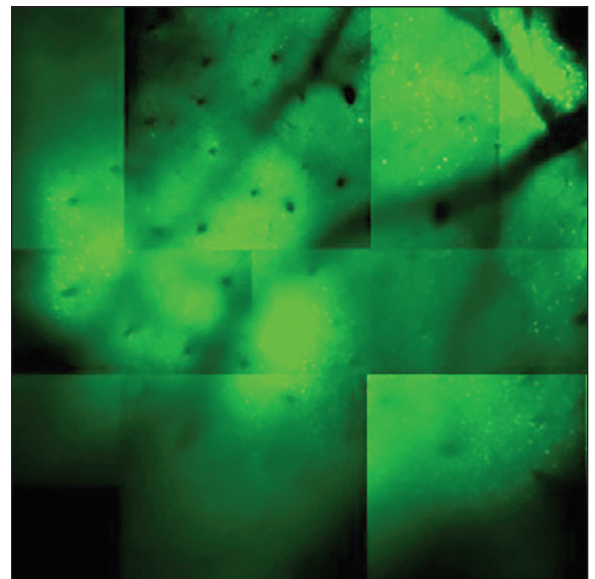
The research team focuses on the brain’s auditory cortex. Their work will help identify precise interactions between millions of nerve cells that enable humans to do things like make decisions and speak. Disorders such as schizophrenia, autism and epilepsy may be related to changes in these interactions.

“By investigating the influence of single neurons relative to key groups of neurons, we may be able to ultimately modify and control behavioral outcomes,” Kanold said. “This holds promise for correcting diseases like schizophrenia.”

The research team also includes Professor Wolfgang Losert (Physics); and Dietmar Plenz, chief of the Section on Critical Brain Dynamics at NIMH. Losert will develop approaches for distinguishing neuron crowd patterns to determine how they change from activity to activity. This will build on techniques to measure protein patterns Losert developed in collaboration with the National Cancer Institute.

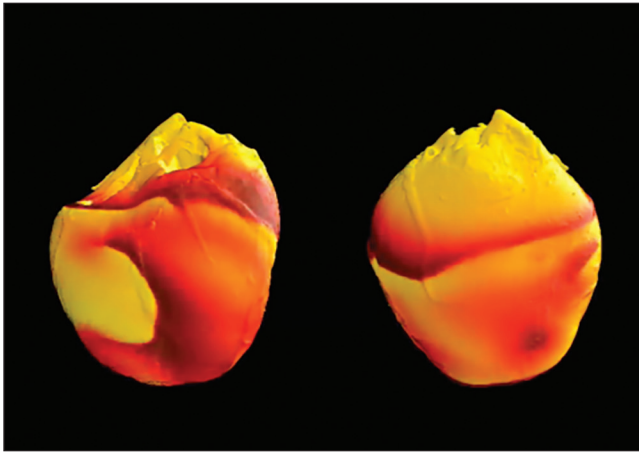
“There’s a big gap between what we want to do in brain research and the technologies available to make exploration possible,” said NIH Director Francis Collins. “These initial awards are just the beginning of an ambitious journey, and we’re excited about the possibilities.”

THERE’S MORE BRAIN RESEARCH NEWS ON PAGE 8.



IN VIVO 2-PHOTON CALCIUM IMAGING: WITH THIS METHOD PATRICK KANOLD AND HIS GROUP CAN IMAGE THE ACTIVITY OF HUNDREDS OF NEURONS OVER LARGE AREAS WITH SINGLE CELL RESOLUTION (EVERY ROUND SPOT IS A NEURON). KANOLD IS LOOKING AT CORTICAL MAPS OF STIMULUS FEATURES AND HOW THEY DEVELOP. —PHOTO: PATRICK KANOLD

Cleaveland part of 'CyberHeart' cyber-physical systems research



CYBERHEART IS A SOPHISTICATED DIGITAL PLATFORM FOR TESTING CARDIAC-CARE DEVICES—FROM EXISTING PACEMAKERS TO NEXT-GENERATION PROTOTYPES.

Imagine a day when a new pacemaker could be calibrated and tested using a patient's real heart data before the device is implanted in her body. Professor **Rance Cleaveland** (CS/ISR) is part of a multi-institutional team developing CyberHeart—a sophisticated digital platform used for patient-specific testing of current devices like pacemakers, as well as prototyping the next generation of implantable cardiac devices now under development. CyberHeart is a cyber-physical system that mimics a real heart and how it would react to a variety of stimuli from devices.

Cleaveland, an expert in the model-based testing of embedded software, is working to accelerate the development of improved implantable medical devices used in the treatment of heart disease.

"We believe these virtual platforms can be used to design, test and validate implantable medical devices faster and at a far lower cost than existing methods," Cleaveland says.

"Compositional, Approximate, and Quantitative Reasoning for Medical Cyber-Physical Systems" is a five-year, \$4.2 million NSF grant involving researchers from seven U.S. universities and centers.

The research group's approach combines patient-specific computational models of heart dynamics with advanced mathematical techniques for analyzing how these models will interact with cardiac medical devices. The

results can be used in a clinical setting to optimize device settings on a patient-by-patient basis.

"We're able to take a specific patient's history and then run a detailed analysis of how a device might work, interchanging different settings on the device and seeing the reactions, before the device is implanted in the patient," Cleaveland says.

For new devices under development, these same CyberHeart analytics can be used to detect potential

flaws early on during the device's design phase, before animal and human trials begin.

"We believe that our coordinated, multi-disciplinary approach—which balances theoretical, experimental and practical concerns—will yield transformational results in medical-device design and foundations of cyber-physical system verification," says Scott Smolka, a professor of computer science at Stony Brook University and the principal investigator of the project.

In addition to Smolka and Cleaveland—who co-directs the project—other researchers include Edmund Clarke, Carnegie Mellon University; Elizabeth Cherry, Rochester Institute of Technology; Flavio Fenton, Georgia Tech; Rahul Mangharam, University of Pennsylvania; Arnab Ray, Fraunhofer Center for Experimental Software Engineering; and James Glimm and Radu Grosu, Stony Brook University. Richard A. Gray of the U.S. Food and Drug Administration also is a key contributor.

NSF's cyber-physical systems efforts seek to develop state-of-the-art engineered systems built from and dependent on the seamless integration of computational and physical components.

A video of some of the early testing is available at go.umd.edu/cyberheart.

Seven ISR faculty prominent in NIFTI Center

Seven ISR faculty are playing major roles in the new Air Force Center of Excellence on Nature-Inspired Flight Technologies and Ideas (NIFTI). NIFTI conducts research into how animals move, navigate and use their senses, then creates solutions for challenging problems related to building small, remotely operated aircraft. NIFTI is funded by the Air Force Office of Scientific Research for up to \$9 million over six years.

Associate Professor **Pamela Abshire** (ECE/ISR) is working on tradeoffs between performance and resources in natural and engineered systems. ISR-affiliated Professor **Cynthia Moss** (JHU), contributes to multisensory integration guiding behavioral decision processes and flight control.

Associate Professor **Sarah Bergbreiter** (ME/ISR) is engineering robotics down to sub-millimeter sizes. Associate Professor **Timothy Horiuchi** (ECE/ISR) contributes neuromorphic analog VLSI design, sensorimotor neural computation, and robotics. Associate Professor **Nuno Martins** (ECE/ISR) conducts research in control and information theory and estimation.

