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CONNECTIONS

DEPARTMENT of ELECTRICAL & COMPUTER ENGINEERING

A. JAMES CLARK SCHOOL *of* ENGINEERING

Machine Learning

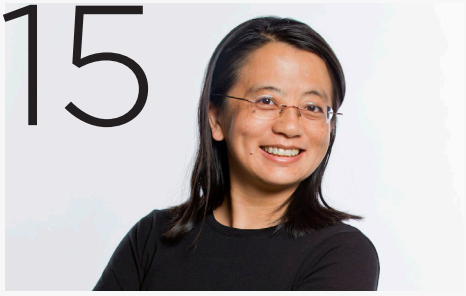
Education & Research in ECE

In This Issue:

2018-2019 | Vol. 24 No. 1

CONTENT

2018-2019 | Vol. 24 No. 1



message from the chair

I am honored to have been selected to serve as the Interim Chairman of the Department of Electrical and Computer Engineering (ECE) for the period of July 1, 2018 – June 30, 2019. I have served as a Professor at the University of Maryland in ECE since 1983, and I hold a permanent joint appointment in the University of Maryland Institute for Advanced Computer Studies (UMIACS). While at UMD, I have served as Director of UMIACS from 1994-2004 and as Interim Vice President and Chief Information Officer of the University of Maryland's Office of Information Technology from 2010-2011. I have also been very involved with ECE, teaching undergraduate and graduate courses and maintaining a strong research group. I look forward to contributing to our department's continued advance as one of the finest programs in the country.

Our outstanding 60 tenure-track faculty members, 26 researchers and postdocs, and students are conducting incredible research in many areas including Quantum Technology, Cybersecurity, Signal Processing, Embedded Systems and Internet of Things (IoT), Devices and Circuits, and Applied Physics. Their work involves cutting-edge, cross-disciplinary, and team-oriented research projects that have led to major contributions to many areas of ECE. For this issue of *Connections*, we are pleased to feature Machine Learning Education and Research. You will read about how the subject has rapidly evolved since the introduction of an undergraduate course in the spring of 2017. Machine Learning has a strong presence within the department and many ECE faculty and students conduct a wide range of research activities in this area. We strive to keep our curriculum fresh and dynamic, and as a result we are currently working diligently to develop a cross-disciplinary minor in Machine Learning with our colleagues in the Department of Computer Science (CS). Other major joint efforts with CS in Artificial Intelligence and Machine Learning are currently underway.

In addition, we are proud to announce that Dinesh Manocha has joined the department this year as the Paul Chrisman Iribe Professor of Computer Science through a joint appointment with CS. Prof. Manocha's research focuses on geometric and scientific algorithms with applications to computer graphics, robotics, and virtual reality.

Moreover, our ECE faculty members have won prestigious honors and have been elevated as Fellows to a variety of professional societies. Professors John Baras and Isaak Mayergoyz have been named University of Maryland Distinguished University Professors, and Professor Sennur Ulukus has been awarded the Anthony Ephremides Chair in Information Sciences and Systems in addition to being ECE's new Associate Chairman of Graduate Studies, to name a few.

ECE remains committed to enhancing undergraduate education. While the number of students choosing electrical or computer engineering as a major has increased, we have emphasized hands-on education through sponsored team competitions, National and International Research Experience for Undergraduates in Transportation Electrification, and the introduction of the Texas Instruments Peer Mentoring Fellowship. Our Corporate Affiliates sponsor invaluable programs and research in ECE, which foster collaborative efforts between the department and industry. ECE's Colloquium Series, sponsored by Booz Allen Hamilton, will be celebrating its 10th anniversary this year.

The University has also unveiled *Fearless Ideas: The Campaign for Maryland*, a comprehensive, campus-wide, seven-year development effort to raise $1.5 Billion by December 31, 2021. For ECE, we hope to continue to improve undergraduate teaching labs and facilities, increase funded research projects for all students, and attract outstanding faculty in innovative research areas. In addition, a matching gift scholarship program will be implemented where all new scholarship gifts over $50,000 will be matched through a generous donation from the Clark Foundation. This will allow UMD to offer attractive financial aid packages to students most in need.

It is my sincerest hope that you will take the opportunity to help ECE in whatever way is most meaningful to you. The time, expertise, and financial support of our alumni, whether personal or through industry sponsorship, are crucial to the success of our programs. To learn more about our department or to discuss any of the subjects outlined in *Connections*, please contact our Director of External Relations, Amanda Stein, at steina@umd.edu.

Thank you for supporting our department and inspiring Maryland pride!

Joseph F. JáJá

PROFESSOR AND INTERIM CHAIR

CONNECTIONS is published for alumni and friends of the Department of Electrical and Computer Engineering at the A. James Clark School of Engineering, University of Maryland, College Park. Your alumni news and comments are welcome. Please send them to: Kara Stamets, Marketing Communications Coordinator in ECE, 2455 A.V. Williams Building, College Park, MD, 20742 or stametsk@umd.edu. Visit our website at: **www.ece.umd.edu**

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the 2017-2018 graduating class

233

B.S. Degrees were awarded
62 in the fall
171 in the spring

523

Students (51.6%) were in either College Park Scholars or University Honors

Computer Engineering

85% employed or attending graduate school (77% employed, 8% grad school)

Top Employers for CE:

- Amazon
- Appian
- Google
- JHU Applied Physics Lab
- Northrop Grumman

Electrical Engineering

80% employed or attending graduate school (71% employed, 9% grad school)

Top Employers for EE:

- Booz Allen Hamilton
- Hughes
- Leidos
- Lockheed Martin
- Texas Instruments

Fast Facts:

18

Students studied abroad in Fall '17 and Spring '18

Electrical & Computer Engineering Programs Accredited by ABET

The Engineering Accreditation Commission (EAC) of ABET recently held its 2017 Fall Meeting to act on the program evaluations conducted in 2017. The undergraduate programs to aquire a Bachelor of Science degree in both Electrical and Computer Engineering have been accredited through 2024.

82%

In-state students

ECE Inventions Sweep Innovate Maryland

The University of Maryland announced its Invention of the Year award winners—innovations with potential for life-changing impact in health outcomes, electric vehicle charging, and facial detection software—on April 11, 2018 at Innovate Maryland, an annual event hosted this year at The Hotel at the University of Maryland.

More than 400 faculty, students, staff, and campus partners gathered to celebrate groundbreaking research, innovations, entrepreneurship, and partnerships connected to the University of Maryland. More than a dozen startup companies borne from UMD research were featured in a showcase, with products ranging from a smart wood stove and a living green patio umbrella to an electronic home plate and mobile personal air conditioner. Prior to the awards program, the UMD Office of Technology Commercialization hosted a CEO Mixer to help connect faculty entrepreneurs with serial entrepreneurs in search of their next venture opportunity.

Since 1987, UMD has honored exceptional inventions that have the potential to make an important impact on science, society, and the free market. The Invention of the Year award finalists are selected from prior-year invention disclosures in three categories: Physical Sciences, Life Sciences, and Information Sciences. A panel of judges selected one invention from each category to win the 2017 Invention of the Year Award. Julie Lenzer, Associate Vice President for Innovation and Economic Development and Co-Director of UM Ventures, presented the awards.

Professor **Alireza Khaligh** (ECE/ISR) and his Ph.D. students **Jiangheng Lu** and **Ayan Mallik** were the Physical Sciences and Overall Invention of the Year Winners for "Integrated Power Electronics Interface for Enhanced Electric Vehicle Charging."

Although electric vehicles are becoming increasingly popular, they have yet to reach widespread adoption as manufacturers aim to reduce costs. One reason electric vehicles are expensive is because they have two batteries, which require two different charging systems. Khaligh, Lu, and Mallik invented a new interface for electric vehicle charging that condenses previous charging mechanisms into one system which is over 50 percent cheaper and lighter, almost 40 percent smaller, and eight percent more efficient.

Professor **Reza Ghodssi** (ECE/ISR), **Ryan Huiszoon**, Ph.D. student in the Fischell Department of Bioengineering, and **Pradeep Rajasekaran**, post-doctoral researcher (ISR) won the Life Sciences category for "Flexible Urinary Catheter Insert to Detect and Prevent Bacterial Infections."

Urinary tract infections are the most commonly reported health-care associated infection, and more than 75 percent of reported cases involve the use of a catheter. Catheter-associated UTIs develop when bacterial biofilms form on the surface of an indwelling catheter. Ghodssi, Huiszoon, and Rajasekaran invented a catheter insert that can detect and prevent the formation of biofilms and can treat the infection when combined with an antibiotic.

Professor **Rama Chellappa** (ECE/UMIACS), **Rajeev Ranjan,** graduate student with the University of Maryland Institute for Advanced Computer Studies (UMIACS), and **Carlos Castillo,** assistant research scientist at UMIACS, won the Information Sciences category for "Robust System for Large Scale Facial Verification and Search."

Photos courtesy of UMD Research

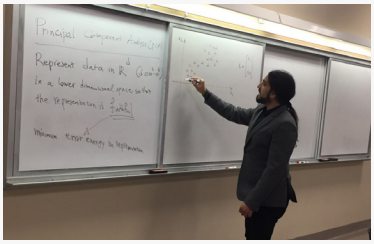
Facial recognition software has steadily gained popularity over the past decade, but its unreliability and tendency to produce false-positives make it problematic for widespread adoption. However, Chellappa, Ranjan, and Castillo recognized the potential for face-detection software adoption in many industries and have invented a new software that uses deep convolutional neural networks to analyze images, producing vastly better results than previous software. ■

Machine Learning
Education & Research in ECE

"Topics in Signal Processing; Machine Learning" (ENEE 439M) is an undergraduate senior level course at the University of Maryland (UMD), College Park that is taught by Prof. **Behtash Babadi** (ECE/ISR), and aims to teach students the foundations of machine learning (ML) and statistical pattern recognition. ML is the science behind systems that can make sense of data, identify patterns, and make predictions with minimal human intervention. ML has proven successful in numerous applications such as medical imaging, computer vision, recommender systems, and neural engineering.

Inspiration for the Development of the Course

In the spring of 2017, Prof. Babadi and Distinguished University Professor **Rama Chellappa** (ECE/UMIACS) developed and co-taught *ENEE439, Introduction to Machine Learning,* and received positive and overwhelming demand to continue offering the course. ENEE 439M is therefore the second offering, with nearly 70 students enrolled this past spring. The students in ENEE 439M learn the mathematical foundations of ML, gain insight on how to pose various problems in data analysis in the framework of ML, and implement classical and state-of-the-art ML algorithms on real-world data sets. A sample project of the course includes a classical problem of hand-digit recognition, in which students will solve the problem by implementing various ML algorithms that aim to recognize handwritten digits. A real-world application of this data analysis tool is depositing checks at ATM machines, which today can perfectly recognize handwritten digits and identify a check amount automatically. Another project includes designing a recommender system that utilizes available user ratings of various products to provide recommendations to online users, advanced versions of which are seen on websites such as Amazon, Facebook, and Netflix.



Prof. Babadi's own research deals with ML and signal processing techniques that use high-dimensional recordings from the brain in order to decipher the neural mechanisms underlying sophisticated brain functions such as attention, learning, and decision-making.

For those who are interested in taking the course, Prof. Babadi says, "ML is an exciting but advanced topic, therefore senior level undergraduates who have a background and interest in probability, statistics, and algorithm design should definitely consider taking this course." Additionally, Prof. Babadi adds, "the ML course will equip our seniors with a unique skill set that is highly advantageous in building successful careers in industry in related areas such as automation, data analytics, and neural engineering, or joining top graduate programs in science and engineering."

