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# SYSTEMSOLUTIONS

THE INSTITUTE FOR SYSTEMS RESEARCH

A. JAMES CLARK SCHOOL *of* ENGINEERING

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## Solving mysteries

ISR researchers connect disciplines to solve wide-ranging problems



# director's MESSAGE

As I write this, we are coming to the close of a very exciting fall semester in the 2016–2017 academic year. I would like to share with you three important developments. I encourage you to learn more about and participate in them. If you have any questions, comments, or thoughts, relay them to me at [ghodssi@umd.edu](mailto:ghodssi@umd.edu) or to Rebecca Copeland at [rebeccac@umd.edu](mailto:rebeccac@umd.edu).

First, ISR recently successfully completed an extensive, two-year review by the University of Maryland and a distinguished external panel. In preparation, our faculty, staff and students spent many hours gathering statistical information, preparing documents and discussing ISR's strengths, the challenges we face and directions we could take in the future.

In conjunction with and parallel to the review process, our faculty developed a Strategic Research Plan to guide ISR into the future. They are now working with a subset of ideas from the plan to strengthen and focus our research.

I am pleased to report that the external reviewers, campus administrators and our ISR Strategic Advisory Council gave us excellent feedback and praised ISR's 30-year history of outstanding research and academic contributions.

At the conclusion of the review process, the University of Maryland and the A. James Clark School of Engineering committed significant new support to ISR that will help us enhance our educational and research programs in robotics and systems engineering. Soon you will be hearing more about the steps we are taking to enhance these vital programs.

Second, our *System Solutions* cover celebrates the first anniversary of the Brain and Behavior Initiative (BBI), the University of Maryland initiative to revolutionize the interface between engineers and neuroscientists by generating novel tools and approaches to understand complex behaviors produced by the human brain. ISR played a key role in incubating BBI with help from many other units and individuals on campus. Now brain

research is one of the central emphases on our campus, from seed grant projects to collaborations with new colleagues at the University of Maryland School of Medicine in Baltimore, to holding dialogues with other leading brain researchers across the country. You can learn more about the latest BBI news online at [bbi.umd.edu](http://bbi.umd.edu).

Third, I am in my final year as ISR director, and I seek your help in identifying my successor, whose term will begin July 1, 2017. The director will be a senior faculty member of the University of Maryland, hold an ISR joint appointment and serve a five-year renewable term. Candidates should have earned a doctorate, hold a senior faculty appointment in an academic department; have a distinguished record of scholarly research, and have demonstrated leadership and visionary skills. The director provides the intellectual leadership to identify research directions, coordinate emerging programmatic opportunities with faculty interests and organize efforts to develop large project funding from government and industry.

The Clark School is conducting a national search. If you know of people—perhaps yourself!—who may be good candidates, I encourage you to consider the position posting at <https://ejobs.umd.edu/postings/46559>. It lists the requirements for and responsibilities of the position, and gives detailed instructions about how and what is required to apply.

I look forward to welcoming the new director next year, and working with him or her on many exciting societal systems challenges. It has been a great privilege to serve in this position for the past eight years!

Best regards,



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## Sennur Ulukus named Distinguished Scholar-Teacher



Professor **Sennur Ulukus** (ECE/ISR) has been selected as a 2016–2017 Distinguished Scholar-Teacher by the University of Maryland.

The Distinguished Scholar-Teacher program recognizes faculty members who have demonstrated outstanding scholarly achievement along with equally outstanding accomplishments as teachers. Winners of the award give a lecture during the fall semester. Ulukus chose “The Wireless Revolution” as the topic for her lecture in December.

Eight ISR faculty have received the honor. Ulukus joins ISR Director **Reza Ghodssi** (ECE/ISR) 2014–2015; Professor **Min Wu** (ECE/UMIACS) and Professor **Carol Espy-Wilson** (ECE/ISR), 2012–2013; Professor **Avis Cohen** (Biology/ISR), 2011–2012; Professor **K. J. Ray Liu** (ECE) 2007–2008; Professor

**Michael Fu** (BMGT/ISR), 2004–2005; Professor **Steve Marcus** (ECE/ISR), 2000–2001; and Professor Emeritus **Thomas McAvoy** (CheBE/BioE/ISR), 1997–1998; as ISR winners of the award.

# John Baras inducted into Clark School's 'Innovation Hall of Fame'

The A. James Clark School of Engineering has inducted Professor **John Baras** (ECE/ISR) into its Innovation Hall of Fame.

Baras created algorithms and protocols by which Internet services can be delivered over satellite, beginning with the introduction and demonstration of the first working broadband Internet over satellite protocol in 1994. When the new Internet over satellite technology was introduced in 1994, it was much faster than the fastest available broadband for consumers: 480 kbps vs. 96 kbps terrestrial.

Baras' research was performed under the Center for Satellite and Hybrid Communication Networks (CSHCN), which Baras co-founded with his colleague Anthony Ephremides in 1992. CSHCN (now HyNet—the Maryland Hybrid Networks Center) began as a NASA Center for the Commercial Development of Space, with the vision that the success and long-term viability of the communications satellite industry would require efficient integration of satellite technology into terrestrial networks, resulting in hybrid networks (integrated interoperable satellite and terrestrial networks).

Since he foresaw the explosion in Internet use over communication networks of all types, Baras focused his CSHCN (and later HyNet) work on the key challenge of developing broadband Internet over hybrid networks. His specific initial solution emerged from the framework of his joint work with Anthony Ephremides and their students, which was recognized by an Outstanding Invention of the Year Award from the Office of Technology Liaison of the University of Maryland in 1994. The specific initial Internet over satellite protocol, developed by Baras, consisted of a request for Internet service sent using a telephone connection to a satellite gateway with the response coming from the satellite directly to the home or office using the new protocol. Baras' initial innovation involved: (i) "splitting the connection"; (ii) "address spoofing"; and (iii) "selective acknowledgment." Combined, these three elements informed the TCP protocol that the delay in receiving an acknowledgment of a request was actually due to the satellite physical path delay and not due to congestion (which the TCP protocol is designed to assume).



To ensure that Internet over satellite technology would remain a competitive alternative to terrestrial Internet technologies, and to overcome the limitations of the initial asymmetric design (especially reliance on telephone companies), Baras continued this research effort in the ensuing years (1993–present). He aimed to develop new two-way Internet over satellite protocols with faster service and with a guarantee of security. With his students, he developed several important innovations and was granted several patents, targeting such issues as: fast Internet service to broadband wireless LANs connected to a satellite; efficient Internet multicasting schemes over hybrid networks; efficient and adaptive hybrid (multicast and unicast) data delivery systems; secure and scalable two-way broadband satellite Internet services; provision of mobile wireless telephone services to rural and underdeveloped areas; acceleration schemes for broadband two-way satellite Internet services; Layered Encryption Security resulting in the Layered IPSEC International Standard; new lightweight symmetric-key digital certificates (extended TESLA certificates) and a source authentication protocol for group communication in hybrid wireless-satellite networks (much less expensive in terms of processing power and energy of the smart devices,

compared to digital signatures); innovations on security of satellite Internet services; and extensions to space communications, including Internet service to planes, to the International Space Station and communications between Earth and expedition teams on the moon.

Baras' results were implemented progressively over time, in a long-term (1993–2004), extremely successful collaboration with Hughes Network Systems (HNS) engineers in several HNS award winning products (Turbo Internet, DirecPC, DirecDuo, DirecWay) culminating with HughesNet®, which became the company's largest single business.

Baras' contributions and innovations made possible widespread and inexpensive Internet connectivity via satellite and other broadband wireless networks, at high data rates reaching tens and hundreds of Mbps. They were essential to the creation of the industry sector for Internet services over satellite, serving consumers, businesses, ships and aircraft, remote oil rigs, military networks, and facilitating Internet connectivity to rural and underdeveloped areas, telemedicine services, environmental information, and emergency and disaster relief. Today many companies provide such services and products, with billions of dollars in sales, tens of millions of users and broad societal impact.



Baras involved many graduate and undergraduate students in this research over the years. He graduated 22 M.S. and 11 Ph.D. students whose work was focused on the theme of Internet over satellite, all of whom joined the industry upon graduation.

John Baras holds the Lockheed Martin Chair in Systems Engineering, and was the Founding Director of the Institute for Systems Research and the Co-Founding Director along with Ephremides of the Maryland Hybrid Networks (HyNet) Center. Baras is a Foreign Member of the Royal Swedish Academy of Engineering Sciences, and a Fellow of IEEE, SIAM, AAAS, NAI, and IFAC.

Learn more at [go.umd.edu/Baras-IHOF](http://go.umd.edu/Baras-IHOF).