ISR-affiliated Associate Professor **Miao Yu** (ME) works on bio-inspired systems, sensors and actuators and micro/nano systems. ISR Assistant Research Scientist **Susanne Sterbing-D'Angelo** researches sensorimotor specializations for complex flight behaviors in animals.

NIFTI is directed by Tom Daniel at the University of Washington.



INAUGURAL NSF ERC DIRECTOR LYNN PRESTON AND FORMER UNIVERSITY OF MARYLAND SYSTEM CHANCELLOR BRIT KIRWAN—BOTH WERE VITAL TO GETTING ISR OFF THE GROUND IN 1985.

Two new Maryland Robotics Center labs debut

Autonomy Robotics Cognition Lab, Robotics Realization Lab add to research capabilities

ARC Lab

The Autonomy Robotics Cognition (ARC) Lab brings together leading edge experts in systems engineering, autonomous robotics, computer vision, and cognitive computation.

In general, the lab works on problems relevant to cyber-physical systems. In the near future, such cognitive systems will collaborate with humans and will need to understand what humans are doing, interpret human action in real time and predict humans' immediate intention in complex, noisy and cluttered environments.



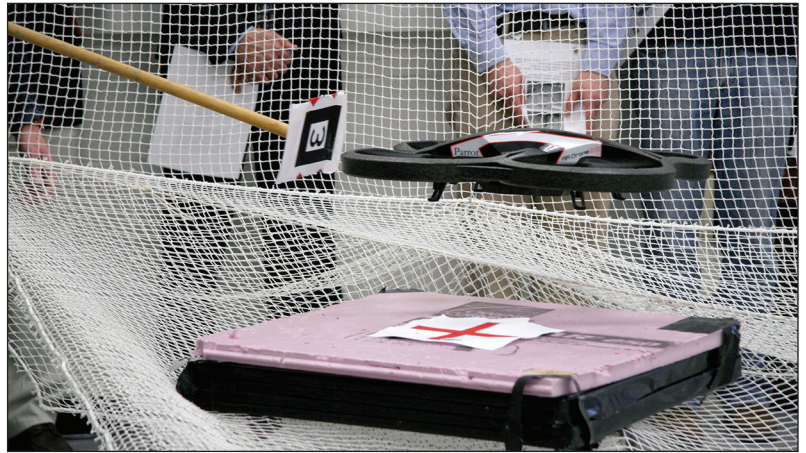
THIS BAXTER ROBOT HAS LEARNED TO MAKE SALAD.

The lab is part of both ISR and the University of Maryland Institute for Advanced Computer Studies (UMIACS). It is directed by Professor **John Baras** (ECE/ISR), ISR-affiliated Professor **Yiannis Aloimonos** (CS/UMIACS), UMIACS Associate Research Scientist Cornelia Fermüller (UMIACS) and Professor Don Perlis (CS).

The lab uses Baxter robots as platforms that can process scenes using computer vision and learn sequences of commands that they then imitate. In one recent experiment, the robots learned to make salad by watching a human do the same thing in a YouTube video. In another example, the robots watched a human in the lab pour liquids from different

bottles into a container, and then imitated the procedure. This work by Aloimonos and Fermüller received much media attention.

Quadcopters are used in another part of the lab to perform synchronized aerial maneuvers using only their own basic onboard sensors and cameras rather than external motion-tracking cameras. The experimenters follow model-based systems engineering methods to create modular software that can autonomously launch, fly and land the multiple aircraft. This work is under the direction of John Baras.



QUADCOPTERS RESPOND TO VISUAL CUES USING ONLY THEIR ONBOARD SENSORS.

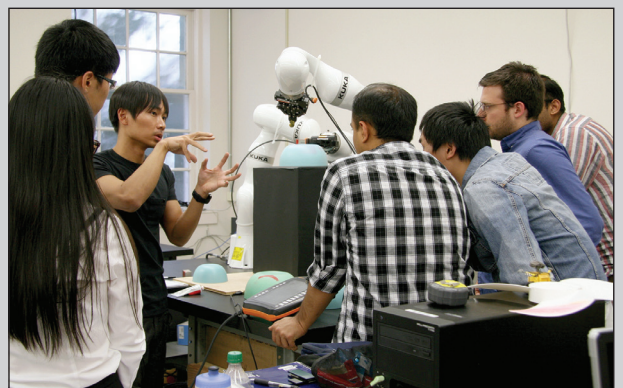
Robotics Realization Lab

The Robotics Realization Lab is a multi-user lab that offers space to both fabricate and test robots. It is intended to facilitate a thriving community of robotics researchers, from those working with industrial robots to those shrinking robots down to incredibly small

ROBOTS AND THE ARTS

The Maryland Robotics Center had two unusual opportunities to interact with the arts in 2015. In late spring, Robo Raven was exhibited at the 9th Biennale Internationale Design Saint-Etienne 2015, a major international design show in France. The exhibit's curator chose Robo Raven to participate in the exhibit because of its unique design and engineering.

In late September, the Taiwanese choreographer Huang Yi performed his signature work, dancing with a KUKA industrial robot, at the Clarice Performing Arts Center on campus. **S. K. Gupta** interviewed Yi on stage about the intersection of his art with robotics, and Yi also learned about the KUKA robots used in research at Maryland.

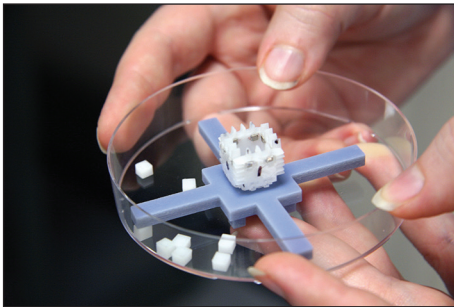


sizes. The lab director is Associate Professor **Sarah Bergbreiter** (ME/ISR).

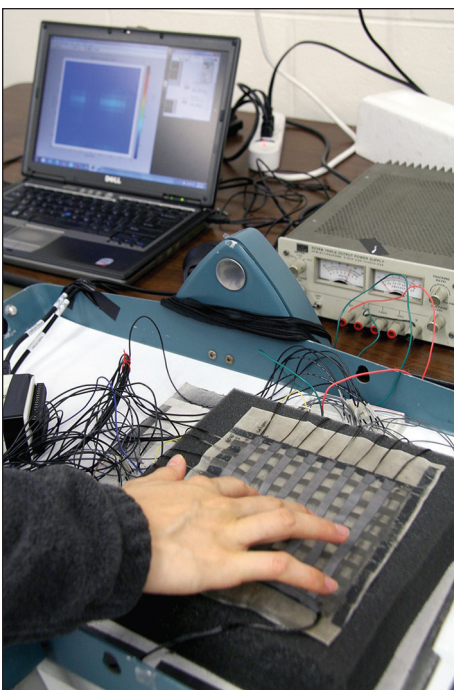
Equipment can be reserved by lab members who have received training. Equipment includes:

- Four-camera OptiTrack Prime 17w motion capture system
- uPrint SE Plus fused deposition modeling 3D printer
- Baxter humanoid research robot with two 7-axis arms, integrated cameras, sonar, torque sensors and direct programming access
- Milling, cutting, wire bonding and soldering stations, a fume hood, and more.