The ML field has its origins in pattern recognition, statistical learning, and artificial intelligence. While research and teaching activities in ML are traditionally associated with the computer science discipline, at the University of Maryland, the ECE department has a strong presence in this area. Prof. Rama Chellappa's research in computer vision is heavily based on ML techniques. Over the past four years, his group has developed under the support of an IARPA effort known as JANUS, a system for unconstrained face verification and recognition using deep learning methods. One of the concerns of ML developers is the sensitivity of the systems to adversarial inputs, which may lead to a reduction in performance. Chellappa's group has developed methods based on generative adversarial networks, for the tasks of providing robustness to black and white attacks as well as domain adaptation, which allow ML-based systems to adapt to new environments and sensors.

"I think ENEE439 is a fantastic class, and was definitely eye opening for me," says alumnus **Cheng Peng** (B.S. '16), now a Research Assistant in Prof. Chellappa's research group. "When I took it, Prof. Babadi and Prof. Chellappa presented it with a lot of insights/intuitions while staying mathematically rigorous. The things I learned from that class, such as the concept of Bayesian Inference, Neural Networks, and Deep Learning, are useful in many facets of both the industry and academia. As far as I know, many top universities, such as Stanford, Berkeley, MIT, etc. are moving these concepts into their undergraduate curriculum, due to the rise in popularity of Artificial Intelligence (AI) and ML, and I think ENEE439 provides UMD students at least equally challenging and rewarding material. For those who wish to get an introduction to machine learning and data analytics, this class will give you a very good foundation. I joined Prof. Chellappa's research group after taking that class, and am currently working on problems in the domain of computer vision. I'd say that taking ENEE439 definitely has helped me in understanding the academic landscape of the field of deep learning and AI."

ECE's Diverse Faculty Research in ML

Professor **Steve Marcus** (ECE/ISR), in joint research with Professor **Michael Fu** (Smith School/ISR/ECE affiliate) and their colleagues, has developed simulation-based algorithms for Markov decision processes that have been incorporated into ML systems and algorithms. For example, ideas first explored in their work are at the core of AlphaGo, Google's Go-playing artificial intelligence system that defeated some of the top-ranked Go players in the world in 2016. AlphaGo is powered by a combination of machine learning and Monte Carlo tree search techniques that were based on algorithms developed by Professors Marcus and Fu. Their current research is focused on algorithms that incorporate risk sensitivity into ML.

Professor **Edward Ott** (ECE/PHY/IREAP) focuses on applying ML to issues in nonlinear dynamics. His work has addressed problems in which data are taken from an unknown dynamical system and then used to infer various aspects. Particular interest is in large spatiotemporally chaotic systems, with past and current studies on inference of unmeasured state variables, forecasting future system states, inferring Lyapunov exponents, using data and ML to mitigate error in a knowledge-based dynamical model, and machine learning Kalman filters. One application of interest for the future is using the above to improve data assimilation for weather forecasting. Ott's work on ML to predict chaos has been featured recently in *Wired* Magazine (read more on page 9).

Professor **Tudor Dumitrias** (ECE/UMIACS/MC2) focuses his work on data-driven security. He conducts empirical studies of adversary behavior, builds ML systems for detecting malware and attacks, and studies the security of ML in adversarial environments. His research group recently built a system called FeatureSmith, to automate the feature engineering process to detect malware, which is often the toughest aspect of building ML systems.

Professor **Uzi Vishkin's** (ECE/UMIACS) research interests are in parallelism in computing, design and analysis of algorithms, programming and architecture for an easy-to-program general-purpose parallel computer platform, ML for parallel computing, pattern matching, and computing theory.

"ML and Parallel Computing (PC) share a historical anecdote," says Vishkin. "Each of these fields has experienced sharp ups and downs for at least five decades. However, in what has been described as serendipity, the success of classic ML approaches known as 'deep learning' coincides with unprecedented market industry interest in PC, as this ML success was enabled by highly parallel graphic processing units (GPUs)."

Prof. Uzi Vishkin, a parallel algorithms pioneer and PC expert, believes that the whole field of ML—beyond just deep learning, where the results are also known for handicaps such as defying human understanding and thereby limiting usability—is potentially a "killer application" for PC. An exciting research challenge for the two fields would be to jointly develop new opportunities for greatly broadening the bandwidth between ML and PC. Like winning the lottery, serendipity is nice when it happens. But, serious engineering requires strategic research-based planning. In fact, Prof. Vishkin's team has begun researching how his methodical approach (known as XMT) for building hardware and software PC systems, guided by the main theory of parallel algorithms (known as PRAM), which he co-founded, can help. They have already demonstrated that this approach can drastically outperform GPUs for some successful marketplace ML approaches.

Professor and ECE Interim Chairman **Joseph JaJa's** research group is developing deep learning techniques tailored for network-based data arising in many domains such as social media, biology, transportation, and neuroscience. In a recent joint work with Professor **Luiz Pessoa** (Department of Psychology and Maryland Neuroimaging Center) and ECE graduate student **Manasij Venkatesh**, a powerful approach analyzed the temporal dynamics of brain networks during task or mental conditions using fMRI (functional Magnetic Resonance Imaging) data. Other applications explored using different types of deep neural networks, including protein and chemical compounds datasets.

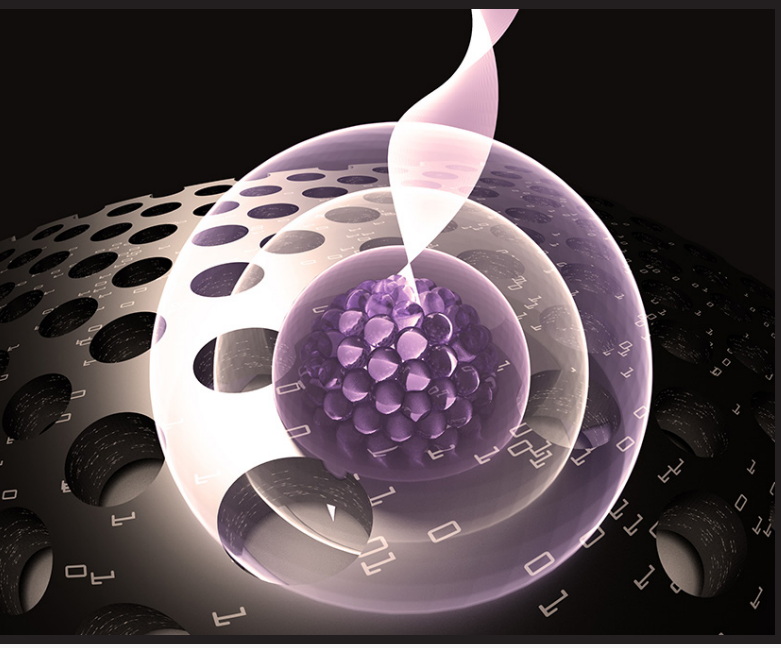
Professor **Min Wu's** (ECE/UMIACS/MC2) research projects harvest very small signals and analyze them to answer important questions in security and health applications. Her research on these "micro signals" builds on the synergy of advanced signal processing, machine learning, and domain knowledge. One of her recent projects exploited the invisible signals in video and audio that come from the power grid. "The frequency of power mains goes slightly up and down, depending on the load placed on the grid," says Wu. "We have developed techniques to extract these kinds of micro signals from a video, and it gives us some clue about where the video was taken." In fact, electric grids of different countries have their telltale patterns of the power frequency variation, and this is where machine learning can help forensic scientists link the power variation pattern to the likely grid in which the video was taken.

Together with her graduate students and several international colleagues, Prof. Wu transferred the knowledge from the research to educational outreach tailored to an undergraduate level. Their proposal was adopted by the IEEE for its "Signal Processing Cup" global undergraduate competition. More than 300 students from 23 countries across six continents formed 52 teams that registered for the competition, and most of them were studying ECE in their respective universities. The participants were asked to extract the power traces from sensor recordings, then build a machine-learning system that could learn the unique characteristics of the power signals from different grids. "We were so happy to see the enthusiastic participations from undergraduates around the world, including strong involvement of female students in a number of teams," says Wu. "Many teams considered the competition a catalyst to help them integrate multiple subjects in the ECE training, including machine learning, sensing, signal processing, and circuit, to solve a real-world problem."

Upcoming: A Minor in ML at UMD

Due to the rising demand for ML researchers, many academic institutions have initiated programs for training and equipping undergraduate students with ML skill sets. UMD ECE undergraduate students are already being rigorously trained in areas such as probability and statistics, computer programming, and signals & systems, which form some of the main ingredients of ML. In addition, UMD Computer Science (CS) undergraduates have strong backgrounds in the areas of algorithm design, AI, computing, and programming languages. To optimally utilize these sources of strength, the ECE and CS Departments are working toward developing a streamlined minor centered on ML that will include core and elective courses from the ECE and CS Departments. The minor is a work in progress, but is expected to be a tremendous advantage to students interested in applying these skills to real-world problems in both industry and academia.

"The course itself has facilitated internships for several ECE students at top companies, both locally and nationwide, and the minor will provide a wider range of UMD's undergraduate students with a competitive advantage in their future careers in industry or academia," says Babadi. ■



Semiconductor Quantum Transistor Opens the Door for Photon-based Computing

Researchers demonstrate the first single-photon transistor using a semiconductor chip. They used a single photon, stored in a quantum memory, to toggle the state of other photons. Credit: E. Edwards/Joint Quantum Institute

Transistors are tiny switches that form the bedrock of modern computing; billions of them route electrical signals inside a smartphone, for instance.

Quantum computers will need analogous hardware to manipulate quantum information. But the design constraints for this new technology are stringent, and today's most advanced processors can't be repurposed as quantum devices. That's because quantum information carriers, dubbed qubits, have to follow the rules of quantum physics.

Scientists can use many kinds of quantum particles as qubits, even the photons that make up light. Photons have added appeal because they can swiftly shuttle information over long distances, and they are compatible with fabricated chips. However, making a quantum transistor triggered by light has been challenging because it requires that the photons interact with each other, something that doesn't ordinarily happen on its own.

Now, researchers at the University of Maryland's A. James Clark School of Engineering and Joint Quantum Institute (JQI)—led by Professor of Electrical and Computer Engineering, JQI Fellow, and Institute for Research in Electronics and Applied Physics Affiliate Edo Waks—have cleared this hurdle and demonstrated the first single-photon transistor using a semiconductor chip. The device, described in the July 6 issue of *Science*, is compact; roughly one million of these new transistors could fit inside a single grain of salt. It is also fast and able to process 10 billion photonic qubits every second.

"Using our transistor, we should be able to perform quantum gates between photons," says Waks. "Software running on a quantum computer would use a series of such operations to attain exponential speedup for certain computational problems."

The photonic chip is made from a semiconductor with numerous holes in it, giving it a honeycomb-like appearance. Light entering the chip bounces around and gets trapped by the hole pattern. A small crystal called a quantum dot sits inside the area where the light intensity is strongest. Analogous to conventional computer memory, the dot stores information about photons as they enter the device. The dot can effectively tap into that memory to mediate photon interactions—meaning that the actions of one photon affect others that later arrive at the chip.