### Ray Adomaitis helping lead Maryland's Solar Decathlon effort

The University of Maryland is fielding one of 16 collegiate teams in the U.S. Department of Energy's 2017 Solar Decathlon. The competition culminates in a fall 2017 judging and challenges participants to design, build, and operate cost-effective, energy-efficient and attractive solar houses. For the first time, teams are competing for \$2 million in prize money.

Teams come from across the U.S., the Netherlands and Switzerland. They consist of students, faculty, and mentors in a wide range of disciplines including engineering, architecture, plant sciences, business and communications. During each competition, teams spend two years working on a design from concept to creation. At the end, they assemble and present their sustainable homes. The buildings are tested and judged in a variety of contests, which evaluate everything from market appeal to appliance operation.

The Maryland group is led by three principal investigators: Professor **Ray Adomaitis** (ChBE/ISR); Lecturer Michael Binder (MAPP); and Professor Garth Rockcastle (MAPP).

The university has participated in the competition five times, winning in 2011 and placing second in 2007. The 2011 winning creation, WaterShed, was inspired by the Chesapeake Bay ecosystem and emphasized both solar and water efficiency. After the competition, the building was purchased by the regional electric service provider Pepco. It was moved to a Pepco campus and renamed the Sustainability Center.

Learn more. Follow the team's progress at [sd2017.umd.edu](http://sd2017.umd.edu).

## Gary Rubloff named Distinguished University Professor



**Gary Rubloff** (MSE/ISR) has been named a Distinguished University Professor by the University of Maryland. Rubloff is a Minta Martin Professor of Engineering.

"Distinguished University Professor" is the highest academic honor the University of Maryland confers upon a faculty member. It is reserved for a small number of faculty who have been internationally recognized for the importance of their scholarly or creative achievements, and who have demonstrated the breadth of interest characteristically encompassed by the traditional role of scholar, teacher and public servant.

Rubloff's citation reads, "In acknowledgment of your internationally recognized work in nanoscience, nanoscale processing, biomaterial engineering and advanced device systems."

Rubloff joined the University of Maryland in 1996 as professor in the Department of Materials Science and Engineering and the Institute for Systems Research, where he was the third director. He is the founding and current director of the Maryland NanoCenter. In 2004 Rubloff was named Minta Martin Professor of Engineering. He is a Fellow of the American Physical Society and the American Vacuum Society and has published more than

270 papers. Rubloff holds 26 patents and six IBM Invention Achievement Awards. He won the AVS Gaede-Langmuir Prize in 2000 "for inventive application of surface science and vacuum technology to the semiconductor industry, and for fostering an effective bridge between AVS research and manufacturing."

His research has included solid state physics, surface physics and chemistry, interfaces, semiconductor materials and processing science and technology, process diagnostics and modeling, manufacturing science, combinatorial materials science, biomaterials and bioMEMS.

His semiconductor process research has emphasized the elucidation of chemical and physical mechanisms involved in surface cleaning, thermal oxidation, chemical vapor deposition, and plasma etching. In pursuing these directions he pioneered the exploitation of ultrahigh vacuum process environments and their integration with in-situ surface and interface diagnostics.

In 2008, he initiated—with Sang Bok Lee (Chem/Biochem), Ellen Williams (Physics) and Michael Fuhrer (now at Monash University, Australia)—a successful proposal with the U. S. Department of Energy for a Energy Frontier Research Center (EFRC) at the University of Maryland. Rubloff became the director of the Nanostructures for Electrical Energy Storage EFRC (NEES EFRC), with Lee as deputy director. The center is devoted to understanding the role of nanostructures in next generation energy storage. In its eighth year, the \$25 million NEES EFRC encompasses the work of seven universities and two national lab sites. It was renewed for funding in 2014.

In 2015, Rubloff won the Clark School's Senior Faculty Outstanding Research Award for his "extremely novel, important, and exciting research in the past five years, focused on nanoscience and technology." He has twice won the university's Invention of the Year in the Physical Sciences; in 2015 for "A Revolutionary, High Energy Density Nanopore Battery, and in 2010 for "Nano Arrays for Energy Storage."





## National workshop provides opportunity for mid-career STEM faculty to learn from senior peers

More than 175 mid-career STEM faculty and other academic leaders from across the country met in Madison, Wisc., on June 3 for the Denice Denton Emerging Leaders Workshop.

Inspired by the work and legacies of Denice D. Denton, recipients of the decade-old Denice Denton Emerging Leader ABIE Award organized the workshop. It focused on helping mid-career faculty develop knowledge, skills, strategies, and critical networks. The goal was to support, develop, prepare and energize a new generation of academic women and men to be leaders, mentors and coaches. It also contributed to enabling success for those in science and engineering independent of race, ethnicity, gender, gender identity and expression, sexual orientation, country of origin, and other dimensions of diversity.

The participants included some 120 mid-career faculty, 20 full professors who acted as coaches—including Professors **Steve Marcus** (ECE/ISR) and **Elisabeth Smela** (ME/ISR), senior staff from several academic institutions and 16 senior graduate students who were competitively selected for their ability and interest in pursuing academic careers. They came from the STEM fields of engineering, computing, mathematical and physical sciences, and were assistant or associate professors with 4-15 years of experience in tenure-line faculty positions.

They learned from plenary speakers, panels of distinguished academic leaders, and their more senior colleagues in small group “laser

coaching” sessions designed to help them develop strategies for success and individual leadership plans. In addition, participants gained insight from working with their peers and near-peers throughout the day.

Topics included strategies for mid-career development planning; modes of academic leadership; developing and utilizing mentors and sponsors; skills for effective team science; conflict resolution; negotiation; mitigating implicit bias; performance evaluation; accountability plans and practices to improve strategies for inclusion within lab groups, departments, and schools; and work-life integration.

University of Washington President Ana Mari Cauce gave a keynote address titled, “My Life in Administration: From Accident to Career.” Cauce, who once considered herself an “accidental administrator,” shared insights she gained during her journey from assistant professor to university president.

Harvey Mudd College President Maria Klawe gave a keynote address via Skype. “Twists and Turns as an Academic Leader” described her adventures, mishaps and insights as a female scientist and engineer who was mindful of both her professional career and her family. She described her goal of making the culture of science and engineering welcoming to everyone with passion and ability, from poets and football players to women and under-represented minorities.

A “Panel on Cultivating Leadership Potential and Overcoming Challenges on

the Path to Leadership” featured four speakers who each brought a unique perspective to the topic. The panel was co-moderated by Professor **Carol Espy-Wilson** (ECE/ISR), and TSMC Distinguished Professor in Microelectronics Tsu-Jae King Liu from the University of California, Berkeley.

The panelists were Emily Allen, California State University, Los Angeles; Molly Carnes, University of Wisconsin-Madison; Robert Gray, Boston University; and Evelyn Hammonds, Harvard University.

The workshop’s steering committee was chaired by ISR Director **Reza Ghodssi** (ECE/ISR) and included Naomi Chesler, Beth Pruitt, Susan Daniel, Rachel Pottinger, Nadya Mason, Tiffani Williams, Alice Pawley, Thamar Solorio and Lydia Tapia. Its advising committee was Susan Burkett, Leslie Field, Tsu-Jae King Liu, Carol Muller, Telle Whitney, Carol Espy-Wilson, Deanna Kosaraju, Steve Marcus, Benedicte Richardson and Chris Zorman. The organizing committee was Jennifer Sheridan, Amy Wendt, Regina King, Vicki Bier, Lydia Zepeda, Bari Mitchell, Katherine Cline and Rebecca Copeland.

The workshop was sponsored by the National Science Foundation, the Anita Borg Institute, the University of Wisconsin, Stanford University, the University of Maryland, and the University of Alabama.

[Learn more.](#) Insights gained from the speakers were live tweeted under [#ddelworkshop](#).



## ISR research contributes to Google's AlphaGo AI system

Ideas first explored by ISR Postdoctoral Researcher **Hyeong Soo Chang**, Professor **Michael Fu** (Smith School/ISR), ECE Ph.D. student **Jiaqiao Hu**, and Professor **Steve Marcus** (ECE/ISR) in a 2005 paper are at the core of AlphaGo, Google's Go-playing artificial intelligence (AI) system. AlphaGo defeated Lee Se-Dol, one of the top Go players in the world, in early March, by a score of four games to one.

AlphaGo is the latest in the line of AI systems developed to beat humans at games like checkers, chess, Scrabble and Jeopardy. Each successive challenge extends the boundaries of machine learning and its capabilities.

Go is a 2,500-year-old game popular in east Asia, where players take turns placing black or white stones on a board, trying to capture their opponent's stones or surround empty space to make points of territory. An average 150-move game contains  $10^{170}$  possible board configurations, a level of complexity that presented entirely new challenges for computer programmers. They could not rely on the traditional method of constructing a search tree that covers every possible move, looking for the best one. A different approach that could recognize patterns in the game was needed.