SEEN IN THE ROBOTICS REALIZATION LAB...



THIS CUBE COMES IN MANY SIZES—SOME AS SMALL AS A PENCIL POINT. ORIGINALLY FLAT, IT IS ABLE TO SELF ASSEMBLE THROUGH THE ATTRACTION OF BUILT-IN MAGNETS.



ONE DAY ROBOTS COULD FEEL THEIR SURROUNDINGS WITH THIS TOUCH-SENSITIVE 'SKIN' THAT INCORPORATES A GRID OF FLEXIBLE SENSORS.

Krishnaprasad, Justh suggest copying in social groups is governed by optimal control theory

Nature has provided herding animals and flocking birds with abilities to react to predator attacks and to sense risky features in their environment—like trees or cliffs—that might impede their defense. But how do these abilities work? What's going on inside individual animals and the group as a whole as they protect themselves with coordinated movements?

Research by Professor **P. S. Krishnaprasad** (ECE/ISR) and his former student **Eric Justh** (EE Ph.D. 1998), an electronics engineer at the Naval Research Laboratory, published this year in the *Proceedings of the Royal Society A* explores how an avoidance signal from a single animal closest to danger can quickly spread through the collective. In "Optimality, reduction and collective motion," the researchers developed mathematical models of optimal control that capture imitative behavior in a collective as if a "master clock" governs all group members.

"The nearly-in-unison movement of a herd of animals away from danger may be the result of rapid transfer of information in a collective," says Krishnaprasad. "An individual close to danger senses it and signals avoidance to others through an action such as turning. Signals need to propagate, and in this case, the flock itself is the medium through which such information spreads in a wave of activity arising from an optimality principle."

When engineers and biologists make models of flocks, they envision them as composed of individual agents (self-steering particles) with free will to control actions such as turning or escape based on perceptual feedback: what they sense is going on in the environment. A collaborator in Italy, Dr. Andrea Cavagna, shared three-dimensional position data from observations of large flocks of European starlings (numbering in the hundreds) displaying striking flight behavior. His team's analysis of the data investigates information transfer in a flock using Hamilton's equations arising from the application of statistical physics principles. The Maryland team formulated an optimal control problem for flocking and derived Hamilton's equations based on principles of optimality associated with Pontryagin and others.

"We have already used optimal control principles in solving inverse problems such as reconstructing smooth trajectories from sampled data of natural flocks," says Krishnaprasad. "We expect insights from optimal control could yield testable predictions on information transfer in some flocking events. This is work in progress."

These insights from the study of nature have practical implications. For example, they can be used to devise algorithms for collective behavior in robotics. Justh and Krishnaprasad's findings may lead to the creation of new algorithms for networked robots to work together on tasks such as vigilance. Recent work in ISR's Intelligent Servosystems Laboratory is pursuing these avenues of research.

Shamma, Espy-Wilson named to influential NIH advisory councils

Professor **Shihab Shamma** (ECE/ISR) was named to the National Institute of Health's National Deafness and Other Communication Disorders Advisory Council. The council advises the Secretary of Health and Human Services; the Director of the National Institutes of Health; and the Director of NIH's National Institute on Deafness and Other Communication Disorders. The council covers the conduct and support of research and research training, health information dissemination, and other programs having to do with disorders of hearing and other communication processes. This includes diseases affecting hearing, balance, smell, taste, voice, speech and language.

Professor **Carol Espy-Wilson** (ECE/ISR) was named to the National Institute of Health's National Advisory Council for Biomedical Imaging and Bioengineering. The council advises the Secretary of Health and Human Services; the Director of the National Institutes of Health; and the Director of NIH's National Institute of Biomedical Imaging and Bioengineering. The council covers the conduct and support of research, training, health information dissemination and other programs that address biomedical imaging, biomedical engineering and associated technologies and modalities with biomedical applications.

BRAIN RESEARCH

Simon continues 'auditory scene' research

Professor **Jonathan Simon** (Biology/ECE/ISR) continues his work on “the cocktail party problem,” how in an environment with many sounds and voices, people are able to concentrate on an individual voice and what it is saying.

Simon is the principal investigator of a five-year, \$1.5 million NIH grant, “Auditory Scene Analysis and Temporal Cortical Computations.”

When many people in a room are talking at the same time, our ears hear the mixed sounds of their voices. Sorting this sound mixture, or “auditory scene,” into individual voices is a profoundly difficult mathematical problem—but the human brain routinely accomplishes this task, often with little apparent effort.

How our brains do this is not well understood. And when this ability declines due to hearing loss or aging, we don't know which specific neural processing mechanisms are key to preserving the remaining function.

Simon will use magnetoencephalography-based temporal representations recorded from the human auditory cortex to investigate how complex auditory scenes are neurally encoded. He hypothesizes the auditory cortex employs a universal temporal neural encoding scheme, which underlies not only general auditory processing but also auditory scene segregation.

Simon will determine how the auditory cortex neurally represents speech in difficult listening situations. He also will investigate the detailed neural mechanisms by which the auditory cortex identifies and isolates individual speakers in a complex acoustic scene.

Waks, Shapiro receive NSF EAGER grant to test spintronic devices

Professor **Benjamin Shapiro** (BioE/ISR) is the co-PI on an NSF BRAIN EAGER grant, “Wireless Measurement of Neuronal Currents Using Spin-Torque Nano-Oscillators.” Associate Professor **Edo Waks** (ECE/IREAP) is the principal investigator.

The brain is a complex network of interconnected circuits that exchange signals in the

form of “action potentials,” which hold the key to understanding cognition and complex thought. Currently available non-invasive methods for probing neuronal activity are limited because they cannot achieve sufficient spatial or temporal resolution to observe individual action potentials from single neurons or small clusters.

Waks and Shapiro are developing a novel approach for non-invasive measurements that can read out individual action potentials across the entire brain. Their project takes advantage of recent advances in spintronic devices to create injectable nano-reporters. These nano-reporters will detect weak electrical signals in the brain and convert them to microwave signals that can be detected wirelessly outside the body using a spin-torque nano-oscillator.

This approach could ultimately lead to the first non-invasive technology capable of measuring activations of individual neurons and small-scale neuronal networks in primates and humans, and could have a major impact on the understanding of the inner workings of the brain and cognition. The approach also could have important clinical applications, particularly in neurological disorders and brain-machine interfaces.



KEYNOTE SPEAKERS AT THE 30TH ANNIVERSARY EVENT—TOP ROW: HARVARD AND ISR-AFFILIATED PROFESSOR ROGER BROCKETT; PROFESSOR P. R. KUMAR, TEXAS A&M UNIVERSITY. BOTTOM ROW: PROFESSOR RAYMOND ADOMAITIS (ChEBE/ISR); ISR FOUNDING DIRECTOR JOHN BARAS (ECE/ISR).

WIRELESS NETWORK RESEARCH

Ulukus furthers wireless network research with three NSF grants

Professor **Sennur Ulukus** (ECE/ISR) has received three NSF grants in the past year related to improving wireless networks.

In “Synergistic Exploitation of Network Dynamics and Knowledge Heterogeneity in Wireless Networks,” Ulukus is researching transformative approaches that could help commercial wireless systems make better use of the spectrum—a necessity as these networks serve more users and provide additional services.