"In a single-photon transistor, the quantum dot memory must persist long enough to interact with each photonic qubit," says Shuo Sun, lead author of the new work and postdoctoral research fellow at Stanford University, who was a UMD graduate student at the time of the research. "This allows a single photon to switch a bigger stream of photons, which is essential for our device to be considered a transistor."

To test that the chip could operate like a transistor, the researchers examined how the device responded to weak light pulses that usually contained only one photon. In a normal environment, such dim light might barely register. However, in this device, a single photon gets trapped for a long time, registering its presence in the nearby dot.

The team observed that a single photon could, by interacting with the dot, control the transmission of a second light pulse through the device. The first light pulse acts like a key, opening the door for the second photon to enter the chip. If the first pulse didn't contain any photons, the dot blocked subsequent photons from getting through. This behavior is similar to a conventional transistor, where a small voltage controls the passage of current through its terminals. Here, the researchers successfully replaced the voltage with a single photon and demonstrated that their quantum transistor could switch a light pulse containing around 30 photons before the quantum dot's memory ran out.

Waks says that his team had to test different aspects of the device's performance prior to getting the transistor to work. "Until now, we had the individual components necessary to make a single photon transistor, but here we combined all of the steps into a single chip," he says.

Sun says that with realistic engineering improvements, their approach could allow many quantum light transistors to be linked together. The team hopes that such speedy, highly connected devices will eventually lead to compact quantum computers that process large numbers of photonic qubits. ■

Wired Magazine Features Ott and Collaborators' work on Machine Learning to Predict Chaos

Jaideep Pathak, Michelle Girvan, Brian Hunt and Edward Ott
Photo: Faye Levine/University of Maryland

Distinguished University Professor **Edward Ott** (ECE/Physics/IREAP) and collaborators at the University of Maryland have been featured in an article in *Wired* Magazine.

The article, originally published in *Quanta* Magazine and reprinted in *Wired*, titled "Machine Learning's 'Amazing' Ability to Predict Chaos," details the results of new papers published in the journals *Physical Review Letters* and *Chaos*, to highlight the application of machine learning to calculate the future evolution of chaotic systems out to extremely distant horizons.

The interdisciplinary researchers include Prof. Ott and current graduate student and lead author on the paper **Jaideep Pathak**, Associate Professor **Michelle Girvan** (IPST/Physics), Professor **Brian Hunt** (IPST/Mathematics), and Postdoctoral Researcher **Zhixin Lu** (now of the University of Pennsylvania).

The researchers' employed a machine-learning algorithm termed reservoir computing to "learn" the dynamics of an archetypal chaotic system called the Kuramoto-Sivashinsky equation, and the evolving solution to this equation acts like a flame front, flickering as it advances through a combustible medium.

Their results demonstrate that machine learning, and more specifically reservoir computing, offers an effective potential means for model-free prediction of large spatiotemporally chaotic systems. Their technique can be applied to areas such as weather forecasting and monitoring of cardiac arrhythmias for signs of approaching heart attacks, as well as neuronal firing patterns in the brain for signs of neuron spikes. ■

Ephremides Leads New NSF Age of Information Project

Professor **Anthony Ephremides** (ECE/ISR) is the principal investigator for a new National Science Foundation award, On the "Fundamental Nature of the Age of Updates." Professor Yin Sun will be the collaborative researcher at Auburn University.

This Communication and Information Foundations collaborative research project will use the new concept of Age of Information to discover the relationships between information theory and signal processing, two of the main pillars of information science. Its foundational core is the context of communication, namely on the purposes and goals of signal transmission.

The Age of Information (AoI) is clearly connected to many aspects of information theory, signal processing, and multiple applications. However, the fundamental nature of this concept has been elusive so far. This project will investigate all three aspects of the AoI, namely its significance as a performance metric, its usefulness as a tool, and, more importantly, its potential to explore profound aspects of, and fundamental interconnections among, the theories that underlie our understanding of information structure, causal information processing, and the context (or semanteme) of information.

The project will explore how the transmission and the age of received updates relate to the information structure of a signal, and understand how information ages over time. ■

Barg is PI for New NSF Information Recovery Award

Professor **Alexander Barg** (ECE/ISR) is the principal investigator for a new three-year, $500K National Science Foundation award, "Information Recovery Under Connectivity and Communication Constraints." The Communication and Information Foundations project addresses data storage issues connected with modern, large-scale distributed storage systems.

These systems store data on thousands of storage nodes, and failure of individual nodes is an everyday operational reality. Companies maintaining storage systems make provisions for node failures, relying on erasure codes to ensure data integrity. While specialized encoding methods developed in recent years involve the minimum amount of inter-nodal communication possible for such systems, most current solutions rely on the common assumption of universal connectivity between the nodes. At the same time, in many applications starting with the Internet of Things, connections between the nodes are established based on physical proximity or similar features that affect the ability of the nodes to communicate with each other or with the data collector.

This project investigates methods of data recovery in systems with limited connectivity whereby the cost of data repair is governed by the length of the path between the nodes, and therefore depends on the topology of the network. It intends to establish fundamental limits of communication complexity of data recovery that account for connectivity properties of the underlying network as well as to construct coding methods that ensure data integrity against node failures, incorrect information, or adversarial action that approach the bounds on the minimum possible amount of communication. ■

Study Validates Face Recognition Experts, but Shows Humans Perform Best with an AI Partner

Photo: Are these two faces the same person? Trained specialists called forensic face examiners testify about such questions in court. A new study indicates combining their expertise with state-of-the-art face recognition software gives the best accuracy. Credit: J. Stoughton/NIST

New research that combines computer vision research, forensic science, and psychology shows that experts in facial identification are highly accurate, but that the highest accuracy in face recognition comes through the partnering of a human expert with state-of-the-art face recognition software.

A team of scientists from the University of Maryland, the National Institute of Standards and Technology, the University of Texas at Dallas, and the University of New South Wales tested and compared the face recognition accuracy of forensic examiners, computer face recognition programs, and people with no training in face recognition. A paper based on the research was published May 29, 2018, in the journal *Proceedings of the National Academy of Sciences (PNAS).*

The study, part of efforts to strengthen forensic science in the U.S., found that the performance of professionally trained facial identification experts was much more accurate than that of people untrained in facial recognition. And it showed this accuracy was further enhanced by combining the evaluations of multiple experts, a common forensic practice.

However, Distinguished University Professor **Rama Chellappa** (ECE/UMIACS), a study co-author and nationally recognized leader in computer face recognition, said that the other two main results were more surprising.

"We found that the face recognition performance of the best computer algorithms is up there with the performance of forensic examiners," said Chellappa.

Study co-author and UMIACS Assistant Research Scientist **Carlos Castillo** said: "This finding represents a computer achievement comparable to the chess playing performance of IBM's Deep Blue in matches [1996-1997] with then-World Chess Champion Garry Kasparov."

"We don't know yet how this finding should be implemented in forensic practices, but it appears that computer face recognition is a tool that forensic science can use," said Chellappa, whose postdoctoral associate, **Jun-Cheng Chen**, and two doctoral students, **Rajeev Ranjan** and **Swami Sankaranarayanan**, designed and developed the three face recognition programs used in the study. The top performing program, A2017b, whose inventors are Rajeev Ranjan, Carlos Castillo, and Rama Chellappa, was named a UMD Invention of the Year in April.

According to Chellappa, the broader context for the study is that it is a step in the process of learning how machine and humans can best work together. "These findings add to such knowledge and to the possibility that humans can trust machines to help them."

The team's effort began in response to a 2009 report by the National Research Council, *Strengthening Forensic Science in the United States: A Path Forward*, which underscored the need to measure the accuracy of forensic examiner decisions. In their recent study published in *PNAS*, the researchers note that remarkably little was previously known about the accuracy of forensic facial comparisons by examiners relative to such comparisons by people without training, and nothing was known about their accuracy relative to computer-based face recognition systems.

"This is the first study to measure face identification accuracy for professional forensic facial examiners, working under circumstances that apply in real-world casework," said NIST electronic engineer and lead author P. Jonathon Phillips. "Our deeper goal was to find better ways to increase the accuracy of forensic facial comparisons."

The study involved a total of 184 participants. Fifty-seven were forensic facial examiners, with the highest level of professional training in the identification of faces in images and videos. Thirty were facial reviewers with a lower level of training in facial identification. Thirteen were "super recognizers," people with exceptional natural ability to recognize faces. The remaining 84—the control groups—included 53 fingerprint examiners and 31 undergraduate students, none of whom had training in facial comparisons.

For the test, the participants received 20 pairs of face images and rated the likelihood of each pair being the same person on a seven-point scale. The research team intentionally selected extremely challenging pairs, using images taken with limited control of illumination, expression and appearance. They then tested four of the latest computerized facial recognition algorithms, all developed between 2015 and 2017, using the same image pairs. ■

Papamanthou Awarded Grant to Study Security in Blockchains and Cryptocurrencies

Assistant Professor **Charalampos (Babis) Papamanthou** (ECE/UMIACS/MC2), has been awarded a $50,000 grant to explore connections and applications of authenticated data structures and verifiable computing involving blockchains and crypto currencies.

Authenticated data structures provide cryptographic proofs of their correctness. They are already being used in popular cryptocurrencies like Bitcoin and Ethereum to assist computationally light nodes in participating in the protocol, without having to store an order-of-GB large validation state, which is necessary to detect double spending.

The grant is from Ergo Platform through the Blockchain Institute, an international research and development center that supports the production and implementation of blockchain-based solutions.

"It's great to see authenticated data structures—a field I've been studying for a long time—having real-world applications and being deployed at a massive scale," says Papamanthou. "Blockchains and cryptocurrencies offer great opportunities to test their scalability, and also provide inspiration for new and more flexible designs."

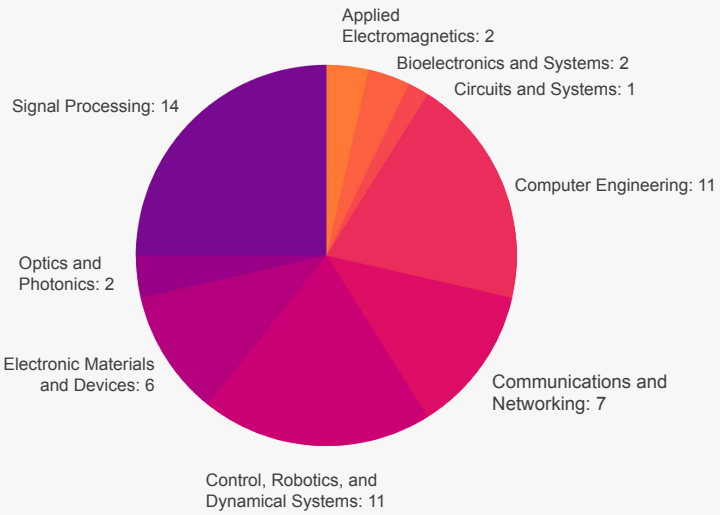
For example, he says, after talking to cryptocurrency research scientists and developers at Real World Crypto in January 2018, Papamanthou's team—in collaboration with Ergo Platform—began designing new distributed algebraic authenticated data structures to erase validation states from cryptocurrency nodes altogether, a notion put forward by the cryptocurrency community as "stateless clients."

Other directions that the team plans to pursue include extending a recently developed proof system to provide a more flexible and practical approach for privacy-preserving smart contracts. This work was presented in May at the 39th IEEE Symposium on Security and Privacy in San Francisco, California. ■

GRADUATE STUDENTS AREA OF FUNDING

Approximately 56 new graduate students joined the Department of Electrical and Computer Engineering this fall. Students attending our programs are from Bangladesh, China, Ecuador, Egypt, Greece, India, Iran, Pakistan, South Korea, Sri Lanka, Turkey, United States, and Vietnam.