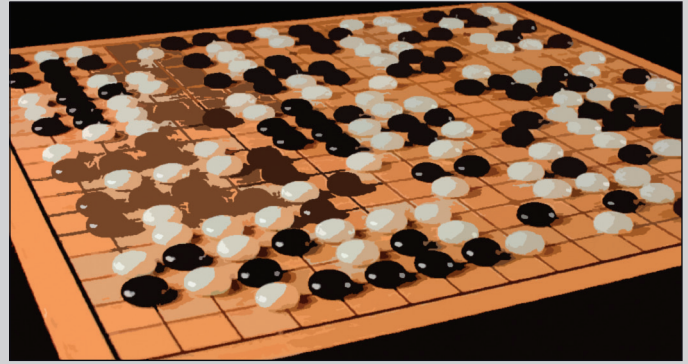
AlphaGo is powered by a combination of both machine learning and new Monte Carlo tree search techniques, guided by a "policy network," which selects the next move, and a "value network," which predicts the winner of the game. Both networks are implemented using brain-inspired deep neural network technology with millions of connections. AlphaGo couples these techniques with extensive training, both by observing human play and by playing itself in extensive trials.

An algorithm that balances exploitation and exploration in estimating the value of possible actions by Monte Carlo simulation for sequential decision making problems under uncertainty was first proposed by Chang, Fu, Hu and Marcus in their 2005 *Operations Research* paper, "An adaptive sampling algorithm for solving Markov decision processes." The paper was the first to apply upper confidence bounds to Markov decision processes by generating Monte Carlo trees.

The next year, Rémi Coulom coined the term "Monte Carlo tree search" and described how the Monte Carlo method could be applied to game-tree search in the paper, "Efficient Selectivity and Backup Operators in Monte-Carlo Tree Search." Also in 2006, Levente Kocsis and Csaba Szepesvári developed an algorithm based on Monte Carlo tree search with upper confidence bounds as applied to games in their paper, "Bandit based Monte-Carlo Planning." The two papers were the impetus for tackling the AI problem in Go, and cited the earlier Maryland paper for containing the main seeds for their algorithms.

Google's AlphaGo victory was another watershed moment for modern artificial intelligence. AlphaGo's techniques have implications for other tasks that require recognition of complex patterns, long-term planning and decision-making, such as image and speech recognition, natural language processing and robotics.

Chang has gone on to become a professor in the Department of Computer Science and Engineering at Sogang University in Seoul, South Korea. Hu graduated with a Ph.D. in electrical engineering in 2006 and is an associate professor in the Applied Mathematics and Statistics Department at Stony Brook University in New York.



The four researchers reunited to write an article for the October 2016 issue of *OR/MS Today*, the main magazine of the professional society INFORMS. In "Google DeepMind's AlphaGo," the researchers talk about how their ideas influenced the development of AlphaGo, and delve into disconnects between the operations research (OR) and computer science/artificial intelligence (CS/AI) communities that hinder idea sharing between the disciplines.

They argue that disciplines' very different academic cultures make things difficult—for example, while the CS/AI community mainly publishes through conference proceedings, the OR community values journal publications. The authors then suggest ways these communities could interact in a mutually beneficial way to build on the research strengths of both.

**Learn more.** Watch AlphaGo in action in this YouTube video produced by Google: [youtu.be/SUBqykXVx0A](https://youtu.be/SUBqykXVx0A). Read the *OR/MS Today* article by Chang, Fu, Hu and Marcus: [go.umd.edu/alphago](http://go.umd.edu/alphago).

## Otomagnetics' magnetic injection work is highlighted

The company Otomagnetics and Professor **Benjamin Shapiro** (BioE/ISR) were recently featured in a "scientifically speaking" article in the newsletter of the United Kingdom charity, Action on Hearing Loss (AHL). ISR Associate Research Scientist **Didier Depireux** also is a co-founder of Otomagnetics and a key member of the research team.

AHL was founded in 1911 as the National Bureau for Promoting the General Welfare of the Deaf to support and care for people with hearing loss and to raise awareness and educate about what can damage hearing. The charity has created initiatives and supported research into these subjects.

The article is written from Shapiro's perspective as an academic researcher who is developing technology to magnetically inject drugs such as antibiotics and steroids into the cochlea. The therapy is showing great promise in healing ear infections, treating noise-induced hearing loss (in animal models); suppressing tinnitus, and protecting hearing from chemotherapy regimens, which are known to damage hearing.

Shapiro says, "My ultimate goal is to improve lives. There are steps to take and challenges to meet, but it's clear we can better deliver therapy to the cochlea. We'll get there."

**Learn more.** Read the article at [go.umd.edu/OtoAHL](http://go.umd.edu/OtoAHL).

## It's not your ears, it's your brain

"Could you repeat that?" The reason you may have to say something twice when talking to older people may not be because of their hearing. **Samira Anderson** (HSS/NACS), **Jonathan Simon** (ECE/ISR/BIO) and their former student **Alessandro Presacco** (NACS Ph.D. 2016, a postdoctoral researcher at the University of California, Irvine) have determined that something is going on in the brains of typical older adults that causes them to struggle to follow speech amidst background noise—even when their hearing would be considered normal on a clinical assessment.

In an interdisciplinary study published in the *Journal of Neurophysiology*, the trio found that adults aged 61–73 with normal hearing scored significantly worse on speech understanding in noisy environments than adults aged 18–30 with normal hearing.

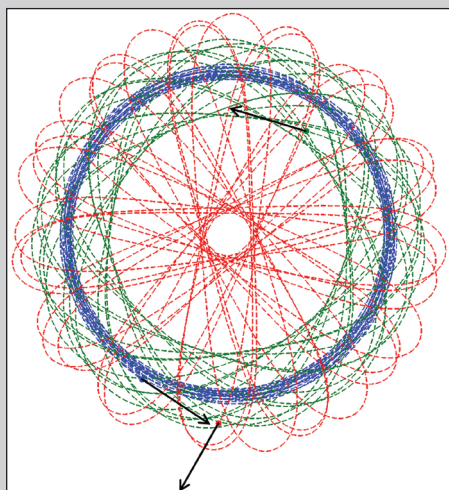
"Evidence of degraded representation of speech in noise, in the aging midbrain and cortex" is part of ongoing research into the so-called cocktail party problem, or the brain's ability to focus on and process a particular stream of speech in the middle of a noisy environment. This research brings together the fields of hearing and speech science, neuroscience and cognitive science, electrical engineering, biology and systems science.

For older listeners, even when there isn't any noise, the brain is already having trouble processing speech. Part of the comprehension problems experienced by older adults could be linked to age-related imbalance between excitatory and inhibitory neural processes in the brain, impairing the brain's ability to correctly process auditory stimuli. This could be the main cause of the abnormally high cortical response observed in the study.

"Older people need more time to figure out what a speaker is saying," Simon noted. "They are dedicating more of their resources and exerting more effort than younger adults when they are listening to speech."

**Learn more.** An expanded version of this story and links to ongoing "cocktail party" research are online at [www.isr.umd.edu/media/release.php?id=436](http://www.isr.umd.edu/media/release.php?id=436).

## Small collectives and nonlinear dynamics



PLANAR PRECESSION OF THREE PARTICLES (FIGURE 7A OF THE PAPER; SCREENSHOT FROM ANIMATION CREATED BY K. S. GALLOWAY; COPYRIGHT ROYAL SOCIETY)

Imagine a hiker lost in an overgrown forest or hard-to-access mountainous region, seeking and failing to get back to the trail and desperately needing to be rescued. Or consider the possibility of a lone sailor adrift in the open ocean and low on supplies, hoping that distress signals from the boat will draw the attention of Coast Guard vessels. In such situations enormous effort is often expended to save lives, at great cost and risk to the first responders.

Would a small team of cooperating, unmanned autonomous aerial vehicles provide an effective alternative to current solutions based on personnel- and equipment-intensive operations? The answer depends on our ability to design and implement intelligent behaviors in such collectives, using feedback control laws that can realize patterns of persistent search and tracking, and actions based on detecting targets of interest.

While many technological issues—such as on-board power, sensing and computational resources, and platform design—merit consideration, the mathematical challenges of creating and sustaining mobility patterns are no less worthy of attention. The authors of a new paper, "Symmetry and reduction in collectives: low dimensional cyclic pursuit," published Oct. 26 in the *Proceedings of the Royal Society A*, investigate the types and stability of motion patterns in controlled small collectives.

The journal website includes supplementary material in the form of animations of small collectives.