Ulukus is exploiting interference as side information, developing new approaches that embrace interference through synergistic exploitation of feedback, network dynamics and network knowledge heterogeneity. She is characterizing the gain provided by feedback, and analyzing the scalability and dependence of such gains on network topology.

“Rechargeable Networks with Energy Cooperation” will make strides in the ability to harvest and transfer energy wirelessly, with

the goal of building a new breed of extended-lifetime wireless networks. Such networks could be deployed in challenging conditions and difficult locations. Applications range from enabling perpetual remote environmental and structural monitoring and surveillance, to on- and in-body networking for health monitoring, medical diagnosis and treatment. Nodes could harvest natural energy to continually recharge their batteries and could share energy with similar devices in the network.

Ulukus is calling on communication theory, optimization and networking to determine the optimum transmission, scheduling, reception and networking methods for such systems. Her team will determine optimum wireless energy transfer times and amounts to optimize the overall energy arrival profile at the energy receiving node.

"Foundations of Energy Harvesting Wireless Communications" continues Ulukus' work on devices that operate with energy harvested from the environment. Ulukus is establishing fundamental performance limits and design principles for wireless communication networks containing these devices.

Ulukus is identifying the randomness, intermittency, and causality of energy availability, and the uncertainty about the energy states of transmitters at receivers, as new ingredients to be incorporated in determining the fundamental performance limits of energy harvesting wireless communication systems. She will determine the information theoretic capacity of an energy harvesting link and the accompanying optimum coding and transmission scheme by incorporating energy harvesting constraints into the information theoretic capacity formulation.

Ephremides bridging wireless network theories; creating scalable networking

Professor **Tony Ephremides** (ECE/ISR) is the principal investigator for "Theoretical Foundation of Distributed Wireless Channel Access," an NSF grant that should significantly improve the energy and bandwidth efficiency of wireless systems.

Wireless networks tend not to be either energy or bandwidth efficient. Wireless channel access research has followed either a traditional information-theoretic approach that assumes perfect user coordination and ignores

the modularized network architecture, or a traditional network-theoretic approach that focuses on access control protocols and ignores the impact of the physical layer.

Ephremides' research bridges the gap between these two approaches by developing a theoretical foundation for channel access in distributed wireless systems. He is developing both a channel coding theory for physical layer distributed communication and a medium access control framework for distributed networking, where physical layer properties are efficiently exploited at the link layer.

In addition, Ephremides and his colleague Behnaam Aazhang at Rice University have received an NSF grant for "Service-Centric Architecture for Efficient Spectral Utilization in Wireless Networks," a fundamentally novel approach to address spectrum efficiency. They will develop a novel view of wireless networks that centers on virtual users and includes the evolving paradigms of social networks and service-based applications.

The goal is to expand the application base of wireless networks to include the development of realizable networks for scalable mobile health care, first responders, security applications, transportation, factory automation and robotics.

Ephremides and Aazhang will conceptualize and prove the theoretical foundations, as well as system level designs and algorithms necessary to bring these networks to fruition.

CYBER-PHYSICAL SYSTEMS RESEARCH

Cleaveland, Marcus developing cyber-physical systems models

Professor **Rance Cleaveland** (CS/ISR) is the principal investigator and Professor **Steve Marcus** (ECE/ISR) is co-PI of an NSF grant to develop new mathematical modeling techniques for cyber-physical systems.

"Compositional Modeling of Cyber-Physical Systems" will devise novel conceptual methods for assembling systems from subsystems, and for reasoning about the behavior of systems in terms of the behavior of their computational or physical subsystems.

The research will enable scientists and engineers to develop more realistic models of the systems they are designing, and to obtain greater insights into the eventual behavior of these systems without having to build costly prototypes.

Specifically, the researchers will develop the novel modeling paradigm Generalized Synchronization Trees (GSTs) into a rich framework for both describing cyber-physical systems and studying their behavior under interconnection.

Cleaveland and Marcus will develop an algebraic theory of composition for GSTs. Developing the theory involves five distinct but complementary endeavors. Standard models for cyber-physical systems are being encoded as GSTs in a semantically robust way; meaningful notions of composition and congruence are being described and studied algebraically; the interplay between behavioral equivalence and the preservation of system properties is being investigated; a notion of real-time (or clock time) is under consideration for GSTs; and GSTs are being assessed as modeling tools for practical design scenarios.

Fermüller, Baras, Aloimonos to help cyber-physical systems understand humans

UMIACS Associate Research Scientist Cornelia Fermüller is the principal investigator and Professor **John Baras** (ECE/ISR) and ISR-affiliated Professor **Yiannis Aloimonos** (CS/UMIACS) are the co-PIs on an NSF grant, "MONA LISA—Monitoring and Assisting with Actions."

Cyber-physical systems of the near future will collaborate with humans and will need to understand what the humans are doing, interpret human action in real time and predict humans' immediate intention in complex, noisy and cluttered environments.

This research will develop a new three-layer architecture, motivated by biological perception and control, to help cognitive cyber-physical systems understand complex human activities, specifically manipulation activities.

At the bottom layer are vision processes that detect, recognize and track humans, their body parts, objects, tools and object geometry. The middle layer contains symbolic models of human activity. It assembles through a grammatical description the recognized signal components of the previous layer into a representation of the ongoing activity. Cognitive control is at the top layer, deciding which parts of the scene will be processed next and which algorithms will be applied where. It modulates the vision processes by gathering additional

knowledge when needed, and controls attention by manipulating the active vision system to direct its sensors to specific places.

The feasibility of the approach will be demonstrated through developing a smart manufacturing system, called MONA LISA, which assists humans in assembly tasks. This system will monitor humans as they perform assembly tasks, recognize assembly actions, and determine whether they are correct. It will communicate to the human possible errors and suggest ways to proceed.

The research will be conducted in the Autonomy Robotics Cognition Laboratory.

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Principles for secure or private function computation

Professor **Prakash Narayan** (ECE/ISR) is the recipient of an NSF grant on "Secure and Private Function Computation by Interactive Communication." This project was developed collaboratively with his former student **Himanshu Tyagi** (EE Ph.D. 2013 alumnus), now an assistant professor at the Indian Institute of Science; and his former ISR Visitor **Shun Watanabe**, now an associate professor at Tokyo University of Agriculture and Technology.

The project takes an information theoretic approach to develop principles that govern secure or private function computation by multiple terminals that host user data. The goal of the terminals is to compute locally and reliably, a given function of all the possibly correlated user data, using an interactive communication protocol. The protocol is required to satisfy separate security and privacy conditions.

Rooted in information theory, estimation theory and theoretical computer science, a central objective of the research is to elucidate tradeoffs among computation accuracy, terminal security and user privacy.

Barg developing better ways to store 'big data'

Professor **Alexander Barg** (ECE/ISR) is the principal investigator for the NSF grant, "Efficient Codes and their Performance Limits for Distributed Storage Systems."

Large data centers and distributed storage systems play an ever-increasing role in everyday computational tasks. While a data center

should never lose data, industry statistics confirm that disk failures occur on a daily basis.