Our 14 new Masters students and 42 Ph.D. students have chosen to specialize in the following research areas:



WAKS RECEIVES COMPETITIVE DURIP GRANT

Four faculty members of the University of Maryland's A. James Clark School of Engineering have received funding through the Defense University Research Instrumentation Program (DURIP). DURIP supports university research in technical areas of interest to the Department of Defense (DoD) by providing funding for state-of-the-art research instrumentation necessary to carry out high-quality, cutting-edge research.

Edo Waks (ECE/IREAP/JQI) has received the DURIP for "Tunable Laser System & Low-Temperature Magneto-Optical Microscope."

Waks's research focuses on quantum photonics, quantum information, strongly interacting light-matter systems, and nanophotonics. Through this DURIP award, he will develop an ultra low-temperature spectroscopy system to characterize and control quantum materials. This work will develop new quantum memories in a solid-state chip-integrated device that could enable scalable quantum technology in a semiconductor platform. This DURIP award will support a recently funded Multidisciplinary University Research Initiative of certifiable quantum systems, also funded by the Air Force Office of Scientific Research. ■

Khaligh, McCluskey to Lead New $2.37M DOE Solar Power Converter Project

Associate Professor **Alireza Khaligh** (ECE/ISR) is the Principal Investigator for a new three-year, $2.37M Department of Energy (DOE) cooperative agreement, "Compact and Low-Cost Microinverter for Residential Systems." Professor **Patrick McCluskey** (ME) is the co-Principal Investigator. The team also includes Dr. Patrick Chapman, SunPower Corporation, San Jose, Calif.; and Assistant Professor Fariborz Musavi, Department of Electrical Engineering, Washington State University Vancouver.

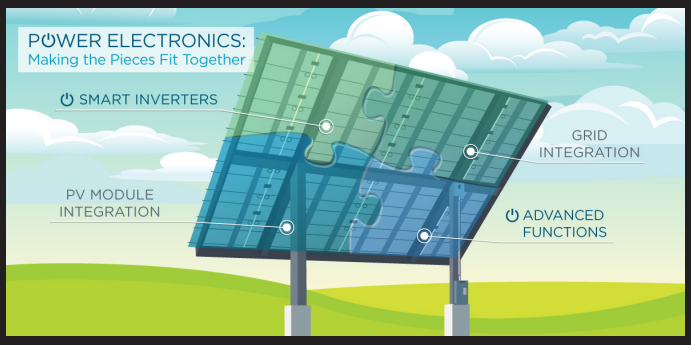
Khaligh directs the Maryland Power Electronics Laboratory and McCluskey is affiliated with the Center for Advanced Life Cycle Engineering.

The $2.37M award includes funding from the DOE and a 20 percent awardee cost share from the participating collaborators.

The project is one of nine DOE recently announced as part of its goal of cutting the cost of solar energy system power electronics in half by 2030. Together, the projects are worth a total of $20M.

Hardware innovations are critical to address solar photovoltaic (PV) reliability challenges and drive down the cost of installing and maintaining a PV solar system, the DOE said in its announcement. Power electronics, which convert electricity from one form to another, are the critical link between PV arrays and the electric grid. Advances in power electronics can help grid operators rapidly detect and respond to problems, protect against physical and cyber vulnerabilities, and enable consumers to manage electricity use. Advanced solar power electronics can help deliver power safely, integrate PV with storage controls, and ensure power reliability.

Khaligh's team will focus on developing a new generation of residential system microinverters using emerging gallium nitride (GaN) semiconductors. The new microinverters will have reduced costs of manufacturing and enhanced reliability, thermal management, and packaging. The resulting products will be commercialized by SunPower, a market leader in high performance PV systems technology for residential, commercial and power plant applications.



"We are excited to be a part of revolution in the solar PV industry," said Khaligh.

"There is remarkable potential for power electronics technologies to improve the reliability and flexibility of solar energy on the grid," said Daniel Simmons, the DOE's principal deputy assistant secretary for the Office of Energy Efficiency and Renewable Energy. "These projects represent a critical step in exploring the potential grid services such advanced technologies can provide." The nine research projects also will help the DOE accelerate the penetration of low-cost PV systems in the U.S.; enhance U.S. international competitiveness in this important field; and create more U.S. technology and manufacturing jobs. ■

Photo: Andrew Muir/UMD Sustainability

Awards & Honors for ECE Faculty

Baras and Mayergoyz named Distinguished University Professors

Professors **John S. Baras** (ECE/ISR) and **Isaak Mayergoyz** (ECE) have been named Distinguished University Professors of the University of Maryland (UMD). Prof. Baras holds a joint appointment in the Institute for Systems Research (ISR) and is the Lockheed Martin Chair in Systems Engineering. Prof. Mayergoyz is an Alford L. Ward Professor and Distinguished Scholar-Teacher of UMD. They will formally receive the prestigious title at the University's Convocation this fall.

Distinguished University Professor is an official title and the highest academic honor that UMD confers upon a faculty member. Selected faculty have been recognized nationally and internationally for the importance of their scholarly or creative achievements, and have demonstrated the breadth of interest characteristically encompassed by the traditional role of scholar, teacher, and public servant.

Professor **John S. Baras** was the Founding Director of the Institute for Systems Research (one of the first six NSF Engineering Research Centers) from 1985-1991. Since August 1973, he has been with the ECE Department, and the Applied Mathematics Faculty, at UMD, where he is currently a Professor holding a permanent joint appointment with ISR. In February 1990, he was appointed to the Lockheed Martin Chair in Systems Engineering. Since 1992, Prof. Baras has been the Founding Director of the Maryland Hybrid Networks Center (HyNet) (an industry-university-government consortium, with substantial support from DoD, NASA and industry focusing on hybrid wireless networks). Since 2013, he has been Guest Professor at the Royal Institute of Technology (KTH), Sweden.

He received the 1980 George Axelby Prize from the IEEE Control Systems Society, the 2006 Leonard Abraham Prize from the IEEE Communications Society, the 2014 Tage Erlander Guest Professorship from the Swedish Research Council, and a three-year (2014-2017) Senior Hans Fischer Fellowship from the Institute for Advanced Study of the Technical University of Munich, Germany. In 2016, he was inducted in the A. J. Clark School of Engineering Innovation Hall of Fame at the University of Maryland, and received the 2017 IEEE Simon Ramo Medal, and the 2017 AACC Richard E. Bellman Control Heritage Award.

He is a Fellow of the IEEE, SIAM, AAAS, and the Royal Swedish Academy of Engineering Sciences, the National Academy of Inventors, and the International Federation for Automatic Control.

His research interests include systems and control, optimization, communication networks, signal processing and understanding, applied mathematics, robotics, computing systems and networks, network security and trust, and model-based systems engineering.

He received a B.S. in Electrical and Mechanical Engineering from the National Technical University of Athens, Greece, in 1970, and his M.S. and Ph.D. in Applied Mathematics from Harvard University in 1971 and 1973, respectively. ■

Professor **Isaak Mayergoyz** has been awarded the title of Distinguished University Professor in recognition of his highly innovative work in mathematical modeling of hysteresis and computational nanoscience.

Prof. Mayergoyz received his M.S. and Ph.D. degrees in the former Soviet Union, where he worked as a senior research scientist in the Institute of Cybernetics of the Ukranian Academy of Sciences before his emigration to the United States. In 1980, he became a full professor of the UMD ECE Department. In cooperation with Prof. Fawzi Emad, he established the electric power engineering curriculum and educational program in the ECE Department and has maintained it for more than 30 years. For many years, he served as a consultant for the Research and Development Center of General Electric Company and has been selected as a visiting research fellow of this center. He has authored and co-authored 14 books and more than 400 scientific papers.

In 1987, he received the Outstanding Teacher Award of College of Engineering. In 1988, he became a Fellow of IEEE. In 1994, he became a Distinguished Lecturer of the IEEE Magnetics Society as well as a Distinguished Scholar-Teacher of University of Maryland, College Park. In 2009, he was appointed the Alford L. Chair of Engineering and received the Achievement Award of the IEEE Magnetics Society, the highest award given by the society, that same year. He was recently selected to be featured on the 2017 IEEE Magnetics Letters journal, in recognition of his unique contributions to the area of magnetics. He has served on numerous IEEE committees, editorial boards of scientific journals, and as the Editor of Academic Press-Elsevier Electromagnetism series.

His areas of research include plasmon resonances in nanoparticles, nonlinear magnetization dynamics induced by spin-polarized current injection, fluctuations in nanoscale semiconductor devices, mathematical models of hysteresis, stochastic analysis of systems with hysteresis, drive independent recovery and forensics of hard disk data, computational electromagnetics, and power engineering. ■

Waks Named APS Fellow

Prof. **Edo Waks** (ECE/IREAP/JQI) has been named a 2017 American Physical Society Fellow.

The APS Fellowship Program was created to recognize members who may have made advances in physics through original research and publication, or made significant innovative contributions in the application of physics to science and technology. They may also have made significant contributions to the teaching of physics or service and participation in the activities of the Society.

Prof. Waks was nominated by the society's Division of Laser Science (DLS) for "significantly advancing the field of quantum photonics and for developing new concepts to strongly interact solid-state quantum emitters with nanophotonic devices."

Prof. Waks is a member of the Institute for Research in Electronics and Applied Physics and of the Joint Quantum Institute. He oversees the Nanophotonics and Quantum Information Research Group at UMD.

Each year, no more than one half of one percent of the total APS membership is recognized by their peers for election to the status of Fellow in the American Physical Society. ■

Srivastava Named Clark School Inaugural Associate Dean for Graduate Affairs

Dean **Darryll Pines** has announced that Professor **Ankur Srivastava** (ECE/ISR), has been named the new Inaugural Associate Dean for Graduate Affairs effective January 8, 2018.

In his announcement, Dean Pines wrote, "Srivastava is a professor in the Department of Electrical and Computer Engineering (ECE) and brings experience and scholarship to his new role as Associate Dean. He has served ECE as Associate Chair for graduate affairs since 2013. There, he has led several unique and innovative activities for graduate recruitment and retention and improving diversity. In his new role, Dr. Srivastava will help start new college-level initiatives with hope to inject new energy and opportunities for growth in our graduate environment and experience."

Dr. Srivastava received his Ph.D. from the University of California Los Angeles in 2002, where he was presented the outstanding Ph.D. award from the Computer Science Department. His research focus lies in computer engineering with interests in hardware synthesis for high performance, low power, and secure computer systems. ■

Munday Receives 2017 Clark School Junior Faculty Outstanding Research Award

Professor **Jeremy Munday** (ECE/IREAP) was selected to receive the 2017 Clark School Junior Faculty Outstanding Research Award.

This award is given to a faculty member at or below the rank of Associate Professor, in recognition of research impact and quality during the past five years. The award, which includes a plaque and monetary award, was presented to Prof. Munday at the Clark School Faculty Dinner. This award recognizes Prof. Munday's research contributions in the fields of optics, photonics, nanosystems, and energy." ■

Liu Elected 2018 IEEE Technical Activities Vice President

Christine Kim Eminent Professor of Information Technology and Distinguished Scholar-Teacher **K.J. Ray Liu** (ECE) has been elected as the 2018 IEEE Technical Activities Vice President-Elect, which will oversee 50+ societies/councils within IEEE. The voting membership of IEEE annually elects officers that serve on the top-tier IEEE governing bodies. The candidates are drawn from recommendations made by divisional and regional nominating committees.