The paper was written by U.S. Naval Academy Assistant Professor **Kevin Galloway** (ECE Ph.D. 2011), Naval Research Laboratory Electronics Engineer **Eric Justh** (ECE Ph.D. 1998), and University of Maryland Professor **P. S. Krishnaprasad** (ECE/ISR). They use an abstraction of agents in a collective as self-steering particles interacting according to a strategy known as constant bearing cyclic pursuit, to develop an understanding of spatial motion patterns.

In the case of collectives with two or three agents, they predict the presence of periodic orbits in phase space and precession in physical space. Key elements of the work include exploitation of nonlinear feedback laws to execute the strategy, and use of rigid motion group symmetry and reduction to shape space, as (detailed) in their earlier collaboration, also published in the *Proceedings of the Royal Society A*. The presence of periodic orbits in the case of small collectives supports the possibility of using associated control laws to guide a team of vehicles to achieve coverage and persistent surveillance for purposes such as search and rescue. Recent developments in the work of **Galloway, Biswadip Dey** and **Kenneth Miltenberger, Jr.** show these ideas can be taken further to practical implementations (missions in a testbed).

The mathematics underlying the current paper has modern control-theoretic aspects as well as classical roots. In recognizing the presence of time-reversal symmetry in the problem of small collectives, the authors use a theorem of G. D. Birkhoff from his studies in 1915, on three body problems of Newtonian particles bound by gravitation. It is rewarding that one can build intellectual bridges between problems arising from widely separated concerns.

There are other threads to explore, such as how small collectives are embedded as network motifs in larger multi-agent systems, and whether this would lead to insights into the behavior of complex interacting systems in nature and in the engineered world.

**Learn more.** Read the paper at [go.umd.edu/prsasc](http://go.umd.edu/prsasc).



## Chuan Shi wins energy research fellowship

The University of Maryland Energy Research Center has selected ECE Ph.D. student **Chuan Shi** for a 2016 Harry K. Wells Energy Research Fellowship. The fellowship provides a \$20,000 stipend, as well as travel expenses to present research results at a technical conference. Shi is advised by Associate Professor **Alireza Khaligh** (ECE/ISR).

Shi's research topic, "Towards Miniature Power Electronics for Smart Grid Sensors," will focus on power electronics converters in application of smart sensor networks for smart grids. The proposed topologies and the design methodology will be extendable to smart sensor networks applied in distributed solar energy plants, distributed wind energy systems, and other renewable energy systems.

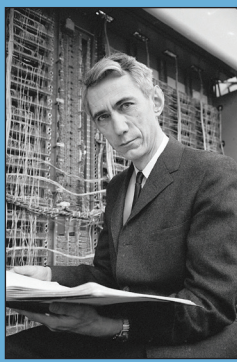
## Min Ye, finalist in Bell Labs Shannon competition

ECE Ph.D. student **Min Ye** was a graduate student finalist in the Shannon Centennial Student Competition organized by Bell Labs, Nokia. Ye is a student of Professor **Alexander Barg** (ECE/ISR). The competition was part of the First Shannon Conference on the Future of the Information Age, convened to celebrate the 100th birthday of Claude Shannon, who proposed the central ideas of information theory while working for Bell Labs in the late 1940s.

A paper by Ye and Barg based on this research has been accepted for publication in *IEEE Transactions on Information Theory*.

## ISR celebrates 2016 as the 'Year of Shannon'

Along with colleagues around the world, ISR celebrated the centennial of Claude Shannon's birth with a series of lectures in his honor. Shannon has been widely proclaimed "the father of information theory." Learn more about Shannon in this IEEE Information Theory Society video: [youtu.be/pHSRH77RKM](http://youtu.be/pHSRH77RKM)



## Berger: Goldwater Scholarship

BioE undergrad **Adam Berger** has won a Goldwater Scholarship. With ISR-affiliated

Associate Professor **Ian White** (BioE), Berger is investigating methods for using surface-enhanced Raman spectroscopy to detect THC, the chemical responsible for most of marijuana's psychological effects, in saliva. In addition, Berger is testing paper-based SERS biosensors for antibiotic detection, a topic on which he co-authored a book chapter.

## Rui Zhang wins excellence award

**Rui Zhang** (BMGT Ph.D. 2016) won second place in the WINFORMS Student Excellence Award competition for his paper, "Mathematical Programming Approaches to Influence Maximization on Social Networks." Zhang was a student of Professor **S. Raghavan** (BMGT/ISR). WINFORMS is the Washington, D.C. chapter of the professional society INFORMS.

## Four students in Future Faculty Fellow program

Four students mentored by ISR faculty were selected for the Clark School's 2016 Future Faculty Fellow program. Launched in 2007, the program was created to prepare students for academic careers in top-50 engineering schools. The students are:

**Daigo Shishika** (AE), advised by Associate Professor **Derek Paley** (AE/ISR)  
**Ahmed Arafa** (ECE), advised by Professor **Sennur Ulukus** (ECE/ISR)  
**Vidya Raju** (ECE), advised by Professor **P. S. Krishnaprasad** (ECE/ISR)  
**Ryan St. Pierre** (ME), advised by Associate Professor **Sarah Bergbreiter** (ME/ISR)

## Hyun Jung is distinguished teaching assistant

ECE Ph.D. student **Hyun Jung** was named a Distinguished Teaching Assistant by his department. He was selected for his high caliber faculty and student evaluations. Jung is a member of the MEMS Sensors and Actuators Laboratory and is advised by ISR Director **Reza Ghodssi** (ECE/ISR).

## Maira Bruck wins student paper competition

**Maira Bruck**, an undergraduate Economics major, won the student paper competition at the 2016 ASME Power & Energy Conference in Charlotte, N.C. Her paper, "A Levelized Cost of Energy Model for Wind Farms that Includes Power Purchase Agreement Energy Delivery Limits," develops a new cost model

to evaluate the price of electricity from wind energy under a PPA contract. The co-authors on the paper are ME postdoctoral researcher **Navid Goudarzi** and ISR-affiliated Professor **Peter Sandborn** (ME).

## Winkler wins multiple awards

In November, Ph.D. candidate **Thomas Winkler** (BioE) won the American Vacuum Society's Russell & Sigurd Varian Award, one of the most prestigious graduate research awards given by the society.

Winkler also won the 2016 Dean's Doctoral Research Award Competition for his Ph.D. thesis, "Microsystems Integration Towards Point-of-Care Monitoring of Clozapine Treatment for Adherence, Efficacy and Safety," and earlier was awarded an Ann G. Wylie Dissertation Fellowship, which provides support to students in the latter stages of writing their dissertations.

He is part of the MIND (MICROsystems development for Neuropsychiatric Disorders) effort in the MEMS Sensors and Actuators Laboratory. His thesis relates to developing a BioMEMS device for drug treatment planning and monitoring. Winkler is advised by ISR Director **Reza Ghodssi** (ECE/ISR).

## Gilboy wins research award

Congratulations to **Matthew Gilboy**, an M.S. student of ISR-affiliated Professor **Rajeev Barua** (ECE). Gilboy is the winner of the 2016 Dean's Masters Student Research Award competition for his thesis, "Fighting Evasive Malware With Dvasion."

## Banis wins AVS award

Ph.D. student **George Banis** (BioE) received the "Best Technical Presentation Award" from the AVS Biomaterial Interfaces Division at the American Vacuum Society's (AVS) 63rd annual Symposium and Exhibition in Nashville. He is advised by ISR Director **Reza Ghodssi** (ECE/ISR).

## Huiszoon is presentation finalist

Ph.D. student **Ryan Huiszoon** (BIOE) was selected as one of two student candidates for the "Best Oral Presentation" by the MEMS and NEMS Technical Group at the American Vacuum Society's (AVS) 63rd annual Symposium and Exhibition in Nashville. He is advised by ISR Director **Reza Ghodssi** (ECE/ISR).



## Tolstaya wins NSF Graduate Research Fellowship

**Ekaterina Tolstaya** (B.S. EE/CS 2016) won an NSF Graduate Research Fellowship, based on her proposal in the broad area of distributed RF sensing. She is using this highly competitive award to pursue Ph.D. studies in electrical and systems engineering at the University of Pennsylvania. At Maryland, Tolstaya was a Banneker/Key Scholar, a fellow of the RISE program, the recipient of a Women in Engineering Fellowship, a laboratory teach-

ing fellow in the Introduction to Engineering Design course, and an undergraduate teaching fellow. She worked with ISR faculty and students in the Intelligent Servosystems Lab and the MEMS Sensors and Actuators Lab.