Barg's research is addressing efficient ways to store the huge amounts of data being generated and collected today. He is developing more efficient data management procedures for large-scale distributed storage systems. Barg will develop methods and ideas about error-correcting codes that will enable systems to provide better guarantees against data loss and reduce the amount of data that needs to be moved to enable information recovery after disk failures.

Barg also will use algebraic methods of constructing data encoding procedures as well as novel algorithms of data exchange and recovery to reduce the storage overhead needed to support the recovery procedures. This will enable tradeoffs between overhead and repair bandwidth, based on the concept of local recovery.

The project also addresses the problem of simultaneous recovery of data from multiple locations, enhancing data availability in the large-scale distributed storage systems that are a key component of the 21st century economy.

Paley: bio-inspired underwater sensing and control

Associate Professor **Derek Paley** (AE/ISR) is the principal investigator of "Bio-inspired Underwater Sensing and Control with Mechanosensitive Hairs," an Office of Naval Research grant to develop an underwater robotic perception and control system based on lateral line and vestibular systems in fish.

The closed-loop control system will use bio-inspired, multi-modal sensing. Emerging tools such as functional imaging will be used to help resolve the role of multi-modal sensing in behavior. Tools from comparative physiology, materials science, and dynamical control systems will be applied to solve the problem of closed-loop sensing and robotic control with artificial lateral line and vestibular organs.

Co-PIs on the grant are alumnus and Michigan State University Professor **Xiaobo Tan** (EE Ph.D. 2002, advised by **John Baras**); and Matt McHenry, an associate professor at the University of California, Irvine.

Miao Yu receives MIPS grant to develop medical sensors

ISR-affiliated Associate Professor **Miao Yu** (ME) is teaming with College Park-based

MedSense LLC to develop innovative, ultra-miniature fiber-optic pressure sensors for a wide range of applications in the medical industry with a \$135K grant from the Maryland Industrial Partnerships (MIPS) program.

MIPS has supported research projects with more than 500 different Maryland companies since 1987.

Khaligh developing electric vehicle charger/converter

Associate Professor **Alireza Khaligh** (ECE/ISR) continues his work on an "Integrated On-Board Universal SiC-based Fast Charging for Plug-In Electric Vehicles. He is working with Professor Patrick McCluskey (ME) on a NSF GOALI grant to design a charger compatible with all charging levels.

Using level-1 and level-2 low power charging at home overnight or during the day at the office with a 120VAC or 240VAC main connection can take 4-20 hours depending on available power and battery size. Khaligh and McCluskey are collaborating with Steven Rogers of Genovation, a Rockville, Md.-based electric car company, to overcome these limitations.

Khaligh also is the principal investigator for a Phase I MII Research and Development grant, "Integrated Power Electronic Charger/Converter for Electric Vehicles."



UNIVERSITY OF MARYLAND PRESIDENT WALLACE LOH LEADS THE GATHERING IN SINGING 'HAPPY BIRTHDAY' TO ISR.

Fellows

ISR Director **Reza Ghodssi** (ECE/ISR) was elected to three Fellow positions in the past year. He was named a Fellow of the American Vacuum Society “for outstanding leadership in microsystems technology achieved by combining knowledge of materials and processing, innovative device concepts, and diverse applications.” He was elected a Fellow of the Institute for Electrical and Electronics Engineers “for contributions to materials and processes for microsystems technologies.” He was elected a Fellow of the American Society of Mechanical Engineers “for design and development of microfabrication technologies and processes.”

Professor **John Baras** (ECE/ISR) has been named a Fellow of the American Association for the Advancement of Science “for distinguished contributions to the fields of systems and control, communication networks, network security, and leadership in establishing outstanding cross-disciplinary research and education programs.”

ISR-affiliated Professor **Jaydev Desai** (ME) has been named an American Society of Mechanical Engineers Fellow.

ISR-affiliated Professor **Alison Flatau** (AE) has been elected a Fellow of the American Institute of Aeronautics and Astronautics for her many years of service and her contributions in teaching, mentorship, research, innovation and commercialization of aerospace science and technology.

Plenary addresses

Professor **Carol Espy-Wilson** (ECE/ISR) was a plenary speaker at The College Board’s 2015 Diversity Conference: A Dream Deferred: The Future of African American Education. Espy-Wilson spoke on “A Change Must Come: African Americans and STEM.” The conference was developed to discuss new solutions, share best practices, and collaborate with colleagues to make a difference for African-American students.

Professor **Benjamin Shapiro** (BioE/ISR) gave a semi-plenary lecture on “Magnetic Control of Therapy to Hard-to-Reach Disease Targets,” at the 2015 American Control Conference. He spoke about challenges and progress in better understanding magnetic drug targeting.

Professor **Michael Ball** (BMGT/ISR) gave a plenary lecture on “Model Decom-

position and Integration: Case Studies from Urban Transit and Airline Planning Problems,” at the 2015 INFORMS Workshop on Transportation Science and Logistics in Berlin.

ISR-affiliated Professor **Steven Gabriel** (ME) gave a keynote address on “Energy in Quebec and Canada” at the 2nd Annual Trotter Symposium on Sustainable Engineering, Energy and Design. Gabriel also gave the Humboldt Lecture at the 2015 Berlin Conference on Energy and Electricity Economics (BELEC), where he talked about energy security issues in “Energy Insecurity: From Cologne to “Cowboyistan.”

Professional service

Professor **P. S. Krishnaprasad** (ECE/ISR) organized a full-day “Workshop on Geometry of Collective Behavior: Control, Dynamics and Reconstruction” at the 53rd IEEE Conference on Decision and Control in Los Angeles. The workshop provided a self-contained and structured perspective of advances in the study of collective dynamic behavior in nature and technology and introduced participants to a class of models and interaction strategies, associated control laws, and principles and algorithms for the discovery and synthesis of control laws that achieve collective behavior with a purpose.

Associate Professor **Alireza Khaligh** (ECE/ISR) was the program chair of the 2015 IEEE Applied Power Electronics Conference and Exposition, held in March. It is the leading conference for practicing power electronics professionals.

Professor **Gang Qu** (ECE/ISR) organized an Army Research Office workshop on military information technologies. It concentrated on emerging technologies and how they can be used in the ground combat field. Lectures incorporated basic tools from Lie group theory and Lie algebras, as well as differential geometry.

Best paper awards

A paper by Associate Professor **Alireza Khaligh** (ECE/ISR) received the Best Vehicular Electronics Paper Award from the IEEE Vehicular Technology Society. “Comprehensive Topological Analysis of Conductive and Inductive Charging Solutions for Plug-In Electric Vehicles” was co-written by Khaligh and his former student at the Illinois Institute of Technology, Serkan Dusmez. This is the

third year in a row Khaligh and his students have won the prize.

“Natural Language Processing of Textual Requirements,” a paper by alumnus **Andres Arellano** (MSSE 2014), MSSE student **Edward Carney** and Associate Professor **Mark Austin** (CEE/ISR), won the Best Paper Award at the 10th International Conference on Systems (ICONS 2015) in Barcelona this spring. Natural language processing (NLP) is the application of automated parsing and machine learning techniques to analyze standard text. In requirements engineering, NLP can be used to extract ontologies from a requirements specification and verify the consistency and/or completion of a requirements specification.