Prof. Liu's candidacy features vision with strong conviction: *Together we are stronger than apart*. As the 2018 Technical Activities Vice President, Prof. Liu will refocus IEEE membership to be a true international organization, lead with transparency and consensus building, and create additional products and services to increase membership value.

Of his nomination, Prof. Liu says, "The support I have received in this election was incredible. I promise and will make sure your voices are heard! Let's work together to build a stronger and better IEEE community."

Prof. Liu received his Ph.D. from UCLA in 1990. His research contributions encompass broad areas of signal processing and communications. He is the recipient of the 2016 IEEE Signal Processing Society Meritorious Service Award for "exemplary service to and leadership in the Signal Processing Society," the 2016 IEEE Leon Kirchmayer Award, the 2014 Society Award for "influential technical contributions and profound leadership impact," the IEEE Signal Processing Society 2009 Technical Achievement Award, and more than a dozen best paper awards. Recognized as a Thomson Reuters Highly Cited Researcher, Prof. Liu is a Fellow of IEEE and AAAS.

Prof. Liu is a member of IEEE Board of Director as the Division IX Director (2016-present). He was President of IEEE Signal Processing Society (2012-2012) and President-Elect (2010-2011), in which he also served as Vice President-Publication (2006-2008) and a member of the Board of Governor (2004-2005). ■

Baras Named Recipient of 2018 AIAA Aerospace Communications Award

The American Institute of Aeronautics and Astronautics (AIAA) has named Professor **John S. Baras** (ECE/ISR) the recipient of its 2018 AIAA Aerospace Communications Award.

The AIAA Aerospace Communications Award was established in 1968. It is presented for outstanding contributions in the field of aerospace communications. Candidates are individuals or small teams of up to four members whose achievements have had a positive impact on technology and society.

Baras received the award for "outstanding technical contributions and commercialization leadership of Internet over satellite, hybrid satellites, and terrestrial networks, with transformational industrial, economic and societal impact." He was nominated by Professor **Alison Flatau** (AE) with assistance from Professor **Eyad Abed** (ECE).

Baras will receive a medal and certificate of citation on October 17, during the Awards Luncheon at the Joint Conference of the International Communications Satellite Systems Conference (ICSSC) and the Ka and Broadband Communications Conference (Ka) in Niagara Falls, Canada. ■

Abshire and Shamma Elected IEEE Fellows

Professor **Pamela Abshire** (ECE/ISR) has been elected a Fellow of the Institute of Electrical and Electronics Engineers, effective Jan. 1, 2018. Her citation reads, "For contributions to CMOS biosensors."

Abshire's research interests are in CMOS biosensors; adaptive integrated circuits (ICs) and IC sensors; hybrid microsystems incorporating CMOS, MEMS, optoelectronics, microfluidics, and biological components; low power mixed-signal ICs for a variety of applications, including cell-based sensing, high performance imaging, miniature robotics, spike sorting, adaptive data conversion, and closed loop control of MEMS and microfluidic systems. ■

Professor **Shihab Shamma** (ECE/ISR) has been elected a Fellow of the Institute of Electrical and Electronics Engineers, effective Jan. 1, 2018. His citation reads, "For applications of signal processing to auditory neuroscience."

Shamma's research interests are in the acoustic signal at various levels in mammalian auditory systems. His work ranges from theoretical models of auditory processing in early and central auditory stages, to neurophysiological investigations of the auditory cortex, to psychoacoustical experiments of human perception of acoustic spectral profiles. ■

Espy-Wilson Named ISCA Fellow

Professor **Carol Espy-Wilson** (ECE/ISR) has been elevated to the rank of Fellow by the International Speech Communication Association (ISCA) for "contributions to speech acoustic modelling, speech signal processing, and applications to knowledge-driven speech recognition and speech enhancement."

The title of ISCA Fellow is one of ISCA's most prestigious honors for an individual in the field of speech science/technology.

The honor will be publicly announced during the opening ceremony of INTERSPEECH-2018 in Hyderabad, India, in September. INTERSPEECH is an international conference on the science and technology of spoken language processing, which is at the heart of multimodal artificial intelligence and machine learning. ■

Wu Named AAAS Fellow

Professor **Min Wu** (ECE/UMIACS), has been named a Fellow of the American Association for the Advancement of Science (AAAS). She joins 395 other scientists and scholars in receiving this prestigious recognition from the AAAS, the world's largest scientific organization.

Wu, a noted University of Maryland expert in information security and digital forensics, was selected for "distinguished contributions to the field of signal processing, particularly for multimedia security and forensics," according to the AAAS.

She was formally honored by the AAAS on February 17, 2018 at the organization's annual meeting in Austin, Texas.

"Professor Min Wu is a world-renowned researcher in multimedia and forensics, and being elected to the Fellow status in AAAS is a well-deserved recognition of her scholarship and leadership in this important area," says Rama Chellappa, Minta Martin Professor of Engineering, Distinguished University Professor, and former Chair of the Electrical and Computer Engineering Department. ■

JaJa Named Interim Chair of ECE Department

Professor **Joseph F. JaJa** has been named interim chair of the Electrical and Computer (ECE) Engineering Department, effective July 1, 2018. Prof. JaJa, who holds a permanent affiliate appointment in the University of Maryland Institute for Advanced Computer Studies (UMIACS), will be replacing Rama Chellappa, Distinguished University Professor and Minta Martin Professor of Engineering, who has served as chair of ECE since 2011.

"Dr. Joseph JaJa is a highly respected leader in the Clark School and University," said **Darryll J. Pines**, Farvardin Professor and Dean of the A. James Clark School of Engineering. "He brings great knowledge and skill in his new role to serve the department following the inspiring leadership of Dr. Chellappa."

Prof. JaJa received his Ph.D. degree in applied mathematics from Harvard University in 1977. He joined the University of Maryland faculty in 1983, and served as director of UMIACS from 1994-2004. Under his leadership, UMIACS research funding grew from $2.5M annually to more than $18M. He also served as Interim Vice President and Chief Information Officer of the University of Maryland's Office of Information Technology from 2010-2011.

Prof. JaJa's current research interests involve big data, computational neuroscience high-performance computing, and statistical machine learning.

He has published extensively in several areas, including parallel and distributed computing, and serves on several editorial boards in the computing field. He has received numerous awards including the IEEE Fellow Award in 1996, the 1997 R&D Award for the development of software for tuning parallel programs, the ACM Fellow Award in 2000, and the Internet2 IDEA Award in 2006.

"Dr. Joseph JaJa brings several decades of research and administrative experience to serve as the ECE department chair," said Prof. Chellappa. "Under his leadership and support from outstanding faculty and staff, I am confident that the department will move forward and upwards. ■

Dachman-Soled Wins Faculty Award for Significant Contributions to Electrical and Computer Engineering Education

Dana Dachman-Soled (ECE/MC2), the recipient of ECE's George Corcoran Award for Teaching, has been honored for her outstanding contributions to engineering education and teaching at the University of Maryland. The award is given for significant contributions to electrical or computer engineering through excellence in teaching and the advancement of the profession. ■

Devaney and McKinney Win ECE Staff Service Award

Electrical and Computer Engineering's Senior Business Manager **Marion Devaney** and Director of Computing Facilities **Jeff McKinney** have both received ECE's 2018 Corcoran Staff Service Award.

The award is given in recognition of their level of dedication, excellence in performance, and commitment to service to the department this year. Their work in support of ECE has allowed others to turn their full attention toward their primary responsibilities, be they teaching, learning, or working behind the scenes. ■

S. Saketh Rambhatla Wins ECE Graduate Teaching Assistant Award

S. Saketh Rambhatla received this year's George Corcoran award for graduate teaching assistants (TAs). This award is given to students who show excellent leadership skills and commitment to education in their teaching assistant positions. ■

Nahmias Wins ECE Graduate Student Service Award

David Nahmias is the recipient of this year's George Corcoran award for Graduate Student Service. This award is given to nominees who demonstrate a firm commitment to the welfare of the department and of the students studying within it. ■

The Jimmy H.C. Lin Invention Competition Award

This year's UMD Invention of the Year winners also won the Jimmy H.C. Lin Invention Competition Award. Read more about the three winning groups on page 5. ■

Espy-Wilson Wins ECE Jimmy H.C. Lin Innovation Award

Carol Espy-Wilson (ECE/ISR) Won ECE's Lin Innovation Award for her U.S. patent 9,886,967: "Systems and Methods For Speech Extraction." The patent was issued Feb. 6, 2018.

A speech extraction process can improve the quality of the speech signals produced by these technologies and devices. This invention relates particularly to system and methods of speech extraction. In the invention, a processor-readable medium stores code representing instructions to cause a processor to receive an input signal having a first component and a second component.

The Lin Innovation award is given to promote innovation among ECE students, staff and faculty by stimulating, encouraging and rewarding the invention and patenting process, and to help students, staff and faculty move their ideas forward through the complicated and often expensive patenting process. ■

Dinesh Manocha Joins ECE as the Paul Chrisman Iribe Professor of Computer Science

Dinesh Manocha has joined the University of Maryland as the inaugural Paul Chrisman Iribe Endowed E-Nnovate Professor. His tenure home appointment is in the Department of Computer Science with joint appointments in the Department of Electrical and Computer Engineering (ECE) and the University of Maryland Institute for Advanced Computer Studies (UMIACS).

Manocha's research focuses on geometric and scientific algorithms with applications to computer graphics, robotics, and virtual reality. His research group also developed software packages for physically based modeling, computer-aided design, and scientific computing, which have been downloaded by more than 200,000 users worldwide and licensed to more than 55 corporations, including Fortune 500 companies. He is also named as an inventor on nine patents, several of which have been licensed to industry.

"I am truly honored to join the University of Maryland with appointments in two top-ranked departments. With very strong research groups in virtual reality, computer vision and graphics, and robotics, the University of Maryland is regarded as the world leader in these areas," Manocha says. "I am also looking forward to the new Brendan Iribe Center for Computer Science and Innovation opening later this year. It is going to offer unprecedented opportunities and new world-class laboratories to develop the next generation of technologies."

Manocha joined UMD from the University of North Carolina at Chapel Hill where he was the Phi Delta Theta/Matthew Mason Distinguished Professor in the Department of Computer Science. As a member of the UNC faculty since 1992, he published more than 480 conference and journal papers and received 16 best paper or test-of-time awards. Manocha's work is well cited in the computer graphics and robotics literature, with more than 34,000 citations according to Google Scholar.

He also supervised more than 65 master's and doctoral students. Many of Manocha's 35 Ph.D. advisees are professors at top universities and group leaders in industry.

"Dinesh Manocha is a world-renowned researcher in geometric computing, interactive computer graphics, physics-based simulation, and robotics," said Rama Chellappa, Distinguished University Professor and former ECE Chair (2011-2018).

"His joint appointment in ECE will contribute to enhanced research and teaching activities in these areas as well as in AR/VR domain." ■

Ulukus Named The Anthony Ephremides Professor in Information Sciences and Systems and The ECE Associate Chair for Graduate Studies

Professor **Sennur Ulukus** (ECE/ISR) has been selected to hold the Anthony Ephremides Chair in Information Sciences and Systems.