## Team wins QUALCOMM prize

The computer science Ph.D. student team of **Michael Maynord** and **Anupam Guha** is one of eight winners nationwide of the annual Qualcomm Innovation Fellowship competition. The competition focuses on

recognizing, rewarding, and mentoring innovative Ph.D. students across a broad range of technical research areas. Maynord and Guha received a \$100,000 fellowship for their project, "Feedback for Vision." They also received mentoring from Qualcomm engineers.

Maynord is advised by Professor Don Perlis (CS) and Guha is advised by ISR-affiliated Professor **Yiannis Aloimonos** (CS/UMIACS). Associate Research Scientist Cornelia Fermüller (UMIACS) is also an advisor to the project.

# new GRANTS

## Babadi wins NSF CAREER Award

ISR-affiliated Assistant Professor **Behtash Babadi** (ECE) has received an NSF Faculty Early Career Development (CAREER) Award for "Deciphering Brain Function through Dynamic Sparse Signal Processing." The project's main objective is to develop a mathematically principled methodology that captures the dynamicity and sparsity of neural data in a scalable fashion with high accuracy and to employ it in studying the brain function with a focus on the auditory system. The five-year award is worth \$490,000.

Capturing the adaptivity and robustness of brain function in real time is crucial not only for deciphering its underlying mechanisms, but also for designing neural prostheses and brain-computer interface devices with adaptive and robust performance. Babadi's research will provide a unified framework to efficiently process data and deliver new applications in systems neuroscience.

## Barg receives grant for local data recovery

Professor **Alexander Barg** (ECE/ISR) has received a three-year, \$250K NSF Computing and Communication Foundations grant for "Coding and Information: Theoretic Aspects of Local Data Recovery."

Barg will study fundamental problems in data coding that can improve the efficiency of distributed storage systems. The idea is to increase data reliability and availability while reducing storage overhead. This research will benefit storage applications ranging from

financial, scientific monitoring, and signal processing to social networks and sharing platforms.

Barg's project will advance the theory and practice of data coding with local recovery by investigating broad implications of the locality constraint in coding problems. These include studying new error-correcting code families and their decoding, fundamental limitations on the code parameters and capacity bounds under the requirements of local data recovery.

## Khaligh receives NSF grant for electric vehicle technology

Associate Professor **Alireza Khaligh** (ECE/ISR) is the principal investigator of an 18-month, \$200,000 NSF grant, "Integrated Bidirectional Power Electronic Charger/Converter for Plug-in Electric Vehicles." The research focuses on translating an integrated bidirectional onboard charger and DC/DC converter technology for compact and efficient power converters used in plug-in electric vehicles. The researchers will design, develop and validate technology to reduce the weight, volume and cost of onboard converters, while enhancing their efficiencies, and enabling bidirectional operation.

Co-principal investigators are Professor Patrick McCluskey (ME), and Steven Rogers, co-founder, president and CTO of Genovation, a green technology automobile company based in Rockville, Md.

The project will result in a prototype integrated charger/converter with enhanced efficacy, greater power density, and considerable cost savings over the conventional meth-

od of using an individual charger and auxiliary load converter. It will contribute to the eventual widespread adoption of electric vehicles.

## Qu receives NIST cryptography grant

Professor **Gang Qu** (ECE/ISR) has received a \$100,000 National Institute of Standards and Technology (NIST) grant to study the use of silicon physical unclonable functions as an entropy source for cryptographic keys. This is the first time the NIST Computer Security Division has awarded a research grant specifically focused on randomness extraction in hardware security research.

Keys play a vital role in modern cryptography and almost all security applications. A short key is easy to break, but a longer key does not guarantee better security. Strong keys are random and unpredictable, which can be measured by entropy.

Qu will investigate whether the randomness in silicon fabrication variation can be captured and used as a source to generate entropy and enhance the quality of other entropy sources.

## Khaligh is co-PI on new Boeing contract

Associate Professor **Alireza Khaligh** (ECE/ISR) is the co-principal investigator and Professor Patrick McCluskey (ME) is the principal investigator on a \$200,000 contract from The Boeing Company to investigate and design an innovative power electronics-based regulated transformer rectifier unit for Boeing's next generation of more electric aircraft.

## Multiple options for systems engineering graduate education

ISR offers a number of ways to obtain graduate education in systems engineering through our partnership with the Clark School of Engineering. There are two systems engineering masters degrees: the Master of Science in Systems Engineering (MSSE) and the Master of Engineering in Systems Engineering (MEngSE). The college also offers a Graduate Certificate in Engineering (CGEN) in Systems Engineering.

Students in both the MSSE and MEngSE programs take the same six core courses, but there are differences in admission requirements, electives and tuition.

ISR administers the **MSSE**, a research-oriented degree that requires completion of 30 credits (usually 10 courses). The student may opt to produce either a master's thesis or scholarly paper that reflects their systems engineering-related research. Students work under the guidance of a faculty advisor on a topic of mutual interest. Full-time students enrolled in this program are eligible for graduate research assistantships (GRAs), MSSE-specific internships, and possibly teaching assistantships (TAs). This degree program is particularly well-suited to students who are interested in research and who may be considering the possibility of pursuing a Ph.D. in an engineering-related field. In-state tuition rates for the MSSE program are lower than those for the MEngSE program, which makes the degree attractive for Maryland residents.

The **MEngSE** is a professional degree offered through the Clark School's Office of Advanced Engineering Education. It requires completion of 30 credits (usually 10 courses) and does not require either a master's thesis or scholarly paper. It is particularly well-suited for working professionals who are likely to be taking only one or two courses a semester. Students enrolled in this program are not eligible to be GRAs or TAs, or to receive MSSE-specific internships. Since the MEngSE tuition is lower than out-of-state MSSE tuition, international and out-of-state students may find this program more attractive.

If a student in either of the masters programs and decides to switch to the other program, they may apply to the other program. If accepted, any core systems engineering courses they have taken will transfer to the other program. Credit for electives will be evaluated with respect to the policies of each program. Admission and degree requirements for each program may be found on their respective websites.

The **CGEN in Systems Engineering**, offered through the Clark School's Office of Advanced Engineering Education, requires completion of four approved courses (12 credits total). It is designed for engineering professionals who would like to obtain added credentials in systems engineering.

[Learn more](#) about graduate systems engineering education options, including admission and degree requirements, at [www.isr.umd.edu/education/systems-engineering-education](http://www.isr.umd.edu/education/systems-engineering-education).

## Herrmann to lead undergraduate 'FIRE' program

Beginning in 2017, Professor **Jeffrey Herrmann** (ME/ISR) will lead a "Designing Innovations" innovation and research stream for the University of Maryland's First-Year Innovation & Research Experience (FIRE) program. Students in Herrmann's stream will study how designers work and consider how they tackle system design problems.

The FIRE program includes some 400 first-year undergraduate students every year, providing them with authentic research experience, broad mentorship, and institutional connections that will enhance their academic success, personal resilience and professional development.

## New graduate certificate in robotics

A graduate certificate program in robotics is being offered by the Maryland Robotics Center and the Clark School of Engineering's Office of Advanced Engineering Education. (The Maryland Robotics Center is part of the Institute for Systems Research.) This four-course, 12-credit certificate is designed for engineering professionals who wish to obtain added credentials in robotics. Certificate credits can be applied towards the Clark School's Master of Engineering degree.

The courses offered are: Planning for Autonomous Robots, which introduces planning techniques for realizing autonomous robots; Introduction to Robot Modeling, which introduces basic principles for modeling a robot with an emphasis on modeling manipulators based on serial mechanisms; Control of Robotic Systems, which introduces design of controllers for robotic systems; and Perception for Autonomous Robots, which introduces sensors including inertial sensors and accelerometers, sonar sensors, visual sensors and depth sensors, all of which relate to kinetic stabilization and motion estimation.

Requirements for admission to the certificate program include a bachelor's degree in engineering from an accredited institution; courses in mathematics (Calculus I, II, III, and Differential Equations) a GPA of 3.0 or better, official copies of transcripts and three letters of reference. The Graduate Record Exam (GRE) is *not* required; TOEFL is required for international students.

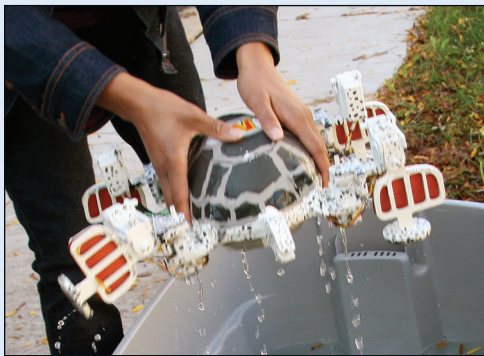
[Learn more.](#) Visit [robotics.umd.edu/content/graduate-certificate](http://robotics.umd.edu/content/graduate-certificate).