Associate Professor **Mark Austin** (CEE/ISR), his student **Parastoo Delgoshai** and alumnus **Alan Nguyen** (MSSE 2014), won the MITRE Best Transition in Systems Engineering Research Award at the Conference on Systems Engineering Research in March for “Distributed System Behavior Modeling with Ontologies, Rules and Message Passing Mechanisms.” Delgoshai is a 2012 MSSE graduate who is currently in the CEE Civil Systems Ph.D. program.

Books

Professor **Jeffrey Herrmann** (ME/ISR) has written *Engineering Decision Making and Risk Management*, a textbook published by Wiley for courses on decision analysis, decision making, and risk management within engineering design, operations research, business and management science, and industrial and systems engineering. The book emphasizes practical issues and examples of decision making with applications in engineering design and management.

ISR-affiliated Associate Professor **Nikhil Chopra** (ME) is a co-author, with Masayuki Fujita of the Tokyo Institute of Technology, Mark Spong at the University of Texas at Dallas, and Takeshi Hatanaka at the Tokyo Institute of Technology, of *Passivity-Based Control and Estimation in Networked Robotics*, by Springer. The book synthesizes a unified, passivity-based approach to the emerging cross-disciplinary subject of networked robotic systems control.

Patents

MIT Professor Evelyn Wang; ISR Director **Reza Ghodssi** (ECE/ISR); Professor James Culver (PS&LA); former ISR postdoc and Drexel University Professor **Matthew McCarthy**; Ryan Enright of Bell Labs Ireland; and **Konstantinos Gerasopoulos** (EE Ph.D. 2012) have been awarded U.S. Patent 8,986,814 for "Superhydrophobic surfaces." These new surfaces mimic the water-resisting properties of wetland plant leaves and have a hierarchical structure with both microscale and nanoscale features. The properties of these surfaces could one day make them useful as coatings on buildings, solar cells, and textiles.

ISR Director **Reza Ghodssi** (ECE/ISR), his former student **Mariana Meyer**, (BioE Ph.D. 2014), Professor William Bentley (BioE), Associate Professor Herman Sintim (Chem & Biochem), Varnika Roy (BioE Ph.D. 2011) and Jacqueline Smith (Chemistry Ph.D. 2011) were issued U.S. Patent 8,952,192 for "Phosphorylated and Branched Dihydroxy-Pentane-Dione Analogs as Quorum Sensing Inhibitors in Bacteria." These are compounds useful for modulating quorum sensing in bacteria. They provide a variety of benefits, enhance the effectiveness of conventional antibiotics and inhibit the formation and persistence of biofilms.

ISR Director **Reza Ghodssi** and his former students **Mustafa Beyaz** (EE Ph.D. 2011) and **C. Michael Waits** (EE Ph.D. 2008) have been issued U.S. Patent 9,083,208 for "Ball bearing supported electromagnetic microgenerator." This versatile invention improves electrome-

chanical devices and methods for forming them, by allowing a motor, generator or other suitable MEMS device to be operated at sufficient speeds to function on a micron length scale or below.

Associate Professor **Alireza Khaligh** (ECE/ISR) has been issued U.S. Patent 8,853,888 for a multiple-input DC-DC converter capable of power diversification among energy sources with different voltage-current characteristics. The converters are useful in grid-connected, integrated hybrid generation systems, fuel cells, micro grid-based telecom power systems, uninterruptible power supplies and electric and hybrid electric vehicles.

ISR-affiliated Professor **Christopher Davis** (ECE), Research Professor Stuart Milner (CEE) and Davis's former student **Jaime Llorca** of Alcatel-Lucent Bell Labs were awarded U.S. Patent No. 8,831,524 for "Systems, Methods, Devices, and Computer Program Products for Control and Performance Prediction in Wireless Networks."

Promotions

Jeffrey Herrmann (ME/ISR) has been promoted to the rank of full professor by University of Maryland President Wallace Loh. Herrmann is known for his work applying operations research to engineering decision-making systems, manufacturing and public health preparedness.

ISR-affiliated **Rajeev Barua** (ECE) also was promoted to full professor. Barua is known for his work in compilers, embedded systems and computer architecture. His recent

work has tackled the problem of compiler approaches to reliable software in embedded systems, memory allocation for embedded systems, and compiling to VLIW processors.

Alireza Khaligh (ECE/ISR) was promoted to associate professor with tenure. Khaligh directs the Power Electronics, Energy Harvesting and Renewable Energies Laboratory. His major research interests include modeling, analysis, design, and control of power electronic converters.

New ISR faculty

Huan "Mumu" Xu, formerly a research assistant professor with ISR and the Department of Aerospace Engineering, is now a tenure-track assistant professor with a joint appointment in the two departments. Xu has research interests in control and dynamical systems, formal methods with applications in autonomy, planning, and system identification; as well as the specification, design, and synthesis of networked control systems.

Editorship

ISR-affiliated Professor **Min Wu** (ECE/UMIACS) is the current editor-in-chief of *IEEE Signal Processing Magazine*, becoming only the second woman to hold this position. The publication is the main communication platform for the IEEE Signal Processing Society.

Honors

The American Institute of Aeronautics and Astronautics' National Capital Section selected Associate Professor **Derek Paley** (AE/ISR)



IT WAS STANDING ROOM ONLY IN THE PACKED BALLROOM DURING THE 30TH ANNIVERSARY MORNING LECTURES.

as its 2015 Engineer of the Year. Paley was honored “for pioneering research that applies methods from engineering and biology to study collective behavior in robotic and natural systems, and for dedication to teaching and mentoring students.”

ISR-affiliated Professor **Steven Gabriel** (ME) was the “Professeur Invité Trottier” during his 2014–15 sabbatical visit to the Institut de L’Énergie Trottier in Montréal. Gabriel worked on a variety of energy modeling and policy-related topics and interacting with faculty and other researchers at Polytechnique Montréal and GERAD.

Gabriel also received a Humboldt Research Award from the Alexander von Humboldt Foundation to study energy market modeling in Berlin. He developed equilibrium modeling/algorithms with discrete restrictions, for example in everyday electric power markets when considering the “unit commitment” problem for power generation (go/no-go decisions) combined with market-clearing conditions.

Professor **Ray Adomaitis** (ChBE/ISR) received the Illinois Institute of Technology’s (IIT) Charles W. Pierce Distinguished Alumni Award. The award recognizes alumni who “have brought recognition to the department through their outstanding contributions.”

Maryland awards

Invention of the Year awards

Professor **Gary Rubloff** (MSE/ISR) and ISR-affiliated Professor **Min Wu** (ECE/UMIACS) were winners of University of Maryland Invention of the Year Awards this year.

Rubloff, Professor Sang Bok Lee (Chemistry and Biochemistry), and their research team won in the Physical Sciences category for their invention, “A Revolutionary, High Energy Density Nanopore Battery.”

The battery is made of nanotubular electrodes and an electrolyte, confined in an anodic aluminum oxide nanopore. It is an all-in-one device with excellent capacity retention. It signifies the potential that nanostructure design

has for high power electrochemical storage.

Wu and her research team won in the Information Sciences category for their invention, “Verifying the Source of Video Streams Using Electric Network Frequency (ENF) Signals.” This invention enables the source verification of a video stream. It is a novel technique to measure the ENF signals of objects lit with incandescent or fluorescent lighting, exploiting the rolling shutter mechanism in modern Complementary Metal-Oxide-Semiconductor (CMOS) cameras.