Of her nomination, Prof. Ulukus says, "I am honored to be selected to hold this Chair. I am especially honored to hold a Chair in the name of Professor Ephremides, who has made tremendous contributions to information sciences and systems over the past 45+ years."

In 2007, **Anthony Ephremides**, Cynthia Kim Professor in Information Technology, and his wife, Jane, established a Fund in the A. James Clark School of Engineering for the creation of the Anthony Ephremides Chair in Information Sciences and Systems. The chaired professorship provides annual support for a faculty member in the field of Information Sciences and Systems in the Department of Electrical and Computer Engineering. The award to Prof. Ulukus of this Chaired appointment makes her the inaugural holder of this Chaired position.

In addition, Ulukus has been named Associate Chair for Graduate Studies for the ECE Department. She succeeds Professor Ankur Srivastava (ECE/ISR) who held the position from 2013-2018.

"We welcome Prof. Ulukus to her new role and thank Prof. Srivastava for his outstanding and dedicated service to ECE's Graduate Studies for the past five years," said ECE Professor and Interim Chair **Joseph JaJa** (ECE/UMIACS). "I am confident that Prof. Ulukus will continue the upward trajectory of our graduate programs, bringing excellence and innovation as she has done throughout her career."

Prof. Ulukus is a fellow of the IEEE, and a Distinguished Scholar-Teacher of the University of Maryland. She received the 2003 IEEE Marconi Prize Paper Award in Wireless Communications, a 2005 NSF CAREER Award, the 2010-2011 ISR Outstanding Systems Engineering Faculty Award, and the 2012 ECE George Corcoran Education Award. She is Distinguished Lecturer of the IEEE Information Theory Society for 2018-2019. ■

Jafarkhani Inducted into 2017 Innovation Hall of Fame

Photo: Greg Fiume

The A. James Clark School of Engineering named alumnus **Hamid Jafarkhani** (EE Ph.D. 1997) as the 2017 inductee to its Innovation Hall of Fame. At the November 27 induction ceremony, Jafarkhani was honored for pioneering different space-time methods and algorithms for multi-antenna wireless communication systems and networks. He was a primary contributor to the development of space-time block codes, which are used to improve wireless transmission quality. The codes have created an active area of research and are used in billions of wireless devices worldwide. His collective work has profoundly influenced the commercialization, standard specifications, and fundamental advancement of the theory of space-time processing and multiple-input multiple-output (MIMO) for wireless communications. ■

Chakrabarti Named Distinguished Alumnus of IIT Kharagpur

Alumnus **Chaitali Chakrabarti** (M.S. '86, Ph.D. '90) has received the 2018 Distinguished Alumnus Award from the Indian Institute of Technology Kharagpur (IIT Kharagpur). She will be honored at the 64th Convocation of the Institute on Friday, July 20.

Distinguished Alumnus awardees are renowned experts in their respective fields, who have reached the pinnacle of excellence in addition to associated and community services, which bring them this highest honor from their Alma Mater IIT Kharagpur.

Professor Chakrabarti is a professor of Electrical Engineering at Arizona State University, where she has been a faculty member since 1990.

Her research in VLSI architectures for signal processing and communications, algorithm-architecture co-design, and low-power embedded system design has had major impact on the circuits and systems, signal processing, and computer architecture communities.

Chakrabarti received the ECE Distinguished Alumni Award from the University of Maryland in 2013. While at Maryland, she was advised by Professor and ECE Interim Chair, **Joseph JaJa**. ■

Connecting with Strangers, Digitally

While attending the University of Maryland, **Jameel Francis** (B.S. '08, Electrical Engineering) noticed how hard it is for college students to connect. He couldn't find others with similar interests to join him in on-campus research and share startup ideas with. To strengthen communication among students, Francis co-founded the app ComYoot, which launched in the iOS App Store last fall.

ComYoot uses machine learning and text and data analytics to help users build connections, according to its website. While many similar apps, such as Slack, are invite-based, ComYoot places users in networks based on information they provide when they download the app. ■

Tandon Receives 2018 Keysight Early Career Professor Award

Keysight Technologies, Inc. has awarded Alumnus **Ravi Tandon** (EE Ph.D. 2010) the 2018 Keysight Early Career Professor Award for his work on wireless networks and cloud computing environments.

The Keysight Early Career Professor Award was established in 2016 to recognize and encourage excellent research enabling design, test, or measurement of electronic systems. The program seeks to create strong collaborative relationships between Keysight researchers and leading professors early in their careers and to highlight Keysight's role as a sponsor of university research.

Since August 2015, Tandon has been an assistant professor of electrical and computer engineering at the University of Arizona. At Maryland, Tandon was advised by Professor Sennur Ulukus (ECE/ISR). Following his Ph.D. at Maryland, Tandon completed a postdoctoral fellowship at Princeton University with Professor Vincent Poor, and held a research assistant professor position at Virginia Tech, before joining the University of Arizona. Tandon received a National Science Foundation CAREER Award in 2017 from the Division of Computing and Communication Foundations.

Tandon's research focuses on developing information theory that supports efficient distributed computation. This work applies to large-scale machine learning, and distributed cloud computing. His research establishes mechanisms to store, access, and compute data in distributed cloud environments, reducing communications overhead while preserving data reliability and security. He also explores new methods for interference management, a major issue in future wireless networks. ■

Company Co-Founded by Rajiv Laroia Receives $121 Million Investment

Light's L16 camera. Light

Light, a company co-founded by alumnus **Rajiv Laroia** (M.S. '89, Ph.D. '92), has received a $121 million investment from Tokyo-based SoftBank. Focusing on Light's core technology of a "software defined camera," SoftBank's Vision Fund is supporting development of better sensing system for self-driving cars. Also investing in this program is renowned camera company Leica Camera AG.

A passion for photography led Laroia and partner David Grannan to join forces and form Light. Despite owning advanced cameras and photographic equipment, they realized that they were relying more and more on their smartphones to take pictures. Thus, they set out to develop a technologically advanced camera that would produce higher quality, higher resolution photos and require the least amount of equipment possible. The result, the L16 camera, features 16 lenses that take separate photos and combines machine learning and other software designs to create beautiful images. The camera is the size of a cell phone.

This technology is what led Softbank Chairman and CEO, Masayoshi Son, to envision using this computational imaging to replace the current spinning laser-based sensors currently used on self-driving cars. Using multiple lenses, a camera could extract multiple photos into 3D images that would, for instance, let a driver know how far away a car is from the curb. With this breakthrough, Light is jumping into the rapidly advancing field of self-driving cars.

Having expanded to a company of 120 employees, including 18 with Ph.D.s, Light plans to further expand its business to include cameras with nine lenses to be installed into smartphones. In fact, they are currently working with a smartphone manufacturer and should have their product included in smartphones as early as this fall. They are also branching out into intelligent imaging for robots and security cameras.

Laroia previously founded and served as CTO of Flarion Technologies, which developed the base technology for LTE. Flarion was acquired by Qualcomm in 2006. Prior to Flarion, Rajiv held R&D leadership roles in Lucent Technologies Bell Labs. He received his Masters and Ph.D. degrees in Electrical Engineering from the University of Maryland in 1989 and 1992, respectively. At Maryland, Laroia was advised by former UMD Provost Nariman Farvardin (ECE/ISR), now President of the Stevens Institute of Technology. In 2006, The A. James Clark School of Engineering named Laroia to its Innovation Hall of Fame for significant advances in telephone and mobile wireless communications. In 2013, he won the IEEE Industrial Innovation Award and the University of Maryland ECE Distinguished Alumni Award. Laroia is currently a member of ECE's Advisory Board. ■

Alumnus Profile: Joseph Drayton

UMD Degree: B.S. '93, Electrical Engineering

Maryland native **Joseph (Joe) Drayton** graduated from the University of Maryland, College Park in 1993 with a degree in electrical engineering. While attending UMD, Drayton was active on campus and held several leadership roles such as President of the Black Student Union and Director of Commuter Affairs for the Student Government.

After working for the Baltimore Gas and Electric Company for several years, Drayton decided to follow a significantly different path,enrolling at the University of Pennsylvania Law School in 1997. "As a young black male at the time, I felt that knowing your rights and being able to navigate the legal system and being a resource for others was very important," said Drayton.

Following graduation from law school in 1997, he moved to New York City. Drayton is currently a partner for Cooley LLP, which represents many technology companies. As a patent trial lawyer, he has used his engineering background in cases focusing on electronics,computer,software,andtelecommunication.Hehasalso been recognized for his pro bono work on housing discrimination.

In 2018, Drayton was awarded the 2018 Distinguished Leader of the Year Award by the *New York Law Journal*. Other awards include One of the Most Influential Black Lawyers in America by Savoy Magazine twice, in 2015 and 2018; Client Service All-Stars LIst MVP by the BTI Consulting Group in 2017; and Private Practitioner of the Year 2017 by the Metropolitan Black Bar Association. Recognized as one of the top lawyers in the United States, Drayton is also active in the American Bar Association Section of Litigation, is an Executive Committee Member of the New York City Bar, and is listed on the IAM Patent 1000 List. Finally, he is also a lifetime member of Omega Psi Phi, an international fraternity, which is also the oldest mainly African American fraternity in the country.

Drayton was sworn in on August 2, 2018 as the 76th President of the National Bar Association, the oldest and largest United States network of predominantly African American attorneys and judges.

"Engineers can be highly successful as lawyers because they can turn theory into practice" he says. "Keep an open mind and you can do anything you want, if you put your mind to it." ■

ECE Inducts Three New Distinguished Alumni

This spring, the Electrical and Computer Engineering (ECE) Department inducted the 2018 class of distinguished alumni for their leadership and meritorious contributions to the field of engineering, their humanitarian efforts, and the application of their engineering education to other disciplines. At the seventh annual ECE Distinguished Alumni Award presentation on May 18, fellow alumni, faculty, and staff gathered to honor the recipients. This year, ECE's Distinguished Alumni are **Reza Ghanadan, Xiaobo Tan,** and **Yannis Viniotis.**

Reza Ghanadan (B.S. '88, M.S. '90, Ph.D. '93) obtained his Ph.D. under the supervision of Professor **Gil Blankenship** (ECE), who nominated him for this award. Ghanadan received two B.S. degrees in Physics (Summa Cum Laude) and Electrical Engineering (Summa Cum Laude), and M.S. and Ph.D. degrees in Electrical Engineering, all from the University of Maryland, College Park. He also received an Executive MBA from New York University Stern School of Business.

Ghanadan is a Senior Manager at Google Inc. in Mountain View, California. He is leading Google's Cloud AI Advanced Solution Lab to create transformational enterprise products and services using artificial intelligence and machine learning. Prior to joining Google, Ghanadan was a program manager at DARPA's Defense Sciences Office. At DARPA, he created several foundational programs to advance complex problems in artificial intelligence, autonomy, and data analytics. Prior to joining DARPA, Ghanadan spent 18 years in industry, in start-ups, and at large research and development organizations including Boeing, where he was a Technical Fellow at the Research and Technology Division, and BAE Systems. He led programs across diverse engineering domains, including: information sciences; adaptive autonomous systems; data analytics, tactical communication; ISR and EW systems; cognitive and machine learning algorithms; communications and networking; 4G mobile wireless technology; modeling and simulation of complex multi-modal systems; mathematical systems theory, control and optimization algorithms.