## Bergbreiter named robotics director

Associate Professor **Sarah Bergbreiter** (ME/ISR) has been named director of the Maryland Robotics Center. The microrobotics researcher brings an impressive record of accomplishments to the position. Bergbreiter is the recipient of a Presidential Early Career Award for Scientists and Engineers (PECASE) in 2013; an NSF CAREER Award for "Microrobot Legs for Fast Locomotion over Rough Terrain," in 2011; and a DARPA Young Faculty Award in 2008.



## Bioinspired robotics NSF REU program starts in 2017



THE STUDENT-BUILT 'ROBOTER' CAN SWIM AND CRAWL AND WAS INSPIRED BY THE STRUCTURE AND MOVEMENT OF TURTLES.

Beginning in 2017, the Maryland Robotics Center will offer undergraduates across the country an exciting opportunity to conduct research into bioinspired robots through a new NSF Research Experiences for Undergraduates (REU) program.

Bioinspired robots incorporate features of natural systems such as insects, birds, mammals and reptiles. They have the potential to significantly enable or enhance capabilities in manufacturing, health care, reconnaissance, exploration, food safety, and search and rescue.

Because of their unique design, bioinspired robots offer a truly interdisciplinary systems research challenge that encompasses biology, materials, mechanical design, control, sensors and actuators, power, electronics, and computer science among other topics.

The program, which is led by Professor **Hugh Bruck** (ME) and Maryland Robotics Center Director **Sarah Bergbreiter** (ME/ISR), will teach students about bioinspired robotics and their applicable technologies and applications; engage them in team-based interdisciplinary research programs; prepare them for graduate school or research jobs in industry and labs; and build a strong community between undergraduates, graduate student mentors, and faculty.

During the 10-week summer program (June 5–Aug. 11, 2017), students will develop research projects, attend technical tutorial seminars, visit local government labs involved in bioinspired robotics research, attend professional and academic development seminars, and tour Maryland's cutting-edge facilities supporting robotics research. Lunch discussions provide an informal setting for students and mentors to discuss technical and non-technical topics. The program culminates in student presentations on their summer research.

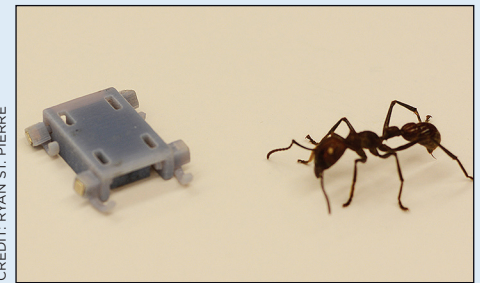
Students may work on insect-inspired microrobots; multifunctional robotic skins; robot birds; bioinspired robot navigation, sensing or actuation; dynamics and control of land and water soft robots; or bioinspired robotics for outer space.

Participants receive a \$5,000 stipend for their summer work and funding is available for on-campus housing and travel support. Local students (within commuting distance of the University of Maryland) are generally not eligible for on-campus housing.

The REU program seeks a talented and diverse cohort of student participants. Awards are made on the basis of students' strong potential and motivation to perform bioinspired robotics research, academic preparation in their area of interest, letters of reference, and interest in interacting with diverse mentors and peers in interdisciplinary research. Students from all undergraduate institutions, including the University of Maryland, are welcome to apply, and those from colleges and universities having limited research facilities (non-R1 schools), including tribal colleges and universities and community colleges, are especially encouraged to apply. Applicants must be U.S. citizens or permanent residents.

**Learn more.** Visit [www.robotics.umd.edu/REU/](http://www.robotics.umd.edu/REU/). The application deadline for the summer 2017 program is Feb. 17, 2017.

## Pronking robot in the news



CREDIT: RYAN ST. PIERRE

THE 'PRONKING' ROBOT NEXT TO A BULLET ANT.

*IEEE Spectrum*, the Institute of Electrical and Electronics Engineers' flagship magazine, recently spotlighted microrobotics work by Associate Professor **Sarah Bergbreiter** (ME/ISR) and her Ph.D. student **Ryan St. Pierre**.

"This Is the Tiniest Little Quadruped Robot We've Ever Seen," was featured in its robotics blog and highlighted work the two recently presented "on the gait characteristics of magnetically actuated legged robots weighing less than 2 grams" at IEEE's International Conference on Robotics and Automation.

The tiny robots currently measure 20mm in length and have the potential to get much smaller. After they are 3-D printed, magnetically actuated motors are added. Each of the robot's four hips has an embedded 2mm neodymium cube magnet. When a large magnet is rotated in close proximity to the robot, the magnetic field causes the small magnets to rotate as well, spinning the robot's legs. By changing the dipole orientation of the leg magnets in different combinations, the robot can move with different gaits, including trotting, waddling, bounding and pronking.

Bergbreiter and St. Pierre discovered that "pronking"—a motion where all four limbs lift off the ground simultaneously—was the best gait for moving over flat and mildly uneven terrain. On flat ground, the little robots were able to cover approximately four times their body length per second at this gait. However, as the going got tougher, other gaits outperformed pronking.

**Learn more.** Watch a video of the robot in action at [go.umd.edu/pronk](http://go.umd.edu/pronk).

## Fellows

Professor **John Baras** (ECE/ISR) has been elevated to the rank of Fellow by the International Federation for Automatic Control. The citation reads, "For contributions to the theory and applications of stochastic systems and control and communication networks and for leadership in cross-disciplinary research and education."

John Baras and ISR-affiliated Professor **Ben Shneiderman** (CS/UMIACS) have been named Fellows by the National Academy of Inventors. They were selected for their "highly prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development, and the welfare of society."

Professor **Sennur Ulukus** (ECE/ISR) has been elevated to Fellow by the Institute of Electrical and Electronics Engineers (IEEE) "for contributions to characterizing performance limits of wireless networks." Ulukus' research interests include cognitive radio networks, wireless network security and energy-harvesting and rechargeable networks.

## Plenary and invited speakers

Professor **Jonathan Simon** (ECE/Biology/ISR) was the invited opening speaker at the Paris Workshop on Decoding of Sound and Brain. He spoke on "Neural Representations of the Cocktail Party in Human Auditory Cortex." Alumna **Mounya Elhilali** (EE Ph.D. 2004), a former student of Professor **Shihab Shamma**, (ECE/ISR) also was a presenter, speaking on "Investigating Auditory Bottom-Up Attention." Elhilali is an associate professor at Johns Hopkins University.

In January, Simon was an invited keynote speaker at the Speech Processing in Realistic Environments Workshop in Groningen, Netherlands. Simon spoke on "Neural Representations of Speech, and Speech in Noise, in Human Auditory Cortex."

In September, he gave invited lectures on "Neural Representations of Speech, and Speech in Noise, in Human Auditory Cortex" at three different locations in China.

Associate Professor **Derek Paley** (AE/ISR) was a presenter at the 2016 US Frontiers of Engineering Symposium in Houston this September. The invitation-only event is organized by the National Academy of Engineering

and brings together a select group of emerging engineering leaders from industry, academia and government labs. Paley spoke on the topic, "Autonomy Underwater: Ocean Sampling by Autonomous Underwater Vehicles," at the "Extreme Engineering: Extreme Autonomy in Space, Air, and Land" session.

Associate Professor **Alireza Khaligh** (ECE/ISR) gave a keynote talk at the 2016 IEEE Transportation Electrification Conference and Expo, the flagship conference of IEEE in transportation electrification, in June. Khaligh spoke on "Plug-In Charging: Challenges, Opportunities, and Directions."

Professor **Anthony Ephremides** (ECE/ISR) was the guest speaker at a Princeton University Electrical Engineering Department commencement breakfast reception and ceremony in May. The event honored the department's 2016 Masters and Ph.D. recipients. Ephremides earned his Ph.D. in Electrical Engineering from Princeton in 1971.

In January, Professor **Carol Espy-Wilson** (ECE/ISR) delivered a plenary address for the WISE Inspirations Network at Stanford Speaker Series, "Privileging Signal: Listen, Pay Attention and Keep It Moving." Espy-Wilson, who earned her B.S. at Stanford, spoke to help young women understand "there is a lot of noise" as they move through their careers and lives, and that "privileging the signal means giving privilege to your calling, paying attention, not getting distracted by noise."

## Professional service

Associate Professor **Alireza Khaligh** (ECE/ISR) has been elected a 2017–2018 Distinguished Lecturer for the IEEE Industry Applications Society, one of 12 people worldwide to be so honored. The program allows local chapters to invite experts to visit and give lectures in their fields of specialization. Khaligh will be available to speak on two topics: "High-Efficiency, Isolated Onboard Electric Vehicle Battery Chargers with Ultra-wide DC Link Voltage Ranges," and "Regulated Transformer Rectifier Units for More Electric Aircrafts."