Invention of the Year Awards are sponsored by the University of Maryland’s Office of Technology Commercialization, part of the Division of Research.

Clark School teaching award

Associate Professor **Derek Paley** (AE/ISR) received the Clark School of Engineering’s E. Robert Kent Teaching Award for Junior Faculty for his outstanding record in teaching and mentoring, and for major contributions to teaching aerospace engineers in both undergraduate and graduate curriculum.

studentNEWS

Mechanical Engineering Ph.D. student **Ivan Penskiy**, advised by Associate Professor **Sarah Bergbreiter** (ME/ISR), received a 2015-2016 University of Maryland Graduate Dean’s Dissertation Fellowship, one of only 10 graduate students at Maryland selected. He is developing microscale motors using MEMS technologies for millirobotics applications.

ECE graduate student **Sangwook Chu** won a best poster award at the University of Maryland’s 2015 Graduate Research Interaction Day (GRID). His poster, “Biotemplated Hierarchical Nickel Oxide Supercapacitor Electrodes,” took first prize in the Novel Technology to Address Challenges session. The poster describes Chu’s work in fabrication and characterization hierarchical nickel oxide supercapacitor electrodes utilizing Tobacco mosaic virus (TMV) as biological nano-scaffolds. Chu is associated with ISR Director **Reza Ghodssi’s** (ECE/ISR) MEMS Sensors and Actuators Laboratory (MSAL).

Bioengineering Ph.D. candidate **Thomas Winkler** won the Best Graduate Student Poster Award at the 2015 Mid-Atlantic Micro/Nano Alliance (MAMNA) Symposium in April. His poster was titled

“Microsystem for Particle Counting and Sizing with Tunable Sensitivity and Throughput.” Winkler is a Fulbright Foreign Fellow. He is associated with ISR Director **Reza Ghodssi’s** (ECE/ISR) MEMS Sensors and Actuators Laboratory (MSAL).

ISR places six in Future Faculty Fellow program

Six graduate students mentored by ISR faculty are among those selected for the A. James Clark School of Engineering’s 2015 Future Faculty Fellow program. The selective program prepares students for academic careers in top-50 engineering schools, helping them hone their skills in technical and grant writing, curriculum development, teaching, research, oral presentations and interviewing. ISR students in the 2015 program are: **Abbas Kazemipour** (ECE), advised by ISR-affiliated Professor **Min Wu** (ECE/UMIACS); **Francis Lagor** (AE), advised by Associate Professor **Derek Paley** (AE/ISR); **Mahshid Najafi** (ECE), advised by Professor **Jonathan Simon** (ECE/Biology/ISR); **Ganesh Sivaraman** (ECE), advised by Professor **Carol Espy-Wilson** (ECE/ISR); **Qiuwei Wang** (ECE),

advised by ISR-affiliated Professor **Min Wu** (ECE/UMIACS) and **Thomas Winkler** (BioE), advised by ISR Director **Reza Ghodssi** (ECE/ISR).

Introducing a combined ChBE B.S. and M.S. in Systems Engineering

ISR and the Clark School’s Department of Chemical and Biomolecular Engineering (ChBE) are offering a new five-year B.S. in Chemical and Biomolecular Engineering/M.S. in Systems Engineering degree. Interested ChBE undergraduate students can gain a strong foundation in process systems engineering concepts and open new employment opportunities in the Washington, D.C., area. Admission to the program will start with the first set of ChBE juniors in Spring 2016.

ISR hopes to partner with additional engineering departments to create similar programs in the future.

Northrop Grumman, Loccioni join Associate Partners Program

ISR is pleased to announce the addition of Northrop Grumman Corp. and Loccioni USA to its Associate Partners Program.

Through its Electronic Systems sector, Northrop Grumman has a long and productive history of collaborations with ISR. This Associate Partner relationship focuses on robotics systems and systems engineering.

Loccioni integrates ideas, people, and technologies to measure and test solutions and improve the quality of products and processes for the manufacturing and service industry. They look forward to combining their work and the ideas and expertise of ISR researchers to benefit their company and customers.

There are currently 11 ISR Associate Partner companies (see back cover for list). The program grants a level of preferred access to ISR faculty and students. Associate partners receive priority for research and recruiting opportunities, as well as up-to-date information on activities. ISR actively facilitates direct relationships among its associate partners, faculty and students. ISR also seeks out and guides associate partners toward mutually beneficial opportunities for research collaborations with ISR faculty.

Learn more about the Associate Partners Program at www.isr.umd.edu/industry/assoc-partners. Or contact Jeff Coriale at 301-405-6604, coriale@umd.edu.

Time to reconnect at alumni networking events

ISR is at work building relationships with its alumni community, most recently through local alumni networking receptions. These informal social events provide opportunities to reacquaint with ISR, meet local fellow alumni, and interact with ISR faculty and students.

Two events have been held in 2015. The first was held in March in Rockville, Md. Alumni hosts were **Raj Mittu** (MSSE 1995) of ESCgov, **Vikram Manikonda** (EE Ph.D. 1997) of Intelligent Automation, Inc., and **Ali Hirs** (Applied Math Ph.D. 1998) of Sauma Capital. The 25 participants enjoyed energetic conversation, renewing relationships and meeting fellow alumni. A second event was held in November in Washington, D.C., hosted by **Gayathri** and **Manav Kher** (ENPM M.E. 2001) of fusionSpan and **Aastha Verma** (MSSE 2003) of Catalist LLC. ISR faculty and students and local Associate Partner member companies also participated in the event.

If you would like to be a host at the next event in spring 2016, contact Jeff Coriale at 301-405-6604, coriale@umd.edu.

ISR fellowship fund

ISR is working to establish an endowed Ph.D.-level student fellowship. Creating this fellowship will ensure ISR's ability to recruit the best students and increase diversity in the Institute's research and education programs. ISR invites you to join this effort. Learn more at www.isr.umd.edu/giving/ISR-Fellowships.

Seminar series sponsorships: another way to connect

Sponsoring one of the Institute's seminar series is a cost-effective way for companies to increase visibility among ISR students, faculty and alumni, as well as within the Clark School, the greater University of Maryland and beyond.

Currently, three series are sponsored: the Lockheed Martin Robotics Seminar Series, the UTRC Control and Dynamical Systems Lectures and the Intelligent Automation, Inc. Colloquia Series.

Company names are displayed prominently in printed and online materials, and are mentioned at each seminar in the series. There also is an opportunity for company representatives to attend the live events and give a short welcome to the participants.

Most series average between 4–6 events per semester, and most events are videotaped for ISR's YouTube archive.

The following ISR series are available for sponsorship: Microsystems Seminar Series, Advanced Networks Colloquia, Model-Based Systems Engineering Colloquia, ISR Distinguished Lecturer Series, Brain-Based Systems Seminar Series.

If your company would like to learn more about seminar series sponsorship opportunities, contact Jeff Coriale at 301-405-6604, coriale@umd.edu.

Talk with ISR students at company information sessions

ISR has created a series of informal information events to help companies to introduce themselves to ISR students, talk about their line of work and the kind of employees they are looking for, explore opportunities for internships and full-time hiring, and discuss the role of systems engineering in the company.

These are great opportunities for students to network with companies and their technical/management staff.