Prior to his work in industry, Ghanadan was a founding team member of Flarion Technologies, and from 1995-2000, he was a member of the technical staff at AT&T/Lucent Bell Laboratories. He was named a Boeing Technical Fellow in 2010 and a BAE Engineering and Scientific Fellow in 2008. He received the Boeing Technology Innovation Challenge award, BAE's Gold Chairman's Award for Innovation, and several Bell Labs project awards for outstanding achievements. He is a fellow of the National Engineering Honor Society (Tau Beta Pi).

Xiaobo Tan (Ph.D. '02) was co-advised by Professor **P.S. Krishnaprasad** (ECE/ISR) and Professor **John Baras** (ECE/ISR), who nominated him for this award. Tan is an MSU Foundation Professor in the Department of Electrical and Computer Engineering at Michigan State University (MSU). He received his B.S. and M.S. degrees in Automatic Control from Tsinghua University, China, in 1995 and 1998, respectively, and his Ph.D. degree in Electrical and Computer Engineering from the University of Maryland, College Park, in 2002. He was a postdoc with Institute for Systems Research at University of Maryland before joining the faculty at MSU in 2004. His research interests include bio-inspired underwater robots and their application to environmental sensing, electroactive polymer sensors and actuators, modeling and control of systems with hysteresis, and soft robotics. He has published more than 200 journal and conference papers and holds three U.S. patents on these topics.

Tan has served on the editorial boards of *Automatica, IEEE/ASME Transactions on Mechatronics, and International Journal of Advanced Robotic Systems*. He has also been a Guest Editor for special issues or focused sections for six journals, and is serving as the General Chair for the 2018 ASME Dynamic Systems and Control Conference. Tan is keen to integrate his research with educational and outreach activities, and has served as Director of an NSF-funded Research Experiences for Teachers (RET) Site program at MSU from 2009-2016 and as Curator of a robotic fish exhibit at MSU Museum in 2016.

Tan is a Fellow of IEEE, and a recipient of the NSF CAREER Award (2006), MSU Teacher-Scholar Award (2010), Withrow Distinguished Scholar Award from MSU College of Engineering (2018), and several Best Paper Awards.

Yannis Viniotis (M.S. '85, Ph.D. '88) received his Electrical Engineering diploma from the University of Patras, Greece, in 1981 and his M.S. and Ph.D. degrees in Electrical Engineering from the University of Maryland, College Park, in 1985 and 1988, respectively. While at Maryland, Viniotis was advised by Professor **Anthony Ephremides** (ECE/ISR), who nominated him for this award.

Viniotis is a Professor at North Carolina State University. His current research interests are in the areas of service engineering, design of high speed networks (with special emphasis on Quality of Service, transport protocols, and ASIC implementations), network algorithm analysis, IoT and applications of IT in healthcare.

Viniotis has chaired two international conferences on networking. He was a guest editor for a special issue of the *Performance Evaluation Journal* on high speed networks. In 1997, he authored a textbook on probability theory and random processes.

In 1998, Viniotis co-founded Orologic, a successful startup company in RTP. Orologic was acquired by Vitesse Semiconductor Corporation in March 2000, for $450M. While at Orologic, he designed two chips for Quality of Service in IP and ATM networks, the first such chips that operate at 2.4 Gbps. In 2004, he authored a textbook on mathematical principles for electrical and computer engineers. ■

Mingyan Liu Named ECE Chair at University of Michigan

Alumna **Mingyan Liu** has been named the Peter and Evelyn Fuss Chair of Electrical and Computer Engineering (ECE) at the University of Michigan, effective September 1, 2018. ECE is one of two divisions in the university's Department of Electrical Engineering and Computer Science. She will become the university's 15th chair of Electrical and Computer Engineering. At Maryland, Liu received her M.S. in Systems Engineering degree in 1997 and her Ph.D. in Electrical Engineering in 2000. She was advised by Professor **John Baras** (ECE/ISR) for both degrees. She won The UMD ECE Distinguished Alumni Award in 2017.

Liu, a Fellow of IEEE, has research interests in resource allocation, performance analysis, and energy-efficient design of wireless, mobile ad hoc, and sensor networks. She received a 2002 NSF CAREER Award, the University of Michigan Elizabeth C. Crosby Research Award in 2003 and 2014, the 2010 EECS Department Outstanding Achievement Award, the 2015 College of Engineering Excellence in Education Award, and the 2017 College of Engineering Excellence in Service Award. Her cyber risk startup company QuadMetrics was acquired in 2016 by FICO, the company known for credit rating scores.

"Mingyan's wide range of academic experiences and achievements will be invaluable," said Alec D. Gallimore, Michigan's Robert J. Vlasic Dean of Engineering. "I look forward to her innovative and inclusive leadership."

"Electrical and computer engineering as a discipline has been tremendously successful over the past decades both in terms of pushing the frontiers of fundamental research and shaping our daily lives," Liu stated. "We are truly the Engineering of Everything."

This spring, Liu was named the Principal Investigator for "Multiscale Network Games of Collusion and Competition," a $6.25M 2018 Multidisciplinary University Research Initiative (MURI) funded by the Army Research Office (ARO).

The project, built on game theory, will develop tools to understand and shape online and on-the-ground networks that drive human decision making. It will focus on areas such as international diplomacy, street crime, cyber-terrorism, military strategy, financial markets, and industrial supply chains. The tools developed by the project could help researchers and officials tease out the innermost workings of networks as small as a group of online bots or as large as the global financial system. ■

Electrical and Computer Engineering Wins 2018 Alumni Cup


Photo: John T. Consoli

On Friday, February 23, the Electrical and Computer Engineering Department clinched their first-time win with a childhood toy-themed machine for the 2018 Clark School Alumni Cup. Students, faculty, staff, and alumni gathered to support their teams in the Kim Engineering Building Rotunda.

The Fire Protection Engineering Department's medieval-themed machine placed second and the Mechanical Engineering Department's Disney EPCOT themed machine took third.

The Alumni Cup is an annual engineering design competition that was started in 2012 by the Engineering Alumni Network. The event takes place each year during National Engineers Week, which raises awareness and support for the roles engineers play in creating, designing, and building the world around us.

A week prior to the competition, teams of students from each of the eight engineering disciplines began designing a Rube-Goldberg inspired machine, and this year's task was to accurately putt a golf ball one meter into a hole with no assistance. On the day of the event, each team demonstrated their machines, which were judged by members of the Clark School administration and the Alumni Association on the complexity of their energy transfers, design package, and display of departmental spirit.

ECE's machine successfully performed the task three times and their theme of childhood toys such as mini golf, Hot Wheels, and pool was well received. Further features of ECE's machine included three Arduino microcontrollers, continuity sensors, servos, relays and various motors. Also, rather than purchasing their power supply, the team built theirs from scratch. ■

Three ECE Students Named Outstanding Graduate Assistants

ECE graduate assistants **Shahriar Aghaeimeibodi, Usman Fiaz, and Aneesh Raghavan** are three of approximately 80 winners of the University of Maryland Graduate School's 2017-2018 Outstanding Graduate Assistant Award. The award recognizes the outstanding contributions that graduate assistants provide to students, faculty, departments, administrative units, and the university as a whole. Recipients of the award are among the top two percent of GAs on campus in a given year.

Shahriar Aghaeimeibodi is advised by Prof. **Edo Waks** (ECE/IREAP/JQI). His area of research is at the intersection of engineering and quantum physics, with emphasis on strongly interacting light and matter and Quantum photonic structures. He is a member of the Institute for Research in Electronics and Applied Physics (IREAP) and the Joint Quantum Institute (JQI).

Usman Fiaz is advised by Prof. **John S. Baras** (ECE/ISR). His research interests are in Robotics and Control Systems, with emphasis on autonomous multi-agent systems. He is affiliated with the Autonomy, Robotics, and Cognition (ARC) Lab and the Institute for Systems Research (ISR).

Aneesh Raghavan is also advised by Prof. John S. Baras (ECE/ISR). His research interests are in control and networked cyber-physical systems. He focuses on understanding the value of information, the application of non-commutative probability models, and the effects of order in measurements in decision problems involving multiple agents. He is affiliated with ISR.

The awards were given at the Annual Fellowship and Award Celebration on May 8, 2018. ■

UNIVERSITY OF MARYLAND 1856 THE GRADUATE SCHOOL

Aneesh Raghavan wins Ann G. Wylie Dissertation Fellowship

Aneesh Raghavan, an ECE Ph.D. student advised by Professor **John Baras** (ECE/ISR), has won an Ann G. Wylie Semester Dissertation Fellowship.

The Ann G. Wylie Dissertation Fellowship is part of the University of Maryland Graduate School's Semester Dissertation Fellowship Program, providing support to University of Maryland doctoral candidates who are in the latter stages of writing their dissertations. The Wylie is a full-time fellowship and awarded students can choose to use the fellowship in either Fall 2018 or Spring 2019. Fellowship benefits include a $15,000 stipend, a candidacy tuition award, and a credit for mandatory fees and reimbursement for the semester.■

UMD Hosts Third Technica with over 800 Students from Around the Country

Technica, the University of Maryland's all-women hackathon, attracted over 800 female hackers at he third annual event held November 4-5, 2017 at the Reckord Armory in College Park, Maryland. Over the duration of 24 hours, women of all ages and from around the country and Canada gathered to engage in tech culture and attend panels and workshops to develop innovative hacks such as games, apps, and websites. This is the third year that UMD has hosted Technica, and it remains the largest all-women's hackathon in the world.

The workshops at Technica welcomed all skill levels and featured a variety of interest areas, including cybersecurity, entrepreneurship, virtual reality, product design, web development, and hardware. Many of the participants were involved in STEM-related fields at various universities and about one-third of the attendees were high schoolers, said Nazifa Chowdhury, a junior computer science major, who also helped organize Technica. For 61 percent of attendees, this was their very first hackathon.

"I've been to many hackathons, but the vibe here is totally different," said Sabrina Smai, a more experienced hacker and a junior computer science major from the University of Toronto. "We've been to a few workshops and they were pretty helpful," added Smai. "This event is unique because it builds up the confidence of female hackers and promotes their involvement in the field." While at Technica, Smai created an augmented reality app to teach people how to speak new languages in interactive ways.

Over 50 sponsors, including UMD's A. James Clark School of Engineering and the College of Computer, Mathematical, and Natural Sciences, both supported and hacked alongside the students. Sponsors offered a combined $5,570 in prizes for competitions such as "Best Cybersecurity Hack", "Best Hack for Social Good", and "Best Hack to Help in a Crisis."

Technica 2018 will be held November 10-11, 2018. For more information, visit their website at gotechnica.org. ■

Engineers Without Borders Provides Electricity for Yabucoa Elder Care Center in Puerto Rico

On June 24-28, 2018, a team of three students and one advisor from the University of Maryland chapter of Engineers Without Borders (EWB-UMD) traveled to Puerto Rico to provide electricity to the Yabucoa Elder Care Center (nursing home) by installing a solar photo-voltaic system as well as emergency backup electricity to the center for future storm-related emergencies.

The Puerto Rico travel team consisted of **John Heide** (Sophomore, Electrical and Computer Engineering), **Megan Gertmenian** (Sophomore, Civil Engineering), **Meredith Bertulaitis** (Sophomore, Mechanical Engineering), and Advisor **Bryan Quinn,** Director of Technical Operations for the Department of Electrical and Computer Engineering.