Khaligh also was the general chair of the 2016 IEEE Applied Power Electronics Conference and Exposition, held in March. It is the premier event for practicing power electronics professionals. In September he was

named an area editor for *IEEE Transactions on Vehicular Technology*. He will edit the "Vehicular Electronics and Systems" section.

## Best paper awards

Professor **Alexander Barg** (ECE/ISR) and his former postdoctoral researcher **Itzhak Tamo** (2013-2014) received the 2015 IEEE Information Theory Society Paper Award for their paper, "A family of optimal locally recoverable codes." The paper was published in the August 2014 edition of *IEEE Transactions on Information Theory*. Tamo is now a senior lecturer (assistant professor) at Tel Aviv University, Israel.

At the INFORMS annual meeting in November, Professor **S. Raghavan** (BMGT/ISR), **Si Chen** and **Ivana Ljubić** won the Telecommunications Section Prize Best Paper Award for "The Generalized Regenerator Location Problem," published in the *INFORMS Journal on Computing*. Raghavan also won the 2016 Prize for the Teaching of the OR/MS Practice.

## Patents

Professor **Anthony Ephremides** (ECE/ISR), former postdoctoral researcher and visiting scholar **Lasha Ephremidze**, Gigla Janashia, and Edem Lagvilava were issued U.S. Patent No. 9,318,232 on April 19. The patent is for "Matrix spectral factorization for data compression, filtering, wireless communications, and radar systems." The invention can be used for efficient implementation of engineering solutions to problems in data compression, filtering, wireless communications and radar systems, which are computationally reducible to matrix spectral factorization.

Professor **John Baras** (ECE/ISR), his former student **Paul Yu** (EE Ph.D. 2008), and long-time collaborator Brian Sadler of the Army Research Laboratory were issued U.S. Patent 9,161,214 for "Wireless communication method and system for transmission authentication at the physical layer." It is an authentication scheme encompassing a large family of authentication systems which may be built over existing transmission systems.

## Promotions

**David Lovell** (CEE/ISR) has been promoted to full Professor. His research interests are in geometric methods of transportation facility



design; sensors in civil engineering applications; vehicle technology; traffic engineering, operations and control; dynamic retroreflective and electrophoretic materials for transportation applications.

**Richard La** (ECE/ISR) also has been promoted to full Professor. His research interests are in Internet congestion control, resource allocations in wireless networks, network performance modeling, game theory, contract theory, and network pricing mechanisms.

ISR-affiliated **Patrick Kanold** (Biology) has been promoted to full Professor. His research investigates the circuits of the developing and adult brain from a single-cell level to large assemblies of neurons by using advanced imaging and electrophysiological methods.

## New ISR faculty

ISR gained five affiliate faculty in July.

**Ken Wood, D.O.**, is a professor of medicine at the University of Maryland School of Medicine in Baltimore. He is the associate chief compliance officer for the University of Maryland Medical Center and director of the Maryland Critical Care Network. Wood's research joins systems engineering applications to critical care medicine; he is also active in re-engineering health care processes.

**Bill Fagan** is professor and chair of the Department of Biology. His research involves meshing field biology with theoretical models to address critical questions in community ecology and conservation biology. Several areas illustrate this melding of theory and problem-solving: spatial ecological dynamics; ecoinformatics, biodiversity databases, and conservation planning; and biological stoichiometry and paleoecostoihioproteomics.

**Daniel Butts** is an associate professor in the Department of Biology and the Program in Neuroscience and Cognitive Science. His research interests are in sensory computation and neural coding; natural vision and the role of eye movements; network modulation of sensory processing; statistical modeling of neural data; and activity-dependent development and synaptic plasticity.

**Monifa Vaughn-Cooke** is an assistant professor in the Department of Mechanical Engineering. Her research interests are in

human reliability assessment, human factors, systems engineering, healthcare system and medical device design, design decision making, psychometric tool development, bio-behavioral risk assessment and decision support systems.

**Ilya Ryzhov** is an assistant professor in the Smith School's Department of Decisions, Operations and Information Technology. His research interests are in business analytics, encompassing topics in optimization, probability and statistics. He studies decision-making under uncertainty, often with the additional dimension of information collection.

## Books

Professor **Dana Nau** (CS/ISR) and his colleagues Malik Ghallab and Paulo Traverso have written *Automated Planning and Acting*, a sequel to their 2004 book *Automated Planning*. The book introduces complex computational techniques for planning and performing actions to graduate students and others interested in this area of artificial intelligence.

ISR-affiliated Professor **Ben Shneiderman** (CS/UMIACS) is the author of the Oxford University Press book, *The New ABCs of Research: Achieving Breakthrough Collaborations*. The book recognizes the nature of human creativity, the power of teamwork, and the catalytic effects of innovation. It covers strategies for nurturing individuals, managing teams, weaving networks, and cultivating communities.

## Honors

Professor **Min Wu** (ECE/UMIACS) received the 2015 IEEE Signal Processing Society Meritorious Service Award for exemplary service to and leadership in the society.

Professor **John Baras** (ECE/ISR) will receive IEEE's 2017 IEEE Simon Ramo Medal. The award is given for exceptional achievement in systems engineering and systems science.

ISR-affiliated Professor **Steven Gabriel** (ME) has been named an associated member of the Group for Research in Decision Analysis. He will concentrate on developing models and algorithms to solve optimization and equilibrium problems in energy and other networked industries.

Gabriel also was an invited speaker at three European energy-related workshops in Fall 2016. He spoke on topics related to international power markets.

Professor **Jeffrey Herrmann** (ME/ISR) has received the Institute of Industrial Engineers' 2016 IIE/Joint Publishers Book of the Year Award for his textbook, *Engineering Decision Making and Risk Management*. The award is given for "an outstanding published book that focuses on a facet of industrial engineering, improves education, or furthers the profession."

## In the news

MIT recently featured Professor **Carol Espy-Wilson** (ECE/ISR) in an issue of its *Technology Review* magazine for her expertise in both academia and industry. Espy-Wilson is an alumna of MIT and the first African-American woman to earn her doctorate in electrical engineering there. Her research integrates engineering, linguistics and speech science. Espy-Wilson founded the company Omni-Speech, and as CEO leads her company to improve voice clarity on cell phones and communication devices in noisy environments.

## Maryland awards

Associate Professor **Alireza Khaligh** (ECE/ISR) has received the Clark School's 2016 Junior Faculty Outstanding Research Award. This is one of the highest honors the Clark School bestows on junior faculty.

ISR-affiliated Associate Professor **Ian White** (BioE) received the university's 2016 Faculty Advisor of the Year Award. He was selected for his ability to help students reach their full potential, his individual approach, his dedication to helping students develop as researchers, and his open door policy. A former advisor for the Biomedical Engineering Society, White helped establish the university's chapter of Alpha Eta Mu Beta, the national biomedical engineering honor society, as well as the Bioengineering Honors program.

ISR Associate Research Scientist **Didier Depireux** has won the inaugural Provost's Excellence Award for Professional Track Faculty for his excellence in research. He was selected by a panel of instructional and research faculty serving in primarily administrative appointments.

## Opportunities for industry to partner with ISR

There are many ways for representatives from industry to participate in and benefit from ISR's activities. Here are just a few of the opportunities ISR makes available.

**Sponsoring ISR seminar series.** Sponsoring an ISR seminar series brings a company a number of benefits, including increased visibility to the ISR community, including students. The following companies currently are sponsors. Intelligent Automation, Inc., has sponsored ISR's faculty colloquium series since 2011. Lockheed Martin has sponsored the Robotics Seminar Series since Fall 2012. United Technologies Research Center has been sponsoring the Control and Dynamical Systems Invited Lecture Series since Fall 2014. Northrop Grumman began sponsoring the ISR Microsystems Seminar Series in Fall 2016. Several other ISR seminar series currently are available for sponsorship.

**Participating in an ISR student-company information session.** Several times a semester, ISR holds interactive events that allow a company to present itself to our students. Industry representatives talk about their company, its line of work and the opportunities available for internships and full-time hires. Students bring their CVs, talk with the representatives and leave with valuable information about a potential employer. We always are open to hearing from new companies that would like to participate in these events.

**ENES 489P student team project mentoring and competition judging.** ISR offers a senior-level undergraduate capstone course that introduces undergraduate engineering students to model-based systems engineering concepts. They learn about technical aspects of systems engineering practice through team-based project development and a systematic step-by-step procedure for product development. Team projects address problems from a wide variety of disciplines. Industry is invited to suggest projects, mentor student teams, and sponsor and participate in the panel judging the competition held at the end of the course. We encourage companies to participate in any of these ways.