Companies participating in six fall 2015 events range from long-time strategic partners of ISR, to companies new to the Institute:

Catalist, LLC; Textron Systems; ThrivOn Management; Intelligent Automation, Inc.; Hughes; and the Johns Hopkins University Applied Physics Lab.

The spring schedule is currently being planned. To learn more about participating, contact Jeff Coriale at 301-405-6604, coriale@umd.edu.



HARVARD'S ROGER BROCKETT, AN ORIGINAL ISR FACULTY MEMBER, HAS BEEN THE ADVISOR OF SEVERAL ISR FACULTY, INCLUDING BEHTASH BABADI, ONE OF THE NEWEST.

A paper describing improvements to a robotic octopus by **Dimitris Tsakiris** (EE Ph.D. 1995) and his research group was a finalist for two different best paper awards at the IEEE International Conference on Intelligent Robots and Systems. Tsakiris is principal researcher in the Computational Vision and Robotics Laboratory in the Institute of Computer Science at the Foundation for Research and Technology-Hellas (FORTH). At Maryland he was advised by Professor **P. S. Krishnaprasad** (ECE/ISR). The paper showed how adding a soft and supple silicone web has doubled the speed of the lab's robotic octopus, which also can crawl, carry objects, and swim freely.

Xiaobo Tan, (EE Ph.D. 2002), a professor at Michigan State University, is developing a new robotic fish that can "stalk" fish of interest in the Great Lakes. The Grace (Gliding Robot ACE) robot is an energy-efficient, highly maneuverable underwater glider/robotic fish hybrid. It is equipped with receivers that can detect the presence of fish tagged with acoustic-transmitting devices. Grace will track the movements of lake trout, walleye and lake sturgeon to identify important habitats, understand why they move from one place to another, and determine how they are being affected by invasive species such as sea lampreys. At Maryland, Tan was advised by Professor **John Baras** (ECE/ISR) and Professor **P. S. Krishnaprasad** (ECE/ISR).

Ashis Banerjee (ME Ph.D. 2009) has accepted a tenure-track position at the University of Washington, with a joint appointment in Mechanical Engineering and Industrial Engineering. At Maryland, Banerjee was advised by Professor **S. K. Gupta** (ME/ISR) and received both the 2009 George Harhalakis Outstanding Systems Engineering Graduate Student Award and the Mechanical Engineering Department's best dissertation award.

Haoyu Wang (EE Ph.D. 2014) has joined Shanghai Tech University as a tenure-track assistant professor in its School of Information Science and Technology. He has research interests in power electronics, plug electric vehicles, energy harvesting and conversion, and power management integrated circuits. Wang was advised by Associate Professor **Alireza Khaligh** (ECE/ISR).

Two ISR alumni were part of the inaugural class of Glenn L. Martin Medal winners last fall. The medal is awarded to those who

have upheld and contributed to the mission and ideals of the A. James Clark School of Engineering. Winners were nominated by their peers and selected for their engineering accomplishments and dedication to the University of Maryland. The ISR alumni honored were **Naomi Leonard** (EE Ph.D. 1994), the Edwin S. Wilsey Professor of Mechanical and Aerospace Engineering at Princeton University; and **Vikram Manikonda** (EE Ph.D. 1997), the president and CEO of Intelligent Automation, Inc.

Former postdoctoral researcher **Itzhak (Zachi) Tamo** has joined the Department of Electrical Engineering Systems at Tel Aviv University, Israel, as an assistant professor. At Maryland, he worked with Professor **Alexander Barg** (ECE/ISR) on coding systems for distributed storage applications.

Matteo Mischiati (EE Ph.D. 2011), was the principal author of "Internal models direct dragonfly interception steering," published in the journal *Nature* last winter. The researchers examined to what extent dragonflies' prey interception requires the dragonfly to create internal models. Mischiati and his colleagues performed extremely accurate, high-speed measurements of dragonfly head and body orientation relative to various prey positions using a sophisticated "flight arena" they built to provide a controlled, indoor setting. Mischiati is a postdoctoral associate in the Leonardo Lab at the Howard Hughes Medical Institute's Janelia Research Campus in Ashburn, Va. At Maryland he was advised by Professor **P. S. Krishnaprasad** (ECE/ISR).

Radha Poovendran (EE Ph.D. 1999) has been elected a Fellow of the Institute for Electrical and Electronics Engineers (IEEE), "for contributions to security in cyber-physical systems." He also was recently appointed chair of the Electrical Engineering Department at the University of Washington. At Maryland, Poovendran was advised by Professor **John Baras** (ECE/ISR).

Enlu Zhou (EE Ph.D. 2009) received an NSF Faculty Early Career Development (CAREER) Award in 2015 to conduct research in optimization and sampling in stochastic simulation. Zhou is an assistant professor in the H. Milton Stewart School of Industrial and Systems Engineering at the Georgia Institute of Technology. At Maryland she was advised by Professor **Steve Marcus** (ECE/ISR) and Professor **Michael Fu** (BGMT/ISR).

Former ISR postdoctoral researcher **Matthew McCarthy** has received an NSF CAREER Award for "Investigation of Boiling Heat Transfer Mechanisms and their Enhancement using Biotemplated Nanostructures." McCarthy is an assistant professor in the Mechanical Engineering and Mechanics Department at Drexel University in Philadelphia, where he directs the Multiscale Thermofluidics Laboratory. He is a former postdoctoral researcher of ISR Director **Reza Ghodssi** (ECE/ISR).

Alumna **Jing Yang** (EE Ph.D. 2010) received an NSF CAREER Award for "When Energy Harvesting Meets 'Big Data': Designing Smart Energy Harvesting Wireless Sensor Networks." Yang will construct a new paradigm of sensing and transmission schemes in data-intensive energy harvesting wireless sensor networks. She is an assistant professor of electrical engineering at the University of Arkansas. At Maryland, Yang was advised by Professor **Sennur Ulukus** (ECE/ISR).

Sheryl Chocron-Spieler (BioE MS 2014) was awarded Best Poster Runner-Up at the "BMES/FDA Frontiers in Medical Devices Conference: Innovations in Modeling and Simulation," held in May in Adelphi, Md. "Multi-Variate Modeling for Blood Measurement: Accounting for Population Variability" was one of more than 70 posters presented at the conference. At Maryland, Chocron-Spieler was a member of the MEMS Sensors and Actuators Laboratory, and was advised by ISR Director **Reza Ghodssi** (ECE/ISR). She is currently a business analytics associate at ZS Associates, a pharmaceutical and medical devices firm in Princeton, N.J.

Sagar Chowdhury (ME Ph.D. 2013) received the 2015 ASME Computers and Information in Engineering Division's Best Dissertation Award for his work, "Planning for Automated Optical Micromanipulation of Biological Cells." Chowdhury's dissertation describes his research into optical tweezers, which can be viewed as a robot that uses a highly focused laser beam for precise manipulation of biological objects and dielectric beads at micro-scale. Chowdhury was advised by Professor **S. K. Gupta** (ME/ISR) and won ISR's George Harhalakis Outstanding Systems Engineering Graduate Student Award in 2013. He is currently a postdoctoral research associate in the Department of Mechanical Engineering at Purdue University.



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Spotted at ISR's 30th anniversary celebration...