Hurricane Maria devastated the electrical grid in the town of Yabucoa, downing trees and wires, and destroying many homes. Roads have been cleared since but the electrical grid restoration is still in the process of being rebuilt, which can take up to a year. Quinn and the team of students assisted with the installation of a 3 kW solar array on the upper flat concrete roof of the building, installation of inverter and batteries in the laundry room and interconnection to the building electrical system, and replacement of approximately 50 percent of the existing light tubes and bulbs with LEDs to reduce the electrical load.

Engineers Without Borders USA is a national nonprofit organization dedicated to sustainable development through engineering assistance and training internationally responsible engineering students. ■

ECE Launches Texas Instruments Peer Mentoring Fellowship Program

In the spring of 2017, the Electrical and Computer Engineering (ECE) Department piloted a Peer Mentoring Fellowship (PMF) Program at the University of Maryland, College Park. Led by ECE's Undergraduate Advising office Program Coordinators **Jenn Parkhurst and Mary Walters,** peer mentors serve as a resource to first-year students by providing support and encouragement as they navigate through their academic journey. Peer mentors check in with their mentees periodically throughout the academic year and direct them to resources on campus that can enhance their academic performance.

Mentors go through a thorough application process and are carefully selected, and are given annual stipends. The 2017 pilot program consisted of ten mentors and ten mentees. The following semester, the ECE Department teamed up with corporate affiliate Texas Instruments (TI) to provide further support.

Since then, the program has grown to 19 mentors and 29 mentees. Each semester, mentors and mentees participate in a variety of networking, support, and social activities such as team-building events, ice cream socials, dinners, and more.

The program has been a positive experience for both mentors and mentees to gain exposure and develop connections.

"What I enjoyed the most was getting to know other mentors/mentees personally. I know their names now and can walk up and start having a conversation when I meet them around campus, which makes me feel like I have a bigger ECE community," says a current mentee.

The ECE Advising Office has enjoyed initiating the program and looks forward to many more years of working with the students and promoting the PMF program and events. "Getting to know the students outside of advising sessions, building relationships, and staying in contact with them after graduation has been a rewarding aspect of the program," says Mary Walters, ECE Academic Advisor and TI PMF Program Coordinator.

As the program grows, the department hopes to expand their reach and invite transfer students to join the program as well. The department also plans to add more social events and continue to work alongside TI.

For more information, contact peermentoring@ece.umd.edu.

TDF Ventures

The Department of Electrical and Computer Engineering welcomes **TDF Ventures,** an early stage venture capital firm that focuses on start-ups that specialize in infrastructure, software, and services, as the newest member of its Corporate Affiliates Program. With offices in Washington, D.C., and Silicon Valley, TDF is a privately owned company that invests from a $150 million permanent pool of capital.

TDF has invested in a wide range of entrepreneurs and companies that are working on advanced technology in their specified fields. Areas of interest are cybersecurity, cloud services, data, edge computing, software defined networks, financial technology, business process automation, satellite, mobility, artificial intelligence and machine learning. The company's broad knowledge of these areas contributes to the goals of ECE.

Another focus of TDF Ventures is the TDF Foundation, established in 2008 as an independent entity. The Foundation supports technological needs for both public and private organizations in unserved and underserved communities. The beneficiaries of their sponsorships include students, professionals, entrepreneurs, small businesses, and community organizations. Their mission is to promote the positive impact of technology on society through grants and other funding options.

The TDF Foundation's impact includes supporting academic research at top universities, providing free internet to community centers and housing units in low-income areas, building computer labs, and providing high-speed internet and computer literacy programs to underserved communities. Locally, the Foundation partners with computer education company General Assembly to sponsor the D.C. Innovation Opportunity Program. This program provides training workshops in Web Development and User Experience Design to high-potential, low-income individuals looking to advance their career skills. The Foundation offers five full-tuition scholarships to cover longer training programs, mentorship, and paid apprenticeships with companies such as Microsoft, Capital One, and Medstar.

The quantum engineering research of Professors **Edo Waks** and **Mohammad Hafezi** helped establish TDF's partnership with ECE, since TDF Ventures has identified quantum technologies as an area of growth.

"Quantum computing may be one of the most transformative technologies of the next decade. We're excited to support and work with one of the country's most forward-thinking academic programs in quantum," says **Jim Pastoriza**, Managing Partner of TDF. ■

STEER Tech

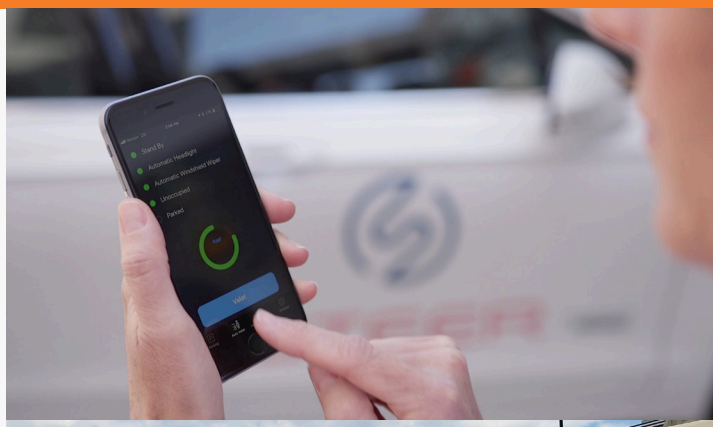
Have you ever become frustrated looking for a parking space in a busy parking lot? Have you ever been late to a movie or a meeting because you spent too much time searching for a space? You are not alone. The average person spends about 107 hours a year searching for parking. It leads to unnecessary stress, inconvenience, and a waste of time and gas. **STEER Tech**, a UMD alumni-led company, has created the perfect solution to these problems.

STEER Tech, based in Columbia, Maryland, has developed a computer-assisted driving device that can be retrofitted to any standard car produced after 2012. This technology can convert an ordinary vehicle into a fully autonomous driverless parking vehicle that can be controlled through a mobile phone app. Here is how it works: Once the technology is installed, drivers can pull up to a location—whether it's their place of work, a restaurant, or a commuter parking lot—and, if the location is a STEER partner, drivers get out of the car at the designated drop-off location, then pull up the STEER app to instruct the car to go park itself. When they are ready to leave, they summon the car via the mobile app. The car can even detect pedestrians and street signs, follow the road and know where to turn, and where to search for parking.

The company has also secured their first U.S. contract. The Merriweather District Project in downtown Columbia will feature the first STEER parking lots in the country. This development project features 391 acres of residential, commercial, retail, and parks. STEER's technology will be available to the tenants, residents, and visitors. The self-parking technology will also be available at the Baltimore-Washington International airport in the future, and then other parts of the country, as part of a national growth strategy. The company has stressed that it is fully focused on self-parking cars and does not currently have plans to branch out to fully-autonomous cars. They already have a waitlist of 500+ people to purchase the kit, which will be released mid-2019.

Dr. **Anuja Sonalker**, founder and CEO of STEER Tech, earned her Ph.D. in Electrical Engineering from the University of Maryland in 2007. Before founding her own company, she achieved advances in cybersecurity as Vice President of Engineering and Operations for TowerSec. Prior to joining TowerSec, she worked for Battelle's Automotive Security Cyber Innovation Group. here, she co-authored two patents: "Temporal anomaly detection on automotive networks" and "Anomaly detection for vehicular networks for intrusion and malfunction detection." In addition, Dr. Sonalker serves as a mentor to young women and high-school students in helping them develop career aspirations in engineering.

STEER Tech became a member of the ECE Corporate Affiliates Program in fall 2017. Most recently, the company has supported ECE Ph.D. Fellow Bohan Wang, who graduated in spring 2018 and will be joining STEER full-time this fall. STEER hopes to continue the partnership with ECE and the A. James Clark School of Engineering through the 2018-2019 school year supporting recruitment events and student research. For more information on the company, or to sign up for an advance kit, go to www.steer-tech.com. ■



Celebrating the Largest Investment in UMD History

New scholarships for incoming and transfer students that increase college affordability and access. Graduate fellowships and expanded scholarships for generations of promising University of Maryland students. Funding to recruit high-level faculty across campus who will pursue research opening new frontiers. New facilities that will cement the A. James Clark School of Engineering's stature among the world's finest.

This is what an unprecedented new investment of $219,486,000 from the A. James & Alice B. Clark Foundation, announced October 4, 2017 will do to transform the university.

The largest gift ever given to a Washington metro area public institution, Building Together: An Investment for Maryland celebrates the legacy of the late A. James Clark '50, noted philanthropist and a builder of modern Washington, D.C., and his belief in the power of education. ■

Building Together: An Investment for Maryland Programs

Photo: John T. Consoli and Danielle Tarr

- **The Clark Challenge for Maryland Promise:** Gifts from other donors in support of this new program will provide need-based scholarships to hundreds of students every year from all majors. If fully matched, this program aims to generate a $100 million fund to support students with financial need.
- **A. James Clark Scholars Program:** A new program providing scholarships to 40 high-performing engineering undergraduates. Reflecting the Clarks' commitment to the local community, priority will be given to in-state students.
- **Clark Opportunity Transfer Scholars Program:** The endowment of a pilot program which will provide need-based scholarships to 40 engineering majors coming from Maryland community colleges.
- **Clark Distinguished Chairs:** The creation of eight faculty chairs for stellar engineering researchers that directly address engineering's most critical research areas, such as additive and advanced manufacturing, autonomy and robotics, and energy and sustainability.
- **Clark Leadership Chairs:** The establishment and endowment of five faculty chairs throughout the campus in interdisciplinary fields that are critical to the knowledge-based economy of the future, such as data analytics, neuroscience, virtual and augmented reality, and cybersecurity.
- **Clark Doctoral Fellows Program:** An endowment supporting 30 additional first-year doctoral fellowships, allowing the Clark school to increase research productivity and graduate more outstanding Ph.Ds every year.
- **New Engineering Building:** A new space that secures the university's stronghold in engineering innovation by helping recruit and retain world-class faculty and facilitating collaborations between disciplines with institutional and business partners.
- **IDEA Factory:** An expansion of the Clark School's signature Jeong H. Kim Engineering Building which will foster innovation with new cutting-edge labs, start-up space, and areas dedicated to cross-disciplinary research.
- **Mpact:** The 125th Anniversary Fearless Ideas Mpact Challenge is the A. James Clark School of Engineering's "moonshot" engineering program to spur innovative engineering research solutions. Commemorating the school's 125th Anniversary in 2019, this program provides funding for Clark School teams to develop solutions to engineering problems and innovations in engineering research that have the potential to improve the lives of millions of people. ■

Photo: Matthew Worden/Washingtonian

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The University of Maryland has launched a $1.5 billion campaign, Fearless Ideas: The Campaign for Maryland. The fundraising campaign—our most ambitious to-date—will focus on elevating and expanding the university's mission of service, enhancing our academic distinction and bolstering UMD's leading-edge research enterprise.

Fearless Ideas will support the university's future and continued ascent as a world-class public research university through: investments in our world-renowned faculty; support for innovative programs and capital projects; scholarships and innovative co-curricular programs for students; and expanded pioneering programs that amplify our impact as the state's flagship university and the nation's first Do Good campus.

For The Electrical and Computer Engineering Department that means: improve undergraduate teaching labs and facilities, increase funded research projects for all students, and attract outstanding faculty in innovative research areas.

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To learn how you can make a charitable contribution and have a measurable impact on the future of the Electrical and Computer Engineering Department, or to explore other options, contact Amanda Stein, ECE Director of External Relations.
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