**ISR alumni networking receptions.** ISR holds these receptions in the spring and the fall for its local alumni, current students, faculty and friends from industry. The locations rotate throughout the Maryland, Virginia and Washington, D.C. region. The receptions are a great opportunity for alumni to reconnect with each other and their former advisors, and for graduate students to network with alumni and industry regarding internships and full-time, post-graduation employment. If you or your company are local to the region and would like to attend, we encourage you to let us know. We will place you on the notification list for upcoming receptions.

**Learn more.** Contact ISR's External Relations Director **Jeff Coriale** at [coriale@umd.edu](mailto:coriale@umd.edu); 301-405-6604.

## ISR Strategic Advisory Council

ISR's Strategic Advisory Council is comprised of 11 scientifically and technically diverse, seasoned professionals, principally from industry. The Council is a key component of the Institute for Systems Research, and provides evaluation and guidance for its research directions, educational programs, and management, with the goal of delivering strategic benefits to ISR and to its external partners. The current members of the council include:

**Dr. Andrzej Banaszuk;** Senior Director, Systems; United Technologies Research Center

**Dr. Albert Benveniste;** Directeur de Recherche; IRISA/INRIA, France

**Mr. Marco De Fazio;** Advanced Research Manager; Advanced Systems Technologies; ST Microelectronics

**Dr. Evgeni Gousev;** Senior Director; QUALCOMM

**Dr. Robert Mandelbaum;** Director, Advanced Technology Laboratories; Lockheed Martin

**Dr. Vikram Manikonda,** Chair; President & CEO; Intelligent Automation, Inc.

**Dr. Daniel Mulvihill;** Director of Reliability, System Safety, and Specialty Engineering; Aerojet Rocketdyne

**Dr. R. Eric Reinke;** Vice President and Chief Technology Officer; Northrop Grumman Mission Systems

**Dr. Vijay Srinivasan;** Chief, Manufacturing Systems Integration Division; National Institute of Standards & Technology

**Dr. Kuansan Wang;** Director, Internet Services Research Center; Microsoft Research

**Dr. Donald York;** Technical Fellow, Senior Systems Engineer; TASC, An Engility Company

## ISR alumni are LinkedIn!

There are many ways to stay in touch with ISR. Did you know there is an ISR alumni LinkedIn group? Join almost 200 of your fellow ISR alums who are already in our group: [www.linkedin.com/groups/6644581](http://www.linkedin.com/groups/6644581).

We'd love to share your news online and here in *System Solutions*. Just send your updates to [rebeccac@umd.edu](mailto:rebeccac@umd.edu). And thanks!





L-R: MINGYAN LIU, WESLEY HUFFSTUTTER, MANISH KARIR  
AT QUADMETRICS HEADQUARTERS IN ANN ARBOR, MICH.

## Mingyan Liu sells cyber risk company to FICO

A cyber risk startup company led by **Mingyan Liu** (MSSE 1997; EE PhD 2000), **Manish Karir** (EE BS 1996; EE MS 1999) and Wesley Huffstutter has been purchased by FICO, the company known for credit rating scores.

QuadMetrics leverages predictive analytics to monitor signals from both open source and proprietary data sources, providing an overall security score for an enterprise. It helps security professionals address gaps and enables partners and insurers to understand a firm's security risk. The system is based on Liu's research in cybersecurity and insurance markets at the University of Michigan, where she is a professor of electrical engineering and computer science.

"We have built a system using state-of-the-art Internet measurement and predictive analytics techniques to enable quantitative security risk assessment as well as proactive measures," Liu said. "Ours is the only predictive solution currently on the market."

At Maryland, Liu was advised by Professors **John Baras** (ECE/ISR) and **André Tits** (ECE/ISR). Karir also was advised by Baras for his MS degree, working on security of Internet over satellite protocols.

## Shinkyu Park is MIT postdoc

**Shinkyu Park** (EE Ph.D. 2015) is currently a postdoctoral researcher in the Senseable City Laboratory at the Massachusetts Institute of Technology. He is working on the Underworlds research project, designing a distributed robotics system to examine wastewater in the sewage network and extract information on human health and behavior from sewage samples. The findings and data will be

used to shape public health strategies and to study urban epidemiology.

At Maryland, Park was advised by Associate Professor **Nuno Martins** (ECE/ISR).

## Ravi Tandon joins University of Arizona faculty

**Ravi Tandon** (EE Ph.D. 2010) has joined the University of Arizona's Electrical and Computer Engineering Department as a tenure-track assistant professor. Tandon's

research interests are in information theory, wireless communications and signal processing, with applications to machine learning and data analytics, distributed cloud storage systems, cyber-physical systems, cyber-security, and privacy. For his Ph.D. thesis, he developed capacity bounds for wireless networks with feedback, relaying and cooperation. At Maryland, Tandon was advised by Professor **Sennur Ulukus** (ECE/ISR).

## Tan named IEEE Fellow; 'Foundation Professor'

**Xiaobo Tan** (EE Ph.D. 2002) has been elevated to a Fellow of IEEE "for contributions to modeling and control of smart materials and underwater robots." He also has been named an MSU Foundation Professor. At Maryland, Tan was advised by Professor **John Baras** (ECE/ISR) and Professor **P. S. Krishnaprasad** (ECE/ISR).

Tan's research interests are in electroactive polymer sensors and actuators, modeling and control of smart materials, and bio-inspired underwater robots.

MSU Foundation Professorships recognize faculty who are world-class scholars. Tan will hold the designation permanently.

## Radha Poovendran is PI for cybersecurity MURI

**Radha Poovendran** (EE Ph.D. 1999) is the principal investigator for a five-year, \$7.5 million Department of Defense Multidisciplinary University Research Initiative (MURI) grant. "ADAPT: An Analytical Framework for Actionable Defense against Advanced Persistent Threats," will protect against a new type of continuous computer hacking attack, known as advanced persistent threats.

Poovendran is the chair of the University of Washington Electrical Engineering Department. He founded and directs its Network Security Lab. At Maryland, Poovendran was advised by Professor **John Baras** (ECE/ISR).

## Peng Qiu wins NSF CAREER Award

**Peng Qiu** (EE Ph.D. 2007) has received a 2016 NSF Faculty Early Career Development (CAREER) Award for "Experimental Design and Model Reduction in Systems Biology." He is an assistant professor in the Department of Biomedical Engineering at Georgia Tech and Emory Universities. The five-year award is worth \$440,000. He was advised by Professor **K. J. Ray Liu** (ECE).

## Leandros Tassioulas wins IEEE Kobayashi Award

**Leandros Tassioulas** (Ph.D. EE 1991) has been named the recipient of the 2016 IEEE Koji Kobayashi Computers and Communications Award for "contributions to the scheduling and stability analysis of networks." Tassioulas is the John C. Malone Professor of Electrical Engineering at Yale University. At Maryland, Tassioulas was advised by Professor **Anthony Ephremides** (ECE/ISR).

Tassioulas has revolutionized scheduling and stability analysis in communications networks, providing dynamic resource allocation tools to improve performance of wireless networks and Internet switches.

## Enlu Zhou earns tenure at Georgia Tech

**Enlu Zhou** (EE Ph.D. 2009) has been promoted to associate professor with tenure in the H. Milton Stewart School of Industrial & Systems Engineering at Georgia Tech.

Her research interests include simulation optimization, stochastic control, and Monte Carlo methods, with applications in financial engineering and revenue management. In 2015 she won an NSF CAREER Award for "Optimization and Sampling in Stochastic Simulation." She also is the recipient of a 2012 Young Investigator award from the Air Force Office of Scientific Research for "Dynamic Decision Making under Uncertainty and Partial Information."

At Maryland she was advised by Professor **Steve Marcus** (ECE/ISR) and Professor **Michael Fu** (BMGT/ISR), and was part of the Clark School's Future Faculty program.



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## NEXTOR celebrates 20 years of aviation operations research



CREDIT: REGINA KING

ISR has been the administrative home of NEXTOR since its inception in 1996 as a four-university Federal Aviation Administration Center of Excellence for Aviation

Operations Research. Today NEXTOR is an eight-university FAA-sponsored consortium with a rich history of working on a variety of activities with the FAA, other government

sponsors and industry partners. A 20th anniversary workshop held in College Park at the end of September brought together well over 100 faculty and present and former students as well as sponsors and industry partners.

Participants celebrated NEXTOR research accomplishments and the rich legacy of alumni who have graduated from its programs and are now the next generation of leaders in air transportation operations.

Keynote speakers included Randy Park, the deputy chief operating officer of the FAA Air Traffic Organization; and Norm Fujisaki, the first FAA NEXTOR program officer.